**Chapter 2 – Defining energy**

***What is energy?***

**Chapter Overview**:

Human energy usage is so vital for our day-to-day functions in today’s world. Therefore, we must first define *energy*. Energy is an abstract term which is hard to define because there are many forms. The goal of this Chapter is to explore where energy comes from, describe how it is conserved, and provide interesting and exciting examples of its use in our world.

**Curriculum areas for key stage 2 in this chapter:**

physics, astronomy (history), digestive system, philosophy

**Essential questions:**

* What is the definition of energy?
* What are the different forms of energy?
* How is energy used?
* What is the difference between energy and electricity? (Is there a difference?)
* When did humans begin to understand energy as a concept?

**Enduring understandings:**

* Concretize the concept that energy is never created or destroyed, only transformed.
* Learning how energy is transferred through the formation of the universe as well as through the human body (food ingestion, digestion, and excretion)
* Electricity is one of the many different forms of energy

**Vocabulary:**

Energy, power, electricity, conservation of energy, heat, photon/light, property, citizen science

**Outline: Chapter 2a outline (total run time = 45 min)**

**Introduction (20 min)**

* Start by asking the students the question: *what is energy?* The expectation is that they will have trouble defining it but may have some ideas of what it is, or at least, give some examples (maybe related to movement or excitedness). It might be useful to write a list and save this for later.
* **Definition of energy:** *Energy is a property that is transferred from one object to another but is never created or destroyed – it can take on many different forms*
* **Definition of property:** *an attribute, quality or characteristic*. (curly hair example)

**Activity (25 min)**: - energy forms and eco-diary

Supplies needed may include\*: gears, a lightbulb or LED, balloons, magnets (needle and standard bar), baking soda/vinegar, bell

Circuit activity

Some of the forms of energy are (4 min at 3 of the activities circuit)\*:

1. mechanical – i.e. movement (pulling or pushing an object – or turning a gear or turbine)
2. gravitational (jumping up and down in different ways) motion  landing
3. thermal – (heat) (rubbing hands together) motion  heat
4. radiative (light) – lightbulb/LED electrical  radiative
5. electrical (electricity – static electricity with balloons) motion --> electrical
6. magnetic – have a magnet table; perhaps different types, like needle magnets displaying magnetic  motion.
7. chemical – baking soda and vinegar experiment. Chemical  sound/motion
8. sound – clapping or ringing a bell (motion  sound)

**Regroup!**

After they are finished, ask the students to assess themselves.

Movement (mechanical, heat) energy has been transferred into our bodies into thermal energy, causing our bodies to heat up emitting more energy and work harder.

Energy always has to go somewhere. How it is transferred depends on many different factors

\*these are just examples and will be based on classroom resources

**Outline: Chapter 2b – Energy on Earth outline (total run time = 50 min)**

**Introduction to the Energy Mapping Challenge (20 min)**

**Interactive:** Last time we learned that there are many different forms of energy. But how are these energy forms embedded into the world around us? There are lots of things on earth that are energetic: Things that are energetic possess a lot of energy to make things happen and can do a lot of work. In this lesson, we will first go through a few examples and then you will begin your own scientific investigation. In the UK, solar and wind energy are fast growing ways of generating electricity to power the things we do. More and more homes and businesses are being powered by energy from solar panels and wind turbines.

It is important to choose carefully *where* we put things like solar panels and wind turbines. **Have the students seen any examples of renewable energy in their local area?** *What and where?*

Now there is a big question for your class to answer: **Can the school be powered by energy from the sun and the wind?**

To find out, you are going to become scientists and will use special tools to measure the amount of sunlight and the speed of the wind, in your school playground. The experiment will be for 2 different students to go outside in the middle of each day and measure the sunlight with a **lux meter** and the wind speed with a **wind meter**.

This video explains how to do the experiments:

<https://energymap.oe.phy.cam.ac.uk/>

The **instruction booklet** outlines all of the details for the students to do their measurements. It would be great to have a printed copy for the pair of students to take outside each day.

The **data logging** document shows how to add data to the challenge website. It would be great to print and keep this by the computer for students to use when logging their data. Logging can be done as often as is convenient for the teacher!

**Questions to ask:**

* Do the students think that the school should be powered by solar panels **or** wind turbines **or** both? *Upload the data to the website to see how much energy you would get from the sun or wind.*
* Where are the **sunniest** and **windiest** spots in the school grounds?*Can the students find the best places to build solar panels or wind turbines?*
* Advanced: Can the students research how much it would cost to build solar panels or a windmill in their playground?

**Practicing outside (20 min exercise)**

**Scientific experiments**

Once the class has watched the video, take them outside to practice with the equipment. *Perhaps form lines so that each student gets a shot with the tools.*

From the video, here are some things that are important for the students to try for when they take their measurements:

Activities:

* *Finding the wind* - drop some grass, a leaf, look at the trees or anything else…
* *Testing the wind meter* - blow into the fan and what speed it reads. What happens if you run with it?
* *Finding the sun -* **Don’t look at the sun!** If the sun is out, use your shadow to find it. If the sun is not out, face the lux meter straight upwards.
* *Finding a location -* Are there shaded/sheltered areas of the playground? Would we want to put solar panels or wind turbines here? Why not?

**Energy mapping, eco-diary, online resources (10 min)**

**Interactive:** Go to the data-logging website here: [Primary School Energy Mapping Challenge](https://energymap.oe.phy.cam.ac.uk/data)

Here the students can see all the schools who are/have been participating in the challenge. They can compare their own data with others. Once the data is uploaded by the students it will remain there for the duration of term so that they can view the graphs as they accumulate more and more data points. Data should be collected for 4-8 weeks. After 2-4 weeks students will begin to appreciate the day-to-day variation in the data and can make real comparisons with other participants. They will begin to see whether they are generally receiving more power from the sun or from the wind.

**Regroup! Write in your eco-diary your response to the following questions:**

1. Would it be better to build solar panels or a wind turbine at my school?

2. Where around our school grounds should we build them?

3. On the map of the UK, where do the students expect will receive the most sunlight and wind? And why?

**Citizen Science example:** If there is time, show the students another example of Citizen Science. *Citizen Science* is the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists (just like the Energy Mapping Challenge!). From [this Nature article](https://www.nature.com/articles/d41586-019-02846-4) (2 min 40 s video)

Finally, met the creator of the ‘how many trees’ experiment, Thomas Crowther, our next Sustain/Ed Changemaker!

**BONUS ACTIVTY**

Use this Met Office resource to show sunshine data from the UK, for different months of the year [See slides for examples]: [UK actual and anomaly maps](https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps)

**What do the students notice about different regions? Can the students remember any months that had particularly good/bad weather last year?**

Use this resource to show the students live wind data from all over the world (*it is amazing*):

<https://earth.nullschool.net/>

**How does the wind look across the UK? Can the students find any storms anywhere on the globe? Explore some of the extra features in the lower left panel e.g. Ocean currents.** Slides are provided as a tutorial for using and interpreting the maps.

Students can be allowed to explore this final resource themselves on individual computers, as a homework exercise, or as groups.

**Data handling exercise** (extra time required):

Students are shown maps of a small storm in the north Pacific Ocean. Data of wind speed and wave height at different locations within the storm are provided. Using the templates provided, ask students to draw graphs of the wind speed and wave height inside the storm.

**Interpretation:** Can the students identify a relationship between the strength of the wind and the height of waves in the sea? Are there any anomalies in the data (things that stand out and perhaps don’t make sense)?

**Resources:**

* Information about renewables, for kids:

<https://archive.epa.gov/climatechange/kids/solutions/technologies/index.html>

* Instructional video: <https://energymap.oe.phy.cam.ac.uk/>
* Data logging page: [Primary School Energy Mapping Challenge](https://energymap.oe.phy.cam.ac.uk/data)
* UK sunshine and weather data: [UK actual and anomaly maps](https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps)
* Interactive worldwide weather data: <https://earth.nullschool.net/>

**Chapter 2c outline (total run time = 45 min)**

**Energy transfer examples: astronomy and food digestion (45 min):** **Review:** ask the students to recall the definition of energy: *Energy is a property that is transferred from one object to another but is never created or destroyed – it can take on many different forms.* (5 min)

Go over two tangible examples of how energy transfer works:

1. Astronomy: When we look up the sky (night or day) what are some things that we see? Stars, planets, the sun, the moon. How did these objects get there? Were they “created”?

We have used a lot of telescopes that have helped us figure out how the formation the Earth/Moon/Stars/Sun were formed. We are stardust – but what does that mean? A large star died and exploded, release a lot of energy, more energy than we can imagine, throwing off elements and overtime the mechanical energy is transfer into gravitational energy and elements are pulled together.

Where did the original energy come from? The leading theory is called The Big Bang. This is still an ongoing field of research and scientists do not know what came before the Big Bang. Imagine: all the universe’s energy in one speck, this speck exploded and distributed matter, gasses, etc which eventually formed into galaxies, stars, planets, and more.

Leave time for a nice discussion/questions here.

\*Optional showing of solar system formation via this YouTube video: <https://youtu.be/x1QTc5YeO6w> [6 min]

1. The digestive system and food energy (chemical energy):
   1. Highly recommend showing this fun video (4 min); https://www.youtube.com/watch?v=RPAien1dbEQ&ab\_channel=OperationOuch

Now, with these two examples in mind, refocus the discussion on *how* people were obtaining access to energy – via the grid.

What’s the difference between energy and power?

**energy:** a property that is transferred from one object to another but is never created or destroyed – it can take on many different forms

**power:** amount of energy used / time (energy/sec, energy/hour...)

**Teacher survey:** [FORM HERE](https://forms.office.com/r/weLJL91zi9)

Reference:

1. Solar system formation: https://www.youtube.com/watch?v=x1QTc5YeO6w&ab\_channel=TDC
2. Food: <https://www.youtube.com/watch?v=AA0QMn9VfoE&ab_channel=WhatsUpDude>