Low Carbon Energy Generation in Wales

Updated study of low carbon energy
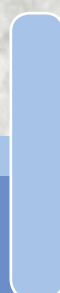
Helpu Cymru i leihau
ei Hôl Troed Carbon

**Help Wales reduce
its Carbon Footprint**

November 2015

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Foreword

In "Green Growth Wales: Local Energy", I set out our approach to local energy. My vision is to see all communities and businesses generating both electricity and heat locally from a range of renewable installations, to supply local demand and to minimise our dependence on central generation. I believe that this is the most affordable way to deliver decent jobs locally whilst minimising our dependence on fossil fuels and imported energy.

It is important to track where we are in Wales on making the most of our renewable resources, which is why we commissioned research on renewable energy in Wales as at 2012. This survey is an update to that baseline, which was published in 2013. It provides an important and timely measure of our progress in the transition to a low carbon, local energy economy.

The evidence shows that people in Wales are embracing the opportunity to take control of their own energy needs, demonstrated by the increasing capacity of renewable energy technologies being deployed across the country. This increase is evident in all sectors and at all scales: Wales is home to many thousands of solar PV installations on domestic rooftops, over 120 community energy projects and one of the largest offshore wind farms in the world.

We now have more than 51,000 low carbon energy installations recorded across Wales. The majority of this capacity is electricity, but there has been a four-fold increase in low carbon heat capacity. Our low carbon, local energy installations have the potential to meet 57% of Wales's electricity consumption.

The survey results show the very real progress Wales is making. By using our natural resources in the most effective and sustainable ways, we will create the local energy systems that Wales needs, tackle poverty for the long term and put Wales at the forefront of carbon reduction.

Carl Sargeant AM
Minister for Natural Resources and Food

Introduction

Energy Wales: A Low Carbon Transition is helping to lead Wales towards a sustainable, low carbon economy. Wales is rich in natural resources and these provide the opportunity to create the local energy systems that will deliver social, economic and environmental benefits. It is important to measure the progress Wales is making in becoming a low carbon economy - this report tracks that progress.

The report makes an assessment of the number of low carbon energy generation projects installed in Wales up to the end of December 2014. It updates the baseline survey undertaken in 2013 and follows a similar methodology. It estimates the amount of electricity and heat that these installations produced in 2014, and calculates the amount of carbon dioxide saved when compared to fossil fuel energy generation.

The report demonstrates the progress that Wales has made in achieving its vision of becoming a low carbon, local energy economy, and the significant increase in capacity of renewable technologies since the baseline survey was undertaken in 2013.

It provides a breakdown of projects by technology, and summarises the level of deployment for each of the 22 local authority areas. It is worth pointing out that the potential for renewable energy deployment differs regionally across Wales, and therefore these results cannot be directly compared. The results do indicate that deployment is taking place throughout Wales, across all of the heat and electricity technologies and at all scales.

The report includes some interesting case studies from the different sectors that help to demonstrate the economic, social and environmental benefit that can be achieved through the effective and sustainable use of our natural resources.

This report:

- Updates a previous study we published in June 2014
- Tells us about low carbon energy projects installed up to the end of December 2014
- Allows for a breakdown of projects by local authority and by technology
- Identifies over 51,000 low carbon energy projects in Wales
- Estimates 8,919GWh of renewable energy generation across Wales
- Estimates an annual saving in excess of 4m tonnes of CO_2

The national picture

Since 2012 the total capacity for low carbon energy in Wales has grown by over 70 percent to 2,770 MW. The majority of this capacity is electricity, although low carbon heat capacity has also begun to grow significantly, more than tripling its 2012 capacity to 255 MW in 2014. There are now 51,303 low carbon energy projects recorded across Wales.

Generation potential has increased substantially since 2012, up by 54 percent to 8.92 TWh. Electrical generation potential totals 8.16 TWhe, equivalent to 57 percent of Wales's national electricity consumption. Heat generation has also increased, largely due to a surge in biomass energy projects. As a result, heat generation in Wales now provides the equivalent of 3.1 percent of gas consumption.

Table 1: Low carbon energy in Wales by technology

Technology	Number of projects	Capacity (MW_e)	Capacity (MWth)	Estimated generation (MWh_e)	Estimated generation (MWhth)	CO_2 saved (tonnes CO_2 per annum)
Anaerobic Digestion	10	3.30	0.23	17,413	1,380	8,610
Biomass	2,000	0.06	205.07	420	628,751	152,126
Fuelled	8	126.22	-	884,550	-	420,427
Heat pumps	2,578	-	27.27	-	52,550	12,698
Hydropower	184	154.32	-	283,882	-	134,929
Landfill gas	23	35.38	-	176,030	-	83,667
Nuclear	1	490.00	-	2,578,250	-	1,225,442
Offshore wind	3	726.00	-	2,418,960	-	1,149,732
Onshore wind	756	597.75	-	1,427,838	-	678,651
Sewage gas	9	9.77	11.85	36,988	72,640	17,583
Solar PV	41,570	372.16	-	332,531	-	158,052
Solar thermal	4,161	-	11.07	-	6,785	1,639
Total	**51,303**	**2,514.96**	**255.48**	**8,156,862**	**762,106**	**4,043,555**

Progress during 2013 and 2014

Onshore and offshore wind, solar PV and biomass have grown in capacity and project numbers dramatically since 2012. These technologies accounted for 86 percent of the capacity growth and 85 percent of the increase in the number of projects. Domestic installations continue to dominate the number of projects, but commercial projects dominate the total capacity. Nearly 90 percent of the total electrical capacity is accounted for by projects over 100 kW.

Approximately half of the increase in electrical capacity is due to Gwynt y Mor offshore wind farm, which at 576 MW_e, is the second largest offshore wind farm in the world.

Table 2: Growth in low carbon energy over the period 2008 to 2014

Year	Number of new projects	Growth in Capacity (MW_e)	Growth in Capacity (MW_{th})	Growth in generation (MWh_e)	Growth in generation (MWh_{th})
2008	243	29.16	3.93	13,201	142,776
2009	631	181.64	7.35	18,736	481,758
2010	2,145	20.92	15.38	55,034	67,001
2011	18,427	116.66	18.46	174,513	45,671
2012	14,831	139.65	32.11	266,813	87,627
2013	6,971	118.20	42.82	229,819	121,526
2014	7,409	832.25	128.72	2,424,253	386,156

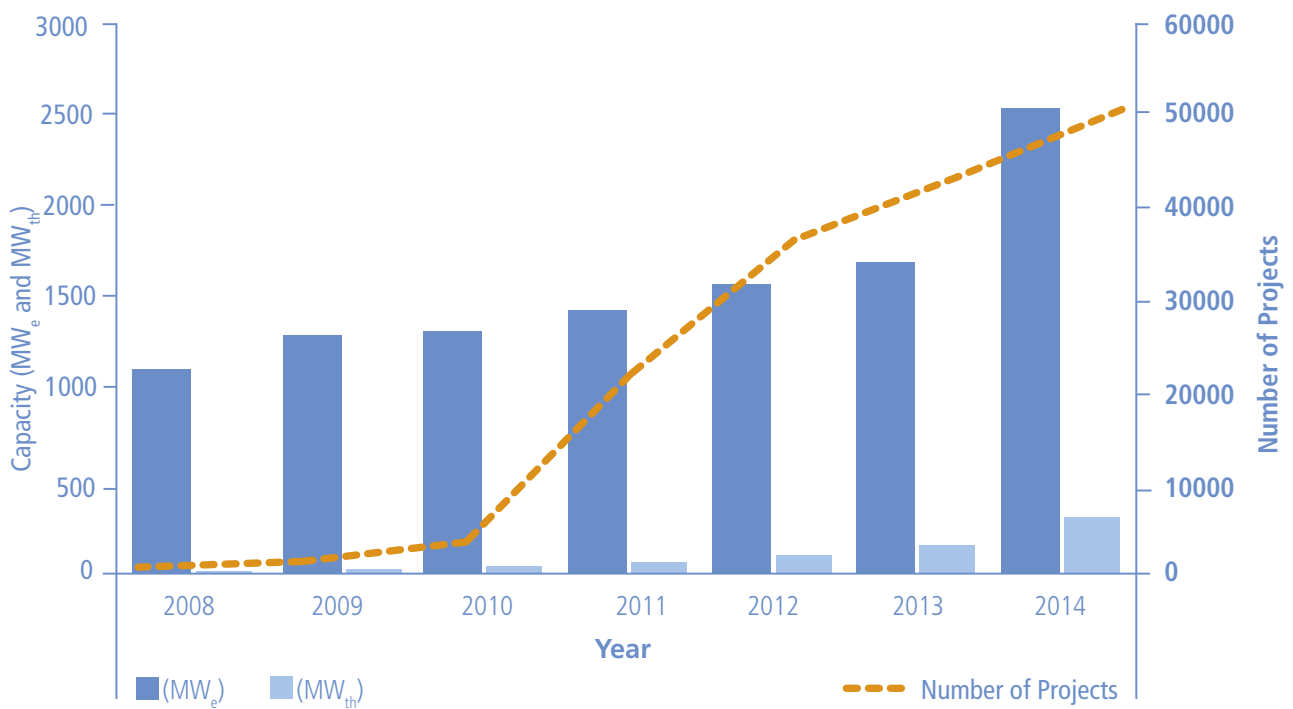*Figure 1: Growth of low carbon energy in Wales from 2008 to 2014*

Table 3: New projects in 2013-2014 by technology

Technology	Number of projects	Capacity (MW$_e$)	Capacity (MW$_{th}$)	Estimated generation (MWh$_e$)	Estimated generation (MWh$_{th}$)	CO$_2$ saved (t CO$_2$ per annum)
Anaerobic digestion	4	2.00	0.03	10,542	153	5,048
Biomass	1,500	-	157.85	-	483,970	116,942
Fuelled	2	35.99	-	252,183	-	119,863
Heat pump	1,052	-	11.55	-	22,263	5,380
Hydropower	26	2.72	-	5,005	-	2,379
Offshore wind	1	576.00	-	1,950,000	-	926,835
Onshore wind	183	94.43	-	222,507	-	105,758
Solar PV	10,865	239.32	-	213,835	-	101,636
Solar thermal	747	-	2.11	-	1,295	313
Total	**14,380**	**950.45**	**171.54**	**2,654,071**	**507,682**	**1,384,151**

The local picture

The table below summarises the findings of the research for all low carbon energy technologies by local authority area. This contains findings for all low carbon energy generation, including nuclear.

The graph shows a summary of how different energy generating technologies make up these totals. To make it easier to read, we have not included the electricity generation from nuclear or offshore wind in the graph.

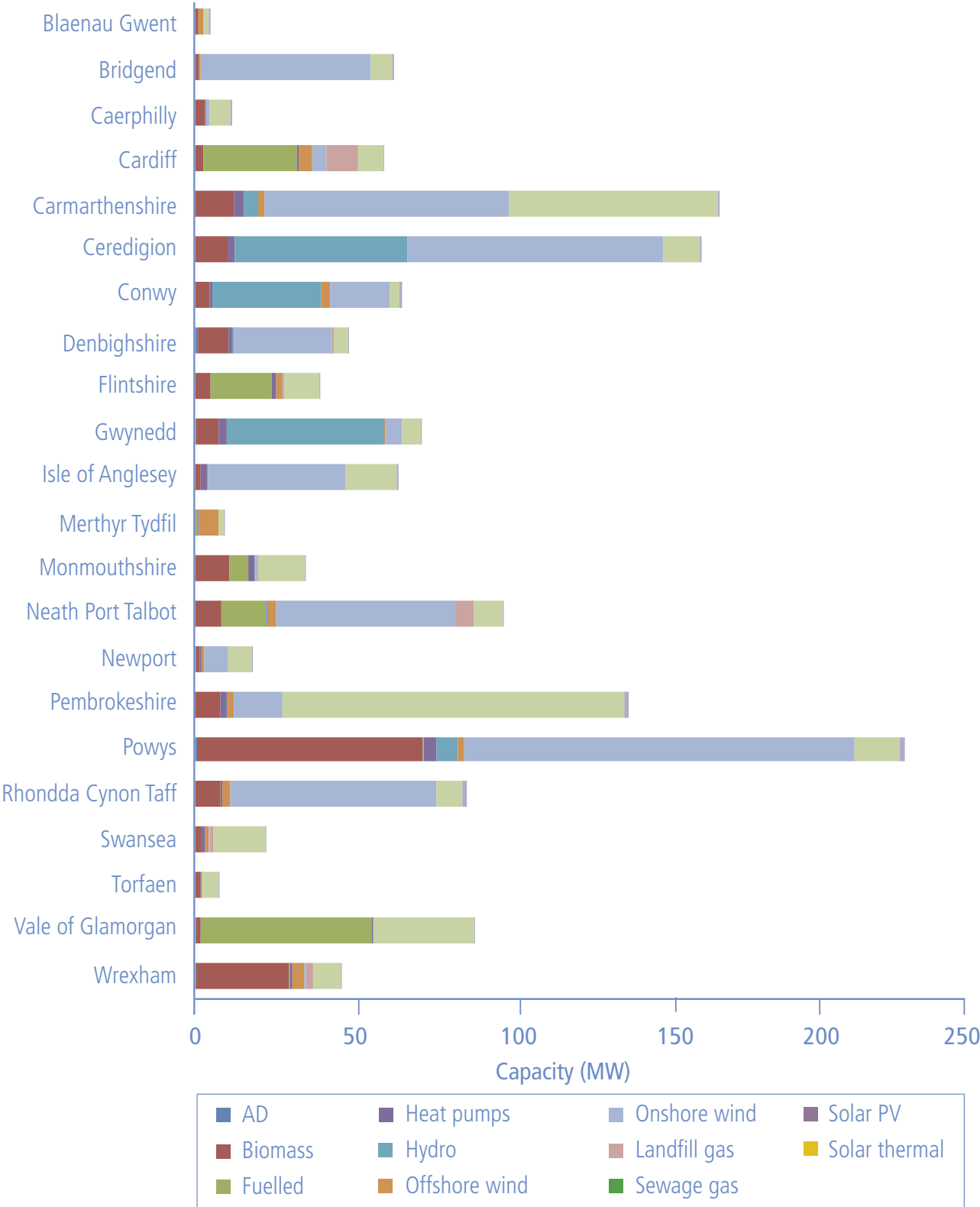*Table 4: Low carbon energy in Wales by local authority*

Local Authority	Number of projects	Capacity (MW_e)	Capacity (MW_{th})	Estimated generation (MWh_e)	Estimated generation (MWh_{th})	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	861	3.48	1.53	10,239	3,379	5,683
Bridgend	1,754	62.02	1.83	136,848	4,303	66,084
Caerphilly	2,505	7.66	4.37	8,562	11,360	6,814
Cardiff	2,595	51.55	9.12	266,994	44,277	129,215
Carmarthenshire	3,856	152.10	16.54	282,618	45,137	145,235
Ceredigion	2,343	149.40	13.46	306,008	37,233	154,442
Conwy*	1,367	726.18	6.47	2,362,179	16,637	1,126,764
Denbighshire*	1,533	97.74	11.52	269,031	34,535	135,813
Flintshire	2,275	33.25	6.89	158,744	19,710	79,880
Gwynedd	2,252	63.01	9.97	115,754	27,037	61,551
Isle of Anglesey**	1,691	551.13	4.21	2,699,200	9,801	1,285,298
Merthyr Tydfil	536	8.90	0.37	39,904	807	19,162
Monmouthshire	3,462	21.71	13.76	57,500	40,383	36,615
Neath Port Talbot	1,263	86.59	12.39	266,452	47,450	133,206
Newport	1,686	16.86	1.65	32,301	4,248	16,379
Pembrokeshire	3,453	127.54	11.80	145,492	30,116	76,430
Powys	4,920	149.67	78.38	336,631	232,093	215,933
Rhondda Cynon Taf	3,031	76.99	10.36	175,997	27,206	90,225
Swansea	2,208	18.71	4.31	23,533	13,533	13,270
Torfaen	1,755	5.65	2.06	5,482	5,934	4,039
Unknown	24	2.34	-	5,514	-	2,621
Vale of Glamorgan	1,660	87.69	1.98	416,982	5,094	199,422
Wrexham	4,273	14.80	32.51	34,896	101,834	39,474
Total	**51,303**	**2,514.96**	**255.48**	**8,156,862**	**762,106**	**4,043,555**

* Includes offshore wind.
** Includes nuclear.

A more detailed analysis of how this is broken by individual technologies in each local authority area can be found in later sections of this report.

Figure 2: Capacity by local authority (excluding nuclear and offshore wind)

Local progress in 2013 and 2014

Table 5: Increase in low carbon energy since 2012 by local authority

Local Authority	Number of projects	Capacity (MW$_e$)	Capacity (MW$_{th}$)	Estimated generation (MWh$_e$)	Estimated generation (MWh$_{th}$)	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	148	0.6	0.2	516	470	359
Bridgend	472	56.8	1.3	130,697	3,616	62,994
Caerphilly	551	2.8	1.6	3,932	4,568	2,973
Cardiff	620	32.3	1.9	212,257	5,303	102,167
Carmarthenshire	1,117	51.9	11.2	48,786	32,290	30,990
Ceredigion	764	2.8	10.5	3,454	30,339	8,972
Conwy*	505	578	5	1,952,345	13,342	931,174
Denbighshire	539	3.1	9.5	7,651	28,357	10,488
Flintshire	751	2.8	4.9	2,623	13,839	4,590
Gwynedd	533	4.7	6.0	8,670	17,009	8,231
Isle of Anglesey	320	19.0	1.6	24,939	3,968	12,812
Merthyr Tydfil	157	0.8	0.2	679	520	448
Monmouthshire	1,448	10.3	10.7	45,980	31,711	29,517
Neath Port Talbot	445	6.8	8.6	6,337	25,996	9,293
Newport	392	1.8	1.4	2,149	3,957	1,977
Pembrokeshire	990	104.1	6.7	106,916	18,613	55,315
Powys	1,617	7.5	58.4	12,449	176,344	48,527
Rhondda Cynon Taf	1,098	21.5	2.0	44,868	5,737	22,712
Swansea	603	11.5	1.7	10,291	4,491	5,976
Torfaen	257	1.2	0.6	1,063	1,846	951
Vale of Glamorgan	535	28.5	1.1	25,497	2,871	12,812
Wrexham	518	2.0	27.0	1,974	82,495	20,872
Total	**14,380**	**950.4**	**171.5**	**2,654,071**	**507,682**	**1,384,151**

The number of new projects per local authority varies greatly, with just 148 new projects in Blaenau Gwent, compared to 1,617 new projects in Powys. However, excluding offshore wind, the greatest increase in capacity was in Pembrokeshire thanks to the growth of ground mounted solar PV capacity within the local authority.

There are now over 120 community energy projects in Wales, with many registered through the Feed-in Tariff. The majority of these projects are hydropower, anaerobic digestion, biomass and solar PV installations, ranging from very small domestic scale installations to 0.5 MW schemes.
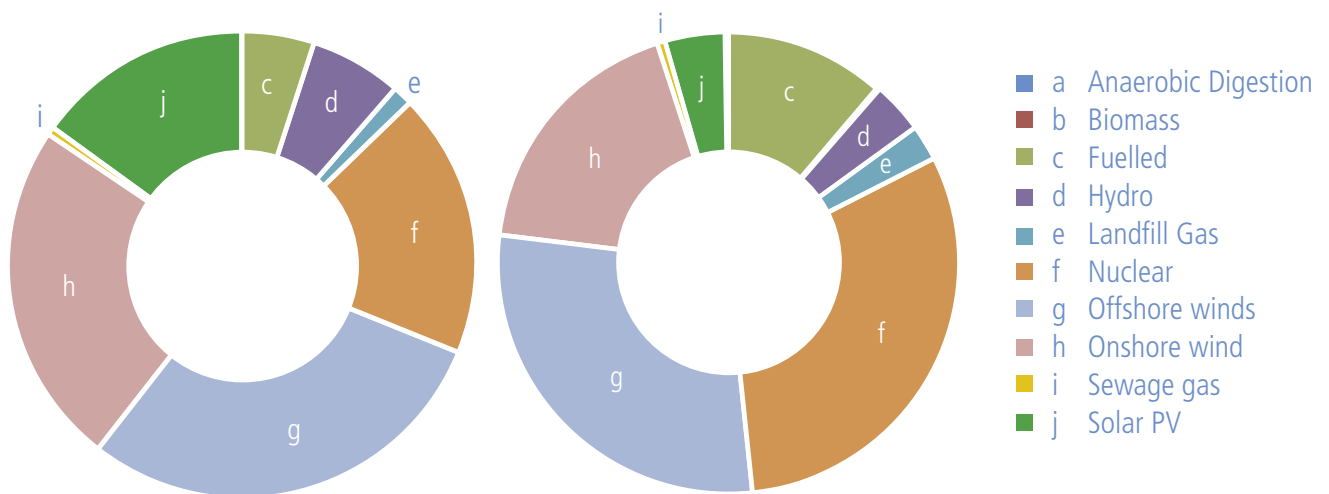
Summary by technology

Electricity

The total capacity for low carbon electricity has grown to 2,515 MW$_e$, the majority of which is delivered by solar PV, onshore and offshore wind, and nuclear. Anaerobic digestion, fuelled projects and hydropower capacity are also growing but contribute just 11 percent of the total electrical capacity.

In 2012, half of all the low carbon electrical generation was delivered by nuclear, however, thanks to the growth in renewable electricity technologies, this has decreased to 32 percent. Offshore wind now provides 30 percent of the total low carbon electricity generation, while sewage and landfill gas capacity and generation has decreased.

*Figure 3: Low carbon electricity capacity and generation by technology*

a Anaerobic Digestion
b Biomass
c Fuelled
d Hydro
e Landfill Gas
f Nuclear
g Offshore winds
h Onshore wind
i Sewage gas
j Solar PV

Heat

There is now 255.5 MW$_{th}$ of low carbon heat in Wales, a dramatic increase from 58.6 MW$_{th}$ in 2012. This is largely due to the growth of biomass boilers, although heat generated from heat pumps and anaerobic digestion is also increasing.

The greatest increase in renewable heat was in Powys, where approximately a third of new renewable heat capacity in Wales has been installed. The majority of this capacity is from biomass boilers approximately 200 kW$_{th}$ in size, which is a typical size for farm based projects. Under the Non-Domestic RHI, there are now over 250 biomass projects associated with crop and animal production in Powys, in addition to over 150 associated with accommodation.

Figure 4: Low carbon heat capacity and generation by technology

- Biomass
- Heat Pumps
- Sewage Gas
- Solar Thermal
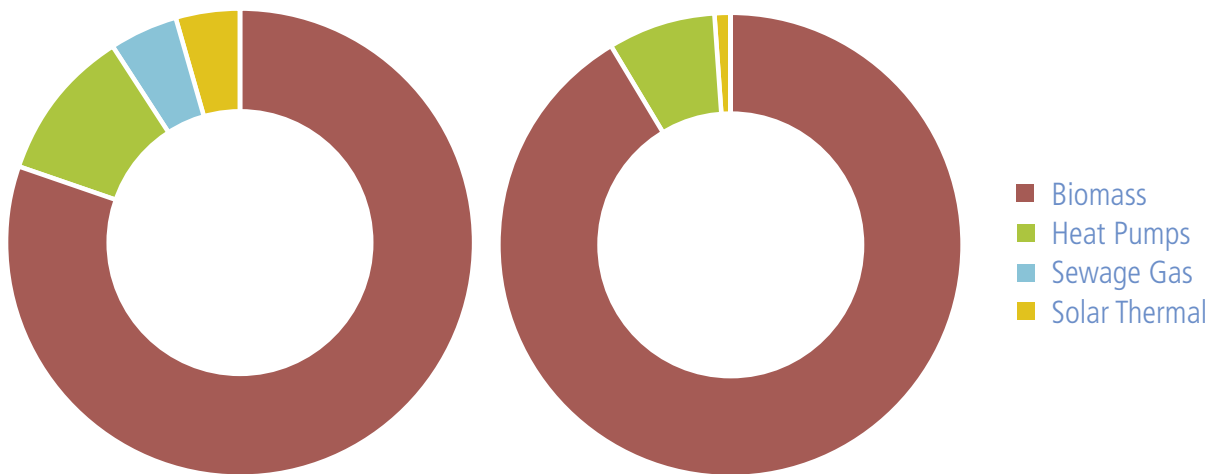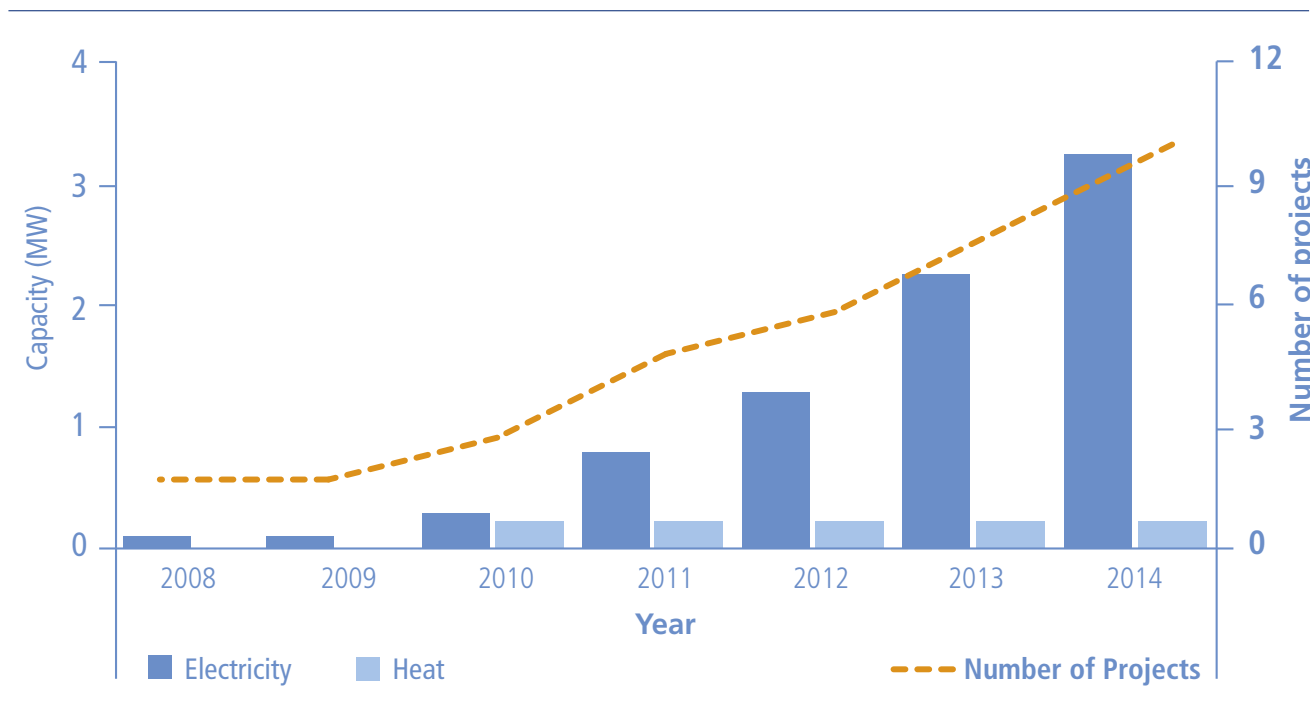
Anaerobic digestion

There are ten anaerobic digestion projects across Wales with a total capacity of 3.3MW$_e$ and 0.23 MW$_{th}$. These sites are located across eight local authorities in Wales and could potentially generate 18,793 MWh.

Denbighshire and Powys have the most anaerobic digestion projects with two projects each. Denbighshire also has the largest anaerobic digestion project in Wales, the Waen anaerobic digestion plant, which was built in 2014 and processes food waste.

Table 6: Anaerobic digestion generators by local authority

Local Authority	Number of projects	Capacity (MW$_e$)	Capacity (MW$_{th}$)	Estimated generation (MWh$_e$)	Estimated generation (MWh$_{th}$)	CO$_2$ saved (tonnes CO$_2$ per annum)
Carmarthenshire	1	0.02	-	84	-	40
Denbighshire	2	1.00	0.03	5,274	153	2,544
Gwynedd	1	0.50	-	2,637	-	1,253
Newport	1	0.50	-	2,631	-	1,251
Pembrokeshire	1	0.00	-	16	-	8
Powys	2	0.62	-	3,291	-	1,564
Vale of Glamorgan	1	0.50	-	2,637	-	1,253
Wrexham	1	0.16	0.20	844	1,226	697
Total	**10**	**3.30**	**0.23**	**17,413**	**1,380**	**8,610**

Figure 5: Trends in the deployment of anaerobic digestion

Case study

The Welsh Government's £750m waste infrastructure procurement programme supports local authorities to meet EU landfill diversion and statutory national recycling targets.

Within the programme, investment in anaerobic digestion is achieving revenue savings by providing a cost effective food waste treatment option over the whole life cycle of the plant. Detailed carbon studies have demonstrated that anaerobic digestion has a far greater positive impact on climate change than alternative treatment options. As well as renewable energy, the process also produces a high quality digestate, providing farmers with a cheaper, more sustainable biofertiliser.

Of the seven projects in the anaerobic digestion programme, three are operational, and four have awarded contracts with two in construction. The first facility purpose built to treat municipal food waste in Wales is fully operational at Llwyn Isaf, Gwynedd, producing 0.5MW of green electricity. In total, around 7MW of power is forecast to be generated when all facilities become operational by 2016/17.

Biomass

In 2014, the total installed biomass capacity reached 205.1 MW$_{th}$ with 2,000 projects installed across Wales. Potentially, biomass projects could generate 628,751 MWh$_{th}$ per year of low carbon heat and 450 MWh$_e$ of electricity, attributed to three 0.2 MW combined heat and power projects. The local authority with the highest number of biomass installations is Powys, with 608 projects delivering a total installed capacity of 72.73 MW$_{th}$. The largest project is located in Wrexham at a manufacturing site. This project was commissioned in 2014 and has a capacity of 23 MW$_{th}$.

The majority of the biomass capacity in Wales is supported by the Non-Domestic Renewable Heat Incentive (RHI), under which the majority of installations are small and medium biomass boilers for farm and commercial activities. The number of domestic projects has also increased thanks to support from the Domestic RHI, and the relatively large number of properties that are off the gas grid.

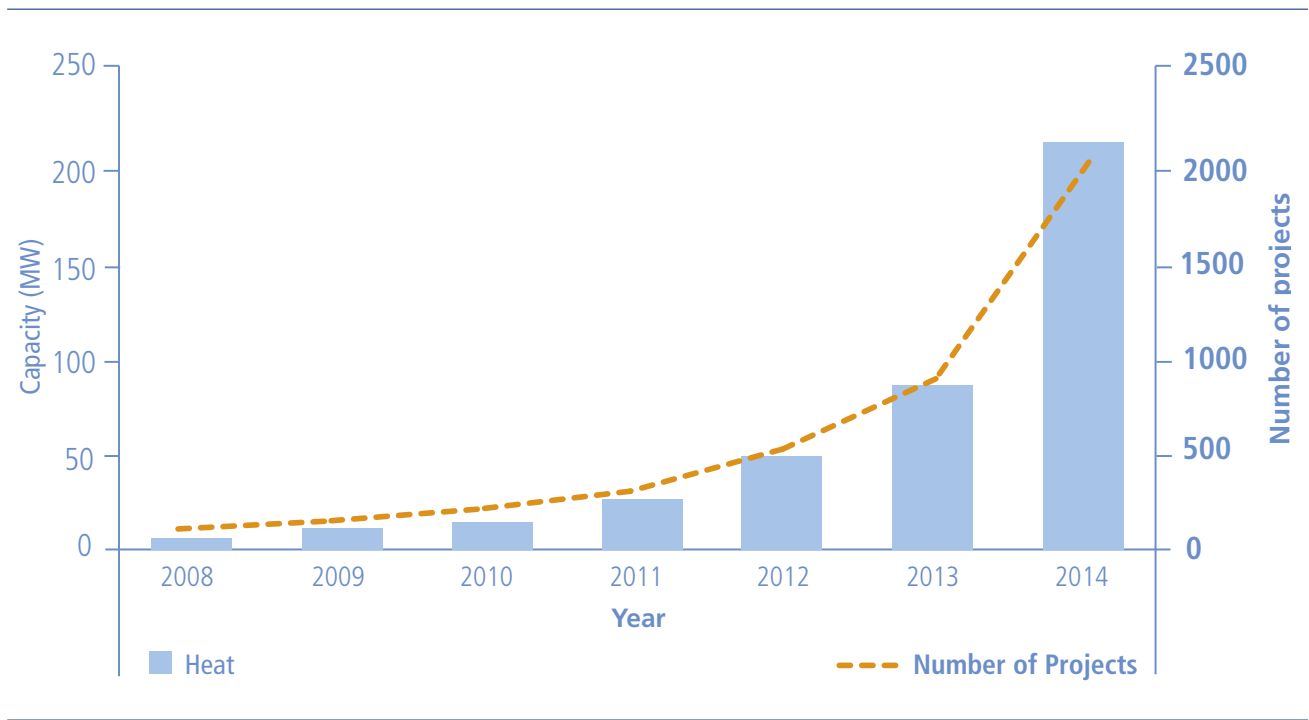*Figure 6: Trends in the deployment of biomass*

Table 7: Biomass generators by local authority

Local Authority	Number of projects	Capacity (MW$_e$)	Capacity (MW$_{th}$)	Estimated generation (MWh$_e$)	Estimated generation (MWh$_{th}$)	CO$_2$ saved (t CO$_2$ per annum)
Blaenau Gwent	4	-	0.95	-	2,923	706
Bridgend	15	-	1.21	-	3,717	898
Caerphilly	28	-	3.33	-	10,211	2,467
Cardiff	12	-	2.77	-	8,506	2,055
Carmarthenshire	222	-	12.54	-	38,446	9,290
Ceredigion	161	-	10.63	-	32,598	7,877
Conwy	80	-	4.62	-	14,150	3,419
Denbighshire	113	-	9.90	-	30,361	7,336
Flintshire	81	-	5.06	-	15,523	3,751
Gwynedd	126	-	7.25	-	22,237	5,373
Isle of Anglesey	39	-	1.94	-	5,938	1,435
Merthyr Tydfil	3	-	0.12	-	368	89
Monmouthshire	119	-	11.25	-	34,507	8,338
Neath Port Talbot	59	-	8.57	-	26,276	6,349
Newport	16	-	1.08	-	3,315	801
Pembrokeshire	156	-	8.11	-	24,862	6,008
Powys	608	-	72.73	-	222,985	53,880
Rhondda Cynon Taf	37	-	8.13	-	24,911	6,019
Swansea	30	-	2.01	-	6,173	1,492
Torfaen	14	0.06	1.78	420	5,448	1,516
Vale of Glamorgan	25	-	1.26	-	3,855	932
Wrexham	52	-	29.82	-	91,439	22,095
Total	**2,000**	**0.06**	**205.07**	**420**	**628,751**	**152,126**

# Fuelled *(biomass electricity and energy from waste)*

There are eight fuelled projects identified across Wales, totalling 126.22 MW_e of low carbon energy capacity. These sites could potentially generate 884,550 MWh_e per year, delivering 11.4 percent of the total low carbon electricity generation in Wales.

Of the seven projects, six are fuelled biomass or energy from waste plants (EfW), the other being co-firing biomass at Aberthaw Power station. The co-firing part of Aberthaw was developed thanks to a £9.5 million investment which enabled biomass fuels such a sawdust and woodchip to be processed and supply up to 55 MW_e, replacing some of the coal burnt. Uskmouth Power station, another co-firing plant is not included, as the amount of biomass fuel used was negligible and for the majority of 2014, the site was not operational.

Table 8: Trends in the deployment of fueled and energy from waste generators

Local Authority	Capacity (MW$_e$)	Estimated generation (MWh$_e$)	CO$_2$ saved (t CO$_2$ per annum)
Cardiff	30.00	210,240	99,927
Flintshire	19.66	137,742	65,469
Merthyr Tydfil	1.00	7,008	3,331
Monmouthshire	5.99	41,943	19,935
Neath Port Talbot	14.00	98,112	46,633
Powys	0.29	2,032	966
Vale of Glamorgan	55.00	385,440	183,200
Wrexham	0.29	2,032	966
Total	**126.22**	**884,550**	**420,427**

Figure 7: Trends in the deployment of fueled and energy from waste projects
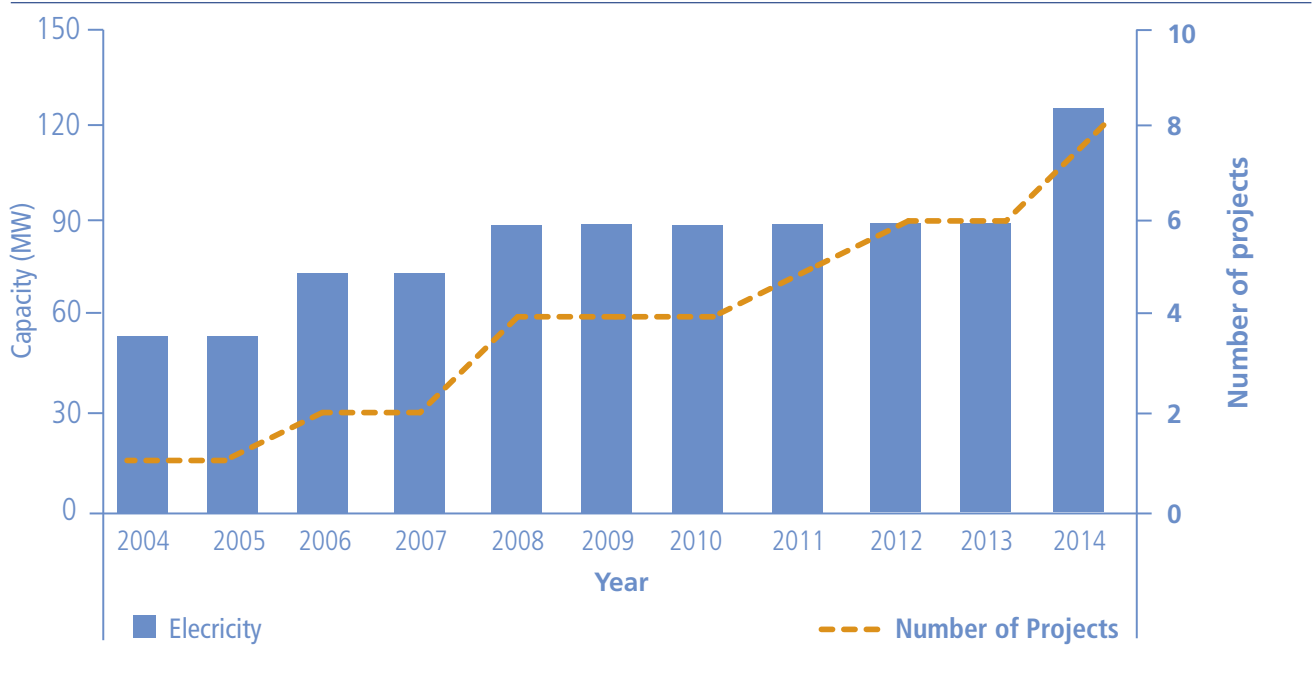
Heat pumps

Of the 2,578 heat pump projects operating across Wales in 2014, the majority (1,775) are air source heat pumps with a total capacity of 18 MW$_{th}$. Powys experienced the most growth in heat pump installations and remains the local authority with the highest number of heat pump projects, totaling 430.

The number of ground source heat pump projects reached a total of 801 across Wales, with a total capacity of 8.88 MW$_{th}$. There are also two water source heat pumps located in Carmarthenshire and the Isle of Anglesey. These generate heat for the National Botanical Garden and the Plas Newydd National Trust property respectively.

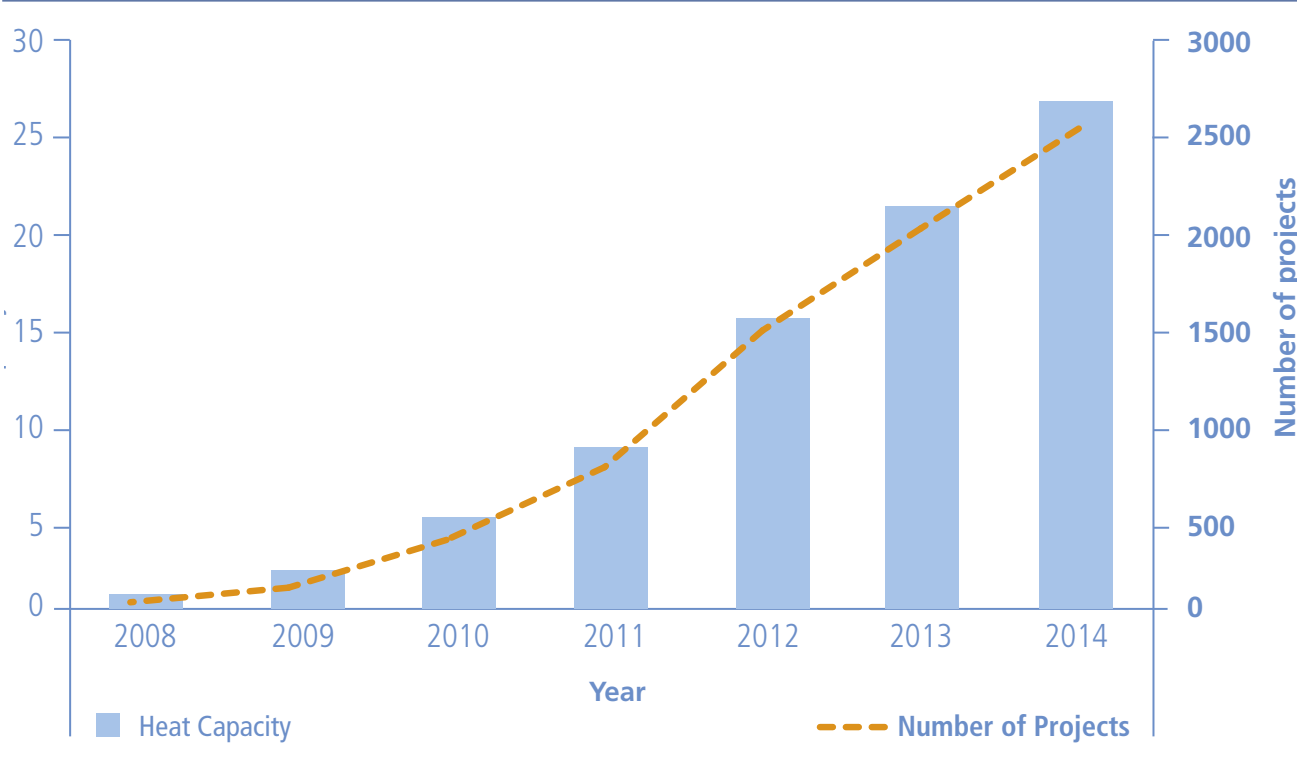*Figure 8: Trends in the growth of heat pumps*

Table 9: Heat pumps by source per local authority

Local Authority	Air sourced		Ground sourced		Water sourced	
	Number of projects	MW$_{th}$	Number of projects	MW$_{th}$	Number of projects	MW$_{th}$
Blaenau Gwent	14	0.08	-	-	-	-
Bridgend	6	0.08	6	0.07	-	-
Caerphilly	28	0.27	9	0.12	-	-
Cardiff	34	0.36	5	0.13	-	-
Carmarthenshire	137	1.57	134	1.60	1	0.06
Ceredigion	178	1.58	66	0.63	-	-
Conwy	54	0.59	18	0.44	-	-
Denbighshire	63	0.73	44	0.44	-	-
Flintshire	103	1.09	32	0.29	-	-
Gwynedd	176	1.74	62	0.65	-	-
Isle of Anglesey	103	1.16	39	0.41	1	0.31
Merthyr Tydfil	7	0.11	4	0.11	-	-
Monmouthshire	125	1.26	68	0.70	-	-
Neath Port Talbot	39	0.27	11	0.16	-	-
Newport	20	0.28	12	0.17	-	-
Pembrokeshire	132	1.43	73	0.84	-	-
Powys	295	2.66	135	1.22	-	-
Rhondda Cynon Taf	61	0.63	7	0.08	-	-
Swansea	58	0.75	34	0.43	-	-
Torfaen	16	0.19	4	0.04	-	-
Vale of Glamorgan	33	0.45	16	0.16	-	-
Wrexham	93	0.74	22	0.21	-	-
Total	**1,775**	**18.02**	**801**	**8.88**	**2**	**0.37**

Hydropower

In total, there are 184 hydropower projects operating across Wales. These projects have a total installed capacity of 154.3 MW_e, and have the potential to generate 283,882 MWh_e, equating to 3.6 percent of the total low carbon electricity generation in Wales. Five local authorities, Ceredigion, Gwynedd, Conwy, Powys and Carmarthenshire have 99 percent of the hydropower capacity across Wales.

Gwynedd and Powys remain the two local authorities with the highest number of projects, with 45 and 44 schemes respectively. Although both authorities experienced the highest increase in numbers of projects since 2012, the total capacity of these projects varies significantly. Gwynedd has a capacity of 50.9 MW_e, whilst Powys has a larger number of smaller projects with a total capacity of 7.0 MW_e.

In 2014, Ceredigion remains the local authority with the largest total installed capacity, reaching 19 projects and a capacity of 55.5 MW_e. Both pumped storage stations at Dinorwig (1,728 MW_e) and Ffestiniog (360 MW_e) are not included in this analysis, as the renewable energy aspect is dependent on management and catchment conditions.

Table 10: Hydropower generators by local authority (excluding pumped storage)

Local Authority	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Bridgend	5	0.05	87	41
Caerphilly	1	0.01	14	7
Carmarthenshire	12	4.69	8,625	4,100
Ceredigion	19	55.47	102,043	48,501
Conwy	20	34.85	64,105	30,469
Denbighshire	10	0.58	1,073	510
Gwynedd	45	50.78	93,409	44,397
Monmouthshire	6	0.19	352	167
Neath Port Talbot	12	0.52	956	454
Pembrokeshire	8	0.14	266	126
Powys	43	6.95	12,788	6,078
Rhondda Cynon Taf	2	0.06	111	53
Torfaen	1	0.03	53	25
Total	**184**	**154.32**	**283,882**	**134,929**

Figure 9: Trends in the growth of hydropower
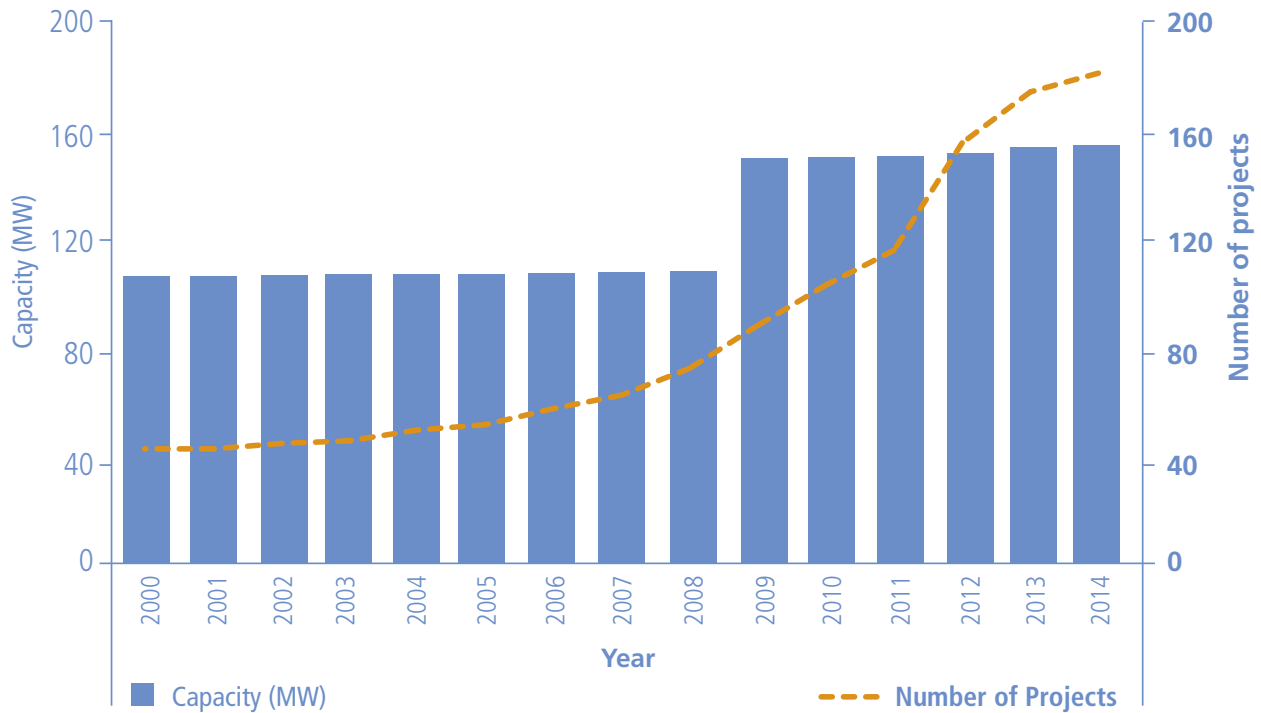
Case study – Anafon Hydro

Anafon Hydro will be the largest community-owned hydro project in Wales when it is commissioned, having received planning consent in December 2013. The 270 kW$_e$ project is located just inside the northern boundary of Snowdonia National Park, 4 km south west of Llanfairfechan in Conwy. The Anafon Hydro is a high-head run-of-river scheme. A one metre high weir will feed water in a buried three kilometre pipe, descending a total of 234 vertical metres. To finance the project, initial development costs were covered by grants, resources and support provided by a range of organisations including Ynni'r Fro, Abergwyngregyn Regeneration Company and the Cooperative Community Energy Challenge.

The total sum required to fund the project is approximately £1,249,000 and in 2014, £450,900 was raised from the sale of shares in the project. The target date for generating electricity is December 2015. In addition, a portion of the profits generated by the project will be gift-aided to a charity set up by the Abergwyngregyn Regeneration Company who will distribute them for the benefit of local communities.

Landfill gas

The total landfill gas capacity reduced to 35.38 MW_e in 2014, from the 23 projects operating across Wales. No additional projects were developed in 2014, and the capacity values of several operating sites have declined slightly following the general trend of decreasing capacity as less waste goes to landfill. Landfill gas can now potentially generate 176,030 MWhe of low carbon electricity and save 83,667 tonnes of CO_2 each year.

Merthyr Tydfil remains the local authority with the highest total capacity of 6.33 MW_e, from two projects based at the Trecatti landfill site.

Table 11: Landfill gas generators by local authority

Local Authority	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	1	1.57	7,792	3,703
Bridgend	1	0.33	1,642	780
Cardiff	2	4.35	21,664	10,297
Carmarthenshire	1	2.01	9,981	4,744
Conwy	1	3.07	15,280	7,263
Flintshire	2	1.92	9,553	4,541
Gwynedd	1	0.30	1,493	709
Isle of Anglesey	1	0.44	2,189	1,041
Merthyr Tydfil	2	6.33	31,491	14,968
Neath Port Talbot	2	2.53	12,588	5,983
Newport	1	1.01	5,006	2,379
Pembrokeshire	1	2.17	10,777	5,122
Powys	1	2.00	9,951	4,730
Rhondda Cynon Taf	2	2.58	12,827	6,097
Swansea	1	1.15	5,732	2,724
Wrexham	3	3.63	18,062	8,585
Total	**23**	**35.38**	**176,030**	**83,667**

Wind

There are 756 onshore wind projects across Wales, generating approximately 1.4 TWh$_e$ through a total capacity of 597.7 MW$_e$. Onshore wind generates 18 percent of all low carbon electricity in Wales, powering approximately 440,000 typical homes.

The local authority with the most onshore wind capacity is Powys, with 151 projects and 21 percent of the total Welsh onshore wind capacity, equating to 125.3 MW$_e$. Outside of Powys, five local authorities have an installed onshore wind capacity of over 50 MW$_e$, which with Powys accounts for over half of the total installed capacity in Wales. These are Bridgend, Carmarthenshire, Ceredigion, Neath Port Talbot and Rhondda Cynon Taff.

Although offshore wind capacity is generally counted as a UK national resource, Wales contributed three operating offshore wind projects in 2014. Gwynt Y Mor offshore wind farm was commissioned in 2014, but was operational in 2014 and so was included in this report due to its significant contribution to low carbon energy in Wales.

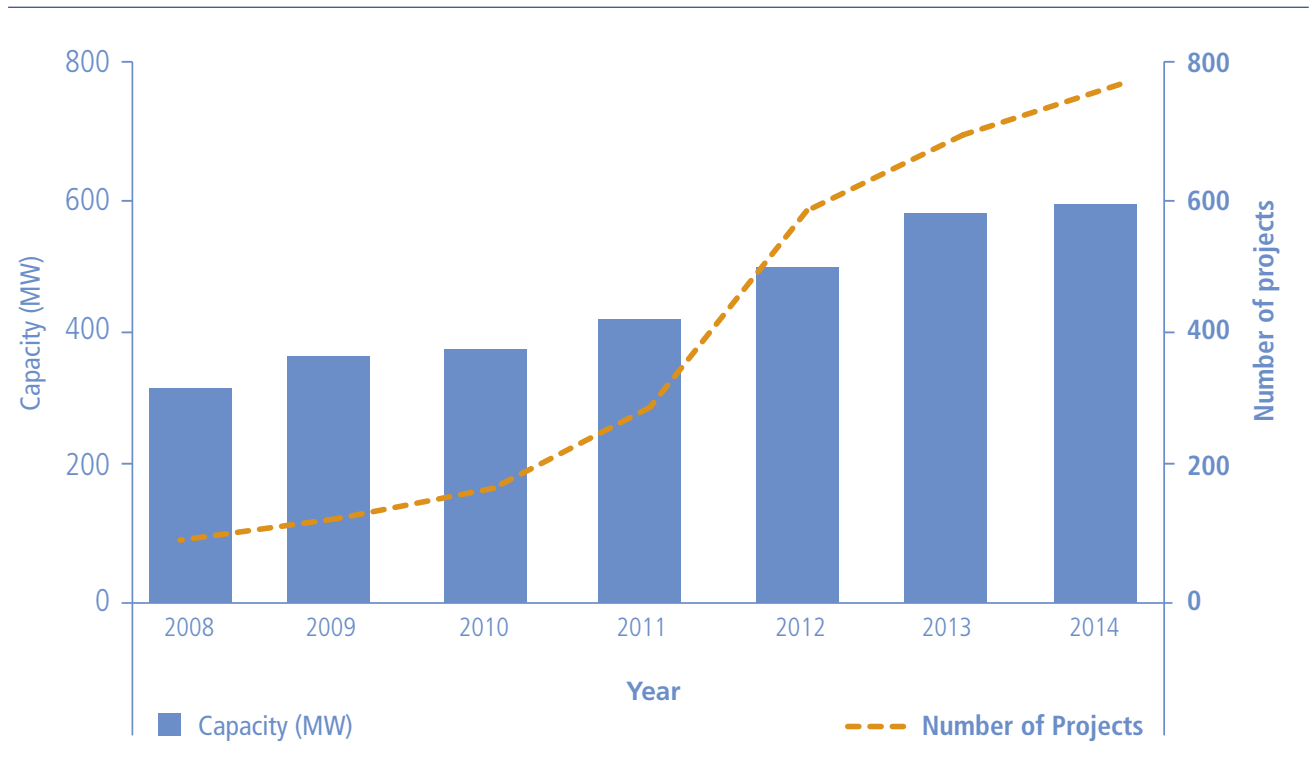*Figure 10: Trends in the growth of onshore wind*

Table 12: Onshore wind by local authority

Local Authority	Number of projects	Capacity (MWe)	Estimated generation (MWhe)	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	2	0.50	1,181	561
Bridgend	8	54.71	128,928	61,279
Caerphilly	12	1.17	2,759	1,312
Cardiff	6	4.74	11,172	5,310
Carmarthenshire	101	78.43	204,104	97,011
Ceredigion	74	82.05	193,348	91,898
Conwy	29	19.07	44,948	21,364
Denbighshire	30	31.36	73,886	35,118
Flintshire	25	0.32	749	356
Gwynedd	55	5.47	12,892	6,127
Isle of Anglesey	56	44.11	103,948	49,406
Monmouthshire	26	0.56	1,312	623
Neath Port Talbot	6	57.48	135,458	64,383
Newport	7	7.48	17,635	8,382
Pembrokeshire	110	15.41	36,307	17,257
Powys	151	125.34	295,350	140,380
Rhondda Cynon Taf	8	66.05	155,641	73,976
Swansea	4	0.34	801	381
Torfaen	4	0.03	70	33
Unknown	24	2.34	5,514	2,621
Vale of Glamorgan	6	0.10	236	112
Wrexham	12	0.68	1,601	761
Total	**756**	**597.75**	**1,427,838**	**678,651**

Case study – Gwynt y Môr offshore wind farm

The £2 billion project is the second largest wind farm in the world and was built by RWE Innogy UK in partnership with Stadtweke München and Siemens. Located in Liverpool Bay, off the North Wales coast, Gwynt y Môr consists of 160 turbines and has an installed capacity of 576 MWe. The operation of a dedicated operations and maintenance base at the Port of Mostyn requires at least 100 long term skilled engineers, supporting local jobs in the area.

Around £20 million will be invested locally across the lifetime of the project, including annual payments of £768,000, and a five year partnership with the Royal National Lifeboat Institution. In addition, a one off tourism fund totalling £690,000 has been invested in local initiatives over the three year construction period of the project, to increase tourism across Conwy and Denbighshire.

Table 13: Offshore wind projects by local authority

Local Authority	Generator	Capacity (MW$_e$)	Estimated generation (MWh$_e$)	CO_2 saved (t CO_2 per annum)
Offshore (Conwy)	Gwynt y Mor	576	1,950,000	926,835
Offshore (Conwy)	Rhyl Flats	90	285,000	135,461
Offshore (Denbighshire)	North Hoyle	60	183,960	87,436
Total	**3**	**726**	**2,418,960**	**1,149,732**

Case study – Egni co-operative

Egni co-operative launched the first solar PV co-operative in Wales in 2014. They currently have 94 members and have successfully completed four installations for their first project. Raising £171,000 through a share offer, they have installed 89 kW$_e$ of solar PV on four community buildings in South Wales. The current buildings are:

• Dove Workshop (14 kW$_e$) a community centre located in Banwen

• Awel Aman Tawe (4 kW$_e$) a community renewable energy charity in Cwmllynfell

• Ysgol y Bedol (50 kW$_e$) a primary school in the Amman Valley

• Glynneath Training Centre (21 kW$_e$)

The community buildings will benefit from free energy, saving an estimated £6,000 to £8,000 on energy bills each year.

Sewage gas

The number of sewage gas sites has decreased in 2014, with Rhuthin and Porthmadog no longer in operation. The remaining nine projects across Wales have a total electricity capacity of 9.77 MW_e and a thermal capacity of 11.85 MW_{th}.

The largest sewage gas project is Cardiff East Waste Water Treatment Works CHP with an electricity capacity of 4.0 MW_e and thermal capacity of 4.96MW_{th}. Sewage gas sites can potentially generate 109,628 MWh of low carbon energy each year equating to 1.2 percent of the total generation across Wales.

Table 14: Sewage gas projects by local authority

Local Authority	Number of projects	Capacity (MW_e)	Capacity (MW_{th})	Estimated generation (MWh_e)	Estimated generation (MWh_{th})	CO_2 saved (t CO_2 per annum)
Cardiff	2	4.43	5.66	16,746	34,707	7,960
Denbighshire	1	0.19	0.27	719	1,668	342
Flintshire	1	0.19	0.23	719	1,380	342
Monmouthshire	1	0.18	0.32	670	1,956	319
Neath Port Talbot	1	2.96	3.31	11,209	20,297	5,328
Powys	1	0.10	0.10	378	613	180
Swansea	1	0.56	0.80	2,119	4,906	1,007
Wrexham	1	1.17	1.16	4,428	7,113	2,105
Total	**9**	**9.77**	**11.85**	**36,988**	**72,640**	**17,583**

Solar PV

The total capacity of solar PV in Wales is 372.16 MW$_e$, delivered from 41,570 individual projects, accounting for 81 percent of all low carbon projects. With an annual generating potential of 332,531 MWh$_e$, solar PV saves 158,052 tonnes of CO_2 annually. Due to a low load factor, solar PV contributes four percent of Welsh low carbon energy generation while accounting for 15 percent of installed electrical capacity.

The largest project installed in 2014 was a 36 MW$_e$ solar farm in Pembrokeshire, north east of Haverfordwest. Pembrokeshire is the local authority with the most installed capacity, contributing 28 percent of the total. However, Wrexham has the most individual projects, despite accounting for just 2.5 percent of all capacity. This is thanks to Wrexham County Borough Council developing a flagship project to install solar panels on 3,000 social housing roofs.

The number of monthly solar PV installations has remained relatively steady since 2012, with small peaks occurring towards the end of each quarter due to upcoming subsidy degressions. However, installed capacity has greatly increased thanks to the relatively low number of large solar farms that have been installed at a greater rate. There are now 27 solar farms of over 1 MW$_e$ in size, the majority of which, and particularly the larger ones, were installed in 2013-14. Most of these large projects are within Pembrokeshire and Carmarthenshire, which have eight and six projects over 1 MWe respectively.

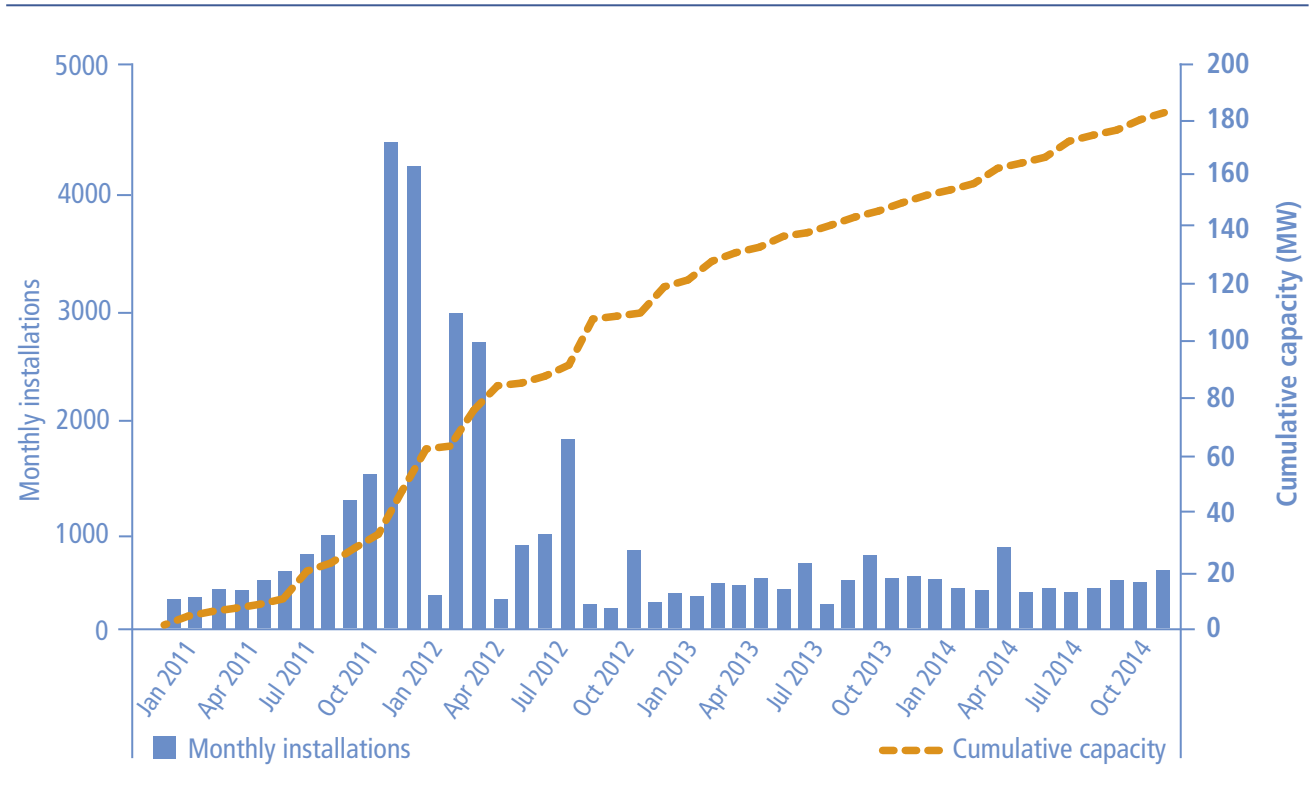*Figure 12: Monthly Feed-in Tariff installations and cumulative capacity*

Table 15: Solar PV projects by local authority

Local Authority	Number of projects	Capacity (MW$_e$)	Estimated generation (MWh$_e$)	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	550	1.42	1,266	602
Bridgend	1,623	6.93	6,192	2,943
Caerphilly	2,085	6.48	5,788	2,751
Cardiff	2,453	8.03	7,173	3,409
Carmarthenshire	3,009	66.95	59,823	28,434
Ceredigion	1,601	11.88	10,617	5,046
Conwy	909	3.19	2,846	1,353
Denbighshire	1,214	4.61	4,119	1,958
Flintshire	1,933	11.17	9,980	4,743
Gwynedd	1,648	5.96	5,324	2,530
Isle of Anglesey	1,290	16.58	14,813	7,041
Merthyr Tydfil	456	1.57	1,405	668
Monmouthshire	3,031	14.80	13,224	6,285
Neath Port Talbot	1,099	9.10	8,129	3,864
Newport	1,601	7.87	7,029	3,341
Pembrokeshire	2,482	109.82	98,126	46,640
Powys	3,068	14.37	12,840	6,103
Rhondda Cynon Taf	2,377	8.30	7,418	3,526
Swansea	1,954	16.65	14,881	7,073
Torfaen	1,699	5.53	4,939	2,347
Vale of Glamorgan	1,495	32.09	28,669	13,627
Wrexham	3,993	8.87	7,929	3,769
Total	**41,570**	**372.16**	**332,531**	**158,052**

*Figure 13: Trends in the growth of solar PV*
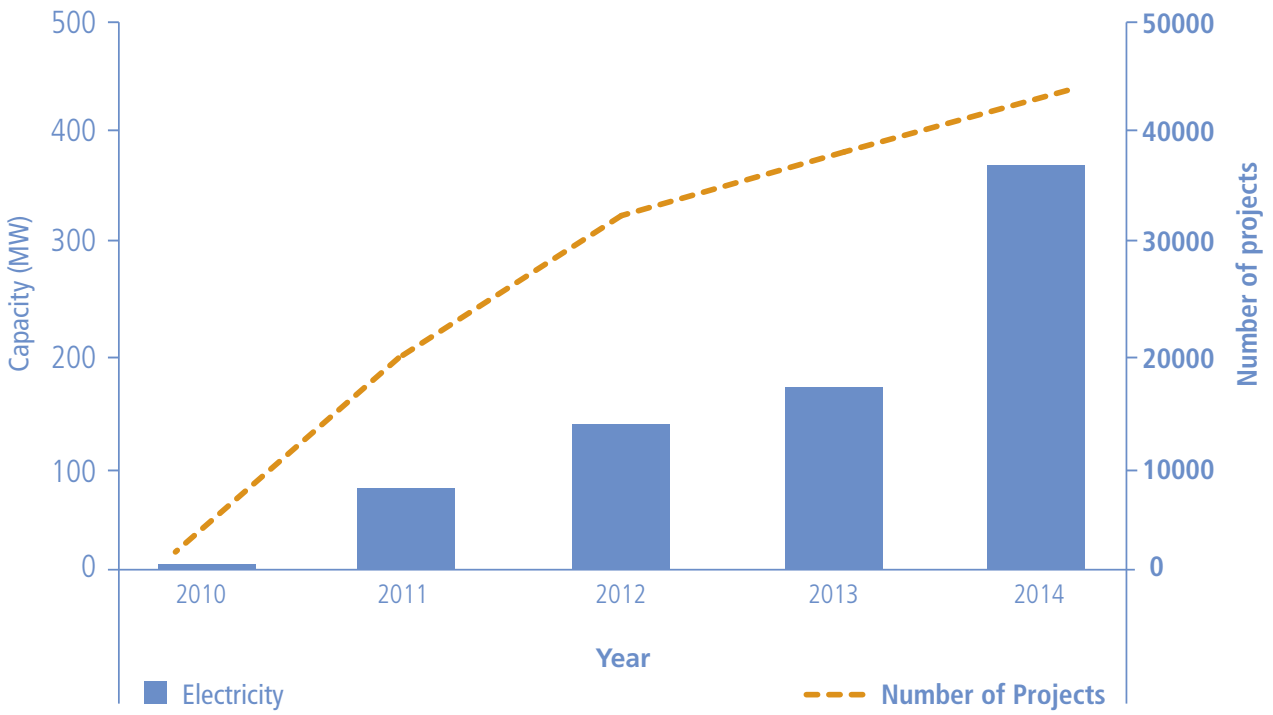
Solar thermal

There are 4,161 solar thermal projects installed with a total capacity of 11.1 MW_{th}, with the potential to generate 6,785 MWh_{th}. The greatest capacity increase occurred in Powys, this local authority has the largest number of solar thermal projects (615) with a total installed capacity of 1.67 MW_{th}. The largest solar thermal project is located on the Isle of Anglesey, and at 40 kW is registered under the Non Domestic Renewable Heat Incentive.

Table 16: Solar thermal projects by local authority

Local Authority	Number of projects	Capacity (MW_{th})	Estimated generation (MWh_{th})	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	290	0.50	307	74
Bridgend	90	0.46	284	69
Caerphilly	342	0.65	400	97
Cardiff	80	0.20	122	30
Carmarthenshire	238	0.78	476	115
Ceredigion	244	0.62	380	92
Conwy	254	0.83	510	123
Denbighshire	55	0.15	92	22
Flintshire	97	0.21	130	31
Gwynedd	138	0.33	201	49
Isle of Anglesey	161	0.39	242	58
Merthyr Tydfil	63	0.03	19	5
Monmouthshire	85	0.22	135	33
Neath Port Talbot	33	0.09	53	13
Newport	28	0.12	74	18
Pembrokeshire	490	1.42	868	210
Powys	615	1.67	1,026	248
Rhondda Cynon Taf	537	1.53	939	227
Swansea	126	0.32	197	47
Torfaen	17	0.05	30	7
Vale of Glamorgan	83	0.12	71	17
Wrexham	95	0.38	230	56
Total	**4,161**	**11.07**	**6,785**	**1,639**

Figure 14: Trends in the growth of solar thermal
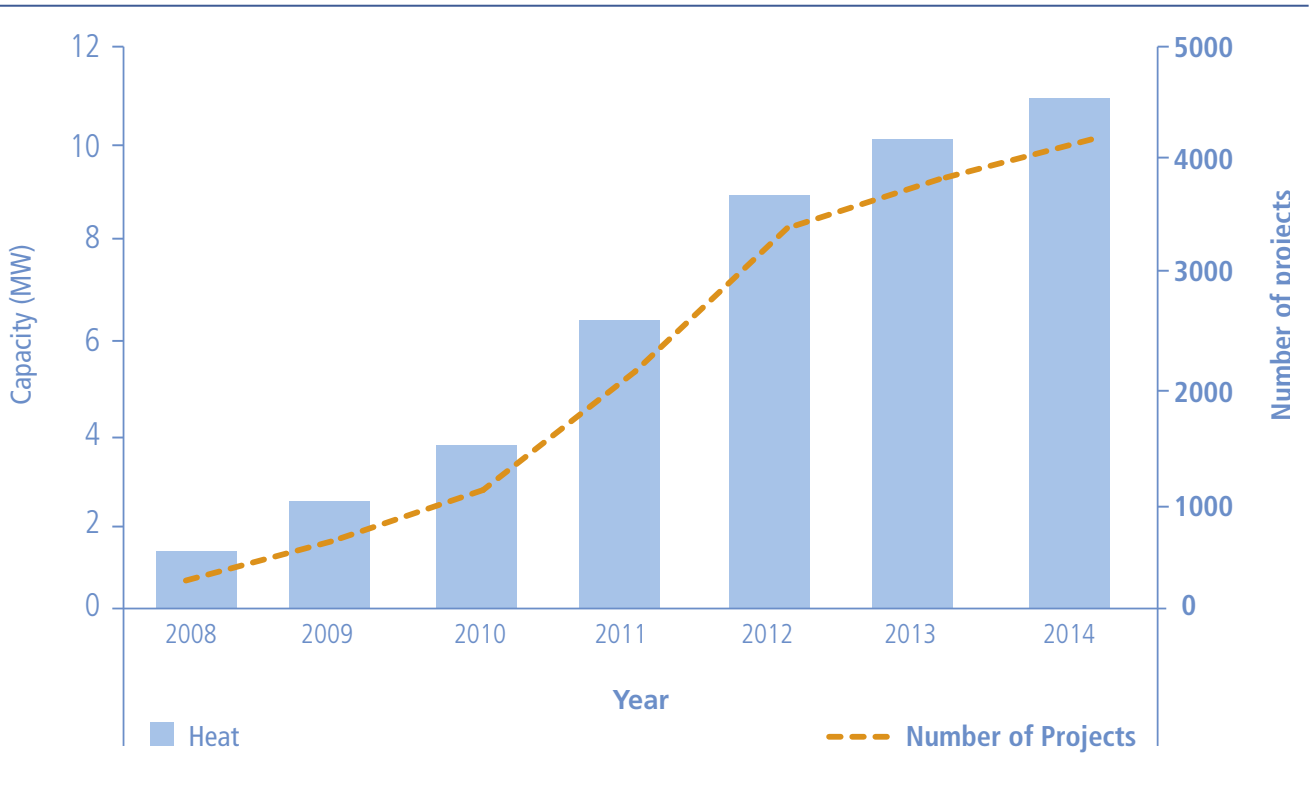
Nuclear

Wylfa Nuclear Power Station on the Isle of Anglesey is the only nuclear plant in Wales, delivering 20 percent of Welsh electricity demand. There is one reactor currently operating at the site, but there are proposals to construct two new reactors totalling 2.7 GW_e of new capacity. An application to the Department for Communities and Local Government is currently planned for 2017, with operation for the new sites potentially starting in the 2020's.

The "Energy Wales: A Low Carbon Transition" report identifies nuclear as a low carbon electricity generating technology, but not a renewable source of energy.

Table 17: Nuclear generating stations

Local Authority	Generator	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Isle of Anglesey	Wylfa Reactor 1	490	2,578,250	1,225,442

Glossary / abbreviations

MW_e	Mega Watts of electrical capacity
MW_{th}	Mega Watts of heat capacity
Estimated generation	Estimates the total amount of power generated by multiplying the capacity by an estimated load factor
MW_h	Mega Watt Hours of generation
GW_h	Giga Watt Hours of generation (equal to 1,000 MW_h)
TW_h	Tera Watt Hours of generation (equal to 1,000 GW_h, or 1,000,000 MW_h)
CO_2	Carbon dioxide emissions (in metric tonnes)