A4: EXPLORING ENERGY GENERATION

Overview

With a view to showing global leadership on renewables, the EU has set an ambitious, binding target of **32% for renewable energy sources** in the EU's energy mix by **2030.**

Current renewable energy levels in Europe were up to 18% of gross final consumption in 2018. This document also shows Ireland at 11.1% renewable energy share against a target of 16% in 2020.

This overall energy share target has sub targets for **electricity, transport and heat**. For Ireland, we have targets of 40%, 10% and 12% respectively for these. In 2018 we reached 33.2% renewable electricity share, 7.2% renewable energy transport share and 6.5% renewable heat energy share.

Over **97% of all the water on Earth is contained in the oceans**. However, it is saltwater, thus undrinkable for humans. Desalination might be the answer but this process is very energy intensive. Perhaps the fact that only **about 5% of the oceans have been explored** may be one of the reasons why the use of the ocean as a potential renewable source of energy is just beginning. Current research presently concentrates on harnessing tidal, and wave, energy. Both sources have their respective advantages and disadvantages. This section enables students to explore both of these energies – the advantages, disadvantages and ethical issues involved in developing each of these energies.

A4 ACTIVITY 1: FARADAY'S EUREKA MOMENT is an activity that introduces the students to the principle of electromagnetic induction and shows that electricity can be generated using a magnet and a coil of wire.

A4 ACTIVITY 2: WHAT MOVES? looks at how Faraday's principle is still being used in power plants to generate electricity.

In **A4 ACTIVITY 3: ENERGY FROM THE SEA**, students explore the emerging new technologies that use waves from the ocean to generate electricity.

Earth's non-renewable resources, particularly oil, are running out. Transport is one of the greatest consumers of energy, and currently relies predominantly on oil. **A4 ACTIVITY 4: EXPLORING ELECTRIC VEHICLES (EVS)** looks at an alternative transport programme being led by SEAI.

Suggested approaches:

- Ask the class to think about the following questions:

  ? ***What would a typical weekend be like if there was no electricity?***

  (Ask members of the class to tell you what they are doing this weekend. Point out all the ways in which it would be different without electricity.)

  ? ***How dependent are we on electricity?***

  The questions serve to highlight our **dependence** on electrical energy and to help students to understand how the issue of **renewable energy relates to them**.

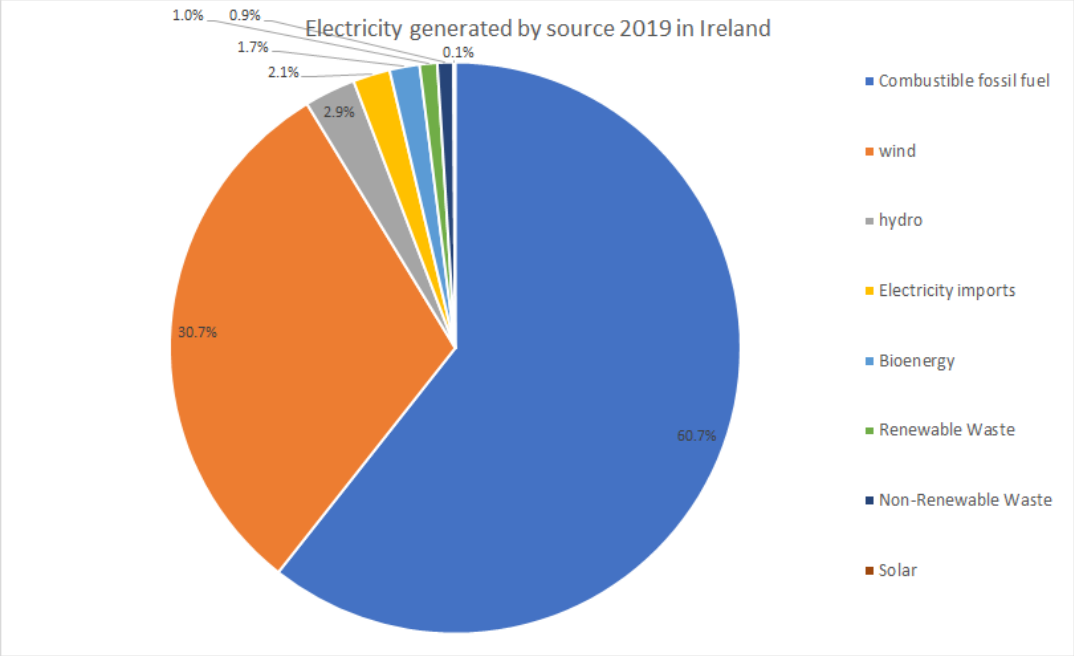
- Start by getting the students to list the various primary and secondary resources used to generate electricity. Then hand out the following, and ask the students to link the percentage of electricity generated (column A) to the sources that generate it (column B).

A: Percentage of Electricity	B: Generated by
6.5%	Hydro
60.7%	Wind
2.9%	Renewable and non renewable waste
1.7%	Combustible fossil fuels
0.1%	Bioenergy
30.7%	Solar

Source: SEAI EPSSU

When this is completed, show them the following chart.

A short discussion may take place comparing their results with those represented on the actual pie chart.



Source: SEAI EPSSU

A4 ACTIVITY 1: FARADAY'S EUREKA MOMENT

Background

In **1831 Michael Faraday** discovered that moving a magnet in and out of a coil of wire produced what he called a **wave of electricity**. He found that this **wave of electricity** only occurred as the magnet was moving in and out of the coil. This was a new discovery – electricity without the need for a battery!

Faraday had discovered the principle of **electromagnetic induction**, which is still the basis for generating electricity. The aim of this activity is for the students to replicate Faraday's original experiment in order to appreciate how ocean and tidal movements are used to generate energy.

Equipment required:

- Strong neodymium magnet
- Solenoid of at least 1,000 turns
- LED
- Crocodile clips and leads

What to do:

1. Connect the LED across the solenoid.
2. Quickly bring the neodymium towards the solenoid as shown.
3. Ask the class what they noticed about the LED.
4. Let the neodymium quickly slip through the solenoid and take note of the appearance of the LED.
5. Ask the class to identify when the LED lights up and what they conclude from their answer.

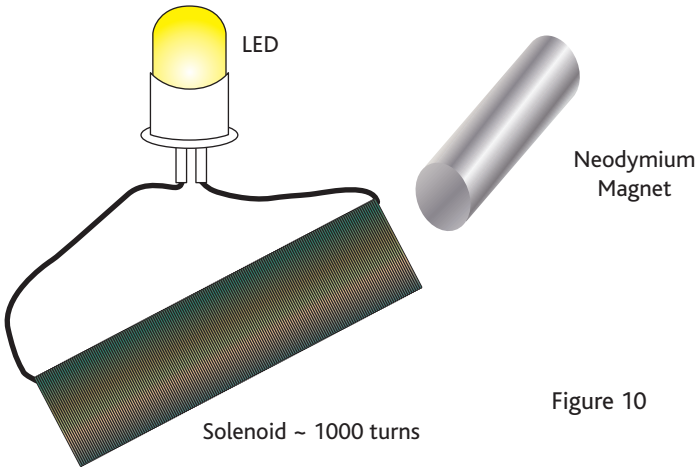


Figure 10

ALTERNATIVE ACTIVITY

Equipment required:

- Strong bar magnet or barrel neodymium magnet
- Galvanometer (an instrument that detects electric current)
- Insulated copper wire
- Cardboard tube
- Crocodile clips plus leads
- Sandpaper

What to do:

1. Wrap the wire around the cardboard tube to form a solenoid.
2. Scrape both ends of the wire clear using sandpaper.
3. Connect the solenoid to the galvanometer.
4. Quickly bring the magnet towards one end of the solenoid and observe the galvanometer.
5. Withdraw the magnet and observe the deflection of the galvanometer's needle.

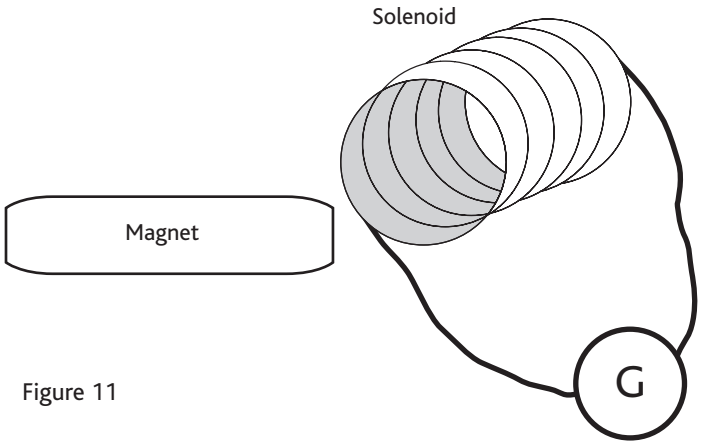


Figure 11

In your own words write a brief summary of the activity and explain why it is considered to be one of the most important experiments ever carried out.

A4 ACTIVITY 2: GENERATING ENERGY

Background

Faraday used the principle of **electromagnetic induction** to construct the **dynamo**, which could be considered the forerunner of modern power generators. The principle of **electromagnetic induction** is still fundamental to all energy generators. Having carried out Faraday's classic experiment the next step is to explore **how this principle is present** in many of the ways in which **primary** and **secondary sources** are used to address energy needs.

What to do:

1. Arrange the students into teams and assign each team one of the following electrical energy generators:
   a) Coal burning generators
   b) Natural gas burning generators
   c) Nuclear power plants
   d Wind farms
   e) Hydro power generators
2. In the case of each of the generators consider the following:
   - ***What primary source is used?***
   - ***Is the primary source freely available?***
   - ***If it is not freely available, is it available locally?***
   - ***If it is not available locally, from where can it be obtained?***
   - ***How is the primary source used to generate electricity?***
   - ***How are each of the following used to generate electricity?***
     i) Steam turbines
     ii) Gas combustion turbines
     iii) Water turbines
     iv) Wind turbines

- What environmental issues might be associated with your assigned generator? How are they addressed?

Each team will decide how to present their responses (e.g. poster, oral, PowerPoint presentation, pamphlet). Encourage them to be creative and imaginative.

A4 ACTIVITY 3: ENERGY FROM THE SEA

Background

As the non-renewable energy resources are dwindling, the demand for energy is increasing. Despite over 97% of the Earth being covered by water, using it as a primary source of energy has not really been exploited until now. **Ocean energy** is also referred to as **marine energy**. The movement of the oceans creates a vast store of kinetic energy – waves, tides, temperature differences – all of which can be used to generate electricity. The rhythmic nature of the oceans is more reliable for generating electricity than the unpredictable and random nature of wind.

Suggested approaches:

- Ask the students to compare the advantages of solar energy with those of wind energy. What might the disadvantages be – Is wind energy always available? How can it be used to generate electricity? What about solar energy, can we depend on it? What about the seasons? Could it be too hot for solar panels to work? (You might like to show this video to help the discussion https://www.youtube.com/watch?v=eiK3tcjJXiA). Do the advantages outweigh the disadvantages?
  This video is an excellent introduction to wave energy. See what SEAI are doing in relation to Ocean Energy in Ireland
- How many advantages can the students list for developing ocean energy? What is the source material? What might some of the disadvantages be? Are there any ethical issues to consider – for example, what about marine habitats? Which should have priority, our need for energy or marine life?
- The two sheets – **A4 ACTIVITY 3 (I) DISCUSSION POINTS: WIND VERSUS SUN** and **A4 ACTIVITY 3 (II) DISCUSSION POINTS: WHY GO TO THE SEA?** – could be used as guidelines for debating the issues, providing students with the opportunity to carry out their own research and then present their arguments.

Resources:

1. https://www.youtube.com/watch?v=Tsyx1qhzy08
   This short video describes how waves are created in the test laboratory at Cork University.
2. http://www.oceanenergyireland.com/Planning
   This is a short introduction to converting tidal power into electricity.
3. http://www.oceanenergyireland.com/TestFacility
   This site looks at the Atlantic Ocean as a power source.
4. http://www.oceanenergyireland.com
   This is a short video making the case for developing ocean energy.

A4 ACTIVITY 3 (I) DISCUSSION POINTS: WIND VERSUS SUN

1. Is wind energy always available?
2. Is it possible to predict how much energy the wind will generate in any given place at a given time?
3. Is energy lost in storage?
4. How can wind energy be used to generate electricity?
5. Can we depend on the quantity of energy generated by the sun in any given place?
6. Is it ever too dark for solar panels?
7. Is it ever too cold for solar panels?
8. Is it ever too hot for solar panels?
9. How can solar panels be used to generate electricity?
10. List some disadvantages of using wind energy.
11. List some advantages of using wind energy.
12. List some disadvantages of using solar energy.
13. List some advantages of using solar energy.
14. List some advantages of solar energy over wind energy.
15. List some advantages of wind energy over solar energy.
16. What is the role of ethics in research?

A4 ACTIVITY 3 (II) DISCUSSION POINTS: WHY GO TO THE SEA?

1. List some advantages for Europe in developing ocean energy.
2. List some advantages for Ireland in developing ocean energy.
3. Which energy sources are harnessed when using the ocean as an energy generator?
4. List some possible disadvantages of using the ocean to generate energy.
5. What is the role of ethics in research?
6. What effect could using the ocean have on marine habitats?
7. Our need for energy could compromise marine life — which should have priority?
8. What ethical issues might need to be considered before embarking on harnessing ocean energy?