Royal Academy of Engineering

Employer Engagement Challenge

Net Zero Schools

How carbon efficient can your school be?

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

THIS IS ENGINEERING

Acknowledgement

The Royal Academy of Engineering thank Twynyrodyn Community School and Morgan Sindall Construction for developing this challenge resource.

They have helped to raise awareness of engineering among young people, improve STEM teaching in schools and create new career opportunities for STEM learners.

Morgan Sindall Construction

Morgan Sindall Construction is a UK based construction and regeneration company, specialising in carbon neutral projects across schools, office buildings, and residential housing.

In Wales, Morgan Sindall is involved in several large-scale infrastructure projects and is recognised for its strong commitment to sustainability. The company focuses on reducing carbon emissions throughout a project's lifecycle — from planning and construction to the maintenance phase – contributing positively to the local environment and economy.

What does 'carbon neutral' mean?

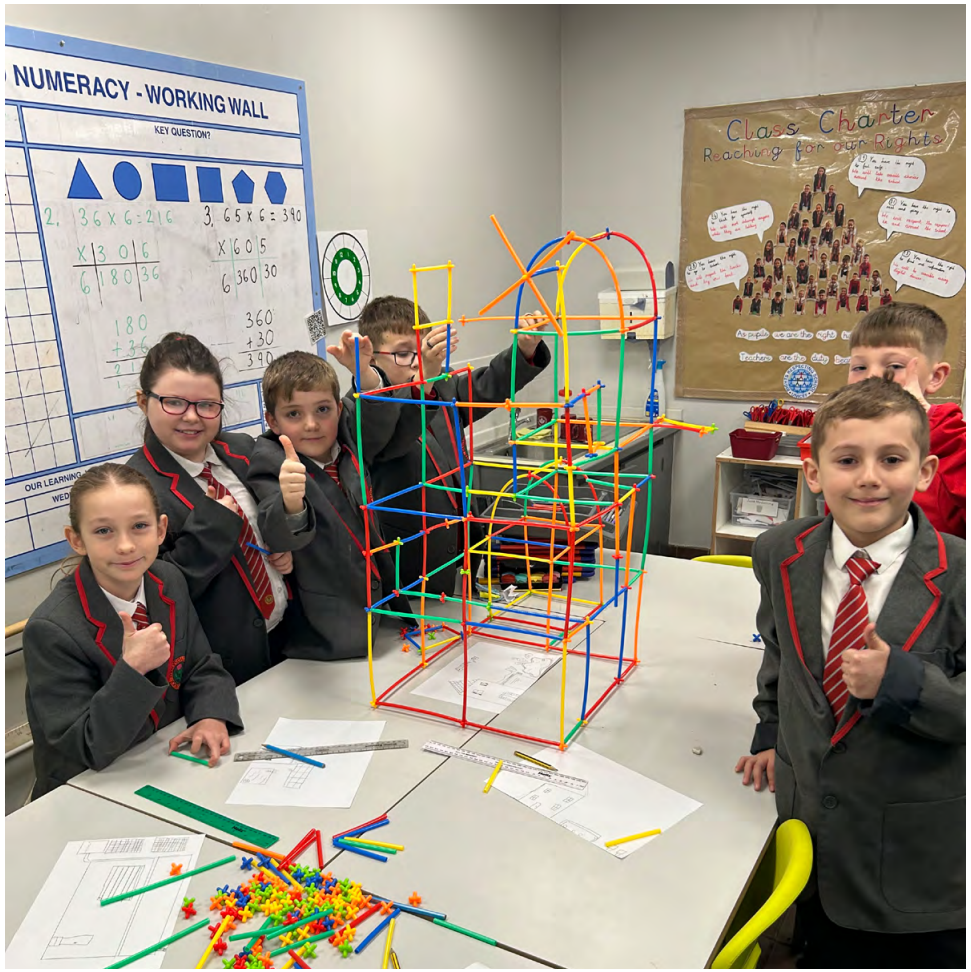
Carbon neutral, also known as Net Zero, refers to the practice of reducing harmful carbon dioxide (CO_2) emissions by offsetting them. This is achieved by removing or reducing an equivalent amount of CO_2 from the atmosphere, such as through tree planting or investing in renewable energy projects.

How carbon efficient can your school be?

This challenge focuses on identifying sources of CO_2 emissions in your school and finding ways to reduce them. Working in teams, pupils will rethink the school's infrastructure by designing and building new features that incorporate cleaner, renewable energy sources such as wind, solar, or hydroelectric power – while improving energy efficiency and adopting sustainable practices throughout the school day.

The goal is to reduce CO_2 emissions, achieve carbon efficiency, and create a more sustainable learning environment for everyone. Pupils will learn to think and act like engineers while exploring various roles in the engineering and sustainable construction industry.

This challenge has been designed for primary school pupils and can be adapted for different ages and abilities. At the end, teams will celebrate their outcomes and achievements by presenting what they have learned.



Here are some of the learning opportunities that the challenge provides:

- **Teamwork and collaboration**
- **Creativity and design**
- **Test and improve outcomes**
- **Project management**
- **Environmental awareness**

Challenge overview

Setting the class challenge

You have been set the challenge to redesign your school to use less energy and move towards net zero.

This means using less energy from wasteful sources and making your school a cleaner, greener place for everyone. In teams, you will investigate where your school's carbon emissions come from and come up with new ideas to reduce them.

You will get to redesign the school using clean energy sources such as solar panels, wind turbines, and hydroelectric power. You will also look at ways to save energy and make the school more eco-friendly.

During this challenge, you will:

- Find out how your school uses energy and what causes pollution.
- Learn about clean energy like solar, wind, and hydroelectric power — and how they could help your school.
- Think of ways to stop wasting energy, such as using natural light and heat, recycling more and making transport to school greener.

By participating in this challenge, young learners will develop the skills and practices that engineers use every day in their professional lives.

Asking questions, imagining and planning ideas, creating and refining outcomes, while continuously reflecting on how things could be improved, are all 'Engineering Habits of Mind', as demonstrated in the 'Progressing to be an Engineer' cycle.

The Progressing to be an Engineer cycle

Learning opportunities	Core skills
■ Teamwork and collaboration ■ Creativity and design ■ Test and improve outcomes ■ Project management ■ Environmental awareness	**Literacy:** research, writing, reporting, presenting, and communication. **Numeracy:** data collection, analysis, measurements, and calculation. **Scientific:** problem-solving, experimenting, and spatial awareness. **Technical:** systems thinking, problem-solving, communication, and teamwork.

Engineering design process		Activity	Success will look like
0–1 hour	Research the challenge	**Watch the introductory videos** **Time to think** – human impact on climate change	Understand the aims and requirements of the challenge, as well as how engineering concepts relate to it. Gather relevant information and have a clear and comprehensive understanding of the topics.
1–2 hours	Ask	**Time to play** – renewable resources interactive **Time to question** – systems thinking **Time to problem solve** – energy use in schools	Identify problems and ask questions to understand how to resolve them. Explain how systems work while identifying ways they can be improved.
2–4 hours	Imagine Plan	**Time to imagine** – design ideas for carbon efficient school features **Time to present** – showcase design ideas to the class **Time to plan** – team planning of 3D model build of chosen feature	Draw and label multiple design ideas, effectively communicating fitness for purpose and why certain ideas are better than others. Use simple annotated sketches to turn ideas into words and drawings. Plan a design that aims to solve a problem or task for a specific user, by transforming one idea in a better one.
4–6 hours	Create	**Time to create** – build a functioning model of the selected carbon efficient feature for the school	Use knowledge of how systems and components work and interact to create a product that achieves a specific purpose. Evaluate the product's fitness for purpose and look to find ways to improve this based on observation and improvement.
6–7 hours	Improve	**Time to reflect** – on experiences in relation to each stage of the challenge	Test for quality control using a logical approach gathering evidence to make an informed decision. Evaluate how the product is working, identifying areas for improvement and describe possible changes that can enhance the design.
7–8 hours	Present the challenge	**Time to raise awareness** – net zero social awareness campaign	Communicate ideas effectively and with confidence, making complex concepts understandable to the audience. Engaging interactions and making a lasting impression.

Research the challenge

Ask

Imagine

Plan

Create

Improve

Present the challenge

Time to start

1. **Start by showing** the class three introductory YouTube videos on climate change and the greenhouse effect.
2. **Access the videos** by following the link provided or scanning the QR code.
3. **Preview the videos** in advance to ensure they are appropriate for your pupils' age group and prior knowledge. You may choose to show all three or select the most relevant content for your class.

[Climate Change for Kids]

[Climate Change]

[What is the Greenhouse Effect?]

Time to think

Human impact on climate change

Guide a conversation towards how human activities contribute to climate change and speeds up global warming. Explain that our energy use and emissions release CO_2 into the atmosphere, which traps heat and causes the planet to warm up.

Use relatable examples to help students understand.

1. Driving cars burns fossil fuels, releasing CO_2.
2. Using electricity at home (lights, TV's, computers) often comes from power stations that burn fossil fuels.
3. Heating our homes with gas radiators also adds CO_2 to the air.

Encourage students to think critically by asking questions such as:

1. What happens if we keep adding more CO_2 to the atmosphere?
2. Can we use different types of energy that don't harm the planet?

Time to play

By the end of these first activities, pupils will be able to:

- Make informed decisions about the differences between renewable and non-renewable energy sources.
- Understand what energy is, where it comes from, and how reducing energy consumption is connected to climate change.
- Calculate how much energy they use each day and how much energy a school consumes.
- Think like systems engineers, understanding how interconnected systems work.

In pairs, ask pupils to identify renewable and non-renewable energy sources using the website link below or by scanning the QR code.

There are several games that can be played.

Then, have a class discussion about how they decided which sources were *renewable* and which were non-renewable.

Wordwall Interactive Games

https://wordwall.net/en-us/community/renewable-and-nonrenewable-resources

Time to research

Organise pupils into small groups and assign them the task of researching energy using the prompt questions.

Research can be done in different ways. Teachers decide the most suitable method based on their class's resources and needs.

Encourage pupils to take notes and prepare to share their findings with the class.

- What is energy?
- Where does energy come from?
- How is energy made?
- What is energy used for in schools?
- Why is it important to save energy?
- How could we save more energy?
- How is energy linked to climate change?

Time to problem solve

Calculate how much energy you use in a school day and then estimate the total energy required to teach 100 pupils every day.

Energy use in school

Calculate how much energy you use in a school day and then estimate the total energy required to teach 100 pupils every day.

1. Ask pupils to think about all the electrical devices and services they use in a school day.
   - Laptop or tablet
   - Classroom lights
   - Interactive whiteboard
   - Car to school in the morning
   - Heating or air conditioning
   - Charging a phone *(if allowed in school)*
   - Hot canteen lunch
   - Bus home after school
2. Choose at least **three** electrical devices / services and find out their **power rating in watts (W)** using the table below.
3. Estimate how long they use each device in a school day (in hours).
4. Use the formula to calculate the energy used in – watt/hours (Wh)

   Energy used = Power (W) × Time (hours)
5. Add up the total energy used for all the devices / services chosen.

Power Rating – Watts (W)			
Computer / laptop	50	Heating / Air conditioning	1000
Classroom lights	100	Phone charger	10
Interactive whiteboard	200	School canteen hot lunch	60
Electric car to school in the morning	500	Electric bus back home in the afternoon	750

Extension questions

Assume that all 100 pupils use similar devices in a school day.

Multiply the total energy use by 100 to estimate the energy used by 100 pupils in one day.

Scaling up

If your school operates 5 days a week, how much energy would be used in a school week?

How could the school reduce its energy use while still supporting learning?

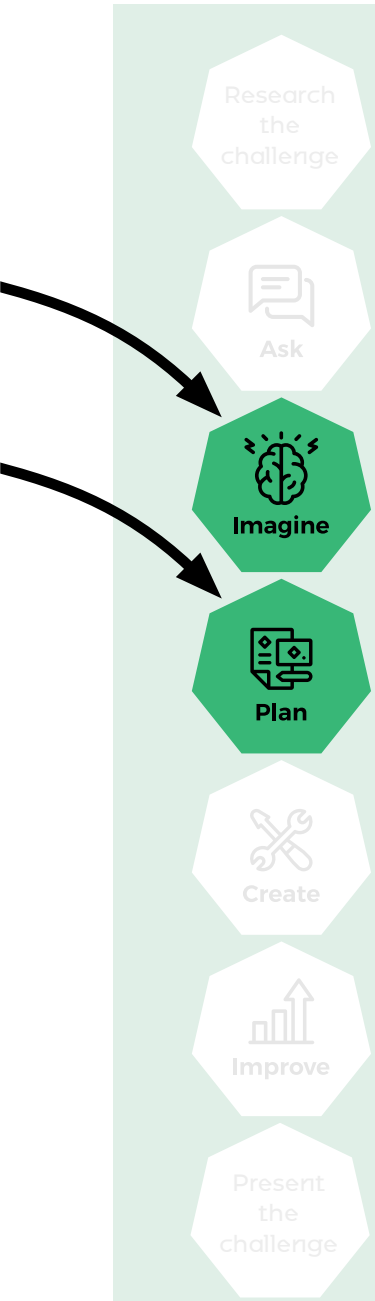
Time to question

Systems thinking is "explaining how things work together and why each part is there".

Ask pupils to discuss the following questions in groups, guiding and supporting them throughout their conversation.

Afterwards, encourage pupils to share and present their key points and ideas to the rest of the class.

Systems thinking questions	
1	How can we use less electricity in our school, such as for lights and computers, to help the planet?
2	What are our school buildings made of, and are there better materials we could use to help the environment?
3	How can we add more plants and trees to our school to make the air cleaner?
4	What are the best ways for pupils and teachers to travel to school without harming the environment?
5	If we change one thing to make our school greener, how might it change other things, like how we learn and play?



Time to imagine

The aim of this activity is to design and present ideas for new eco-friendly features that will help make the school carbon efficient.

In pairs, ask pupils to design two new infrastructure features that will contribute to a carbon neutral school. These can be either exterior and interior features, or a combination of both.

They can use what they have learned from previous activities to come up with ideas that make the school more energy efficient and environmentally friendly.

Things to think about

1. **Location** – where in the school will these ideas work best?
2. **Layout** – how will these features fit into the school's building footprint?
3. **Technology** – what equipment or systems are needed to make them work?
4. **Sustainability** – how will they help the school use less energy and reduce CO_2?

What to do

1. Sketch designs and label key features.
2. Use creativity and imagination to design a greener, more eco-friendly future for the school.
3. Make notes to explain how each idea works and why it will help the school.

Time to present

In pairs, ask pupils to present their ideas to the class.

In the next activity, they will be working in larger teams, so sharing ideas at this stage is important.

Encourage the class to ask questions after each presentation.

Time to plan

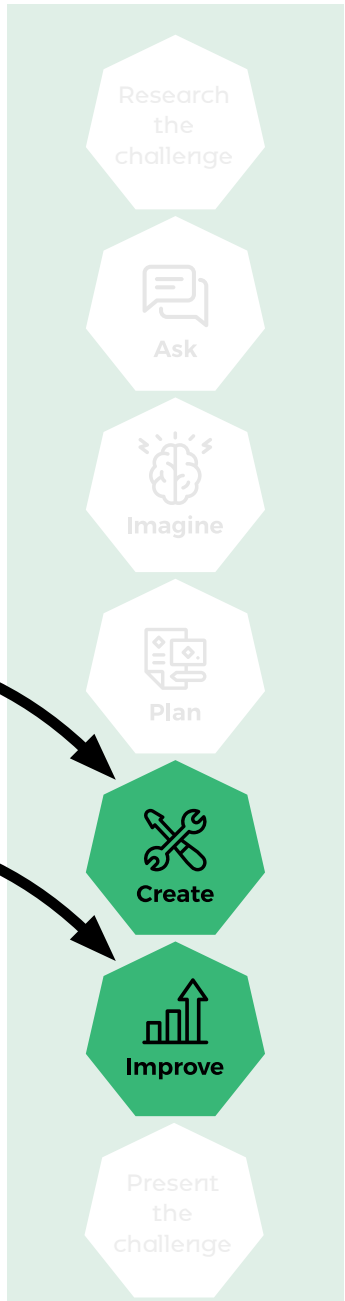
The aim of this activity is to plan each stage of building a 3D model feature for a carbon-efficient school.

Ask pupils to 'double up' and form a larger group of four. Each team should choose a specific infrastructure feature that can be incorporated into those built by other teams, creating a complete set of features that contribute to the whole-school net zero project.

Assign roles to each team or allow them to decide these themselves. Roles can be shared or reassigned during the building stage:

- **Designer** – ensures the construction of the team's feature follows the design specification.
- **Materials coordinator** – gathers materials and ensures they are cut to the correct size.
- **Assembler** – builds the carbon efficient feature and ensures it demonstrates its intended function.
- **Quality controller** – inspects each stage of the build and the final outcome to ensure it meets quality standards.

Planning as a group requires each team member to actively contribute and communicate their ideas while also being open to listening and considering the views of others.



Time to create

The aim of this activity is for pupils to work together to build a 3D eco-friendly feature for a carbon efficient school.

By the end of this activity, pupils will be able to:

- Work together in teams to design and create a 3D model of an eco-friendly feature for the school using recycled materials.
- Practice problem-solving, creativity, teamwork, and critical thinking.
- Get hands-on experience in planning, designing, and building models.
- Learn how each feature helps create a school that produces no carbon emissions.

Ask pupils to review their design ideas and collectively select one feature to focus on, such as solar-powered lighting or heating, a rainwater collection system, or a vertical garden.

Encourage teams to consider how they can incorporate recycled materials into their model building.

Provide guidance during their discussions to ensure the features are realistic and relevant to the school's needs.

Once the builds are complete, bring the teams and their 3D models together to review their collective efforts and experience what a carbon efficient school of the future could look like.

Materials

- A selection of recycled and repurposed materials – cardboard, paper rolls, old plastic bottles, fabric off-cuts, etc.
- Glue sticks, tape and scissors.
- Markers for decoration and design.
- Measuring tools – rulers, tape measure.
- Sketch paper and pencils for planning.

Time to reflect

Success can be based on the skills pupils develop and the practices they acquire throughout each stage of the challenge.

These include the ability to ask questions, imagine and plan ideas, create and refine outcomes, while continuously reflecting on how things could be improved.

Engineers also demonstrate the following practices as part of their day-to-day activities.

- Problem finding and creative problem-solving
- Systems thinking and visualising
- Adapting and improving
- Teamwork and collaboration
- Project and time management

At the end of the challenge, gather teams for a post-challenge debrief. Encourage them to reflect on their experiences and assess their personal growth in relation to the skills they have developed and practised throughout the challenge.

Time to raise awareness

The aim of this final activity is to create a persuasive campaign that raises awareness about the importance of schools becoming carbon neutral.

Working in teams, pupils will develop a social campaign to share what they have learned and showcase their collective outcomes. Their campaign should encourage schools to introduce a net zero policy.

This can be achieved in several ways, and collaboration with the English department in creating the campaign is encouraged:

- Write a letter to the local authority requesting funding for carbon-efficient projects such as solar panels, wind turbines, or bike sheds.
- Create an energy-saving booklet to be published on the school website and distributed at home with families.
- Establish an Energy Committee within the school to monitor classrooms, provide recommendations, and reward other year groups for their energy-saving efforts.
- Host a workshop for parents on reducing energy consumption when traveling to and from school.
- Partner with local businesses or environmental groups to gain insights, resources, or funding for sustainability initiatives.

Royal Academy of Engineering

The Royal Academy of Engineering is harnessing the power of engineering to build a sustainable society and an inclusive economy that works for everyone.

In collaboration with our Fellows and partners, we're growing talent and developing skills for the future, driving innovation and building global partnerships, and influencing policy and engaging the public.

Together we're working to tackle the greatest challenges of our age.

What we do

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We're growing talent by training, supporting, mentoring and funding the most talented and creative researchers, innovators and leaders from across the engineering profession.

We're developing skills for the future by identifying the challenges of an ever-changing world and developing the skills and approaches we need to build a resilient and diverse engineering profession.

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We're building global partnerships that bring the world's best engineers from industry, entrepreneurship and academia together to collaborate on creative innovations that address the greatest global challenges of our age.

Policy & engagement

We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

We're engaging the public by opening their eyes to the wonders of engineering and inspiring young people to become the next generation of engineers.

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