Gwynedd and Anglesey Joint Planning Policy Unit

Renewable Energy Capacity Assessment for Anglesey

Final Report

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Executive Summary

Introduction

Renewable energy is described by Welsh Government as "energy from a source that is either unlimited (at least from our perspective) or which can be renewed without harming the environment". It does not include nuclear power, which can be described as a "low carbon" technology, but not as renewable.

This report assesses the natural resources available to produce renewable energy within Anglesey. It covers the following technologies:

- Onshore Wind
- Hydropower
- Biomass
- Energy from Waste (EfW)
- Microgeneration
- Anaerobic Digestion
- Tidal

The aim of this study is to provide an evidence base for the emerging Joint Local Development Plan (JLDP) for the area. Arup has been commissioned to assess the available natural resources. The next stage will be to further assess likely levels of deployment, and use the evidence contained in this report to inform the development of land use policies and to influence other local plans and strategies.

The methodology for the assessment is based on the Welsh Government Practice Guidance: *Planning for Renewable and Low Carbon Energy - A Toolkit for Planners* (June 2010, referred to as the "Welsh Government Toolkit"). This is supplemented by other assessment methodologies where appropriate.

Energy Baseline

In 2009, Anglesey used 1,341.9GWh of energy. The majority of this was made up of petroleum products (31%), natural gas (35%); grid electricity (24%). 4% was from off-grid renewables. It is expected that gas and electricity demand will increase by up to 10% up to 2020. This means that an increase in renewable energy will be required to meet this demand and reduce carbon emissions.

There is already some renewable energy in place on Anglesey. There is a total of 35MW of installed capacity; most of this is made up of wind energy (Llanbabo Wind Farm is the largest), with some solar energy. This accounts for approximately 6% of Anglesey's existing energy demand.

Planned developments that may be important for Anglesey's renewable energy industry and supply chain include;

- National Grid's proposed transmission infrastructure improvements to accommodate 7GW+ of renewable and low carbon energy
- The proposed 4.2GW offshore wind array in the Irish sea (Centrica)
- A proposed 299MW biomass plant near Holyhead (Lateral Power)
- A proposed 10.5MW tidal array between Skerrier and Carmel Head (SeaGen Wales).

In addition, a new 3.3GW nuclear power is planned at Wylfa. Whilst this is not a renewable energy (and therefore outside the scope of this report), it is included here for completeness.

Renewable Energy Assessment

The greatest potential for renewable energy in Anglesey is Tidal power (estimated to be 180MW of larger scale tidal). However, as this is an offshore technology, the local planning authority has less direct influence over the ability to realise this resource.

Onshore wind has a relatively large potential for Anglesey (78MW, plus over 100MW of micro-scale wind). However, it should be noted that all schemes will require consultation with the Ministry of Defence (MoD) and it may be that the full capacity is unlikely to be realisable.

The potential of microgeneration (solar photovoltaic, solar thermal, heat pumps) appears reasonably high (150MW in total). However, the reality of achieving this level of deployment will be challenging. Planning policies have the most control over the integration of microgeneration technologies to new development, so this provides a sensible area of intervention for the JLDP. Planning policies can also encourage and facilitate greater integration of renewable energy technologies through the appropriate retrofitting of such technologies to existing buildings.

However, some barriers to retrofit, particularly on domestic properties, remain, and it may be hard to deliver the full quotient of renewable energy that is technically available. Homeowners tend to perceive retrofit measures as disruptive, and it is often difficult to achieve uplift in property value as a result of the initial investment. However, initiatives such as the Green Deal may be expected to overcome some of these barriers.

There will also be wider issues relating to the deployment of renewable energy. It is beyond the scope of this report to consider these constraints in detail. However, from our experience elsewhere, the following are seen to be some of the most significant factors:

- Financial constraints;
- Public perception;
- Readiness of the supply chain for some technologies;
- Real and perceived grid constraints.

Anglesey Energy Island is an important local partnership, and is likely to be instrumental in achieving deployment of renewable energy within the County. It is therefore recommended that any further work undertaken by the planning authority should involve this group to ensure a joined up approach to renewable energy on Anglesey.

1 Introduction

1.1 Aims of the Study

Arup has been commissioned the by Anglesey and Gwynedd Joint Planning Policy Unit (JPPU) on behalf of both Councils to undertake a renewable energy generation capacity assessment for Anglesey. The purpose of this study is to provide an evidence base for the emerging Joint Local Development Plan (JLDP) for the area. Arup has been commissioned solely to produce the figures relating to the available resources, rather than to provide any analysis or make recommendations as to how they might impact on policy proposals. The next stage will be to use the evidence contained in this report to inform the development of land use policies and to influence other local plans and strategies.

Renewable energy is described by Welsh Government as "energy from a source that is either unlimited (at least from our perspective) or which can be renewed without harming the environment". It does not include nuclear power, which can be described as a "low carbon" technology, but not as renewable.

1.2 Methodology

The methodology is based on the Welsh Government Practice Guidance: Planning for Renewable and Low Carbon Energy - A Toolkit for Planners (June 2010, referred to as the "Welsh Government Toolkit").

Where appropriate, reference is also made to the DECC / SQW Energy guidance, Renewable and Low Carbon Energy Capacity Methodology: Methodology for the English Regions (January 2010, referred to as "the DECC methodology"). Whilst this was written as guidance for English Regions, some of the methodology is easily transferrable to a local scale and is also applicable in Wales. This has been used to supplement the Welsh Government guidance where value can be added to the process for Anglesey, for example, through reference to additional or more appropriate data sources. The resources assessed are described within **Table 1** below, which also identifies the methodology for each technology.

Table 1: Resources and methodologies considered within assessment

Category	Sub-Category	Methodology
Onshore Wind	Wind Clusters	Welsh Government Toolkit
	Small Scale	DECC Methodology
Hydropower	Small scale hydropower	Welsh Government Toolkit
Biomass	Managed Woodland	Welsh Government Toolkit
	Energy Crops	Welsh Government Toolkit
	Waste Wood	Welsh Government Toolkit
Microgeneration	Heat Pumps	DECC Methodology
	Solar	DECC Methodology
Anaerobic Digestion	Food Waste	Welsh Government Toolkit
	Poultry Litter	Welsh Government Toolkit
	Animal Manure	Welsh Government Toolkit

	Sewage Sludge	Welsh Government Toolkit
Energy from Waste (EfW)	Municipal Solid Waste	Welsh Government Toolkit
	Commercial and Industrial Waste	Welsh Government Toolkit
Tidal	Tidal	Marine Renewable Strategic Framework

1.2.1 The Welsh Government Planning Toolkit

The Welsh Government Toolkit was commissioned by the Welsh Government in November 2008. The use of the toolkit was aimed at assisting planning policy officers for Local Planning Authorities to deliver two national planning policy expectations as set out in Planning Policy Wales, namely, Planning for Renewable Energy, and Planning for Sustainable Buildings.

The assumptions and steps required vary between each resource and further details can be found within the respective 'Project Sheets' accompanying the toolkit. In principle the methodology involves the following steps:

- Establish the quantity of the available resource;
- Establish the constraints on this available resource (e.g. environmental or regulatory constraints);
- Establish the amount of this resource that can viably be collected or used;
- Establish the energy content of the resource; and
- Establish the overall potential energy by multiplying the above factors.

1.2.2 The DECC Methodology

The Department of Energy and Climate Change (DECC) methodology takes a sequential approach to developing the evidence base. **Figure 1** shows the sequential approach for the broader process of developing an evidence base and then targets. This methodology summary covers the first four of these stages.

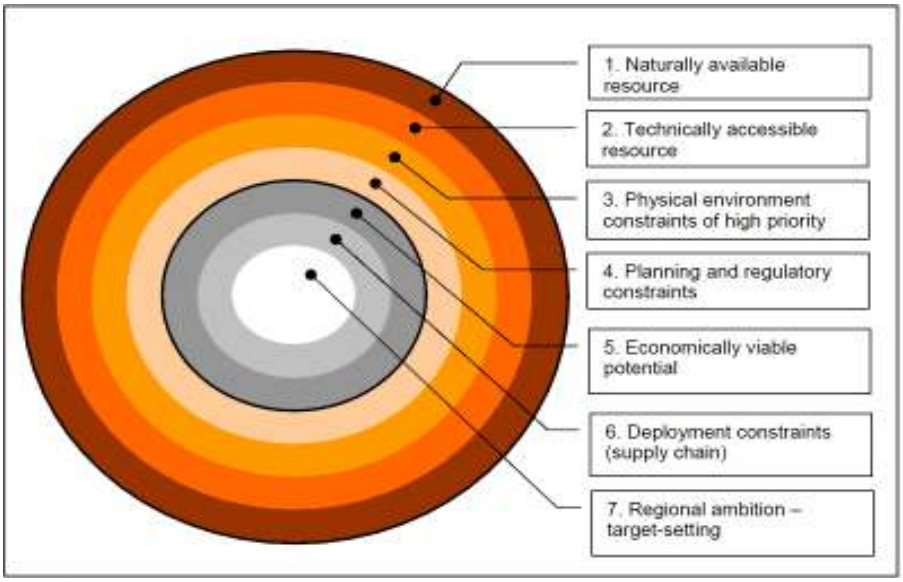

Figure 1: Stages for developing a comprehensive evidence base for renewable energy potential

Stages 1 and 2 represent the process of establishing the maximum naturally available resource. Some technologies, such as solar and wind, are abundantly available and these stages focus on considering what proportion can be captured. Other technologies, such as biogas, have an absolute limit due to the total quantity of feedstock theoretically available.

After the establishment of the theoretical maximum resource Stages 3 and 4 then consider the effect of a number of constraints on the resource. Constraints include issues such as regulatory and planning limitations; and competing demands for the resources (in cases such as managed woodland). **Table 2** is reproduced from the DECC report and summarises the assessment process.

Table 2: DECC methodology resource assessment summary

Main element	Stage and description
Opportunity analysis	**Stage 1. Naturally available resource:** Explore and quantify the naturally available renewable energy resource within the geographical boundary. This will be based on data and information analysis including resource maps and inventories.
	Stage 2. Technically accessible resource: Estimate how much of the natural resource can be harnessed using commercialised technology (currently available or expected to reach the market by 2020). This will be based on applying parameters regarding the deployment of technology.
Constraints analysis	**Stage 3. Physical environmental constraints:** Explore the physical barriers to deployment such as areas where renewable schemes cannot practically be built e.g. large scale wind turbines on roads and rivers. This layer of constraints will reduce the overall deployment opportunity. The analysis will be based on GIS maps and various relevant data inventories.
	Stage 4. Planning and regulatory constraints: Apply a set of constraints relevant to each renewable technology that reflects the current planning and regulatory framework, such as excluding from the assessment areas and resource which cannot be developed due e.g. health & safety, air/water quality, environmental protection.

Whilst these methodologies do not provide an approach to assessing wider constraints and opportunities on renewable energy deployment, some commentary on this is made in Chapter 4.

1.3 Report Structure and Content

Findings and baseline data from this exercise are presented in this report, the structure of which is as follows:

- **Chapter 2** provides an indication of current and historical renewable energy (heat and electricity) supplies. An assessment of future energy demand forecasts are produced for Anglesey. This provides a baseline from which to assess renewable energy potential.
- **Chapter 3** contains the renewable and low carbon resource assessment of the renewable energy sources in Anglesey in accordance with the appropriate methodology.
- **Chapter 4** provides a conclusion on the existing and potential renewable energy resource in Anglesey.

2 Energy Baseline

2.1 Introduction

Electricity and heat demand in Anglesey has been estimated using actual energy consumption data from national statistics. This has then been used to estimate future energy demand projected to 2021. The existing energy supply networks and major power generation sites have been identified.

Energy systems must be continually balanced to match supply and demand. Balancing has traditionally been achieved by varying the output of generation to meet indicated demands for electricity. This has been available through the flexibility of coal and gas fired generating stations. However, as we begin the necessary transition to decarbonise energy generation by using new energy sources and technologies, this brings with it significant demand and supply challenges. Firstly, some renewable sources have variable outputs (e.g. onshore wind energy generation is variable depending upon wind speed), and secondly low carbon sources set to be deployed maybe inherently less flexible than traditional generation plants e.g. decentralised energy systems and district heating etc.

2.1.1 Explanation of terms

The Welsh Government Toolkit[1] sets out a useful explanation of the key terms; power, energy, electricity and heat, this is replicated here:

Power vs. Energy output

In the context of this report, power is measured in either kiloWatts (kW), or MegaWatts (MW), which is a thousand kW, or gigaWatts (GW), which is a thousand MW. It is a measure of the electricity or heat output being generated (or used) at any given moment in time. The maximum output of a generator, when it is running at full power, is referred to as its installed capacity or rated power output.

Energy, on the other hand, is the product of power and time. It has the units of kWh (the h stands for "hour") or MWh, or GWh. As an example, if a 2MW wind turbine ran at full power for 1 hour, it would have generated 2 x 1 = 2MWh of energy. If it ran at full power for one day (24 hours), it would have generated 2 x 24 = 48MWh.

A TerraWatt is a thousand MW.

Electricity vs. Heat output

In terms of the units used, to avoid confusion, it can be important to distinguish between whether a generator is producing electricity or heat. This is because some renewable energy fuels (i.e. biomass) can be used to produce either heat only, or power and heat simultaneously when used in a Combined Heat & Power (CHP) plant.

[1] Welsh Government, *Planning for Renewable and Low Carbon Energy - A Toolkit for Planners*, July 2010, p22

It is also important to be able to distinguish between renewable electricity targets and renewable heat targets. To do this, the suffix "e" is added to denote electricity power or energy output, e.g. MWe, or MWhe, whilst for heat, the suffix "t" is used (for "thermal"), to denote heat output, e.g. MWt, or MWht.

2.2 Current Energy Demand

2.2.1 Total Energy Demand

The total energy demand in GWh for Anglesey for 2005 -2009 (excluding transport) is set out in **Table 3** below. This data is taken from the Department of Energy and Climate Change (DECC) data on sub-national energy consumption[2].

Of particular note is the 31% of energy provided by petroleum products in 2009, which demonstrates the number of off grid properties in Anglesey.

Table 3: Total Non-Transport Energy Demand in Anglesey, 2005-9 (GWh)

Year	Coal	Manufactured fuels	Petroleum products	Natural gas	Electricity	Renewables & waste	Total (non-transport energy)
2005	31.6	58.0	450.2	571.7	351.2	34.7	1,497.5GWh
2006	36.4	44.0	443.9	554.0	350.2	39.1	1,467.6GWh
2007	46.9	39.9	416.7	542.5	340.2	43.4	1,429.7GWh
2008	53.2	38.1	421.2	518.5	323.3	46.9	1,401.2GWh
2009	50.5	42.1	418.2	463.5	318.6	49.1	1,341.9GWh
2009 (%)	**4%**	**3%**	**31%**	**35%**	**24%**	**4%**	**100%**

2.2.2 Current Anglesey Electricity Consumption

The base electrical consumption data for the Anglesey is provided to DECC at Meter Point Administration Number (MPAN) level by the data aggregators, agents of the electricity suppliers. These agents collate and aggregate electricity consumption levels for each MPAN[3].

Table 4 shows past domestic and non-domestic electricity consumption within Anglesey. These figures do not include energy use for transport.

Table 4: Anglesey electrical consumption, 2005 - 2010

Year	Domestic Electricity Customers		Commercial and Industrial Customers		Sales per Customers	
	Sales (GWh)	MPANs (Thousands)	Sales (GWh)	MPANs (Thousands)	Average Domestic Consumption (kWh)	Average C&I Consumption (kWh)
2005	179	33.0	172	4.0	5,441	43,206
2006	175	33.2	175	3.9	5,286	44,424

[2] DECC (2012) *Sub-National Electricity Consumption Data.* Available from: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/electricity/electricity.aspx [Accessed 08 August 2012].

[3]DECC (2012) *Sub-National Electricity Consumption Data.* Available from: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/electricity/electricity.aspx

2007	176.1	33.5	164.1	4.0	5,251	41,183
2008	162.7	32.4	160.6	3.6	5,028	44,812
2009	165.7	34.1	152.9	3.7	4,857	41,423
2010	166.8	34.3	153.0	3.7	4864	41,790

This information represents normal direct sales from the national grid. It is assumed that Anglesey Aluminium figures are not included.

It is important to note that changes in data collection methods and variation in data quality means that caution should be taken when comparing differences in electricity consumption using this data. However, it can be used to give an indication of the trend of electricity consumption.

2.2.3 Current Anglesey Gas Consumption

As with electricity, the principal information repository for current and historical gas consumption is the Department of Energy and Climate Change (DECC). The data is a compilation obtained from Xoserve and groups of independent gas transporters[4]. DECC hold this gas consumption information at Meter Point Reference Number (MPRN) level, together with associated information on the location of the meters.

DECC has augmented the Xoserve data with data from independent gas transporters (i.e. companies that install and own the local gas distribution pipelines between the National Grid network and, usually, recently built properties)[5]. **Table 5** shows past domestic and non-domestic gas consumption within Anglesey years 2005-2010.

Table 5: Anglesey gas consumption, 2005-2010

Year	Domestic Gas Customers		Commercial and Industrial Customers		Sales per Customers	
	Sales (GWh)	No. of Customers (Thousands)	Sales (GWh)	No. of Customers (Thousands)	Average Domestic Consumption (kWh)	Average C&I Consumption (kWh)
2005	225	14.5	317	0.2	17,659	1,601,966
2006	243	14.5	311	0.2	16,756	1,601,300
2007	237.1	14.9	305.4	0.2	15,959	1,641,828
2008	229.7	15	288.8	0.2	15,278	1,622,273
2009	207.6	15.2	255.9	0.2	13,671	1,619,679
2010	200.9	15.4	252	0.2	13,076.80	1,491,403.40

[4]Xoserve delivers gas transportation transactional services on behalf of the major gas network transportation companies and is essentially the custodian of the Annual Quantity (AQ) consumption data

[5] DECC, *Guidance Note for Regional Energy Data*. Report number: 10D/1003.

2.3 Future Energy Demand

2.3.1 Future Electricity Demand

Forecast of electricity demand for Great Britain (GB) 2010-2017 are contained within the National Grid's Seven Year Statement[6]. In order to forecast demand, it was assumed that Anglesey's proportion of electricity demand will follow the same rate as that for GB to 2021. It should be noted that this is approach does not take into account the specific drivers and expected changes on Anglesey, such as growth of manufacturing.

The Seven Year Statement presents three scenarios of varying annual electricity requirements, as **Table 6** shows.

Table 6: Great Britain annual electricity requirement forecasts

Year	Low Scenario (TWh)	Yr/ Change	Base Forecast (TWh)	Yr/Change	High Scenario (TWh)	Yr/Change
2009/2010	325.4	-	325.4	-	325.4	-
2010/2011	321.2	-1.3%	323.7	-0.5%	326.8	0.4%
2011/2012	318.9	-0.7%	323.9	0.1%	329.8	0.9%
2012/2013	315.8	-1.0%	324.2	0.1%	333.7	1.2%
2013/2014	312.6	-1.0%	325.6	0.4%	339.7	1.8%
2014/2015	312.2	-0.1%	330.1	1.4%	349.3	2.8%
2015/2016	309.0	-1.0%	329.6	-0.1%	351.9	0.7%
2016/2017	301.8	-2.4%	326.9	-0.8%	354.3	0.7%

Each scenario presents an average change in electricity demand over the seven year period, of the following; Low Scenario (-1.07%/yr), Base Scenario (0.1%/yr), and High Scenario (1.2%/yr). Consumption (demand) is recorded by suppliers, collated by DECC. Figures are reported in gigawatt-hours (GWh) [2]. In June 2009, the following local authority figures were reported via the DECC website[7]. **Table 7** converts the baseline 2010 electricity demand to the predicted demand for Anglesey based on each GB scenario to 2020 for domestic and non-domestic consumption.

Table 7: Anglesey Electricity Demand Forecasts 2011 – 2020

Year	Low Scenario (GWh)		Base Forecast (GWh)		High Scenario (GWh)	
	Domestic	Non-Domestic	Domestic	Non-Domestic	Domestic	Non-Domestic
Baseline	166.8	153	166.8	153	166.8	153
2010/2011	164.6	151.0	166.0	152.2	167.5	153.6

[6] National Grid (2012) *2011 National Electricity Transmission System (NETS) Seven Year Statement.* Available from: http://www.nationalgrid.com/uk/Electricity/SYS/current/ [Accessed 20 August 2012].
[7] DECC (2012) *Total Final Energy Consumption at Sub-National Level.* Available from: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/total_final/total_final.aspx [Accessed 20 August 2012].

2011/2012	163.5	150.0	166.1	152.4	169.0	155.0
2012/2013	161.8	148.5	166.3	152.5	171.0	156.9
2013/2014	160.2	147.0	167.0	153.1	174.1	159.7
2014/2015	160.1	146.8	169.3	155.3	179.0	164.1
2015/2016	158.5	145.4	169.1	155.1	180.2	165.3
2016/2017	154.7	141.9	167.8	153.9	181.5	166.5
2017/2018	153.0	140.3	167.9	154.0	183.7	168.5
2018/2019	151.4	138.8	168.1	154.2	185.9	170.5
2019/2020	149.8	137.4	168.2	154.3	188.1	172.6
2020 Total	**287.1**		**322.5**		**360.7**	

2.3.2 Future Gas Demand

Forecasts of gas demand for GB 2010-2020 are contained within the National Grid's Gas Transportation Ten Year Statement[8]. In order to forecast demand it was assumed that the Anglesey's proportion of gas demand will follow the same rate as that for GB to 2020. The ten year statement details two scenarios; Slow Progression and Gone Green:

- Slow Progression is consistent with forecasts in the 2009 ten year statement, taking into account forecasts of fuel prices, the economy, the impact of government energy policy and other relevant indicators.
- Gone Green is a scenario that depicts National Grid's views on the plausible energy mix under the assumption that the 2020 environmental targets are met. This scenario takes into account the same drivers as Slow Progression.

However, the fundamental aim is to meet the 2020 environmental targets and the unilateral UK GHG emissions target (34% reduction by 2020). It takes a holistic approach to the meeting of the targets i.e. assumes that heat and transport will contribute towards the environmental target of 15% of UK's energy to come from renewable sources by 2020. It therefore reflects the approach taken by the UK Renewable Energy Strategy[9].

Table 8: Gas demand forecast for Great Britain[10]

Year	Slow Progression Scenario (TWh)	Gone Green Scenario (TWh)
2011	982,672	1,453,921
2012	987,798	1,433,779
2013	1,000,558	1,449,176
2014	992,641	1,448,085
2015	968,011	1,447,561
2016	977,489	1,424,277
2017	971,718	1,413,231

[8] National Grid Gas Transportation Ten Year Statement, December 2010.

[9] The UK RES identified that to meet a target of 15% renewable energy by 2020, 12% of the UK's heat will need to come from renewable sources.

[10] Excluding export demand

2018	957,910	1,403,747
2019	960,457	1,339,532
2020	943,013	1,309,841

The percentage change for each scenario up to 2020 based on GB statistics have been calculated and incorporated into the gas demand figures for the Isle of Anglesey, **Table 9.**

Table 9: Anglesey Gas Demand Forecast 2011-2020

Year	Slow Progression		Gone Green	
	Domestic (GWh)	Non-Domestic (GWh)	Domestic (GWh)	Non-Domestic (GWh)
Baseline	**200.9**	**252**	**200.9**	**252**
2011/2012	201.9	253.3	198.1	248.5
2012/2013	204.5	256.5	200.2	251.1
2013/2014	202.9	254.5	200.0	250.9
2014/2015	197.7	248.0	200.0	250.8
2015/2016	199.6	250.4	196.7	246.7
2016/2017	198.5	248.9	195.2	244.8
2017/2018	195.6	245.3	193.8	243.1
2018/2019	196.1	246.0	184.5	231.5
2019/2020	192.5	241.4	180.4	226.2
Total 2020	**433.9**		**406.6**	

2.3.3 Comparison between Future Energy Demand and Current Energy Demand

Table 10 compares the 'best' (i.e. low consumption) and 'worse' (i.e. high consumption) case future energy demand scenarios and provides electricity and gas forecasts for Anglesey in 2020.

Assessing the future demand against current demand reveals that the low consumption scenario energy demand is projected to decrease by 10.2% on 2010 levels. Projections under the high consumption scenario conversely reveal a potential energy demand increase of 2.8 % on 2010 levels.

Table 10: Forecasted energy demand 2020

Demand scenario	GWh		GWh	Total GWh
Gas Scenario		Electricity Scenario		
Slow Progression	433.9	High Scenario	360.7	794.6
Gone Green	406.6	Low Scenario	287.1	693.7

2.4 Existing Renewable Energy Generation in Anglesey

2.4.1 Introduction

When considering renewable energy schemes, it should be noted that the installed generating capacity of a renewable energy scheme is not the same as the actual amount of energy generated. Some renewable technologies (e.g. wind power) are intermittent due to the natural fluctuations of wind speed and are not in operation and therefore not generating energy all of the time. In order to calculate the actual amount of energy produced during a given period, a Capacity Factor is usually applied.

The capacity factor is the ratio of the energy generated over an extended period, (typically a year to take account of seasonal effects), compared to the energy that could have been generated if the plant had operated at full capacity all of the time. The capacity factor is normally applied to wind farm developments on a regional scale rather than an individual site basis. The calculation for the Capacity Factor:

Capacity Factor	Electricity generated during the period [kWh] ÷ (Installed Capacity [kW] x Number of hours in the period [hours])[11]

The Welsh Government derived a series of capacity factors which reflect the amount of electrical/heat output from each of the different technologies across Wales[12]. A summary of different capacity factors for different technologies is given in **Table 11** and **Table 12**. Most energy generating plants operate at a capacity factor of less than 100%. For conventional plant this may include requirements for maintenance periods, faults or variations in consumer demand.

Table 11: Renewable Electricity Generation Capacity Factors, 2010

Technology	Capacity factor	Comments and source
Onshore wind	0.27	DUKES 2009, figure for 2008[13]
Biomass (animal and plant matter)[14]	0.9	Typical for gas and coal fired power stations
Hydropower	0.37	DUKES 2009, figure for 2008
Energy from Waste	0.9	Typical for gas and coal fired power stations
Landfill gas	0.60	DUKES 2009, figure for 2008,
Sewage gas	0.42	DUKES 2009, figure for 2008
Microgeneration	0.1	This is an average for PV and micro and small wind
Tidal	0.25	Welsh Government, 2010[15]

[11] DTI, (March 2006) *Energy Trends* [online]. (pg. 28-32), [Accessed July 2012].
[12] Welsh Assembly Government, (2010) *Practice Guidance: Planning for Renewables and Low Carbon Energy - A Toolkit for Planners*. Cardiff
[13] Table 7.4, DECC (2012) *Digest of United Kingdom Energy Statistics (DUKES)*. Available from: http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx [Accessed July 2012].
[14] i.e. This should be applied to both generation from energy crops, as well as generation from AD of animal slurry and/or food waste
[15] Appendix 1, A Low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement, March 2010

Table 12: Renewable Heat Generation Capacity Factors, 2010

Technology	Capacity factor	Comments and source
Heat from CHP (from biomass or energy from waste, or from large scale heat only biomass or energy from waste)	0.5	This allows for the fact that not all of the waste heat can be usefully used 100% of the time.
Microgeneration heat (solar water heating, heat pumps, biomass boilers)	0.2	This is an average across a range of technologies, covering heat pumps, wood chip and pellet boilers and solar water heating.

2.4.2 Current Renewable Energy Generation

Information has been obtained for Anglesey regarding renewable energy schemes within the County as of April 2012 that are operational. Please refer to **Table 13**.

Table 13: Anglesey, Current Renewable Energy Installed, August 2012

Scheme	Technology	Installed Capacity (MWe)	Status	Source
Trysglwyn Wind Farm	Onshore Wind	5.6	Operational	DECC [16]
Llanbabo Wind Farm	Onshore Wind	20.4	Operational	DECC
Rhyd-y-Groes Wind Farm	Onshore Wind	7.2	Operational	E.ON
Domestic Onshore Wind	Microgeneration	0.028	Operational	Anglesey
Non-domestic Onshore Wind	Microgeneration	0.025	Operational	Anglesey
Domestic PV	Microgeneration	1.498	Operational	Ofgem[17]
Non-domestic PV	Microgeneration	0.096	Operational	Ofgem
Total	-	**34.85**	-	-

2.4.3 Future Renewable Energy Generation in Anglesey

As part of the study, consideration has been given to renewable energy schemes which will generate electricity into the grid in the near future and those schemes which are currently being considered in the planning system. Table 14 represents renewable energy schemes that have been approved and are waiting to be constructed.

Table 14: Approved Renewable Energy Schemes in Anglesey (August 2012)

Scheme	Technology	Capacity (MWe) to be installed	Status	Source
Ysgellog Farm Wind Farm	Onshore wind	4.6	Awaiting construction	DECC
Mona Industrial Estate (AD)	Biomass – Dedicated	0.2	Awaiting construction	DECC

[16] Department of Energy and Climate Change (DECC) https://restats.decc.gov.uk/cms/planning-database/, [Accessed July 2012]
[17] Ofgem, Feed-in-Tariff Installation Report 31 March 2012, http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=33&refer=Sustainability/Environment/fits, [Accessed 10 May 2012]

Domestic onshore wind	Microgeneration	0.01	Consent Granted	Anglesey
Non-domestic onshore wind	Microgeneration	0.03	Consent Granted	Anglesey
Total	**-**	**4.84**	**-**	**-**

In addition, there are two major proposed schemes that it is useful to be aware of:

- A proposed 299MW biomass plant near Holyhead (Lateral Power)
- A proposed 10.5MW tidal array between Skerrier and Carmel Head (SeaGen Wales). Whilst this is offshore, it has been included here to provide consistency with a similar report for Gwynedd.

In addition, a new 3.3GW nuclear power is planned at Wylfa. Whilst this is not a renewable energy(and therefore outside the scope of this report), it is included here for completeness.

2.5 Summary and Analysis

Using the available information of current total energy demand (Section 2.2) and current renewable electricity generation **Table 13**, it is estimated that approximately **6%** of Anglesey's total energy demand is currently provided by renewable energy. This provides a baseline for Anglesey to build on.

3 Renewable Energy Resource Assessment

3.1 Introduction

The assessment of existing and potential renewable and low carbon energy capacity in Anglesey is based upon the total practically available resource within each of the given areas identified within the methodology, as set out in Chapter 1. This part of the assessment does not, in general, take into account existing market or policy constraints. The actual available resource for additional renewable capacity in some cases therefore might be slightly lower that the assessment suggests and will need to be considered in light of any current or future constraints.

3.2 Wind Energy

3.2.1 Wind Clusters

Overview

The UK has one of the largest potential wind energy resources in Europe. Onshore wind is one of the most established, large scale sources of renewable energy in the UK, particularly Wales. As part of this assessment, onshore wind developments have been assessed against several spatial constraints.

Main Assumptions

The analysis of the commercial scale onshore wind resource potential relates to GIS constraints mapping. The key considerations are as follows[18]:

- Annual average wind speeds (above 6m/s);
- Environmental and heritage constraints (e.g. Areas of Outstanding Natural Beauty (AONB), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar, NNR, Sites of Special Scientific Interest (SSSI), Schedule Ancient Monuments etc);
- Transport infrastructure constraints (e.g. Primary roads (A/B roads), Secondary roads, other minor roads and rail);
- Existing dwelling and associated noise constraints (e.g. Local Land and Property Gazetteer dwellings & neighbouring Local Authority boundaries (500m buffer); and
- Aviation and radar constraints (e.g. Civil Air Traffic Control, High Priority Low Fly Zones).

Results

Based on the use of 2MW turbines, it is possible to fit 5 turbines of this size into 1km² (or 100ha)[19], which equates to a potential installed capacity of 10MW/km². It should be noted that this figure lies towards the upper limit of average installed capacity per unit area for Welsh wind farms.

[18] Please note that further information can be found within the Welsh Toolkit on the approach to this assessment, *Project Sheet B*.

[19] This assumes spacing between turbines of 4 blade diameters perpendicular to the prevailing wind direction, and 6 blade diameters downwind.

To calculate potential MW installed capacity, land area without constraints is multiplied by 10MW/km². The results of which are shown in **Table 15.** A capacity factor of 27% has been used in line with the Welsh Toolkit.

Table 15: Wind Priority Capacity

Wind Cluster	Unconstrained Area (km2)	Estimated Resource (MW)	Potential Annual Generation (GWh)
1	0.28	2.80	6.62
2	1.40	13.98	33.05
3	1.11	11.06	26.17
4	1.87	18.69	44.21
5	2.44	24.42	57.77
6	0.68	6.84	16.18
Total	**7.78**	**77.8**	**184**

The location of this available land area is shown on Figure 3.1 below. It should be noted that all of Anglesey is classified as a "regular military low flying area", where consultation with the Ministry of Defence (MoD) may be required and mitigation may be necessary to resolve concerns.

It should be noted that this approach only considers potential new wind turbine sites, and does not allow for the potential re-powering of existing sites, which may present opportunities in Anglesey.

3.2.2 Micro wind

Overview

Small-scale wind installations differ from large scale by the size and scale, generally comprising single turbines supplying on-site developments primarily. Small-scale wind potential is assessed as a function of the number of properties in a region with a number of assumptions made.

Assumptions

The potential of small-scale wind developments includes the following considerations but does not consider any site specific constraints[20].

- Average annual wind speeds at 10m above ground level (above 4.5m/s); and
- Categorisation of properties into Urban, Suburban and Rural at LSOA level using the Defra Rural-definition dataset.

A capacity factor of 10% has been used, in line with the figure for microgeneration.

Results

Based on the use of 6kW turbines the estimated resource available for micro scale wind is shown in **Table 16**. The distribution of suitable properties is shown in Map Figure 3.2. It should be noted that this analysis does not take into account the location of any existing micro-wind developments.

Table 16: Potential micro-wind resource

	Number of properties	Estimated resource (MW)	Potential annual generation (GWh)
Residential	16,217	97.3	85.2
Non-residential	3,693	22.2	19.4
Total		**119.5**	**104.6**

[20] For more detail please refer to Table 3-2 in the DECC Methodology.

3.3 Biomass

Biomass is a flexible resource, which through various conversion processes can be applied to meet a variety of types of energy demand, including transport, heat or power. However, biomass resources are limited, and the precise level of their future availability is uncertain. Deciding how best to use limited biomass resources is influenced in part by the comparative efficiency of the conversion processes which are used. Another important factor is the relative value to the wider energy system of having biomass in one form or another. This latter factor will be influenced by developments elsewhere in the energy system.

Generally, biomass fuel can arise from plants (woody or grassy), animals (manure, slurry) and human activity (commercial, industrial and municipal waste). All of these options are considered within the study. In most cases, the useful fuel is in a solid or gaseous form. Bioliquids (i.e. liquid fuel for energy purposes other than for transport) are also available and varied, however they are not directly included in this study as (1), they compete with the other biomass fuel categories for natural resource (productive land or bio waste) and therefore are not an additional resource, and (2) they often need to be imported to meet commercial scale demand (e.g. palm seed oil), for which district resource assessment is not appropriate.

Biomass from outside the county has been excluded from this assessment to avoid double counting of resource availability in multiple locations. However, the planned biomass plant near Holyhead is noted, and will provide an important resource for Anglesey.

3.3.1 Plant Biomass

There are two types of 'clean' plant biomass which have been considered in this assessment; managed woodland and dedicated energy crops.

The nature of the fuel resource is such that direct combustion is seen as the most viable approach to conversion to useful energy from economic and carbon perspectives, although other approaches are also available, such as pyrolysis and gasification.

3.3.1.1 Managed Woodland

Overview

Managed woodland covers the production of wood from Forestry Commission (FC) and privately owned woodlands. Wood produced from woodland has a high demand and a significant proportion is unavailable for use as an energy source due to competing uses such as chipboard production[21].

[21] Forestry Commission Detail on Resource: Non-forecastable brash – Long term contracts are in place that use all of this resource within South Wales, however there are opportunities for new interested markets. A new contract for this resource across the whole of Wales is currently being drafted and is due for release in October 2012. The FC will be trialling a resource study over approximately the next 5 months which will assess future quantities of this resource within South Wales. Poor Quality Final Crops – this is sometimes retained by the FC and used as biofuel to supply existing long-term market contracts. Several long term

Results

This analysis was carried out by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU)[22], and the results are set out in **Table 17** below.

Table 17: Potential Managed Woodland Resource

Outputs	Woodland
Available area [ha]	2,852 (Forestry Commission Wales owned = 2,397)
Usable area [ha]	2,852
Yield [odt per ha]	1,711
Required odt per 1MWt	6,000
Potential installed capacity [MWt] from boilers	**2.6 MWt**

3.3.1.2 Energy Crops

Overview

In this assessment Energy Crops refers to those plants grown and harvested intentionally for energy production. Such crops often include Miscanthus and Short Rotation Coppice (SRC) on which the assessment is based. SRCs are often poplar or willow and are harvested usually every 3 years.

These crops require suitable agricultural land and a well-established supply chain to provide certainty to farmers of a market. Inappropriately located large scale biomass crop growth may have an impact on local hydrology, ecology (including bird populations) and landscape character. Competing pressures for agricultural land in Anglesey d may restrict the achievement of the full potential of energy crop growth.

Miscanthus and SRC may be pelleted or combusted directly to produce electricity, heat or both within a CHP scheme. This could be used within a medium to large scale scheme installed within Anglesey or could be available for purchase by owners of small biomass boilers or stoves which are generally installed within homes as an alternative to conventional gas or electric hot water and space heating.

Results

Table 17 shows the accessible energy crop scenario with regards to land availability. The Welsh Toolkit suggests 10% of the total suitable land area could be planted with energy crops. This analysis was carried out by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU)[23], and the results are set out in **Table 18** below.

contracts exist for sales of small roundwood. There is also an opportunity for any buyers to bid every 2 months via the FC's 'Esales' system.

[22] These calculations have not been checked by Arup

[23] These calculations have not been checked by Arup

Table 18: Energy Crop Resource

Outputs	Energy crops
Available area [ha]	53,148
Percentage of area that can be used	10%
Usable area [ha]	5,315
Yield [odt per ha]	63,780
Electricity	
Required odt per 1MWe	6,000
Potential installed capacity [MWe]	10.63
Heat from CHP	
Potential installed capacity [MWt]	21
Heat-only option	
Required odt per 1MWt	660
Potential installed capacity [MWt] from boilers	97

3.4 Energy from Waste

Overview

Solid Waste includes the residual waste that is not currently recycled or composted within Anglesey; this resource is split into Commercial and Industrial Waste (C&IW) and Municipal Solid Waste (MSW). All baseline data has been collected by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU).

Main Assumptions

The resource assessment follows a three stage process:

- Establishing the quantity of residual MSW and C&IW in Anglesey
- Establishing the potential generation capacity; and
- Establishing the biodegradable element (the renewable energy fraction).

Results

Table 19 provides a breakdown of the MSW and C&IW available within Anglesey.

Table 19: Quantity of MSW and C&IW yield

Total tonnes of Municipal Solid Waste available (2010-2011)	Total tonnes of Commercial and Industrial Solid Waste available (2007)	Percentage available for energy recovery according to Welsh toolkit assumptions	Tonnes available for energy recovery (tonnes/annum)
42,154	84,380	30	37,960

For the purposes of this resource assessment, it has been assumed that the residual waste resource is used for Combined Heat and Power (CHP) biomass facilities and therefore the same assumptions as managed woodland apply. The resource potential is shown in **Table 20.**

Table 20: MSW and C&IW resource potential (total)

Source	Waste for energy recovery (tonnes)	Tonnes of waste per 1MWe	Estimated Resource		Potential Annual Generation	
			Electricity (MW)	Heat (MW)	Electricity (GWh)	Heat (GWh)
MSW and C&IW	37,960	10,320	3.7MWe	7.4MWt	29.0 GWh	32.4 GWh

The Welsh Toolkit suggests that an assumption of 30% of the power and energy output of any waste facility would count as renewable. Therefore, the final resource output per annum for residual waste is shown in **Table 21**

Table 21: MSW and C&IW resource potential (renewable element)

Source	Estimated Resource		Potential Annual Generation	
	Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
MSW and C&IW	1.3 MWe	2.6 MWt	10.1 GWh	20.3 GWh

3.5 Anaerobic Digestion

Overview

Wet organic wastes comprise manure and slurry from the keeping of livestock and also wastes produced by the broader food and drink industry. These wastes are typically converted to energy through Anaerobic Digestion (AD) resulting in bio-gas which can be combusted for a heat and power generation. This assessment is based on the waste resource available as manure from cattle and pig farming.

3.5.1 Animal Manure

Overview

Animal manure (from both cattle and pigs) produces slurry which can be converted to energy through Anaerobic Digestion (AD).

Results

This analysis was carried out by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU)[24], and the results are set out in **Table 22** below.

Table 22: Wet organic waste resource potential

Livestock	Cattle	Pigs
Number	57116	3631
Available resource per head per year [wet tonnes]	85,674	544.65

[24] These calculations have not been checked by Arup

Electricity		
Total wet tonnes required per MWe	225,000	225,00
Potential installed capacity [MW]	0.4	0
Heat from CHP		
Potential installed capacity [MW]	1.1	0

3.5.2 Poultry Litter

Overview

Poultry litter can be converted to energy through direct combustion or through anaerobic digestion.

Results

This analysis was carried out by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU)[25], and the results are set out in **Table 23** below.

Table 23: Available resource from poultry litter

Poultry	Existing Resource
No. of birds from mass producing farms [>10,000]	1,784,300
Litter [tonnes] / 1,00 birds/year	42
Total available litter	74,941
Electricity	
Required tonnes for 1MWe	11,000
Potential installed capacity [MWe]	6.8
Heat from CHP	
Potential installed capacity [MWh]	53,611

3.5.3 Sewage Sludge

Overview

Sewage sludge is a waste produced by wastewater treatment plants. Sewage sludge is treated using a variety of digestion techniques, the purpose of which is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic and aerobic digestion.

Results

This analysis was carried out by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU)[26], and the results are set out in **Table 24** below.

[25] These calculations have not been checked by Arup

Table 24: Potential sewage sludge resource

	Existing Resource
Total sewage sludge [dry solid tonnes per annum]	1959[27]
Electricity	
Required dry solid [tonnes] for 1MWe	13,000
Potential installed capacity [MWe]	0.2
Heat from CHP	
Potential installed capacity [MWt]	0.3

There is a proposed scheme to convert the existing plant at Treborth, Gwynedd from liming to digestion (Methane production). It is possible that this would provide biogas for transport within Gwynedd, rather than contributing to heat and power. Once operational, this plant would take all the sewage sludge from Anglesey and Gwynedd.

3.5.4 Food Waste

Overview

Food waste can be used to generate power through direct combustion, AD, and pyrolysis and gasification. The Welsh Government's Food Waste Treatment Programme promotes the use of Anaerobic Digestion as an appropriate mechanism to deal with Food Waste. All baseline data for this assessment has been collected by Gwynedd and Anglesey Joint Planning Policy Unit (JPPU).

Results

Table 25 sets out the potential resource from both domestic and commercial (e.g. restaurants, food processors).

Table 25: Potential Food Waste Resource

Source	Food waste (Tonnes)	Tonnes of food waste per 1MWe	Estimated Resource		Potential Annual Generation	
			Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
Domestic food waste	2,100	32,000	0.11	0.16	0.34	0.51
Tonnages of Commercial Food Waste	27,232	32,000	1.10	1.66	3.58	5.37
Total	**29,332**	**32,000**	**1.21**	**1.82**	**3.92**	**5.88**

[26] These calculations have not been checked by Arup
[27] Discussions between Gwynedd and Anglesey Joint Planning Policy Unit (JPPU) and Dŵr Cymru Welsh Water suggest reducing the sewage sludge (tonnes) figure indicated in Table 44 of the Welsh Toolkit by 15%

3.6 Hydropower

Overview

Hydropower involves harnessing the power of flowing or falling water through a turbine in order to produce electricity. The parameters determining the amount of electricity produced include the turbine generating capacity, the turbine discharge flow (the volume of water passing through the turbine at any given time, which will change depending on the time of year) and available head (the vertical distance between the point where the water is highest and the turbine). The larger the head, the more gravitational energy can be converted to electrical energy. Hydropower can also be combined with storage (pumped storage), by pumping water from a low elevation to a high elevation at times of plentiful supply of electricity for release when needed. However, pumped storage is not considered a renewable form of electricity in its own right.

The data available on the available hydropower resource is limited. We have used data from the Environment Agency's Mapping Hydropower Opportunities in England and Wales report[28] for the purposes of this study. This data looks at what are described as small scale opportunities (although the largest capacity identified is 1200MW) for existing 'barriers' (these are mostly weirs, but could also be other anthropogenic structures or natural features, such as waterfalls) to provide hydropower. This means that this assessment does not look into larger scale hydro (or pumped storage opportunities), where there may be no existing barriers in place.

Main Assumptions

Both the DECC methodology and Welsh Government Toolkit recommend the use of the results of the Environment Agency's Mapping Hydropower Opportunities in England and Wales report[29] to identify the total resource and the portion of that resource which is accessible and viable.

It is noted that the methodology used in the Environment Agency's Mapping Hydropower Opportunities in England and Wales report is based mainly on identifying low head barriers as potential sites, and therefore underestimates the resource in Anglesey, where most of the potential resource is in high head sites. However, limited other sources of information make this the best available data.

Opportunities identified in the Environment Agency (EA) study were classified according to an environmental sensitivity-hydropower potential matrix. In a separate exercise, a subset of the barriers were identified as potential sites which include those barriers which have the potential to provide a good hydropower opportunity as well as increasing the status of the associated fish population (e.g. by improving fish passage).

The EA study suggests there are of potential hydropower opportunities or 'barriers' in Anglesey, accounting for a total of 0.3MW of installed capacity. However, the report also concludes that a number of opportunities are highly sensitive from an environmental perspective. The sensitivity of a site is determined by the presence of a SAC or predicted fish populations.

[28] Environment Agency, (2010) *Mapping Hydropower Opportunities in England and Wales* [online] [Accessed 19 April 2012]
[29] Environment Agency, (2010) *ibid* [online] [Accessed 19 April 2012]

Results

Table 26 details the potential accessible resource for small scale hydropower that has a low environmental sensitivity. A capacity factor of 37% has been followed in line with the Welsh Toolkit.

Table 26: Potential accessible hydro energy in Anglesey

Resource	Estimated resource (MWe)	Potential Annual Generation (GWh)
Small scale hydro	0.09	0.29

A map showing these opportunities is shown below, with those of high environmental sensitivity greyed out.

3.7 Heat Opportunities

Overview

District heating schemes can have an important role to play in reducing CO_2 emissions through utilisation of centralised higher efficiency plant. They are most likely to be viable when they meet one or more of the following criteria;

- There is waste heat available locally which could be used;
- There are "anchor loads" - buildings that have a high heat demand to provide the baseload for the scheme;
- It can be incorporated into a new development. It can be very expensive to retrofit district heating.

Main Assumptions

As detail of future new development is still be set out, through the Local Development Plan, no work has been done to consider the potential opportunities in relation to that.

LLPG data has been examined, alongside the Carbon Reduction Commitment (CRC Energy Efficiency) league tables[30] and participants list[31] to identify large energy users in Anglesey, which might be able to act as anchor loads.

Conclusions

There appears to be a concentration of large heat users around Llangefni. Further work could be undertaken to investigate the feasibility of a heat network in this area.

In the medium term, the biggest producer of waste heat is likely to be the planned 299MW biomass plant. It has been reported that this waste heat is likely to be used to create a specialist fish farm[32], but further work could be done alongside Lateral Power to understand if there might be further opportunities to use this waste heat effectively.

3.8 Microgeneration

Microgeneration typically refers to renewable energy systems that can be integrated into buildings to primarily serve the on-site energy demand. They are applicable to both domestic and non-domestic buildings and can be connected to the grid, although this is not essential as the majority of the output is often used on-site. Thus microgeneration systems are typically designed and sized either in relation to the on-site demand or in proportion to the physical constraints on-site such as available space or access to the resource in question.

[30] CRC Energy Efficiency Scheme, League Table 2010-11 http://crc.environment-agency.gov.uk/pplt/web/plt/public/2010-11/CRCPerformanceLeagueTable20102011 [accessed 20th August 2012]
[31] CRC Energy Efficiency Scheme, List of Registered Participants, November 2011, http://www.environment-agency.gov.uk/static/documents/Business/Registered_Participants.xls [accessed 20th August 2012]
[32] As reported by Wales Online, http://www.walesonline.co.uk/news/local-news/holyhead/2012/07/17/job-threat-to-metal-workers-on-anglesey-91466-31408629/ [accessed 22nd August 2012]

Microgeneration technologies cover the full range of renewable energy categories: wind, solar, biomass, hydropower and heat pumps. Technologies that directly depend on the built environment capacity to take micro-generation systems are:

- Solar - i.e. solar water heating (thermal) and solar photovoltaics (electric); and
- Heat pumps - i.e. ground source heat pumps and air source heat pumps.

3.8.1 Solar

Overview

Micro-scale solar panels are either solar thermal creating renewable heat from solar energy or photovoltaic which produce electricity from solar energy. Solar Thermal Panels are usually used within buildings to heat water and sometimes for space heating. When used in conjunction with a hot water tank Solar Thermal heat can be stored whereas solar electricity either needs to be used immediately or exported to the grid.

The energy generated by solar will depend upon the number of suitable sites; the take-up and installation rates; and the size, efficiency and load factor of the solar panels. It is also recognised that a high deployment rate of solar PV could result in grid instability.

Main Assumptions

The assessment considers residential and non-residential properties. Data is taken from the 'Local Land and Property Gazeteer' (LLPG). The DECC methodology makes an assessment of non-residential buildings in terms of Commercial or Industrial. Data of this detail was not available for Anglesey and therefore all non-residential buildings are included. The assessment assumes 2kW panels are suitable for residential properties and 5kW for non-residential properties. Not all properties are suitable for solar panels as they should be installed in a south facing position at angle of approximately 30 degrees[33]. It is therefore assumed that 25% of existing dwellings will be suitable and 40% of existing non-dwellings. Looking forward, information has been derived from Welsh Government's local household projections for Wales[34]. This suggests that there will be an additional 2,137 households by 2020.

Results

The resulting figures are shown in the table below. A capacity factor of 10% has been assumed to calculate annual output.

[33] Energy Saving Trust (2012) *Choosing a Site, Planning Permission, and Installation,* Available from: http://www.energysavingtrust.org.uk/Generate-your-own-energy/Solar-panels-PV/Choosing-a-site-planning-permission-and-installation [Accessed 19 April 2012].
[34] Household Projections for Wales - Headline Statistics by Local Authority - 2006-2031 NS, http://www.statswales.wales.gov.uk/TableViewer/tableView.aspx [accessed July 2012]

Table 27: Potential Solar Resource Available

Type of Property	Number of Properties with Suitable Roofs for Solar	Estimated Resource (MW)		Potential Annual Generation (GWh)	
		Electricity	Heat	Electricity	Heat
Domestic Properties by 2020 [2kW]	9,478	18.96	18.96	16.61	16.61
Non-residential properties [5kW]	2,926	14.63	-	12.82	-
Total		**33.59**	**18.96**	**29.42**	**16.61**

3.8.2 Heat Pumps

Overview

Heat pumps are a renewable technology because they extract heat from their surroundings. The most common types are Ground Source Heat Pumps (GSHP) and Air Source Heat Pumps (ASHP) but heat can also be recovered from water sources. ASHP units are usually fitted to the side of a property at ground level.

GSHPs require pipe work sunk into the ground either via a vertical bore hole or a horizontal network of pipes across a large area of land. Because of this GSHPs are more difficult to retrofit and are more suited to large properties or those with large gardens.

Main Assumptions

Both ASHP and GSHP use a small amount of electricity to run the pumps to generate electricity. This is generally a third or quarter of the energy produced and is described as a coefficient of performance (CoP). The Heat Pump association assume a CoP of 4 to1;35 generating 4kW for every 1kW used. This is therefore used to calculate the renewable energy element of this technology.

However, this will vary between GSHP and ASHP, the type of system used and environmental conditions. There have been various studies into why the CoP is so variable in recent years (e.g. DECC and EST, *Detailed analysis from the first phase of the Energy Saving Trust's heat pump field trial*. 2012). Whilst certainty about the CoP is improving, we have not applied a capacity factor has not been to this technology.

[35] Heat Pump Association *Facts about Heat Pumps,* Available from: http://www.heatpumps.org.uk/FactsAboutHeatPumps.htm [Accessed 19 August 2012].

The assessment considers whether properties are residential or non-residential and suitability in terms of housing type. Data is taken from the 'Local Land and Property Gazeteer' (LLPG). The assumption is that 50% of new dwellings will be suitable for one type of heat pump. The same assumption has been made in terms of numbers of new dwellings as for the solar calculations; namely 2137 new households. The DECC methodology makes an assessment of non-residential buildings in terms of Commercial or Industrial. Data of this detail was not available for Anglesey and therefore all non-residential buildings are included.

Results

Table 28 details the potential accessible heat pump resource for Anglesey.

Table 28: Potential Resource Available from Heat Pumps

Type of Property	Overall Number of Properties suitable for Heat Pumps	Capacity (MWt) [Heat]	Renewable energy element (MW) (CoP assumed is 4 to 1)
Existing Residential On-Grid Properties	10,175	51	38
Existing Residential Off-Grid Properties	18,035	90	68
Future Residential Properties	1,068	5	4
Non-residential Properties	3,658	37	27
Total	**32,936**	**183**	**137**

3.9 Tidal

Overview

Around the coast of Wales are some of the largest tides in the world with potential for substantial electricity generation. Along the coast of north Wales and including the Conwy and Dee estuaries, shallow water is present for some distance from the coast.[36]

Main Assumptions

We have taken the potential installed capacity from the Welsh Marine Renewable Energy Strategic Framework (mresf), produced in 2011[37]. This explored all large scale marine potential in Wales, and identified an area off the coast of Anglesey. In reality there is likely to be additional smaller resource available around the coast of Anglesey (e.g. in the Menai Straits), but there is no existing data available on this.

[36] Tidal energy in Wales, A note by Sir John Houghton, Chief Scientific Advisor Climate Change Consortium, of Wales, (C3W), February 2012

[37] RPS for Welsh Government, *Marine Renewable Energy Strategic Framework*, March 2011, http://mresf.rpsgroup.com/

A capacity factor of 25% has been used to estimate electricity generation from tidal power[38].

Results

Table 29 provides information on the available resource and potential electrical generation of tidal power off the coast Anglesey.

Table 29: Tidal Resource Potential

Available Resource	Potential Capacity (MW)	Potential Annual Generation (GWh)
Mresf Resource Area B	110	240.9
Mresf Resource Area G	50	109.5
Mresf Resource Area C	20	43.8
Total	**180**	**394.2**

[38] See Appendix 1, A Low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement, March 2010

4 Overview and Conclusions

It is estimated that approximately 9.1% of Anglesey's total energy demand is currently provided by renewable energy. Energy demand is predicted to increase to 2020, but there are opportunities for renewable energy to be generated to meet this demand.

As set out in **Table 30** below, the greatest potential for renewable energy associated with Anglesey is Tidal. However, as this is an offshore technology, the local planning authority has less direct influence over the ability to realise this resource.

Table 30: Summary of potential renewable energy capacity in Anglesey

Category	Sub-Category	Potential Capacity (MWe) [Electricity]	Potential Generation (GWh) [Electricity]	Potential Capacity (MWt) [Heat]	Potential Generation (GWh) [Heat]
Wind (onshore)	Wind Clusters	77.8	184	-	-
	Micro-wind	119.5	104.6		
Biomass	Managed Woodland	-	-	2.6	11.4
	Energy Crops	10.63	83.8	21	92.0
Energy from Waste (EfW)	MSW and C&IW	3.7	29.0	7.4	32.4
Anaerobic Digestion	Animal Manure	0.4	3.2	1.1	4.8
	Poultry Litter	6.8	53.6	-	
	Sewage Sludge	0.2	1.6	0.3	1.3
	Food Waste	1.21	3.92	1.82	5.88
Hydropower	Small Scale Hydropower	0.09	0.29	-	-
Microgeneration	Solar	33.59	29.42	18.96	16.61
	Heat Pumps	-	-	137	-
Tidal	Tidal	180	394.2	-	-
	Total	**433.9**	**887.6**	**190.2**	**164.4**

After tidal, onshore wind has a relatively large potential for Anglesey. However, it should be noted that all schemes will require consultation with the Ministry of Defence (MoD) and it may be that the full capacity is unlikely to be realisable.

The potential of microgeneration appears reasonably high. However, the reality of achieving this level of deployment may prove difficult to achieve quickly as it requires action to be taken by large number of individuals and organisations.

Planning policies have the most control over integration of microgeneration technologies to new development. Planning policies can also encourage and facilitate greater integration of renewable energy technologies through the appropriate retrofitting of such technologies to existing buildings.

However, some barriers to retrofit, particularly on domestic properties, remain, and it may be hard to deliver the full quotient of renewable energy that is technically available. Homeowners tend to perceive retrofit measures as disruptive, and it is often difficult to achieve uplift in property value as a result of the initial investment. However, initiatives such as the Green Deal may be expected to overcome some of these barriers.

There will also be wider issues relating to the deployment of renewable energy, which may mean that deployment of the technically realisable potential takes time. It is beyond the scope of this report to consider these constraints in detail. However, from our experience elsewhere, the following are seen to be some of the most significant factors, which a positive and proactive approach in Anglesey could help to overcome:

- Financial issues, such as the ability to raise capital;
- Public perception - there is a lack of urgency around the public's perception on the need to act to tackle climate change. Particularly in relation to larger schemes, negative perception of some member of the public to renewable energy schemes can lead to a delay in deployment;
- Readiness of the supply chain for some technologies – this will apply more to technologies such as wave and tidal, where the technology and supply is younger;
- Real and perceived grid issues - some of this is related to perception; the DNO will explore options of how to connect to the grid for any proposed development. It is expected that the proposed transmission infrastructure, as discussed below will help to address this issue in Anglesey.

Other planned developments that may be important for Anglesey's renewable energy industry and supply chain include;

- National Grid's proposed transmission infrastructure improvements to accommodate 7GW+ of renewable and low carbon energy
- The proposed 4.2GW offshore wind array in the Irish sea (Centrica)

These, coupled with other proposals as outlined above (tidal and biomass), would (since proposed) provide significant contributions to Anglesey's economy and may provide local skills and expertise, and the requisite infrastructure, which contribute to making further renewable energy projects easier to get off the ground.

Anglesey Energy Island is an important local partnership, and is likely to be instrumental in achieving deployment of renewable energy within the County. It is therefore recommended that any further work undertaken by the planning authority should involve this group to ensure a joined up approach to renewable energy on Anglesey.