

Energy Generation in Wales

2020



Llywodraeth Cymru
Welsh Government



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Ministerial foreword

A smart, flexible, renewables based energy system is fundamental to support our net zero ambitions. But we want our energy transition to deliver even more benefits through local and shared ownership, seizing supply chain opportunities and the creation of good jobs for local people.



Julie James MS

Minister for Climate
Change

Our Vision is for Wales to generate renewable energy to at least fully meet our energy needs and utilise surplus generation to tackle the nature and climate emergencies. We will accelerate actions to reduce energy demand and maximise local ownership retaining economic and social benefits in Wales. This vision and associated recommendations arose from our recent Renewable Energy Deep Dive.

The Energy Generation in Wales 2020 report provides a complete and transparent picture of energy generation and a consistent measure against our Welsh Government energy targets. It also provides a time series of data, illustrating trends in the deployment of generating capacity across a range of technologies.

The headline figures are encouraging – we supply the equivalent of approximately 56% of our annual consumption from renewables working towards our target of 70% by 2030. This represents an increase of 5% compared to 2019 levels. We have achieved 86% of our 1 GW local ownership target with nearly 73,000 locally owned renewable electricity and heat projects in Wales.

However, we need to recognise that the Covid-19 pandemic had a significant impact on energy generation and consumption in 2020 making it difficult to draw firm conclusions from looking at single years in isolation. The longer-term trend points to a decline in the rate of deployment of renewable energy capacity since its peak in 2015 in large part driven by the decline in UK Government financial support. We must urgently reverse this trend.

Following an intensive process to identify the barriers to scaling up renewables in Wales, we are now implementing the recommendations of our deep dive, breaking down the barriers to deployment and setting the conditions to deliver social and economic benefits to Wales while protecting our natural environment. Future editions of this report will provide evidence of the impact of our actions.



Lee Waters MS

Deputy Minister for
Climate Change

Introduction

The Energy Generation in Wales 2020 report sets out the energy generation capacity in Wales in 2020 and analyses how it has changed over time. The aim of the report is to support the Welsh Government with the development of energy policy, helping to evidence the economic, social and environmental benefits from the development of Welsh energy projects.

The report brings together a wide range of data sources to analyse the total capacity of renewable and fossil fuel electricity generation, as well as renewable heat and energy storage, in Wales. It also looks at the development of renewable energy in 2020, reviewing the growth prospects of each technology. The analysis builds on prior publications:

- Previous Energy Generation in Wales reports
- The first and second editions of the Energy Use in Wales reports, which set out how energy is used in Wales and how energy use has changed over time

Energy generation deployment is broken down into the 22 local authority areas and four regions in Wales. This allows analysis of the local factors, including natural resources, local policies and other demographic elements, which may influence the deployment of different technologies.

The value of local ownership of energy assets has been recognised by the Welsh Government, and is a key part of Wales' energy strategy. The current ownership of energy generation assets in Wales has also been examined, providing a measure against Wales' target of 1 GW of locally owned renewable energy capacity by 2030.

This report:

- Breaks down Welsh electricity and renewable heat generation and storage by technology, capacity and local authority area to the end of 2020
- Estimates 56% of electricity consumption comes from renewable sources
- Estimates that 33% of total electricity generation in Wales comes from renewable sources
- Estimates 859 MW of installed renewable energy capacity is locally owned

Technologies analysed:

- Renewable electricity and heat technologies
- Electricity storage technologies
- Fossil fuel electricity generation (generation from coal, gas and diesel)



Electricity generation in Wales

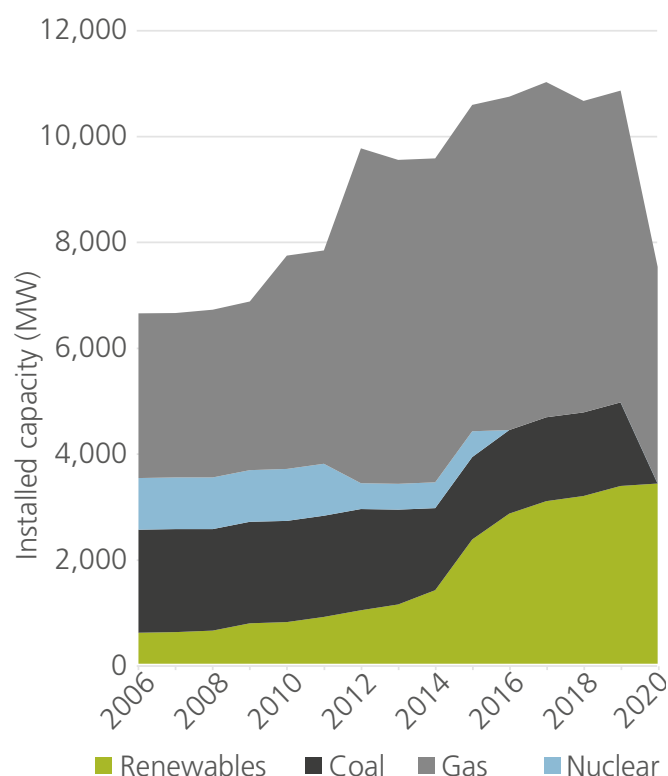
Both electricity generation and electricity consumption reduced in Wales in 2020; in particular, the closure or suspension of some fossil fuel power stations in Wales reduced Welsh electricity generation, while the impacts of the coronavirus (COVID-19) pandemic reduced Welsh electricity consumption. Wales remains a net exporter of electricity, having generated approximately 23.1 TWh in 2020 while consuming 13.8 TWh.

2020 was the first year since the 1800s that there was zero electricity generation from coal in Wales exported to the electricity grid. Furthermore, while the reduction in Welsh gas-fired electricity generation in 2020 may only be temporary (see page 33), the overall reduction in fossil-fuelled electricity generation in Wales means that over 33% of Welsh electricity generation was from renewables, up from 27% in 2019.

Electricity consumption represents about 16% of Wales' estimated 92.8 TWh¹ total energy consumption. The remaining 78.9 TWh is attributed to transport, heating, agriculture and industry.

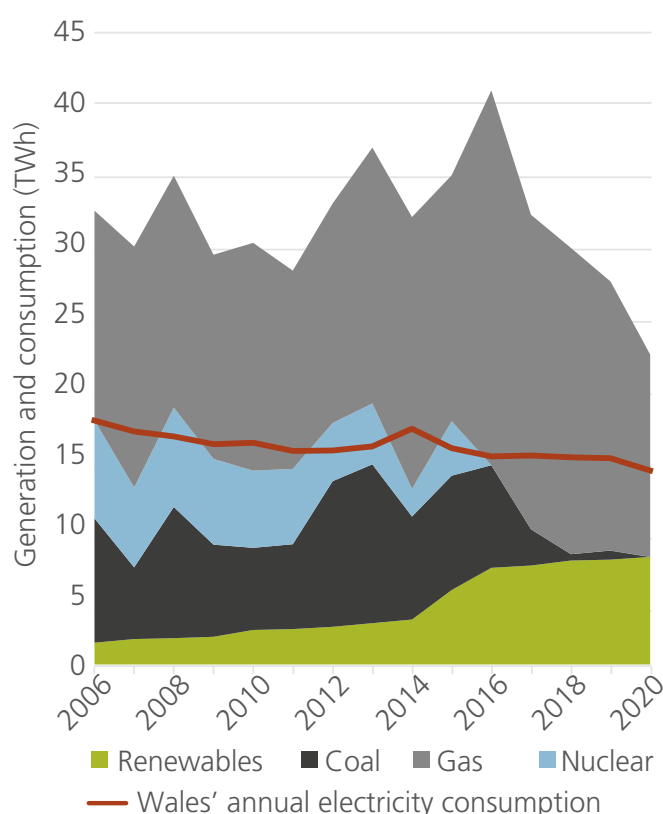
Electricity capacity trends

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Electricity generation trends

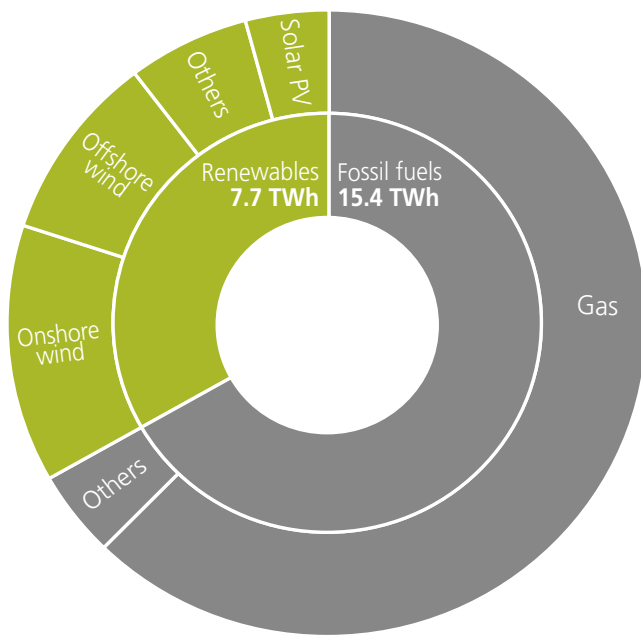
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1 BEIS, 2021; Subnational total final energy consumption United Kingdom, 2019 www.gov.uk/government/statistics/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2019

Electricity generation in Wales

Data source: 1



- A total of 39 MW of renewable electricity capacity was installed in 2020. Solar PV and Energy from Waste contributed the majority of this capacity, with a total of 27 MW of solar PV and a 21 MW Energy from Waste plant commissioning in 2020, of which half is estimated to be renewable, while the other half is assumed to be non-renewable waste.
- Electricity generation from renewable electricity increased by approximately 200 GWh in 2020, mostly due to an increase in estimated onshore wind generation resulting from above average windspeeds, rather than a significant increase in renewable capacity.
- It is estimated that the non-renewable constituent of Energy from Waste generation is 50%. Therefore, half of generation and capacity from this technology has been assigned to renewables, and half to fossil fuels.
- Aberthaw power station ceased commercial generation in December 2019, meaning that no coal-fired power stations were operational in Wales in 2020.
- Electricity generation from gas reduced in 2020 as Calon Energy, an operator of gas-fired power plants, went into administration. The future of the two gas power plants that Calon Energy operate in Wales remains uncertain.

Electricity generation in Wales key statistics

Data source: 1

Technologies	Number of projects	Electrical capacity (MW)	Estimated electricity generation (GWh)
Fossil fuels	96	4,291	15,429
Coal	0	0	0
Diesel	21	248	868
Energy from Waste	2	26	136
Gas	73	4,018	14,425
Storage	5	-	-
Large-scale battery storage	3	29.1 (MWh)	-
Pumped hydro	2	2,088 (MW)	-
Hydrogen	0	0	-
Renewables	61,030	3,417	7,673

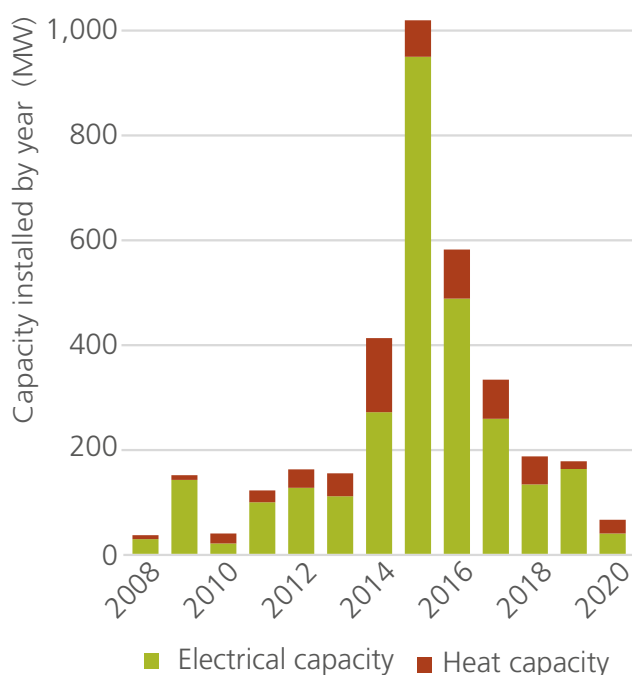
Renewable energy in Wales

65 MW of new renewable capacity was commissioned in 2020 – 39 MW of electrical capacity and 26 MW of heat capacity. 2020's new capacity figure represents the lowest annual deployment rate since 2010, which is 94% lower than the 2015 peak, when 1,019 MW was commissioned.

- Parc Adfer Energy from Waste plant in Deeside was the largest renewable electricity project commissioned in Wales in 2020. It has an estimated electricity capacity of 21, MW of which 10.5 MW is estimated to be renewable, meaning it accounts for around 27% of new renewable electricity capacity that commissioned in 2020.
- Five further renewable electricity projects with a capacity greater than 1 MW were commissioned in 2020, including three solar PV projects, an onshore wind project and a hydropower project, totalling 15 MW.
- Offshore and onshore wind play a major role in renewable electricity generation in Wales, accounting for 29% and 39% of renewable electricity generation respectively. Together, this equates to 23% of all electricity generation in Wales.
- A total of 26 MW of renewable heat capacity is estimated to have commissioned in 2020, including nearly 17 MW of thermal heat pump capacity and 9 MW of thermal biomass capacity.

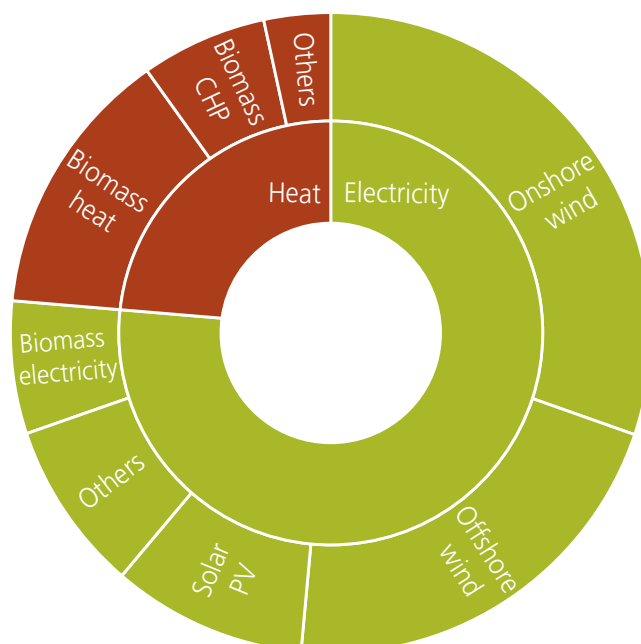
Wales' annual renewable energy deployment rate

Data source: 1



Renewable electricity and heat generation

Data source: 1



Renewable energy in Wales key statistics

Data source: 1

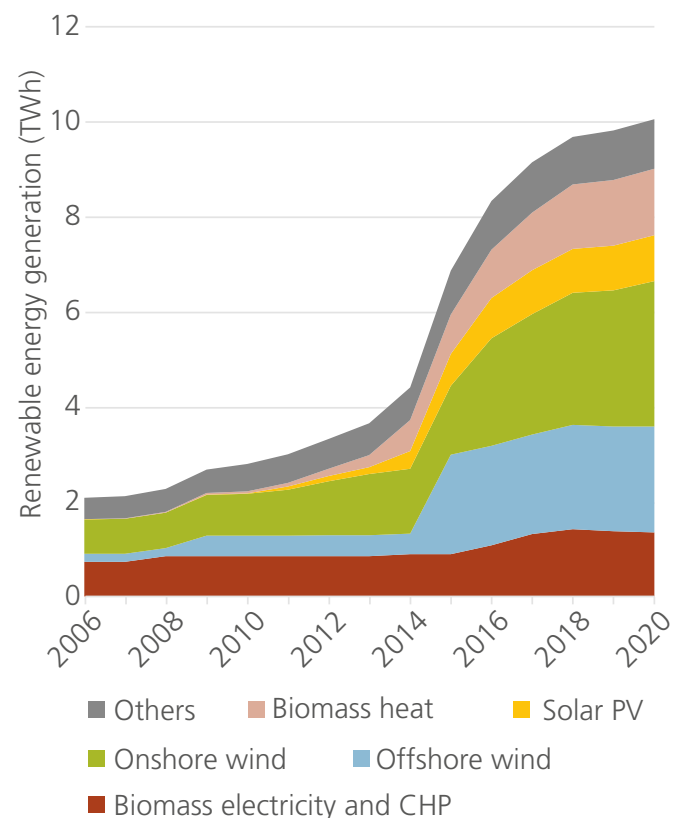
Renewable energy technologies	Number of projects	Electricity		Heat	
		Capacity (MW)	Estimated generation (GWh)	Capacity (MW)	Estimated generation (GWh)
Anaerobic digestion	46	19	100	8	49
Biomass heat	3,468	0	0	457	1,401
Biomass electricity and CHP	50	131	686	120	663
Energy from Waste	2	26	136	0	0
Heat pump	9,027	0	0	104	173
Hydropower	369	184	365	0	0
Landfill gas	23	30	83	0	0
Offshore wind	3	726	2,226	0	0
Onshore wind	751	1,273	3,070	0	0
Sewage gas	6	12	44	14	84
Solar PV	59,803	1,016	963	0	0
Solar thermal	4,736	0	0	13	8
Total	78,284	3,417	7,673	716	2,378

Renewable heat in Wales

- Four renewable heat projects over 1 MW were commissioned in 2020, all biomass projects accredited under the non-domestic Renewable Heat Incentive scheme.
- An additional 1,222 renewable heat projects under 1 MW were commissioned in Wales in 2020. 93% of these projects were heat pumps, totalling 16.6 MW.
- Biomass (including CHP projects) generates 85% of all renewable heat generation in Wales. The 3,518 biomass and biomass CHP projects in Wales total 557 MW.

Renewable energy generation in Wales

Data source: 1



Progress towards targets

The Welsh Government has a target for Wales to meet the equivalent of 70% of its electricity demand from Welsh renewable electricity sources by 2030. In 2020, this figure stands at 56%, up from 51% in 2019. The 2020 change is due to a reduction in electricity demand² and a small increase in estimated renewable electricity generation.

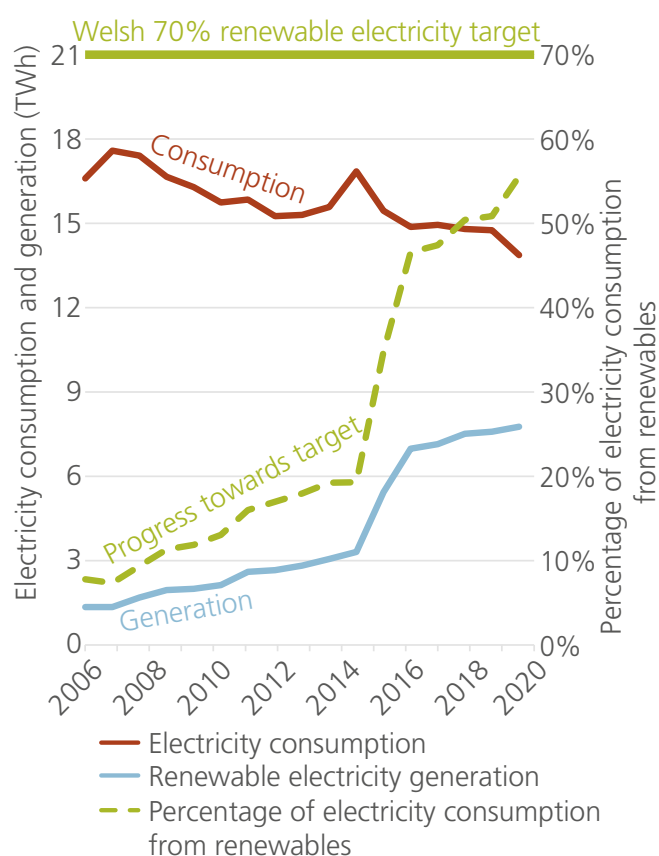
Progress towards the 70% renewable electricity target is affected by both electricity demand and renewable electricity generation – factors that can vary between years as a result of both predictable and unforeseen events. In 2020, COVID-19 impacted electricity demand, in particular reducing non-domestic electricity demand as a result of reduced activity. Therefore, the relative surge seen in 2020 towards Wales' 70% target may be temporary.

Furthermore, the Climate Change Committee's (CCC) 6th carbon budget estimates that while total energy consumption should reduce in Wales as progress is made towards net zero, electricity demand will increase as a result of increasing electricity consumption in the heat and transport sectors.

All of the CCC's net zero scenarios for Wales suggest that electricity consumption will remain approximately steady until 2030, before increasing by between 200% and 300% by 2050. For comparison, Wales' 2020 electricity generation is equivalent to approximately 21% of the CCC Balanced Scenario's 2050 electricity demand for Wales.

As well as potentially rising electricity demand, there remain significant challenges to deploying renewable generation at the pace required to meet the 70% target by 2030. Securing price support, gaining planning permission and securing a grid connection are some of the key challenges for new renewable generation projects. Projects are therefore struggling to develop sustainable, subsidy-free business models that accommodate the necessary network reinforcements.

Growth in the percentage of electricity consumption from renewable sources in Wales Data source: 1

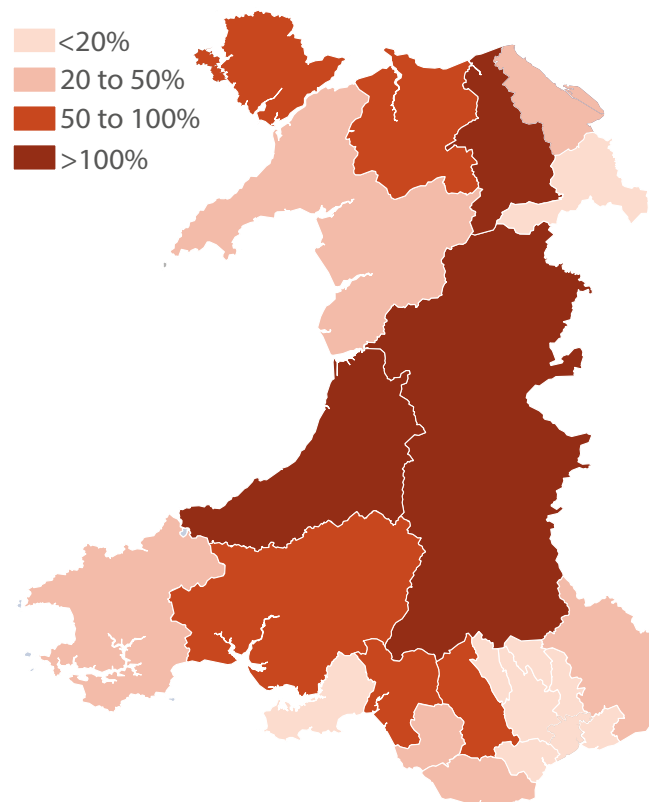


² BEIS, 2021; Subnational electricity consumption statistics, 2020 www.gov.uk/government/collections/sub-national-electricity-consumption-data

- Onshore and offshore wind are responsible for over two thirds of Wales' progress towards the 70% renewable electricity target.
- Since 2005, electricity consumption has fallen by 21% and renewable electricity generation has increased by over 540%.
- The 70% renewable electricity target is just the first step in renewable energy development in Wales, as Wales aims to generate renewable energy to at least meet its consumption.

Equivalent percentage of electricity consumption delivered by local renewable generation

Data source: 1, 2



Net Zero and energy security

The recent surge in the global price of gas, combined with Russia's war in Ukraine, has resulted in huge increases in energy prices across the world, with the impact felt hardest by those who are least able to bear it. The Welsh Government is providing support to those in urgent need in the short term, while building a future energy system which insulates Wales from the worst of the impacts. Extending fossil fuel use will only result in problems in the longer term. Instead, Wales will improve energy efficiency and develop a renewables-based energy system fit for the future.

Locally owned renewable energy

The Welsh Government has a target for at least 1 GW of renewable electricity and heat capacity to be locally owned by 2030. All new energy developments are required to have at least an element of local ownership. Furthermore, the Welsh Government has pledged to expand renewable energy generation by public bodies and community groups in Wales by over 100 MW by 2026.

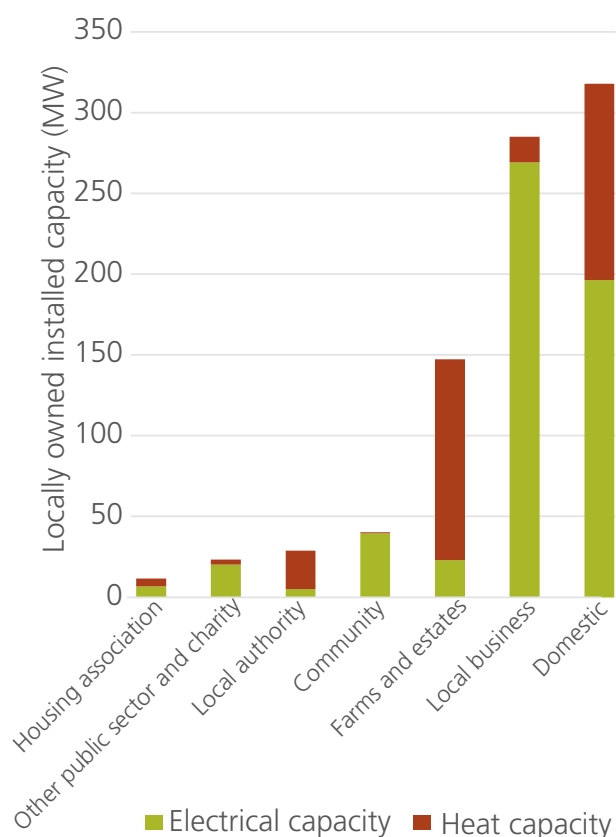
Wales has achieved 86% of its 1 GW local ownership target, with 859 MW of locally owned renewable capacity.

In 2020, over 32 MW of locally owned renewable energy capacity was commissioned, consisting of 14 MW of electrical capacity and 18 MW of heat capacity. Around 60% of this electrical and heat capacity was focussed in the domestic sector, largely due to the installation of solar PV and heat pumps. Around 20% of the new locally owned capacity is attributable to the commissioning of two local authority-owned solar farms on landfill sites.

There are now nearly 73,000 locally owned renewable electricity and heat projects in Wales, up from 69,700 in 2019. Nearly 90% of locally owned projects are domestic, including over 52,700 domestic solar PV projects and over 8,600 domestic heat pumps.

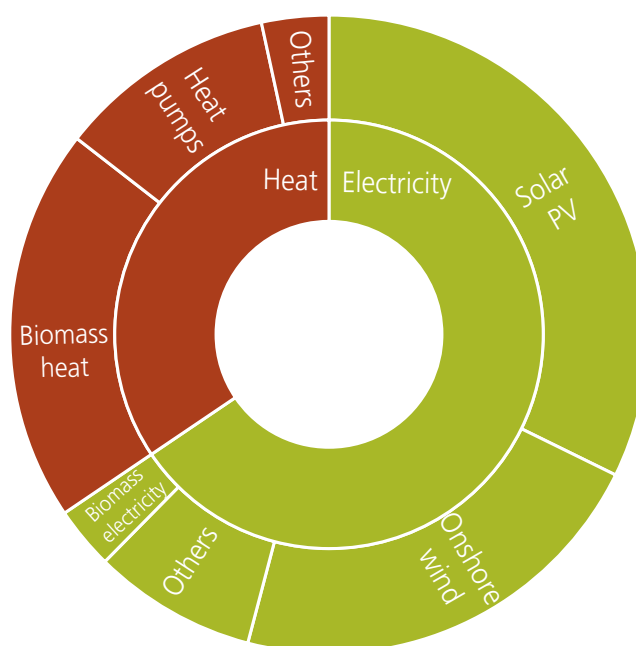
Locally owned renewable electricity and heat capacity by ownership type

Data source: 1



Locally owned renewable energy generation by technology (GWh)

Data source: 1



Definition of ownership

The definition for 'locally owned' is set out in Welsh Government's policy statement detailing local ownership of energy generation in Wales³. It covers energy installations that are located in Wales, owned by households, communities, local authorities, housing associations, other public sector bodies, charities (including faith organisations), further education establishments, local businesses (registered in Wales) and Welsh farms and estates. The figures are likely to be an underestimate due to limitations in the source data.

Locally owned renewable energy in Wales summary

Data source: 1

Ownership category	Total number of projects	Capacity (MWe)	Capacity (MWth)	Estimated generation (GWh)
Community	199	40	1	54
Domestic	65,111	197	122	453
Farms and estates	793	23	125	442
Housing association	5,687	7	5	9
Local authority	302	20	3	38
Local business	383	271	16	796
Other public sector and charity	417	5	24	80
Total	72,892	563	296	1,872

Fossil fuels

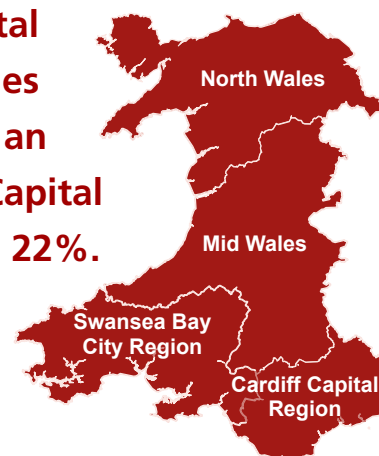
The ownership of fossil fuel electricity projects has not been fully assessed, as there are no appropriate datasets available for analysis. It is estimated that approximately 100 MW of gas, diesel and coal electricity generation capacity was locally owned in 2020, attributable to small-scale projects such as farm diesel generators. This is down from 1,500 MW in 2019, due to two large-scale gas plants that were owned by the Welsh-based power producer Calon Energy that are now dormant. Both of these plants may be repowered in the future. It is expected that a higher proportion of small-scale fossil fuel generators would be locally owned, often being associated with farms, businesses or public buildings as back-up generators for remote or essential services.

³ Welsh Government, 2020; Policy Statement: local ownership of energy generation in Wales – benefitting Wales today and for future generation, 2020 www.gov.wales/sites/default/files/publications/2020-02/policy-statement-local-ownership-of-energy-generation-in-wales.pdf

Regional context

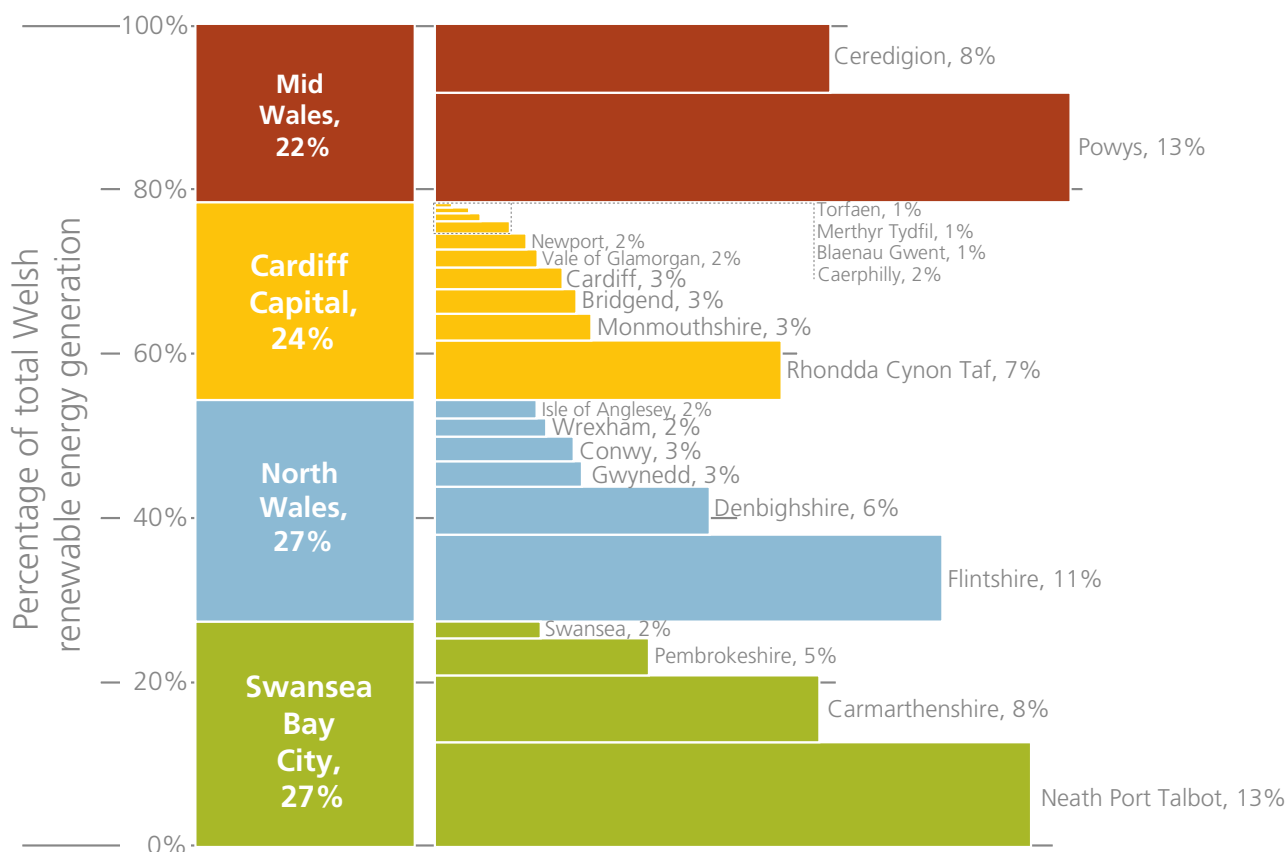
Regional context

Each region contributed a similar proportion of total renewable generation in Wales in 2020. North Wales and the Swansea Bay City Region both represented an estimated 27% of total generation, while the Cardiff Capital Region represented 24% and Mid Wales represented 22%. Powys is the local authority area that generated the most energy from renewable technologies in 2020, at an estimated 1050 GWh.



Estimated annual renewable energy generation by region and local authority, 2020

Data source: 1



Capacity growth by local area

20 out of 22 local authority areas saw an increase in their renewable energy capacity in 2020, but only five of those saw an increase greater than 5%. The remaining local authority areas saw an average increase in their renewable energy capacity, compared to 2019, of 2%.

In the Cardiff Capital Region, 71% of the increase in generation capacity was due to new solar PV projects, with the remainder coming from an onshore wind site located in Blaenau Gwent. In Flintshire, however, most of the capacity increase is attributable to a single 21 MW capacity Energy from Waste site. In Powys, the technology most responsible for the increased generation capacity is heat pumps, with over 160 being installed in a single year.

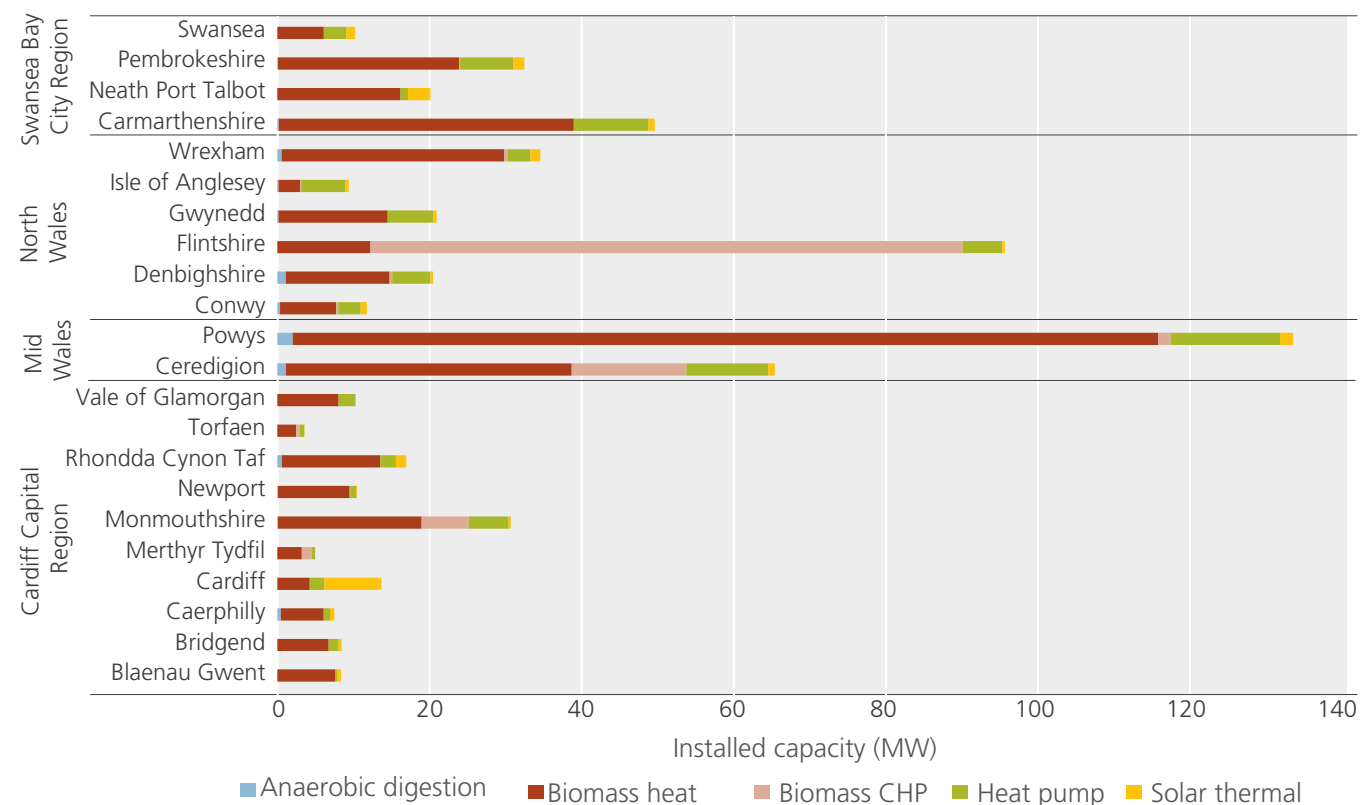
Top five local authorities with the highest increase in renewable energy capacity

Data source: 1

Region	Local authority area	Increase in renewable energy capacity
Cardiff Capital	Torfaen	22%
Cardiff Capital	Cardiff	18%
Cardiff Capital	Blaenau Gwent	12%
North Wales	Flintshire	11%
Mid Wales	Powys	5%

Renewable heat capacity by local authority

Data source: 1



Renewable heat

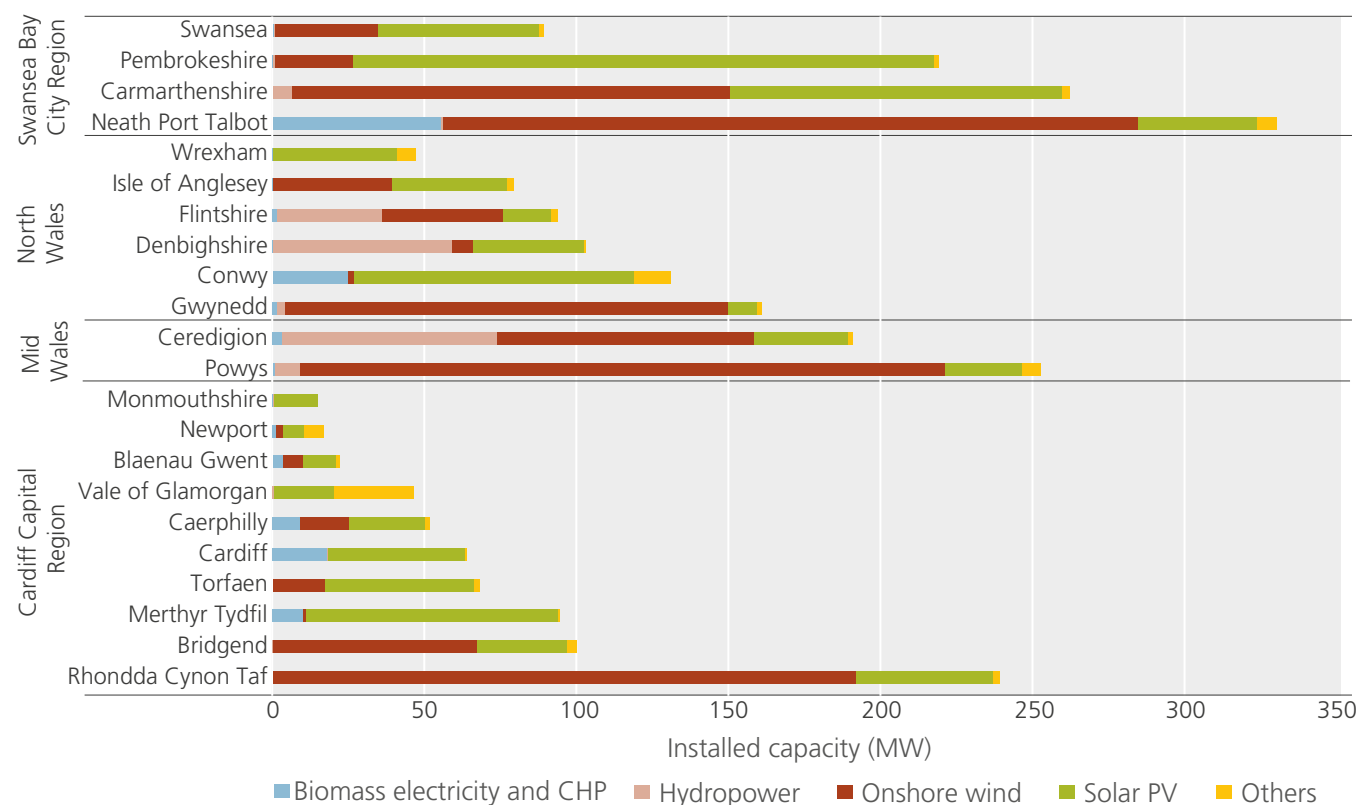
When looking specifically at heat, the greatest proportion of Wales' renewable heat capacity can be found in Mid Wales (32%), followed closely by North Wales (31%). In both regions, this capacity is mostly from biomass and biomass CHP heat generation. The two local authorities with the greatest renewable heat capacity are Powys, in Mid Wales, and Flintshire, in North Wales. Nationally, approximately 0.7% of all households in Wales now have heat pump systems.

Renewable electricity

The Swansea Bay City Region represents a third of Wales' renewable electricity capacity, with a total of 906 MW in 2020. Mid Wales, with 446 MW in 2020, accounts for 17% of Wales' renewable electricity capacity, with North Wales and the Cardiff Capital Regions representing 23% (618 MW) and 27% (721 MW) respectively. The local authority area with the greatest renewable electricity capacity is Neath Port Talbot (332 MW), followed by Carmarthenshire (264 MW), both of which are situated in the Swansea Bay City Region. The following graph does not include generation from offshore renewables, or the non-renewable proportion of Energy from Waste capacity.

Renewable electricity capacity by local authority

Data source: 1



Local consumption and generation

Data source: 1

Ceredigion is the area with the highest equivalent percentage of its electricity consumption delivered by local renewable electricity generation. This is due to a combination of comparatively low electricity consumption, and its diverse and relatively high amount of renewable energy generation. Powys also features in the top three local authority areas by percentage of electricity consumption met by renewables, with both local authority areas in Mid Wales generating more electricity in 2020 than they consumed.

Region	Local authority area	Equivalent percentage of electricity consumption delivered by local renewable generation
Mid Wales	Ceredigion	120%
North Wales	Denbighshire	112%
Mid Wales	Powys	107%

Cardiff Capital Region

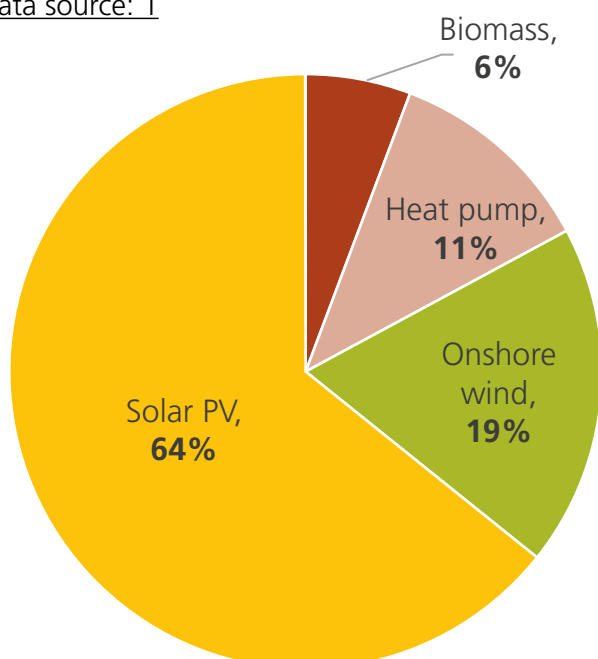
The Cardiff Capital Region commissioned 974 new renewable projects in 2020, representing an increase in capacity of 18.8 MW. The majority of these were small-scale installations, with only three projects commissioned with an individual capacity greater than 1 MW.

Data source: 1

Technology	Total Renewable heat and electricity			Commissioned in 2020	
	Number of projects	Total capacity (MW)	Estimated generation (GWh)	Number of projects	Total capacity (MW)
Anaerobic digestion	10	10	56	0	0
Biomass electricity and CHP	14	51	271	0	0
Biomass heat	504	92	281	6	1.1
Energy from Waste	1	15	78	0	0
Heat pump	1,608	18	35	178	2.2
Hydropower	25	1	3	0	0
Landfill gas	9	12	34	0	0
Onshore wind	94	304	734	1	3.5
Sewage gas	2	15	77	0	0
Solar PV	23,973	330	313	787	12.1
Solar thermal	1,695	4	3	2	0.005
Total	27,935	854	1,884	974	18.8

Percentage of renewable capacity commissioned in 2020, by technology

Data source: 1



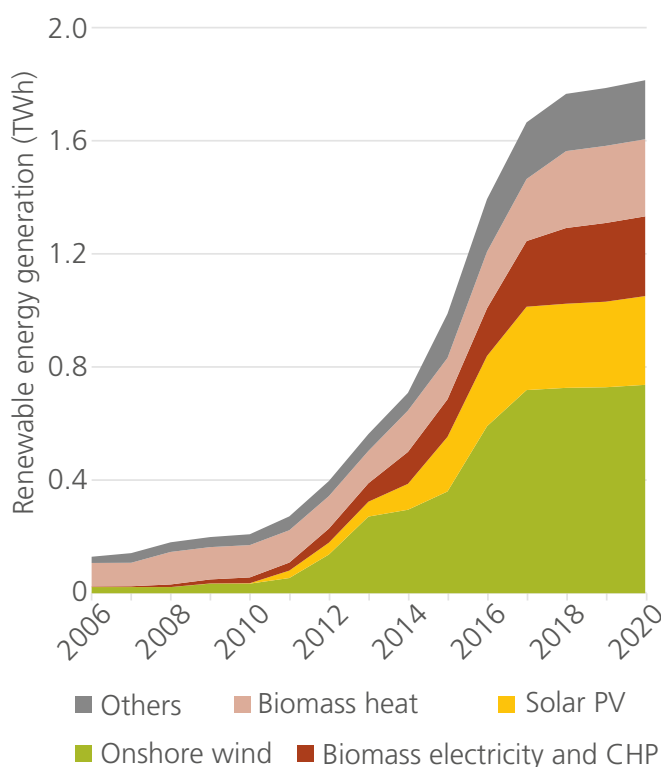
Largest projects in the Cardiff Capital Region commissioned in 2020, by capacity

Data source: 1

Project name	Local authority area	Technology	Capacity (MW)
Lamby Way	Cardiff	Solar PV	4.8
Budweiser	Blaenau Gwent	Onshore Wind	3.5
Mamhilad	Torfaen	Solar PV	3.2

Renewable energy generation in the Cardiff Capital Region

Data source: 1



An estimated 39% of the Cardiff Capital Region's renewable energy generation in 2020 came from onshore wind. This is more than double the next best-performing technology, solar PV, which represented an estimated 17% of renewable generation in the region in 2020.

2020 saw a 12.1 MW increase in solar PV capacity in the Cardiff Capital Region, with 64% of the total capacity commissioned in 2020 coming from solar PV projects. This is a marked increase on the previous two years, with 5.3 MW commissioned in 2019 and 3.2 MW in 2018.

Budweiser Wind Turbine

As part of their ambition to become net zero by 2040⁴, the Budweiser Brewing Group has commissioned a 3.5 MW onshore wind turbine just one mile from their Magor brewery in South Wales⁵. The turbine, commissioned in December 2020, is believed to be the tallest to enter commercial operation in the UK, with blade tips reaching a height of 150 m. Its proximity to the brewery means that it was possible to connect the two sites via a direct wire, and it is expected that the turbine will meet 25% of Magor Brewery's energy consumption by generating c.9 GWh of electricity annually.

4 Renewables Now, 2021; Budweiser UK goes 100% wind and solar www.renewablesnow.com/news/budweiser-uk-goes-100-wind-and-solar/

5 Renewables Now, 2020; Budweiser UK brewery adds private wire wind turbine www.renewablesnow.com/news/budweiser-uk-brewery-adds-private-wire-wind-turbine-725236/

Swansea Bay City Region

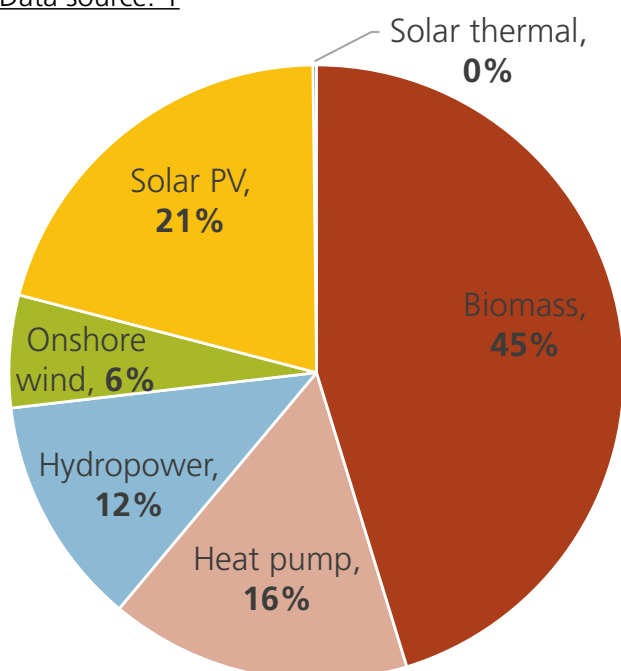
The Swansea Bay City Region commissioned 795 new renewable projects in 2020, representing an increase in capacity of 14.9 MW. The majority of these were small-scale installations, with only four projects commissioned with an individual capacity greater than 1 MW.

Data source: 1

Technology	Total Renewable heat and electricity			Commissioned in 2020	
	Number of projects	Total capacity (MW)	Estimated generation (GWh)	Number of projects	Total capacity (MW)
Anaerobic digestion	4	1	4	0	0
Biomass electricity and CHP	5	57	296	0	0
Biomass heat	943	98	301	27	6.7
Heat pump	2,141	24	46	222	2.4
Hydropower	40	8	15	1	1.8
Landfill gas	5	8	21	0	0
Onshore wind	280	435	1,050	1	0.9
Sewage gas	2	8	38	0	0
Solar PV	13,327	395	374	530	3.1
Solar thermal	1,060	3	2	14	0.03
Total	17,807	1,036	2,149	795	14.9

Percentage of renewable capacity commissioned in 2020, by technology

Data source: 1



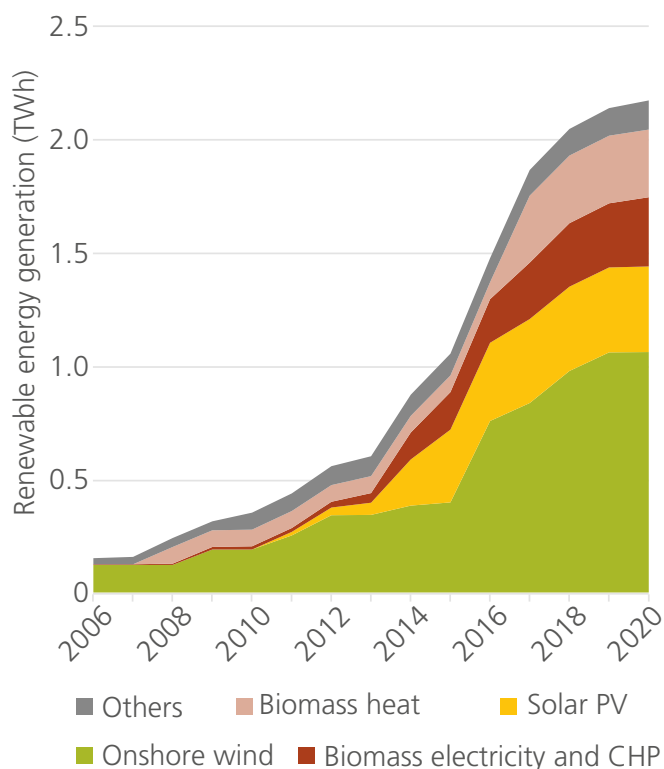
Largest projects in the Swansea Bay City Region commissioned in 2020, by capacity

Data source: 1

Project name	Local authority area	Technology	Capacity (MW)
-	Neath Port Talbot	Biomass	2
-	Swansea	Biomass	2
Ystradffyn Hydro	Carmarthenshire	Hydropower	1.8
-	Neath Port Talbot	Biomass	1.3

Renewable energy generation in the Swansea Bay City Region

Data source: 1



An estimated 49% of the Swansea Bay City Region's renewable energy generation in 2020 came from onshore wind, making it the highest generating technology type in the region. It generates more than twice as much as the next highest technology, solar PV, which represented an estimated 17% of 2020 renewable generation.

Deployment has been steadily slowing in the Swansea Bay City Region since 2014, with only 15 MW of capacity being commissioned in 2020. This is less than half of that commissioned in the previous year (40 MW), and a fraction of the 201 MW commissioned in the peak year of 2014.

Prouts Park Turbine

This community-owned 900 kW turbine at Prouts Park farm near Tenby took over eight years to come to fruition. After securing land agreements in 2012, the Pembrokeshire South East Energy Group first applied for planning permission in 2015, which was rejected⁶. An appeal in 2016 was successful, and the group then navigated securing an Active Network Management agreement to overcome grid constraint issues. With support from the Welsh Government Energy Service to develop the business plan, the project commenced construction in 2019. It was commissioned in March 2020 and is estimated to generate over 2,000 MWh of electricity annually.



Image credit: Community Energy Pembrokeshire

⁶ Community Energy Pembrokeshire, 2020; Background to the Prouts Park Turbine www.communityenergypembrokeshire.org/the-story-of-prouts-park-turbine.html

Mid Wales

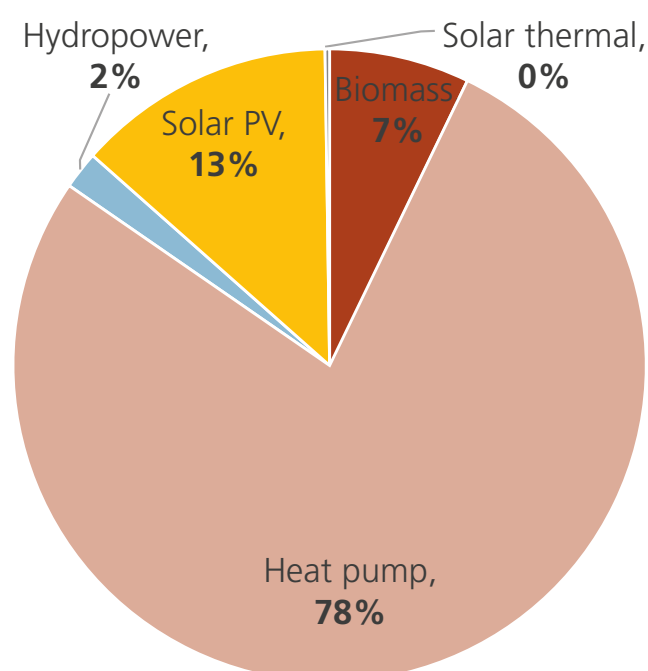
Mid Wales commissioned 527 new renewable projects in 2020, representing an increase in capacity of 8.2 MW. The majority (90%) of these were small-scale domestic installations, with no single commissioned project having an individual capacity greater than 0.5 MW.

Data source: 1

Technology	Total Renewable heat and electricity			Commissioned in 2020	
	Number of projects	Total capacity (MW)	Estimated generation (GWh)	Number of projects	Total capacity (MW)
Anaerobic digestion	17	9	51	0	0
Biomass electricity and CHP	14	24	129	0	0
Biomass heat	1,217	175	537	22	0.6
Heat pump	2,497	29	56	258	6.4
Hydropower	106	79	151	1	0.2
Landfill gas	1	2	6	0	0
Onshore wind	197	298	720	0	0
Solar PV	6,765	57	54	239	1.1
Solar thermal	1,031	3	2	7	0.02
Total	11,845	676	1,704	527	8.2

Percentage of renewable capacity commissioned in 2020, by technology

Data source: 1



An estimated 42% of Mid Wales' renewable energy generation in 2020 came from onshore wind, making it the dominant source of renewable generation in the region. This is followed by biomass, which represents an estimated 31% of the region's renewable generation in 2020.

The majority of new capacity commissioned in 2020 came from renewable heat projects, most notably heat pumps (78%) and biomass (7%). The increase in renewable electricity capacity in 2020 was made up of solar PV and hydropower projects.

Dolanog

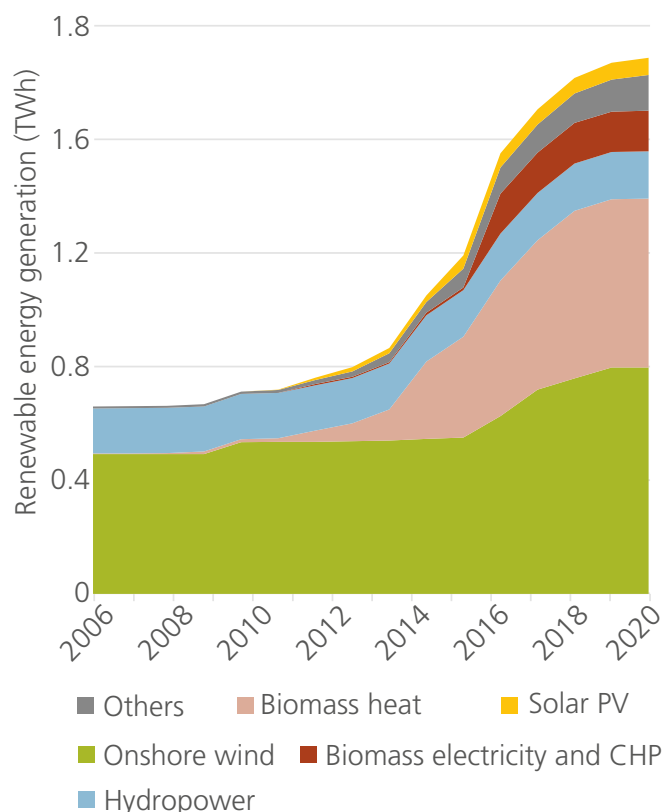
Passing through Dolanog in Powys is the River Vyrnwy, which first powered a hydroelectric system in 1921. At that time it supplied electricity to five houses, the church and chapel in the local village⁷. Since then, the scheme has undergone several evolutions. Most recently, in 2020, the owners Derwent Hydro⁸ replaced the former multi-turbine arrangement with a single crossflow turbine rated at 160 kW. A new debris screening arrangement was also installed which has significantly improved consistency of output. This has given new life to the Dolanog hydropower station, which is now estimated to generate over 500 MWh of electricity annually.



Image credit: Derwent Hydro

Renewable energy generation in Mid Wales

Data source: 1



⁷ Berrybros; The Dolanog Estate www.uklandandfarms.co.uk/properties/49840/36023_100690001317_DOC_00.pdf

⁸ Derwent hydro; Our Sites www.derwent-hydro.co.uk/our_sites/

North Wales

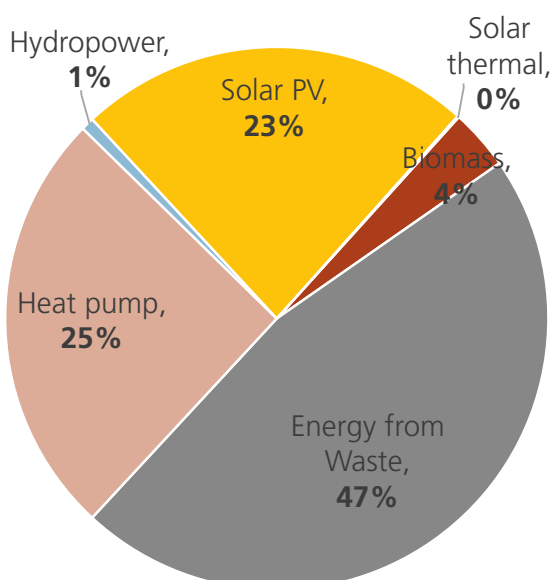
North Wales commissioned 1,378 new renewable projects in 2020, the highest number of all four regions. More than 880 of these were solar PV installations, all of which had a capacity of less than 0.05 MW, except for a single 2 MW site in Flintshire. The largest electricity project commissioned in Wales in 2020 was the Parc Adfer Energy from Waste in Flintshire, with an electricity capacity of 21 MW, 10.5 MW of which is classed as renewable.

Data source: 1

Technology	Total Renewable heat and electricity			Commissioned in 2020	
	Number of projects	Total capacity (MW)	Estimated generation (GWh)	Number of projects	Total capacity (MW)
Anaerobic digestion	15	7	38	0	0
Biomass electricity and CHP	15	120	652	0	0
Biomass heat	804	92	283	7	0.81
Energy from Waste	1	10.5	57	1	10.5
Heat pump	2,781	32	62	475	5.7
Hydropower	195	97	196	1	0.18
Landfill gas	8	8	23	0	0
Onshore wind	181	235	566	0	0
Sewage gas	2	3	13	0	0
Solar PV	15,715	234	222	886	5.3
Solar thermal	950	3	2	8	0.02
Total	20,667	841	2,114	1,378	22.5

Percentage of renewable capacity commissioned in 2020, by technology

Data source: 1



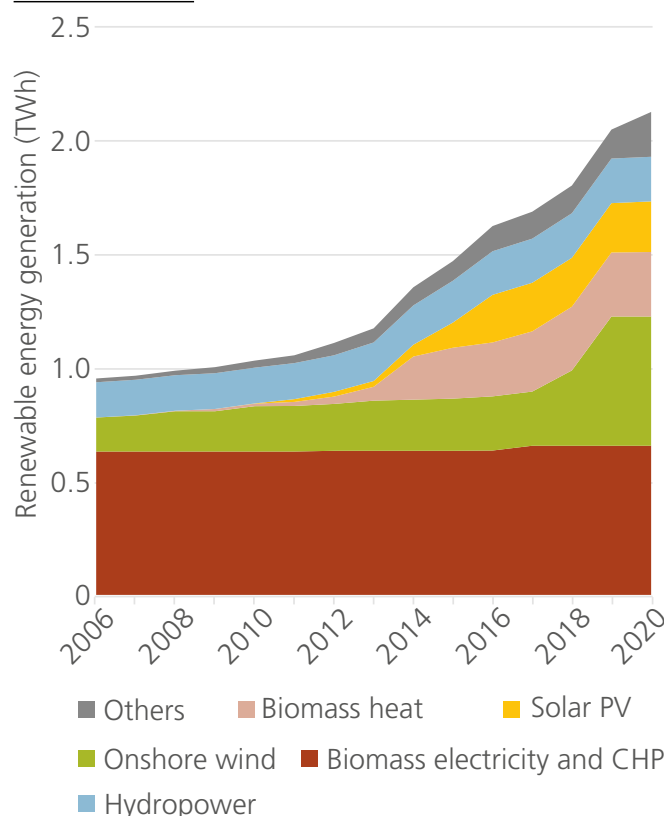
Largest projects in North Wales commissioned in 2020, by capacity

Data source: 1

Project name	Local authority area	Technology	Capacity (MW)
Parc Adfer EfW	Flintshire	Energy from Waste	21 (10.5 classed as renewable)
Flint Landfill Site Castle Park	Flintshire	Solar PV	2

Renewable energy generation in North Wales

Data source: 1



An estimated 44% of North Wales' renewable energy generation in 2020 came from either biomass electricity and CHP (31%) or biomass heat (13%). The next highest technology, onshore wind, represented an estimated 27% of renewable generation in the region in 2020. Despite North Wales receiving slightly less solar irradiance than the more southern regions of Wales, solar PV still represented an estimated 10% of renewable generation in 2020, making it the region's next most significant technology type.

Corwen Energy Local

In December 2016, the Corwen Electricity Cooperative successfully commissioned a 55 kW hydro scheme in the town of Corwen. The scheme is owned and run by the community, with 50% of the £300,000 project funded by people in the local area. Shareholders will have their capital returned to them by 2036, by which time the Cooperative anticipates that the scheme would gross over £800,000⁹.

A new scheme, Corwen Energy Local, has now been set up by South Denbighshire Community Partnership, in order to maximise local use of renewable generation¹⁰. Owners of solar panels and other renewable generation assets have been invited to join the energy scheme,

which will pool energy from local generation. Members can access a mobile app which tells them when the Energy Local scheme is generating cheap electricity. It is expected that members will save approximately £100 a year on their energy bills.

Image credit: Corwen Energy Local



9 Renew Wales; Corwen Reservoir Hydro Power Scheme www.renewwales.org.uk/corwen-reservoir-hydro-power-scheme/

10 North Wales Live, 2020; North Wales town set to become the greenest in the country www.dailypost.co.uk/news/local-news/corwen-renewable-energy-hydro-electricity-17505122

Low carbon technologies

Hydropower

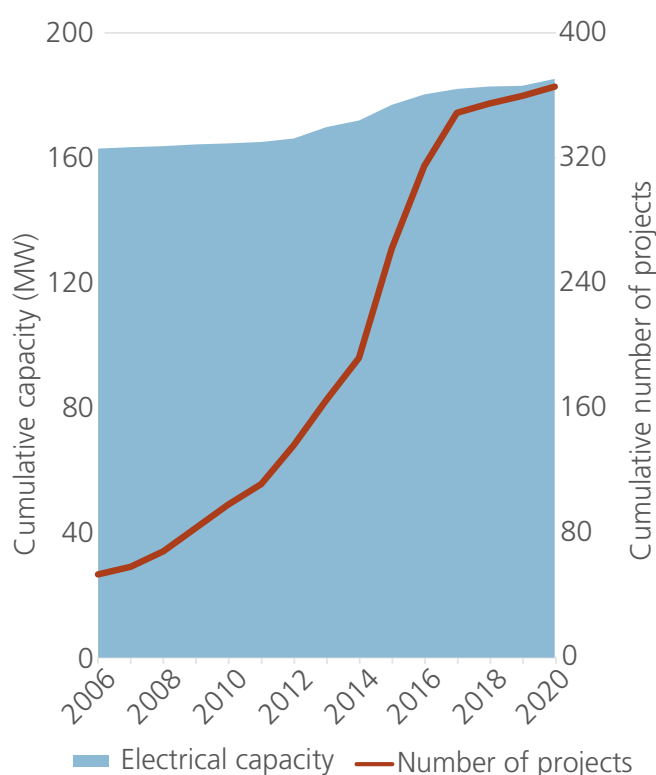
There were six new hydro projects commissioned across Wales in 2020, with a total capacity of 2.2 MW. This brings the total installed capacity to 184 MW across 369 projects, generating an estimated 365 GWh of renewable electricity each year. The 1.8 MW Ystradffin scheme, commissioned in the Swansea Bay City Region, is the largest hydropower project to be commissioned this century.

Most recent hydropower development has been in North Wales. With 14 MW developed across 156 projects since 2010, North Wales now accounts for 52% of hydropower capacity in Wales. There has also been significant activity in Mid Wales, the second highest region in Wales for hydropower capacity (43%), with 2.5 MW developed across 71 projects. Cardiff Capital Region and Swansea Bay City Region have each seen 19 new projects, with 0.89 MW of new capacity in the Cardiff Capital Region and 2.6 MW, including the new Ystradffin project, in the Swansea Bay City Region.

Hydropower generation in Wales consists of 12 large-scale projects with capacities greater than 1 MW and almost 350 smaller projects. The majority of these smaller projects were developed over the past decade, with 268 commissioned since 2010 with an average capacity of around 76 kW. This high level of activity reflects the support that was available through the Feed-in Tariff and Renewables Obligation, resulting in an additional 20 MW of capacity delivering an estimated 54 GWh of generation per year. These support schemes have now been removed; as a result, the number of projects connecting has slowed since 2017. Financing further hydro projects is now extremely challenging and there is very little new capacity in the planning pipeline.

Deployment of hydropower over time

Data source: 1



Top local authority areas by hydropower capacity

Data source: 1

Local authority area	Region	Capacity (MW)
Ceredigion	Mid Wales	71
Gwynedd	North Wales	59
Conwy	North Wales	35

Offshore wind

There are three operational offshore wind projects in Wales, all in Liverpool Bay off the North Wales coast, with a total capacity of 726 MW. Offshore wind plays a major role in renewable generation in Wales, accounting for an estimated 29% of renewable electricity generation in 2020. Additional capacity of both fixed and floating offshore wind is in development around the Welsh coastline.

The majority of the UK's offshore wind farms are currently located in the North Sea, and the diversification of sites around the UK coast is essential to security of supply by taking advantage of the geographic variation in weather patterns. While the last fixed offshore wind farm in Welsh waters was commissioned in 2015, high levels of activity over the last two years has resulted in the valuation of The Crown Estate's marine portfolio in Wales having increased from £49.2 million in 2020 to £549.1 million in 2021¹¹. This includes the Round 4 leasing round in February 2021, which included a successful bid from a consortium of EnBW and BP for a project located off the Northern Welsh coast, with a potential capacity of 1.5 GW.

RWE is also scoping for the Awel y Môr offshore wind farm, adjacent to the existing Gwynt y Môr wind farm. Development work is still in the early stages, so the capacity of the farm has not yet been confirmed, but RWE intends for the wind farm to be operational by 2030. Fixed offshore wind has received £200m in Pot 3 of Contracts for Difference (CfD) Allocation Round 4 at a strike price of £46 /MWh.

Existing offshore wind projects in Wales, by commissioning year

Data source: [1](#)

Wind farm	Commission Year	Capacity (MW)
North Hoyle	2003	60
Rhyl Flats	2009	90
Gwynt y Môr	2015	576



Image credit: RWE

Gwynt y Môr wind farm, which contains 160 turbines in total.

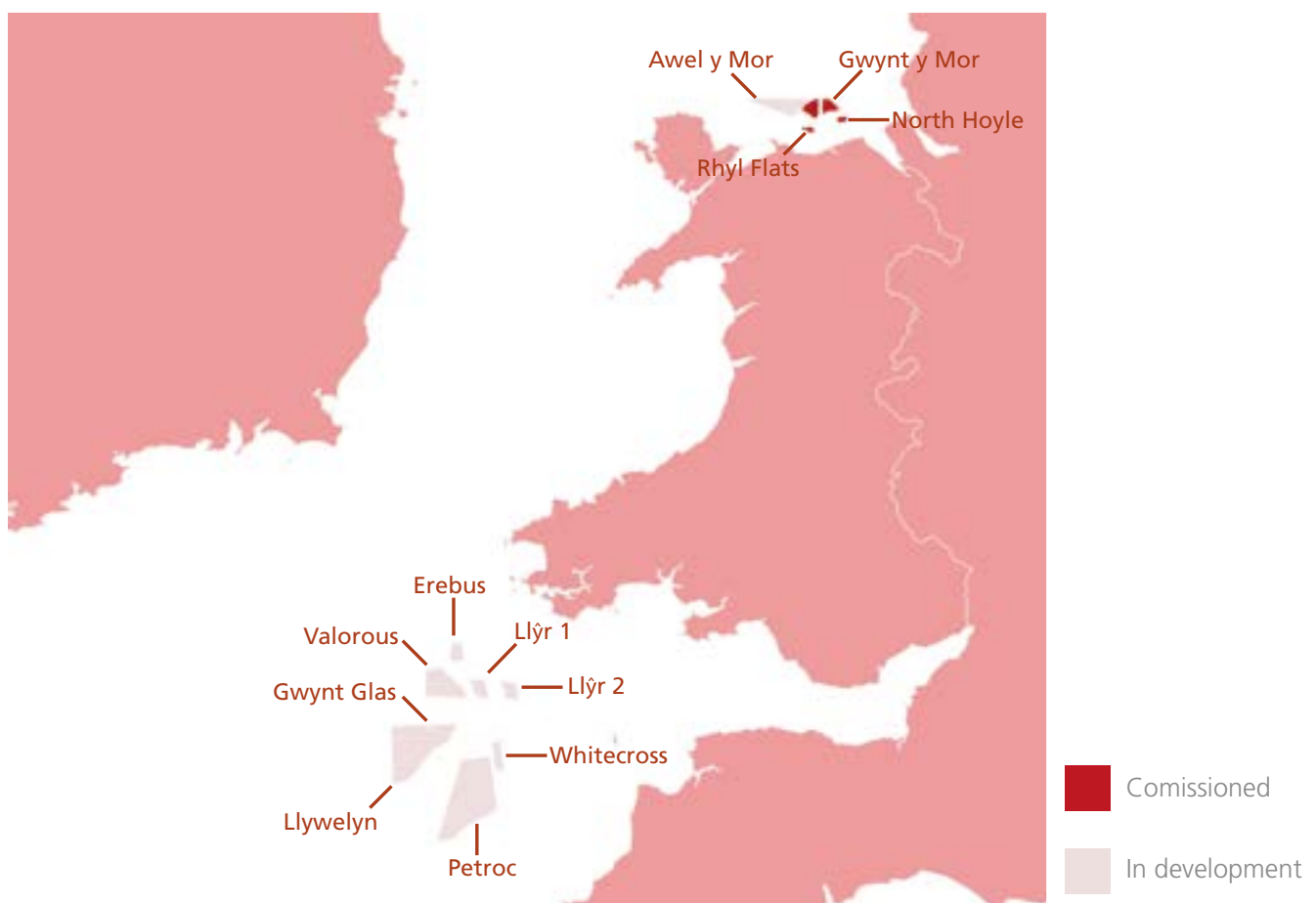
¹¹ The Crown Estate, 2021; Wales Highlights 2020/21 www.thecrownestate.co.uk/media/3872/wales-highlights-2021-final.pdf

Floating offshore wind

Floating offshore wind (FLOW) is a subset of offshore wind that allows developers to access deeper water and stronger winds by removing the need to be fixed to the seabed. In November 2021, The Crown Estate announced its ambition to unlock 4 GW of floating offshore wind in the Celtic Sea by 2035, through a seabed leasing round to be awarded in 2023. Around a similar time, floating offshore wind was awarded a ring-fenced £24m in CfD Allocation Round 4, a significant boost to the sector so soon after the Celtic Sea announcement. According to Marine Energy Wales, the FLOW sector has contributed nearly £2.2 million to the Welsh economy in recent years, but with significant growth expected over the next decade, a forecasted £682 million could be delivered in supply chain opportunities for Wales and Cornwall by 2030.

The Celtic Sea has 150-250 GW of wind resource¹², with 15-50 GW estimated to be capturable through renewable energy developments. Erebus, a 100 MW test and demonstration project developed by Blue Gem Wind, hopes to be operational by 2026 and will be the first floating wind farm contributing to Welsh energy generation. This will then be followed by Valorous, a 300 MW early-commercial project, and the various FLOW projects announced by developers following the announcement of the Celtic Sea leasing round.

Location of offshore wind projects



¹² Marine Energy Wales, 2021; State of the Sector www.marineenergywales.co.uk/wp-content/uploads/2021/07/State-of-the-Sector-2021.pdf

While marine energy has not yet contributed to Welsh electricity generation, in its 2021 'State of the Sector report' Marine Energy Wales identified 465 MW of marine energy sites that have been leased in Welsh waters (covering tidal stream, tidal range, wave energy and floating offshore wind technologies), with an additional 3.4 GW of sites identified for future development¹³.

Wave and tidal technologies are still in the pre-commercialisation stage, with tidal stream recently being awarded a ring-fenced £20m in Allocation Round 4 of the CfD scheme. A number of tidal developers have now met the eligibility criteria for CfD Allocation Round 4 and could see the first commercial deployment of these technologies in the coming years.

For tidal range, including tidal lagoons, various setbacks have caused concerns over its viability, particularly the economics of such a large-scale civil infrastructure project. The Welsh Government is currently investigating the feasibility of undertaking a competition to support the delivery of a tidal lagoon in Welsh waters. The North Wales Tidal Energy project is hoping to achieve this through a tidal lagoon, most likely between Llandudno and Prestatyn, with a 31 km sea wall and an installed capacity of 2.5 GW.

2020-2021 was a busy and productive year for the emerging offshore renewables sector, with £29.1 million invested in marine energy in Wales. Welsh Government has strongly supported marine energy for many years and recognises the “key part marine energy must play for the resilient and diverse energy sources” needed not only for net zero but to ensure energy security.

Bombora

Founded in 2012 in Perth, Western Australia, Bombora has since established its European operations in Pembrokeshire and is currently progressing the 1.5 MW mWave Pembrokeshire Demonstration Project supported by ERDF funding through the Welsh Government¹⁴. This project is expected to become operational in 2022. Bombora is also working with TechnipFMC to develop an offshore energy platform, integrating floating offshore wind with the innovation wave technology.



Image credit: Bombora

Mockup of an integrated floating offshore wind platform with Bombora's mWave technology.

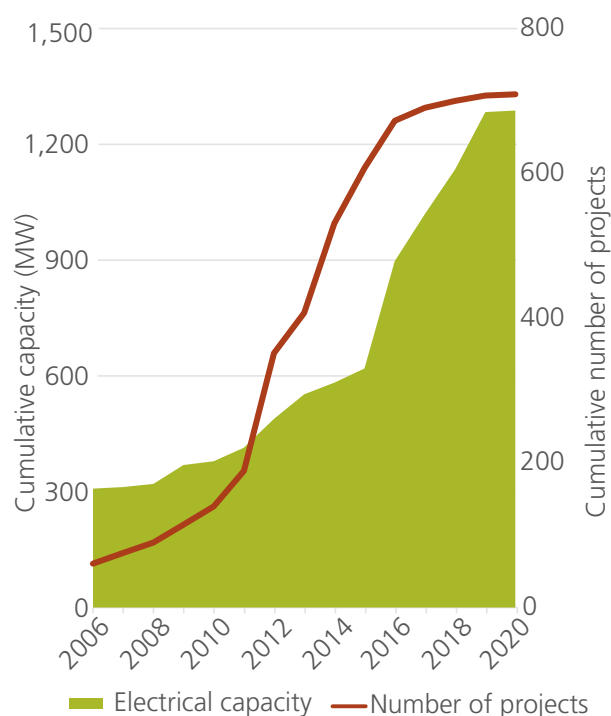
¹³ Marine Energy Wales, 2021; State of the Sector www.marineenergywales.co.uk/wp-content/uploads/2021/07/State-of-the-Sector-2021.pdf

¹⁴ Bombora, 2020; About the Pembrokeshire project www.bomborawave.com/latest-news/project/1-5mw-pembrokeshire-project/

Onshore wind

With 4.4 MW of capacity commissioned from two projects, 2020 saw the lowest levels of onshore wind deployment in Wales in over a decade. This is in stark contrast to the 147 MW of capacity that was commissioned in the previous year, and the 205 MW commissioned during the peak of 2016. Onshore wind capacity now stands at 1,273 MW in Wales, 34% of which is situated in the Swansea Bay City Region. The Cardiff Capital Region contains 24% of onshore wind capacity, followed closely by Mid Wales (23%) and North Wales (18%) .

Deployment of onshore wind over time Data source: 1



The Welsh Government's Future Wales plan, published in 2021, reiterated strong support for onshore wind, and there are over 20 onshore wind projects over 1 MW in the development pipeline. However, many applications are hampered by grid constraints, which the Welsh Government has recognised in its Future Energy Grids for Wales project¹⁵. Future Energy Grids for Wales will achieve a long-term approach and joint view, across all grid operators and other stakeholders, of the likely future energy needs across Wales to 2050. The project will decide on the steps to evolve networks to support Wales' Net Zero Carbon ambition and the work needed to achieve this, drawing on the perspectives of a wide range of people across Wales.

Some potential to access revenue support for new projects is due in the form of the CfD Allocation Round 4, which should once again offer support to 'pot 1' onshore wind and solar projects. However, onshore wind projects are increasingly diversifying their income streams, such as energy company Ripple's Graig Fatha wind farm. Situated in the Rhondda Cynon Taf local authority area and due to begin generating in 2022, the farm is owned by over 900 members of the public, as well as being supported with a grant from Welsh Government.

Onshore wind projects commissioned in 2020 Data source: 1

Project name	Local authority area	Region	Capacity (MW)
Budweiser Wind Turbine	Blaenau Gwent	Cardiff Capital	3.5
Prouts Park	Pembrokeshire	Swansea Bay City	0.9

15 Energy Systems Catapult, 2021; Welsh Future Energy Grid for Net Zero es.catapult.org.uk/project/welsh-future-energy-grid-for-net-zero/

Renewable heat

An additional 16.6 MW of air, ground and water source heat pump capacity was commissioned in Wales in 2020, the greatest proportion of which was in Mid Wales (6.4 MW). 62 new biomass projects, and 31 new solar thermal projects, were commissioned in 2020, almost half (44%) of which were in the Swansea Bay City Region.

Heat pumps

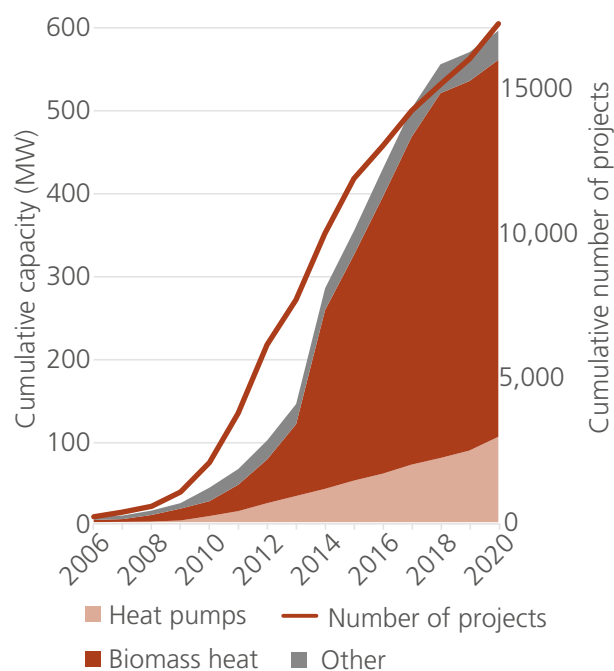
Despite COVID-19, 2020 saw the greatest number of heat pumps installed across Wales in a single year (1,133), the majority of which were domestic installations. The largest heat pumps installed in 2020 were three 480 kW ground source heat pumps in Powys, accredited under the non-domestic Renewable Heat Incentive. Mid Wales now has over 29 MW of heat pump capacity, much of which can be attributed to social housing providers in this region upgrading tenant homes with air source heat pumps.

In the Net Zero Wales Carbon Budget 2 (2021 to 2025) the Welsh Government stated its aim to “increase the proportion of heat that is electrified by 3% by 2025”¹⁶, reinforcing their commitment to move away from fossil fuel heating. However, the relatively high upfront cost of heat pumps remains the main barrier to widespread deployment. The closure of the domestic Renewable Heat Incentive scheme in 2022 may have an impact on heat pump deployment rates, although it has been replaced by a new Boiler Upgrade Scheme that will help consumers with the high upfront cost of purchasing and installing a low carbon heating system.

Biomass

Biomass heat projects totaled 1401 MWth in 2020, representing an estimated 58% of renewable heat capacity. In November 2021, the UK Government published a biomass policy statement¹⁷, which aimed to provide a strategic view on the role of biomass across the economy in the medium-to-long-term. In recognition of biomass being a finite resource, it highlighted the challenge of securing a sustainable and reliable supply of quality biomass, while committing to strive for sustainable biomass use only. The policy statement is a precursor to a more in-depth Biomass Strategy document, due to be published in late 2022.

Deployment of renewable heat projects over time Data source: 1



¹⁶ Welsh Government, 2021; Net Zero Wales Carbon Budget 2 (2021 to 2025) www.gov.wales/net-zero-wales-carbon-budget-2-2021-2025

¹⁷ UK GOV, 2021; Biomass Policy Statement www.gov.uk/government/publications/biomass-policy-statement-a-strategic-view-on-the-role-of-sustainable-biomass-for-net-zero

Solar PV

There was 21.7 MW of solar PV commissioned in Wales in 2020, bringing the total capacity to over 1 GW from nearly 60,000 projects. Almost all of these, over 99%, are rooftop installations; however, due to their small scale, these account for less than a quarter of total installed solar PV capacity. The remaining 76% of capacity is accounted for by approximately 100 larger ground-mounted solar projects.

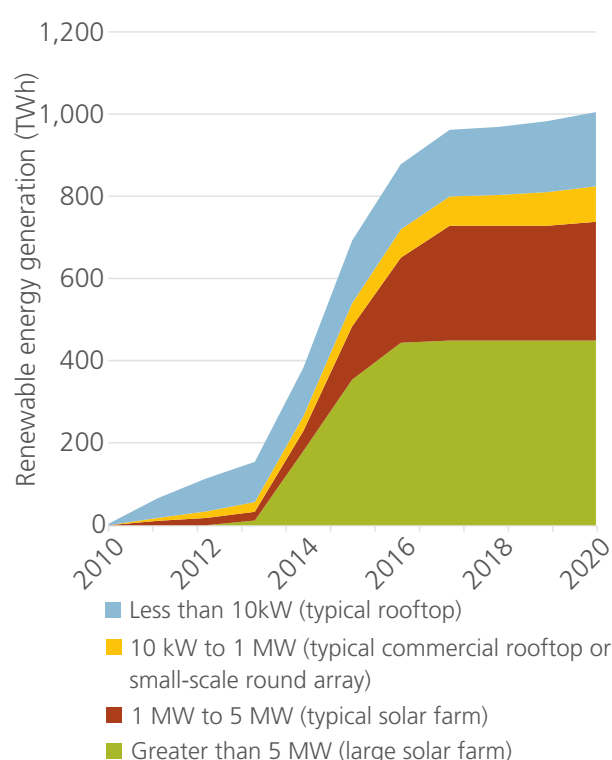
Three solar farms were commissioned in Wales in 2020, all of which were installed on landfill sites. Two of these sites, located in Cardiff and Flintshire, are owned by local authorities. Therefore, in addition to contributing to Wales' renewable electricity generation target, they also contribute to Wales' target of hosting 1 GW of locally owned renewable energy capacity by 2030.

71% of solar PV capacity can be found in the two most southern regions of Wales, with 39% of capacity in the Swansea Bay City Region, and 32% in the Cardiff Capital Region. North Wales accounts for 23% of solar PV capacity in Wales, with Mid Wales representing the remaining 6%. The local authority area with the most solar PV capacity is Pembrokeshire, with 192 MW of capacity.

The ending of support mechanisms during the latter part of the 2010s has been a key factor in slowing deployment of solar PV, and in combination with rising installation costs in recent years, developing a viable subsidy-free business case for solar PV projects has been challenging.

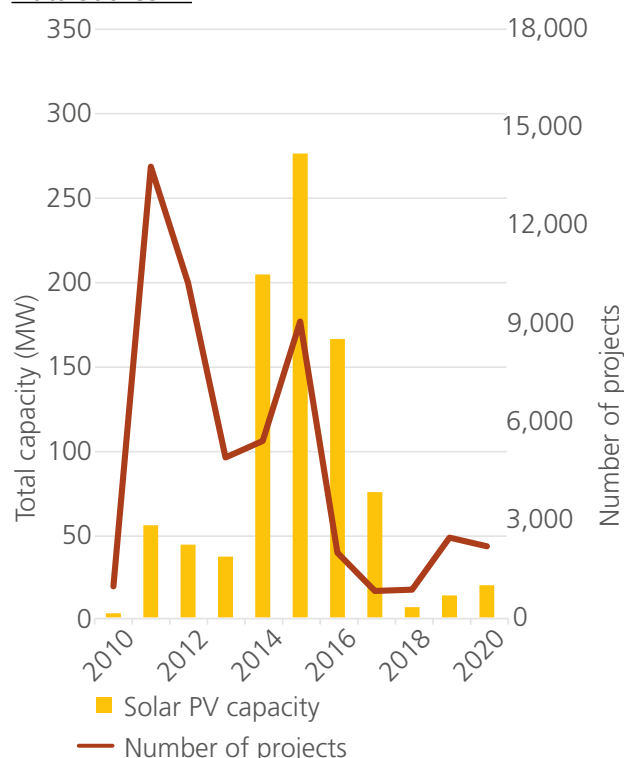
Solar PV deployment in Wales by scale

Data source: 1



Annual solar PV deployment in Wales

Data source: 1



Waste technologies

The 21 MW Energy from Waste site, Parc Adfer in Flintshire, was the only generation from waste technology to be commissioned in Wales in 2020. With 68 MW of capacity, the Cardiff Capital Region dominates in these technologies, representing 50% of all generation from waste technologies in Wales. North Wales, with an estimated 40 MW of capacity, represents 29% of generation, while the Swansea Bay City Region and Mid Wales account for 12% (16 MW), and 8% (11 MW) respectively.

Energy from Waste

While only two regions in Wales have commissioned Energy from Waste generation plants, the largest is at Trident Park in Cardiff. With a capacity of 30 MW, it has generated an estimated 15.6 GWh of electricity annually since it commissioned in 2015, 50% of which has been assumed to be renewable. In March 2021, the Welsh Government announced a moratorium on new Energy from Waste plants, which covered those of 10 MW or greater with immediate effect, impacting the development of future plants.

Anaerobic digestion (AD)

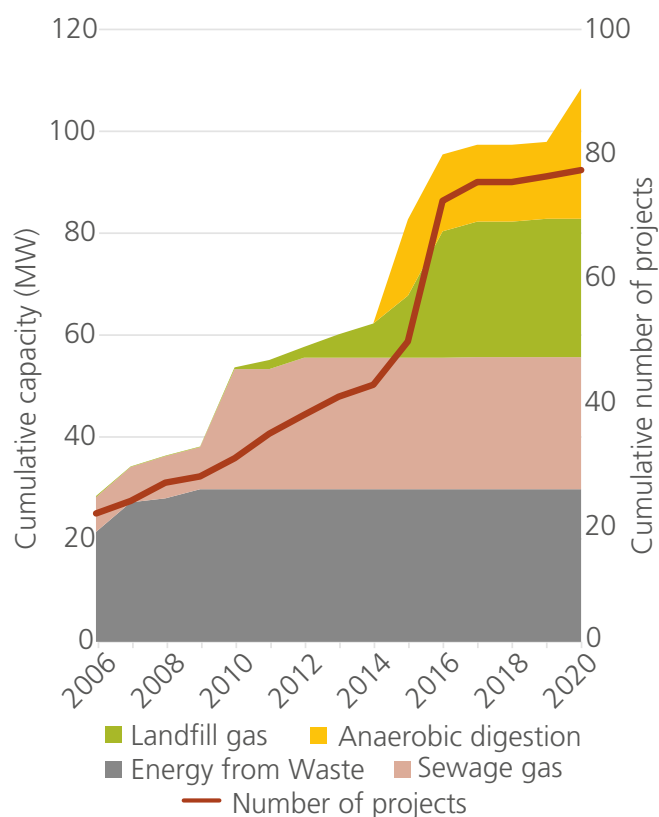
The number of AD projects in Wales increased significantly during the 2010s, from three in 2010 to 46 in 2020. These are all small-scale generators, with the largest site having a capacity of 2.8 MW, and the majority (36 sites) having a capacity of less than 1 MW. 13 anaerobic digestion generators are located in Powys - more than in any other local authority area.

Sewage and landfill gas

No new landfill or sewage gas generators have been commissioned in Wales since 2017, when a 0.05 MW capacity microgeneration site was commissioned at a landfill in Rhondda Cynon Taf. In 1999, less than 5% of municipal waste was recycled - in 2020, this figure was over 65%. As the amount of organic waste in landfill sites continues to reduce into the 2020s, in line with the Welsh Government's commitment to transition to a circular economy, there will be less of a role for landfill gas generation.

Deployment of waste technology projects over time

Data source: 1



Fossil fuels

Fossil fuel electricity generation

The total capacity of fossil fuel generation in Wales was nearly 4.4 GW in 2020, comprising predominantly of 4.1 GW of gas and 0.25 GW of diesel. Generation from fossil fuels was 15.3 TWh, which is 44% of Wales' total electricity generation and the equivalent of 110% of Wales' electricity consumption. 2020 marked the first year with no coal-fired electricity generation in Wales for more than 120 years.

Installed capacity fell from 7.3 GW in 2019 to 4.4 GW, reflecting the closure of several large- and medium-sized power stations. This included Wales' last coal station at Aberthaw, and the dormant gas stations at Baglan Bay and Uskmouth due to the collapse of Calon Energy.

The majority of the remaining gas capacity is accounted for by two large CCGT power stations at Pembroke (2,181 MW) and Connah's Quay (1,380 MW). There are also 55 smaller gas stations with a combined capacity of 670 MW which operate largely as flexible 'peaking' plants. In terms of output, generation from gas dropped by 23% to 14.7 TWh compared with the previous year, while coal generation dropped to zero compared to 0.6 TWh in 2019.

It is also assumed that half of electricity generated from waste is non-renewable, comprising around 26 MW of assumed non-renewable electrical capacity and 0.1 TWh of non-renewable electricity generation.

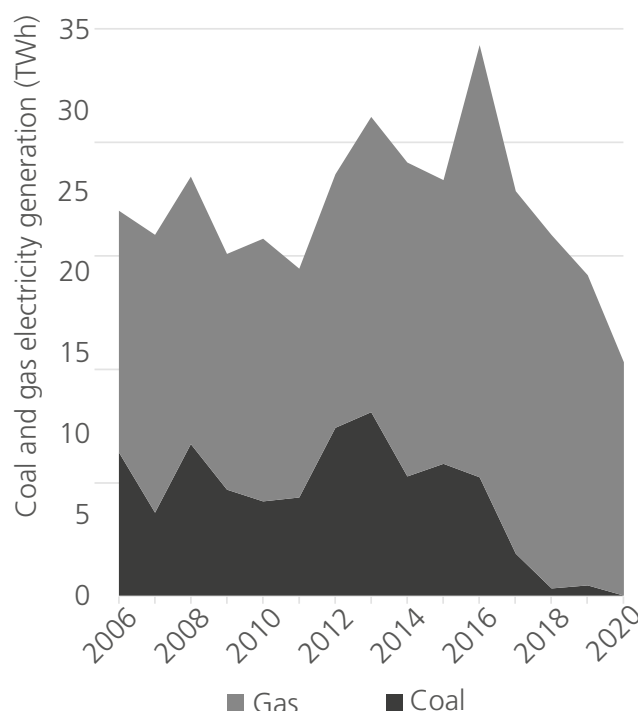
Future

The reduction in fossil fuel generation reflects the continued focus on decarbonisation in Wales. With Wales achieving 'coal free' status five years ahead of the UK Government's commitment to close coal fired generation by 2025, the focus is now on the evolving role of gas in the future energy mix.

The trend towards gas capacity operating flexibly, rather than as baseload, is continuing. In the short-to-medium-term, 'peaking' plants - which operate for a relatively small number of hours per year - and the remaining large power stations will have an important role to play in making sure the system is secure when the wind isn't blowing and the sun isn't shining. In the longer term, the UK government's commitment to delivering a net-zero electricity system by 2035 means that there is no role for new unabated fossil fuel generation.

Generation of fossil fuel generation over time

Data source: 1



There have been no new connections of fossil fuel generators identified in 2020 in Wales. Over the past decade, the development of new fossil fuel generation has been located almost entirely in South Wales. Between 2011 and 2020, there were 31 projects commissioned in the Cardiff Capital Region and 12 in Swansea Bay, two in Mid Wales and none in North Wales.

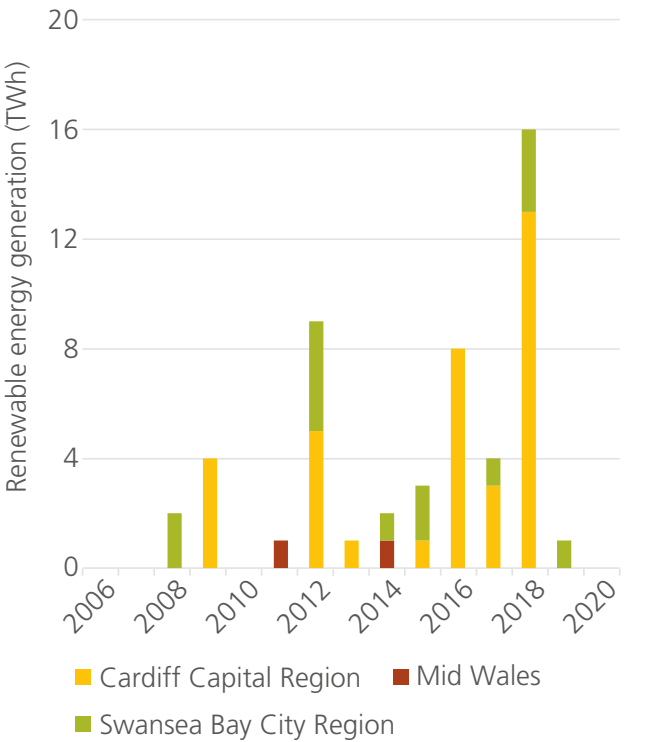
The Cardiff Capital Region has seen the greatest activity for new connections over the past decade, with new fossil fuel projects in the area totalling 302 MW of capacity with an average capacity of around 10 MW. This region has also seen the greatest loss of capacity in 2020; the closure of the Aberthaw and Severn Power Stations reduced capacity by 1,400 MW, which is in addition to the closure of the 235 MW Barry Power station in 2019.

In Swansea Bay City Region, an additional 96 MW has been added from new small-scale stations over the past decade, in addition to the 2,181 MW Pembroke Power Station which began commercial operation in 2012. The recent closure of Baglan Bay Power Station has reduced capacity in the region by 552 MW.

Capacity in Mid Wales has increased slightly over the decade, with 10 MW added across two new stations. In North Wales, installed capacity has remained constant at 1,462 MW, almost all of which is accounted for by the large-scale Combined Cycle Gas Turbine (CCGT) at Connah’s Quay.

New fossil fuel projects in Wales by region and commission year

Data source: 1



Gas and diesel statistics in Wales

Data source: 1

Region	Gas and diesel fuel generation in 2020		
	Number of projects	Total capacity (MW)	Estimated generation (GWh)
Cardiff Capital	53	385	1,376
Swansea Bay City	21	2,424	11,583
Mid Wales	6	11	37
North Wales	14	1,473	2,432
Total	90	4,291	15,293

Storage

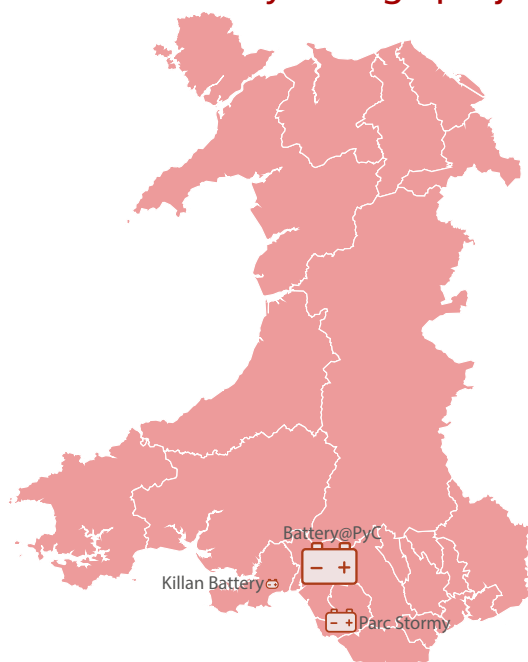
Battery storage

One new commercial-scale battery storage project was developed in Wales in 2020. This is a 232 kW battery developed by Gower Power, connected to a solar farm at Killan Farm on the Gower Peninsular. This takes the total number of commercial-scale batteries in Wales to three, with a total power capacity of 26.6 MW.

The development of commercial-scale battery storage across Great Britain is driven by the growing need for flexibility on the electricity system. Projects provide services to the electricity grid, including the balancing of supply and demand and providing fast-response services such as Dynamic Containment.

Grid constraints continue to form a barrier to new storage connections in Wales, particularly in the south. However, there are currently two projects with a capacity greater than 150 kW under construction, and a further nine with planning permission¹⁸.

Location of battery storage projects



Gower Power

Gower Power is a community co-operative owned and controlled by its members, which develops renewable energy projects and supports the growth of other environmental enterprises¹⁹. In 2017, a 1 MW solar farm was commissioned on Killan Farm in Dunvant with direct investment from the local community. It became the first community-owned solar farm in Wales, supplying 100% clean energy to more than 300 businesses and homes. In order to maximise the benefit from the renewable energy generated, a 232 kW battery and two EV charging points were recently installed on site²⁰.

Ecotricity connects generated electricity to local residents, and over the project's lifetime, it is estimated that half a million pounds will be created for the local community fund, with profits being directed back into local grassroots community projects. Funding for the battery and EV charging points came from the European Regional Development Fund, the Welsh Government Energy Service and a loan from the Development Bank of Wales.

¹⁸ Sourced from the Renewable Energy Planning Database Quarterly Extract, December 2021 www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

¹⁹ Gower Power Coop; About us www.gowerpower.coop/about-us

²⁰ Development Bank Wales, 2021; Swansea Businesses Urged to Plug into Gower Power to Invest in Their Local Community www.developmentbank.wales/news-and-events/swansea-businesses-urged-plug-gower-power-invest-their-local-community

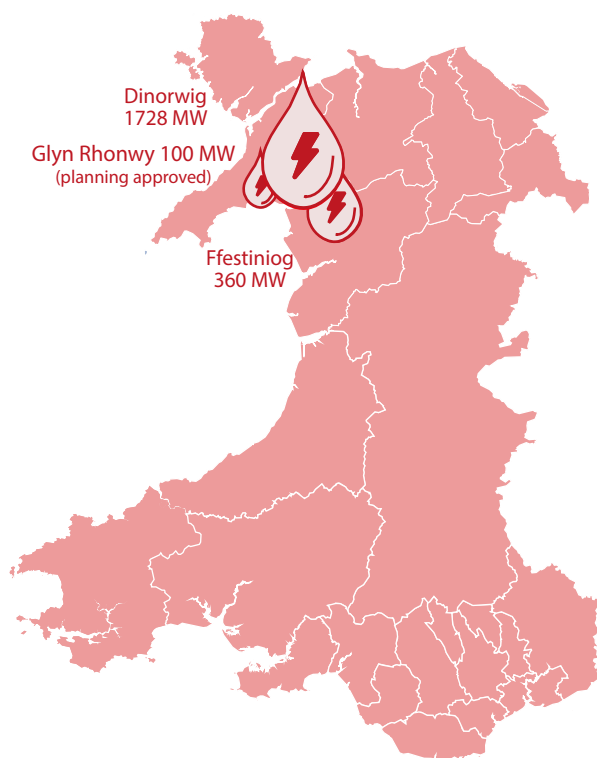
Pumped hydro

The amount of pumped storage in 2020 in Wales remains unchanged from previous years. The operational projects are the 360 MW Ffestiniog pumped storage plant in Gwynedd, which opened in 1963, and the 1.7 GW Dinorwig pumped storage plant, which opened in 1984. Both provide essential services to Great Britain's electricity network.

Wales hosts more than 50% of the UK's total pumped storage capacity. Pumped hydro can respond to changes in demand, helping to keep the system in balance. Today, pumped storage will often store excess renewable power and generate when wind and solar outputs are low. It also provides important services which help keep the electricity system stable and secure.

There is currently one new pumped storage project in development. This is a 100 MW project at Glyn Rhonwy in Snowdonia, which aims to make use of disused quarries to form the scheme's reservoirs.

Location of pumped hydro projects



Energy storage in a net zero energy system

Energy storage of all types will continue to grow in importance as we move towards a fully net zero energy system. National Grid ESO's four Future Energy scenarios²¹ show the capacity of storage connected to the British electricity system increasing to between six- and twelve-times today's levels by 2050, with deployment accelerating over the coming decade. This will be critical in achieving a balanced and resilient high-renewables electricity system.

As well as increased capacity of pumped storage and batteries, there is an opportunity for new technologies to develop including compressed air and liquid air energy storage, and thermal storage paired with heat pumps. Production of and subsequent electricity generation from green hydrogen could be a form of long-term energy storage. There are significant benefits from new storage projects, helping Wales make greater use of its renewable generation, avoiding network constraints and gaining value from the considerable supply chain value associated with large-scale projects.

21 National Grid ESO, 2021; Net Zero and the Future Energy Scenarios www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021/scenarios-net-zero

The production and wider use of low carbon hydrogen is a developing technology sector which has gained momentum in recent years. Much of the hydrogen currently produced in Wales is consumed on-site or exported to local steelworks via pipeline.

Hydrogen requires energy to produce, meaning the hydrogen process can be viewed under both supply and demand of energy. However, within the context of electricity generation, hydrogen's primary application is as a storage technology. It can be produced in several ways:

- 'Grey' hydrogen – produced via reformation of natural gas
- 'Blue' hydrogen – produced in the same way as 'grey' hydrogen, but the carbon dioxide emitted from the process is captured rather than released
- 'Green' hydrogen – produced via the electrolysis of water, a process that produces no CO₂ so long as the electricity used is zero carbon itself

In Wales, grey hydrogen is currently the most widely used type of hydrogen in the industrial clusters and oil refineries across the country. Low-carbon hydrogen production is currently relatively small-scale, with projects seeking to establish the scale of demand for hydrogen.

In 2019, it was announced that the University of South Wales' Hydrogen Centre at Baglan Energy Park Hydrogen Centre, alongside Cardiff and Swansea universities, would be leading a £24 million research project, FLEXIS (Flexible Integrated Energy Systems). One of the key aims of this is to research and develop grid scale hydrogen storage²². Another recent project is Milford Haven: Energy Kingdom, a two-year £4.5 million project, completing in 2022, that is exploring what a decarbonised smart local energy system could look like for Milford Haven, Pembroke and Pembroke Dock. The project will study the potential of hydrogen as part of a multi-vector approach to decarbonisation²³.

The Welsh Government is committed to exploring the role hydrogen could play in Wales in the long term. The 2020 consultation *Developing the hydrogen energy sector in Wales* sought responses to a proposed Wales Hydrogen Pathway, building on the Hydrogen development in Wales baselining report²⁴, which contains details of some of the many other hydrogen projects in development across Wales.

The Hydrogen Pathway²⁵ contains ten key objectives which aim to add momentum to the Welsh hydrogen sector and lay the foundations for upscaling and commercial deployment from the end of the 2020s. The results of the 2020 consultation underpin the policy pledges of the Wales Net Zero Plan and the launch of the new Smart Living HyBRID Small Business Research Initiative (SBRI) fund.

22 H2 Wales, The University of South Wales' Hydrogen Research and Demonstration Centre at Baglan www.h2wales.org.uk/pages/hydrogen-centre/hydrogen-centre.html

23 Pembrokeshire Energy Kingdom www.pembrokeshire.gov.uk/mh2-energy-kingdom

24 Element Energy, 2020; Hydrogen Development in Wales www.gov.wales/sites/default/files/consultations/2021-01/baselining-report-hydrogen-development-in-wales.pdf

25 Welsh Government, 2021; Hydrogen in Wales Consultation Document www.gov.wales/sites/default/files/consultations/2021-01/hydrogen-in-wales-consultation.pdf

Reference pages

Data tables

Local authority	Totals					Renewables								
	Renewables			Fossil fuels		AD			Biomass heat		Biomass electricity and CHP			
	Number of projects	Capacity (MW _e)	Capacity (MW _{th})	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)	Capacity (MW _{th})	Number of projects	Capacity (MW _{th})	Number of projects	Capacity (MW _e)	Capacity (MW _{th})	
Blaenau Gwent	1,229	22	10	5	86	-	-	-	14	9	1	4	-	
Bridgend	2,743	101	10	4	24	1	3	-	35	8	-	-	-	
Caerphilly	2,999	68	9	3	19	2	2	1	46	7	2	0	-	
Cardiff	3,798	47	16	6	37	1	2	-	21	5	1	0	-	
Carmarthenshire	6,439	264	57	2	10	2	1	0	508	45	-	-	-	
Ceredigion	4,461	192	76	2	10	4	1	1	259	43	4	3	17	
Conwy	2,242	94	14	3	2	3	-	0	121	9	5	1	0	
Denbighshire	2,575	162	24	2	1	3	1	1	171	16	5	1	0	
Flintshire	4,337	132	111	4	1,417	-	-	-	142	14	1	25	90	
Gwynedd	3,636	104	24	1	0	2	0	0	222	17	1	0	-	
Isle of Anglesey	2,871	80	11	1	0	2	2	0	59	3	1	0	0	
Merthyr Tydfil	858	17	6	3	40	-	-	-	15	4	1	1	2	
Monmouthshire	4,661	64	35	4	6	2	0	0	189	22	4	18	7	
Neath Port Talbot	2,029	332	23	7	86	-	-	-	90	19	2	56	-	
Newport	2,364	52	12	4	39	2	0	0	40	11	2	9	0	
Pembrokeshire	5,991	220	38	6	2,240	2	0	0	288	28	2	0	0	
Powys	7,384	254	154	4	1	13	4	2	958	132	10	1	2	
Rhondda Cynon Taf	4,645	240	20	11	71	1	1	1	61	15	-	-	-	
Swansea	3,349	90	12	6	86	-	-	-	57	7	1	1	-	
Torfaen	2,066	15	4	5	0	-	-	-	20	3	1	0	1	
Vale of Glamorgan	2,572	95	12	8	63	1	1	-	63	9	2	10	-	
Wrexham	5,007	47	40	3	53	5	0	1	89	34	2	0	1	
Offshore	3	726	-	-	-	-	-	-	-	-	-	-	-	
Unknown	28	0	0	-	-	-	-	-	-	-	2	0	0	
Total	78,284	3,417	716	94	4,291	46	19	8	3,468	457	50	131	120	

Data tables

Local authority	Renewables											
	Energy from waste		Heat pumps		Hydropower		Landfill gas		Offshore wind		Onshore wind	
	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _{th})	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)
Blaenau Gwent	-	-	46	0	1	0	1	1	-	-	8	6
Bridgend	-	-	166	2	3	0	1	0	-	-	15	68
Caerphilly	-	-	90	1	-	-	-	-	-	-	21	17
Cardiff	1	30	186	2	1	0	2	2	-	-	3	0
Carmarthenshire	-	-	1,007	11	14	6	1	2	-	-	113	145
Ceredigion	-	-	1,331	12	26	71	-	-	-	-	78	85
Conwy	-	-	266	3	30	35	1	2	-	-	40	40
Denbighshire	-	-	439	6	21	3	-	-	-	-	39	147
Flintshire	1	21	604	6	-	-	2	1	-	-	17	2
Gwynedd	-	-	635	7	144	59	1	0	-	-	36	7
Isle of Anglesey	-	-	587	7	-	-	1	0	-	-	49	39
Merthyr Tydfil	-	-	38	0	4	0	2	6	-	-	5	2
Monmouthshire	-	-	531	6	11	0	-	-	-	-	10	0
Neath Port Talbot	-	-	113	1	10	1	2	3	-	-	12	230
Newport	-	-	66	1	-	-	1	1	-	-	11	16
Pembrokeshire	-	-	729	8	14	1	1	2	-	-	150	26
Powys	-	-	1,166	17	80	8	1	2	-	-	119	213
Rhondda Cynon Taf	-	-	215	2	4	0	2	1	-	-	12	193
Swansea	-	-	292	3	2	0	1	1	-	-	5	34
Torfaen	-	-	61	1	1	0	-	-	-	-	3	0
Vale of Glamorgan	-	-	209	2	-	-	-	-	-	-	6	1
Wrexham	-	-	250	3	-	-	3	4	-	-	1	0
Offshore	-	-	-	-	-	-	-	-	3	726	-	-
Unknown	-	-	-	-	3	0	-	-	-	-	-	-
Total	2	51	9,027	104	369	184	23	30	3	726	751	1,273

Data tables

Local authority	Renewables								Fossil fuels					
	Sewage gas			Solar PV		Solar thermal			Coal		Diesel and unknown		Gas	
	Number of projects	Capacity (MW _e)	Capacity (MW _{th})	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _{th})	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)	Number of projects	Capacity (MW _e)	
Blaenau Gwent	-	-	-	868	11	290	1	-	-	-	-	5	86	
Bridgend	-	-	-	2,421	30	101	0	-	-	-	-	4	24	
Caerphilly	-	-	-	2,493	49	345	1	-	-	1	18	2	1	
Cardiff	2	7	8	3,487	20	93	0	-	-	1	1	5	21	
Carmarthenshire	-	-	-	4,491	110	303	1	-	-	-	-	2	10	
Ceredigion	-	-	-	2,408	31	351	1	-	-	1	10	1	0	
Conwy	-	-	-	1,524	16	252	1	-	-	-	-	3	2	
Denbighshire	-	-	-	1,755	10	142	0	-	-	-	-	2	1	
Flintshire	1	0	0	3,483	93	86	0	-	-	1	14	3	1,392	
Gwynedd	-	-	-	2,425	37	170	1	-	-	-	-	1	0	
Isle of Anglesey	-	-	-	1,985	38	187	0	-	-	-	-	1	0	
Merthyr Tydfil	-	-	-	726	7	67	0	-	-	1	20	2	20	
Monmouthshire	-	-	-	3,799	45	115	0	-	-	2	6	2	0	
Neath Port Talbot	1	3	3	1,760	39	39	0	-	-	4	47	3	39	
Newport	-	-	-	2,208	25	34	0	-	-	1	12	3	27	
Pembrokeshire	-	-	-	4,249	192	556	2	-	-	-	-	6	2,240	
Powys	-	-	-	4,357	26	680	2	-	-	-	-	4	1	
Rhondda Cynon Taf	-	-	-	3,805	45	545	2	-	-	1	20	10	51	
Swansea	1	1	1	2,827	53	162	0	-	-	3	45	3	41	
Torfaen	-	-	-	1,962	14	18	0	-	-	-	-	5	0	
Vale of Glamorgan	-	-	-	2,204	83	87	0	-	-	3	19	5	43	
Wrexham	1	1	1	4,543	41	113	0	-	-	2	36	1	17	
Offshore	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unknown	-	-	-	23	0	-	-	-	-	-	-	-	-	
Total	6	12	14	59,803	1,016	4,736	13	-	-	21	248	73	4,018	

Methodology

Regen was commissioned by the Welsh Government to produce a database of energy generation projects in Wales, identify the extent to which projects are owned by Welsh individuals, organisations and communities, and analyse the data to produce a report on progress.

The research method developed by Regen to produce a detailed picture of energy generation across Wales includes:

- Identifying, collating, cleaning and cross-referencing records from existing datasets
- Verifying and analysing the data to ensure a robust national overview and locally specific data where it is available
- Verifying the data with stakeholders and industry where appropriate
- Researching ownership details, including referencing to Companies House to identify projects with local ownership

The key sources of data used in the study include:

- Ofgem Feed-in Tariff data
- Renewable Energy Guarantees of Origin data
- Renewables Obligation register
- Renewable Heat Incentive and Renewable Heat Premium Payment data
- Western Power Distribution connections data
- SP Energy Networks connections data
- MCS data
- Renewable Energy Planning Database
- Contact with utilities, installers and industry organisations
- BEIS energy statistics





Data Sources

1. Database compiled by Regen, as described above
2. BEIS Sub-national electricity consumption statistics 2020

Assumptions and references

Assumption	Source
Estimated Welsh domestic heat demand	Evaluated using BEIS Regional and Local Authority Gas Consumption Statistics (2020).
Local authority and Welsh electricity consumption	BEIS Regional and Local Authority Electricity Consumption Statistics (2020).
Fossil fuel electricity generation	Researched by Regen through a survey of major power plants. Actual generation from plants was collected from plants representing 95% of the major electricity generating fossil fuel capacity in Wales.
Number of homes	StatsWales Dwelling stock estimates.
Capacity factors	Evaluated from a 5 year average of DUKES regional capacity factors and other industry established values.
Energy consumption	The figure for Wales' total energy consumption is the most recently published BEIS total final energy consumption data for 2019. As explained in the BEIS sub-national energy consumption statistics methodology, this consumption data excludes autogeneration and some very large energy users for confidentiality reasons.
Heat pump heat generation	To calculate the renewable portion of heat pump generation, the proportion of heat generated from heat pumps that is delivered by fossil fuels through the consumption of electricity is calculated. This proportion (~14%) is then removed from total heat pump generation. The remaining 86% of heat generation from heat pumps is, therefore, categorised as renewable and is published in this report.

A note on power and energy

Power (capacity)	X	Time	=	Energy (e.g. demand and generation)
 50 watts	X	 20 hours	=	1,000 Wh or 1 kWh (of demand)
 1,000,000 watts (1 MW)	X	 1 hour	=	1,000,000 Wh or 1 MWh (of generation)

Abbreviations and definitions

Abbreviation	Explanation
Autogeneration	Electricity generation that is produced onsite (usually in an industrial setting) and wholly consumed onsite, therefore, not exported to the electricity network.
Capacity	How much power a project can generate at maximum output.
Capacity factor	The percentage of a project's maximum theoretically output that it actually achieves. This is calculated by dividing the actual energy generated over a year by its theoretical maximum capacity, i.e., the amount it would have generated if it ran at full capacity, 24 hours a day, 365 days a year. For example, the capacity factor for offshore wind in Wales is evaluated to be 33%.
MW	Megawatt - a unit of power (capacity)
MWh	Megawatt hour - a unit of energy (demand or generation)
MWe	Megawatt of electrical capacity
MWth	Megawatt of thermal capacity
CO ₂	Carbon dioxide emissions
AAD	Advanced anaerobic digestion
CHP	Combined Heat and Power
CCGT	Combined Cycle Gas Turbine
Solar PV	Solar photovoltaic panels

Orders of magnitude	Explanation
W	1 watt = 1 watt
kW	1,000 watts = 1 kilowatt
MW	1,000,000 watts = 1 megawatt
GW	1,000,000,000 watts = 1 gigawatt
TW	1,000,000,000,000 watts = 1 terawatt

