



Hydro Power

Hydroelectric power stations have a low carbon footprint and provide a renewable source of energy. Dammed water holds potential energy that can be turned into electricity. In a hydroelectric power station, the dammed water is released through a pipe to a turbine. When the turbine spins it drives a generator that produces electricity.

With around 80 hydroelectric power stations, Scotland has harnessed around 60% of the estimated hydropower resources available. Small hydropower schemes can be an economical source of electricity for isolated communities, particularly in the developing world.

Considerations

- CO₂ is released during construction, but some dams around the world also release the greenhouse gas methane (CH₄). This happens in areas of flooding as plants decompose.
- Dams can also impact on people living in the area and affect the availability of water to communities living downstream.
- Some potential hydro power station sites could be in protected areas while others might be in remote locations that require expensive infrastructure to carry the electricity to the national grid.



Wind Power

Wind turbines capture kinetic energy from moving air to generate electricity. Modern wind turbines generate energy as the wind pushes on a number of blades to create a rotational motion. Today's wind turbines are technologically advanced, allowing them get the most out of this renewable energy source. Wind is a renewable source of kinetic energy caused by the Sun's uneven heating of the planet's surface

Wind energy is a free, renewable resource so practically all of the costs are to make and install the wind turbines. As the windiest country in Europe, Scotland is well placed to harness wind energy and transform it into low-carbon electricity. Although there is plenty of energy available, we only get electricity when the wind is blowing. The strongest winds tend to be at sea where there are no obstacles such as forests to slow the winds down. Scotland boasts 25% of Europe's offshore wind resources.

Considerations

- There are carbon emissions related to the building and installation of the turbines before the site is operational.
- Off-shore wind farm machinery needs to be protected from the sea, specialised ships are needed to assemble the wind turbines and expensive power lines must be installed to carry the electricity from the remote site to connect to the national grid.
- The variable output from each wind turbine requires treatment with power electronics to give the smooth output and steady frequency needed for the grid.
- For the UK, the strongest winds are offshore but the costs for offshore windfarms tend to be much higher too – sometimes twice as expensive because of the tricky installation required.



Tidal Power

Electricity can be generated from our changing tides using underwater turbines which rotate as the tide passes through them.

As the Earth spins, the gravitational pull of the Moon and Sun causes the seas and oceans to ‘bulge’ which in turn creates huge, predictable ebbs and flows of water around the world. As the tide rises, sluice gates open to allow the water to flow through the barrage, turning the turbine. The flow of water pushes on the blades of the turbine and causes them to spin. The generator converts the spinning motion of the turbine into electricity.

Scotland has around 25% of Europe’s tidal energy resources but there are many challenges to overcome before it can become a significant part of the energy mix. There are engineering challenges presented by the harsh conditions of the seas and potential environmental impacts, both positive and negative, which need to be understood. However tidal energy is a free, predictable, low-carbon resource that has great potential. Another option to harness the energy of the tides is to use offshore turbines, rather like an underwater windfarm. Orbital Marine Power is a company that are building tidal turbine that floats off the shore, a bit like a boat that’s been anchored. Just one turbine will be as long as a jumbo jet and could generate enough clean energy for 1,700 homes for 1 whole year.

Considerations

- The tide is completely predictable. There are two tides every 24 hours, meaning that the energy levels can be predicted.
- Tidal turbines are not expensive to build and maintain. The turbines can be mostly obscured underwater, meaning little visual impact.
- The UK has some of the highest tidal ranges in the world which makes it a good location for tidal power.
- If using a tidal turbine on the shore, bird life on the estuary where the turbines would sit would be affected as they rely on the tide to uncover mud flats in order to feed.
- The tidal technologies could interfere with shipping routes and access to ports. This could be damaging to the industry on the island that rely on the ports for importing and exporting.
- The technology is really new and it might not be widely available for some time.



Solar Power

The most common method of converting light energy into electricity uses photovoltaic cells, also known as solar cells. These devices rely on a phenomenon known as the photovoltaic effect, which can generate electricity with no moving parts. Although some carbon dioxide is emitted during manufacture and installation, once built the cells harness the Sun's freely available energy to generate electricity without emitting carbon dioxide.

During the day, energy from the Sun reaches the ground as sunlight. Solar panels contain a grid of individual solar cells that can convert light energy into electrical energy by taking advantage of the photovoltaic effect. A layer of glass protects the solar cells, which has an anti-reflective coating to stop sunlight from being reflected away. Solar cells produce electricity in a form called direct current but an inverter turns the output into the alternating current that we use in our homes. The electricity that solar panels generate can be connected directly to our household electricity systems or to the national grid.

Considerations

- Solar power varies with cloud cover, time of day and year. This 'intermittent' supply of raw energy creates a challenge for the energy system. To ensure a reliable supply of electricity we need to find better ways of storing electricity.
- Wherever sunlight falls, solar panels can generate electricity – even on the International Space Station.
- Because solar panels are made of a grid of individual cells, they can be as big or as small as necessary. They can be fitted to rooftops, make up large solar farms or be integrated into our electronic devices.
- There are emissions associated with the manufacture and installation of solar panels.
- Solar panels can contain small amounts of environmentally toxic metals and elements (e.g., Lead, Selenium, Cadmium) which need to be properly disposed of.
- Researchers are working to find cheaper ways of producing and recycling solar cells.
- New types of solar panels are being developed, like solar glass for windows, solar shingles for roofs and even floating solar farms.