Scottish Seabird Centre

SSC Dive In!

Marine Renewable Energy

In collaboration with

EMEC
THE EUROPEAN MARINE ENERGY CENTRE LTD

WELCOME!

Scottish Seabird Centre

Hello, and welcome to "SSC Dive In!" - packs of resources providing seaside fun directly into family homes and classrooms.

This pack's theme: Marine Renewable Energy

Burning fossil fuels such as oil, coal and natural gas for electricity has led to a build up of harmful gases in our atmosphere. Switching to **renewable sources** such as wind and solar power is better for the planet because they don't release greenhouse gases. Renewable sources also last forever, whilst fossil fuels will eventually run out if we continue to use them in large amounts.

Did you know ocean waves and tides are also sources of renewable energy? And some of the largest wind farms in the world are found offshore! Excitingly, Scotland is home to world-leading research and testing sites for new marine renewable technology. Find out more about this growing sector inside!

Inside this pack:

- **SSC Children's Blog: Why we need renewable energy**
- **Activity: Fill in the gaps**
- **Guest blog: EMEC**
- **Fact sheets: Wave, Tidal, and Wind Energy**
- **Discover: Marine Renewables—Pros & Cons**
- **Discover: Developments in the Firth of Forth**
- **Craft instructions: Build your own turbine**

Important note: *If you are going outdoors, please follow the social distancing protocols and government advice.*

We'd love to hear from you! If you've had fun having a go at activities, experiments and crafts, let us know. Any comments or pictures you are happy for us to share and have permission for can be sent to marineengagement@seabird.org. More resources available on our website.

Enjoy using our packs and want to see more? The Scottish Seabird Centre is an environmental education and conservation charity. Every penny we raise helps us deliver our important conservation and education work. If you enjoy using our resources and would like to support our work, please consider making a donation through our JustGiving page. Thank you.

We hope you enjoy diving in to the pack!

Scottish Seabird Centre Learning Team

The Scottish Seabird Centre would like to thank the European Marine Energy Centre (EMEC) for their kind contributions to this pack.

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Discover more about their work here:

emec.org.uk • blog • twitter • youtube • facebook

BLOG

Scottish Seabird Centre

WHY WE NEED RENEWABLE ENERGY

Have you ever struggled to walk into a strong wind? Or noticed how powerful crashing waves can be at the seaside?

There is energy in nature – in the wind, in the ocean, in sunlight and in the heat that exists below the surface of the earth. The great thing about energy from these natural sources is that they are **renewable**. This means that they are always available and will not run out. People can make use of these sources of energy to generate power to heat and light our homes, run factories, keep transport moving and much more.

Over the past few centuries, **non-renewable** sources of energy such as coal, oil and gas have been the main source of energy. We have come to learn that these non-renewable energy sources have huge disadvantages. Firstly, they are limited in supply and will eventually run out. Also, energy sources such as coal and oil harm our planet because burning them creates pollution and **carbon dioxide** – a gas that contributes to **global warming**. The warming of our planet at an unnatural rate is a threat to every living thing, both on land and in the ocean.

Developing renewable alternatives is vital so we can keep generating the energy we need while minimising environmental impact. Scotland is well suited to the generation of the renewable energy. With over **18,000 kilometres of coastline**, there is great potential for wave and tidal energy. Our windy weather offers the opportunity to harness the power of the wind. Plus, the mountains, rivers and lochs here create opportunities for hydroelectric power (generating electricity from flowing water).

Around 2,000 years ago humans were using the wind to drive windmills that ground grain and pumped water out of the ground. Huge advances in technology since then make it possible to use natural energy sources more widely and efficiently. The growth of renewable energy can be seen all around us. Look out for **solar panels** on the roofs of houses and other buildings. These turn sunlight into electricity. See if you can spot **wind turbines** on hills or next to farms. The movement of the wind causes their blades to spin, transferring energy to a generator where it can be converted into electricity. In the future, renewable energy could become the only energy source powering our world – helping to protect the planet and keep our wildlife healthy.

Know your renewables

Find out how much you have learned by answering the following questions:

1. Can you name 3 sources of renewable energy?
2. What makes Scotland a good place to generate renewable energy?
3. Why is renewable energy important to the future of our planet?

ACTIVITY

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FILL IN THE GAPS

Use the words in the box below to complete the paragraphs on energy sources.

Fossil Fuels

Fossil fuels were created over millions of _____from the remains of ancient plants and_____. The main fossil fuels are coal, _____ and natural gas.

We burn fossil fuels for electricity, heating and to drive our _____ . If we continue to use lots of fossil fuels they will eventually run out. When we _____ fossil fuels they release greenhouse _____ into the air, such as _____. These have built up in the atmosphere and caused the planet to heat up. This is called _____.

To stop things getting worse we need to find other ways of producing energy.

Renewable energy

An alternative way of getting energy is from _____ sources. These sources will never run out and don't release harmful gases into the environment.

The main renewable energy sources are _____ power, tidal power, wave power, hydroelectric (dams) and solar power.

cars	**animals**	**renewable**	
carbon dioxide	**years**	**oil**	**gases**
burn	**global warming**	**wind**	

Have you put the words in the right places? Take a look at the answer page to find out!

ANSWERS

FILL IN THE GAPS

Fossil Fuels

Fossil fuels were created over millions of _____**years**_____ from the remains of ancient plants and _____**animals**_____. The main fossil fuels are coal, _____**oil**_____and natural gas.

We burn fossil fuels for electricity, heating and to drive our_____**cars**_____. If we continue to use lots of fossil fuels they will eventually run out. When we _____**burn**_____ fossil fuels they release greenhouse ____**gases**_____ into the air, such as __**carbon dioxide**__. These have built up in the atmosphere and caused the planet to heat up. This is called ___**global warming**_____.

To stop things getting worse we need to find other ways of producing energy.

Renewable energy

An alternative way of getting energy is from ____**renewable**_____sources. These sources will never run out and don't release harmful gases into the environment.

The main renewable energy sources are _____**wind**_____ power, tidal power, wave power, hydroelectric (dams) and solar power.

cars	**animals**	**renewable**	
carbon dioxide	**years**	**oil**	**gases**
burn	**global warming**	**wind**	

FACTFILE

Wave Energy

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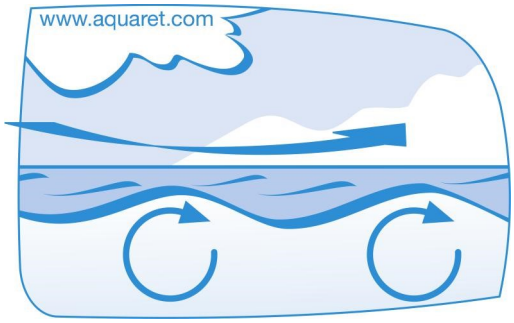
How are waves formed?

Waves are formed by winds blowing over the surface of the sea. The size of waves depends on:

- Strength of the wind—its speed, how long it blows, and how far it travels over the sea
- Depth of the sea
- Currents



The biggest waves occur in areas where strong winds have travelled over long distances. The best waves in Scotland occur along the West coastline because they have been travelling for thousands of miles across the Atlantic Ocean.

How is energy collected from waves?

The moving water in waves carries **kinetic energy** which can be captured and converted into electricity by special devices called **wave energy converters** (WECs). Different designs are being developed around the world. Some sit on the surface, like 'The Penguin' in the photo, whilst others are suspended below the water. See an animation of 'The Penguin' in action here.

Photo: 'The Penguin' WEC © Wello.

Where is wave energy being produced?

The development of wave energy is still at an early stage, with lots of different concepts in development. Trials of these technologies have taken place at EMEC.

FACTFILE

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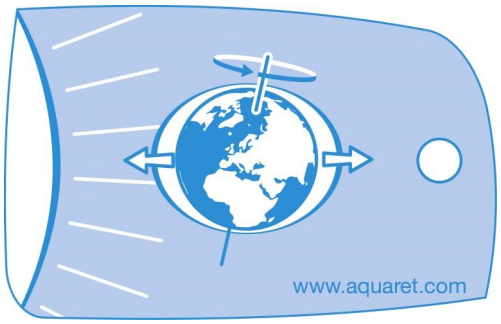
Tidal Energy

How are tides formed?

Tides are created by the **gravitational pull** of the moon and sun on the world's oceans. Gravity acts like a magnet, pulling water towards the moon and the sun, creating a slight bulge of water on one side of the planet and a drop in water level on the other. The bulge then moves around the earth as it spins and the position of the earth and moon changes.



Tides rise and fall twice a day, creating a current of water as it changes direction.

How is energy collected from tides?

Tidal stream technologies capture the **kinetic energy** from currents flowing in and out of the tidal areas and convert it to electricity.

There are lots of different designs, but generally they work like underwater wind turbines—blades under the water generate electricity when moved by currents. Some technologies float on the surface (like the Orbital device pictured below) or some sit on the sea floor.

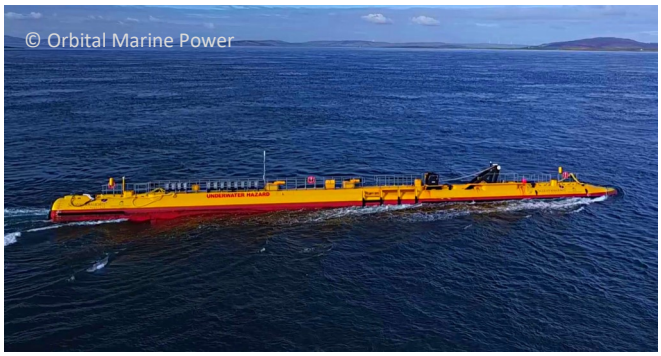
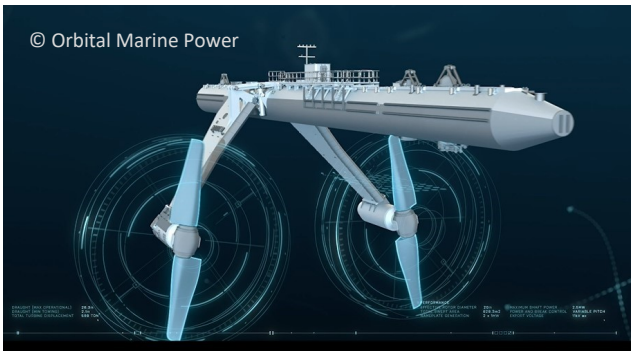


Photo: Orbital Marine Power's SR2000 tidal turbine'



Animation of Orbital Marine Power's 2MW O2 tidal turbine

Where is tidal energy being produced?

MeyGen in the Pentland Firth, Scotland, was the world's first commercial tidal site. It currently has four turbines that produce energy into the grid (our national electricity supply). Previous versions of the turbines, which sit on the sea floor, were tested at EMEC.

There are plans to expand MeyGen, making it the largest planned tidal stream project in the world.

FACTFILE

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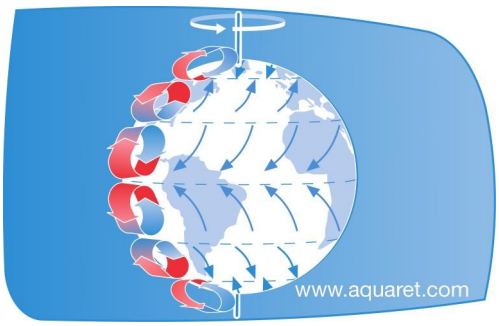
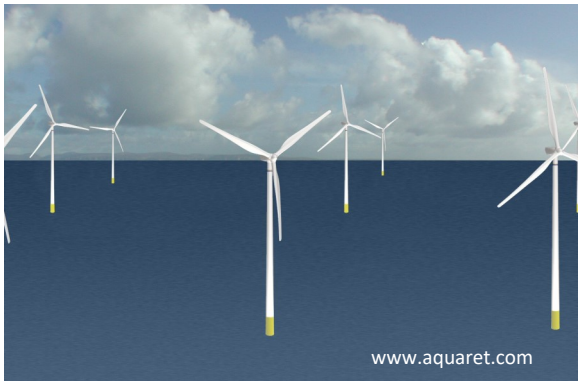
Offshore Wind Energy

How does wind form?

Wind is the movement of air across the planet. It is caused by changes in **atmospheric pressure** (the weight of air pressing down on the earth's surface).

Around the world, air is constantly rising and falling in the atmosphere, creating areas of low and high pressure. Winds occur when air at the surface rushes from an area of high pressure to low pressure.





How is energy collected from wind?

Wind turbines, or **wind energy converters**, are devices that convert **kinetic energy** in the wind to electricity. When lots of turbines are used to generate electricity in one place, it's called a **wind farm**. These windfarms can be constructed on land or at sea (known as offshore).

Where is offshore wind energy being produced?

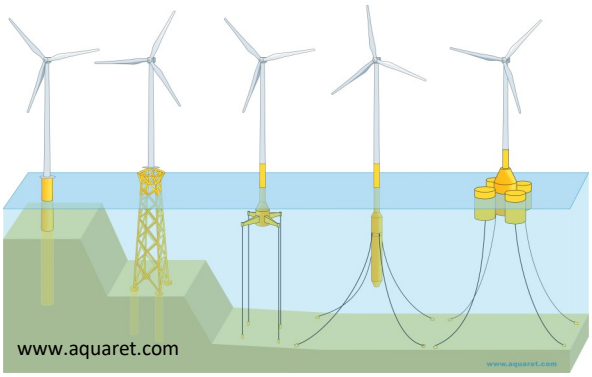
The are currently 5 major offshore windfarms in Scottish waters. The largest is the Beatrice Offshore Wind Farm, located about eight miles off the coast of Wick. It is made up of 84 wind turbines and can generate enough energy to power 450,000 homes!

Scotland can also boast the world's first floating offshore wind farm. The farm is called Hywind Scotland and is found 18 miles off the coast of Peterhead.

Did you know...

There are different ways of anchoring turbines in the sea. Some are built on foundations on the seafloor whilst others float on the water.

The diagram shows different types of foundations and moorings for offshore wind turbines.



GUEST BLOG

EMEC
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Scottish Seabird Centre

HELPING MARINE ENERGY HAPPEN!

By Lara Santos Ayllón, Stakeholder Engagement Officer, EMEC.

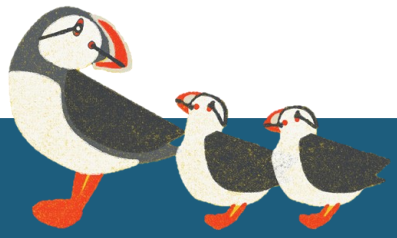
Have you ever been in the sea and felt the strong pull of the water, or seen waves rise up high and crash down with a loud bang? These are examples of the great power in the oceans that surround us. This power, with the right technologies, can be used as energy in our homes, cities and day to day activities. What's more, because it is completely natural, it is available forever and does not harm our environment! Using it can help us fight climate change.

The **European Marine Energy Centre**, or EMEC, was set up to help us learn how to harness energy from the tides and waves. EMEC was created in 2003 in the Orkney Islands, an archipelago in the north of Scotland.

Orkney is a very special place for marine energy because it has some of the strongest tides and biggest waves in the world – it is surrounded by **renewable marine energy**! For this reason, EMEC created a test site, where technologies which are designed to capture the energy in the oceans could be tested, to practice and improve their ability to generate power.

Different types of renewable energy need different devices, which is why solar panels are different to wind turbines. The same happens with marine energy. Wave energy and tidal energy happen in different conditions and places and need different technologies to capture the energy properly.

Photo: EMEC operations preparing waverider buoy for deployment.



This is why EMEC has different test sites for different forms of energy. EMEC has four main test sites around Orkney where different technologies can be tested in the ocean.

Billia Croo has extremely challenging conditions for testing wave technologies, with **waves that can be up to 18m high**! That's the same height as **4 double decker buses** stacked on top of one another. This really tests how wave technologies survive stormy seas, which have a lot of energy.

Photo: Powerful waves at Billia Croo.

Photo: A buoy in strong tidal flow at EMEC Fall of Warness tidal test site.

The Fall of Warness test site is for devices which use energy from **tidal streams**. The site was chosen for its strong currents which reach almost **4m/sec (8 knots)** at their fastest, which is like a car moving at **10 miles per hour**. The tidal streams are fast here because they are funnelled between Orkney's northern islands.

For machines that aren't ready for those sites, EMEC also has two smaller scale test sites, which provide a space to practice until these technologies are ready for Billia Croo or Fall of Warness test sites, which have harsher sea conditions and where devices are connected to the national grid, to generate electricity.

All objects we put into the environment as humans might have an impact on the surroundings. At EMEC we are very aware of this, which is why we spend a lot of time monitoring possible impacts that marine technologies can have on nature. We're pleased to say that, so far, there is little evidence that marine technologies harm the natural environment, and sometimes they even have positive effects!

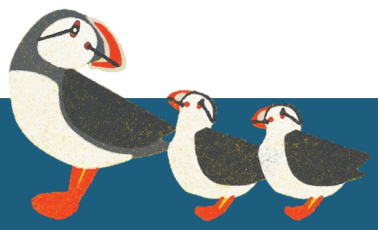


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Photo: A team of workers from EMEC conduct Environmental Monitoring .

Photo: Monitoring is important to protect marine life, such as seabirds.

It is important that we keep monitoring and learning from experience so that wildlife, such as seabirds, fish, and marine mammals, are safe in their ecosystems.

More recently, EMEC has also used its experience with new technologies to develop projects in other areas of renewable energy, such as **hydrogen gas**. Hydrogen can replace fossil fuels for heat and to power transport, and can also be stored for energy use in the future. Hydrogen can be produced without creating any greenhouse gases. How? One way of making it is through a process called **electrolysis** – when water is split into two gases, oxygen and hydrogen. At EMEC, we have used some of the energy made from tides at our site, or energy made by community-owned wind turbines in Orkney, to generate green hydrogen through electrolysis.

Marine energy will help us produce clean energy so that we stop releasing greenhouse gases. Renewable energy sources work well together (combining wave and wind, for example), to make sure we can have a constant supply of energy. We can predict tidal energy hundreds of years into the future, so we can depend on it as an electricity supply while also making sure our energy is good for the planet! EMEC will continue to investigate how to make our energy as clean as can be, while helping marine energy technologies to advance and improve.

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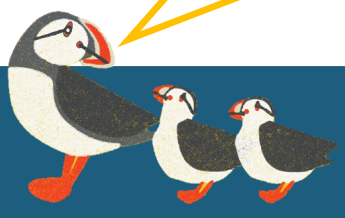
Find out more about EMEC: www.emec.org.uk



DISCOVER

Scottish Seabird Centre

Marine Renewables–Pros & Cons

Marine renewables have the potential to be a major source of green energy in the future, but how does it compare to other sources of energy? Are there any negatives?

Positive

- ✓ Marine renewable sources last forever—there will always be wind, waves and tides.
- ✓ Marine renewable sources don't release greenhouse gases into the atmosphere, helping to reduce global warming.
- ✓ Wind, waves and tides are predictable so you know how much electricity will be available, when. Tides, for example, are predictable hundreds of years in the future.
- ✓ There's a mix of sources— when one source isn't producing as much energy, another can be used.
- ✓ Installing devices may have positive impacts on the environment, such as:
  - Waters around offshore wind farms have been shown to act as safe places for fish
  - Seabirds have been seen roosting on wave and tidal devices
- ✓ The sector is growing. For example, the wave and tidal sectors support >2,400 jobs, which could grow to 23,000 in the next decade, and add £6.1 billion to the economy.

Negative

- ✗ Some people view offshore developments, such as wind farms, as unattractive.
- ✗ Technology isn't as advanced for marine renewable devices as land devices. More money, time and research is needed before they can generate larger amounts of electricity.
- ✗ The amount of electricity that can be made by wind and waves depends on the season or weather. For example, less electricity is made when it's not as windy in spring and summer.
- ✗ Installing devices in the sea may have negative impacts on the environment, such as:
  - Underwater noise pollution
  - Change to habitats
  - Seabirds have been known to collide with offshore wind turbines

Good news: Scientists are working closely with marine renewable companies to research any impacts technologies have on the environment. This allows them to notice any changes—both positive and negative—and reduce disturbance as much as possible.

DISCOVER

Scottish Seabird Centre

Developments in the Firth of Forth

Work has begun on the new 'NnG' offshore wind farm in the Firth of Forth. Here's a bit more information about the development.

Its full name is **'Neart na Gaiothe'**, which means "strength of the wind" in Gaelic.

Once finished, it will consist of **54 turbines** that will produce enough electricity to power the whole of Edinburgh, and more!

The site is located 15.5km off the coast of Fife.

Development of windfarms like these are major engineering projects. In fact, one of the world's largest semi-submersible cranes (Saipem's S7000) is now on site and is visible on the horizon from many places along the coast of the Firth of Forth.

CRAFT

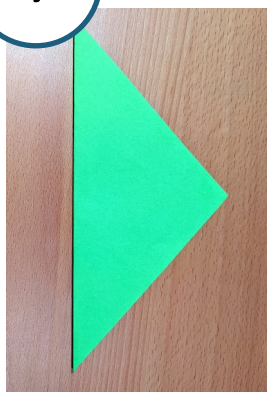
Pinwheel Wind Turbine

Scottish Seabird Centre

What do I need?

- A square of paper (around 18cm x 18cm is a good size)
- Scissors
- Glue
- Pencil, stick or bamboo rod
- Drawing pin
- Ruler

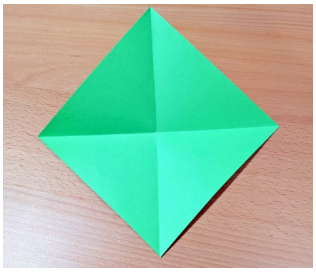
1



Take your square of paper and fold it over into a triangle.

You can use any type of paper—plain, decorated, or a newspaper or magazine page.

2



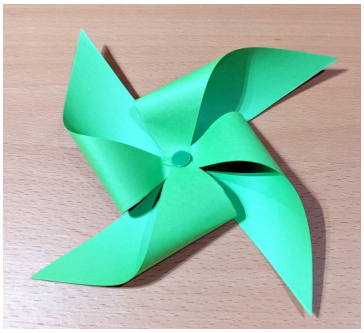
Open it out again and fold the other way to make creases in a cross. From each corner cut along the crease towards the centre.

Only cut about two thirds of the way along the crease. (use the ruler to measure).

3

Pull down one of the points to the centre and glue it in place. Repeat with every alternate point until four points have been glued into the centre. Allow to dry.

4



Once the glue has dried, ask an adult to attach the centre of the pinwheel to a pencil, stick or bamboo rod using a drawing pin.

Do not push the pin in fully, to allow free movement of the pinwheel.

Drawing pins are sharp! Please always supervise children around drawing pins.

Now you are ready to test your pinwheel wind turbine!

You can blow on it to turn the blades, take it outside into the wind or, with the help of an adult, test it with a fan or hair-dryer.

If you enjoyed making your pinwheel wind turbine, why not make a whole wind farm!

You can experiment with different materials for the pinwheel. Try using different types of paper, thin cardboard or foam sheets. Which material works best? Why do you think that is?

TOP TIP: You can fasten your pinwheel to an eraser-topped pencil easily by pushing the pin into the soft eraser!