Key Stage 4 Worksheet

# Podcast: Clean Energy: revolutionary research to generate, store and use renewable energy by chemist, Dr Ian Mabbett

From the series: Exploring Global Problems, by Swansea University

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## Introduction

- How we generate, store and use clean (renewable) energy.
- How engineers are making low-cost, printable solar panels that can be used in the developing world. (You can read more about the developing world, from the Royal Geographical Society, **here)**.
- How engineers and scientists at Swansea University are creating 'smart buildings' that make, store and distribute their own renewable energy, acting as 'energy hubs'.


**Listen to the podcast: www.swansea.ac.uk/research/podcasts/ian-mabbett/**

**Open file in your web browser to click on the links.**

## Background

**The SUNRISE project (read more about it here).**

In this podcast, Dr Ian Mabbett talks about his work with the **SUNRISE** project, which plans to revolutionise the use of solar power in India. In India, there are currently 300 million people without reliable access to electricity and there is a big, ongoing effort to solve this problem and provide continuous power. However, this will lead to a huge increase in energy usage. If the extra energy required was supplied by burning fossil fuels, vast amounts of carbon dioxide ($CO_2$) would be released into the atmosphere. Carbon dioxide is a Greenhouse gas and so contributes to global warming. This would, therefore, have an immense impact on the environment and on global climate.

# Background continued

**Tackling the UN Sustainable Development Goal – 'affordable and clean energy'**

Ian talks about us having the opportunity to 'leapfrog' the use of fossil fuels in countries like India and move straight into clean energy futures.

One of the most important ways in which the developed world can support poorer countries to develop is by helping them transition straight to renewable power generation, without first having to rely on fossil fuels. This means that developing countries can grow, without increasing their greenhouse gas emissions.

Using 'clean', renewable energy, such as solar power, could reduce the environmental impact of providing reliable energy in India, to an additional 300 million people.

The SUNRISE project aims to provide affordable, clean energy by:

- Developing new solar panel materials to generate, store and use solar energy, which can be built into new buildings.
- Developing 'printable' solar panels, which can be produced using similar methods to T-shirt printing. This would allow solar panels to be built locally in India.
- Bringing down the cost of making solar panels and making them more available to people across India.

**Discoveries from watching paint dry.**

Ian talks about his previous research into ways to dry paint faster, using **near-infrared (NIR)** light and how this led to the development of new types of solar panels. Infrared (IR) light is light with wavelengths of between 700 nanometres (nm) and 1 millimetre (mm). So infrared light waves are longer than the waves of visible light that we can see with our eyes. Light is made from particles, called photons, which contain energy. By researching how solar panel materials interact with and absorb photons, Ian and his research team developed a way to make printable solar panels. To do this the team painted a layer of special liquid onto the panel, when it dries it leaves a porous, spongey surface which can absorb photons and convert their energy into electrical energy. This happens by transferring the photon energy to electrons (small, negatively charged particles) within the material.

The team have even looked at using their new liquid to coat the steel used in buildings, so the buildings would generate and store solar electricity. This technology is already being used in a building at Swansea University.

**This is what the solar-powered building looks like.**

The building, Swansea University's Active Office and Classroom was a runner up in a sustainable building competition! You can read more about it here.

## Find out more about it

- **Find out more** about Swansea University's active classroom.
- Watch S4's 'Cells that Capture Light' lesson to find out how photovoltaic (PV) solar panels create electricity from light.
- **Watch this Ted Talk** on 'How to bring affordable, sustainable electricity to Africa'.
- **Try this BBC Bitesize** on different energy sources.
- **Read this NASA Climate** article on the causes of climate change.
- **Read more** about the SUNRISE project

## Questions

**Interactive: Click on box to start typing**

What is renewable energy?

All methods of energy production have advantages and disadvantages.

i. Name a greenhouse gas which is released when fossil fuels (coal, gas, oil) are burned to generate electricity.

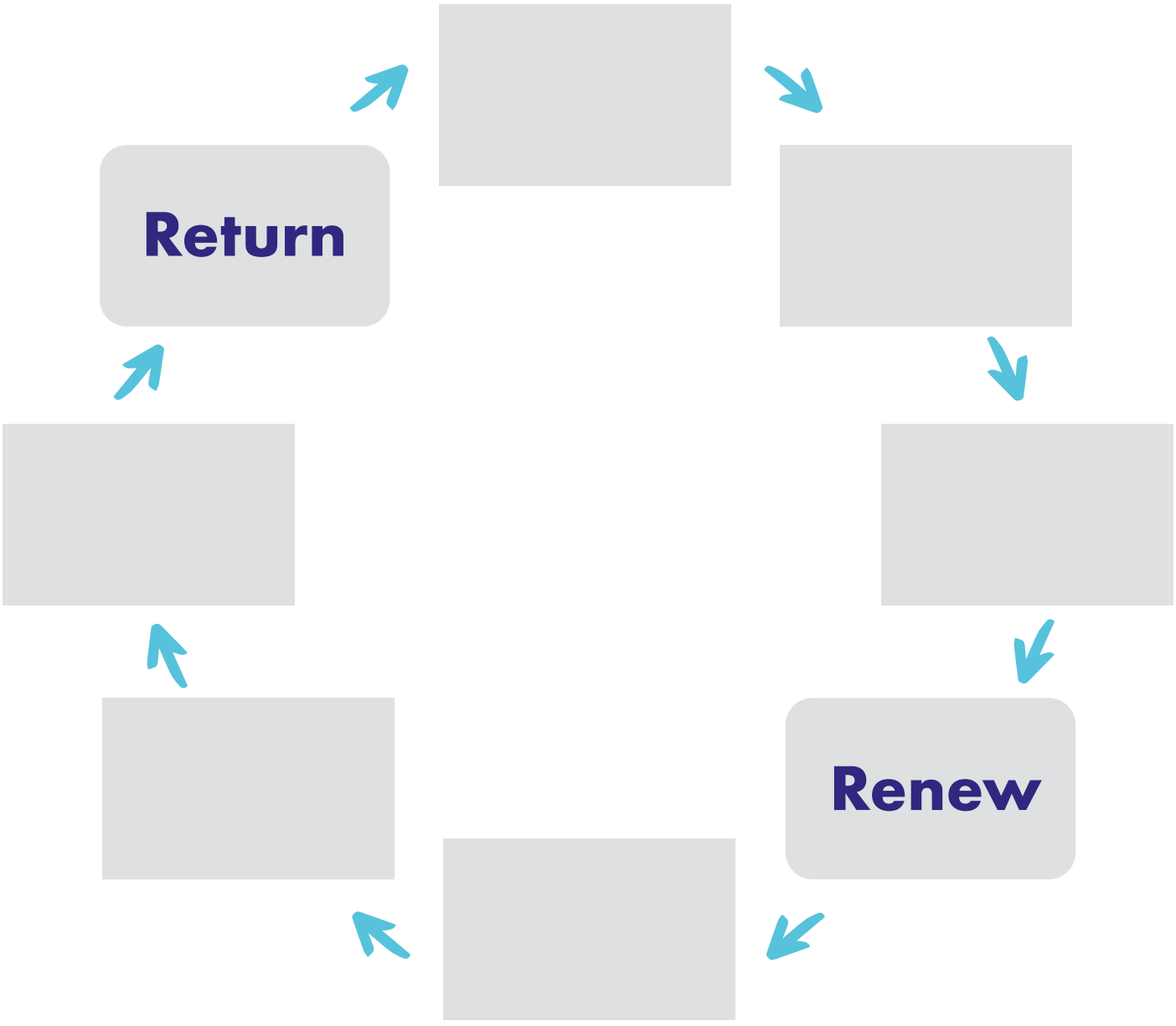
ii. Do photovoltaic solar panels produce electricity in all weather conditions?

iii. What are the advantages of using solar power?

Ian talks about the importance of considering a circular economy when designing products, such as solar panels.

i. What does he mean by 'circular economy'?

ii. Draw an example of what a circular economy cycle might look like for a product you own, maybe trainers, or jeans or your phone. There's a video explaining more about what the circular economy **here.**



## Exercise

**Background information:**

A typical rooftop photovoltaic (PV) solar panel:

- Has an average power output of 250W (watt) which is 0.25kW (kilowatt).
- Requires an area of 1.5m$^2$.

## Table 1

| Item | Power rating in Watts (W) |
|---|---|
| Fridge/freezer | 300 |
| TV | 350 |
| Kettle | 2,400 |
| Toaster | 1,000 |
| Mobile phone charger | 5 |
| Computer | 150 |
| Oven | 12,000 |
| Microwave | 800 |
| Games console | 100 |
| Shower | 9,000 |
| Light/lamp | 50 |

# Questions

Q1. A family wants to put photovoltaic solar panels on their rooftop and use them to produce all the energy for their home. They have made a list of their household electrical items and estimated how long they use them for, per day.

| Item | Time used per day, in hours (h) |
|---|---|
| Fridge/freezer | 24 |
| TV | 2 |
| Kettle | 0.2 |
| Toaster | 0.1 |
| 4 x Mobile phone chargers | 2.5 (each) |
| Computer | 1.5 |
| Oven | 1 |
| Microwave | 0.3 |
| Games console | 0.5 |
| Shower | 0.5 |
| 15 x Light/lamps | 2 (each) |

Use the information in Table 1 above (power ratings of household appliances) to calculate how much energy they use in total, per day (in kWh). The first example (the fridge/freezer has been calculated for you)

| Item | Energy used, in in kilowatt hours (kWh) |
|---|---|
| e.g. Fridge/freezer | e.g. 0.3 kW x 24 h = 7.2 kWh |
| TV | |
| Kettle | |
| Toaster | |
| 4 x Mobile phone chargers | |
| Computer | |
| Oven | |
| Microwave | |
| Games console | |
| Shower | |
| 15 x Light/lamps | |
| Total | |

Q2. How much energy is produced by one PV solar panel per day (assume the solar panel will receive an average of 5 hours of sunlight per day).

Q3. How many solar panels the family would need to put on their roof to supply all their household energy (round up to the nearest whole number)?

Q4. The family have only 36 $m^2$ available on their roof for the solar panels. Based on your answer to Questions 1 and 3, and the background information above, do they have enough space to fit all the panels they will need to supply all their household energy needs?

Q5. The solar panel system will cost £6,000 to install. After installation, how much will it cost for the family to produce electricity? Why?

Q6. The family currently spend £400 per year on electricity. If they were to install all the solar panels and use it to supply all of their electricity, how long would it take for them to start saving money?

**Useful equations:** **Energy = Power x Time**

**1 kW = 1,000 W**

Useful tip: Check all of your values have the right units! Power is measured in kW (kilowatts) and energy is measured in kWh (kilowatt hours).

## Bonus exercise!

Can you estimate the energy usage of your own household? How many solar panels would it take to power your house?

# For teachers and home schoolers

Links to Science in the National curriculum for Wales (KS4)

## GCSE Physics

- The advantages and disadvantages of renewable energy technologies (e.g. hydroelectric, wind power, wave power, tidal power, waste, crops, solar and wood) for generating electricity on a national scale using secondary information
- The advantages and disadvantages of non-renewable energy technologies (fossil fuels and nuclear) for generating electricity
- The cost effectiveness of introducing domestic solar and wind energy equipment, including fuel cost savings and payback time by using data
- The energy output from a renewable source

Swansea University Science for Schools Scheme

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UNDEB EWROPEAIDD EUROPEAN UNION
Llywodraeth Cymru Welsh Government
Cronfa Gymdeithasol Ewrop European Social Fund

(S4) Funded by the European Social Fund and the Welsh Government.