**Power Units and smart power: Chapter 4**

***How much energy do we really need?***

**Chapter Overview**:

This chapter will focus on the energy that we use in our day-to-day lives and how we keep track of this. The class will be introduced to scientific units and think about how these are useful to us. Students will calculate how much power is used in real-world activities. They will also think about what it means for appliances to be efficient and inefficient. Finally, students will discover how computers can help us to use energy in smart ways. [*Leading into Renewable Energy: Chapter 5*].

**Topics:**

**Physics, Maths, Computing, Technology**

**Essential Questions:**

* What is a measurement unit?
* How **much** energy do we use day-to-day?
* What does it mean when something is energy efficient?
* Can computers help us be smart with energy?

**Enduring Understandings:**

* Units help us all describe things in a simple and common way
* We can use units to show how much energy or power we use
* Things that are inefficient, waste energy
* Computers can help save energy and money

**Vocabulary:**

units, energy, power, watts, efficient, inefficient, waste, smart

**Chapter 4a – Power units**

**00 min - 30 min (Intro + discussion + activity)**

**Interactive:** Start with a question: **How far is it from Manchester to London? What is the distance?**

Once students have guessed, reveal the answer in miles **[200 miles]**. *Was anyone close?* Now ask why we measure the distance using *miles* or *kilometres*? We could have said the distance is **1 Wales** or **2 million carrots**, but we didn’t because we measure distances in miles/kilometres/centimetres/millimetres/inches… These are the **units** we have chosen to describe distances. If everyone knows how big each unit is, then we don’t get confused when measuring things.

Also: Why do we think in miles, while some countries use kilometres? [see slides]

It is perfectly ok to use both units. More and more countries now use kilometres to describe distances because they can easily be broken down into smaller units like (1000) metres, centimetres and millimetres (**the metric system**). Miles are broken down into strange amounts of units like (1760) yards and (5280) feet (**the Imperial system**).

Throughout history, people have used lots of different units to measure things. The Romans used lengths like a **finger**, **foot** and **stadium** to measure distance.

*Ask children to tell you why they think this is the case?*

Another fun distance is the *peninkulma* – 10 km in Finland – The distance a barking dog can be heard in still air - <https://www.haggardhawks.com/post/peninkulma> (*peni* means dog, *kuulua* means audible). Let the students debate how far this might be, before revealing the answer on the slides.

In ancient Egypt, *volumes* of things like water were measured in numbers of **jars**, **barrels** and **sacks** instead of the things we use today like litres, milliliters and pints. That is because these were the common implements used when trading food, drink and material. It was convenient!

**Activity: As you have seen, anything can be used as a unit.** But some units are better than others! A good unit is one which is descriptive, a sensible size and easy to understand and remember.

In pairs, ask the students to come up with a way of describing the length of the school playground with a **new unit** that they will make up themselves. E.g. “The playground is 100 dogs long” or “The playground is 500 bananas long”.

*Ask the students to justify why their new distance unit should be used on things like road signs and maps? Are their units* ***unique****,* ***easy*** *to use,* ***fun****,* ***memorable****, …*

**Interactive: (optional) Combining units**

Ask the students if they know any other units of measurement.

**What units do we use for time? What about speed?**

Were *miles-per-hour* mentioned? **[see slides]**

Explain that since speed is the amount of distance we travel in a given time, its unit is a known distance travelled (**number of miles**) in a known time (**an hour**). This is the easiest way of describing the speed that things travel in everyday life.

Would it be better to measure speed in *carrots-per-blink*?

**30 min - 60 min (Discussion + activity)**

**Explanation:** **How much energy do you use…?**

So, we know some units of distance: *Miles, kilometres, metres, centimetres, millimetres*

And we know some units of time: *Years, days, hours, minutes, seconds*

We can also count (or *measure*) the amounts of **power** that we use, with units.

We measure the amount of power we use in **watts**.

The number of watts of power that something is using, tells us how much work it is doing every second.

The light on the ceiling of your classroom probably uses about 50 watts of power to light up your desks. *Does it give out a lot of light?*

The sun uses 300 trillion trillion watts of power (yep, you read that correctly) to light up our solar system… That would cover a lot of classrooms!

**Background information: Power** is the amount of energy units used in the passing of one time unit. If something uses a lot of energy every second, it is operating at high power. A **watt** is a unit of power. A **joule** is a unit of energy.

In fact, **one watt** it is the amount of power being used in a process that requires **one** **joule** of energy every second. If a process occurs with a power of **1 watt**, it uses **1 joule** of energy every **second**. 1 watt is the same as 1 joule-per-second.

**Interactive:** Our homes and appliances use more energy than you might expect, and much more than humans are capable of producing with our own bodies! Propose this question to the students: “*Can I power my own home with a bicycle?”.*

Listen to their initial thoughts of how this might work and how successful it might be.

Ask the students to fill in the blanks on the diagram which show forms of energy: from pedaling the bicycle, to electricity in the wires, to light leaving the lightbulb.

Watch this 4 minute video which answers our question: <https://www.youtube.com/watch?v=xbUxt2x4InE> (link in slides).

Are the students surprised at how much work the cyclist was doing and how little light was produced?

**Activity: Power hour**

Look at the table which shows how much power is used by household appliances. What do the students notice? Does the power rating of some appliances shock you? Are there any links between the appliances which use a lot of power?

* Objects which convert electricity to **heat** energy seem to require the most power! A lot of heat energy is required to raise the temperature of water very quickly, in our kettles and showers. Using a lot of energy in a short amount of time means they require a **high power.**
* Meanwhile, appliances such as a fridge operate over very long periods of time and constantly use a **low power** to carry out their duties.

**How much power?** Using the table on the previous slide, can you work out how much power your class would require allowing every pupil to have a TV on their desk? *Do you think your head teacher would be happy about this?*

Work out the exact amount by multiplying the number of pupils (e.g. 24) by the amount of power used by 1 television. *(24 x 125) = 3000 watts*

**If you had all of the TVs on at once, would they require more power than a kettle which is boiling water?** *Do the pupils find it surprising that boiling 1 kettle requires around as much power as a classroom full of TVs?*Boiling water is a process that requires a lot of energy.

**Final discussion**

Once we add up all the appliances that we use in our homes we find that we use **a lot** of power! It is important that humans use less power than we currently do. *Why?* Some important reasons include:

1. **To reduce carbon emissions**
2. **To conserve the environment and the air**
3. **To save money**

We will talk about the first 2 reasons in future lessons. The third is true because we pay for the amount of energy that we use in our home. If we often use appliances that require a lot of power then this can become expensive!

It is important to make our appliances as **efficient as possible.** That is, we want our appliances to do their jobs using the least amount of energy possible….

**Make a note in your eco-diary** about which appliances you use that might be using lots of power. Just small changes to how you use these can make a big impact over your lifetime. Write ONE idea about how you reduce your impact by using less power.

**Chapter 4b – Smart power**

**00 min - 25 min (Intro + activity)**

**Explanation:** Last time we found that we use a lot of energy in our daily lives. We also know that humans would like to use less energy in their homes, to save money and to protect the environment. By living **more sustainably** we can use and waste less energy, leading to benefits for the planet (**protecting the climate and environment**) and benefits for ourselves (**saving money**). We will explore these ideas in future chapters!

To begin saving energy, the first thing we would like to know is if our appliances are **efficient**.

**Activity: Efficient and inefficient robots**

*An interactive game that shows the benefits of things being* ***energy efficient.***

In groups of 4, students are asked to behave as robots whose job is to do a basic task (*e.g. write out the letters of the alphabet, count to 10 out loud, build a tower of blocks…* Choose something appropriate and inclusive for the group*)*

If the students want to be **efficient robots**, they will just do their task using very little time and energy!

Now, the students are going to become **inefficient robots** as they must introduce useless actions into their task. Each student in the group should have a different useless rule they must follow (e.g. *between writing each letter they must clap 3 times, between saying each number they must say the names of all their group members, between placing blocks on the tower they must stand up and walk around it…)*

Who in the group is finished firstand who is finished last(i.e. which task is the most and least efficient?) **Note: not comparing students’ ability, simply the time wasted on different useless tasks.**

*Written outcome*: Ask the students to write two sentences explaining the understanding of efficiency and inefficiency (they can use the designated spaces on their “outcomes” sheet).

**Efficiency:** To be efficientis to do useful workand waste little energy/power.

**Inefficiency:** To be inefficient is to waste a lot of energy on useless processes.

**Additional information:** When we send electrical energy to a lightbulb it converts this to light energy (useful output) and heat energy (useless output). An efficient lightbulb will release a lot of light energy and little energy will be wasted as heat (the classroom lights are probably fluorescent tubes which are quite efficient, as are modern LED lights and lights on our gadgets). An inefficient lightbulb will release a lot of heat which is useless energy in this case.

We want our electrical appliances to be efficient so that they can do their jobs without using too much electricity. We want cars to be efficient so that we can drive far without using too much petrol.

**25 min - 55 min (Discussion + activity)**

**Interactive: Smart energy use**

We would like our energy use to be more **efficient** to use and waste less energy, to save money and benefit the environment. Computers and technology can help us use energy in **smart** ways, to make things as efficient as possible.

* Firstly, technology such as **smart meters** can help us track how much energy we use. It can also tell us when we are using a lot. This might happen when we switch on a high-power appliance such as a kettle, electric shower, oven, …

*Ask the students what high-power appliance might be being switched on, making the smart meter glow red.*

* Take a look at the streetlights in this town (see slides). *What do you notice about where the lights are brightest?* Hint: can you spot the bike, the car and the people?

This town has **smart street lighting** which means the lights go dim when they are not needed (i.e. when no one is around). When they are dim, they use less power. On the streets around the bike, car and people, the lights brighten so that they can see and be seen. The lights are **smart** because they use motion sensors to detect if there is anyone around.

* Smart switches can help us control our appliances to make them use electricity in the most efficient way possible. **Sustain/Ed Changemaker - Yasser Khattak** from Maidstone, UK. [see slides]

**Activity: Smart school**

*Can you think of other smart ways to use technology to help save energy? Perhaps around your school?* Work in a group and draw a labelled diagram of your design to describe what it can do!

See the examples on the slides for inspiration…

*In your eco-diary:* Write down what idea your group came up with to

Teacher survey chapter 4: [FORM HERE](https://forms.office.com/r/weLJL91zi9)

**Resources:**

* Slides
* Can I power my home with a bicycle:

<https://www.youtube.com/watch?v=xbUxt2x4InE>

* List of power used by household appliances:

<https://www.cse.org.uk/advice/advice-and-support/how-much-electricity-am-i-using>