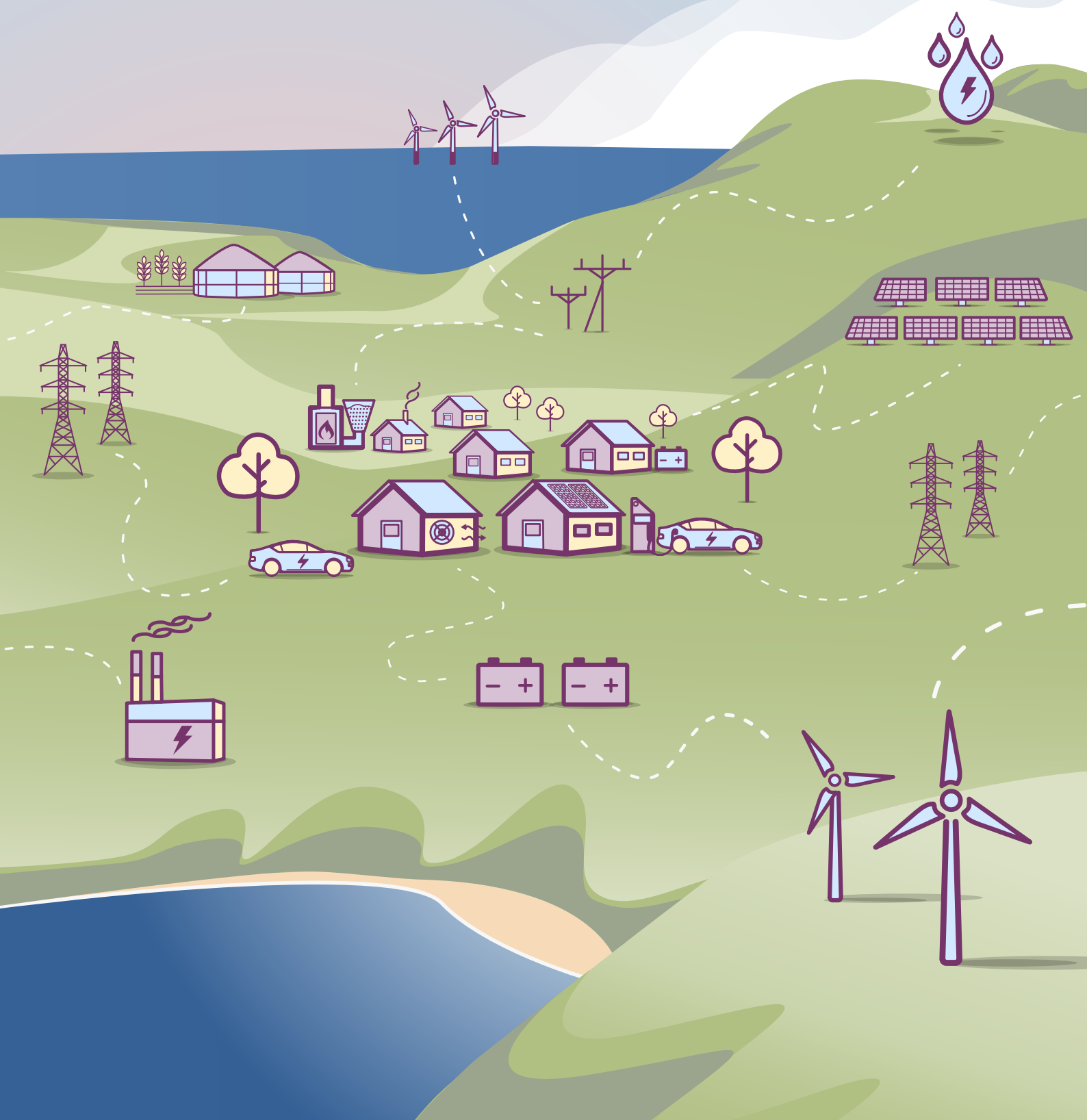


Energy Generation in Wales 2019



Llywodraeth Cymru
Welsh Government



Cover illustration: Regen

Written and produced by Regen for the Welsh Government



Produced October 2020, version 1

ISBN: 978-1-80082-366-2

Contents

Introduction pages

Introduction..... 1

Ministerial foreword..... 2

Electricity generation in Wales

Renewable energy in Wales 5

Progress towards targets 7

The local picture 9

Locally owned renewable energy 11

Low carbon technologies

Anaerobic digestion 14

Biomass heat 15

Heat pumps..... 16

Hydropower..... 17

Offshore wind..... 18

Onshore wind 19

Solar PV 20

Fossil fuels

Fossil fuel electricity generation..... 22

Storage

Battery storage 24

Reference pages

Data tables 27

Methodology 30

Assumptions and references 31

Abbreviations and definitions..... 32

Introduction

The Energy Generation in Wales 2019 report sets out the current energy generation capacity in Wales 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, community 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, nuclear and fossil fuel electricity generation as well as renewable heat and energy storage in Wales. It also looks at the growth of renewable energy in 2019, reviewing the growth prospects of each technology. The analysis builds on prior publications:

- Previous Energy Generation in Wales reports.
- The Energy Use in Wales report, published in 2020, 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 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.

Case studies of recently commissioned significant energy projects are included to illustrate the range of different technologies and scales of deployment in Wales.

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 by technology, capacity and local authority area to the end of 2019.
- Estimates 51% of electricity consumption comes from renewable sources.
- Estimates 825 MW of installed renewable energy capacity is locally owned.

Technologies analysed

- Renewable electricity and heat technologies.
- Nuclear power stations.
- Electricity storage technologies.
- Fossil fuel electricity generation (coal power stations, closed and open cycle gas turbines, reciprocating engines, diesel generators and combined heat and power plants).

Ministerial foreword



I am encouraged to see how our energy system continues to transition towards more renewable sources of energy, with a continuing focus on local ownership. I first commissioned the Energy Generation in Wales report in 2017 to provide a complete and transparent picture of energy generation and a consistent measure against our Welsh Government energy targets. I am pleased to publish this report, which makes the latest information available.

Over the past ten years, we have seen an increase in renewable electricity generation, with approximately 70% of the increase due to large-scale onshore and offshore wind. More recently we have seen the end of coal fired electricity generation in Wales, which has helped decarbonise the electricity supply, one of our commitments in Prosperity for All: A Low Carbon Wales.

Since our last report, I have published our policy on local ownership of energy generation, which explains how we expect all new energy projects to include an element of local ownership, and how this means more of the benefits can be retained in Wales. The Welsh Government Energy Service (WGES) has collaborated over several years with organisations to develop locally owned energy projects, of which a recent example is the Ffrwd Farm wind turbine built in October 2019. The turbine, owned by a Community Benefit Society, will generate enough power to supply 450 homes.

2019 figures reveal positive signs, despite the challenging market conditions faced by developers. We continue to progress towards our target of 70% of Wales' electricity consumption to be from renewable energy by 2030. Renewable electricity generation is now equal to 51% of electricity consumption in Wales. We are 83% of the way towards our target of 1 GW of renewable energy capacity in Wales to be locally owned by 2030. An additional 145 MW of new renewable electricity capacity was installed in 2019 and we now have 825 MW of renewable energy capacity in local ownership.

2019 also saw the first electricity being generated by the 27-turbine wind farm at Clocaenog Forest, on the Welsh Government woodland estate. This is the second largest onshore wind farm in Wales, providing employment and funds which benefit communities local to the development and across the wider north Wales region.

As we look to the future, the Welsh Government remains focussed on our targets and ambitions on climate change and sustainability. To achieve maximum benefit from the energy transition we recognise it needs to happen in a co-ordinated way. Our approach to regional and local energy planning will help identify the low regret, least cost options for new energy infrastructure in all parts of Wales.

A handwritten signature in blue ink that reads 'Lesley Griffiths'.

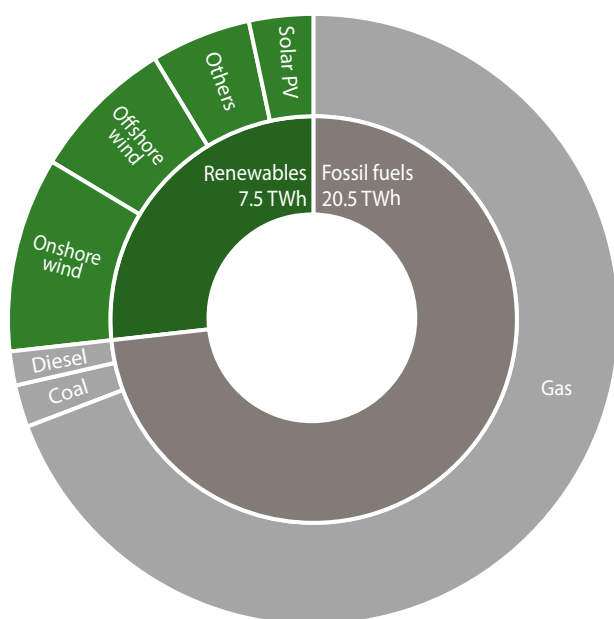
Lesley Griffiths MS

Minister for Environment, Energy and Rural Affairs

Electricity generation in Wales

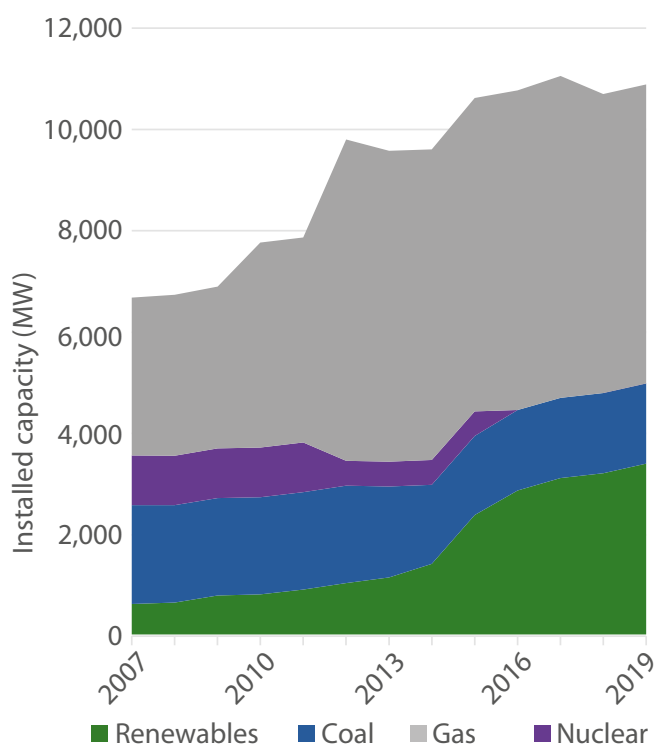
Wales is a net exporter of electricity, having consumed approximately 14.7 TWh⁽¹⁾ of electricity in 2019, while generating approximately 27.9 TWh. Approximately 27% of electricity generation in Wales is from renewables, with much of the rest generated by gas fuelled power stations.

Wales' electricity generation

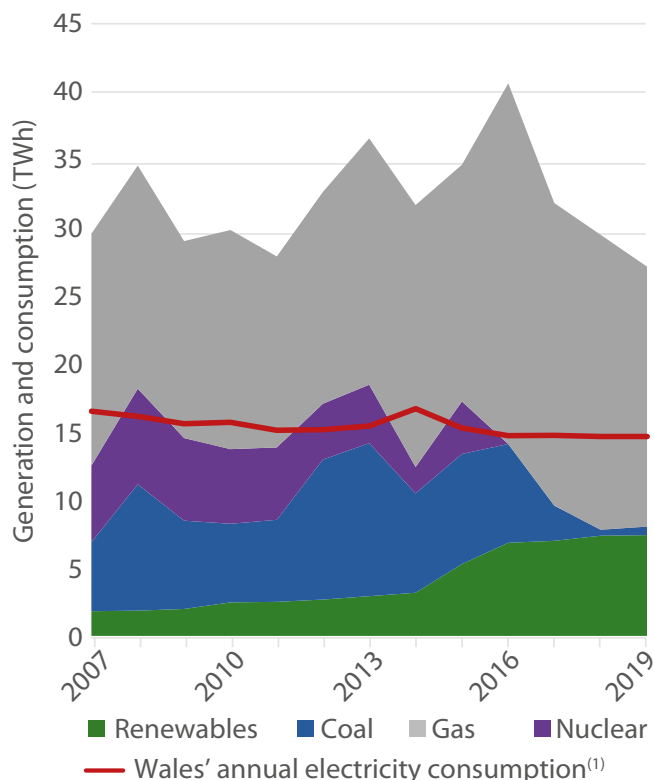


Total electricity generation in Wales has reduced by approximately 8% since 2018. This is predominantly due to a reduction in generation from gas fired power stations. Meanwhile, the total amount of electricity generated from renewables increased by 0.6%. As a result of these two factors, the renewable share of Wales' total electricity generation increased from 25% in 2018 to 27% in 2019. Electricity generation from coal fired power remained low in 2019, representing just 2% of all electricity generated in Wales. This is down from nearly a third in 2012 and 2013.

Electricity capacity trends



Electricity generation trends



Electricity generation in Wales

- Aberthaw power station was the last operational coal-fired power station in Wales, closing in March 2020. Coal fired electricity generation is not expected to contribute to Wales' electricity mix in the future.
- There are no nuclear power stations currently operating in Wales. Plans for a new nuclear plant on the existing Wylfa site were suspended in January 2019 and Hitachi formally ended its involvement in the project in September 2020. The Wylfa Newydd site however, is still regarded as one of the best in the UK for large new nuclear development and discussions continue as to future opportunities. Opportunities also exist at Trawsfynydd for small modular or advanced modular reactors and work is now underway by Welsh Government to create a site development company to help unlock the site's potential.
- An estimated 7.5 TWh of renewable electricity was generated in Wales in 2019, up from 7.4 TWh the previous year. This represents 27% of all electricity generation in Wales.
- An additional 143 MW of new renewable electricity capacity was installed in 2019. This is a small increase from 2018 when 133 MW was installed. However, this is significantly below the deployment levels seen in 2015 and 2016.
- In 2019, there were 56,860 renewable electricity projects in Wales, 1,076 more than in 2018.

Electricity generation projects in Wales

Technologies	Number of projects	Electrical capacity (MW)	Estimated electricity generation (GWh)
Fossil fuels	102	7,419	20,461
Coal	1	1,586	631
Diesel	13	184	643
Gas	88	5,650	19,187
Storage	209	2,088	-
Battery storage	207	29	-
Pumped hydro	2	2,088	-
Renewables	56,860	3,372	7,470

CASE STUDY – CLOCAENOG FOREST WIND FARM

Construction of the 27-turbine wind farm at Clocaenog Forest started in March 2018 and electricity was first generated in July 2019. With a maximum capacity of 96 MW, it is the second largest onshore wind farm in Wales and the 18th largest in the UK. It is situated on the Welsh Government woodland estate, which is managed by Natural Resources Wales. There is an associated community benefit fund, worth up to £768,000 per year over the 25-year operating lifetime of the project, which will be directed to benefit communities local to the development and across the wider north Wales region.

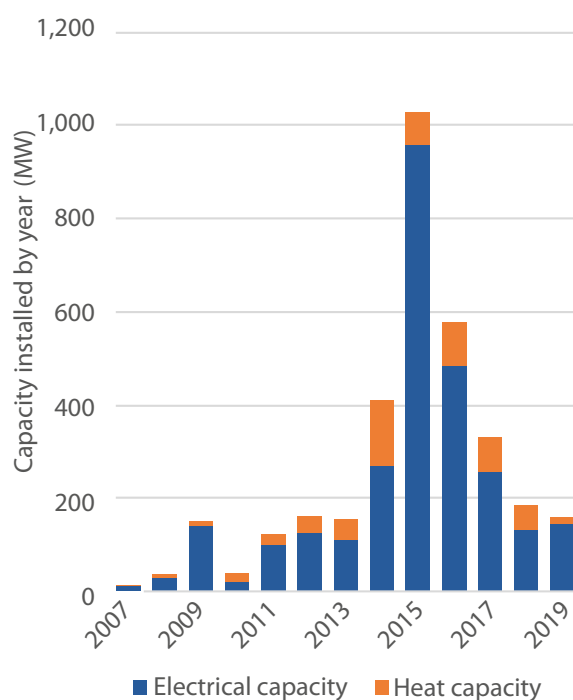


Credit: Innogy via ReNews

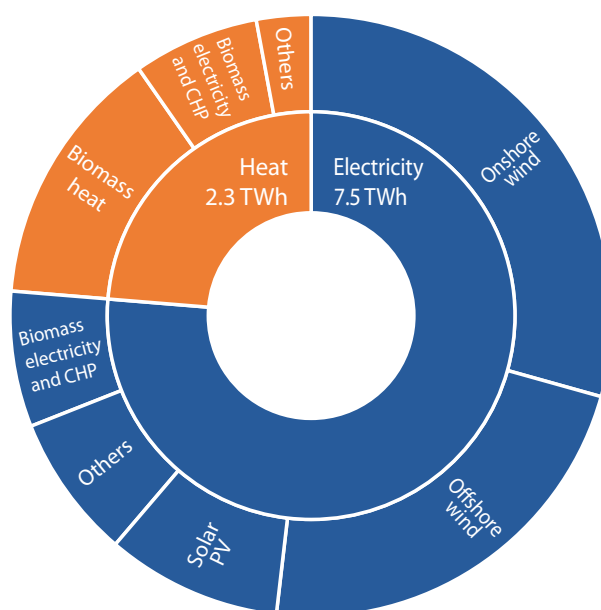
Renewable energy in Wales

145 MW of new renewable electrical capacity was commissioned in Wales in 2019. This brings the total electrical capacity to 3,372 MW from 56,807 installations. An additional 14 MW of renewable heat capacity was commissioned in Wales in 2019. This brings the total renewable heat capacity in Wales to 686 MW.

Wales' renewable energy capacity installation rate



Renewable electricity and heat generation



Renewable electricity in Wales

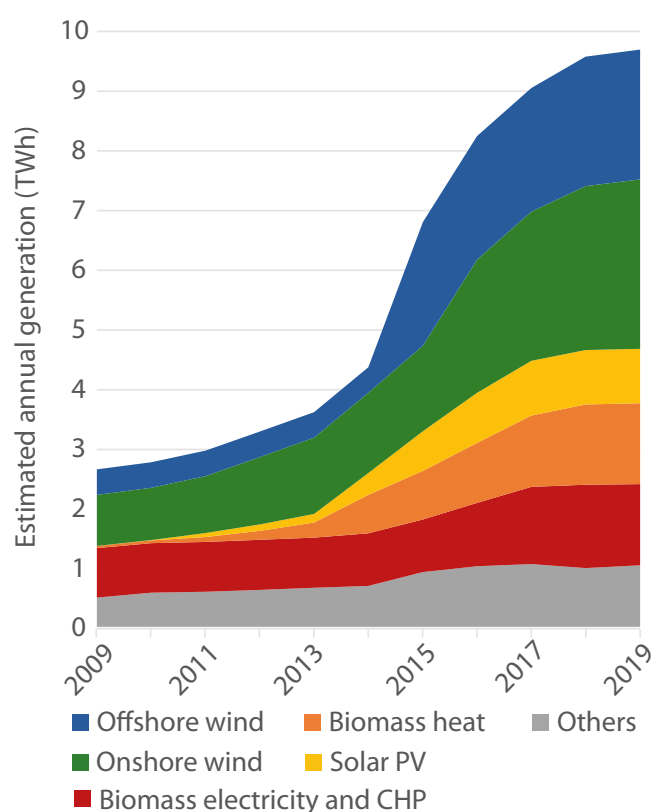
- Clocaenog Forest wind farm was the largest renewable electricity project commissioned in 2019. This 27-turbine development, sited on the border between Denbighshire and Conwy, has a capacity of 96 MW, making it the second largest onshore wind farm in Wales after Pen y Cymoedd.
- There were two further projects with a capacity over 1 MW which were commissioned in 2019. Both were onshore wind developments: the 33 MW Mynydd Y Gwair wind farm near Swansea and the 2 MW Kingspan project in Flintshire.
- Offshore and onshore wind continue to play a major role in Welsh renewable electricity generation, accounting for 29% and 38% of renewable generation respectively in 2019.
- An additional 7 MW of solar PV capacity was commissioned in Wales in 2019. Solar PV now accounts for 12% of all renewable electricity generation in Wales. The two largest solar PV projects commissioned in 2019 both had a capacity of 0.5MW and were both installed in Powys.

Renewable energy technologies	Number of projects	Electricity		Heat	
		Capacity (MW)	Estimated generation (GWh)	Capacity (MW)	Estimated generation (GWh)
Anaerobic digestion	46	19	103	8	49
Biomass	3,450	-	-	449	1,375
Biomass electricity and CHP	50	132	712	120	662
Energy from Waste	1	30	162	-	-
Heat pump	7,817	-	-	86	165
Hydropower	363	182	347	-	-
Landfill gas	24	31	115	-	-
Offshore wind	3	726	2,200	-	-
Onshore wind	748	1,255	2,874	-	-
Sewage gas	5	9	30	10	64
Solar PV	55,634	989	924	-	-
Solar thermal	4,693	-	-	13	8
Grand Total	72,834	3,372	7,469	686	2,323

Renewable heat in Wales

- Approximately 70% less renewable heat capacity was installed in 2019 compared to 2018.
- There are now 16,024 renewable heat projects across Wales, of which 824 were commissioned in 2019.
- The largest renewable heat project commissioned in 2019 was a 1.25 MW biomass boiler in Monmouthshire, which was installed under the non-domestic Renewable Heat Incentive. The hot water arising from the system will be used to heat drying facilities and the poultry sheds at Old House Farm in Dingestow.
- Heat from biomass made up half the renewable heat produced in Wales in 2019 from a total of 3,450 projects. However, heat pumps have a greater prevalence across Wales, totalling 7,817 projects, and producing approximately 7% of the country's renewable heat.

Renewable energy generation in Wales



Progress towards targets

In 2017, the Welsh Government announced a target of meeting the equivalent of 70% of Wales' electricity demand from Welsh renewable electricity sources by 2030. In 2019, it is estimated that this figure stands at 51%.

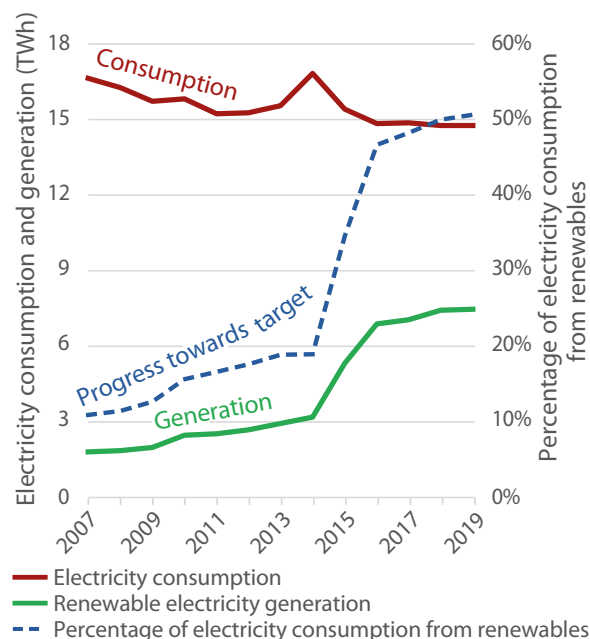
Progress towards the 70% target has historically been a combination of both decreasing electricity consumption and increasing renewable electricity generation. Since 2005, electricity consumption has decreased by 16% while renewable electricity generation has increased by over 500%.

In recent years, the decrease in electricity consumption has slowed and renewable installation rates have significantly reduced as a result of reductions in support and electricity network constraints. Progress towards the target has, therefore, also slowed. In 2019, increased renewable generation was predominantly due to an increase in onshore wind generation following the commissioning of two large-scale projects.

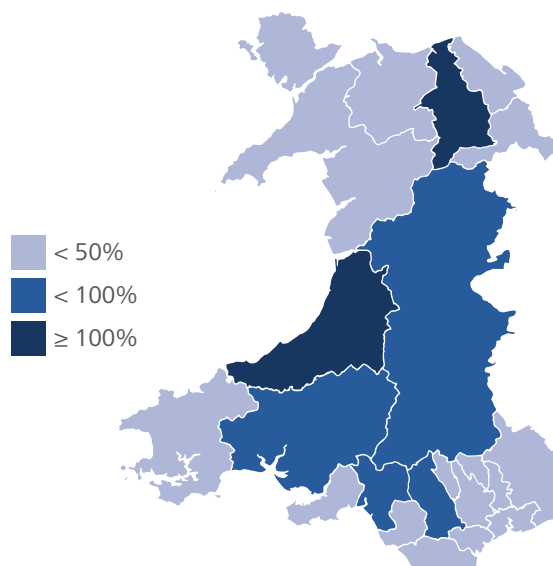
There remain significant challenges to meeting the 70% target by 2030. Securing price support for renewable generation is a key challenge, so projects are working to develop sustainable, subsidy-free business models that accommodate for the necessary network reinforcements.

However, progress towards the target has historically come in step changes when market conditions have been good, and enabled surges in the development of renewable energy projects. We have also seen significant progress when projects with a long development lead time have commissioned, such as large-scale onshore and offshore wind. There is the potential for a similar step change in the 2020s if emerging market conditions, national policies and offshore wind opportunities are realised.

Growth in the percentage of electricity consumption from renewable sources in Wales



Equivalent percentage of electricity consumption delivered by local renewable generation by local authority



In March 2019, the Welsh Government published 'Prosperity for All: a Low Carbon Wales'⁽²⁾. The plan details how Wales intends to meet the first carbon budget (2016-20) and sets the foundations for future action. In April 2019, the Welsh Government declared a Climate Emergency, followed on 1 May by the Senedd becoming the first parliament in the world to pass a Climate Emergency resolution. The Welsh Government has accepted the Committee on Climate Change's (CCC) 2019 recommendation to increase Wales' 2050 emissions reduction target to 95%. It is now seeking the advice from the CCC on how this revised target affects Wales' interim targets for 2030 and 2040, as well as the second carbon budget (2021-25), which were set in legislation in 2018. The Welsh Government has also asked the CCC how Wales might go beyond 95% in 2050. After considering this advice, it will ask the Senedd to amend Wales' emissions reduction pathway early in 2021.

Transforming our energy system whilst building a resilient economy following COVID-19

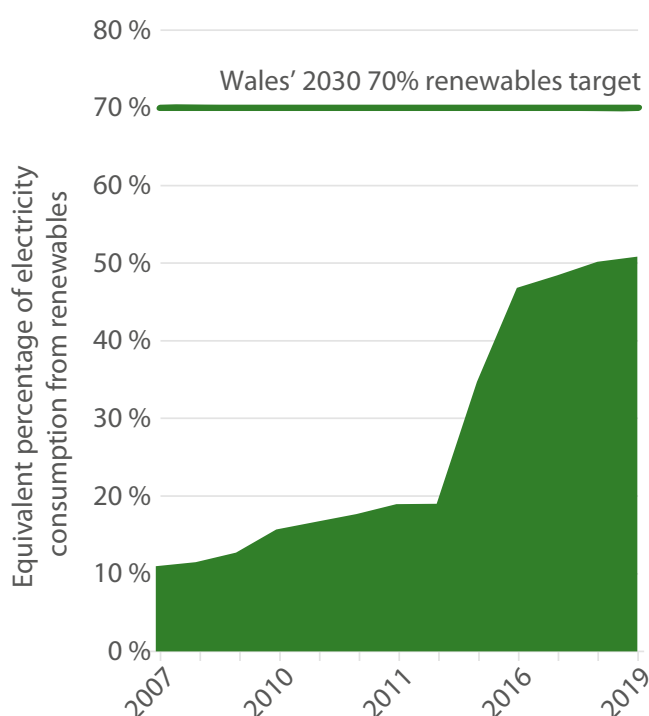
The world is facing a health and economic crisis as a result of COVID-19. Welsh Government aims to rebuild a stronger economy which supports a fairer, greener and more prosperous society more resilient to economic shock. A creative and comprehensive green recovery will accelerate progress towards a low carbon economy and a healthier, more equal Wales.

The path to reconstruction builds on the foundations in Prosperity for all: the Economic Action Plan (EAP). This shapes an economic development programme investing in people and businesses to drive prosperity, spreading wealth and reducing inequality across all regions of Wales. It builds on Prosperity for All: A Low Carbon Wales, and the wider framework set out in the Well-being of Future Generations (WFG) Act.

The aim is to create a green economy where investment is encouraged in low-carbon, climate resilient infrastructure, renewable energy projects and sustainable homes, where high levels of resources are re-used and waste is avoided. The recovery will focus on developing the potential of regional investment, such as City and Growth Deals, and considering local and regional stimulus packages. Through increased efficiency and displacing fossil fuels with low carbon sources, Wales will create the industries and jobs of the future.

Growth in the percentage of electricity from renewable sources in Wales

- Since 2005, electricity consumption has fallen by 16% and renewable electricity generation has increased by over 500%.
- Approximately 70% of the increase in renewable electricity generation in the last ten years has been due to large-scale onshore and offshore wind.
- The decommissioning of some biomass electricity and energy from waste plants has affected the total installed capacity of renewable electricity in Wales.



The local picture

Powys is the local authority area with the greatest installed renewable energy capacity, with a total of 388 MW. Powys also generated the most energy from renewable technologies in 2019, at an estimated 980 GWh.

Local capacity growth

In 2019, only four local authorities saw an increase greater than 2% in their renewable energy capacity. The vast majority of this increase in these areas can be attributed to new onshore wind projects. The Clocaenog Forest wind farm was largely responsible for the capacity increase for both Denbighshire and Conwy, whilst Swansea's increase was largely due to the commissioning of the Mynydd y Gwair onshore wind farm. A single turbine commissioned in Merthyr Tydfil and another in Flintshire drove the growth in their renewable energy capacity.

The remaining local authority areas saw increases in their renewable energy capacity of less than 1% from 2018.

Local authority area	Increase in renewable energy capacity
Denbighshire	87%
Swansea	60%
Conwy	30%
Merthyr Tydfil	6%
Gwynedd	2%

Local consumption and generation

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.

Local authority area	Equivalent percentage of electricity consumption delivered by local renewable generation
Ceredigion	110%
Denbighshire	100%
Powys	91%
Rhondda Cynon Taf	66%
Neath Port Talbot	65%

CASE STUDY – MYNYDD Y GWAIR WIND FARM

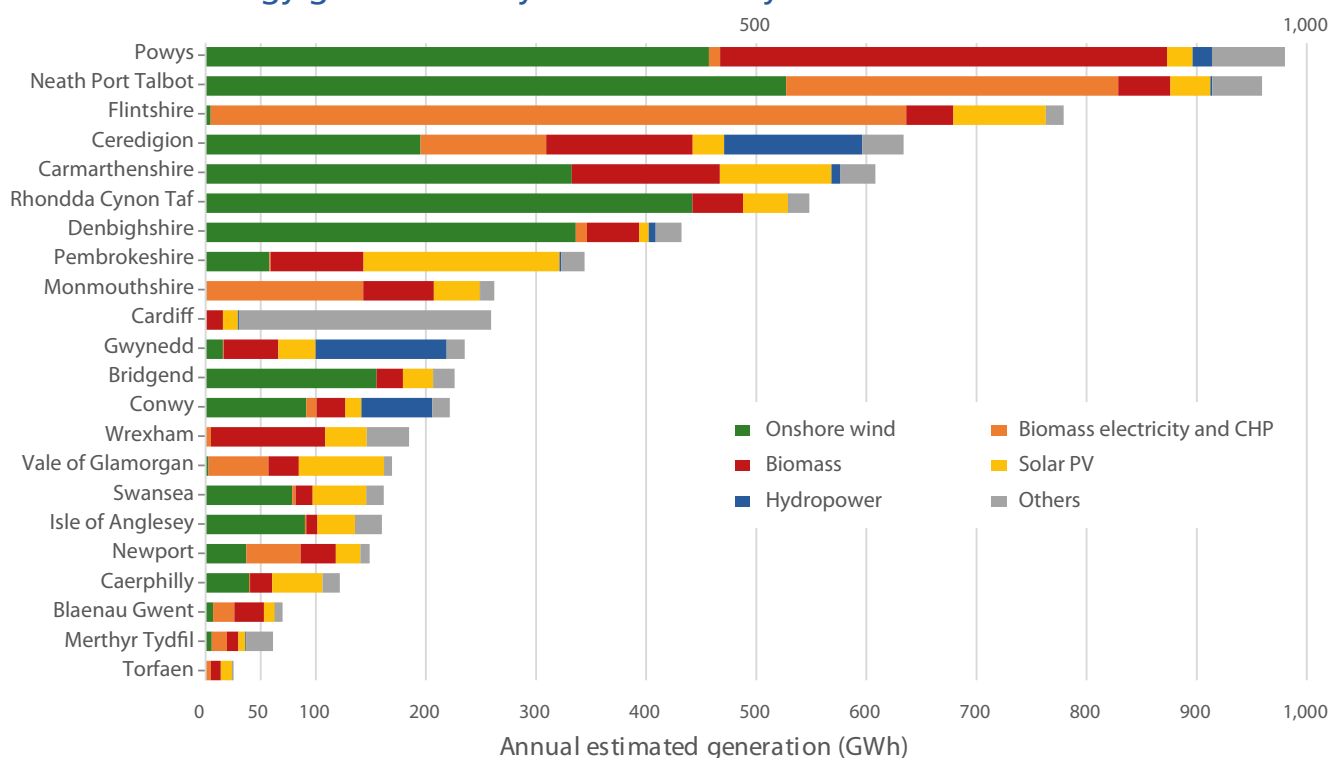
This 16-turbine development, located between Ammanford and Clydach in the Swansea local authority area, has a capacity of 33 MW, making it the ninth largest wind farm (by capacity) in Wales. It is expected to produce enough renewable electricity to power the equivalent of 22,600 average Welsh homes.



Local authority area	Renewable heat and electricity			Fossil fuel electricity		
	Number of projects	Total capacity (MW)	Estimated generation (GWh)	Number of projects	Electrical capacity (MW)	Estimated generation (GWh)*
Blaenau Gwent	982	28	70	5	90	-
Bridgend	2,655	110	226	5	25	-
Caerphilly	2,963	77	122	2	19	-
Cardiff	3,663	65	259	7	33	-
Carmarthenshire	6,119	316	608	2	11	-
Ceredigion	4,143	266	634	3	10	-
Conwy	2,053	107	222	3	2	-
Denbighshire	2,325	183	432	2	1	-
Flintshire	3,859	227	779	4	1,406	-
Gwynedd	3,394	126	236	1	0	-
Isle of Anglesey	2,399	88	160	1	0	-
Merthyr Tydfil	769	22	61	3	42	-
Monmouthshire	4,429	98	262	3	0	-
Neath Port Talbot	1,944	352	959	7	634	-
Newport	2,284	62	149	7	897	-
Pembrokeshire	5,429	255	344	7	2,331	-
Powys	6,994	388	980	4	1	-
Rhondda Cynon Taf	3,956	258	548	11	75	-
Swansea	3,100	98	162	6	87	-
Torfaen	2,022	15	25	5	0	-
Vale of Glamorgan	2,407	106	169	10	1,701	-
Wrexham	4,942	86	185	3	53	-
Offshore	3	726	2,200	-	-	-
Unknown	2	0	1	-	-	-
Grand Total	72,834	4,058	9,793	101	7,419	20,461

* Not disclosed due to confidentiality

Renewable energy generation by local authority



Locally owned renewable energy

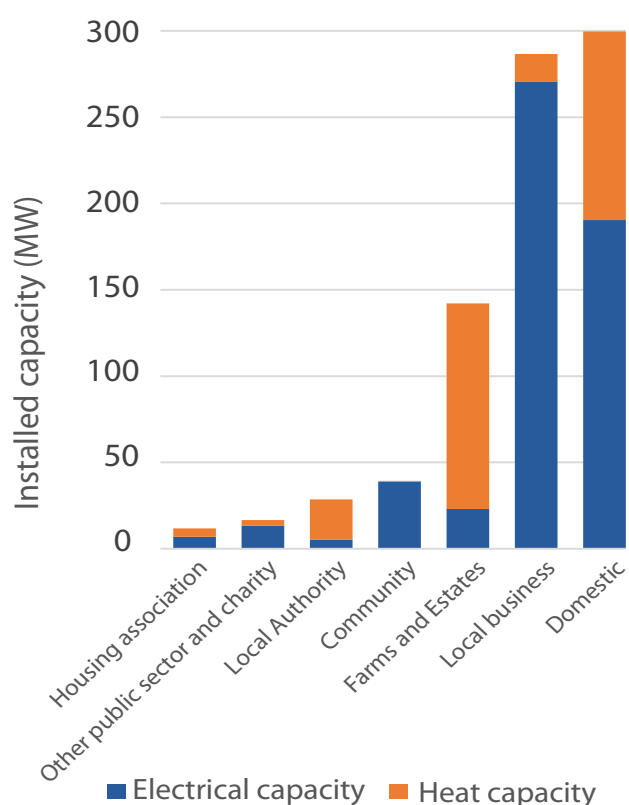
The Welsh Government has set a target for at least 1 GW of renewable energy capacity to be locally owned by 2030. There is also an expectation for all new energy projects in Wales to have at least an element of local ownership from 2020.

An additional 9 MW of locally owned renewable electricity capacity was commissioned in Wales in 2019, bringing the total to 549 MW. There was also an increase in the capacity of locally owned renewable heat, which rose by 11 MW in 2019 to 276 MW. There is now 825 MW of locally owned renewable energy capacity in Wales, 83% of the way towards the 1 GW target.

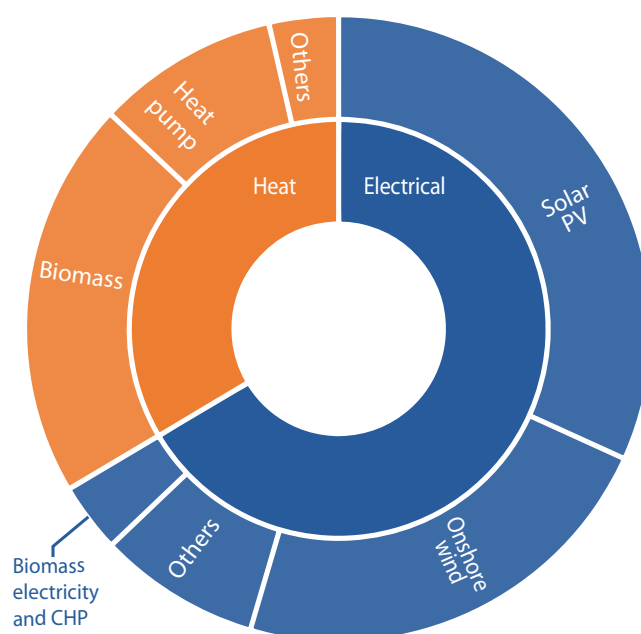
Biomass projects make up nearly two thirds of the locally owned heat capacity in Wales, with 95 projects commissioned in 2019. Nearly half of the locally owned renewable electricity capacity is from solar PV, with 936 new installations in 2019, and just over one third is from onshore wind. There were two new locally owned onshore wind projects commissioned in 2019, the 0.7 MW CAREWT1 turbine in Pembrokeshire and the 0.5 MW turbine installed at Ffwrdd Farm in Ceredigion.

In 2019, 1,729 new locally owned renewable energy projects were installed; 54% of these were solar PV projects, 38% were heat pumps, 5% were biomass projects and the remaining 2% was a mix of other renewable technologies.

Locally owned renewable electricity and heat capacity by ownership type



Locally owned renewable energy generation by technology



Definition of ownership

The definition for 'locally owned' is set out in Welsh Government's policy statement detailing local ownership of energy generation in Wales⁽³⁾. 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 projects in Wales summary by ownership

Ownership category	Number of projects	Capacity (MWe)	Capacity (MWth)	Estimated generation (GWh)
Community	197	39	1	52
Domestic	60,802	190	109	422
Farms and estates	778	23	119	429
Housing association	5,687	7	5	9
Local authority	300	13	3	32
Local business	382	271	16	796
Other public sector and charity	414	5	23	78
Total	68,560	549	276	1,819

Fossil fuels

The ownership of fossil fuel electricity projects has not fully been assessed, as there are no appropriate datasets available for analysis. It is estimated that at least 26%, or approximately 1.5 GW of gas and coal electricity generation capacity was locally owned in 2019. This was predominantly attributable to two large-scale gas plants that are owned by the Welsh-based power producer Calon Energy, though both of these plants are now dormant. It is expected that a higher proportion of small-scale fossil fuel generators would be locally owned.

CASE STUDY – COMMUNITY WIND TURBINE AT FFRWD FARM, CEREDIGION

Grannell Community Energy successfully commissioned the 0.5 MW wind turbine on Ffrwd Farm, Llanwnnen, in October 2019. With support from the Welsh Government Energy Service and costs met by a combination of a loan from the Development Bank of Wales and investment from 129 individuals, there is also an associated fund for the local community. By June 2020, the turbine had generated over 1,000,000 kWh.



Credit: Grannell Community Energy

Low carbon technologies

Anaerobic digestion

There was one new Anaerobic Digestion (AD) project installed in Wales in 2019. There are now 46 active AD projects in Wales, with 19 MW of electrical capacity and 8 MW of thermal capacity.

Analysis

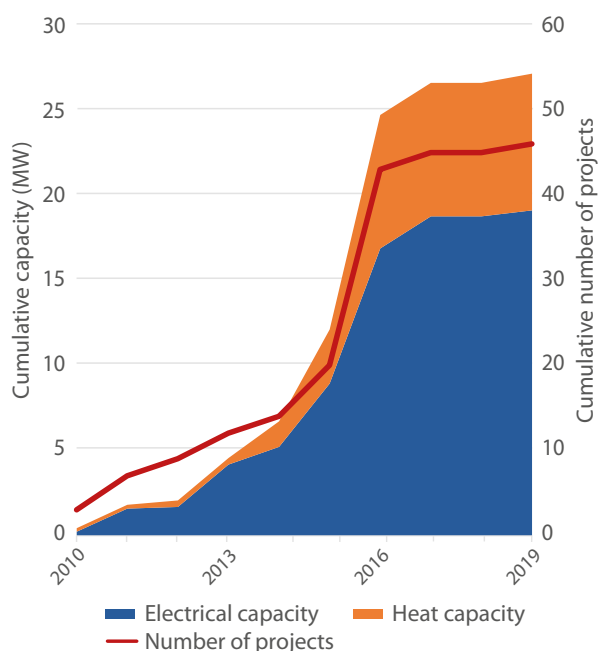
Wales' AD capacity increased by 2% in 2019. This was due to a locally owned plant on the Y Maesydd organic farm in Powys being commissioned. It has an estimated electrical capacity of 0.36 MW and thermal capacity of 0.18 MW and will use farm manure as a feedstock. Nearly three quarters of local authority areas host one or more AD plants, with Powys hosting 13 AD projects, with 6 MW of total capacity.

Future

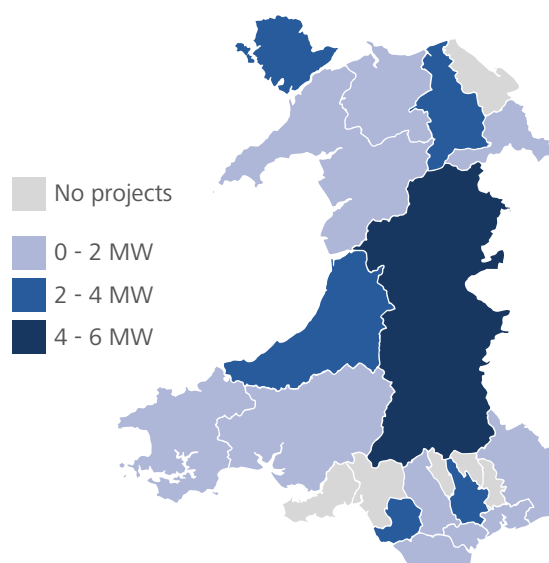
The Renewable Heat Incentive and the Renewable Transport Fuels Obligation are the main incentives for AD deployment. Recent rate increases have further incentivised these tariffs. The proposed successor to the Renewable Heat Incentive, the Green Gas Support Scheme, will support the injection of AD produced biomethane into the gas grid from 2021. AD will also be eligible under the Contracts for Difference scheme in the upcoming 2021 auction.

There are challenges facing the future of AD. The eligibility criteria for the Renewable Heat Incentive specifies that at least 50% of its feedstock must come from waste and Wales' target to halve food waste by 2025 may have an impact. The Green Gas Support Scheme is expected to favour on-farm AD using slurry and manure as a feedstock. However, the limited reach of the gas network in Wales is likely to mean many rural projects will not be able to benefit from this scheme. Nevertheless, the Low Carbon Wales plan⁽³⁾ commits to continuing support for AD and incentivises local authorities to direct food waste to AD plants.

AD deployment over time



Geographic distribution by local authority



Biomass heat

There was a 1% increase in the biomass heat capacity commissioned in Wales in 2019, bringing the total to 449 MW with the majority of these projects situated in Powys.

Analysis

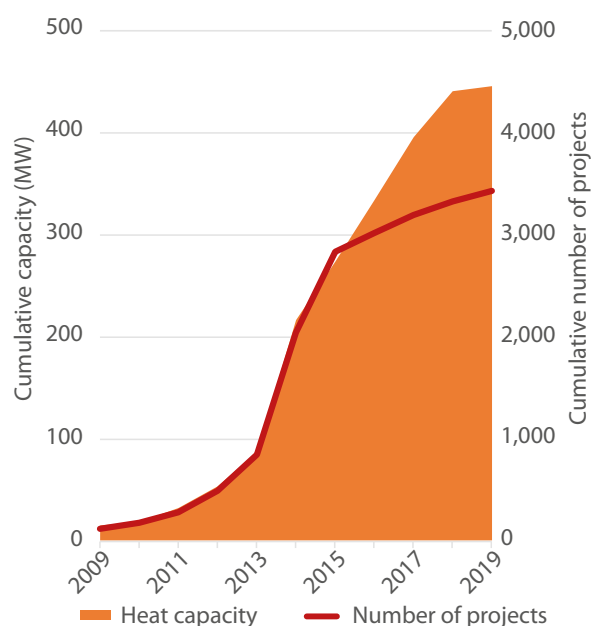
The largest biomass heat project is a solid biomass boiler at a wood manufacturing plant in Wrexham, with a total capacity of 23 MW. Only one installation was commissioned in 2019 with a capacity of 1.25 MW: a solid biomass boiler installed under the non-domestic Renewable Heat Incentive at Old House Farm in Monmouthshire, fed by 2,000 tonnes of wood chip annually. Powys has the highest biomass heat capacity, with a total thermal capacity of 132 MW, 0.7 MW of which was commissioned in 2019. Biomass heat projects in Wales produced an estimated 1.4 TWh of heat, enough to meet the equivalent heat demand of approximately 147,000 Welsh homes. Much of this is produced by commercial and industrial projects. Biomass boilers are installed in less than 0.1% of Welsh homes, with only 48 new installations in 2019.

Future

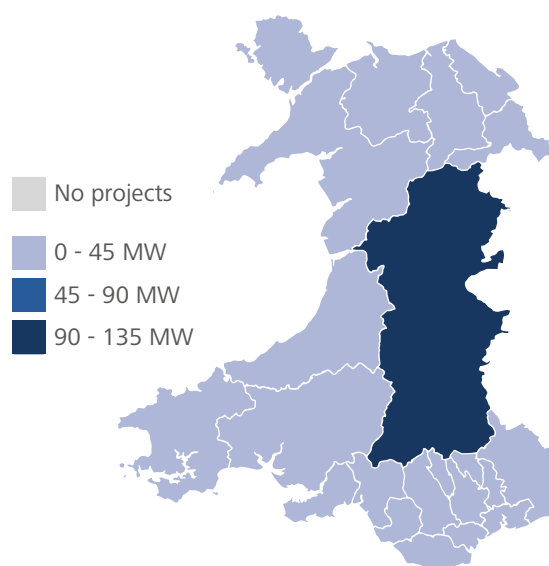
The challenges facing further deployment of biomass projects for heating include local air quality impacts and ensuring feedstocks are sustainable. Welsh Government published the Clean Air Plan for Wales⁽⁴⁾ in August 2020 which aims to improve air quality and reduce the impacts of air pollution on human health, biodiversity, the natural environment and our economy.

The non-domestic Renewable Heat Incentive concludes for new projects in 2021 but the domestic scheme is expected to continue until 2022. New biomass projects will be eligible for support under its proposed successor, the Clean Heat Grant, but only in certain circumstances. The potential remains for small-scale biomass projects or biomass-fuelled CHP district heating to play a longer-term role where sustainable feedstocks or waste biomass can be sourced locally within Wales.

Biomass heat deployment over time



Geographic distribution by local authority



Heat pumps

An additional 8 MW of air, ground and water source heat pump capacity were commissioned in Wales in 2019. The total capacity from heat pumps in Wales now stands at 86 MW from 7,817 projects.

Analysis

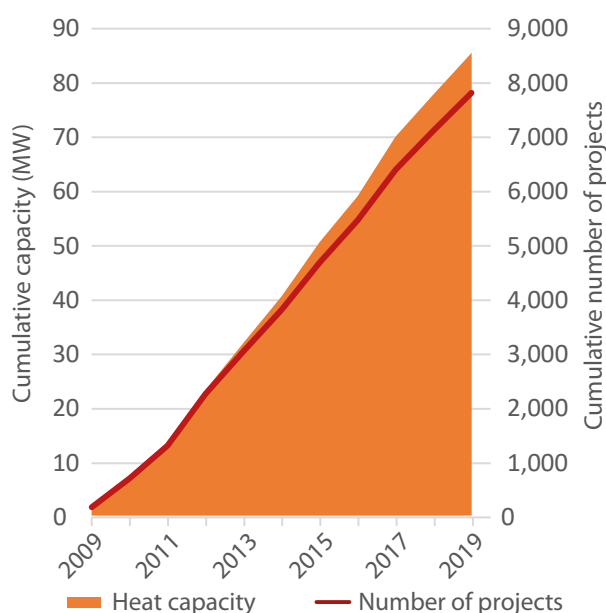
Heat pump installations continued at a steady rate during 2019. Approximately 80% of the 695 new installations in 2019 were air source heat pumps, the majority of which were domestic installations. The largest heat pump installed in 2019 was a 147 kW ground source heat pump in the Vale of Glamorgan, accredited under the non-domestic Renewable Heat Incentive. This heat pump will provide heating and hot water to De Clare Lodge, a retirement development in Cowbridge.

Ceredigion is the local authority area with the highest number of heat pump installations in Wales, with a total of 1,223 heat pumps totalling 11 MW of capacity. Powys also has 11 MW of heat pump capacity through 989 installations. A contributing factor to the high heat pump numbers in these local authorities is social housing providers upgrading tenant homes with air source heat pumps.

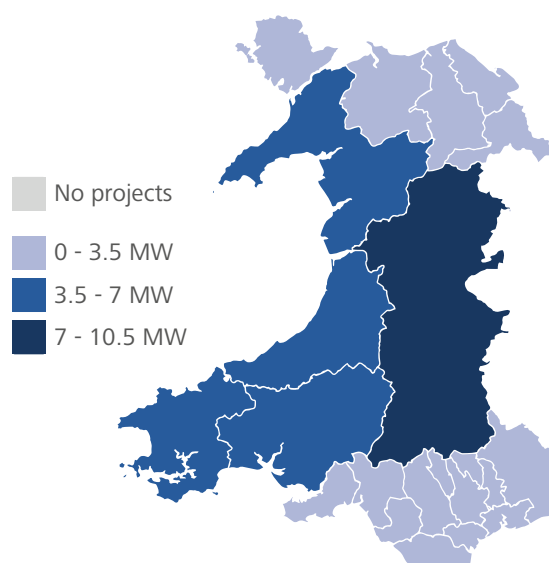
Future

The 'Prosperity for All: A Low Carbon Wales' plan notes that tackling the decarbonisation of off-gas homes, which account for approximately 22% of Welsh homes, is one of Wales' key challenges. The relatively high upfront cost of heat pumps remains the main barrier to widespread deployment. The proposed replacement for the Renewable Heat Incentive, the Clean Heat Grant, is designed to support the majority of domestic installations and may accelerate installation rates. Hybrid heat pumps will also play a role in the decarbonisation of heat in Wales, particularly in the retrofit market where new business models are starting to come to market for these technologies.

Heat pumps deployment over time



Geographic distribution by local authority



Hydropower

Hydropower capacity in Wales increased by 264 kW in 2019, to a total of 182 MW from 358⁽⁵⁾ projects. It's estimated that over 347 GWh is generated annually from Welsh hydropower projects, over half of which is generated by the three largest projects. The largest project commissioned in 2019 was the 85 kW Ffridd Uchaf project in Gwynedd.

Analysis

There were only five new projects commissioned in 2019, compared to six in 2018. These new projects increased the total hydropower capacity by less than 0.2% between 2018 and 2019.

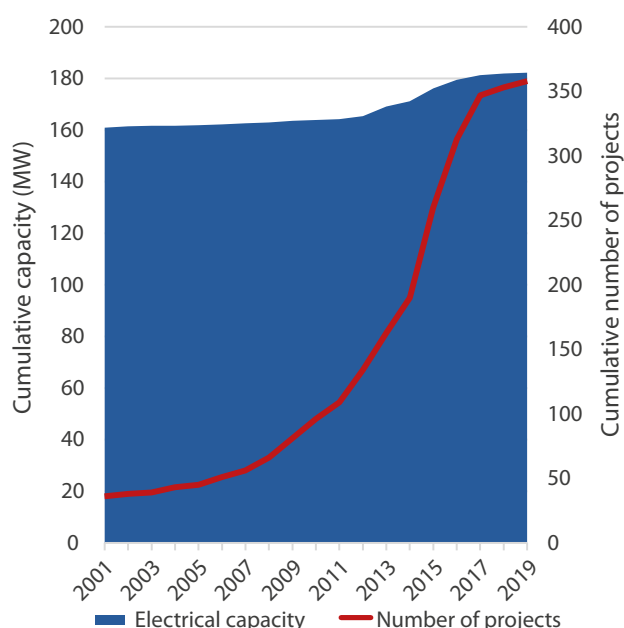
Gwynedd remains the local authority area with the greatest number of hydropower projects in Wales, with 144 projects totalling 59 MW. However, due to hosting Wales' largest hydropower project, Rheidol Power Station, Ceredigion has the greatest hydropower capacity with just under 71 MW across 26 projects. Rheidol Power Station was commissioned in 1964 and has a capacity of approximately 56 MW.

Future

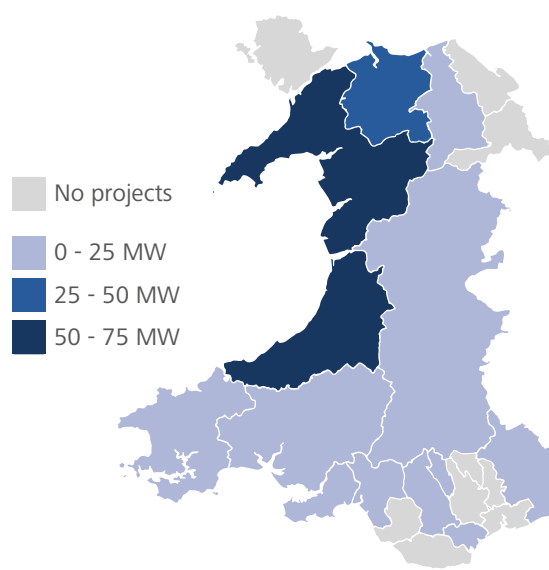
Hydropower is a mature and proven technology that can provide a predictable source of energy. However, the relatively high upfront cost and a lack of cost reduction potential is likely to limit future growth without support.

With the closure of the Feed-in Tariff, the Renewables Obligation in 2017, and hydropower not presently being eligible for Contracts for Difference, there is now no existing or planned tariff support for hydropower. The 2017 revaluation of business rates also impacted the sector, with many schemes seeing a large increase in their rateable value. The Welsh Government has provided some grant support to the sector for payment of business rates.

Deployment of hydropower over time



Geographic distribution by local authority



Offshore wind

There are three offshore wind projects in Wales, all in Liverpool Bay off the North Wales coast, with a total capacity of 726 MW.

Analysis

The Crown Estate's first leasing round led to the development of the North Hoyle and Rhyl Flats projects in 2003 and 2009 respectively, which have a combined capacity of 150 MW. Gwynt y Môr was developed in the second leasing round and commissioned in 2015. With a capacity of 576 MW from 160 turbines, Gwynt y Môr is one of the world's top ten largest offshore wind farms.

Future

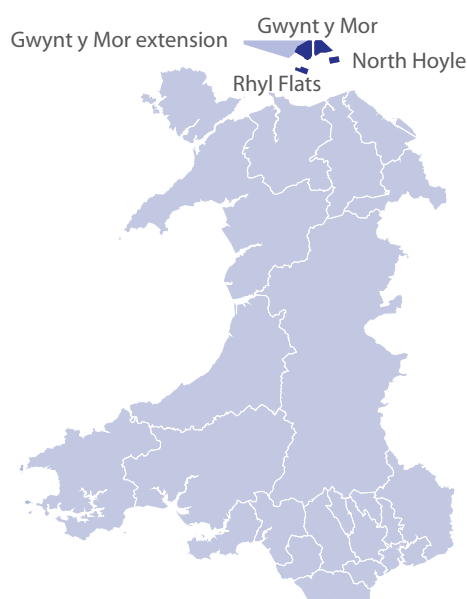
Offshore wind has been a success story across the UK and the reduction in price has accelerated as the technology has matured.

There are strong prospects for offshore wind in Wales and significant potential to deploy both fixed and floating offshore wind. Currently, the majority of the UK's offshore wind farms are located in the North Sea and unlocking sites off the Welsh coast will be essential to security of supply by taking advantage of the different weather patterns around the UK coast. The fourth round of seabed leasing was recently confirmed with the opportunity for an additional 7 GW of new projects in English and Welsh waters and includes a development area focusing on the North Wales region. This round is due to conclude by spring 2022.

The Crown Estate has recently granted seabed rights for a 576 MW extension to the Gwynt y Môr wind farm. Due to be operational in 2030 this will be known as Awel y Môr. The Crown Estate has also recently awarded the rights for a 96 MW floating wind demonstration project 45 km off the south Pembrokeshire Coast to Blue Gem Wind Ltd. This will be the first floating wind farm in Welsh waters and construction is expected to conclude by 2027. This could be the first in a series of projects in the Celtic Sea aimed at maximising local supply chain content. The key challenge to unlock the potential of Welsh

offshore wind sites is ensuring the associated infrastructure, including grid availability, is capable of supporting this technology and a suitable seabed leasing process is in place. Ports will play a significant role in capturing supply chain benefits and investment in Welsh ports will maximise the potential scale of floating wind in the Celtic Sea. Wave and tidal stream technologies are being tested in Wales, with the long term aspiration that our two demonstration zones, the West Anglesey Demonstration Zone and the South Pembrokeshire Demonstration Zone, will enable developers to test prototype and proven technologies.

Geographic distribution



Onshore wind

Welsh onshore wind capacity continued to increase in 2019, with an additional 133 MW deployed across 7 local authority areas. This brings the total onshore wind capacity in Wales to 1.25 GW, a 12% increase from 2018.

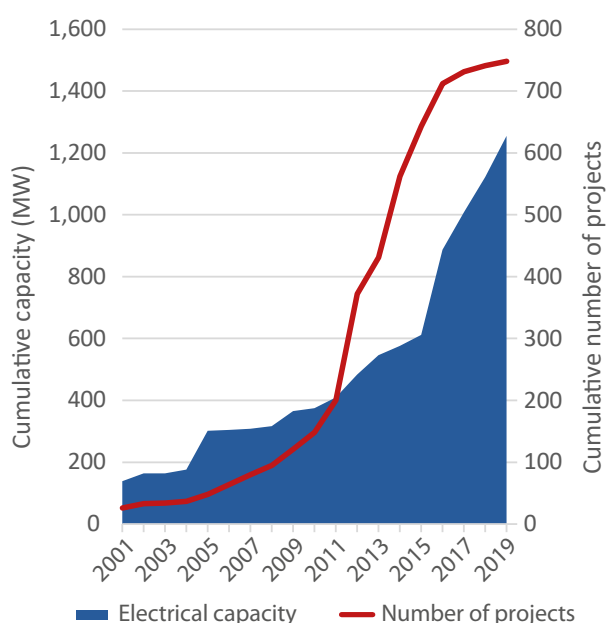
Analysis

Two new large-scale projects accounted for the majority of the capacity increase in 2019: the 96 MW Clocaenog Forest Wind Farm situated on the Welsh Government Woodland Estate on the border of Denbighshire and Conwy, and the 32.8 MW Mynydd Y Gwair Wind Farm in Swansea. Five further projects delivered the remaining 3.9 MW, two of which are community owned; the CAREWT1 development in Pembrokeshire and the Ffrwd Farm turbine in Ceredigion. Approximately 10 MW of the 187 MW of locally owned onshore wind in Wales is community owned. Neath Port Talbot has the highest capacity of onshore wind, with a total of 230 MW. Nearly two thirds of this capacity is from the Pen y Cymoedd wind farm which is situated on the border of Neath Port Talbot and Rhondda Cynon Taf.

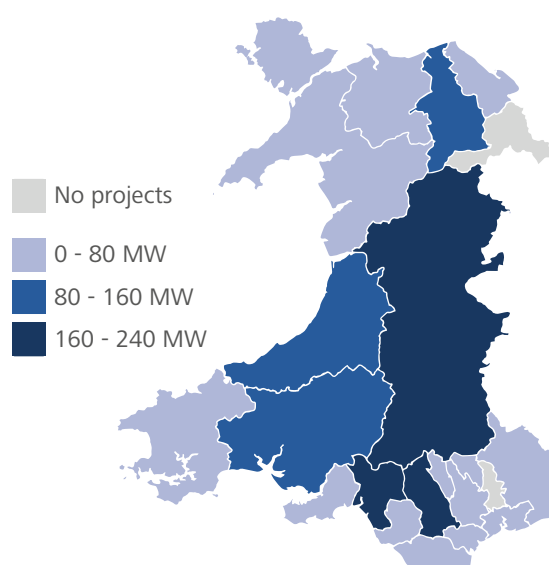
Future

With a supportive planning environment and strong wind resources, Wales has significant potential for further onshore wind development. The major barrier continues to be the geographical disparity between developable areas and suitable network infrastructure. The future of onshore wind will be influenced by the Welsh Government's planning policy and spatial guidance. Some projects may bid under the Contracts for Difference auctions. However, there is increasing developer confidence about the feasibility of subsidy-free projects. The draft National Development Framework sets out the future planning framework and identifies areas for onshore wind. It was laid for scrutiny in the Senedd in September and is due for publication in Spring 2021. There is the potential for subsidy-free projects and it is likely that Wales will be one of the first areas to see these developments.

Onshore wind deployment over time



Geographic distribution by local authority



Solar PV

Welsh solar PV capacity increased by 10 MW in 2019, an increase of less than 1% from last year. The total solar PV capacity now stands at 989 MW, of which nearly 20% is located in Pembrokeshire.

Analysis

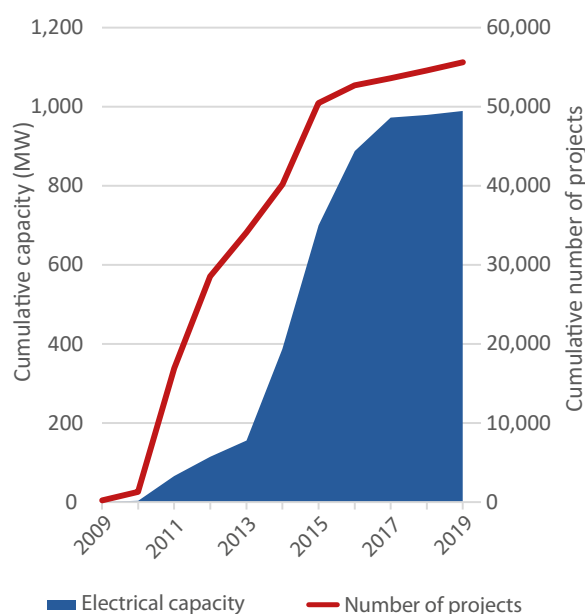
An additional 1,059 installations were commissioned in Wales in 2019, the largest of which were two 0.5 MW installations in Powys. Widespread deployment of this technology has not been seen since the closure of the Feed-in-Tariff in March 2019. However, pre-accreditation periods have been extended for community groups and these projects will continue to deploy into 2021. Deployment of large scale projects has slowed dramatically since the end of the Renewables Obligation.

Pembrokeshire remains the local authority area with the most solar PV capacity and was the area in which the greatest number of projects were commissioned in 2019, with an additional 135 installations. Locally owned solar PV in Wales now totals 262 MW, 26% of the total capacity, with an additional 7.3 MW commissioned in 2019.

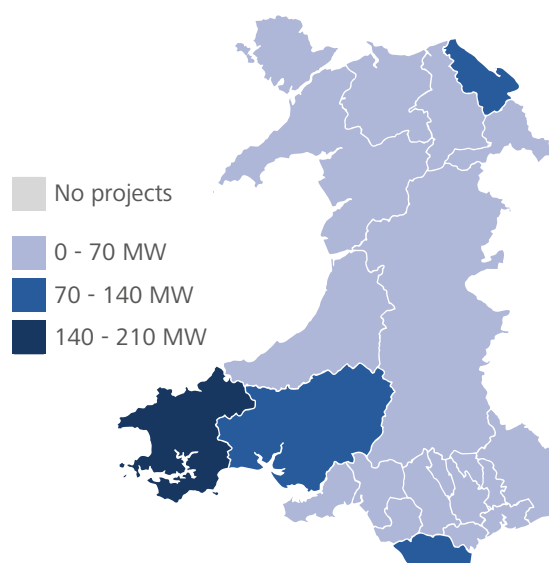
Future

Solar PV will be included in the upcoming 2021 Contracts for Difference auction which is likely to accelerate its deployment. The introduction of the Smart Export Guarantee in January 2020, which ensures electricity suppliers offer tariffs to small-scale low-carbon generators for electricity exported to the grid, may also have a positive impact. There are currently 15 applications for ground-mounted solar PV projects (totalling 236 MW) in the planning system in the South Wales region. There are seven projects (totalling 80 MW) that are either approved or in the planning system in the North Wales region. This pipeline demonstrates the continuing appetite for this technology and its potential in Wales.

Solar PV deployment over time



Geographic distribution by local authority



Fossil fuels

Fossil fuel electricity generation

Fossil fuel generation in Wales in 2019 had a total capacity of 7.4 GW from three fuel sources: 1.6 GW of coal, 0.2 GW of diesel generation and 5.6 GW of gas power.

Analysis

Electricity generation capacity from fossil fuels remained the same in 2019 as it was in 2018. The largest of the gas power plants is situated in Pembrokeshire, the diesel generators are geographically spread across Wales and there was a single coal power station, Aberthaw, in the Vale of Glamorgan, which has now closed.

Following the decommissioning of the Barry Combined Cycle Gas Turbine (CCGT) power station in March 2019, the four remaining gas plants made up 85% of total gas power capacity in 2019; Pembroke, Connah's Quay, Severn Power (now dormant) and Baglan Bay. Wales also has approximately 814 MW of small-scale (<100 MW) fossil fuel electrical capacity, which includes diesel generators, CHP projects, open cycle gas turbines and gas reciprocating engine sites.

Future

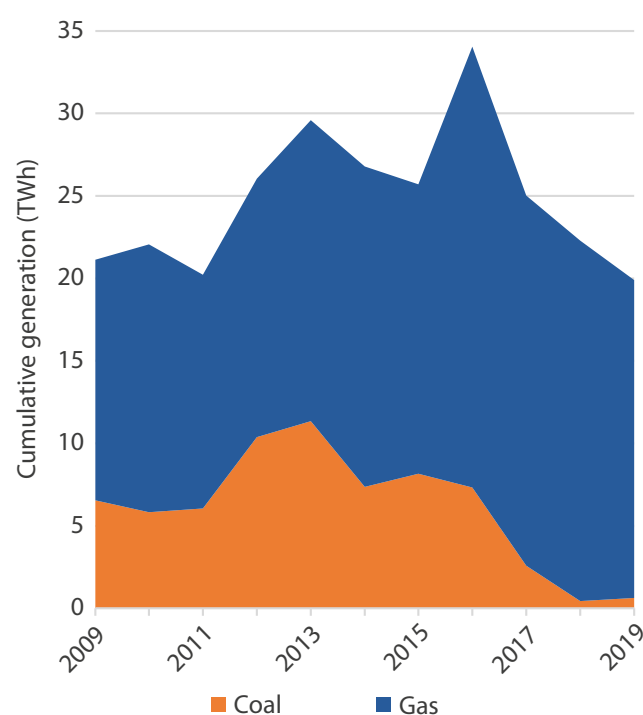
The closure of Aberthaw Power Station in March 2020 means that energy generation in Wales is coal-free five years ahead of the UK-wide target of 2025. In July 2020, the Minister for Environment, Energy and Rural Affairs launched a consultation on Welsh Government's draft coal policy to inform decisions taken on coal in Wales, to support action towards climate change and broader wellbeing aims.

Gas generation in Wales is increasingly changing from providing a steady, baseload supply to a more flexible peaking and backup role. There may be a role to play for small, reciprocating CHP plants which can respond quickly to market signals and provide flexibility to the network.

The key challenge facing diesel generation is the Medium Combustion Plant Directive which prevents unabated large-scale diesel generators being developed and operated. However, small-scale diesel plant may still have a role for backup generation to critical infrastructure in Wales.

The role of fossil fuels in the future energy mix of Wales should be considered in light of the Welsh Government's policy objective to avoid the continued extraction and consumption of fossil fuels.

Fossil fuel electricity generation



Storage

Battery Storage

No large-scale battery storage projects were developed in Wales in 2019. The two existing large-scale battery storage projects were developed in 2018: the 4.3 MW Cenin Renewables' Parc Stormy storage project in Bridgend and the 22 MW Pen y Cymoedd Energy Storage project in Neath Port Talbot.

Analysis

Although no large-scale projects were commissioned in 2019, a survey of leading small-scale battery installers in Wales suggests that, to date, there have been a total of at least 290 domestic and small-scale commercial battery storage installations in Wales, comprising nearly 3.3 MWh of storage. This represents an increase of 0.6 MWh since 2018.

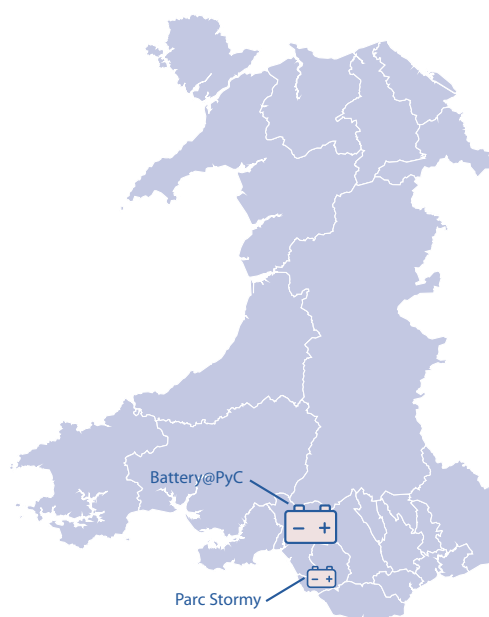
Future

Electricity storage solutions, and batteries in particular, will become increasingly important as renewable energy generation proliferates. They provide an economical solution to address the issues of flexibility and balancing. The cost of lithium ion batteries has decreased significantly, meaning they are now comparative to gas peaking plants for short duration network services. However, there are a number of challenges facing further deployment which include saturated markets, reducing market values and regulatory changes.

The limited deployment in Wales to date is partially due to a constraint on the National Grid transmission network in South Wales, which prevents new battery storage projects above 1 MW from connecting until 2026. However, batteries can provide mitigation against network constraints when co-located and co-operated alongside renewable energy generation. The UK Government's proposed extension to the negative pricing rule in the upcoming 2021 Contracts for Difference auction may encourage this.

There is currently a pipeline of 355 MW⁽⁶⁾ of battery storage projects applying for a grid connection in Wales.

Geographical distribution of large-scale battery storage projects



Reference pages

Data tables	28
Methodology	31
Assumptions and references	32
Abbreviations and definitions	33

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	987	18.6	9.7	5	89.6	-	-	-	14	8.8	1	3.6	-
Bridgend	2,660	100.4	9.6	5	25.2	1	2.8	-	36	7.8	-	-	-
Caerphilly	2,965	68.1	8.7	2	19.2	2	1.9	0.5	48	6.6	2	0.2	-
Cardiff	3,670	53.0	12.4	7	33.4	1	1.8	-	21	4.9	1	0.1	-
Carmarthenshire	6,121	260.6	55.1	2	10.6	2	0.5	0.2	507	43.9	-	-	-
Ceredigion	4,146	191.1	74.4	3	10.3	4	1.3	1.3	257	43.4	4	3.3	17.4
Conwy	2,056	93.6	13.0	3	2.0	3	-	0.4	121	8.5	5	1.4	0.3
Denbighshire	2,327	161.1	21.9	2	1.2	3	1.3	1.3	169	15.5	5	1.5	0.4
Flintshire	3,863	118.2	109.2	4	1,406.0	-	-	-	141	13.9	1	25.0	90.0
Gwynedd	3,395	103.3	22.8	1	0.1	2	0.5	0.2	219	16.2	1	0.1	-
Isle of Anglesey	2,400	78.3	9.9	1	0.1	2	1.9	0.2	59	3.3	1	0.1	0.1
Merthyr Tydfil	772	16.7	5.4	3	42.3	-	-	-	14	3.4	1	1.0	1.5
Monmouthshire	4,432	63.9	34.3	3	0.2	2	0.4	0.1	188	20.9	5	18.3	7.9
Neath Port Talbot	1,951	331.7	20.0	7	633.5	-	-	-	87	15.5	2	55.8	-
Newport	2,291	50.4	11.5	7	896.7	2	0.5	0.1	39	10.4	2	9.0	0.1
Pembrokeshire	5,436	217.9	36.6	7	2,331.1	2	0.0	0.1	286	27.5	2	0.1	0.1
Powys	6,998	239.1	148.5	4	0.7	13	4.1	2.3	957	132.4	9	0.9	1.0
Rhondda Cynon Taf	3,967	239.1	18.9	11	74.5	1	1.2	0.7	61	14.9	-	-	-
Swansea	3,106	88.5	9.1	6	87.4	-	-	-	56	5.1	1	0.6	-
Torfaen	2,027	11.3	4.1	5	0.5	-	-	-	20	2.9	1	0.4	0.5
Vale of Glamorgan	2,417	94.4	11.5	10	1,701.4	1	0.5	-	61	9.0	2	10.1	-
Wrexham	4,945	46.9	38.8	3	53.0	5	0.4	0.7	89	33.8	2	0.3	0.5
Offshore	3	726.0	-	-	-	-	-	-	-	-	-	-	-
Unknown	2	0.1	0.0	-	-	-	-	-	-	-	2	0.1	0.0
Total	72,935	3,372	686	101	7,419	46	19	8	3,450	449	50	132	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	-	-	45	0.4	1	0.0	1	1.6	-	-	7	2.9
Bridgend	-	-	149	1.3	3	0.0	1	0.3	-	-	15	67.7
Caerphilly	-	-	85	0.9	-	-	-	-	-	-	21	17.2
Cardiff	1	30.0	179	2.1	1	0.4	2	2.3	-	-	3	0.1
Carmarthenshire	-	-	899	10.1	13	4.7	1	2.0	-	-	113	145.1
Ceredigion	-	-	1,223	11.3	26	70.8	-	-	-	-	78	85.2
Conwy	-	-	223	2.8	30	34.9	1	2.0	-	-	40	39.9
Denbighshire	-	-	325	4.3	20	2.3	-	-	-	-	39	146.7
Flintshire	-	-	470	4.8	-	-	2	1.3	-	-	17	1.9
Gwynedd	-	-	553	6.0	144	59.4	2	0.2	-	-	36	6.9
Isle of Anglesey	-	-	501	5.8	-	-	1	0.3	-	-	49	39.4
Merthyr Tydfil	-	-	36	0.5	4	0.2	2	6.3	-	-	5	2.4
Monmouthshire	-	-	468	5.2	11	0.2	-	-	-	-	10	0.3
Neath Port Talbot	-	-	110	1.1	10	0.5	2	3.4	-	-	12	230.1
Newport	-	-	58	0.8	-	-	1	1.0	-	-	11	16.1
Pembrokeshire	-	-	653	7.2	14	0.5	1	1.5	-	-	149	25.2
Powys	-	-	989	11.0	79	7.9	1	2.0	-	-	118	199.4
Rhondda Cynon Taf	-	-	149	1.7	4	0.2	2	1.1	-	-	12	193.0
Swansea	-	-	225	2.8	2	0.1	1	0.8	-	-	5	34.2
Torfaen	-	-	60	0.7	1	0.0	-	-	-	-	3	0.0
Vale of Glamorgan	-	-	195	2.3	-	-	-	-	-	-	6	1.1
Wrexham	-	-	222	2.3	-	-	3	4.4	-	-	1	0.0
Offshore	-	-	-	-	-	-	-	-	3	726.0	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-
Total	1	30	7,817	86	363	182	24	31	3	726	748	1,255

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	-	-	-	623	10.5	290	0.5	-	-	1	16.0	4	73.6	
Bridgend	-	-	-	2,349	29.5	101	0.5	-	-	-	-	5	25.2	
Caerphilly	-	-	-	2,460	48.9	345	0.7	-	-	1	19.0	1	0.1	
Cardiff	1	4.0	5.0	3,360	14.3	93	0.4	-	-	1	0.7	6	32.8	
Carmarthenshire	-	-	-	4,291	108.4	293	0.9	-	-	-	-	2	10.6	
Ceredigion	-	-	-	2,203	30.5	348	1.0	-	-	2	10.3	1	0.1	
Conwy	-	-	-	1,379	15.5	251	0.9	-	-	-	-	3	2.0	
Denbighshire	-	-	-	1,623	9.3	141	0.4	-	-	-	-	2	1.2	
Flintshire	1	0.2	0.2	3,143	89.7	84	0.2	-	-	1	14.0	3	1,392.0	
Gwynedd	-	-	-	2,269	36.2	168	0.5	-	-	-	-	1	0.1	
Isle of Anglesey	-	-	-	1,601	36.6	185	0.5	-	-	-	-	1	0.1	
Merthyr Tydfil	-	-	-	640	6.8	67	0.0	-	-	1	21.2	2	21.1	
Monmouthshire	-	-	-	3,632	44.7	113	0.3	-	-	1	0.1	2	0.1	
Neath Port Talbot	1	3.0	3.3	1,681	38.9	39	0.1	-	-	1	21.2	6	612.3	
Newport	-	-	-	2,137	23.8	34	0.1	-	-	-	-	7	896.7	
Pembrokeshire	-	-	-	3,769	190.6	553	1.7	-	-	-	-	7	2,331.1	
Powys	-	-	-	4,153	24.8	675	1.9	-	-	-	-	4	0.7	
Rhondda Cynon Taf	-	-	-	3,182	43.7	545	1.6	-	-	1	21.2	10	53.3	
Swansea	1	0.6	0.8	2,658	52.3	151	0.4	-	-	2	23.6	4	63.8	
Torfaen	-	-	-	1,919	10.9	18	0.1	-	-	-	-	5	0.5	
Vale of Glamorgan	-	-	-	2,055	82.8	87	0.1	1	1,586	2	0.2	7	115.1	
Wrexham	1	1.2	1.2	4,507	40.6	112	0.3	-	-	2	36.0	1	17.0	
Offshore	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	5	9	10	55,634	989	4,693	13	1	1,586	16	184	84	5,650	

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, cleansing 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
- Gemserv MCS data
- Renewable Energy Planning Database
- Contact with utilities, installers and industry organisations
- A survey of small-scale storage installers
- BEIS energy statistics

Regen

Regen is a not-for-profit centre of energy expertise and market insight whose mission is to transform the world's energy systems for a zero carbon future.

For more information, visit www.regen.co.uk



Assumptions and references

Assumption	Source
Estimated Welsh domestic heat demand	Evaluated using BEIS Regional and Local Authority Gas Consumption Statistics (2018).
Local authority and Welsh electricity consumption	BEIS Regional and Local Authority Electricity Consumption Statistics (2018). See Note 1 for more information.
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.

Notes

(1) The 2019 electricity consumption figure for Wales is not yet published. The published figure for Wales' 2018 electricity consumption is used for this report's 2019 calculations, with the knowledge that the 2018 and 2019 UK total electricity consumption that have been published by DUKES remains approximately constant (2% variance).

(2) Prosperity for All: A Low Carbon Wales, 2019.

(3) Policy Statement: local ownership of energy generation in Wales – benefitting Wales today and for future generation, 2020.

(4) The Clean Air Plan for Wales: Healthy Air, Healthy Wales, 2020.

(5) It is known that the number of hydropower projects in this report is higher than Natural Resources Wales' abstraction licence database. It remains an ongoing activity to validate this study's database of predominantly Renewable Obligation, Feed-in Tariff and Renewable Energy Guarantees Origin hydropower projects against Natural Resource Wales' database of hydropower projects.

(6) WPD and SPEN System Wide Resource Registers, 2020.

As part of the analysis for this report, the data for prior years is reviewed and revised data is included to increase accuracy. As a result, some of the figures published in the Energy Generation in Wales 2018 report may have since been superseded. Therefore, year-on-year comparisons made in this report are calculated against the latest available data rather than against previous Energy Generation in Wales reports.

We have not reported on some technologies this year as there has been little or no material change from 2018. These include biomass electricity and CHP, energy from waste, landfill gas, nuclear, solar thermal, sewage gas and pumped hydropower storage.

Abbreviations and definitions

Abbreviation	Explanation
Generation	The energy produced by generators such as wind farms or gas-fired power plants.
Consumption	The final use of energy, either as electrical demand, heat demand, or both.
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 proportion of time an energy generation project will generate for, relative to its maximum capacity. 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
CHP	Combined Heat and Power.
Solar PV	Solar photovoltaic panels.

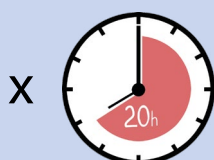
Orders of magnitude	Explanation
W	1 watt = 1 watt
kW	1,000 watts = 1 kilowatt
MW	1,000,000 watts = 1 megawatt
GW	1,000,000,000 watts = 1 gigawatt
TW	1,000,000,000,000 watts = 1 terawatt

A note on power and energy

Power (capacity) X Time = Energy (e.g. demand and generation)



50 watts

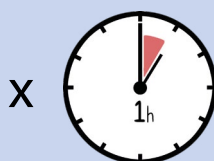


20 hours

= 1,000 Wh or 1 kWh
(of demand)



1,000,000 watts (1 MW)



1 hour

= 1,000,000 Wh or 1 MWh
(of generation)

