Royal Academy of Engineering

Employer Engagement Challenge

Offshore Renewable Energy

Can you design and build an offshore floating wind turbine using recycled materials?

Ariennir gan **Lywodraeth Cymru**
Funded by **Welsh Government**

THIS IS ENGINEERING

Acknowledgement

The Royal Academy of Engineering thank Blessed Carlo Acutis Catholic School (St. Illtyd's Campus) and ORE Catapult for developing this challenge resource.

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

ORE Catapult

Have you ever wondered how we use the power of the wind to generate electricity for our homes, schools and communities?

Or how we can create clean energy without harming the planet?

Engineers have been finding innovative ways to make wind energy more efficient and accessible for centuries – helping to shape a greener, and more sustainable future.

ORE Catapult is a research and innovation company that helps develop new ways to produce clean offshore renewable energy from wind, waves, and tides.

At Pembroke Dock in southwest Wales, they have a special centre called the Marine Energy Engineering Centre of Excellence (MEECE), where they work with universities and companies to create and test exciting new ideas for offshore renewable energy.

This challenge is all about designing and building a floating wind turbine – a structure that can generate electricity from the wind while floating on water. Pupils will work as a team to:

- Design their own floating wind turbine
- Build, test and improve design ideas
- Solve problems and think like engineers

Pupils will learn to think and act like engineers as they explore various roles in the engineering and energy industries and discover how renewable energy can help protect our planet

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 learnt.

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

Wind energy is one of the fastest growing sources of renewable power, and offshore wind farms play a key role in producing clean electricity.

But building a floating wind turbine at sea comes with challenges. Your wind turbine must be capable of generating energy while having minimal impact on the environment and local ecosystems.

- Can you and your team design and build a wind turbine using recyclable materials?
- How will you design a floating platform that is stable on water?
- What materials will you use to ensure your design is eco-friendly?
- And how will your turbine capture wind energy effectively and convert it into electricity, while not harming marine life?

This challenge will put your teamwork, creativity, and problem-solving skills to the test as you work like real engineers in the offshore energy industry.

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:** selective research. Presenting and communication. **Numeracy:** data collection and analysis. Pattern spotting. Measurements and calculation. **Scientific:** problem-solving and experimenting. Visual and special awareness. **Technical:** systems thinking and 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 play** – renewable resources interactive	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 challenge.
1–2 hours	Ask	**Time to research** – offshore floating wind turbines **Time to problem solve** – building and testing turbine blades and floating platforms **Time to questions** – systems thinking	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 a floating wind turbine **Time to present** – showcase design ideas to the class **Time to plan** – team planning for the build of a floating wind turbine	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 into a better one.
4–6 hours	Create	**Time to create** – build a functional floating wind turbine from recycled materials	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 the outcome for quality 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 present** – share the learning journey and highlight the successes of the challenge	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

Note to teachers

Before introducing this challenge to pupils, we recommend familiarising yourself with ORE Catapult and the engineering principles behind floating wind turbines and wind farms. This will help you guide discussions and support pupils in their design and problem-solving tasks.

To get started

Watch the video **A Guide to a Floating Offshore Wind Farm** on YouTube using the linked title or scanning the QR code. This video provides an engaging overview of how floating turbines on wind farms work.

Explore the **Floating Wind Farm Lifecycle**. This interactive overview takes you through the full journey of a floating wind farm, from development and manufacture of the turbine to assembly, operation, and decommissioning.

These web resources will help you and your pupils gain a deeper understanding of the real-world engineering behind offshore renewable energy and inspire creative solutions for their wind turbine designs.

Time to play

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

- Understand what offshore floating wind turbines are and how they generate electricity
- Explore different types of wind turbine
- Identify sources of renewable energy
- Discuss the benefits and challenges of renewable energy
- Present their findings in a creative way

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

Research the challenge

Ask

Imagine

Plan

Create

Improve

Present the challenge

Time to research

In small groups, ask pupils to research offshore floating wind turbines and prepare a short presentation. Their investigation should address the following prompt questions.

- **What** is an offshore wind turbine? What are the different types and how do they work?
- **Where** can we get renewable energy from? Compare wind power to other renewables.
- **Are there** benefits to renewable energy? Why is wind energy important?
- **What** are the barriers to renewable energy? What challenges do engineers face?
- **Why** do we need renewable energy? What happens if we don't use it?
- **Who** works with renewable energy? What jobs and skills are needed?

Time to problem solve

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

Work in teams to design, build and test:

1. Different types of wind turbine blades.
2. A stable floating platform capable of supporting a weight.
3. Explore how blade shape, size, and number (3, 4, or 5) affect energy generation by using a fan or hairdryer to simulate wind.
4. Observe and identify which shapes provide greater stability when a load is applied to the floating platform.

Make and testing turbine blades

1. Each team sketches at least two different blade designs to test.
2. Ask them to consider the blade shape (flat, curved, twisted), blade number (2, 3, 4 or more), and blade length and width.
3. Teams make their blades using the materials provided, attaching them to a central hub so they can rotate freely.
4. Secure the turbine model and place it in front of a fan or hairdryer at a fixed distance.
5. Observe and measure how fast the blades spin (use a stopwatch to count rotations per minute).

Research the challenge

Ask

Imagine

Plan

Create

Improve

Present the challenge

Building and testing a floating platform

TOP TIP: A weighted platform will float if the upward push of the water matches the weight of the water it pushes aside.

To make a platform float, its density must be the same as the water it displaces.

1. Each team sketches at least two different floating platform designs to test.
2. Ask them to consider the size and shape of the platform they will build and where the weight will be placed.
3. Teams then construct their platform using the materials provided and carefully add the weight while placing it in water.
4. Does the platform remain stable and afloat while holding the weight?
5. If not, identify the issue, then redesign, rebuild, and test again.

Materials

For both activities: cardboard, scissors and tape

Turbine blades

- Plastic bottles – for blades
- Straws, wooden skewers, or dowels – for blade supports
- Bottle caps, corks – to attach blades to a central hub
- Small motors – optional, if measuring energy output
- Hairdryer or electric fan – to create wind
- Stopwatch – to measure blade rotations per minute

Floating Platform

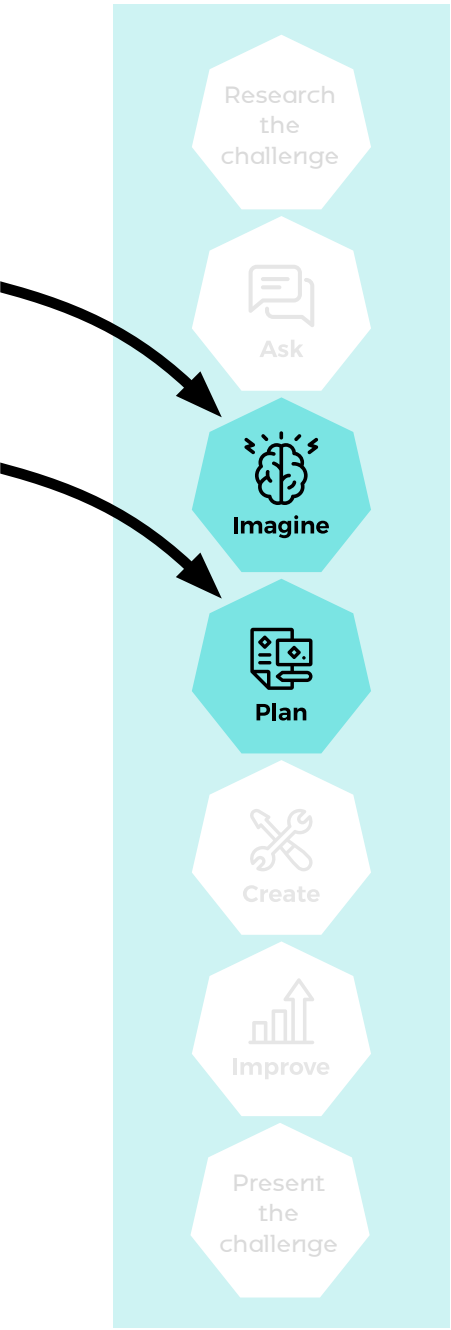
- Wax paper and rubber bands
- Foil and weights (250g)

Time to question

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

Discuss the following questions as a group and facilitate the conversations in class.

Systems thinking questions	
1	How will the different parts of your wind turbine (blades, tower and platform) work together to spin and stay floating on water?
2	How can you use materials that are strong and durable, but also good for the environment?
3	What things, like wind and waves, might make your turbine fall over or stop working, and how can you stop that from happening?
4	How can you test if your wind turbine works well, and what small changes could make it better?
5	If lots of people made wind turbines like yours, how could they help the planet and give people electricity?



Time to imagine

The aim of this activity is to work together to design and present ideas for a floating offshore wind turbine.

Divide the class into groups of four or five. Each team will design a wind turbine and floating platform based on what they have learned from previous activities.

Ask them to consider key factors such as the turbine's location, the wind farm layout, and the mechanics needed for the turbine blades to rotate. They should also take into account stability of the floating platform, energy output, environmental factors and sustainability.

First, the team should list their key requirements before drawing their design ideas.

Then, they can sketch their ideas and add notes, create diagrams, or use 3D CAD modelling to show the turbine structure, anchoring methods, and support such as cables and floating platform.

Time to present

Ask each group to present their floating wind turbine designs and manufacturing plans to the class.

They should explain how their turbine will be built, describe its structure, and justify their material choices based on suitability and environmental impact.

This should be a group task, with every team member contributing to the presentation in some way.

Encourage the class to ask questions after each presentation.

Time to plan

The aim of this activity is to plan each stage of building the floating wind turbine, with each team member focusing on a specific role.

Assign roles to each team or ask them to decide on these themselves. Roles can be "doubled up" or reassigned during the building stage.

- **Designer:** ensures the construction of the wind turbine follows the design specification.
- **Material coordinator:** gathers materials and ensures they are cut to the correct size.
- **Assembler:** builds the wind turbine 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.

Research the challenge

Ask

Imagine

Plan

Create

Improve

Present the challenge

Time to create

The aim of this activity is to build a floating wind turbine using recycled and repurposed materials.

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

1. Use what they have learnt about renewable energy and floating wind turbines to build a prototype (working model) using recycled and materials.
2. Work together as a team to build the turbine, with each team member taking on a specific role.
3. Test how well their floating wind turbine works, considering factors like stability, energy generation, and environmental impact.

Building the offshore floating wind turbine

Each team should consider the following before the building begins.

- Number of blades, shape and size.
- Size and shape of the floating platform.
- Placement of a motor which will act as a generator to convert mechanical to electrical energy.
- How the turbine will stay afloat and stable in the water.

Testing and refining

Once the turbine has been assembled, each team should test their outcome by placing it in a water basin to check if it floats and remains stable.

Use the fan or hairdryer to simulate wind and test how effectively the blades rotate and generate power.

Teams should adjust their designs as needed.

Materials

- Recycled and repurposed materials – cardboard, plastic bottles, straws, wood offcuts
- Small electric motor – for generating energy
- Small fan or hairdryer – to simulate wind
- Fishing line or string – for anchoring
- Craft tools – scissors, glue, tape, rulers
- Measuring cups or small weights – for testing weight capacity
- Paper, pens, and markers – for sketching designs and notes
- Water basin – to test floating functionality

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 for teams to showcase their floating wind turbine and present what they have learnt during the challenge.

This should be a group task where every member of the team contributes to the presentation in some way. The presentation can be divided into the following sections.

- A demonstration of the floating wind turbine and its features.
- What went well during the design and construction process.
- What challenges the team faced and how they overcame these.
- How could the outcome be improved?

Presentations can also be framed using the following stages of the engineering design cycle.

1. Research and investigation.
2. Design process.
3. Construction and testing.

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

Talent & diversity

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.

Innovation

We're driving innovation by investing in some of the country's most creative and exciting engineering ideas and businesses.

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.

Royal Academy of Engineering
Prince Philip House
3 Carlton House Terrace
London SW1Y 5DG

Tel: +44 (0)20 7766 0600
www.raeng.org.uk
Registered charity number 293074