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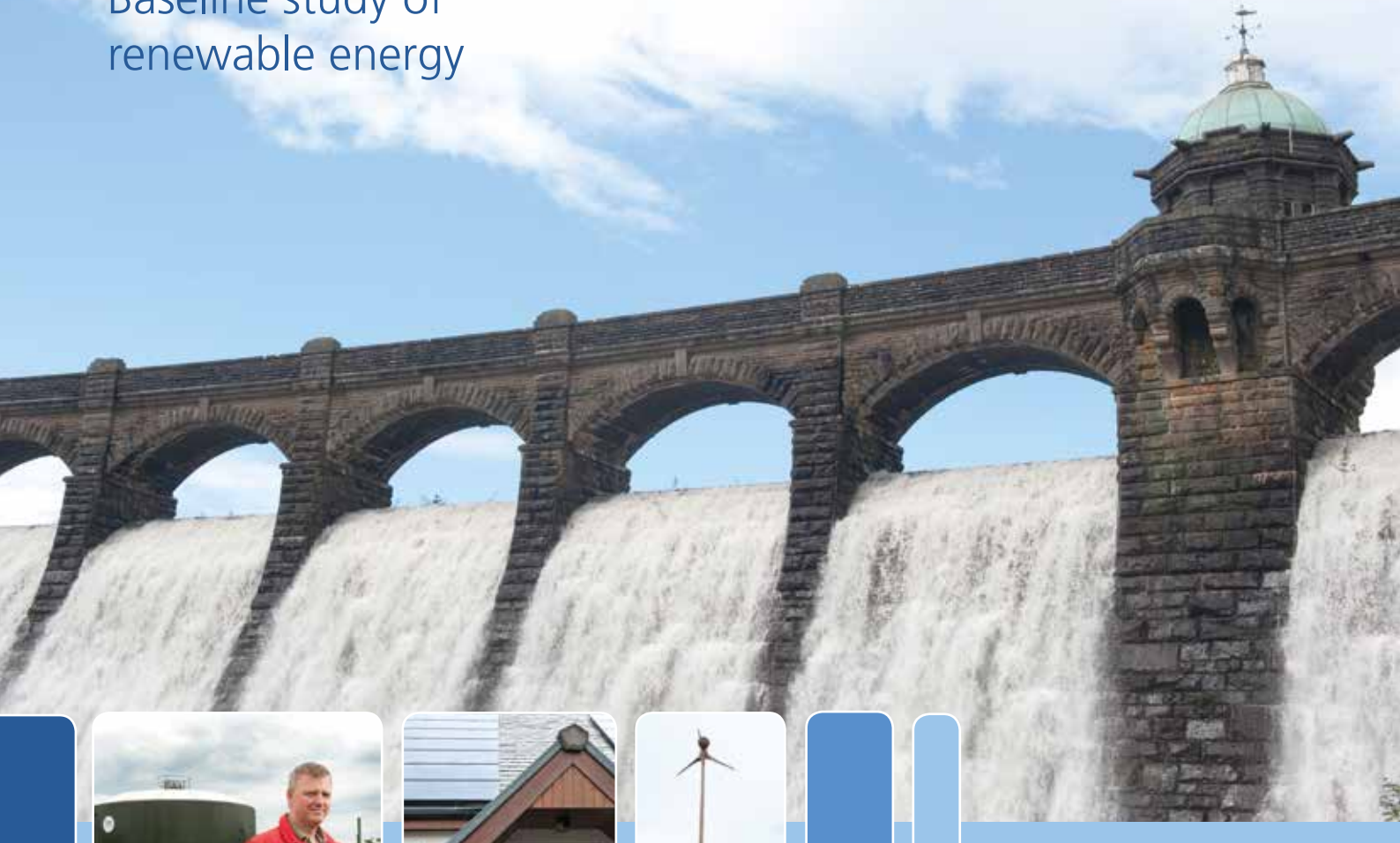
Low Carbon Energy Generation in Wales

Baseline study of renewable energy



Helpu Cymru i leihau ei Hôl Troed Carbon

Help Wales reduce its Carbon Footprint

June 2014

Contents

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Hydro power scheme, Elan Valley

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Foreword

Energy Wales: A Low Carbon Transition is helping to lead Wales towards a sustainable, low carbon economy. Since its launch, we have made substantial progress in many areas, not least in the deployment of low carbon energy generating technologies.

This survey is an important part of measuring our progress in the transition to generating energy, both electricity and heat, in ways that maximise the use of our natural resources in sustainable ways. This study establishes a clear baseline of low carbon energy to the end of 2012, against which we can measure improvements in future years. It also estimates the amount of carbon dioxide emissions that these projects will have helped us to save compared to traditional energy generation.

I'm pleased that, to the end of 2012, we have over 36,000 renewable energy generating projects working on the ground in Wales, making an important contribution to reducing our carbon footprint. As the case studies in this report show these projects are also working to deliver sustainable economic and social benefits in our local communities.

The report shows that we are making progress both with large scale energy generation, but also importantly with domestic and community scale projects too. Increasing energy generation at all of these scales is vital for us to make the break from our carbon intensive forms of generating energy of the past. I intend to publish updates to this survey in the future so that we can see progress continuing in years to come.

Whilst this survey demonstrates we have made significant progress, it also shows that rates have varied across Wales. We are committed to deliver the aims of Energy Wales: A Low Carbon Transition. A critical challenge now is for us to ensure that all Welsh communities, particularly those in more deprived areas, benefit directly from the move to a low carbon economy.

Alun Davies AM
Minister for Natural Resources and Food

Introduction

This report makes an assessment, based on a robust survey method, of how many low carbon energy generation projects are installed in Wales. It also estimates the amount of energy, both electricity and heat, that they produced in 2012 and the amount of carbon dioxide saved when compared to fossil fuel energy generation.

The report should be essential reading for investors, both within and outside of Wales. Householders and communities in Wales who may be considering generating their own energy will find the data and case studies of interest. Our public sector partners who work with communities will also find value in the data, in particular to illustrate barriers to low carbon development in order to tackle these at a local level.

The report illustrates that whilst large scale commercial energy generation dominates the headlines, there are many thousands of small scale, distributed energy generation schemes in Wales. These projects are driving significant economic, social and environmental benefits for Wales from our renewable energy resources.

This survey has helped to give a clearer picture of where we have reached in our journey to creating a low carbon Wales. We will carry out this survey again in the future to measure progress.

Engaging with stakeholders

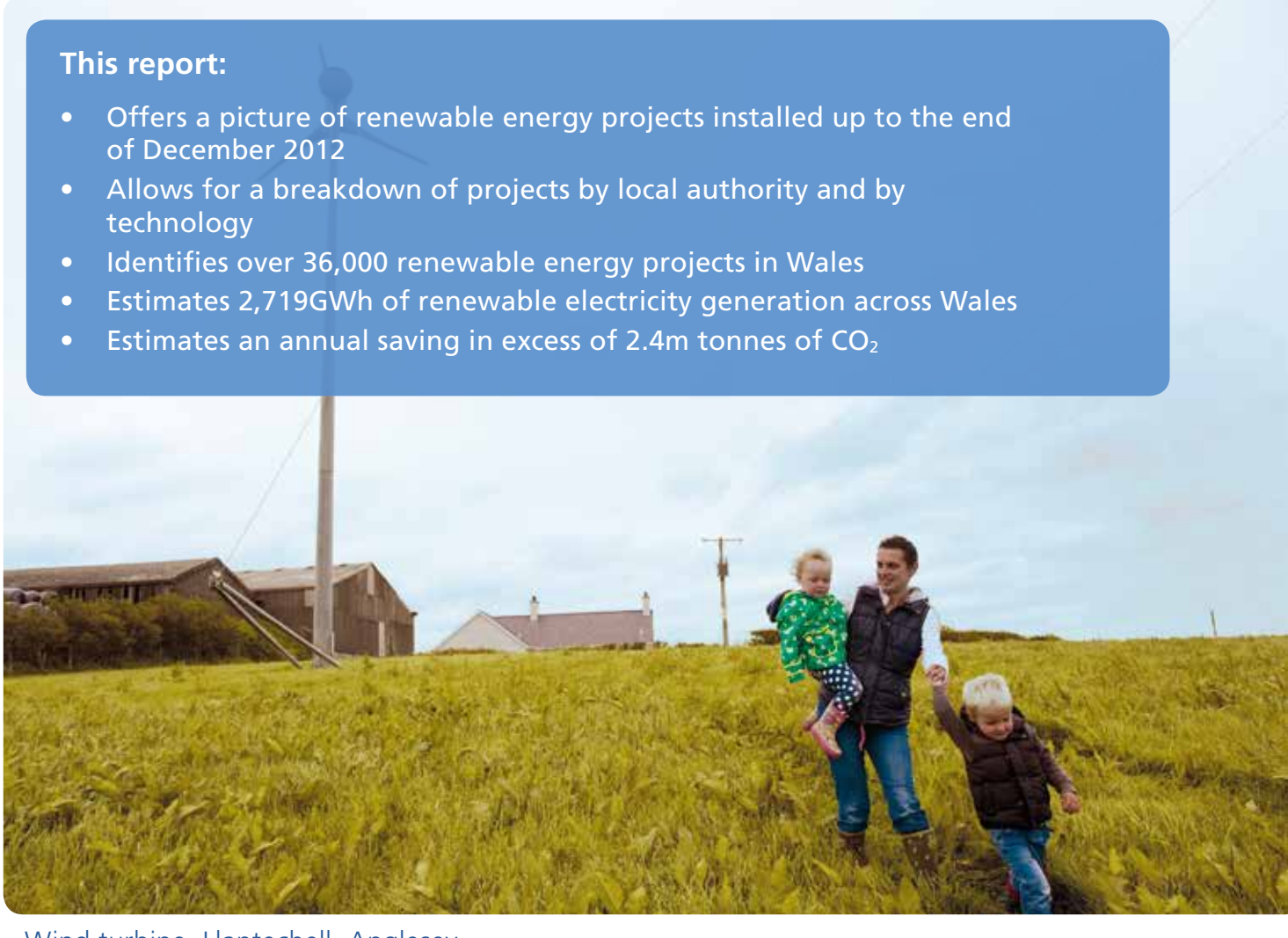
A wide range of stakeholders were involved in the design and delivery of the survey. The Welsh Government thanks all of those who contributed to the survey process.

This data and report is the first part of a process to encourage greater delivery of renewable energy projects in Wales. This survey gives us a good picture of where we have got to, and helps to point us towards where we can do more.

We now need to discuss these findings with all interested stakeholders, to understand more about what the results tell us, what barriers there are to delivering renewable energy projects, and what we can do to accelerate the rate of new projects being installed.

This report:

- Offers a picture of renewable energy projects installed up to the end of December 2012
- Allows for a breakdown of projects by local authority and by technology
- Identifies over 36,000 renewable energy projects in Wales
- Estimates 2,719GWh of renewable electricity generation across Wales
- Estimates an annual saving in excess of 2.4m tonnes of CO_2



Wind turbine, Llantechell, Anglesey

The national picture

Key findings

In 2012 the total capacity for low carbon energy in Wales was recorded as 1,591MW, divided between 1,042MW for renewable electricity, 490MW for nuclear and 58.6MW for renewable heat. There were a total of 36,227 low carbon energy projects recorded across Wales.

At the end of 2012 the generation potential from these projects across Wales reached almost 5.5TWh, providing 35% of the Welsh national electricity consumption and 1% of gas consumption. The annual carbon saving potential from this energy generation has been estimated at 2,442,029 tonnes of CO_2.

Summary of low carbon energy in Wales, 2012

	Renewable electricity	Nuclear electricity	Renewable heat
Capacity (MW)	1,042.346MW_e (MW-electricity)	490MW_e	58.595MW_{th} (MW-thermal)
Estimated Generation (MWh)	2,719,322	2,572,909	166,053
Household equivalent	679,830	643,227	10,934
Per cent of consumption in Wales	18%	17%	1%
CO_2 saving (tonnes)	1,236,013	1,169,464	36,551

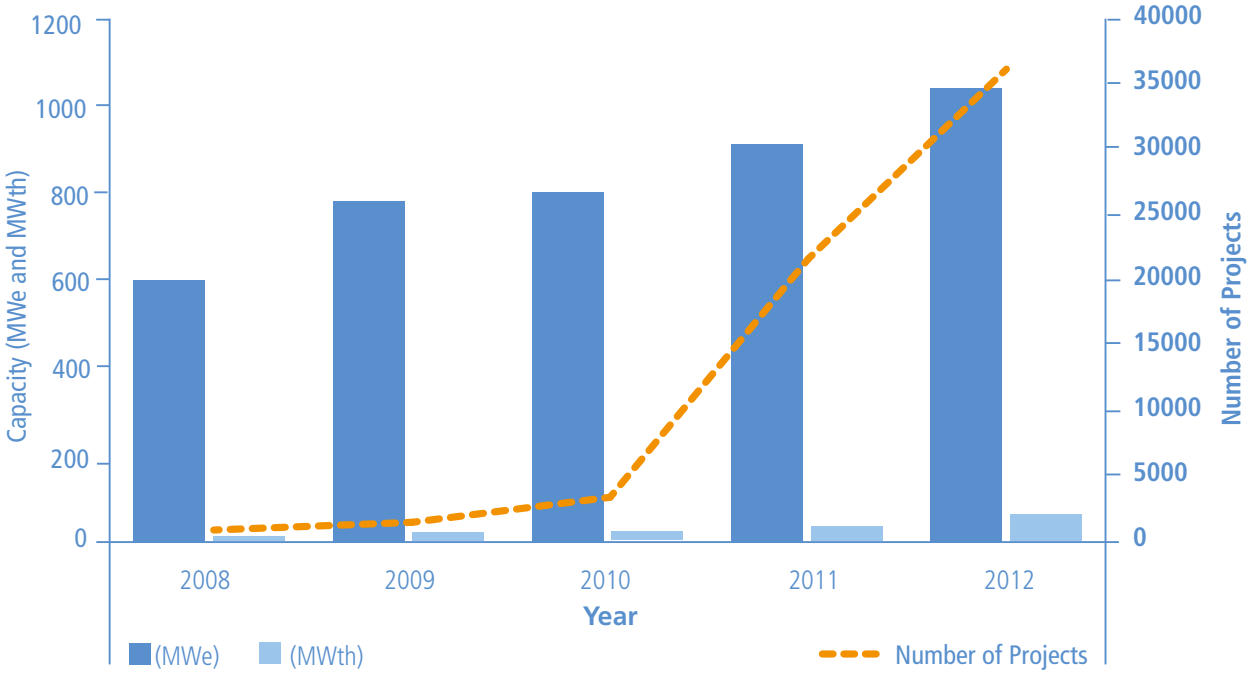
Low carbon energy in Wales by technology, 2012

Technology	Number of projects	Capacity (MW_e)	Capacity (MWth)	Estimated generation (MWh_e)	Estimated generation (MWh_{th})	CO_2 saved (tonnes CO_2 per annum)
Anaerobic Digestion	5	0.800	—	4,558	—	2,07
Biomass	414	0.060	38.033	421	137,577	33,382
Fuelled	4	69.655	—	488,915	—	222,226
Heat pumps	1,228	—	12.107	—	23,348	2,123
Hydro	163	152.217	—	273,539	—	124,332
Landfill Gas	23	40.048	—	193,083	—	87,762
Offshore wind	2	150	—	460,215	—	209,182
Onshore wind	550	498.439	—	1,168,974	—	531,334
Sewage gas	11	9.974	0.1	39,344	0	17,883
Solar PV	30,635	121.153	—	90,272	—	41,031
Solar thermal	3,191	—	8.355	—	5,127	1,239
Nuclear	1	490	—	2,572,909	—	1,169,464
Total	**36,227**	**1,532.346**	**58.595**	**5,292,231**	**166,053**	**2,442,029**

Progress during 2012

Growth in renewable energy over the period 2008 to 2012 (excludes nuclear, and data with unknown commissioning dates)

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	251	29.374	3.133	143,968	8,411
2009	588	181.667	7.262	471,224	21,939
2010	1,920	21.092	4.332	55,328	8,408
2011	18,262	111.117	9.349	152,672	20,040
2012	14,531	127.417	29.251	216,114	93,782



Key findings

In 2012 there were 14,531 new projects installed across Wales of which 84% were solar PV. The remainder is split between the remaining technologies as follows: 4.5% heat pumps, 7.9% solar thermal, 1.8% onshore wind, 1.1% biomass, 0.2% hydropower and 0.007% sewage gas (a single project).

In 2012 domestic installations dominated the numbers, with 98.5% of all new installations being for domestic purposes. Of these, 910 installations were recorded as social or community housing (6% of all installations that year). In addition to this, 33 projects were recorded at schools and there were 28 other new public sector projects.

The estimated carbon saving potential from renewable energy generation in Wales increased by 10% in 2012.

New projects in 2012 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)
Biomass	167	0.060	20.596	421	80,388	19,615
Heat pumps	656	—	6.147	—	11,855	1,078
Hydro	26	1.183	—	2,126	—	966
Onshore wind	266	75.477	—	172,049	—	78,201
Sewage gas	1	1.170	—	4,615	—	2,098
Solar PV	12,271	49.527	—	36,903	—	16,774
Solar thermal	1,144	—	2.508	—	1,539	372
Total	**14,531**	**127.417**	**29.251**	**216,114**	**93,782**	**119,104**

Solar panels, Machynlleth

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 in the graph.

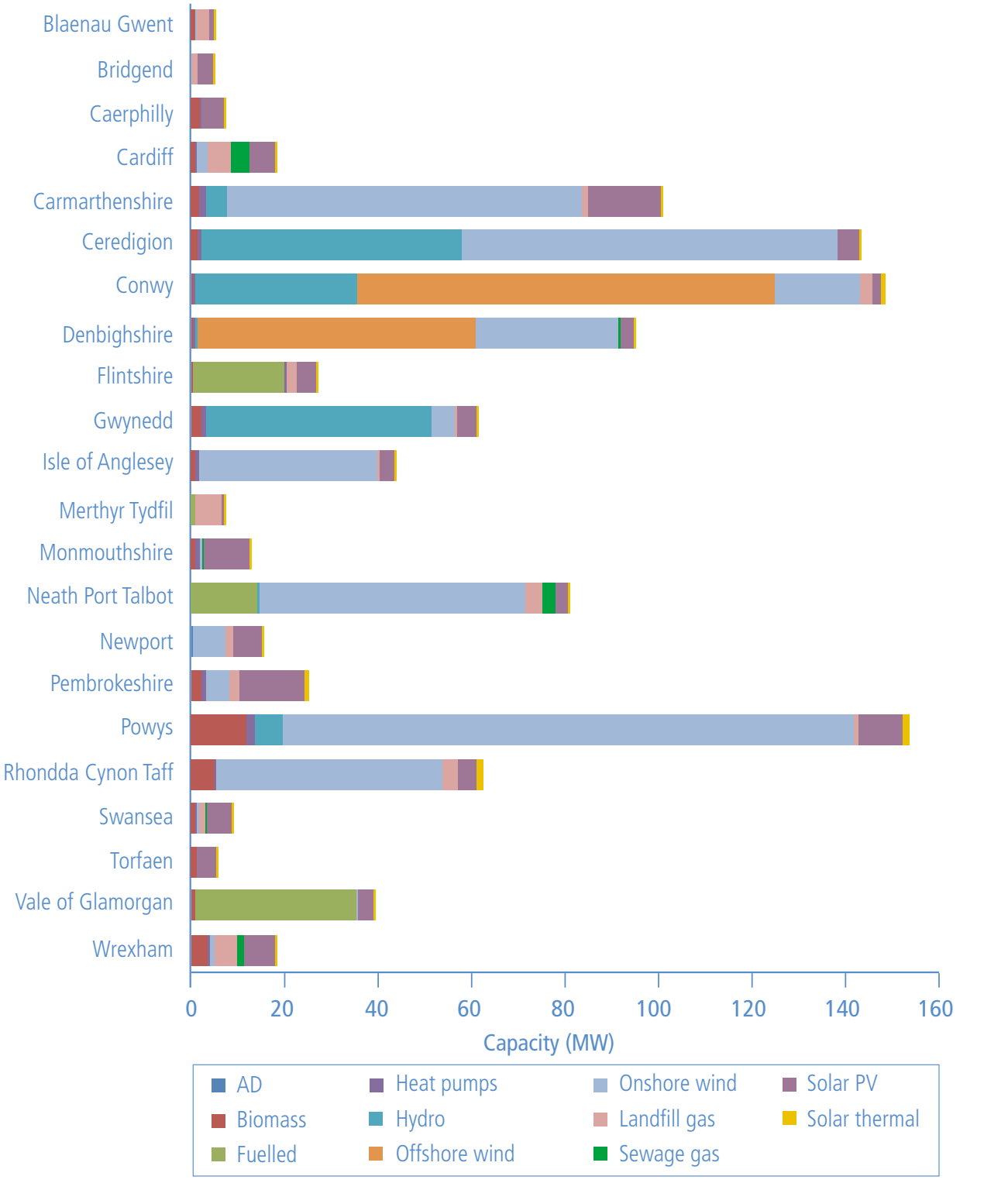
Low carbon energy in Wales by local authority

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	712	3.992	1.363	14,588	3,573	7,478
Bridgend	1,271	4.620	0.458	8,278	409	3,856
Caerphilly	1,946	4.724	2.756	3,614	9,731	3,938
Cardiff	1,949	17.218	1.383	51,056	4,556	24,258
Carmarthenshire*	2,668.5	97.912	3.775	205,520	6,554	94,572
Ceredigion	1,544	141.727	2.640	295,287	4,821	135,122
Conwy**	847	147.860	1.625	397,032	2,716	180,933
Denbighshire**	975	94.791	0.856	261,427	1,475	119,061
Flintshire	1,485	26.252	1.123	151,315	2,173	69,190
Gwynedd	1,681	58.413	3.551	103,820	8,313	48,843
Isle of Anglesey	1,349	531.717	2.143	2,667,324	4,834	1,213,295
Merthyr Tydfil	375	7.016	0.066	33,159	121	15,082
Monmouthshire	1,953	10.724	1.978	9,006	3,719	4,744
Neath Port Talbot	817	80.810	0.396	265,707	811	120,914
Newport	1,285	16.032	0.142	34,090	149	15,517
Pembrokeshire*	2,358.5	21.533	3.993	32,334	9,398	16,676
Powys	3,182	139.963	14.947	313,486	55,224	155,309
Rhondda Cynon Taf	1,915	56.035	6.929	134,032	22,218	66,152
Swansea	1,579	7.687	1.554	14,733	4,129	7,552
Torfaen	1,490	4.414	1.417	3,712	4,837	2,811
Vale of Glamorgan	1,113	38.676	1.077	248,241	2,995	113,477
Wrexham	3,666	14.322	4.426	37,445	13,297	20,054
Unknown	66	5.907	—	7,023	—	3,192
Total	**36,227**	**1,532.346**	**58.595**	**5,292,231**	**166,053**	**2,442,029**

* Project falls on local authority boundary. No information about grid connection available.
** Includes offshore wind.

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.

Capacity by Local Authority (excluding Nuclear)



Local progress in 2012

Increase in renewable energy for 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	374	0.760	0.447	1,377	274	692
Bridgend	657	1.838	0.022	1,394	28	637
Caerphilly	836	2.155	1.479	1,669	3,653	1,619
Cardiff	895	2.613	0.741	1,995	2,400	1,459
Carmarthenshire	1,080	39	1.6	84,640	3,080	39,027
Ceredigion	551	2.403	1.397	2,187	2,803	1,529
Conwy	283	0.858	0.348	728	479	396
Denbighshire	314	1.418	0.349	1,339	576	686
Flintshire	457	1.663	0.466	1,327	908	766
Gwynedd	503	2.889	1.176	3,627	2,369	1,996
Isle of Anglesey	544	1.637	1.387	1,371	3,779	1,376
Merthyr Tydfil	122	0.351	0.056	261	103	128
Monmouthshire	826	2.922	0.770	2,296	1,594	1,317
Neath Port Talbot	412	1.297	0.135	977	212	467
Newport	586	2.281	0.070	2,511	43	1,152
Pembrokeshire	836	8.841	1.473	6,876	3,566	3,833
Powys	1,129	4.948	10.856	4,128	48,038	13,227
Rhondda Cynon Taf	660	35.215	1.733	80,100	5,506	37,652
Swansea	505	2.296	0.449	1,725	885	912
Torfaen	394	2.129	1.195	1,974	4,304	1,909
Vale of Glamorgan	409	1.466	0.788	1,125	2,516	1,097
Wrexham	2,123	5.501	2.284	8,166	6,665	5,265
Unknown	35	2.911	0.000	4,320	0	1,963
Total	**14,531**	**127.417**	**29.251**	**216,114**	**93,782**	**119,104**

The number of new projects per local authority during 2012 shows a wide spread from 122 to 2,123, ranging from 0.35MW_e to 39.0MW_e for renewable electricity, and 0.022MW_{th} to 10.856MW_{th} for renewable heat.

An important part of the discussions with stakeholders following the publication of this report will be to understand the reasons why this wide range is occurring. It will be important to identify whether any local barriers are holding back opportunities, and whether any steps can be taken to reduce the impact of these.

We also wish to identify the good practice in the authorities with the highest numbers of projects and generating capacity to see if any lessons can be learnt and shared.

Summary by technology

Key findings

The report identified 36,227 low carbon projects across Wales.

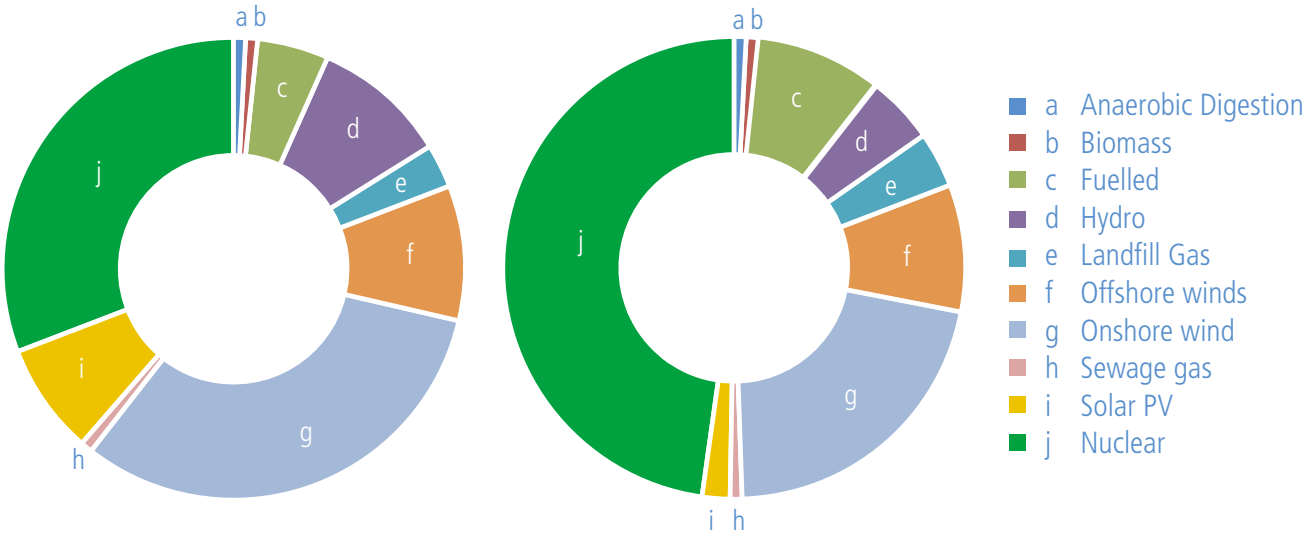
The majority of these (30,635) are solar PV. 3,191 are solar thermal and 1,228 are heat pumps.

Electricity

The total capacity for low carbon electricity is 1,532MW, with the potential to generate 2,719GWh of renewable electricity, and 2,573GWh from nuclear per year.

Half of the total local carbon electricity generation potential is from nuclear. Onshore wind provides 22% of the total, with the other key contributors being fuelled stations, offshore wind, hydropower and landfill gas.

Low carbon electricity capacity (left) and generation (right) by technology

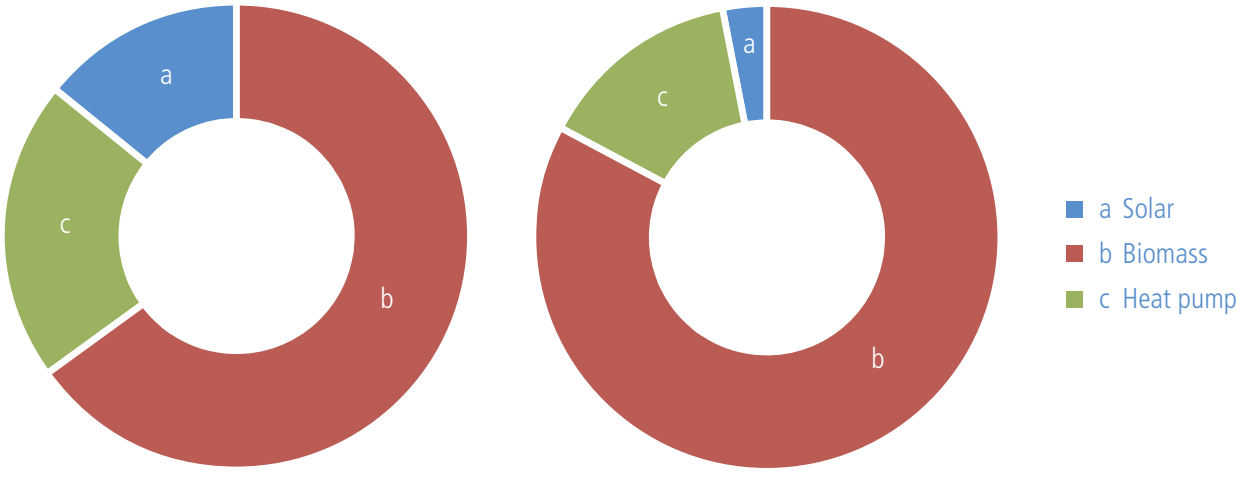


Heat

The total capacity for low carbon heat is 58.595MW, with the potential to generate 166GWh of renewable heat per year.

Over 80% of the generation potential for heat is from biomass, with heat pumps providing most of the remainder. Despite the low capacity factor for solar thermal, it still contributes 5.1GWh of renewable heat per year, 3% of the total.

Low carbon heat capacity (left) and generation (right) contribution by technology



Solar panels, Coed Talon Bowls Club

Anaerobic digestion

Five anaerobic digestion projects have been identified across Wales with a total capacity of 0.8 MW_e. Each project is located within a different local authority area.

Anaerobic digestion generators by local authority

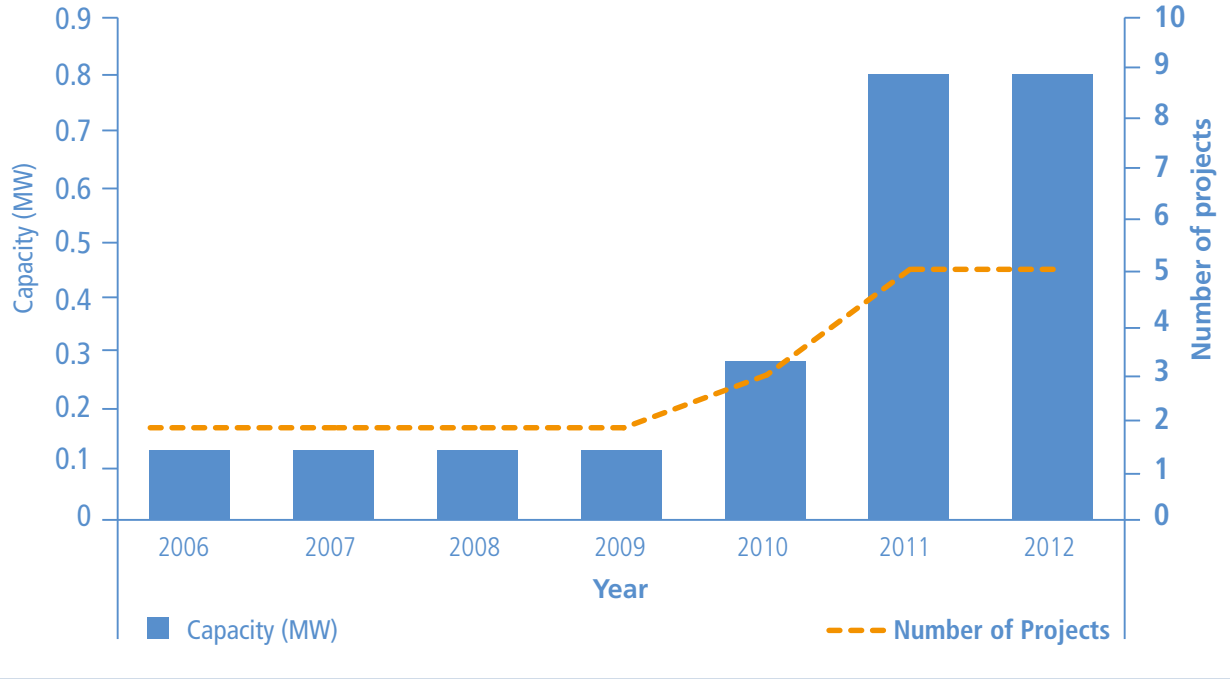
Local Authority	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Carmarthenshire	1	0.016	91	41
Newport	1	0.499	2,843	1,292
Pembrokeshire	1	0.000	0	unknown
Powys	1	0.125	712	324
Wrexham	1	0.160	912	414
Total	**5**	**0.800**	**4,558**	**2,072**

Key findings

None of the Welsh anaerobic digestion plants are listed under the 2011–12 annual sustainability report from Ofgem for fuelled stations, so the fuel mix for anaerobic digestion plants has not been verified.

Data for previous years shows an increase in anaerobic digestion capacity since 2009, and we expect to see further capacity increases in future surveys.

Trends in the deployment of anaerobic digestion (thermal capacity is currently zero)



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.

Wind turbine, Llantechell, Anglesey

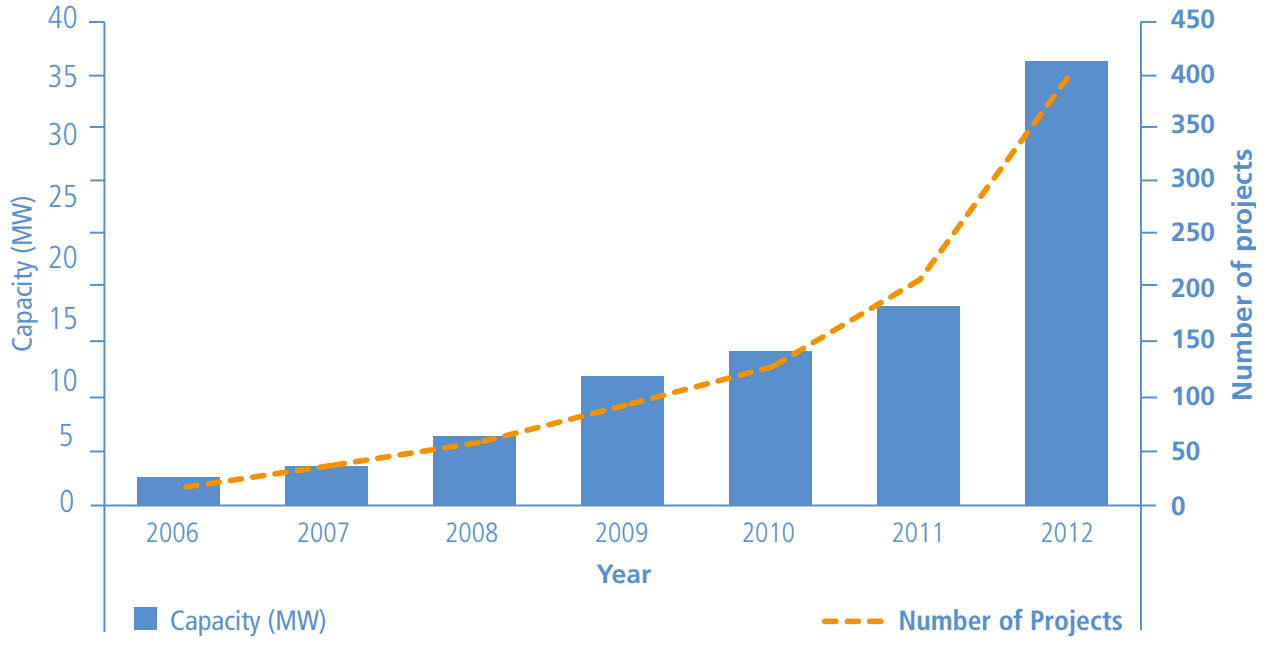
Biomass

There are 414 biomass projects recorded across Wales with a total installed capacity of 38MW_{th} and 0.06MW_e. Biomass has the potential to generate 138GWh per year of renewable heat, and 0.4GWh of electricity per year saving around 33,400 tonnes of CO_2. The equivalent units of gas would power over 9,000 households in Wales.

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	1	—	0.800	—	3,156	43
Bridgend	1	—	0.120	—	179	1.8
Caerphilly	8	—	1.943	—	8,979	578
Cardiff	4	—	1.085	—	4,150	206
Carmarthenshire	56	—	1.855	—	3,447	681
Ceredigion	36	—	1.319	—	2,836	587
Conwy	9	—	0.444	—	1,149	116
Denbighshire	12	—	0.368	—	627	235
Flintshire	13	—	0.626	—	1,390	190
Gwynedd	42	—	2.093	—	5,814	1,028
Isle of Anglesey	18	—	0.999	—	2,994	254
Monmouthshire	26	—	0.987	—	1,990	703
Neath Port Talbot	2	—	0.155	—	420	80
Pembrokeshire	35	—	2.109	—	6,923	244
Powys	93	—	11.855	—	51,224	17,552
Rhondda Cynon Taf	17	—	4.966	—	20,388	2,025
Swansea	9	—	0.861	—	3,058	828
Torfaen	9	0.060	1.216	421	4,509	2,014
Vale of Glamorgan	7	—	0.735	—	2,422	2,454
Wrexham	16	—	3.499	—	11,921	3,562
Total	**414**	**0.060**	**38.033**	**421**	**137,577**	**33,382**

Domestic projects now make up a significant proportion of the number of biomass installations. Given the number of properties that are off the gas grid, increasing installations through opportunities such as the domestic Renewable Heat Incentive will be important in Wales, and we expect to see these increases reflected in future surveys.



Biomass boiler

Fuelled *(biomass electricity and energy from waste)*

There are three dedicated renewably fuelled biomass electricity and energy from waste plants, and one co-fired plant claiming Renewable Obligation Certificates in Wales, with a total capacity of 69.7MW_e. These have the potential to generate almost 500GWh of renewable heat per year, saving around 222,000 tonnes of CO_2. This is equivalent to the electricity consumption of over 122,000 households in Wales.

The fuelled stations at Uskmouth and Trostrey have also used clean and waste biomass fuel. However, only Uskmouth was covered in Ofgem's 2011–12 sustainability report for fuelled stations with 26.5 tonnes of miscanthus listed in January 2012. This amount of fuel is negligible in comparison to the size of the generator. Neither Uskmouth nor Trostrey were included in the renewable energy figures in this report.

Fuelled and energy from waste generators by local authority

Local Authority	Generator	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Flintshire	UPM Shotton Paper Boiler	1	19.655	137,837	62,651
Merthyr Tydfil	Merthyr Biomass CHP	1	1	7,451	3,387
Monmouthshire	Trostrey Generator Station*	0	0	0	0
Neath Port Talbot	Western Wood Energy	1	14	98,179	44,625
Newport	Uskmouth Power Station*	0	0	0	0
Vale of Glamorgan	Aberthaw Power Station – biomass	1	35	245,448	111,563
Total		**4**	**69.655**	**488,915**	**222,226**

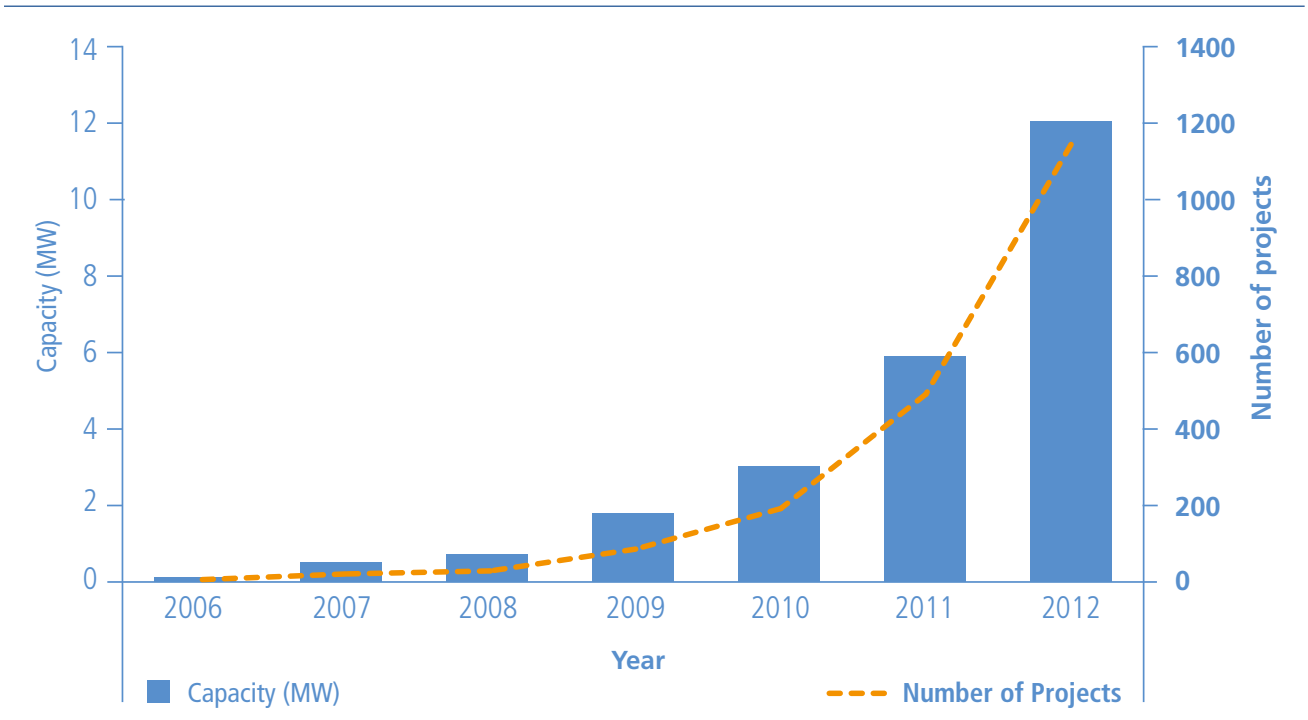
* Primarily fossil fuelled, any co-fired renewable energy generated in 2012 nominal and not counted in this report

Heat pumps

There are 1,228 heat pump projects recorded across Wales with a total installed capacity of 12.1MW_{th}. Two thirds of all heat pumps (802 heat pumps) in Wales source their heat from air and waste air; one third (425 heat pumps) source heat from the ground. There was only one water sourced heat pump reported in Wales, on the Isle on Anglesey. Heat pumps have the potential to generate over 23GWh of renewable heat per year, saving around 2,122 tonnes of CO_2. The equivalent units of gas would power over 1,500 households in Wales.

Heat pumps by source per local authority

	Air sourced		Ground sourced		Water sourced	
Local Authority	Number of projects	MW_{th}	Number of projects	MW_{th}	Number of projects	MW_{th}
Blaenau Gwent	12	0.055	—	—	—	—
Bridgend	1	0.006	1	0.011	—	—
Caerphilly	16	0.131	5	0.062	—	—
Cardiff	22	0.145	2	0.024	—	—
Carmarthenshire	55	0.600	73	0.866	—	—
Ceredigion	75	0.573	33	0.319	—	—
Conwy	20	0.233	15	0.408	—	—
Denbighshire	20	0.240	16	0.177	—	—
Flintshire	18	0.210	23	0.154	—	—
Gwynedd	97	0.893	35	0.327	—	—
Isle of Anglesey	57	0.611	21	0.218	1	0.036
Merthyr Tydfil	2	0.061	—	—	—	—
Monmouthshire	58	0.547	32	0.306	—	—
Neath Port Talbot	26	0.127	5	0.057	—	—
Newport	2	0.015	4	0.032	—	—
Pembrokeshire	60	0.578	38	0.425	—	—
Powys	97	0.983	84	0.662	—	—
Rhondda Cynon Taf	43	0.410	6	0.066	—	—
Swansea	30	0.348	11	0.142	—	—
Torfaen	8	0.115	4	0.042	—	—
Vale of Glamorgan	16	0.219	5	0.057	—	—
Wrexham	67	0.483	12	0.131	—	—
Total	**802**	**7.583**	**425**	**4.487**	**1**	**0.036**



Hydro power scheme, Elan Valley

Hydropower

There are 163 hydropower projects recorded across Wales with a total installed capacity of 152.2MW$_e$. Hydropower has the potential to generate over 273GWh of renewable electricity per year, saving around 124,300 tonnes of CO_2. This is equivalent to the electricity consumption of over 68,300 households in Wales.

The pumped storage power stations at Dinorwig (1,728MW) and Ffestiniog (360MW) in Gwynedd are not included in these figures, as the renewable aspect of these stations depends on their management and the catchment conditions. For the purpose of this report these sites have not been considered a source of renewable electricity.

From the March 2013 Feed-in Tariff report, there were 69 hydropower projects, with a combined capacity of 1.15MW listed as claiming the Feed-in Tariff. There were 22 projects at unknown locations identified as Welsh.

Hydropower generators by Local Authority (excluding pumped hydro)

Local Authority	Number of projects	Capacity (MW$_e$)	Estimated generation (MWh$_e$)	CO_2 saved (t CO_2 per annum)
Bridgend	4	0.034	62	28
Carmarthenshire*	10.5	4.655	8,366	3,802
Ceredigion	20	55.963	100,568	45,711
Conwy	13	34.614	62,203	28,273
Denbighshire	10	0.577	1037	471
Gwynedd	33	48.609	87,351	39,704
Monmouthshire	5	0.180	323	147
Neath Port Talbot	7	0.274	492	223
Pembrokeshire*	7.5	0.168	302	137
Powys	29	6.334	11,383	5,174
Rhondda Cynon Taf	1	0.055	99	45
Torfaen	1	0.029	52	24
Unknown**	22	0.725	1,302	592
Total	**163**	**152.217**	**273,539**	**124,332**

* Project falls on local authority boundary. No information about grid connection available.
** Feed-in Tariff projects including the Welsh country 'WA' code within the accreditation code, but listed as unknown location. No known corresponding projects were identified.

Case study

The Welsh Government Woodland Estate covers about 14% of land in Wales. It was managed previously by Forestry Commission Wales and now by Natural Resources Wales.

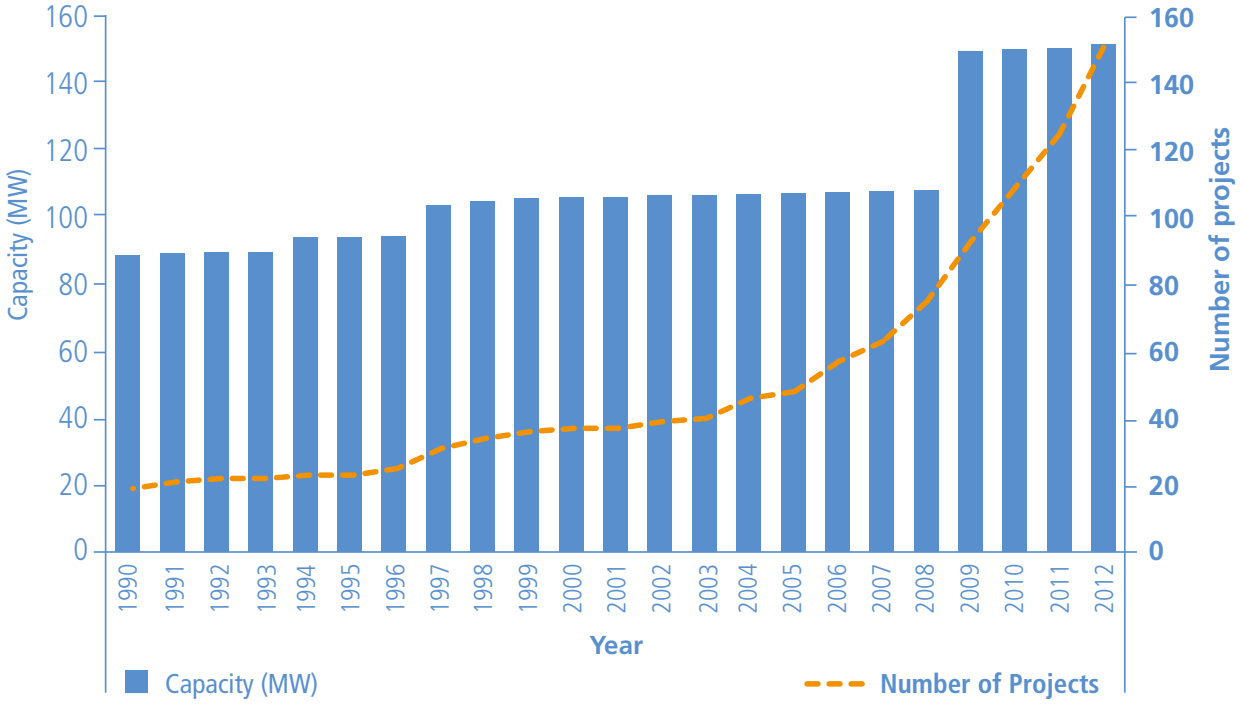
In 2010 the Welsh Government instructed Forestry Commission Wales, Countryside Council for Wales & Environment Agency Wales to be proactive and imaginative in exploring renewable energy potential and opportunities for economic, environmental & social benefits.

In February 2012 Forestry Commission Wales put out a call to the hydropower industry, development trusts, Community Councils and community environmental groups for expressions of interest in developing hydro schemes involving any part of the Welsh Government woodland estate. 303 expressions of interest were received across Wales.

Basic reviews identified potential problems early, including environmental sensitivity and restrictions in land title deeds. The decision making process was further improved with consistent legal packs and improved transparency.

As of December 2013 the Natural Resources Wales Hydro Energy Programme was working on 18 potential schemes. The first legal agreement negotiations are underway and 6 schemes have submitted formal abstraction licence and planning consent applications. Dialogue with developers tells us that there are still 176 potential sites being explored.

The three significant increases in capacity seen here are due to the commissioning of hydropower at Llyn Celyn (4.5MW in 2004), Llyn Brianne (4.6MW in 2007) and the Rheidol Power station (41MW in 2009).



Landfill gas

There are 23 landfill gas schemes recorded across Wales totalling 40MW$_e$. Landfill gas has the potential to generate over 193GWh of renewable electricity per year, saving around 87,760 tonnes of CO_2. This is equivalent to the electricity consumption of over 48,270 households in Wales.

In general the capacity of landfill gas to produce electricity is decreasing, as less waste goes to landfill and there is reduced de-gassing.

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	2.650	12,776	5,807
Bridgend	1	1.170	5,641	2,564
Cardiff	2	4.970	23,962	10,891
Carmarthenshire	1	1.370	6,605	3,002
Conwy	1	2.880	13,885	6,311
Flintshire	2	1.920	9,257	4,208
Gwynedd	1	0.300	1,446	657
Isle of Anglesey	1	0.440	2,121	964
Merthyr Tydfil	2	5.207	25,105	11,411
Neath Port Talbot	2	3.640	17,550	7,977
Newport	1	2.000	9,643	4,383
Pembrokeshire	1	2.166	10,443	4,747
Powys	1	1.025	4,942	2,246
Rhondda Cynon Taf	2	3.300	15,910	7,232
Swansea	1	1.650	7,955	3,616
Wrexham	3	5.360	25,842	11,746
Total	**23**	**40.048**	**193,083**	**87,762**

Wind

There were 550 onshore wind projects recorded across Wales with a combined total installed capacity of 498.5MW$_e$. There are a total of 1,073 turbines onshore in Wales, and 92% of sites are single turbine sites. Onshore wind has the potential to generate over 1,169GWh of renewable electricity per year, saving around 531,300 tonnes of CO_2. This is equivalent to the electricity consumption of almost 300,000 households in Wales.

Although offshore wind energy capacity is generally counted as a UK figure, the contribution being generated off the Welsh coast is significant. Once Gwynt y Mor is fully operational, the three wind farms will contribute the equivalent of over one third of Wales' domestic annual electricity requirement.

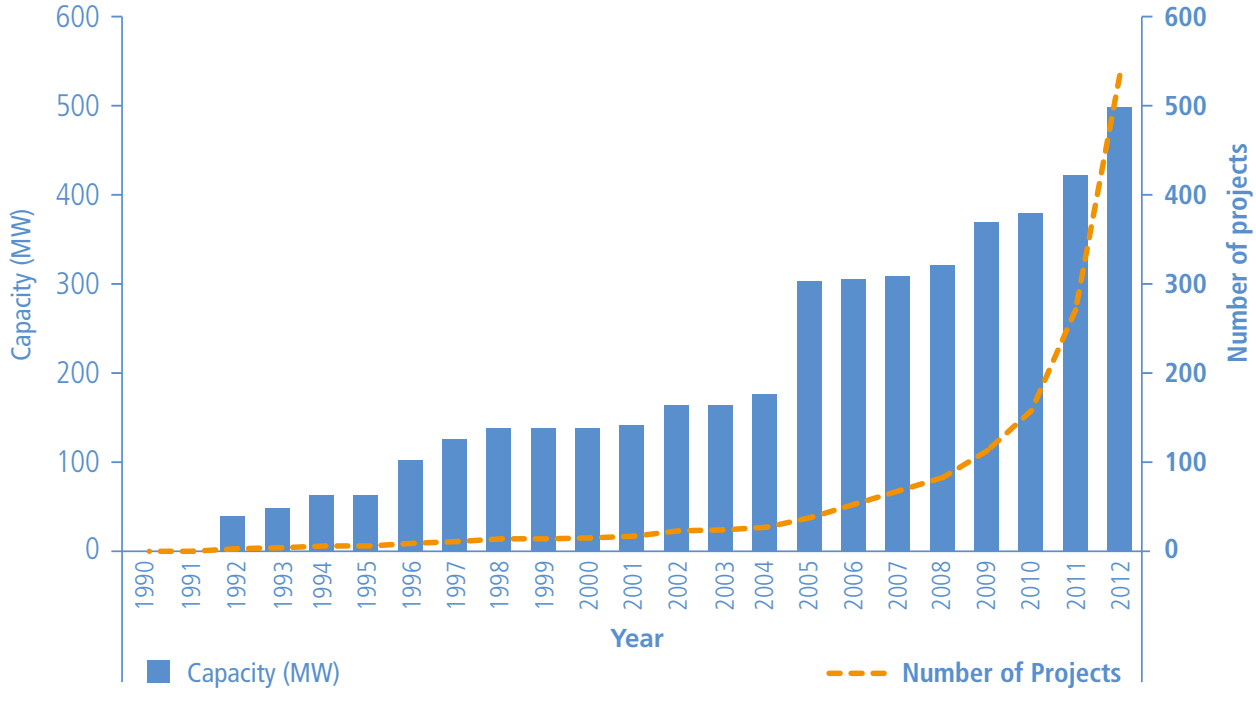
Onshore wind by local authority

Local Authority	Number of projects	Number of turbines	Capacity (MW$_e$)	Estimated generation (MWh$_e$)	CO_2 saved (t CO_2 per annum)
Blaenau Gwent	2	2	0.501	1,185	539
Bridgend	5	5	0.053	70	32
Caerphilly	9	12	0.165	217	99
Cardiff	5	5	2.441	5,629	2,559
Carmarthenshire	72	116	76.029	178,654	81,204
Ceredigion	49	121	81.090	191,237	86,923
Conwy	15	25	18.386	43,340	19,699
Denbighshire	22	49	31.064	73,045	33,201
Flintshire	18	18	0.226	298	135
Gwynedd	41	44	5.223	11,497	5,226
Isle of Anglesey	40	110	38.217	90,014	40,914
Monmouthshire	23	23	0.456	600	273
Neath Port Talbot	5	32	57.459	135,958	61,797
Newport	4	6	7.110	16,818	7,644
Pembrokeshire	80	83	5.125	11,102	5,046
Powys	108	327	122.828	288,939	131,331
Rhondda Cynon Taf	5	48	48.576	114,965	52,255
Swansea	4	4	0.340	742	337
Torfaen	4	4	0.030	39	18
Vale of Glamorgan	5	5	0.095	125	57
Wrexham	10	10	0.683	898	408
Unknown	24	24	2.340	3,603	1,638
Total	**550**	**1,073**	**498.439**	**1,168,974**	**531,334**

Offshore wind by local authority

Local Authority	Generator	Number of projects	Number of turbines	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Offshore (Conwy)	Rhyl Flats	1	25	90	276,129	125,509
Offshore (Denbighshire)	North Hoyle	1	30	60	184,086	83,673
Total		**2**	**55**	**150**	**460,215**	**209,182**

The rate of growth in the number of projects being installed has increased annually. The single greatest jump in capacity is from the commissioning of the 30 turbine, 45MW wind farm at Cefn Croes in Ceredigion. Other significant increases include the 15 turbine, 34MW Mynydd y Betws wind farm commissioned in Carmarthenshire in 2012, and the Ffynnon Oer and Maesgwyn wind farms in Neath Port Talbot, commissioned in 2005 and 2011 respectively. A number of large wind projects have been commissioned since December 2012, and with further large schemes also consented and moving towards construction, we expect to see a significant increase in generating capacity from wind in future surveys.



Case study

The Mynydd y Gwrhyd scheme is developing a community owned wind farm 20 miles north of Swansea with support from Welsh Government's Ynni'r Fro programme. The wind farm will be a wholly owned trading subsidiary of Awel Aman Tawe, returning profits to the local community for low carbon regeneration projects. The wind farm will have two turbines and each will be rated at 2MW

Ynni'r Fro provided a grant to Mynydd y Gwrhyd towards wind speed monitoring, legal advice on negotiating land leases, and Development Officer advice in taking the project forward. The 4MW wind farm will;

- Produce an estimated 10,000 MWh per year;
- Save 9,000 tonnes of CO_2 per year;
- Provide an income stream from electricity sales of at least £1million per year;
- Produce clean energy for the equivalent of 2,000 homes;
- Create 7 new jobs within Awel Aman Tawe which is located in a communities first area;
- Create further employment from construction contracts for local suppliers;
- Develop an educational programme to monitor the wind farm to be used by 3 local secondary schools and 8 primary schools,
- Provide seed funding of a local revolving energy fund to finance renewable energy and energy efficiency work on up to 25 homes per year; targeted at fuel poor households.

Sewage gas

There are 11 sewage gas schemes recorded across Wales totalling 9.97MW_e. Sewage gas has the potential to generate almost 40GWh of renewable electricity per year, saving around 17,900 tonnes of CO_2. This is equivalent to the electricity consumption of almost 10,000 households in Wales.

Sewage gas projects by local authority

Local Authority	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Cardiff	2	4.425	17,455	7,934
Denbighshire	2	0.285	1,124	511
Flintshire	1	0.190	749	341
Gwynedd	1	0.105	414	188
Monmouthshire	1	0.177	698	317
Neath Port Talbot	1	2.962	11,684	5,311
Powys	1	0.100	394	179
Swansea	1	0.560	2,209	1,004
Wrexham	1	1.170	4,615	2,098
Total	**11**	**9.974**	**39,344**	**17,883**

Case study

Dŵr Cymru has installed two advanced digesters in Wales, at their Cardiff and Port Talbot treatment plants, together with a third at Hereford. The digesters operate at high temperatures, to release methane from sewage sludge. The methane generated by the digesters is burnt on site to power machinery used in the water treatment process, saving money for Dŵr Cymru and its customers, and lowering the carbon footprint of its operations. Against an investment of £75m in the three plants, Dŵr Cymru estimates a return of around £8m per year in savings on their energy bills.

Solar PV

Key findings

There are over 30,000 solar PV projects recorded across Wales with a total installed capacity of 121.15MW$_e$. Solar PV has the potential to generate over 90GWh of renewable electricity per year, saving around 41,000 tonnes of CO_2. This is equivalent to the electricity consumption of over 22,500 households in Wales. Solar PV makes an 11% contribution to the overall renewable electrical capacity (excluding nuclear). However, due to the low load factor of Solar PV, it contributes only 3.3% of renewable electricity generation.

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	405	0.840	626	285
Bridgend	1,195	3.363	2,506	1,139
Caerphilly	1,575	4.559	3,397	1,544
Cardiff	1,854	5.382	4,010	1,823
Carmarthenshire	2,268	15.842	11,804	5,365
Ceredigion	1,173	4.674	3,482	1,583
Conwy	624	1.979	1,475	670
Denbighshire	869	2.865	2,135	970
Flintshire	1,358	4.261	3,175	1,443
Gwynedd	1,329	4.176	3,112	1,414
Isle of Anglesey	1,074	3.060	2,280	1,036
Merthyr Tydfil	320	0.809	603	274
Monmouthshire	1,760	9.911	7,385	3,357
Neath Port Talbot	748	2.475	1,844	838
Newport	1,257	6.423	4,786	2,175
Pembrokeshire	1,822	14.075	10,487	4,767
Powys	2,276	9.550	7,116	3,234
Rhondda Cynon Taf	1,319	4.104	3,058	1,390
Swansea	1,438	5.137	3,828	1,740
Torfaen	1,450	4.296	3,201	1,455
Vale of Glamorgan	1,017	3.581	2,668	1,213
Wrexham	3,484	6.949	5,178	2,353
Unknown*	20	2.843	2,118	963
Total	**30,635**	**121.153**	**90,272**	**41,031**

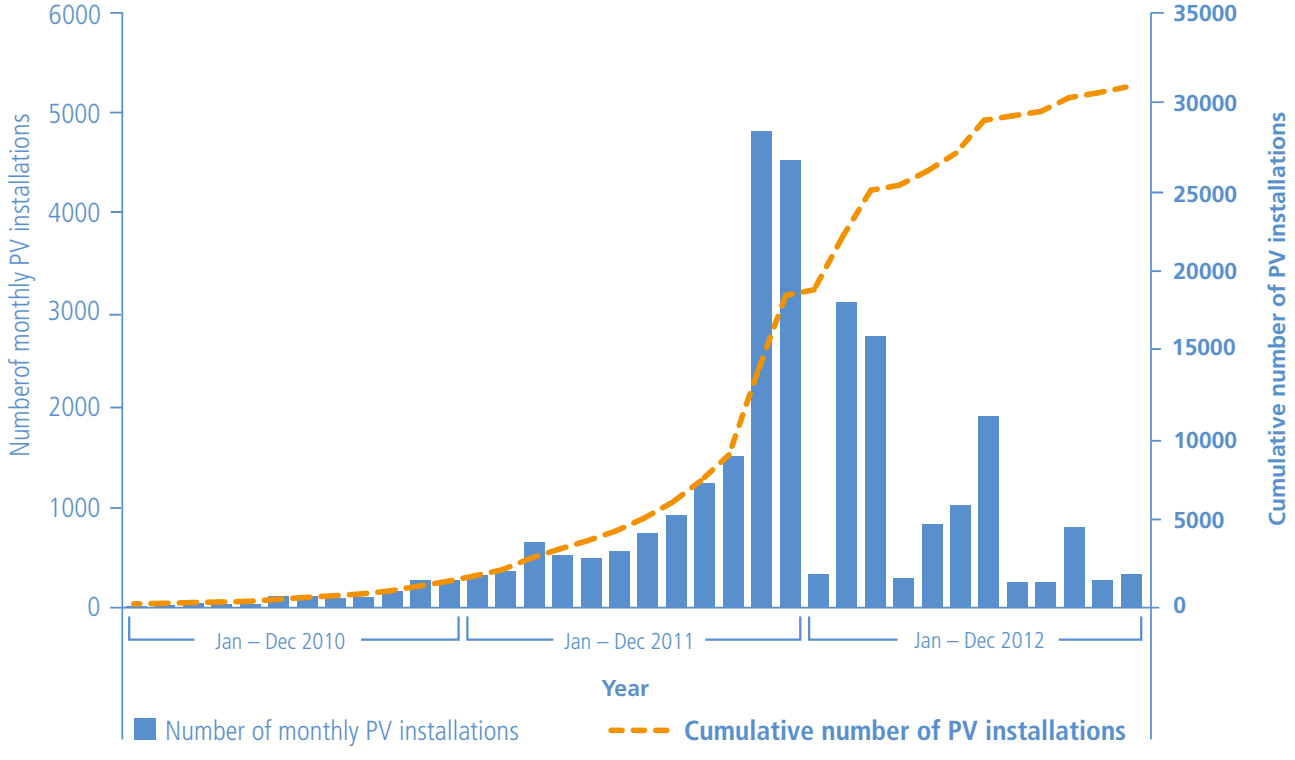
* Primary data with unknown location or Feed-in Tariff projects including the Welsh country 'WA' code within the accreditation code, but listed as unknown location. No known corresponding projects were identified.

Deployment trends for Solar PV and the Feed-in Tariff

There have been four peaks in the number of monthly installations since mid 2011 (at the end of 2011, in the lead up to March 2012, July 2012 and October 2012). Each of these peaks corresponded closely to changes in the Feed-in Tariff rate available.

The monthly Solar PV installation figures show that the change in capacity has remained closely tied to the increase in the numbers of projects. Up until the end of 2012 large scale solar in Wales was not significant enough to impact on this trend, although this is expected to change in future with larger solar farms being developed.

Monthly Solar PV installation figures (based on the commissioning date)



Case study — Wrexham County Borough Council:

Wrexham Council's flagship six month project has installed Solar PV panels at around 3,000 social housing properties in partnership with H.T. Forrest and Sharp Solar.

The project is demonstrating multiple benefits:

- a 25 year income for the Council from Feed-in Tariff payments, generating a commercial return;
- reducing social housing tenant's fuel bills helping to tackle fuel poverty;
- a 3,000 tonne per year reduction in CO_2 footprint;
- local economic benefits by creating jobs and training opportunities — local tradespeople and local businesses were employed directly in the supply chain;
- social benefits from greater engagement in energy efficiency and solar PV amongst the authority's social housing tenants and in the wider community;
- catalysed further investment in energy generating and energy efficiency projects within the county.

Biodigester, Holt, Wrexham

Solar thermal

Key findings

Over 3,148 projects are recorded as domestic, and around half of these are confirmed as social housing. There are 30 projects listed as 'other public sector' and 12 were developed by communities or charities.

The greatest increase in the number of projects and capacity provided from solar thermal was between 2010 and 2012. Of the 2,091 projects commissioned in these two years, over 1,291 were recorded as social housing.

There are 3,191 solar thermal projects recorded across Wales with a total installed capacity of 8.4MW_{th}. Solar thermal has the potential to generate over 5.1GWh of renewable heat per year, saving around 1,239 tonnes of CO_2. The equivalent units of gas would power around 340 households in Wales.

Solar thermal installations 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	291	0.508	312	75
Bridgend	63	0.321	197	48
Caerphilly	333	0.621	381	92
Cardiff	58	0.128	79	19
Carmarthenshire	132	0.454	279	67
Ceredigion	158	0.429	263	64
Conwy	149	0.540	331	80
Denbighshire	23	0.071	43	10
Flintshire	51	0.133	82	20
Gwynedd	102	0.238	146	35
Isle of Anglesey	136	0.279	171	41
Merthyr Tydfil	50	0.004	3	655
Monmouthshire	48	0.138	85	20
Neath Port Talbot	20	0.057	35	8
Newport	16	0.095	58	14
Pembrokeshire	314	0.881	540	131
Powys	492	1.346	826	200
Rhondda Cynon Taf	522	1.487	913	220
Swansea	85	0.203	125	30
Torfaen	14	0.044	27	7
Vale of Glamorgan	62	0.066	40	10
Wrexham	72	0.312	192	46
Total	**3,191**	**8.355**	**5,127**	**1,239**

Nuclear

Key findings

The Wylfa Nuclear Power Station is situated just west of Cemaes Bay on the Isle of Anglesey. Wylfa houses two 490 MW Magnox nuclear reactors, "Reactor 1" and "Reactor 2," which were built from 1963 and became operational in 1971. Reactor 2 was retired in 2012.

In 2012 the load factor for Wylfa 1 was 59.9%, and around 2,573 GWh of low carbon electricity was produced, reducing emissions by around 1,169,464 tonnes of CO_2. Due to the high load factor this is the equivalent to the electricity consumption of 643,200 households in Wales.

Energy Wales: A Low Carbon Transition identifies nuclear as a low carbon electricity generating technology, but not a renewable one.

Nuclear generating stations

Local Authority	Generator	Number of projects	Capacity (MW_e)	Estimated generation (MWh_e)	CO_2 saved (t CO_2 per annum)
Isle of Anglesey	Wylfa Reactor 1	1	490	2,572,909	1,169,464

Research method

Regen SW were commissioned by Welsh Government to devise a research method to identify the total numbers of renewable energy technology projects installed in Wales, and to collect the findings from the first survey.

The research method developed by Regen SW included:

- identifying, collating and verifying records from existing datasets;
- holding a workshop with local stakeholders to develop the survey;
- carrying out a survey across Wales to identify renewable energy projects;
- analysing the data to ensure a robust national overview and locally specific data were available.

Survey responses were gathered from stakeholders that included:

- Water companies
- Waste contractors
- Local authorities
- Housing associations
- Installers and developers of renewable energy projects
- Third sector organisations included charities and community groups

Existing datasets that were verified and collated with the survey findings included:

- Feed-in tariff
- Microgeneration Certification Scheme
- Renewable Heat Incentive
- Renewable Heat Premium Payment
- Low Carbon Building Programme
- Cardiff University Welsh Energy Atlas

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
MWh	Mega Watt Hours of generation
GWh	Giga Watt Hours of generation (equal to 1,000 MWh)
TWh	Tera Watt Hours of generation (equal to 1,000 GWh, or 1,000,000 MWh)
CO_2	Carbon dioxide emissions (in metric tonnes)