Research Briefing

Low Carbon Electricity

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National Assembly for Wales
Research Service

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Research Briefing

Low Carbon Electricity

This Research Briefing is part of a series on low carbon energy in Wales. This section focuses on low carbon electricity, discussing its role in decarbonising the energy system, and giving details of the main technology types and their impact in the Welsh context.

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1. Introduction

This Research Briefing is part of a series on low carbon energy in Wales. This section focuses on low carbon electricity. For further information on low carbon energy, refer to the other parts of the series:

- **Low Carbon Energy in Wales** discusses the national and global context for low carbon energy in relation to the energy trilemma, and outlines the policy landscape in Europe, the UK and Wales;
- **Low Carbon Energy in Wales: in figures** outlines the current energy landscape in Wales, including greenhouse gas trends and energy use;
- **Low Carbon Heat** describes the main low carbon heat sources; and
- **Low Carbon Transport**.

2. The role of low carbon electricity

According to the **final estimates of UK greenhouse gas emissions** for 2015, the energy supply sector was responsible for 29 % of the UKs greenhouse gas emissions. This includes emissions from fuel combustion for electricity generation. As such, the **UK Committee on Climate Change** (UKCCC) has highlighted that decarbonisation of the power sector is vital. In Wales, a **2016 report** to the devolved Governments revealed that electricity supply was responsible for 28.5% of Welsh emissions in 2014.

The electricity generation sector has seen the greatest technological progress in identifying and deploying low carbon alternatives. Renewable electricity technologies have seen **rapid growth and decreasing costs in recent years**.

The centralised nature of electricity generation, albeit with the potential movement towards localised community scale generation in some areas, provides the potential to achieve large-scale emissions reductions more easily than in other more distributed sectors, such as transport. For this reason, increased electrification of the residential sector through electric heating, and the transport sector through electric vehicles, could have a role to play in decarbonising the economy.

However, increased electrification could place significant demands on the electricity system. If electricity were to be used for all passenger transport, as well as domestic heating and cooking, the current demands on the electricity system **would more than triple**. In its **Smarter Energy Future for Wales** report published in 2016, the Environment and Sustainability Committee of the Fourth Assembly identified a lack of capacity on the electricity grid in some parts of Wales and that this is a significant barrier to the development of local energy generation. Thus, while electrification will play a role in energy system transformation, it may be important to consider other means of producing low carbon energy across other emissions sectors.

An overview of the main low carbon electricity generating technologies is set out below, along with consideration of their application and role in the Welsh context.

3. Onshore and offshore wind

Wind turbines operate by converting kinetic energy from the wind into mechanical energy, and subsequently into electricity. Turbines can be located either onshore or offshore, and may be lone installations or part of a wind farm. They range from **domestic-sized turbines** capable of producing 1 to 6 kilowatts (kWs), to larger scale systems generating several megawatts (MWs). Onshore wind is the **second-largest source of renewable energy** in the world.

The UK has been recognised for having a large wind resource, both onshore and offshore. The **UK Government suggested in 2001** (PDF 140 KB) that the UK could realistically produce up to 50 terawatt hours (TWh) of electricity each year from onshore wind, and a further 100 TWh from offshore wind.

Wales also has significant wind resources. The **Welsh Government indicated in 2010** (PDF 1,189 KB) that Wales has potential wind capacity of 2 gigawatts (GW) onshore and 6 GW offshore. A 2015 **Welsh Government statistical release** (PDF 440 KB) indicated that wind generated 1,702 gigawatt hours (GWh) of energy in Wales in 2013. **Provisional UK statistics for 2016** suggest that Wales' installed capacity has now reached 1,562MW for onshore and offshore combined, generating 3,438 GWh of energy.

Onshore wind energy has been a **controversial issue in rural Wales**, marked by protests against the visual impact of turbines and associated electricity transmission infrastructure. Despite this, the **Welsh Government** is supportive of having a mix of onshore and offshore wind:

> *We need a mix of both onshore and offshore wind energy to meet our challenging climate change targets. At the moment onshore is more cost effective. Offshore wind farms take longer to develop because the sea is a more hostile environment… If we only pursued offshore wind generation then we would be likely to miss our renewable energy targets and commitment to tackle climate change.*

In June 2015, the **world's second largest offshore wind farm** opened off the coast of north Wales - Gwynt y Môr has a capacity of 576MW, enough to power 400,000 homes.

Another consideration is intermittency of wind. **The Institute for Public Policy Research** has highlighted that, while wind power is variable, the changes are largely predictable in the short term and thus the effects of variability can be managed. Nonetheless, accommodating these variations would require the rest of the energy system to be flexible.

The levelised cost of electricity is a way of expressing the lifetime costs of electricity. Total capital and operating costs are averaged over the total lifetime electricity output. This gives units of '£/MWh' (or similar). This is a useful tool for comparing the cost of energy sources which may have very different capital and operating costs and a range of lifetimes. In 2016, the levelised cost of energy for offshore wind power in the UK was estimated to be £97/MWh, **a 32% reduction in cost in five years**. This meant that it fell below the UK Government's 2020 target level of £100/MWh four years ahead of forecast.

Onshore wind tends to cost less than offshore wind power. A **review by ClimateXChange** found a range of cost estimates in the region of £50/MWh to £90/MWh for onshore wind power in the UK. The review highlighted that the costs of wind power are highly sensitive to installation-specific considerations such as capacity, lifetime and financing arrangements.

Changes to onshore wind subsidies

In June 2015, the UK Government announced the end of subsidies for large onshore wind projects, by closing the Renewable Obligation Scheme early for onshore wind. In a **statement**, Amber Rudd, then Secretary of State for Energy and Climate Change, stated that the UK was on track to meet its onshore wind capacity objectives, continued subsidy could encourage a reliance on subsidies at a high cost to consumers. Support for onshore wind was available in the first round of allocations for **Contracts for Difference** in February 2015, and a number of projects were **awarded contracts**. However, the **Draft Budget Notice** for the second round indicates no intentions to support onshore wind.

Small onshore wind projects are still eligible for support under the **Feed-in-Tariff scheme**. In a **statement on ending subsidies for onshore wind**, the Secretary of State acknowledged the potential role of wind power in community energy.

4. Solar power

Solar photovoltaic (PV) cells convert light to electricity at the atomic level. Solar PV technology is scalable to many different applications, from domestic installations to much larger solar farms. The most efficient solar panels in the world achieve 40 to 50% efficiency, while PV panels for domestic applications tend to have lower efficiencies, **in the region of 10 to 20%**. Solar tiles are a less obtrusive alternative to panels. These can be used in place of ordinary roof tiles but **typically cost up to twice as much as panels**.

As solar PV depends on sunlight, it is an intermittent energy source. This is a particular challenge in Wales, as the quality and hours of daylight are variable. Load factor is a term used in comparison of actual or average energy generated as a proportion of maximum possible output. Load factors are used to describe differences between installed capacity and actual levels of generation across technology types. In 2015, **solar PV in Wales had a load factor of 11.1%**, lower than any other type of renewable electricity.

In practice, a low load factor signifies operation below full capacity for a high proportion of the time. Figure 1 shows how the load factor of solar PV in Wales compares to other regions of the world (the figure for OECD Europe represents an average for European countries which are members of the Organisation for Economic Co-operation and Development).

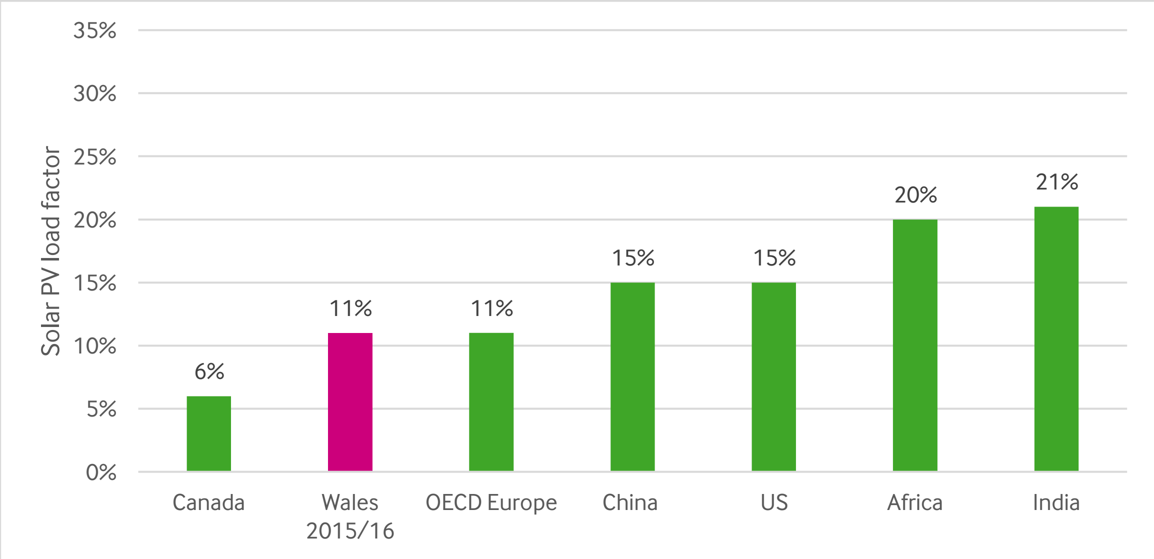


Figure 1 - Solar PV load factors Source: ***BEIS - Regional Renewable Statistics*** *(Wales) and* ***US Energy Information Administration*** *(Others)*

According to the **Energy Saving Trust**, an average domestic solar PV system costs in the range of £5,000 to £8,000 and can generate 3,400 kWh per year, approximately equivalent to the annual electricity needs of a typical household.

In December 2015, the UK Government **announced changes to the Feed-in-Tariff scheme** to prevent over-spend on renewable energy subsidies. This included a reduction in the level of support for solar PV. The move was met with **criticism from the industry**, which stated that it would damage the sector.

An example of solar PV use in Wales is '**Pentre Solar**' in North Pembrokeshire – a 'solar village' comprising six low carbon, affordable homes. Information on Welsh solar farms can be found in the Research Service **Research Note on solar farms in Wales** (PDF 434 KB) published in March 2015.

5. Marine energy

Marine energy generation technologies are typically harness wave and tidal energy. There are three categories of tidal energy technologies: tidal range, tidal steam and hybrid solutions. These are discussed along with wave energy technology below.

Tidal range

Tidal range technologies harvest power from the height difference between high and low tide. A barrier such as a barrage or lagoon is used to create compounded areas of water which change in height with the tides. While **barrages** typically extend across the width of a body of water, **lagoons** enclose an area water behind breakwaters attached to the coastline or offshore. The height differential of water either side of the breakwater is used to drive turbines and generate power. Turbines can be bi-directional, allowing them to operate on both ebb and flow tides which prolongs the power generating period.

The stages in the tidal cycle are illustrated in Figure 2 below.

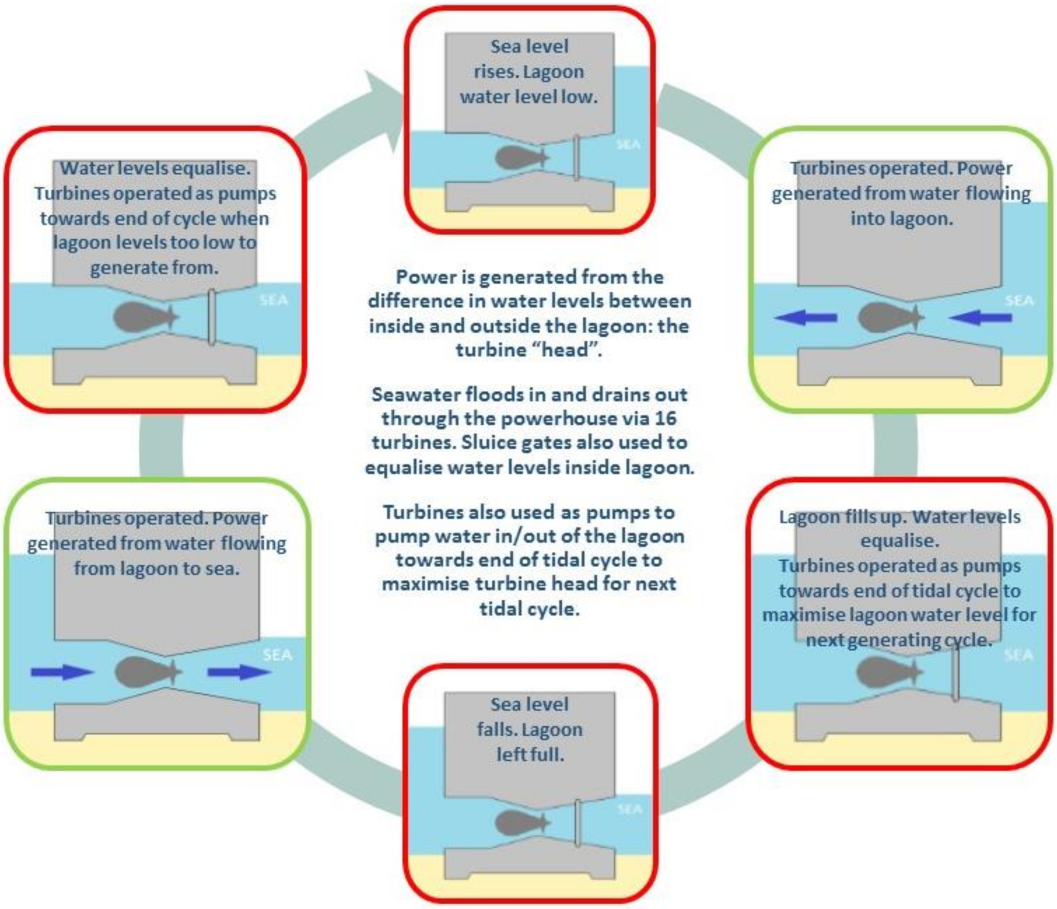


Figure 2 - The principle of tidal range power (Source and copyright: Tidal Lagoon Power)

Tidal range power is variable as it relies upon the timing and extent of the tides. However, it is very predictable. Estimates for the UK suggest that tidal range could theoretically produce **25 to 30 GW of power**, enough to supply 12% of current UK electricity demand.

The Severn estuary has the one of the largest tidal ranges in the world at around 15 metres (a theoretical tidal range resources of 8-12 GW). In 2010, a **UK Government feasibility study** concluded that there was no strategic case for public investment in a Severn tidal power scheme in the medium term, but private sector groups have continued to investigate the potential of both barrages and lagoons.

In 2016, the UK Government commissioned an independent **review** of the strategic case for tidal lagoons in the UK. The **Hendry Review** concluded that tidal lagoons could bring a number of benefits to the country and the communities that live nearby, but suggested that deployment should begin with a small 'pathfinder' project to enable assessment of environmental impacts and technical feasibility. Further information on the Hendry Review can be found in the Research Service blog on **Tidal lagoon energy in Wales.**

Tidal Lagoon Power is working to develop the world's first **tidal lagoon in Swansea Bay**. The project was awarded planning permission by the UK Secretary of State for Energy and Climate Change in June 2015. The project, if built, would have an installed capacity of 320 MW, providing 11% of Wales' electricity needs. There are plans to follow this up with a **full-scale 3 GW scheme in Cardiff**, as well as early stage proposals for **Newport** and **Colwyn Bay**.

Wave and tidal stream

Wave and tidal stream technologies operate on a similar principle to wind turbines and involve the harnessing of kinetic energy from waves or tidal flows in order to generate electricity. Wave technology can be installed at the shoreline or offshore. The typical minimum energy required for wave technologies ranges widely; from 9 kW/m up to 60 kW/m. Tidal stream technologies typically require a **tidal velocity greater than 2 m/s**.

The **Marine Renewable Energy Strategic Framework (MRESF) project** identified up to 7 GW of wave and tidal stream resource in Wales which could generate **up to 20% of UK electricity demand**. However, **research by Ocean Energy Systems** suggests that progress and deployment of wave and tidal stream technology has been slower than expected, with costs remaining relatively high.

In 2015, a 400 kW turbine was installed by **Tidal Energy Ltd** (TEL) as a **demonstration project in Ramsey Sound.** It was supported by £8m of funding from the European Regional Development Fund, and the Welsh Government invested £49,000. The **turbine failed** after several months in operation and TEL is now in administration.

The 10 MW **Skerries Tidal Stream Array**, off the coast of Anglesey, was set to be the first commercial tidal array in Wales, being **approved by the Welsh Government in 2013**. However, the project was **abandoned first by Siemens in 2014**, and **then by Atlantis in 2016**.

Hybrid forms of tidal energy are in early stage of development, but typically include multi-purpose platforms which combine both tidal current and tidal range technologies for electricity generation.

More information on wave and tidal technologies in Wales is available from **Marine Energy Wales**.

Marine energy policy in Wales

Marine energy has been a feature of Welsh Government policy for the last decade. Various Welsh Government commissioned projects have assessed the **economic impact**; **marine energy resource** in Wales; and **opportunities and limits** to growing the Welsh marine energy industry. A **resource assessment by the Crown Estate** (PDF 600 KB) in 2012 estimated that Wales has a total theoretical marine energy resource of:

– Wave: 23 terawatt-hours per year (TWh/year) [**Note**: this figure is for England and Wales];

– Tidal stream: 28 TWh/year [of a 95 TWh/year UK total];

– Tidal range (barrage schemes): 23 TWh/year [of a 96 TWh/year UK total]; and

– Tidal range (lagoon schemes): 7 TWh/year [of a 25 TWh/year UK total].

The Welsh Government convened a **Marine Energy Task and Finish Group** in 2015 to provide advice on a sustainable approach to deliver jobs, growth and wealth from the emerging marine energy sector in Wales. In its response to the Group's recommendations in 2016, the Welsh Government stated that marine energy remains a key policy area.

In March 2017, **Marine Energy Wales** published a **report** exploring the economic benefits of marine energy in Wales. To date, the sector has received over £68m of investment and a further £1.4 billion is expected in the next 5 years, provided market and development incentives are in place.

Further information on the marine economy in Wales can be found in the Research Service blog post on **Making the Most of Marine**.

6. Hydroelectric

Similar to tidal range technology, **hydroelectric power** utilises the height difference between bodies of water to generate power. As water flows downwards, it passes through a turbine to generate electricity.

A hydroelectric scheme may use an impoundment such as a dam to create a reservoir, from which the water is released in a controlled way. Alternatively, it may be a 'run-of-river' facility, which uses the natural flow of the river, sometimes enhanced by use of a weir.

A **hydropower resource assessment** of England and Wales, funded by DECC and the Welsh Government, estimated that the potential resource in Wales is between 26 and 63 MW. The British Hydropower Association provides a register and map of all the **hydropower installations in the UK**.

While many hydropower schemes are on a small, or micro, scale, there are examples of larger schemes. For example, Cardiff City Council **supported the development** of the Radyr Weir Hydro Scheme, a run-of-river installation which uses a weir in the River Taff. The project **opened in July 2016**, cost £2.6m and produces power for around 550 homes.

Wales also has two major pumped hydroelectric storage facilities (which store rather than generate power). **Ffestiniog Power Station** in Gwynedd was the first in the UK, and **Dinorwig Power Station** is the largest scheme of its kind in Europe. Both facilities are capable of storing enough energy to supply Wales' power needs for several hours.

7. Geothermal

Geothermal power makes use of heat stored deep beneath the Earth's surface. Energy from high temperature geothermal reservoirs is used to create steam, which turns a turbine to generate electricity. In volcanic regions, where the heat is accessible, this can be achieved at **relatively low cost**.

The UK is not actively volcanic, and thus has limited geothermal potential in this respect. However, **some parts of Cornwall have a relatively high geothermal gradient** which may be exploited to generate energy using Engineered Geothermal Systems (EGS).

At shallow depths of around 10 to 15 metres, heat within the ground may be used for ground source heat pumps. At this depth, the ground acts as a thermal heat store for the energy from the sun. As such, ground source heat pumps may be considered as a form of solar, rather than geothermal, energy.

8. Nuclear

In a **nuclear reactor**, large amounts of energy are produced by the splitting of uranium atoms (nuclear fission). Like a coal power plant, this heat is used to generate steam, which turns a turbine to generate electricity.

While nuclear power is not a form of renewable energy, it is a low carbon energy source with lifecycle emissions ranging from **5 to 55 g CO_{2e}/kWh** (carbon dioxide equivalent per kilowatt-hour, used to express the relative global warming potential other greenhouse gases, such as methane, nitrous oxide and ozone, in terms of carbon dioxide for comparison purposes.). This is lower than any fossil fuel energy source, and comparable with solar, wind, biomass and hydroelectric power. Due to the ability of nuclear power to deliver large quantities of reliable, low carbon power, the **Cabinet Secretary for Environment and Rural Affairs confirmed in 2016** that nuclear will be part of Wales' energy mix in the medium term.

Modern nuclear power is designed for optimal safety, which **significantly reduces the likelihood of an incident**. However, concerns remain. In the longer term, a potential area for development is reactors which use nuclear fusion rather than nuclear fission. Fusion technology has the added benefit of being inherently safer as it is **intrinsically impossible to have a runaway reaction**. The technology still faces a number of technical and engineering challenges, and its potential future is undetermined.

Other concerns relate to the safe long-term disposal of nuclear waste. The UK Government **website provides a guide** on how the UK plans to deal with its radioactive waste on a long-term basis, and the process for identifying a site for a geological disposal facility.

Due to economies of scale and the extensive amount of equipment required for safe operation, nuclear power facilities tend to be relatively large. An area of more recent technological development focuses on **Small Modular Reactors** (SMRS), designed for nuclear power generation on a smaller, more flexible, and more affordable scale.

A **new nuclear power plant** is proposed in Anglesey, on the site adjoining the former Magnox Wylfa power station. Wylfa Newydd is designed to generate 2.7 GW of power, and would create 4,000 temporary jobs and 850 permanent positions.

In 2016, the Welsh Affairs Committee conducted an **inquiry into the future of nuclear power in Wales**. This examined evidence on the proposed Wylfa Newydd project, the decommissioning of existing sites, and the contribution of nuclear power to the economy of North Wales. The UK Government **responded to the Committee's recommendations** in October 2016. It confirmed that any UK Government-funded nuclear projects would need to be affordable and represent value for money. The UK Government also agreed to be transparent about how the lifetime costs of new nuclear compare with renewable alternatives.

The House of Commons Library briefing on **new nuclear power** provides further information on the future of nuclear energy in the UK.

9. Energy from waste

There are a range of ways to convert waste to electricity, in order to recover energy from materials which may otherwise be sent to landfill. These include incineration, anaerobic digestion and other thermal technologies. Collectively, these are referred to as Energy-from-Waste (EfW) technologies.

Incineration

The most well-established EfW technology is **incineration**, in which mixed residual waste (waste left over when the environmental or economic costs of further separation and cleaning outweigh the potential benefit) is combusted to generate steam, and subsequently electricity. The negative perceptions associated with incineration are explored in a **report by the Environment Agency**.

A key distinction for an incinerator is whether it is defined as a recovery facility or a disposal facility. According to Annex II of the EU **Waste Framework Directive**, an incinerator may be classified as an

'R1' energy recovery facility if it meets certain energy efficiency criteria. This distinction proved to be an important aspect of the **development of the Cardiff Energy Recovery Facility** (ERF).

The **Cardiff ERF** is the largest of its kind in Wales, incinerating and recovering energy from 95% of South Wales' non-recyclable waste. **Enviroparks Hirwaun**, currently under development, will process waste into Refuse Derived Fuel (RDF) and use this for gasification. This plant will receive UK Government support, after being awarded a contract under the **first allocation of Contracts for Difference**.

Anaerobic digestion

Anaerobic digestion (AD) occurs at a range of scales and is used in many different sectors, including the agricultural industry, wastewater treatment plants, the waste management sector, and by other companies which produce large quantities of organic waste, such as **chocolate factories** and **breweries**.

The Wales Centre of Excellence for Anaerobic Digestion provides support and technical services to the AD industry. The Centre is funded by the European Regional Development Fund (ERDF), the Welsh Government and the University of South Wales.

Biogas

Biogas is the gas product that is formed by the anaerobic digestion of organic matter such as food waste, garden waste, sewage sludge, factory effluents, certain animal by-products and agricultural waste. It is typically comprised of around 60% methane, 40% CO_2 and trace amounts of other gases.

Biogas may be used directly to produce electricity, heat, or combined heat and power (CHP). The **incentives in place across Europe** predominantly focus on electricity, although in the UK the **Renewable Heat Incentive** has also incentivized biogas use for heat. In its 2013 report on **progress on reducing emissions and preparing for climate change in Wales**, the UK CCC recommended that the Welsh Government should develop a renewable heat strategy to maximise the uptake of Great Britain-level incentives and help overcome barriers to renewable heat uptake. No such strategy has been produced to date.

Estimates on the carbon intensity of biogas vary with feedstock, process and application. In cases where the feedstock would otherwise have been left to decompose in the open air, biogas production prevents uncontrolled emissions of methane, a powerful greenhouse gas.

When used for electricity production, biogas can offer a **90% reduction in carbon emissions compared to fossil fuels**. **The UK Solid and Gaseous Biomass Carbon Calculator** can be used to estimate carbon intensity of biogas.

A **map of biogas installations** in the UK and **up-to-date information on incentives** can be found on the official online portal for AD.

Landfill gas

Landfill gas is the gas which results from the anaerobic decomposition of organic matter at landfill sites. It is similar to biogas, but with a slightly different composition – it contains around 35-55% methane, 30-44% CO2 and 5-25% N_2 and a small amount of oxygen. It also contains some trace components, some of which are toxic or cause odour. As a result of the lower methane content, raw landfill gas typically has a lower energy content than biogas.

Typically, the landfill is covered over to prevent gas release to the atmosphere, and the gas is collected via gas wells embedded within the waste. Once captured, the gas can be flared so that the methane is converted to carbon dioxide, and most of the toxic and odorous components are destroyed. Alternatively, the gas might be used in various applications, in the same way as biogas. If it is used for power generation, one million tonnes of municipal solid waste generates enough landfill gas to power around 2,000 households.

In 2015, there were 24 sites generating power from landfill gas in Wales, with a total installed capacity of 47.2 MW. In the same year, these sites generated 179.2 GWh of power. Energy generation at landfills has declined in recent years, although this may be associated with the reduction in the quantities of biodegradable waste sent to landfill.

Thermal technologies

Other methods of waste power include Advanced Thermal Treatment (ATT) technologies, such as pyrolysis or gasification. When a carbonaceous material such as waste is thermally treated in a low oxygen atmosphere, it releases combustible gases which can be used to generate electricity. Pyrolysis and gasification have been used for centuries for the production of charcoal and town gas, but it is only more recently that they have been used for the conversion of waste to energy.

More information on Welsh policy on EfW is available on the Welsh Government website.

10.Biomass power

Electrical power can be generated by the combustion of solid biomass fuels in a thermal power plant. The biomass may be burnt as the sole fuel, or it may be co-fired with coal. The ability to convert existing coal plants to use biomass may be a way to secure the future of existing assets, especially in light of the UK Government's plans to phase out unabated coal power by 2025. In 2016, the Welsh Cabinet Secretary for Environment and Rural Affairs confirmed that Wales would similarly be amending "planning policy to restrict proposals for new coal extraction".

Drax power station in North Yorkshire, which generates around 7% of the UK's electricity, has been a leader in this field and is Europe's largest fossil fuel decarbonisation project. Three of its six coal units have already been converted to biomass, and it plans to phase out coal by 2020. To provide sufficient feedstock, Drax has been importing biomass from North America and the EU.

Western Wood Biomass in Port Talbot was the first commercial biomass plant in Wales, commencing operations in 2008. It has an installed capacity of 14.3 MW and produces enough power for around 10,000 homes.

Two Orthios Eco Parks in Anglesey and Port Talbot are to have biomass power stations, which together will provide power for more than 1.5 million homes. The excess heat from the power stations will be used to support secondary industries such as prawn farming and vegetable growing.

Decarbonising biomass

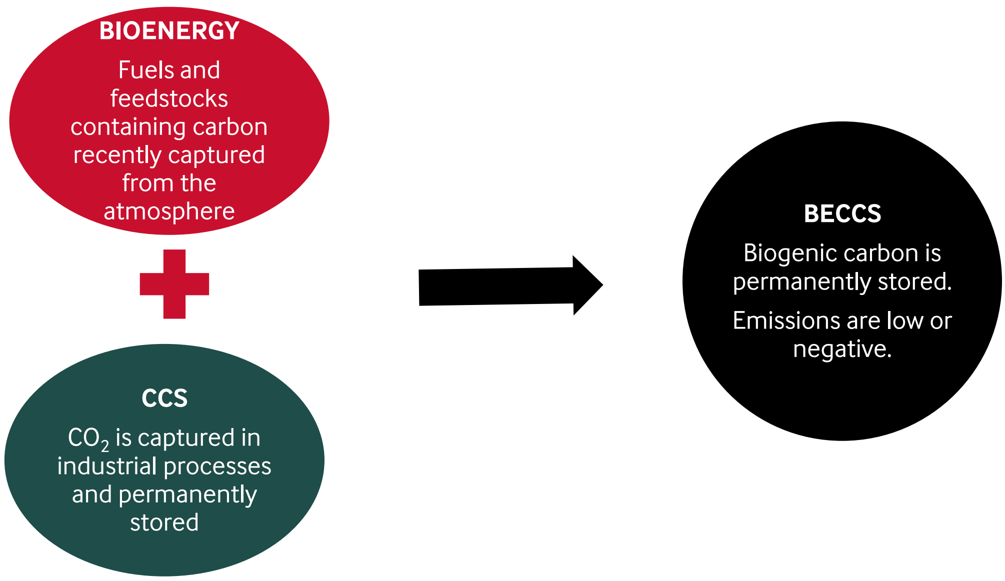
Biomass is considered to be a low carbon source of energy because the CO_2 which is released has recently been captured from the atmosphere by the plant while it was alive – it is 'biogenic' carbon.

Nevertheless, there remains some debate as to whether the technology is really beneficial. The European Environment Agency Scientific Committee stated in 2011 that replacing fossil fuels with bioenergy could actually increase CO_2 emissions, depending on where and how the biomass is produced and harvested. The UK Government report **Life cycle impacts of biomass electricity in 2020** provides detail on how different biomass sourcing scenarios compare.

Carbon capture and storage (CCS) refers to technology used to capture CO_2 from industrial processes and transport it to permanent storage. Potential **storage sites** are porous geological formations such as deep saline aquifers and former oil and gas fields. Using this technique, up to 90% of the CO_2 in the process gas can be captured and stored.

Bioenergy can be combined with CCS technology to improve its life cycle impacts; this is known as BECCS. The intent of BECCS is to achieve emissions which are very low or even negative (i.e. the net effect is removal of greenhouse gases from the atmosphere). However, this is limited by the technical, geographical and economic constraints of CCS implementation. This principle is illustrated in Figure 3.

Figure 3 - The principle of BECCS



It is argued by some, such as **Biofuelwatch**, that there is a risk of overly optimistic expectations for BECCS, which may distract from other efforts to reduce emissions.

Further information on BECCS and other negative emissions technologies are contained in the Parliamentary Office for Science and Technology (POST) note on **Greenhouse Gas Removal**.

11.Decarbonising fossil fuels

By capturing and storing the CO_2 produced through burning fossil fuels, CCS has been identified as a critical technology in the global solution to climate change, with the potential to contribute **one-sixth of the total emissions reductions required in 2050**. Fossil fuel power plants with CCS are sometimes described as 'abated'.

The main advantage of CCS is that it allows the continued use of existing fossil fuel technologies which provide reliable, predictable power on demand. It is often considered a **'bridge technology' to meet climate change commitments in the medium-term**, before dependence on fossil fuels is phased out. However, in its **latest progress report to Parliament**, the UKCCC suggested that CCS may also have a role in the UK energy mix in the longer term.

Much of the technology used in CCS is already proven at industrial scale in the oil and gas industry. However, CCS is yet to be deployed to a significant extent as a technology to mitigate climate change (projects under development worldwide are summarised on the **Global CCS Institute website**). Furthermore, there is some debate as to whether significant investment in CCS as a means to abate fossil fuel emissions could lead to the energy system remaining **locked-in to fossil fuels**.

CCS in the UK

The UK does not yet have any commercial scale CCS. The UK Government has run two CCS competitions, in which companies were invited to bid for investment in the first full-scale deployment of CCS in the UK. Both competitions were later cancelled. In February 2016, the UK Energy and Climate Change Committee published the results of its **inquiry on the future of CCS implementation in the UK**. The report recommends that the UK Government should promptly consider a new CCS strategy in conjunction with a new gas strategy.

Aberthaw Power Station was the first to **trial CCS in Wales**. The pilot plant began capturing carbon from a small slip stream of power station flue gases in 2013, though it **ceased to operate the following year**. The potential for CCS in Wales may be restricted by the lack of ready access to geological resources (such as depleted oil and gas reservoirs) where the CO_2 can be sequestered.

A potential area for development is **storage within Wales' coal seams**, in particular the South Wales coalfield, although the extent of this potential is not well understood. One **preliminary examination**, published in 2016, estimated a proven capacity of 70.1 million tonnes of CO_2, with a possible capacity up to 152 million tonnes. For comparison, estimates of the total storage potential of the UK Continental Shelf are as high as **78 billion tonnes** of CO_2.