Gwynedd Council

Scoping Renewable Energy Opportunities in Gwynedd

Final Report

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1 Introduction

1.1 Gwynedd Werdd

Gwynedd Council's Economy and Regeneration Programme Board has prioritised Gwynedd Werdd in order to achieve the objectives of Result 1 in their Three Year Plan: 'Economic Prosperity – The economy of Gwynedd will prosper'.

Gwynedd Council has a vision that Gwynedd will thrive in the future – with economically and socially enterprising and vibrant sustainable communities, where the Welsh language is central to its prosperity, and where people of all ages can take advantage of new opportunities and choose to stay in the area to live and work.

Gwynedd Werdd has been developed as part of a package of programmes to achieve this vision. Gwynedd Werdd's aim as part of the wider vision is promote "more self-sufficient sustainable communities, maximising the economic benefits from natural resources, local produce and services."

This is a long term aim, but action has been taken in the short term to promote:

- Renewable and Low Carbon Energy
- Local Produce
- Sustainable Transport
- Local Procurement

This report forms part of the action on the first of those four short term priorities.

1.2 Aim of the Study

Arup has been commissioned by Gwynedd Council, on behalf of Gwynedd Werdd to scope the renewable energy opportunities for Gwynedd.

The prime objectives of the scoping exercise are:

i. To determine the economic potential of renewable energy opportunities in Gwynedd;

ii. To highlight barriers to achieving the economic potential of renewable energy opportunities in Gwynedd; and

iii. To determine work streams and actions needed to overcome the barriers identified.

The scope of the study specifically excludes consideration of low carbon generation, energy efficiency measures, and of energy related to transport. This does not mean that these areas (and others) could not contribute to creating jobs and tackling climate change in Gwynedd, but this study is to consider renewable electricity and heat only.

1.3 Gwynedd Context and Study Area

Gwynedd is a predominantly rural area, with a unique high quality natural environment, with a population of 121,900 (census 2011).

There are a number of constraints imposed by designated landscapes in Gwynedd. A large proportion of the area of Gwynedd has been designated a landscape of national importance – the Snowdonia National Park and the Llŷn Area of Outstanding Natural Beauty – and there are many designated Sites of Special Scientific Interest and National Nature Reserves. Approximately 90% of the county's coastal waters – Pen Llŷn and Sarnau and the Menai Straits – have been designated by the European Commission as maritime sites of international importance – Special Areas of Conservation.

Approximately 63% of Gwynedd land area falls within Snowdonia National Park. One of the main purposes of Snowdonia National Park is the conservation and enhancement of the natural landscape, wildlife and cultural heritage of the National Park.

The resource assessment and detailed economic analysis focuses on that which is available within the Local Authority boundary, including the area which is situated within Snowdonia National Park, and on the tidal opportunities off the coast at the end of the Llŷn peninsula. However, it is recognised that there will be wider economic opportunities as part of the supply chain to renewables projects planned for further afield. Some of these wider opportunities for cross-boundary collaboration are considered as part of the action plan.

1.4 Study Method

This study was carried out by Arup between March and August 2012. The work was a combination of desk-based research, workshops and semi-structured stakeholder interviews.

Desk-based research involved carrying out:

i. A baseline of existing policy, existing renewable energy installed, and the socio-economic context of Gwynedd;
ii. An assessment of the technically available renewable resource, using two methodologies:
    - *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 was 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").
iii. An assessment of the economic potential of the technically available resource, using The jobs per MW benchmarks are taken from a 2004 Department for Trade and Industry report entitled *'Renewable Supply Chain Gap Analysis'.*
iv. A review of barriers and constraints to deployment of renewable energy.

Two workshops were held with local stakeholder representatives from local authorities, private sector, community groups, higher education and other public sector bodies to gather their understanding of the local context, barrier and constraints and the main areas of opportunity for Gwynedd.

In addition, semi-structured interviews took place face-to-face and over the telephone with stakeholders who were unable to attend the workshops to enable their views to be incorporated.

1.5 Report Structure and Content

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

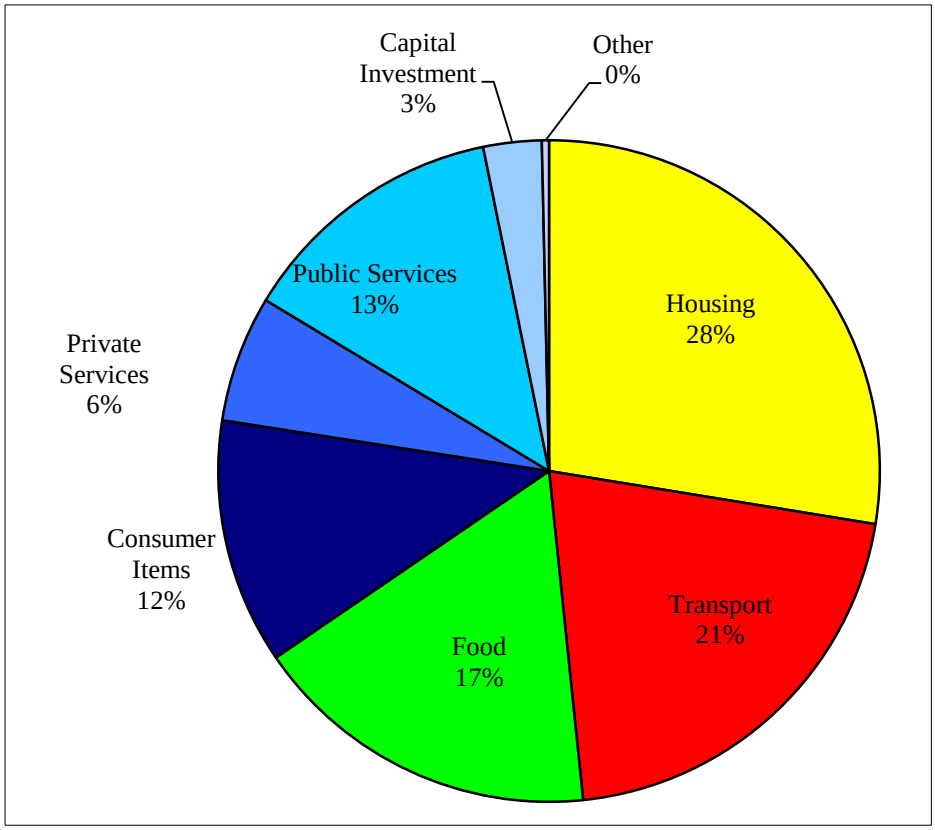
- **Chapter 2** provides a summary of existing and emerging policy frameworks relating to renewable energy and the economics of renewable energy at the national, regional and local level. In addition, the existing evidence base for low carbon and renewable energy is included.
- **Chapter 3** summarises the existing socio-economic and environmental context pertaining to renewable energy opportunities in Gwynedd.
- **Chapter 4** provides an indication of current and historical renewable energy (heat and electricity) supplies. An assessment of future energy demand forecasts are produced for Gwynedd.
- **Chapter 5** contains the renewable and low carbon resource assessment of the renewable energy sources in Gwynedd in accordance with the appropriate methodology.
- **Chapter 6** identifies indicative deployment rates and the potential installed capacity and energy generation potential for each renewable and low carbon technology.
- **Chapter 7** assesses the economic impacts based on the outputs of the capacity assessment. It provides the economic value in terms of turnover, income and gross added value to realise the economic potential that renewable energy offers in Gwynedd.
- **Chapter 8** concludes the existing and potential renewable energy resource in Gwynedd. Furthermore, this section summarises the economic constraints and opportunities of the deployment of the potential renewable energy resource in Gwynedd.
- **Chapter 9** includes the Vision and Action Plan for stakeholders across Gwynedd Werdd which will focus on particular technologies, governance and delivery structures and the next possible steps.

2 Policy Context and Existing Evidence Base

2.1 Introduction

The evidence that our climate is changing overwhelming; and the consensus of the scientific community is that it is caused by release of greenhouse gas emissions into the atmosphere due to human activity. The breakdown of greenhouse emissions for Gwynedd is set out in the chart below.

Figure 2.1: Breakdown of Greenhouse Gas Emissions for Gwynedd
(source: Stockholm Environment Institute, resource-acounting.com**)**



The section that follows includes analysis and highlights of the main economic development, renewable energy, energy and planning policies relevant to the future potential to develop renewable energy in Gwynedd. It is clear that it is the local opportunities which are the overriding concern, however, the funding and drivers from a national and international basis are important too as they provide a basis for action locally, these opportunities are summarised below.

2.2 European Policy and Context

The European Union (EU) has made renewable energy, energy efficiency and measures to achieve a transition to a low carbon economy a key priority from a policy and investment perspective.

The European policy context is set by the Europe 2020 Strategy and regulatory changes which will govern the distribution of structural funds (2014-2020[1]) which will help Gwynedd, West Wales and the whole of the country to invest in the transition to a low carbon economy.

There are a number of energy focused political, strategic, legislative and regulatory directives driven by the EU. These strategies position climate change mitigation at the heart of the European agenda and underline the need to encourage sustainable investments in renewable energy, these include:

- The Europe 2020 Strategy[2];
- The Resource Efficient Europe initiative[3]; and
- The Fifth Cohesion Report on Economic, Social and Territorial Cohesion[4]

Further detail on these can be found in appendix E.

European Regional Development Funds and in particular, the development of the new Operational Programme will trigger new funding in the 2014-2020 programming period. However, it has to be noted that largely funding is moving towards central and Eastern Europe and potentially further south and away from Western European members states. To balance this, the low carbon agenda, sustainability as well as innovation and economic development will be key areas for action.

European Investment Bank

The European Investment Bank provides an avenue to distribute EU funds and to drive forward the development of renewable energy. In particular, the JESSICA revolving fund is able to utilise ERDF grant with private finance to invest in renewables and the ELENA technical support facility[5] to access European Investment Bank funds.

The EIB state that "ELENA support covers a share of the cost for technical support that is necessary to prepare, implement and finance the investment programme, such as feasibility and market studies, structuring of programmes, business plans, energy audits, preparation for tendering procedures - in short, everything necessary to make cities' and regions' sustainable energy projects ready for EIB funding."

In summary the options for investing in renewable energy may be limited in Wales for the current programming period until 2013. This is because ELENA is premised on a first come first served basis and is a relatively limited funding pot across the EU. Also, JESSICA has been established in Wales with a focus on land and property as part of a drive for physical regeneration. Whilst JESSICA can be used for green and sustainable urban development initiatives, such as the London Energy Efficiency Fund or the Foresight Waste Fund this would have to be developed at a national level in the future for Gwynedd to benefit.

[1] The current programming period 2006-13 has a facility to spend grants and funds by the end of 2015 as long as it is agreed by 2013. Europe works on a rolling programme and the new seven year programming period is 2014-2020. One of the main criteria is that funds will largely be spent in areas with less than 75% of EU average GDP; this has seen a trend for funds to be focused in central, Eastern and potentially in light of recession and austerity in Southern European countries.
[2] See: http://ec.europa.eu/europe2020/index_en.htm
[3] See: http://ec.europa.eu/resource-efficient-europe/
[4] See: http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion5/
[5] http://www.eib.org/products/technical_assistance/elena/index.htm

Gwynedd can start planning now for funding that will become available in 2014.

2.3 UK Policy Context

At a UK level the main policy instruments to drive forward the transition to a low carbon economy are a mix of subsidy, tariffs and capital investment. These are visible within the Feed-in Tariff, Renewable Heat Incentive, Renewables Obligation and capitalisation of the Green Investment Bank.

The Carbon Reduction Commitment is subject to review in November 2012 and appears to have been weakened as a result of announcements in the budget (April 2012), unless substantial savings can be achieved.

The UK Government and the Department for Business, Innovation and Skills (BIS), working with the Department for Energy and Climate Change (DECC) and across its agencies recognise that the "transition to a green economy presents significant growth opportunities for UK-based businesses, both at home and abroad. It will require unprecedented investment in key green sectors - an estimated £200 billion is needed for the energy system alone over the period to 2020."

The UK Government has established challenging targets for carbon dioxide reductions, in line with the EU Low-Carbon Economy Roadmap, over the next 40 years to address the dangers of climate change. The challenge has currently been set at a reduction of 80% in carbon dioxide emissions (compared to those of 1990) by 2050. As of July 2009, emissions had fallen 21% below 1990 levels. Local authorities are central to the drive required to achieve these targets and are instrumental in developing the policies, strategies and plans to implement carbon reduction at a local level.

The UK Carbon Plan (2011) sets out the need for emissions from electricity to be near to zero by 2050, and reminds us that the demand for electricity is likely to increase by 30-60% due to the potential electrification of heating, transport and industrial processes. It also sets out the need for mass deployment of renewable heat by the 2020s.

The Electricity Market Reform puts in place measures to attract the £110 billion investment which is needed to replace current generating capacity and upgrade the grid by 2020, and to cope with a rising demand for electricity. In particular, the government is proposing a transitional arrangement prior to the closure of the Renewables Obligation to new generation before April 2017, when it would be replaced by contracts for difference (CfD). There have been various announcements from government about the potential reductions to ROCs in this period, which is likely to create uncertainty for developers.

Further detail can be found in appendix E.

Feed-in Tariff, Renewable Heat Incentive and Renewables Obligation

Feed-in-Tariff (FiTs) schemes were introduced in the UK on 1 April 2010, under the Energy Act 2008. FiTs encourage the deployment of small-scale (less than 5MW) low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market. The financial benefits of FiTs are:

- Generation tariff – the electricity supplier of your choice will pay you for each unit (kilowatt) of electricity you generate;
- Export tariff – if you generate electricity that you don't use yourself, you can export it back to the grid. You will be paid for exporting electricity as an additional payment (on top of the generation tariff); and
- Energy bill savings – you won't have to import as much electricity from your supplier because a proportion of what you use you will have generated yourself.

Small-scale wind, solar photovoltaic panels (PV), hydro, anaerobic digestion, domestic scale micro CHP are eligible for FiTs. FiTs work alongside Renewable Obligation Certificates (ROCs) which is the primary mechanism to support deployment of large-scale renewable electricity generation.

Renewable Heat Incentives (RHI) was introduced (for non-domestic properties) in 2011, under the Energy Act 2008. The RHI acts in a similar way to FiTs but for renewable heat rather than electricity generation.

Renewables Obligation Certificate (2009): This requires licensed electricity suppliers to source a specified and increasing proportion of their electricity from renewable sources, is the key current mechanism for incentivising renewable electricity within the UK. Licensed renewable electricity suppliers receive Renewables Obligation Certificates (ROCs) for each Mega Watt per hour (MWh) of electricity generated. These certificates can then be sold to suppliers, in order to fulfil their obligation. Suppliers can either present enough certificates to cover the required percentage of their output, or they can pay a 'buyout' price for any shortfall. All proceeds from buyout payments are recycled to suppliers in proportion to the number of ROCs they present. ROCs have increased the profitability of renewable energy generation as the certificates have an additional value over and above the price of electricity itself.

A proposal was put forward to reduce ROC payments by up to 25% by the chancellor in June 2012; this is likely to create uncertainty in the market.

Green Investment Bank

The mission of the Green Investment Bank is to "provide financial solutions to accelerate private sector investment in the green economy ... It will build the necessary deep expertise in financial markets and green investments, working towards a 'double bottom line' of both achieving significant green impact and making financial returns."

The overriding objectives of the Green Investment Bank include delivering:

- Sound finance with investments returns of 3.5% +;
- Green impact; and
- Demonstrating additionality.

Investments need to deliver a demonstrable green impact, financial return and leverage co-investment or demonstrate wider added value. This is likely to be in terms of addressing a market failure and delivering environmental, socio-economic and financial returns across the UK.

The ability to deliver effective investments is vital to create a durable Green Investment Bank, once State aid clearance is reached with the EC. The investment pipeline is being developed with an initial £775 million of direct investment in 2012. Overall, the potential exists to invest up to £3 billion by 2015 when borrowing powers will be available subject to national debt falling as a proportion of GDP.

There are a range of investment opportunities in the medium term across 15 broad sectors. The initial investment focus is within five technologies and sectors. These are waste processing and recycling, and energy from waste generation with up to £80 million of investment this year, alongside non-domestic energy efficiency, the Green Deal domestic energy efficiency scheme, and offshore wind projects.

2.4 Welsh Policy and Context

According to the Welsh Government, the energy and environment sector is important component underpinning the drive for 'Economic renewal: a new direction.'

The Welsh Government defines the energy and environment sector as including:

- Energy generation and use;
- Renewable energy;
- Emerging low carbon energy and technologies; and
- Environmental goods and services.

It flags the two main "opportunities for creating jobs for a sustainable economy ... [in]

- Delivering resource efficiency; and
- Driving forward the low carbon, low waste agenda.

The Welsh Government states that "the sector has demonstrated above average growth at the UK level. With targeted intervention, it is recognised that Wales can gain competitive advantages and benefit from growing markets within this sector.

The opportunities relating to this sector in Wales are deemed significant. For example, it is estimated that there could be £50 billion of investments in low carbon electricity production in Wales over the next 10 to 15 years.

Analysis undertaken by the Department for Business Innovation and Skills in 2011 valued the Welsh environmental goods and services sector at £5bn in 2009/10, employing over 40,000 people. Renewable energy forms part of this.

On the basis of its natural resources, existing knowledge base, academic strengths, and the presence of global players, Wales is well placed to take a leading role in the transition to a low carbon, low waste economy.

In 2009 the Welsh Government published a strategy for fulfilling the economic potential of the low carbon sector in a report entitled 'Capturing the Potential: A Green Jobs Strategy for Wales'. This report states:

"We will promote the greening of existing jobs through more efficient use of resources and stimulate new green jobs by helping to develop skills, innovation and new technologies, and strengthening the low carbon energy sector in Wales."

The strategy sets out three priorities which are: supporting business, fostering innovation and technology and investing in a more sustainable economy. The strategy

also recognises the levers which are at the Welsh Government's disposal which include leading by example, making investments, grant aid to encourage high levels of investment and through use of planning and environmental policies.

Welsh Government published *Energy Wales: A Low Carbon Transition* in March 2012, which sets out an ambition to maximise the economic benefits of renewable energy. It sets out the plan to review of all the consenting processes associated with energy. This will be a development that it will be useful for Gwynedd to keep track of. The document sets out the Welsh Government's desire to work with Bangor University and Coleg Menai to develop skills, including the transfer of skills from Trawsfynydd, as part of the Anglesey Energy Island programme. It will undoubtedly be useful for Gwynedd Werdd to work with the Anglesey Energy Island programme in this context.

Further detail on Welsh Government policies can be found in appendix E.

2.5 Gwynedd and Local Policy Context

Some of the key local policies that will impact on the delivery of renewable energy opportunities in Gwynedd are the planning policies of Gwynedd Council and Snowdonia National Park Authority.

Gwynedd Council is currently gathering evidence to produce a Joint Local Development Plan with Anglesey. There is a good opportunity for the evidence from this report to inform the development of appropriate and supportive policies to be contained within this document. Snowdonia National Park Authority is the planning authority for 63% of the land area of Gwynedd. They are currently looking to produce an SPG on renewable energy. This report may again be able to provide evidence to inform appropriate policies.

Further detail on the existing and emerging planning policies of the two authorities can be found in appendix E.

The Gwynedd and Ynys Mon Skills Strategy will also play an important role. This is set out further in section 3.

The **Gwynedd Local Services Board** includes some of the largest public sector organisations in Gwynedd. Its members are Gwynedd Council, Betsi Cadwaladr University Health Board, Snowdonia National Park, North Wales Police, North Wales Fire and rescue Service, The Welsh Government, Grŵp Llandrillo Menai and Bangor University. The Gwynedd Carbon Footprint Reduction Project is one of the Gwynedd Local Services Board's two priority projects. The purpose of the project is initially to concentrate on reducing CO_2 emissions derived from activities associated with the public sector bodies who are members of the Board and focuses on four fields:

- Energy (non-domestic buildings)
- Waste
- Transport
- Procurement

Eventually the project will be expanded to the business and community sector ensuring that the public sector leads by example. Some of the changes already made by these public sector bodies include:

- Building insulation

- Updating boilers
- Improve heat management systems within buildings
- Install solar panels
- Use greener fuel and vehicles
- Increased recycling
- Awareness raising amongst staff

This group could act as an important delivery partner for some of the actions identified in this report.

Anglesey Energy Island Framework – Potential Opportunities and Economic Impacts of the Energy Island Framework (May 2010)

This report was prepared for the Isle of Anglesey County Council and is a framework which focuses on opportunities that can play a significant role in a more resilient, diverse and prosperous economic future for Anglesey and North West Wales. 'The key elements of the Energy Island Framework are:

- **Short term**: Large and small scale biomass installations and supporting energy crops, energy efficiency measures, and micro generation. Initial discussion and negotiation to maximise opportunities from offshore wind Irish Sea round 3 zone;
- **Medium to long term:** New build nuclear power station at Wylfa of up to 3.2 GW; implementation of tidal project at Skerries; offshore wind base at Holyhead Port and the replanting of existing onshore wind farms: and
- **Long term:** Tidal power expansion and development of the hydrogen economy.'

Since the development of this strategy, workstreams have been developed to begin to deliver the vision of the Energy Island. There will be advantages to working together with Anglesey to maximise supply chain benefits for both areas, where there is an overlap in priorities. In many workstreams there is a strong mutual benefit to working together, particularly on areas where there is a cross-boundary, sub-regional impact, such as education and skills, for example.

3 Socio-Economic Context

3.1 Introduction

This section sets out the existing context in Gwynedd in order to be able to frame the path to develop these opportunities in the near and medium term. A clear understanding of the local context is crucial to enable an achievable roadmap to be set out with specific underpinning actions and accountabilities according to the resources, influence and responsibilities of each party involved.

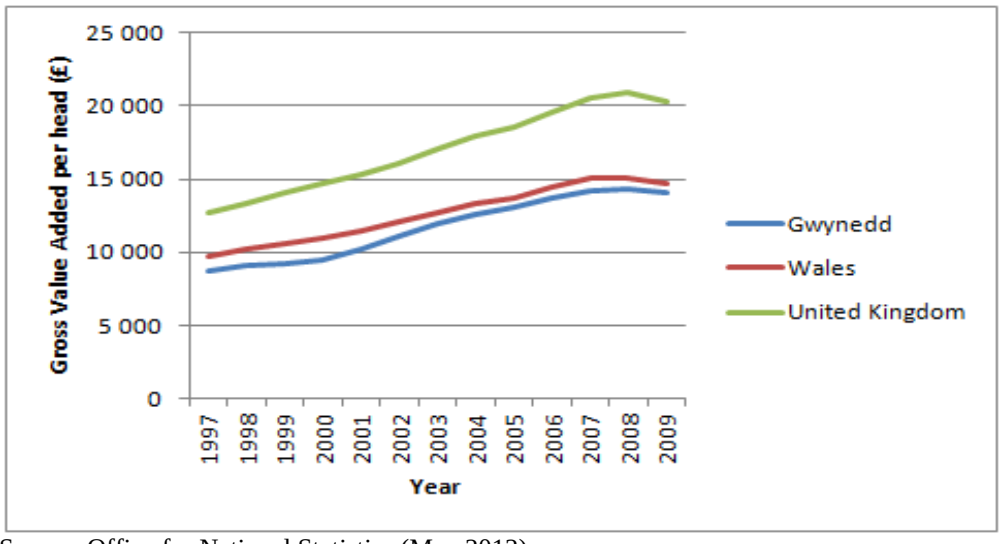
This section focuses on the socio-economic context to ensure that the action plan is predicated upon what the local area needs (which has been developed and reinforced through the local and industry consultations), building upon what strengths it has and what gaps there are that can be addressed by harnessing investment and concerted action.

In particular, where practical this section summarises the labour force capacity and capabilities with a view to realising supply chain opportunities and sections five and six brings this together with the demand side opportunities for renewable energy development in Gwynedd. It is important to note that this is not a detailed supply side assessment of the labour market and skills and training provision in Gwynedd and its travel to work area. The analysis below sets out a summary of the socio-economic profile of Gwynedd.

3.2 Gwynedd Economic Profile

Figure 3.1 shows that Gwynedd has consistently had a lower level of economic activity and output (represented by gross value added (GVA) per head) than both the United Kingdom and across Wales.

Figure 3.1 – Gross Value Added per head 1997-2009

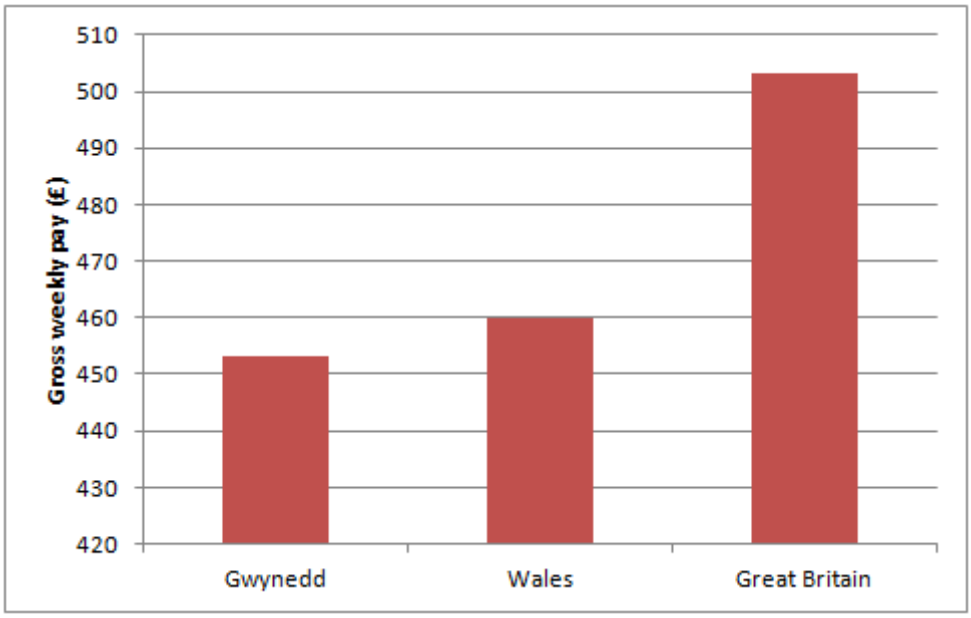


Source: Office for National Statistics (May 2012)

Whilst GVA per head for all three areas increased year on year from 1997 to 2008, the gap between Gwynedd and the United Kingdom and Wales persisted. In 2009, the latest year that data is available for Gwynedd, the GVA per head for Gwynedd was 69% of the GVA per head for the United Kingdom and 96% of the GVA per head for Wales.

In line with having a lower level of GVA, Figure 3.2 shows the median gross weekly pay of residents in Gwynedd to be lower than average wages for Wales which, in turn, is lower than the wage level in the United Kingdom as a whole.

Figure 3.2 – Median gross weekly pay (2011)



Source: Office for National Statistics (May 2012)

Figure 3.3 illustrates that the unemployment rate in Gwynedd, with the exception of 2007, had a lower rate than for Wales and the United Kingdom. However, Gwynedd has experienced an upwards trend in unemployment over the period along with the rates for Wales and the United Kingdom which corresponds with the worsening of economic conditions both nationally and internationally.

Figure 3.3 – Unemployment rate for population aged 16-64 for 2004-2010

Source: Office for National Statistics (May 2012)

A significant challenge facing Gwynedd is the loss of work as the Trawsfynydd nuclear power station is decommissioned Gwynedd needs to be in a position to offer suitable opportunities for these workers (estimated to number 600) coming onto the job market or risks these skilled workers moving elsewhere for employment. To this end, the 'Shaping the Future' programme, which began in February 2010, seeks to

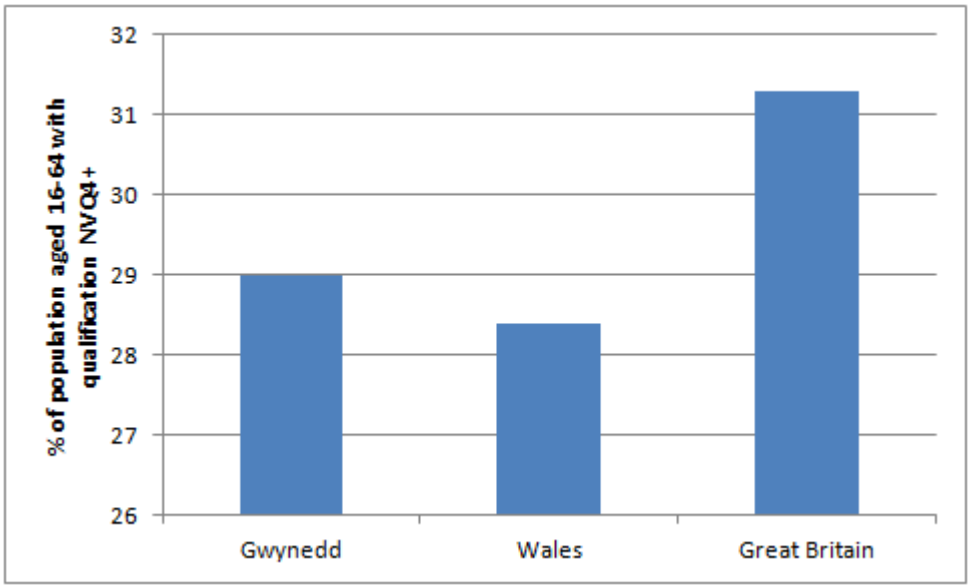
support, retrain and redeploy employees of both Trawsfynydd and Wylfa on Anglesey.

In Gwynedd there is also a tendency for young people to migrate out of the area. This is identified in the 2012 'Trends in Gwynedd' report[6]. This report finds that from 2002-2010 that 6,700 people aged 20-29 left the area. This may be an indication of a lack, or perceived lack, of employment opportunities in Gwynedd which doesn't appear in the unemployment figures. It is also notable that, over the same period, there was also a strong migration into the area of 15-19 year olds which is largely explained by students moving to study at Bangor University.

Figure 3.4 suggests that the skill level in Gwynedd is higher than the average for Wales but lower compared to the levels across Great Britain.

In 2010, 29% of Gwynedd residents had a qualification of NVQ level 4 or above. This was 0.6% higher than 28.4% of population of Wales with a qualification NVQ4+ but 2.3% lower than the level for Great Britain.

Figure 3.4 – Percentage of population (16-64) qualification NVQ4+ (2010)

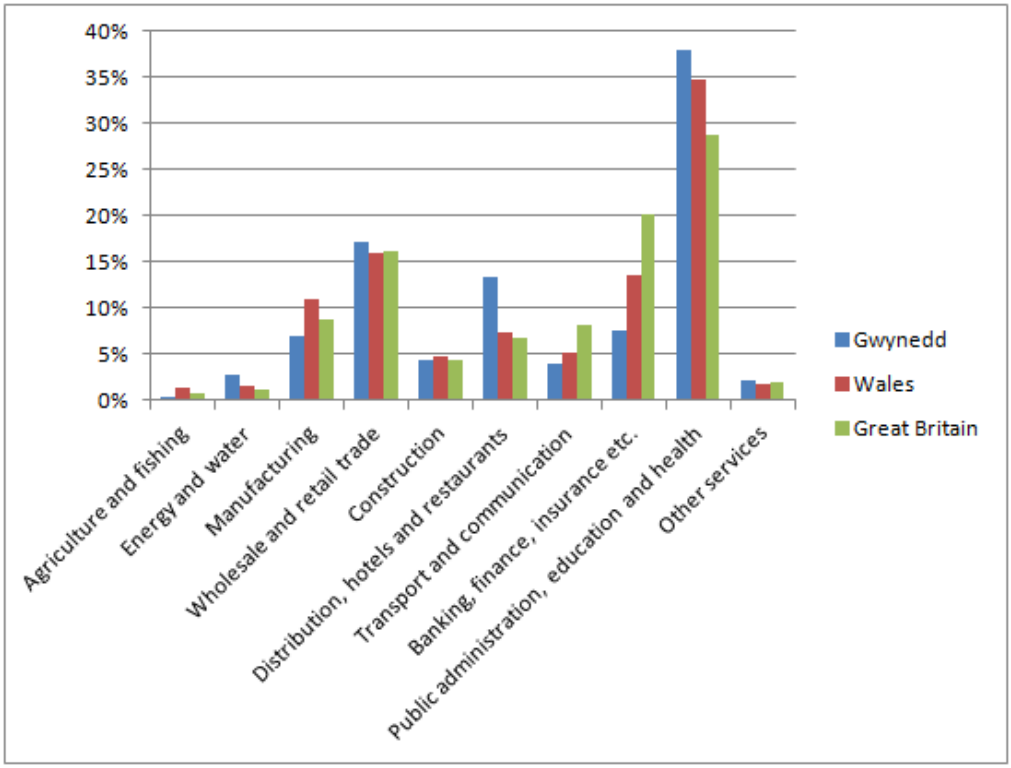


Source: Office for National Statistics (May 2012)

The chart in the figure below indicates the relative sector strength of the local employment base in Gwynedd. The sectors and industries where there is a greater concentration of jobs locally are in wholesale and retail trade, distribution, hotels and restaurants and the public sector.

[6] Trends in Gwynedd by Gwynedd Council Research and Information (2012)

Figure 3.4 – Local Skills Profile Comparative Analysis (2010)



Source: Office for National Statistics (May 2012)

On balance, the economic data indicate that Gwynedd generally lags behind the UK average in terms of output and skills indicators though is broadly similar to the average for Wales. However, Gwynedd had a lower unemployment rate than both the Welsh and UK average. This suggests that whilst Gwynedd may generate lower value added jobs than elsewhere it has a greater proportion of its labour force in work and economically active.

3.3 Renewable Energy Sector

Overall Market Sizing: Low Carbon Opportunities

Market sizing of the sector has been undertaken for the Department for Business, Innovation and Skills (DBIS). Overall, these studies7 focus on the Low Carbon and Environmental Goods and Services (LCEGS) sector; these combinations of industrial and commercial sectors are broader than renewable energy.

The report for the Renewable Energy Association estimated that the renewable energy sector and its supply chain employed around 99,000 in 2009/10 with a total UK turnover of £12.5bn.

For the broad LCEGS industry definition the total UK sales rose from £107bn in 2007-08 to £117bn in 2009-10.

Total employment also increased from 908,000 to 914,000 jobs. This data is broken down into sub-sectors, for the renewables sector sales fell from £35bn to £31bn with

[7] See: http://www.bis.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence/market-data for links to the 2007/08 study, the 2008/09 update and the 2009/10 study.

employment also falling slightly from 267,000 to 266,000 according to the latest Innovas analysis.

The BIS market sizing reports also include statistics focusing on a regional basis. Total sales in the LCEGS sector across Wales for 2007/08 were £4.66bn which rose to £5.05bn in 2009/10.

Over the same period renewables sales also rose modestly from £1.62bn to £1.80bn. Employment in the sector fell from 13,700 to 10,708 and despite the churn the overall number of renewable energy firms was broadly stable with 769 in 2007/08 and 774 in 2009/10.

High-level analysis indicates the following findings; whilst overall turnover increased by £180,000 (11%) and the number of firms in business grew by 1% employment declined by almost 3,000 jobs across Wales in the renewable energy sector (22%). This has the effect of increasing average turnover per employee substantially by almost £50,000 (42%).

Figure 3.5: Renewable Energy in Wales Sector Trend Analysis

	2007/08	2009/10
Turnover (£)	1,620,000,000	1,800,000,000
Firms	769	774
Jobs	13,700	10,708
Ave. turnover per employee (£)	118,248	168,099
Ave. turnover per firm (£)	2,106,632	2,325,581
Ave. jobs per firm	17.8	13.8

Source: Arup analysis of Innovas data, May 2012

According to the Innovas data firms in the renewable energy sector in Wales on average increased turnover by £219,000 (22.5%) whilst average firm size shrank from just under 18 jobs to under 14 per firm. Clearly these are sector averages and there will be a range of micro businesses to large firms in business across Wales. However, the high-level analysis is indicative of overall trends. The logic chain can be articulated in light of the impact of the recession and a contracting employment base within a growing sector, or through an increased use of capital and materials over labour, as installations are fitted across the country and operational efficiencies realised.

The '*Renewable Energy: Made in Britain report*'[8] estimates that the total amount of jobs in renewable energy including the supply chain in the UK was 99,000 in 2010/11. The report also estimates that up to 400,000 jobs will be needed to deliver 15% of UK energy from renewable sources in 2020.

In 2010/11, according to the '*Renewable Energy: Made in Britain'* report, Wales employed 4,700 people in the renewables sector with a turnover of £570 million.

The jobs total for technologies in such sectors such as solar, wind and biomass (when combining production of biomass with utilisation) each employ over 1,000 people each in Wales. There is not any data available in the report to highlight the renewable

[8] Renewable Energy: Made in Britain by Renewable Energy Association (2012)

energy jobs for Gwynedd as a county. This is partly because, in the absence of a dedicated SIC[9] code for the renewables sector, job estimates from the *Made in Britain* report are calculated from a bottom up methodology and not disaggregated at less than a regional level. However, using the Mott Macdonald benchmarks used in Section 7 to estimate the job impacts of renewable energy installations, the current renewables capacity would generate minimal operational jobs with some additional jobs for the installation of new capacity.

With regards to the installation of new capacity, the *Made in Britain* report points towards the potential skills shortage in the low carbon sector. In particular, the report emphasises the need to train building services engineers to install renewable energy technologies which is likely to be a key aspect of the renewable energy jobs in and around Gwynedd. This is particularly prescient for young people to equip them for their career and to help support the local economy in the long term.

It is also notable the 2008 Gwynedd and Ynys Môn Skills Strategy states that anecdotally there are difficulties in recruiting engineers. This fits with issues at a national level with the Institute of Mechanical Engineers 2001 report 'Meeting the Challenge: Demand and Supply of Engineers in the UK'[10] finding that there is a need for around 31,000 new graduate engineers every year to meet industry demand in 2017 and currently around 12,000 engineering students graduate annually. This skills shortage may be a particular issue for Gwynedd and the surrounding area if the Energy Island initiative is progressed and skilled engineers relocate from Gwynedd to Anglesey. However, conversely, the skills initiatives as part of the Energy Island programme could help to broaden the skills available in Gwynedd.

Notwithstanding this, there is evidence of educational institutions in Gwynedd offering courses relevant to the green agenda. Bangor University are active in the area of renewables with research in areas including photovoltaics and marine energy. The School of Environment and Natural Resources offers a specific undergraduate module in renewable energy with the School of Electronic Engineering offering undergraduate electronics courses. Moreover, there are a number of relevant courses at further education colleges in Gwynedd with Coleg Llandrillo Cymru in Pwllheli campus offering a BTEC in marine technology and Coleg Menai offering courses in building services.

Education and skills training is not just provided in the local area, with people relocating to university commonplace, thus training provided across a wider area is relevant. However, where students travel to cities such as Liverpool, Manchester, Birmingham, Cardiff or Bristol to study the key is to attract graduates to return to take up and begin careers in good quality local jobs. Courses at the Centre for Alternative Technology in neighbouring Powys are an important consideration; in particular the courses for renewables installers and broader skills can help equip Gwynedd with the expertise it requires going forward.

The recently announced Enterprise Zone around the Trawsfynydd nuclear power station, which aims to be a hub for IT data centres, energy and environmental business, also offers a chance to attract new business to Gwynedd which could help develop the renewable energy sector locally. Detailed plans need to be developed locally to provide a fit for purpose solution for the future of the site.

[9] SIC – Standard Industrial Classification
[10] Meeting the Challenge: Demand and Supply of Engineers in the UK by Institute of Mechanical Engineers (2011)

3.4 Summary of Findings

Whilst Gwynedd does not have the strongest local economy when measured by output or gross value added, it does offer certain competitive advantages, in particular drawing upon its natural environment and the quality of life it can offer to attract new business investment.

The renewable energy education opportunities in Gwynedd and the surrounding area together with new local opportunities on the horizon, such as potential at the Trawsfynydd Enterprise Zone and Energy Island, offer the potential for Gwynedd residents to capitalise on renewable energy opportunities.

The scale of employment that can be generated has to be commensurate with the investment that can be harnessed and supply side measures implemented locally. Renewable energy companies tend to be small to medium size (as evidenced by the latest Innovas analysis that indicates on average a firm is 14 people) and large scale capital investment and job creation is not likely to flow from local policies alone; external investment is required. The trend for outwards migration of 20-29 year olds poses a challenge to capture the benefits locally. These are important considerations which will inform the development and implementation of an action plan to address these and wider challenges raised within this study.

4 Energy Supply and Demand Baseline

4.1 Introduction

Electricity and heat demand in Gwynedd has been estimated using actual energy consumption data from national statistics. This was then 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.

The UK Renewable Energy Roadmap (2011) sets out a shared approach to unlocking the UK's renewable energy potential. It sets out a comprehensive suite of targeted, practical actions to accelerate renewable energy in the UK in order to achieve the UK's renewable energy target in the next decade – driving innovation and the deployment of a wide range of renewables. This document provides evidence showing that the UK can meet the target to deliver 15% of the UK's energy consumption from renewable sources by 2020. Recent 'bottom-up' analysis, tested with industry, suggests that there is significant upside potential as well as downside risk to deployment.

4.1.1 Explanation of terms

The Welsh Government Toolkit[11] 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.

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

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.

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.

4.2 Current Energy Demand

4.2.1 Current Gwynedd Electricity Demand

The principal information repository for current and historical electricity consumption is the Department of Energy and Climate Change (DECC). The base electrical consumption data for the Gwynedd 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[12].

Table 4.1 shows past domestic and non-domestic electricity consumption within Gwynedd. These figures do not include energy use for transport.

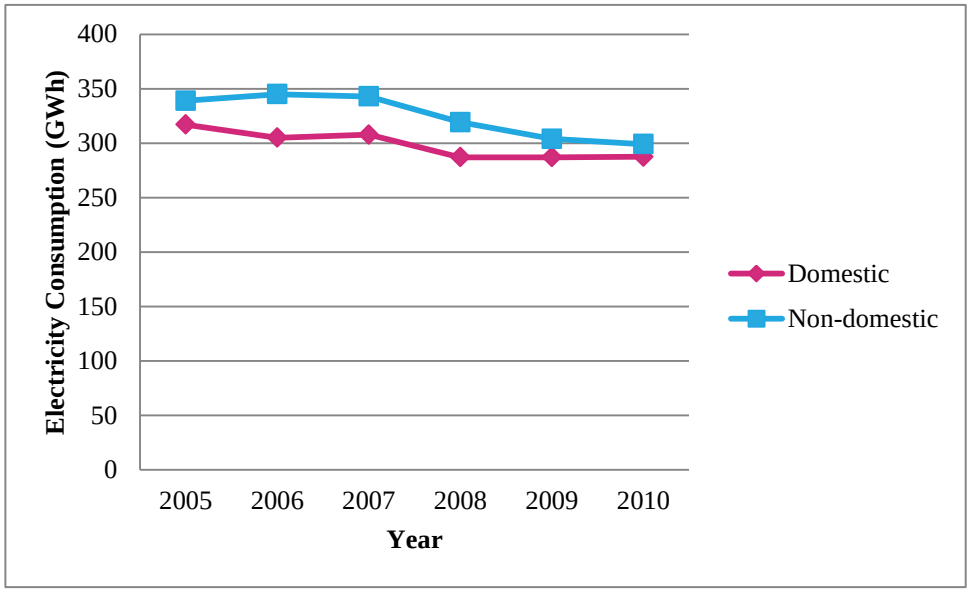
Table 4.1 Gwynedd electricity consumption for the years 2005 – 2010

Year	Domestic Electricity Customers		Commercial and Industrial (C&I) Customers		Sales per Customers	
	Sales (GWh)	MPANs (Thousands)	Sales (GWh)	MPANs (Thousands)	Average Domestic Consumption (kWh)	Average C&I Consumption (kWh)
2005	317	59.2	339	9.0	5,350	37,804
2006	305	59.3	345	8.9	5,134	38,970
2007	307.8	59.8	342.9	8.9	5,144	38,399
2008	287.0	57.4	319.2	8.2	5,002	38,760
2009	287.0	60.4	304.0	8.5	4,753	35,771
2010	287.5	60.7	299.1	8.5	4,733	35,374

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. **Figure 4.1** shows the variation in electricity consumption for Gwynedd.

[12]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 20 April 2012].

Figure 4.1 - Gwynedd electricity consumption



4.2.2 Current Gwynedd 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[13]. 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)[14]. **Table 4.2** shows past domestic and non-domestic gas consumption within Gwynedd years 2005-2010.

Table 4.2 - Gwynedd gas consumption for the years 2005 – 2010

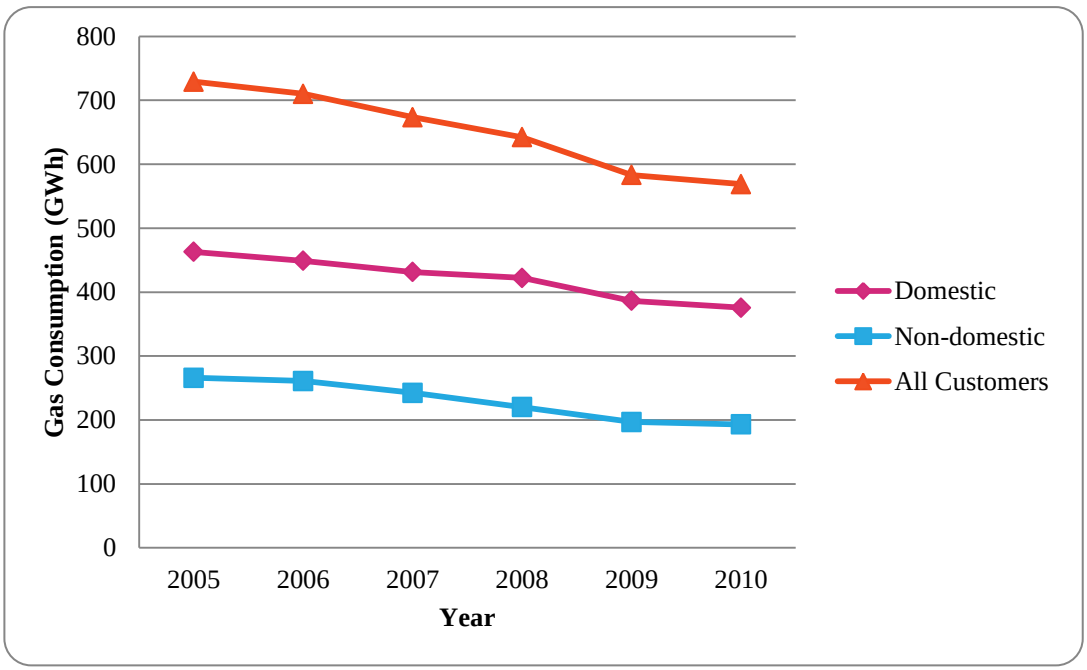
Year	Domestic Gas Customers		Commercial and Industrial Customers		Sales per Customers	
	Sales (GWh)	No. of Customers (Thousands)	Sales (GWh)	No. of Customers (Thousands)	Average Domestic Consumption (kWh)	Average C&I Consumption (kWh)
2005	463	27.3	266	0.6	16,941	448,542
2006	449	27.7	261	0.6	16,199	450,051
2007	431.4	28.0	242.5	0.6	15,379	440, 997
2008	422.1	28.4	220.2	0.5	14,882	428, 445
2009	386.3	28.6	196.8	0.5	13,510	422, 320
2010	375.7	28.8	193.1	0.5	13,023.2	421, 717.6

[13]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

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

Figure 4.2 shows the variation in gas consumption for Gwynedd.

Figure 4.2 – Gwynedd Gas Consumption, 2005-10



4.2.3 Total Energy Demand

The total energy demand in GWh for Gwynedd for 2005 -2009 is set out in table 4.3 below. This includes all non-transport energy for the County, and demonstrates how only 62% of the current energy demand is met by electricity and gas described above. Of particular note is the 489.9GWh currently provided by petroleum products, which demonstrates the number of off grid properties in the County. Given the predictions of peak oil made by many, this provides a real imperative for action in Gwynedd.

Table 4.3: Total Non-Transport Energy Demand in Gwynedd, 2005-9 (GWh)

Year	Coal	Manufactured fuels	Petroleum products	Natural gas	Electricity	Renewables & waste	Total (non-transport energy)
2005	54.1	82.4	532.1	729.2	656.1	54.8	2,108.6 GWh
2006	61.6	61.6	525.6	710.1	649.9	61.6	2,070.3 GWh
2007	77.9	54.2	481.7	673.9	650.7	68.5	2,006.9 GWh
2008	88.5	51.8	497.3	642.3	606.2	74.0	1,960.1 GWh
2009	86.1	57.4	489.9	583.1	591.0	77.4	1,884.8 GWh
2009 (%)	**5%**	**3%**	**26%**	**31%**	**31%**	**4%**	**100%**

4.3 Future Energy Demand

4.3.1 Future Electricity Demand

Forecast of electricity demand for Great Britain (GB) 2010-2017 are contained within the National Grid's Seven Year Statement[15]. In order to forecast demand it was assumed that Gwynedd's proportion of electricity demand will follow the same rate as that for GB to 2021. The Severn Year Statement presents three scenarios of varying annual electricity requirements as **Table 4.4** shows.

Table 4.4 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[16]. **Table 4.5** shows electricity and gas consumption for 2009/10 within Gwynedd. **Table 4.6** converts the predicted electrical demand for Gwynedd based on each GB scenario to 2020 for domestic and non-domestic consumption.

Table 4.5 – Gwynedd Energy demand 2010

	Domestic Electricity (GWh)	Non-Domestic Electricity (GWh)	Domestic Gas (GWh)	Non-Domestic Gas (GWh)	Total (GWh)
Consumption 2009/10[17][18]	287.5	299.1	375.7	193.1	1,155.4

[15] National Grid (2012) *2011 National Electricity Transmission System (NETS) Seven Year Statement*. Available from: http://www.nationalgrid.com/uk/Electricity/SYS/current/ [Accessed 20 April 2012].
[16] 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 April 2012].
[17] 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 20 April 2012].
[18] ht DECC (2012) *Sub-National Gas Consumption Data.* Available from: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/gas/gas.aspx [Accessed 20 April 2012].

Table 4.6 converts the predicted electrical demand for Gwynedd based on each GB scenario to 2020 for domestic and non-domestic consumption.

Table 4.6 – Gwynedd Electricity Demand Forecasts 2011 – 2020

Year	Low Scenario (GWh)		Base Forecast (GWh)		High Scenario (GWh)	
	Domestic	Non-Domestic	Domestic	Non-Domestic	Domestic	Non-Domestic
2010/2011	284.4	295.9	287.8	299.4	291.0	302.7
2011/2012	281.4	292.7	288.1	299.7	294.5	306.3
2012/2013	278.4	289.5	288.4	300.0	298.0	310.0
2013/2014	275.4	286.4	288.7	300.3	301.6	313.7
2014/2015	272.5	283.3	289.0	300.6	305.2	317.5
2015/2016	269.6	280.2	289.3	300.9	308.9	321.3
2016/2017	266.7	277.3	289.6	301.2	312.6	325.1
2017/2018	263.9	274.3	289.9	301.5	316.4	329.0
2018/2019	261.1	271.4	290.2	301.8	320.2	333.0
2019/2020	258.3	268.5	290.5	302.1	324.0	337.0
2020 Total	**521.1**		**593.2**		**661.0**	

4.3.2 Future Gas Demand

Forecasts of gas demand for Great Britain (GB) 2010-2020 are contained within the National Grid's Gas Transportation Ten Year Statement[19]. In order to forecast demand it was assumed that the Gwynedd'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[20].

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

[20] 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.

Table 4.7 – Gas demand forecast for Great Britain[21]

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
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 Gwynedd, **Table 4.8**.

Table 4.8 - Gwynedd Gas Demand Forecast 2011-2020

Year	Slow Progression		Gone Green	
	Domestic (GWh)	Non-Domestic (GWh)	Domestic (GWh)	Non-Domestic (GWh)
2011/2012	377.5	194.1	370.4	190.4
2012/2013	382.4	196.6	374.1	192.3
2013/2014	379.4	195.1	373.7	192.1
2014/2015	369.9	190.2	373.5	192.0
2015/2016	373.2	191.9	367.5	188.9
2016/2017	371	190.8	364.6	187.4
2017/2018	365.8	188.1	362.1	186.1
2018/2019	366.9	188.7	344.7	177.2
2019/2020	360.3	185.3	337.1	173.3
Total 2020	**545.6**		**510.4**	

4.3.3 Comparison between Future Energy Demand and Current Energy Demand

Table 4.9 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 Gwynedd in 2020.

Assessing the future demand against current demand reveals that the low consumption scenario energy demand is projected to decrease by 10.7% on 2010 levels. Projections under the high consumption scenario conversely reveal a potential energy demand decrease of 5.33 % on 2010 levels.

[21] Excluding export demand

Table 4.9- Forecasted energy demand 2020

Demand scenario	GWh		GWh	Total GWh
Gas Scenario		Electricity Scenario		
Slow Progression	545.6	High Scenario	548.2	1093.8
Gone Green	510.4	Low Scenario	521.1	1031.5

4.4 Existing Non-Renewable Energy Generation in Gwynedd

4.4.1 Major Heat and Power Supply

There are no operational non-renewable power stations (1MW+) in Gwynedd as of May 2011[22].

4.4.2 Combined Heat and Power Generation

There is one Combined Heat and Power (CHP) scheme in Gwynedd as indicated in Table 4.10.

Table 4.10 Existing Combined Heat and Power schemes in Gwynedd

CHP Site Name[23]	Prime Mover	Sector	Generating Capacity (kWe)
Gwynedd Hospital, Bangor	Reciprocating engine	Non-domestic	330

4.5 Existing Renewable Energy Generation in Gwynedd

4.5.1 Capacity Factors

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 is:

Capacity Factor	Electricity generated during the period [kWh] ÷ (Installed Capacity [kW] x Number of hours in the period [hours])[24]

[22] DECC, (2010) *Digest of United Kingdom Energy Statistics 2010* [online]. TSO. [Accessed 23 April 2012].
[23] DECC (2012) *CHP Focus.* Available from: http://chp.decc.gov.uk/app/reporting/index/viewtable/token/2 [Accessed 23 April 2012].

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[25]. A summary of different capacity factors for different technologies is given in **Table 4.11** and **Table 4.12**. 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 4.11– Renewable Electricity Generation Capacity Factors, 2010

Technology	Capacity factor	Comments and source
Onshore wind	0.27	DUKES 2009, figure for 2008[26]
Biomass (animal and plant matter)[27]	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[28]

Table 4.12 – 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.

4.5.2 Current Renewable Energy Generation

Information has been obtained from Gwynedd regarding renewable energy schemes within the County as of April 2012 that are operational. Please refer to **Table 4.13**. Hydropower makes up the largest share of existing capacity, with the 30MW Maentwrog power station being particularly notable.

[24] DTI, (March 2006) *Energy Trends* [online]. (pg. 28-32), [Accessed 23 April 2012].
[25] Welsh Assembly Government, (2010) *Practice Guidance: Planning for Renewables and Low Carbon Energy - A Toolkit for Planners*. Cardiff
[26] 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 23 April 2012].
[27] 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
[28] Appendix 1, A Low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement, March 2010

Table 4.13- Gwynedd Current Renewable Energy Installed (February 2012)

Scheme	Technology	Installed Capacity (MWe)	Status	Source
Afon Tyn y Cornel Hydro Scheme	Hydropower	0.12	Operational	DECC[29]
Maentwrog	Hydropower	30	Operational	DECC
Cwm Croesor	Hydropower	0.5	Operational	NFPA[30]
Cwm Dyli, nr Beddgelert	Hydropower	9.8	Operational	RWE[31]
Twrch, Pandy	Hydropower	0.475	Operational	NFPA
Afon Ysgethin, nr Harlech	Hydropower	0.86	Operational	NFPA
Harnog, nr Rhyd y Main	Hydropower	0.45	Operational	NFPA
Afon Ty Cerig, Rhyd y Main	Hydropower	0.195	Operational	NFPA
Cwm Llan, Nant Gwynant	Hydropower	0.44	Operational	NFPA
Gain, nr Ganllwyd	Hydropower	0.55	Operational	NFPA
Coed, nr Bala	Hydropower	0.45	Operational	NFPA
Cwmorthin, Tan y Grisiau	Hydropower	0.415	Operational	NFPA
Dolgoch, nr Tywyn	Hydropower	0.30	Operational	DECC
Pant yr Afon, Llechwedd	Hydropower	0.4	Operational	DECC
Maenofferen, Blaenau Ffestiniog	Hydropower	0.2	Operational	DECC
Bryn Fedw Hydro, Rhyd Ddu	Hydropower	0.7	Operational	DECC
Braich Ddu, Y Bala	Onshore Wind	4.0	Operational	NFPA
Crugeran Farm, Sarn Mellteyrn	Onshore Wind	0.05	Operational	Gwynedd
Cilgwyn RO Generation	Landfill Gas	2.13	Operational	ROG[32]
Domestic Onshore Wind	Microgeneration	0.016	Operational	Ofgem[33]
Non-domestic Onshore Wind	Microgeneration	0.006	Operational	Ofgem
Domestic Hydropower	Microgeneration	0.051	Operational	Ofgem
Non-domestic Hydropower	Microgeneration	0.229	Operational	Ofgem
Domestic PV	Microgeneration	2.4	Operational	Ofgem
Non-domestic PV	Microgeneration	0.094	Operational	Ofgem
Total	**-**	**54.9MWe**	**-**	**-**

Pumped-storage hydroelectricity schemes in Gwynedd, as shown in **Table 4.14**, do not count as renewable energy generation, as the pumping process makes plants net consumers of energy. However, pumped storage can play a useful role in managing energy supply to match demand and does have an economic implication (e.g. through job creation).

[29] Department of Energy and Climate Change (DECC) https://restats.decc.gov.uk/cms/planning-database/, [Accessed 23 April 2012]
[30] Non-Fossil Purchasing Agency Limited (NFPA) http://www.nfpa.co.uk/nffo4.html , [Accessed 23 April 2012]
[31] RWE http://www.rwe.com/web/cms/en/312586/rwe-innogy/sites/hydroelectric-power-station/united-kingdom/sites-in-operation/cwm-dyli/, [Accessed 23 April 2012]
[32] Renewble Obligation Generators (ROG), Renewable Obligation Generators, http://www.ref.org.uk/roc-generators/index.php?start=2600&order=AvAnnMWh&dir=desc, [Accessed 24 April 2012]
[33] 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]

Table 4.14 Pumped-storage hydroelectricity in Gwynedd

Scheme	Technology	Installed Capacity (MWe)	Status	Source
Dinorwig	Pumped Storage Hydro-electric	1800	Operational	DECC[34]
Ffestiniog	Pumped Storage Hydro-electric	360	Operational	DECC
Total	-	**2160**	-	-

Current renewable energy generation for Gwynedd can be calculated by using renewable energy currently installed in Gwynedd available in **Table 4.13** and the capacity factors stated in section 4.5.1. The results are shown in **Table 4.15**.

Table 4.15 Renewable Energy Generation in Gwynedd (April 2012)

	Onshore Wind	Hydro	Landfill Gas	Microgeneration	Total
Installed Capacity (MW)	4	45.9	2.13	2.8	54.8
Electrical Generation (GWh)	9.5	148.8	11.2	2.4	171.9

4.5.2 Future Renewable Energy Generation in Gwynedd

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 4.16** represents renewable energy schemes that have been approved and are waiting to be constructed. **Table 4.17** represents renewable energy schemes that have not been determined and are awaiting a decision on their planning application.

Table 4.16 Approved Renewable Energy Schemes in Gwynedd (April 2012)

Scheme	Technology	Capacity (MWe) to be installed	Status	Source
Caernarfon Airport, Dinas Dinlle	Onshore Wind	0.5	Awaiting construction	DECC
Llwyn Isaf AD Plant	Anaerobic Digestion	0.5	Awaiting construction	DECC
Hen-dy, Pistyll	Biomass	-	Application approved October 2002	Gwynedd Planning Data
Llanllyfni	Biomass	-	Application approved March 2007	Snowdonia National Park Planning Data[35]
Castell March, Abersoch	Onshore Wind	0.08	Application approved March 2012	Gwynedd Planning Data
Penucharllan, Llanfor, Y Bala	Hydropower	0.08	Application approved September 2011	Gwynedd Planning Data
Llys-y-Coed, Trefriw	Microgeneration	-	Application approved	Snowdonia National Park

[34] Department of Energy and Climate Change (DECC) https://restats.decc.gov.uk/cms/planning-database/, [Accessed 23 April 2012]
[35] Snowdonia National Park Planning Authority, http://www.eryri-npa.gov.uk/planning/planning-applications, [Accessed 20/05/2012]

			in March 2006	Planning Data
Heryri, Craflwyn Hall, Beddgelert	Microgeneration	-	Application approved in April 2011	Snowdonia National Park Planning Data
Helfa Fawr, Llanberis	Microgeneration	-	Application approved in December 2007	Snowdonia National Park Planning Data
Total	**-**	**1.16MWe**	**-**	**-**

Table 4.17 Renewable Energy Schemes awaiting a planning decision in Gwynedd (April 2012)

Scheme	Technology	Installed Capacity (MWe)	Status	Source
Gwynt Aelhaearn	Onshore Wind	0.005	Planning application submitted 19 March 2012	Gwynedd Planning Data
Cwmwd, Sarn, Pwllheli	Onshore Wind	1.63	Awaiting planning decision	Gwynedd Planning Data
Hafod y Llan	Hydropower	0.65	Awaiting planning decision	Gwynedd Planning Data
Hendy Farm, Abersoch	Solar	0.05	Planning application submitted December 2011	Gwynedd Planning Data
Total	**-**	**2.3MWe**	**-**	**-**

Whilst an application has not yet been submitted, and most of the scheme will be outside of Gwynedd, Scottish Power Renewables 75MW Mynydd Mynyllod scheme has been engaging with the Planning Inspectorate (formerly the Infrastructure Planning Commission, or IPC). If two of the proposed 2.5MW turbines were to be located in Gwynedd this would represent 5MW additional capacity.

Deployment of these schemes has been given further consideration in **Chapters 5 and 6** in drawing comparisons to the overall resource in the County and future energy demand.

4.6 Summary and Analysis

Using the available information of current total energy demand (Section 4.2.3) and current renewable electricity generation **Table 4.13**, it is estimated that approximately **9.1%** of Gwynedd's total energy demand is currently provided by renewable energy. This provides a baseline for Gwynedd to build on.

Should all current schemes in the pipeline be completed, the total installed renewable capacity in Gwynedd will be as shown in **Table 4.18** below. This would represent 9.7% of the total energy demand.

Table 4.18 All Renewable Energy Schemes in the pipeline

Status	Technology	Installed Capacity (MWe)	Installed Capacity (MWe)
Existing Capacity	Hydropower	45.9	54.9
	Onshore Wind	4.0	
	Landfill Gas	2.1	
	Microgeneration	2.8	
Approved new schemes	Hydropower	0.08	1.2
	Onshore Wind	0.63	
	Anaerobic Digestion	0.5	
Schemes awaiting planning decisions	Hydropower	0.7	2.4
	Onshore Wind	1.6	
	Microgeneration	0.05	
Total	**-**	**-**	**58.5MWe**

This shows that the existing hydropower continues to form the largest proportion of renewable energy in Gwynedd in the short-term. The total potential electrical generation from all of the schemes in the pipeline is shown in **Table 4.19** below.

Table 4.19 Total potential electrical generation

	Installed Capacity (MWe)	Capacity Factor	Annual Electrical Generation (GWh)
Onshore Wind	6.2	0.27	14.7
Landfill Gas	2.1	0.6	11
Hydropower	46.7	0.37	151.3
Anaerobic Digestion	0.5	0.9	3.9
Microgeneration	2.9	0.1	2.5
Total	**58.4MWe**	**-**	**183.4GWh**

5 Renewable Resource Assessment

5.1 Introduction

The assessment of existing and potential renewable and low carbon energy capacity in Gwynedd is based upon the total practically available resource within each of the given areas identified within the methodology below. 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.

5.2 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 therefore applicable in Wales. This has been used to supplement the Welsh Government guidance where value can be added to the process for Gwynedd, for example, through reference to additional or more appropriate data sources. The resources assessed are described within **Table 5.1** below which also identifies for which sections the DECC methodology has been used. **Table 5.1** shows the list of technologies considered in the resource assessment.

Table 5.1 – 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

5.2.1 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.

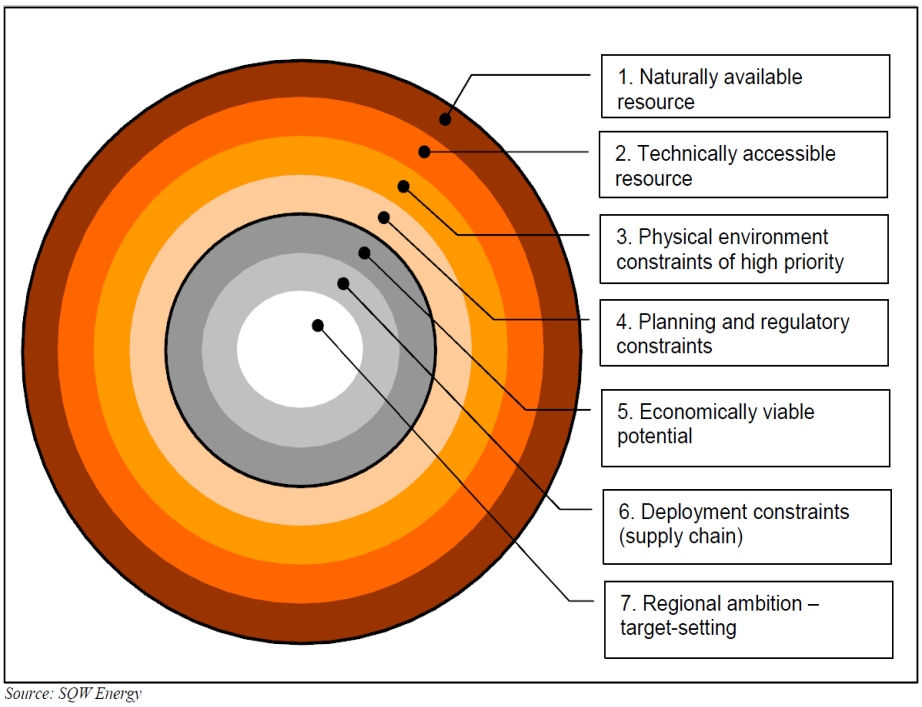
The assumptions and steps required vary between each resource and further details can be found within the respective 'Project Sheets' accompanying the toolkit. In principle the methodology involves the following steps:

- 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.

5.2.2 The DECC Methodology

The DECC methodology takes a sequential approach to developing the regional evidence base. **Figure 5.1** shows the sequential approach for the broader process of developing an evidence base and then regional targets. This methodology summary covers the first four of these stages.

Figure 5.1 - Stages for developing a comprehensive evidence base for renewable energy potential



Source: SQW Energy

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 5.2** is reproduced from the DECC report and summarises the assessment process.

Table 5.2 - 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.

5.3 Onshore 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[36]:

- 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);

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

- 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).
- The National Park: following consultation with Snowdonia National Park Authority, it has been assumed that no wind developments of this scale would be appropriate within the National Park. However, additional capacity is technically feasible.

Results

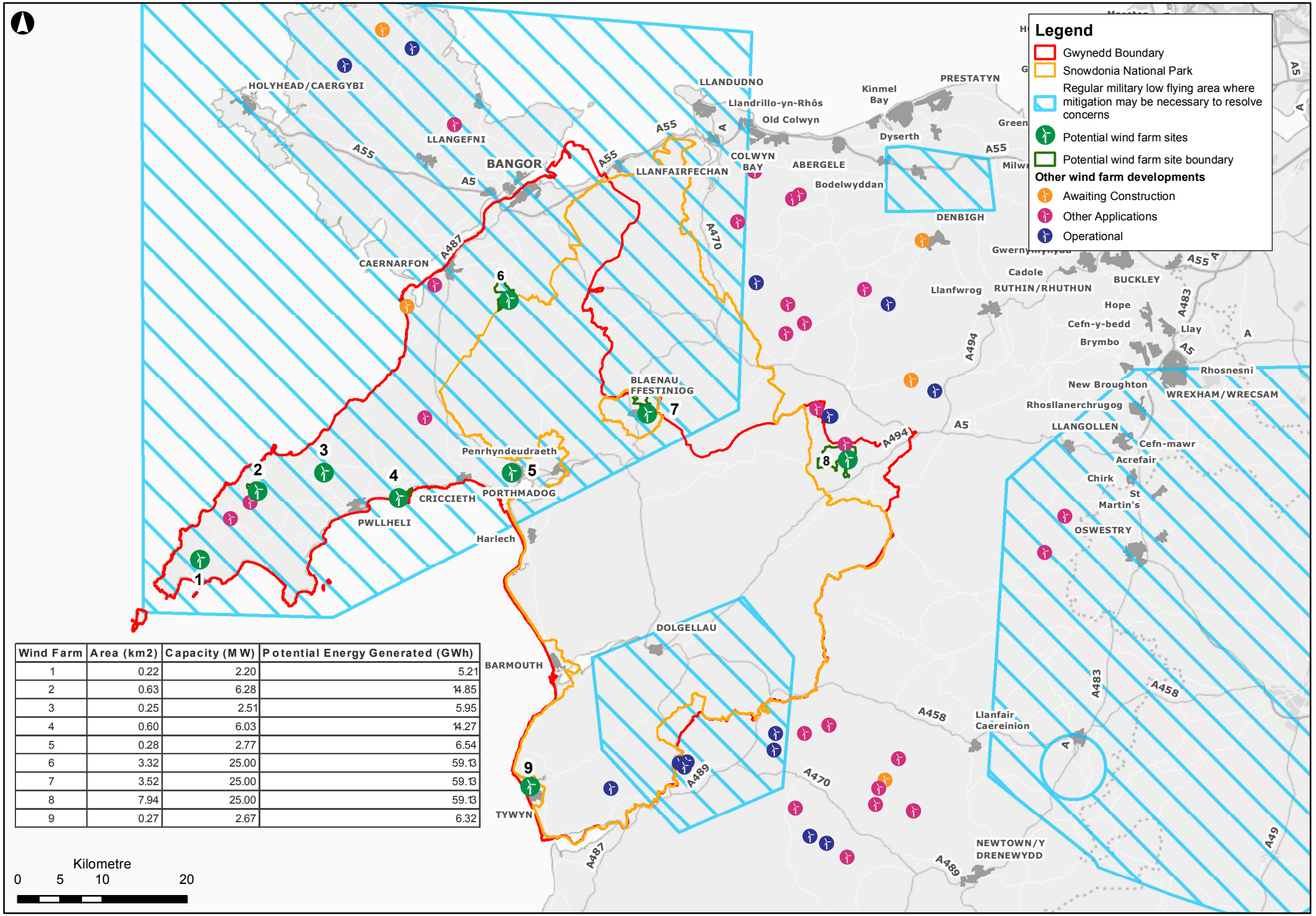
Based on the use of 2MW turbines, it is possible to fit 5 turbines of this size into 1km² (or 100ha)[37], which equates to a potential installed capacity of 10MW/km². It should be noted that this figure lies towards the upper limit of average installed capacity per unit area for Welsh wind farms.

To calculate potential MW installed capacity, land area without constraints is multiplied by 10MW/km². The results of which are shown in **Table 5.3** and **Map 5.1**. A capacity factor of 27% has been used in line with the Welsh Toolkit.

Table 5.3 Wind Priority Capacity

Wind Cluster	Unconstrained Area (km2)	Estimated Resource (MW)	Potential Annual Generation (GWh)
1	0.2	2.2	5.2
2	0.6	6.3	14.8
3	0.2	2.5	5.9
4	0.6	6.0	14.3
5	0.3	2.8	6.5
6	3.3	25	59.1
7	3.5	25	59.1
8	7.9	25	59.1
9	0.3	2.7	6.3
Total	**17.0**	**97.4**	**230.5**

[37] This assumes spacing between turbines of 4 blade diameters perpendicular to the prevailing wind direction, and 6 blade diameters downwind. See the PPS22 Companion Guide, for England



Wind Farm	Area (km2)	Capacity (MW)	Potential Energy Generated (GWh)
1	0.22	2.20	5.21
2	0.63	6.28	14.85
3	0.25	2.51	5.95
4	0.60	6.03	14.27
5	0.28	2.77	6.54
6	3.32	25.00	59.13
7	3.52	25.00	59.13
8	7.94	25.00	59.13
9	0.27	2.67	6.32

5.4 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.

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[38]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.

Existing Schemes

There are currently 16 operational micro-hydropower schemes and two operational pumped storage hydropower schemes in Gwynedd, Dinorwig (1800MW) and Ffestiniog (360MW) as shown in **Table 5.4.**

Table 5.4 Existing Small-scale Schemes in Gwynedd

Scheme	Technology	Installed Capacity (MWe)
Afon Tyn y Cornel Hydro Scheme	Hydro	0.12
Cwm Croesor	Hydro	0.5
Twrch, Pandy	Hydro	0.475
Afon Ysgethin, nr Harlech	Hydro	0.86
Harnog, nr Rhyd y Main	Hydro	0.45
Afon Ty Cerig, Rhyd y Main	Hydro	0.195
Cwm Llan, Nant Gwynant	Hydro	0.44
Gain, nr Ganllwyd	Hydro	0.55
Coed, nr Bala	Hydro	0.45
Cwmorthin, Tan y Grisiau	Hydro	0.415
Dolgoch, nr Tywyn	Hydro	0.30
Pant yr Afon, Llechwedd	Hydro	0.4
Maenofferen, Blaenau Ffestiniog	Hydro	0.2
Bryn Fedw Hydro, Rhyd Ddu	Hydro	0.7
Cwm Dyli, nr Beddgelert	Hydro	9.8
Maentwrog	Hydro	30
Total	**-**	**45.9**

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

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[39] to identify the total resource and the portion of that resource which is accessible and viable. The Environment Agency Study is the first phase in a wider programme of work and subsequent phases will ground truth the data, consider environmental sensitivities in more detail and apply the analysis at river catchment scale.

In 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 Gwynedd, 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 Gwynedd accounting for a total of 46.9MW 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.

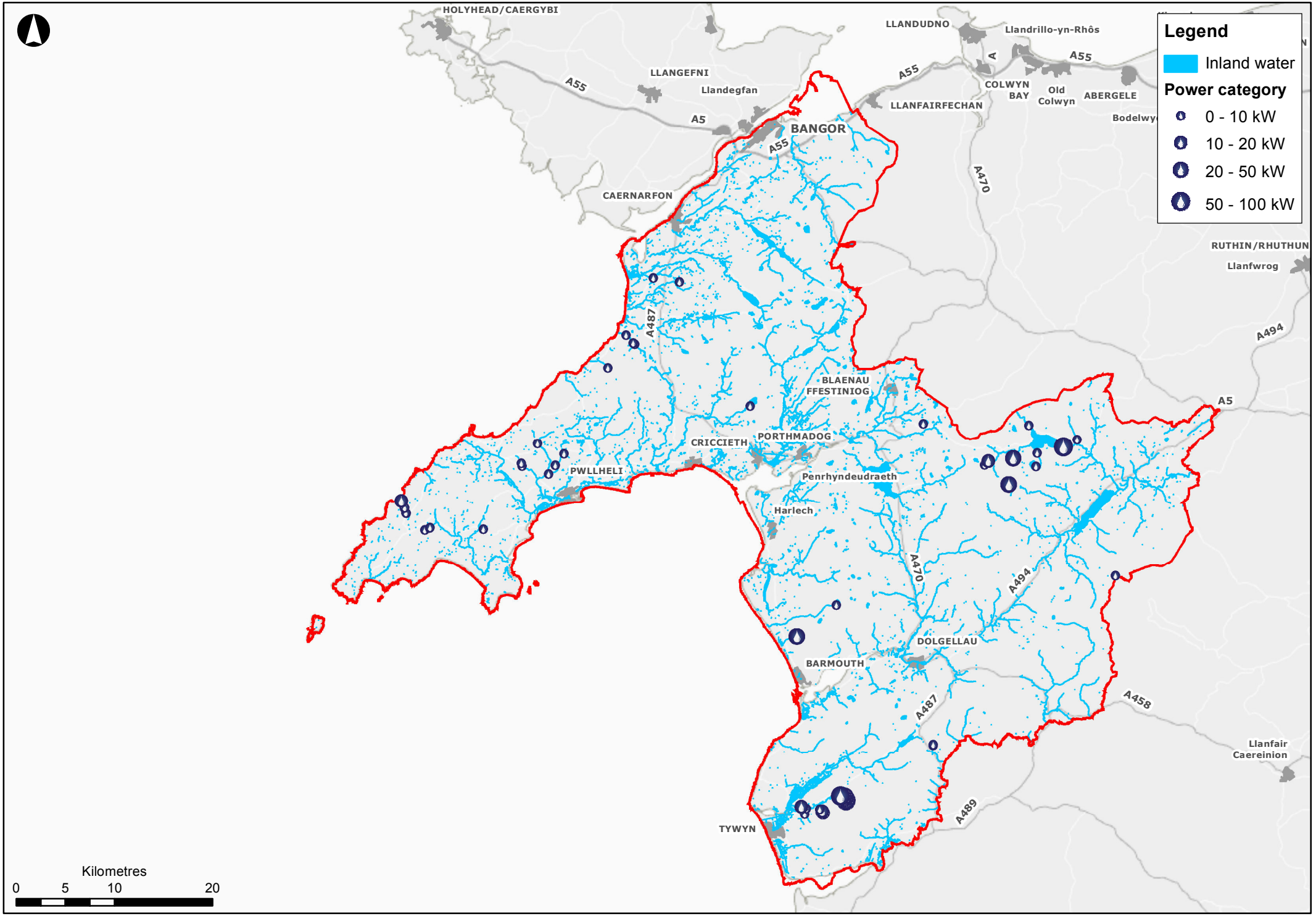
Results

Table 5.5 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. The location of these sites is shown in **map 5.2**

Table 5.5 Potential accessible hydro schemes in Gwynedd

Resource	Estimated resource (MWe)	Potential Annual Generation (GWh)
Small scale hydro	1.1	3.6

[39] Environment Agency, (2010) *ibid* [online] [Accessed 19 April 2012]


Legend
Inland water
Power category
0 - 10 kW
10 - 20 kW
20 - 50 kW
50 - 100 kW
HOLYHEAD/CAERGYBI
LLANDUDNO
Llandrillo-yn-Rhôs
LLANGEFNI
Llandegfan
COLWYN BAY
Old Colwyn
ABERGELE
LLANFAIRFECHAN
Bodelwyd
BANGOR
CAERNARFON
RUTHIN/RHUTHUN
Llanfwrog
BLAENAU FFESTINIOG
PORTHMADOG
CRICCIETH
PWLLHELI
Penrhyndeudraeth
Harlech
DOLGELLAU
BARMOUTH
TYWYN
Llanfair Caereinion
A55
A5
A470
A487
A494
A458
A489
Kilometres
0
5
10
20

5.5 Energy from Waste

5.5.1 Municipal Solid Waste (MSW) and Commercial and Industrial (C&I) Waste

Overview

Solid Waste includes the residual waste that is not currently recycled or composted within Gwynedd. This resource is split into Commercial and Industrial (C&I) Waste and Municipal Solid Waste (MSW). The data on the availability of this resource comes from StatsWales[40]. The resource includes 'Mixed Ordinary Waste' and is based on data at a North Wales level as the data is not available at a county level. A calculation has converted this to a county level assuming that the proportion would be equivalent to Gwynedd's population which is estimated as 17.5%[41] of North Wales[42].

Main Assumptions

The resource assessment follows a three stage process:

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

Results

Table 5.6 provides a breakdown of the MSW and C&IW available within Gwynedd.

Table 5.6 Quantity of MSW and C&IW yield

Total tonnes of Municipal Solid Waste available (2010-2011)[43]	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)
42,011	50,697	30	27,812

For the purposes of this resource assessment, it has been assumed that the residual waste resource is used for Combined Heat and Power (CHP) facilities. The resource potential is shown in **Table 5.7**.

Table 5.7 MSW and C&IW resource potential (100%)

Source	Tonnes of waste for energy recovery	Tonnes of waste per 1MWe	Estimated Resource		Potential Annual Generation	
			Electricity (MW)	Heat (MW)	Electricity (GWh)	Heat (GWh)
MSW and C&IW	27,812	10,320	2.7MWe	5.4MWt	21.2GWh	23.7GWh

[40] Waste Management on StatsWales http://www.statswales.wales.gov.uk/ReportFolders/reportFolders.aspx, [Accessed 25 April 2012]
[41] Population generated from population reports for Gwynedd and North Wales available via StatsWales '[007455] Small Area Population and Local Authority Population Data (2001 onwards) 2010 figures'
[42] North Wales consists of six counties with a Total Population of 678,461 [See StatsWales]
[43] http://www.statswales.wales.gov.uk/TableViewer/tableView.aspx?ReportId=10973, [Accessed 02/05/2012]

There is no specific guidance in Wales as to what the biodegradable fraction should be assumed to be in future. The Welsh Toolkit suggests that an assumption of 35% 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 5.8**.

Table 5.8 MSW and C&IW resource potential (35%)

Source	Estimated Resource		Potential Annual Generation	
	Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
MSW and C&IW	7.5MWe	8.3MWt	58.6GWh	36.4GWh

5.5.2 Waste Wood

Overview

Describing a co-product from the primary processing of wood as a 'waste' wood feedstock is a slight misnomer as it is a valuable commodity which contributes to the financial viability of sawmills. However, the term is used in the context of this assessment to indicate a material stream comprising sawmill co-product, wood from construction and wood from furniture manufacture.

The waste wood resource is based on the wood available through Municipal collections which are currently recycled or composted. The total volume of this resource may be increased by also incorporating waste wood from Commercial and Industrial sources although figures are not currently available for Gwynedd at a Local Authority level.

Main Assumptions

The figures used here are based on reports available through 'StatsWales'[44] and include waste wood collected through Municipal collections.

Results

The quantities available for waste woods are reported in **Table 5.9.** The Welsh Toolkit recommends a figure of 0.6odt (oven dry tonnes) of available wood fuel per ha (hectare) of woodland, per annum, for the maximum accessible resource.

Table 5.9 Potential waste wood yield within Gwynedd

Annual tonnes of wood collected through civic amenity site (2009-2010)	Odt required per 1 MWe of energy output	Available resource as odt/annum[45]
1,667	6,000	1,250.3

The results from the resource assessment for waste wood are reported in **Table 5.10**. For the purposes of this resource assessment, it has been assumed that the waste wood resource is used for CHP biomass facilities and therefore the same assumptions as managed woodland apply (see section 5.6.1.1)

[44] Report '[026737] Local Authority Municipal Waste recycling/composting by material, tonnes, 2009-10 onwards (NS)', Welsh Government, *StatsWales.* Available from: www.statswales.wales.gov.uk [Accessed 24 April 2012]
[45] Based on Assumption from Forestry Commission that recycled wood contains 25% moisture, Forestry Commission (2012) *Forestry Statistics 2009 - Sources.* Available from: http://www.forestry.gov.uk/website/forstats2009.nsf/0/8B4784E90B2A535480257361005015C6 [Accessed 19 April 2012].

Table 5.10 Potential Waste Wood Resource

Available Resource	Potential waste wood resource (odt/annum)	Estimated resource		Potential Annual Generation	
		Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
Waste Wood	1,250.3	0.21	0.42	1.6	1.8

5.6 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 biomass plant in Anglesey is noted, and may provide economic opportunities for Gwynedd.

5.6.1 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.

5.6.1.1 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[46]. Energy generation will typically be in a Combined Heat and Power (CHP) plant. The Welsh Toolkit therefore estimates the potential electric and heat capacity in the County.

Main Assumptions

The Welsh Toolkit proposed two potential sources for woodfuel data. This assessment utilises the Forestry Commission's Legal Boundaries, which was acquired through the FC in GIS format, and private forestry through the National Forest Inventory (NFI), also supplied by the FC.

The assessment did not cover woodfuel resource from the following sources:

- Arboricultural residues: Residues from tree surgery and Council management of street and park trees; and
- Clean Wood Waste: Residue from sawmills and joinery workshops.

Results

The amount of land/quantities available for managed woodland is reported in **Table 5.11**. Based on data contained within the Bioenergy Action Plan for Wales, the Welsh Toolkit recommends a figure of 0.6odt (oven dry tonnes) of available wood fuel per ha (hectare) of woodland, per annum, for the maximum accessible resource. This figure takes account of competition from other markets in Wales.

Table 5.11 Potential wood fuel yield within Gwynedd

Available Resource	Area of available woodland (ha)	Available wood (odt) wood per ha of woodland, per annum	Potential wood fuel resource (odt/annum)
FC Owned or Managed Land	15,868.0	0.6	9,520.8
Privately Owned or Managed Land	23,782.7	0.6	14,269.6

The amount of energy which could be generated annually from this resource is shown in **Table 5.12**. For electricity generation, a biomass facility will require about 6,000odt of wood fuel for each 1MWe of installed power generation capacity. A CHP facility will require the same amount of fuel as a biomass facility but will produce 2MWt of thermal output at the same time from the waste heat.

For the purposes of this resource assessment, it has been assumed that the wood fuel resource is used for CHP biomass facilities. A capacity factor of 90% as outlined in **Table 4.10** and **Table 4.11** has been used for the estimate electricity generation and 50% for heat generation.

[46] 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 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.

Table 5.12 Potential Managed Woodland Resource

Available Resource	Potential wood fuel resource (odt/annum)	Estimated Resource		Potential Annual Generation	
		Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
FC Owned or Managed Land	9,520.8	1.6MWe	3.2MWt	12.6GWh	14.0GWh
Privately Owned or Managed Land	14,269.62	2.4MWe	4.8MWt	18.8GWh	21.0GWh
Total	**23,790.44**	**4MWe**	**8MWt**	**31.5GWh**	**35GWh**

5.6.1.2 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 Gwynedd 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 Gwynedd 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.

Main assumptions

The energy crop resource assessments takes into consideration a number of spatial constraints:

- Agricultural land: Miscanthus and SRC can be grown on land grades 1 to 4 (based on the Agricultural Land Classification)
- Competition with food, other crops and livestock: Farmers may be able to get a higher return from growing other crops, in particular on land grades 1 to 3, and therefore would not choose to plant energy crops;
- Conservation and heritage designations: The following have been excluded from the resource – Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Country Parks, SAC, Local Nature Reserves, SPA, National Park, Historic Landscape Area, Registered Parks and Gardens, Scheduled Monuments; and
- Unsuitable topography: steep slopes make harvesting of energy crops problematic.

Results

Table 5.13 shows the accessible energy crop scenario with regards to land availability. Whilst there is no firm guidance on what proportion of suitable land could be planted with energy crops; the Welsh Toolkit suggests 10% of the total suitable land area could be planted with energy crops.

Table 5.13 Land available for energy crop planting

Total area of Arable land. Grades 1 to 4, excluding any woodland (ha)	Total area of constrained land (ha)	Available area excluding constrained areas (ha)	Proportion suitable for energy crops (Assumptions based on Welsh toolkit) (odt)
71,606.7	2,068.0	69,538.7	6,953.8

In terms of yield, an average figure of 12 oven dry tonnes (odt) per year per hectare is suggested within the Welsh Toolkit. The results from the resource assessment for energy crops are reported in **Table 5.14.** For the purposes of this resource assessment, it has been assumed that the energy crop resource is used for CHP biomass facilities and therefore the same assumptions as managed woodland apply.

Table 5.14 Potential Energy Crop Resource

Available Resource	Potential wood fuel resource (odt/annum)	Estimated resource		Potential Annual Generation	
		Electricity (MWe)	Heat (MWt)	Electricity (MWe)	Heat (MWt)
Energy Crops	83, 445.8	13.91	27.82	109.7	121.9

5.7 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.

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.

Arup was commissioned by Carbon Trust Wales to conduct an assessment of the suitability for integrating renewable technology into 22 of Gwynedd County Council's existing buildings[47]. An extrapolation exercise across the Council's whole estate demonstrated that nearly 70% of sites are suitable for PV and Biomass, whilst approximately 40% and 20% would be suitable for Solar and wind respectively. By

[47] Arup for Carbon Trust, (2011), *Carbon Management Energy Efficiency Report: Feasibility Study into the Integration of Renewable Technology in Existing Buildings for Gwynedd County Council* , Ref PO032639

extrapolating the findings of the study across the whole estate an annual carbon (CO_2) emission saving of approximately 8,190 tonnes CO_2 can be made. The Local Authority's building stock can be considered to be the low hanging fruit of the total available resource. Further consideration has been given to this in chapter 6 on deployment.

5.7.1 Solar

Overview

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-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[48]. It is therefore assumed that 25% of existing dwellings will be suitable and 40% of existing non-dwellings. Looking forwards, information has been derived from the LDP with regards to housing projects for the County. Gwynedd Unitary Development Plan 2001 – 2016 suggests that 4,178 new properties will be built by 2016.

Results

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

Table 5.15 Potential Solar Capacity and Generation

Type of Property	Number of Properties with Suitable Roofs for Solar	Estimated Resource (MW)		Potential Annual Generation (GWh)	
		Electricity	Heat	Electricity	Heat
Domestic Properties [2kW]	17,992	9.0	9.0	7.0	7.0
Commercial properties [5kW]	2,644	13.2	-	11.6	-
Industrial properties [10kw]	1,071	10.7	-	9.4	-
Total	**21,707**	**32.9**	**9.0**	**28**	**7**

[48] 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].

5.7.2 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;49 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.

The assessment considers whether properties are residential or non-residential and suitability in terms of housing type. Data is taken from the 'OS Address Point 2 Dataset, 2010'. The assumption is that 50% of new dwellings will be suitable for one type of heat pump. The DECC methodology makes an assessment of non-residential buildings in terms of Commercial or Industrial.

Results

Table 5.16 details the potential accessible heat pump resource for Gwynedd.

Table 5.16 Existing capacity of 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	20,614	103	77
Existing Residential Off-Grid Properties	30,176	151	113
Future Residential Properties	2,089	10	31
Industrial Properties	670	7	5
Commercial Properties	3,305	33	25
Total	**56,854**	**304**	**252**

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

5.8 Anaerobic Digestion

5.8.1 Animal Manure

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.

Main Assumptions

Data on the number of livestock within Gwynedd is taken from the Agricultural Small Area Statistics, 2002-2010[50]. The Welsh toolkit assumes the following quantities of manure will be available.

- Cattle: 1 tonne/month/head
- Pigs: 0.1 tonnes/month/head

It also assumes that both animals will be undercover for approximately 6 months each year when the waste will be recoverable. Therefore slurry can only be collected 6 months of the year. Therefore:

- Cattle: 1 x 6 tonnes/head
- Pigs: 1 x 0.6 tonnes/head

The toolkit also assumes that 50% of farms in Gwynedd use a slurry system and that of these it would be feasible to capture the slurry from 50%. This means the available resource per head of livestock per annum would be as follows:

- Cattle: 1.5 (wet) tonnes/head
- Pigs: 0.15 (wet) tonnes/head

We have used the assumption from the toolkit, that 1 MWe would be produced on average from 225,000 tons of wet slurry. An AD plant can act as CHP and therefore the waste heat can be usefully used if there is a suitable heat load. For this assessment, for every 1MWe produced, 1.5MWt would also be produced.

Results

Table 5.17 provides information on the number of cattle in Gwynedd and the amount of slurry available for anaerobic digestion.

[50] Welsh Government (2011) *Agricultural Small Area Statistics, 2002-2010.* Available from: http://wales.gov.uk/topics/statistics/headlines/agriculture2011/110728/?lang=en [Accessed 24 April 2012].

Table 5.17 Wet organic waste yield

Source	Number of animals (2010)	Calculated Tonnes of slurry	Calculated tonnes of wet slurry
Cattle	77,624	465,744	116,436
Pigs	302	181.2	45.3

The results from the resource assessment for wet organic waste are reported in **Table 5.18**. For the purposes of this resource assessment, it has been assumed that the wet organic waste resource is used for CHP biomass facilities and therefore the same assumptions as managed woodland apply.

Table 5.18 Wet organic waste resource potential

Available Resource	Calculated tonnes of wet slurry	Estimated resource		Potential Annual Generation (GWh)	
		Heat (MWt)	Energy (MWe)	Heat	Energy
Cattle	116,436	0.78	0.52	3.40	4.08
Pigs	45.3	0	0	0	0

5.8.2 Food Waste

Overview

This analysis is limited to the organic fraction of MSW (primarily comprising household wastes). MSW 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. Within the assessment this waste stream is based on the material available through collections of organic food waste either through domestic kerbside composting schemes or civic amenity sites. Figures are obtained from reports on waste management within Gwynedd available through the 'StatsWales' database[51].

The assessment also considers food waste available through commercial and industrial streams (C&I) within Gwynedd. It is likely that this waste is currently collected through more than one contract and the availability or extent of these contracts may require further analysis. Figures are obtained from reports available at 'StatsWales' database[52].

Main Assumptions

C&I waste data is not currently available at a Local Authority level and therefore the resource has been calculated based on North Wales data for a Gwynedd population percentage which is calculated as 17.5% of North Wales.

32,000 tonnes of food waste is needed for every 1MWe produced. 1.5MWt would also be available for every 1MWe produced if using CHP.

[51] Data from Welsh Government (2011) *Waste Management- Annual Municipal Waste* Available from: http://www.statswales.wales.gov.uk/ReportFolders/reportFolders.aspx [Accessed 25 April 2012]
[52] Data from Welsh Government (2011) *Waste Management- Industrial and Commercial Waste*, Available from http://www.statswales.wales.gov.uk/ReportFolders/reportFolders.aspx [Accessed 24 April 2012]

Results

Tables 5.19 and **Table 5.19** provide information on the volume food waste in Gwynedd from domestic and C&I waste streams respectively.

For the purposes of this resource assessment, it has been assumed that the food waste resource is used for CHP biomass facilities and therefore the same assumptions as managed woodland apply.

Table 5.19 Potential Domestic Food Waste Resource

Source	Food waste Tonnes (Gwynedd)	Tonnes of food waste per 1MWe	Estimated Resource		Potential Annual Generation	
			Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
Domestic food waste composted and other compostable material (09-10)	8,073[53]	32,000	0.3	0.4	2.0	1.7

Table 5.20 Potential C&I Food Waste Resource

Source	Food waste Tonnes (Gwynedd)	Tonnes of food waste per 1MWe	Estimated Resource		Potential Annual Generation	
			Electricity (MWe)	Heat (MWt)	Electricity (GWh)	Heat (GWh)
Tonnages of Commercial Food Waste (from restaurants or food processing companies) (2007)	25,000	32,000	0.8	1.2	6.2	5.1

5.8.3 Poultry Litter

Overview

Poultry litter can be converted to energy through direct combustion or through anaerobic digestion. The assessment considers poultry kept on farms at a commercial scale where collection of waste would be most practical.

Main Assumptions

Data on the total number of poultry available came from the Agricultural Small Area Statistics, 2002-2010[54]. 42 tonnes of waste are likely to be available for every 1000 birds annually, as described by the Welsh Toolkit. For mass producing farms, 100% of the litter can be assumed to be utilised.

The Welsh Toolkit states that 11,000 tonnes of litter per annum is required for each 1MWe of electrical generating capacity.

[53] This figure consist only ‘food waste’ and ‘other compostable waste’ for

[54] Data from Welsh Government (2011) *Agricultural Small Area Statistics, 2002-2010.* Available from: http://wales.gov.uk/topics/statistics/headlines/agriculture2011/110728/?lang=en [Accessed 24 April 2012].

Results

Table 5.21 provides information on the number of poultry in Gwynedd and the amount of litter available for anaerobic digestion.

Table 5.21 Poultry litter yield

Source	Number of animals within Gwynedd[55]	Tonnes of litter per 1000 birds	Tonnes of litter per year
Poultry	27,236	42	1,143.9

The results from the resource assessment for poultry litter are reported in **Table 5.22**. For the purposes of this resource assessment, it has been assumed that the poultry litter resource is used for a combined electricity and heat resource. A capacity factor of 90% as outlined in **Table 4.10** and **Table 4.11** has been used for the estimate electricity generation and 50% for heat generation.

Table 5.22 Poultry litter resource potential

Available Resource	Calculated tonnes of poultry litter/annum	Accessible Resource		Potential Annual Generation	
		Electricity (MWe)	Heat (MWt)	Electricity (MWe)	Heat (MWt)
Poultry	1,143.9	0.1	0.15	0.8	0.7

In practice, a resource of less than 10MW is unlikely to support a dedicated poultry litter power plant. However, it could go towards supporting other anaerobic digestion facilities.

5.8.4 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.

Arup was commissioned by Gwynedd Council in December 2011 to identify and develop solutions to stimulate the use of renewable biogas fuels in and around the Mon a Menai region. The options identified were developed into a feasible business plan, with all cost and benefits, including the wider social and environmental benefits. This is considered further in chapter 6 on deployment.

Main Assumptions

According to the Consultation on a Bioenergy Action Plan for Wales, there is likely to over 100,000 tonnes of dry sewage solids[56], available annually, for the generation of energy utilising anaerobic digestion plant.

[55] Data from Welsh Government (2011) *Agricultural Small Area Statistics, 2002-2010.* Available from: http://wales.gov.uk/topics/statistics/headlines/agriculture2011/110728/?lang=en [Accessed 24 April 2012].
[56] Or rather dry tonnes "equivalent" as the solids in the sewage will not actually be dry

Using the figure quoted in the Consultation on a Bioenergy Action Plan for Wales, the figure of 100,000 tonnes is assumed an equal split of sewage based on population by unitary authority[57].

For electricity generation, 13,000 tonnes of dry solids will be needed per 1MWe[58]. This assumes the following: 1 tonne of dry solids produces 340m³ of biogas; 1m³ of biogas has an energy content of 5.8kWh; an electricity generation efficiency of 30% and a capacity factor of 0.9.

Results

Table 5.23 provides information on the tonnage of available sewage sludge in Gwynedd and the amount of potential installed capacity for anaerobic digestion using sewage sludge. For the purposes of this resource assessment, it has been assumed that the sewage sludge resource is a combined energy resource. A capacity factor of 90% as outlined in Table 4.10 and Table 4.11 has been used for the estimate electricity generation and 50% for heat generation.

Table 5.23 Sewage sludge resource potential

Available Resource	Calculated tonnes of sewage sludge tonnes/annum	Potential Capacity		Potential Annual Generation	
		Electricity	Heat	Electricity	Heat
Sewage Sludge	3,949	0.3MWe	0.4MWt	2.4GWh	2.0GWh

5.9 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.[59]

Main Assumptions

We have taken the potential installed capacity from the Welsh Marine Renewable Energy Strategic Framework, produced in 2011[60]. This explored all large scale marine potential in Wales, and identified an area off the coast of the Llŷn Peninsula. In reality there is likely to be additional smaller resource available around the coast of Gwynedd, but there is now existing data available on this.

A capacity factor of 25% has been as outlined in Table 4.10 and Table 4.11 has been used to estimate electricity generation from tidal power[61].

[57] Table 44, Planning for Renewable and Low Carbon Energy – A Toolkit for Planners, July 2010
[58] Planning for Renewable and Low Carbon Energy – A Toolkit for Planners, July 2010
[59] Tidal energy in Wales, A note by Sir John Houghton, Chief Scientific Advisor Climate Change Consortium, of Wales, (C3W), February 2012
[60] RPS for Welsh Government, *Marine Renewable Energy Strategic Framework*, March 2011, http://mresf.rpsgroup.com/
[61] See Appendix 1, A Low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement, March 2010

Results

Table 5.4 provides information on the available resource and potential electrical generation of tidal power in Gwynedd.

Table 5.24 Tidal resource potential

Available Resource	Potential Capacity (MW)	Potential Annual Generation (GWh)
Tidal range	40	87.6

5.10 Summary of Renewable Resources

A summary of the results of chapter 5 are set out in Table 5.25 below. This represents the total available resource, taking into account existing resource, environmental and spatial constraints.

Table 5.25 Summary of Gwynedd renewable resource potential

Category	Sub-Category	Potential Capacity (MWe) [Electricity]	Potential Generation (GWh) [Electricity]	Potential Capacity (MWt) [Heat]	Potential Generation (GWh) [Heat]
Wind (onshore)	Wind Clusters	97.5	230.5	-	-
Hydropower	Small Scale Hydropower	1.1	3.6	-	-
Microgeneration	Solar	32.9	28	9	7
Anaerobic Digestion	Heat Pumps	-	-	304	-
	Sewage Sludge	0.3	2.4	0.5	2.0
Energy from Waste (EfW)	Poultry Litter	0.1	0.8	0.2	0.7
	Food Waste	1.1	8.2	1.6	6.8
	Animal Manure	0.9	7.1	1.4	5.9
	MSW and C&IW	0.9	7.4	1.9	8.3
Biomass	Waste Wood	0.5	4.3	1.1	4.8
	Managed Woodland	4	31.3	8	34.7
Tidal	Energy Crops	13.9	109.6	27.8	121.8
	Tidal	40	87.6	-	-
Total	-	**238.3**	**670.2**	**346.5**	**185**

5.11 Supply vs. Demand

The tables below set out how supply of renewable energy might meet energy demand in Gwynedd, both now, and in the future.

It can be seen that using all available resource assessed, renewable heat sources could account for 34% of Gwynedd's total predicted gas or heat demand in the year 2020, whereas there is more than enough renewable electricity resource for Gwynedd to be self-sufficient in electricity use.

The assumptions that have been used in the resource assessment have predominantly assumed the use of CHP to supply both heat and electricity. This analysis suggests that there is a greater need for renewable heat, and depending on the location, requirements and context, it might be worth considering producing heat only from some sources (e.g. biomass).

Heat

Table 5.26: Heat Supply and Demand, 2010 and 2020

	Demand (GWh)		Supply (GWh)		% Demand met by renewables	
Year	2010	2020	2010	2020	2010	2020
	586.6	545.6	0	185	0%	34%

Electricity

Table 5.27: Electricity Supply and Demand, 2010 and 2020

	Demand (GWh)		Supply (GWh)		% Demand met by renewables	
Year	2010	2020	2010	2020	2010	2020
	568.8	548.2	171.9	670.2	30%	122%

Total

Table 5.28: Energy (Heat and Electricity) Supply and Demand, 2010 and 2020

	Demand (GWh)		Supply (GWh)		% Demand met by renewables	
Year	2010	2020	2010	2020	2010	2020
	1884.8	1093.8	171.9	855.2	9%	78%

5.12 Opportunities Beyond Gwynedd

The analysis above has looked at the resources within Gwynedd (and on its directly adjoining coast). However, there are also wider opportunities that should be considered as part of this study; that will have the potential to provide both renewable energy and jobs for Gwynedd. The most significant opportunities are outlined in more detail below.

5.12.1 Biomass at Anglesey

Permission has been granted for a 299MW biomass power station at the Anglesey Aluminium site in Holyhead. Reports suggest that this plant would create 250 jobs during the two year construction and 150 new permanent jobs. It is not yet clear where all of the fuel will be sourced from, but there are undoubtedly opportunities for Gwynedd companies to position themselves well to form part of the supply chain.

5.12.2 Offshore wind

A 'round two' offshore wind farm has been consented at Gwynt y Mor of the North coast of Wales, and a large site has been identified in the Irish Sea as part of round three. Whilst much of the supply chain for offshore wind will continue to be best outside the UK, construction at this scale means that is likely that there will be some more local supply chain opportunities that Gwynedd could take advantage of.

5.12.3 Pumped hydro

As noted previously, pumped hydro does not normally count as renewable energy production, but can play an important role in managing our electricity supply. There is already a scheme of approximately 50MW planned at Glyn Rhonwy, and other opportunities within the county have been identified. For example, David MacKay[62] identifies two potential sites in Snowdonia that could be used. These sites were considered alongside Dinorwig in the 1970s when Dinorwig was chosen.

Proposed location	Power (GW)	Head (m)	Volume (million m^3)	Energy Stored (GWh)
Bowydd	2.40	250	17.7	12.0
Croesor	1.35	310	8.0	6.7

5.12.4 Associated infrastructure

Additional associated infrastructure may be required in line with new renewable energy generation. This might be connections to the National Grid, private wires, or new access roads, for example.

Indicative costs for underground cable connections in North Wales are set out in the table below. However, it is noted that costs may be higher in rural Gwynedd.

Table 5.29: Indicative costs for underground cable connections (£000s), Arup analysis

		Distance (km)						
		2.50	5	7.5	10	15	20	25
Capacity (MW)	2	£320	£570	£820	£1,070			
	7.5	£1,060	£1,560	£2,060	£2,560			
	20		£4,610		£8,610	£12,610	£16,610	
	40		£9,740		£16,740	£23,740	£30,740	
	100		£12,570		£18,940	£25,320	£31,690	£38,070
	200		£17,350		£28,500	£39,660	£50,820	£61,970

[62] David MacKay, *Sustainable Energy – Without the Hot Air*, [accessed online http://www.withouthotair.com/]

6 Deployment Rates and Potential

6.1 Introduction

This section contains information on potential deployment constraints and analysis for each of the technologies discussed within chapter 5. Forecasting deployment rates can be extremely difficult and needs to consider a much wider range of economic and political factors than this study has not been able to explore in any detail. For each technology, consideration of the constraints and a high level forecast of future delivery have been discussed and a realistic deployment scenario extracted that ought to be achievable within the next five years.

6.2 Overarching Constraints to Deployment

Many of the constraints and opportunities for renewable energy deployment will be linked to individual technologies. However, there are certain overarching constraints that are applicable to many or all technologies. Table 6.1 below sets out the non-economic constraints related to renewable energy deployment in Gwynedd (economic constraints and market barriers are set out in chapter 7.5).

Table 6.1: Non-economic constraints related to renewable energy deployment

Constraint	Description
Consenting	Perceived (and actual) difficulty in obtaining planning permission and environmental consents, particularly in and around the National Park. This is particularly an issue for larger scale developments.
Grid Connections	Perceived (and actual) difficulty and cost constraints of connecting new development to the grid. This is particularly an issue in more rural parts of the county and for smaller scale development.
Public Perception	There remains 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 public perception of renewable energy schemes can lead to a negative response to developments locally, which can add to a delay in the consenting process.

In many circumstances, these overarching constraints are related to perception, rather than being fixed physical or system constraints. There are actions suggested to overcome these constraints set out in chapter 9.

6.3 Onshore Wind Clusters

There is 4.63MW wind currently installed or approved in Gwynedd (April 2012). The maximum deployment identified was 97.5MW.

Snowdonia National Park presents a major constraint for the development of large scale wind energy within Gwynedd. The 97.5MW already assumes that no wind development will take place within the National Park.

However, of the possible locations for additional wind clusters, all of the areas with the highest potential (each for 25MW) are close to the National Park boundary and may face planning constraints or delays for this reason.

Currently the lead time for construction of equipment is around 15 months, although this is decreasing. In addition, accreditation and certification of equipment is acting as a constraint for deployment in the short term.

In addition, there have been recent government proposals to cut ROCs by 25% for onshore wind developments. This is likely to create uncertainty in the market and may slow investment in this area.

It is therefore felt that a central deployment estimate for the next five years of 25% of the 97.5MW identified in chapter 5 is a realistic estimate, based on current conditions.

6.3.1 Capital Costs

Costs for onshore wind development vary on a project-by-project basis; variation is frequently driven by difficulty in obtaining planning consent and dealing with appeals. Data gathered by Arup for the Department of Energy and Climate Change showing the average cost per MW in the UK for different scales of development is set out in table 6.2 below[63].

Table 6.2: Onshore Wind – capital costs (financial close 2010)

£'000/MW	<50kW	50kW – 5MW	> 5MW
High	4,330	1,858	1,820
Median	3,762	1,548	1,524
Low	2,786	1,174	1,184

6.4 Small-scale Hydropower

There are currently 16 operational hydropower schemes in Gwynedd; the largest being Maentwrog at 30MW.

The topography of the County means that technical opportunities for hydropower are great. However, the Environment Agency (EA) defines most of these opportunities as being highly environmentally sensitive. Further work would be required on a site by site basis to understand whether each of these opportunities was realistic. We estimate that 100% of the 1.1MW which is not highly sensitive is likely to be accessible in the coming 5 years. As previously discussed (section 5.4), the EA data represents a low estimate for Gwynedd. We believe this could be exceeded, but have used this figure for consistency and to reflect the complexity and timescales of planning consent and environmental licensing, particularly within the National Park.

In addition, the cost of grid connection in rural areas can become very expensive, making smaller schemes uneconomical.

The other constraint on deployment is the limited number of suppliers of low head turbines, and these are currently all based in Europe (outside the UK).

6.4.1 Capital Costs

Costs for hydropower development vary on a project-by-project basis; variation is frequently driven by difficulty in obtaining licenses and planning consent. Data gathered by Arup for the Department of Energy and Climate Change[64] showing the average cost per MW in the UK for different scales of development is set out in table 6.2 below. This

[63] Arup for DECC, *Review of the generation costs and deployment potential of renewable electricity technologies in the UK*, 2011
[64] Arup for DECC, *ibid*, 2011

includes data for both high head and low head plants, but does not include pumped storage development.

Table 6.3: Hydropower – capital costs (financial close 2010)

£000s/MW	<1 MW	1 – 5 MW	>5 MW
High	9,507	4,982	2,858
Median	4,481	2,800	2,307
Low	2,797	2,423	1,448

6.5 Energy from Waste

The North Wales Residual Waste Treatment Project conducted a study which identified the Deeside site in Flintshire as the site with most potential for the development of a residual waste management treatment facility. The Partnership is currently evaluating final tenders from contractors, and whilst it is possible that a different site will be selected, this is not expected.

This means that despite the fact that the resource is produced within Gwynedd, there will be no opportunity to use this resource within Gwynedd in the medium to long term.

However, local employment within North Wales is one of the criteria by which the tenders will be judged. This may mean that some employment can be expected to be created in Gwynedd, e.g. during construction or increased demand for waste collection staff.

6.6 Biomass

The most easily accessible biomass resource is Forestry Commission woodland. This is the resource most likely to be deployed in the short to medium term. The single ownership of a large area by a single public sector body should mean the resource is easier to access than privately owned woodland, where ownership and access is often fragmented. For both sources, there is some competition from other uses of woodland.

We have therefore assumed that a total of 40% of woodland resource will be easily accessible over the coming 5 years to reflect the division of Forestry Commission and private woodland.

A 2003 study for the Gwynedd Agri-Innovation Initiative found that 8,300 ha. of land to the north of the County would be suitable for growing Miscanthus. This represents about 12% of the area identified by the Welsh Toolkit methodology.

Energy Crops have become less favoured by many in recent years. The competition for land use with food makes them unattractive to some parties and they can also lead to monocultures and a lack of biodiversity, making them unpopular with many environmental groups. This competition in some quarters has made take up slower than expected, and there is no indication that this will significantly reverse.

Current planting rates are low across the UK, because of uncertainty about the marketability of the fuel, the high prices being achieved for other agricultural products (e.g. wheat currently offers farmers a higher return), and the changes to the Energy Crops Scheme. In addition, when Energy crops are planted then they compete with biofuels for use.

We have therefore assumed a relatively low uptake of 20%.

Waste wood is commodity and will compete with other uses from other industries; but could be largely accessible should the right incentives be in place, we have therefore assumed a high uptake of 80%.

For all biomass, it is worth noting that we have calculated the biomass that could be grown in Gwynedd. In reality, it would be possible for biomass grown elsewhere to be used in Gwynedd, and vice versa.

6.7 Microgeneration

The issues relating to deployment of micro-renewables are not necessarily related to the technologies in use, but rather whether they are built into new developments, or retrofitted onto existing buildings. The local planning authorities have much more control over new development. This is discussed in more detail below.

6.7.1 New Development

New developments provide an excellent opportunity to deliver new microgeneration with minimal disruption and in a cost effective way. This is also the area where the local planning authority has greatest ability to influence developers.

In the past, we have seen varying requirements from local planning authorities across the UK. A famous example is the "Merton Rule" whereby new developments were required to provide 10% of their energy needs from renewable energy. This is still an approach taken by some councils; for example, Bristol City Council, in their Climate Change and Sustainability Practice Note (September 2011) set out the need for developments to provide 20% of their energy needs from onsite renewables. Others have taken different approaches; some argue that this approach is too restrictive and that this prescriptive approach to renewables targets can detract from the energy hierarchy (see **Figure 6.1**).

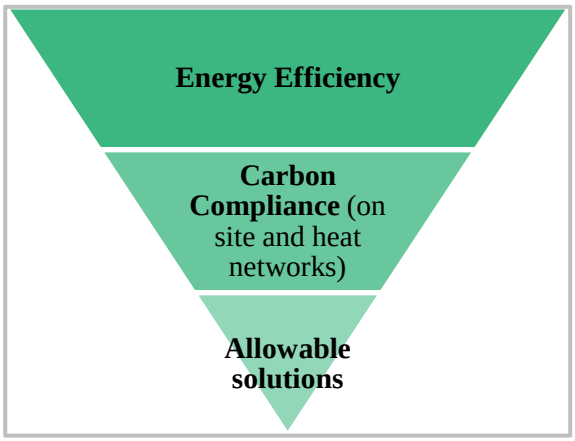


Figure 6.1 Energy Hierarchy

Requiring an Energy Strategy to be produced for developments, with guidance as to what this should entail, and the levels and types of renewable energy that might be expected on designated sites is one way of overcoming this. This could be required for all new developments (as required by e.g. National Parks in Wales or by Bristol City Council), or for sites over a certain size (e.g. over 1000m² as suggested in TAN 8).

Nationally, the following requirements apply or are planned in Wales.

Table 6.4: Timeline for Sustainable Buildings Requirements in Wales

	2009	2010	2013
Building Regulations			55% reduction over 2006 requirements (domestic only)
Code for Sustainable Homes (1 property +)		Level 3 and 1 credit under Ene1 - Dwelling Emission Rate	
BREEAM (non-domestic, over 1,000m2)	Very Good plus Excellent under Ene1 - Dwelling Emission Rate		

These will mean that some improvements to deployment of micro-renewables in new build will happen as a matter of course over the coming years.

6.7.2 Retrofit

Microgeneration is technically one of the areas of greatest potential in Gwynedd, and over 75% of this capacity is available through retrofitting existing buildings. By 2050, over 80% of the housing stock in the UK will be made up of the homes that we live in today[65].

Planning policies can encourage and facilitate greater integration of renewable energy technologies through the appropriate retrofitting of such technologies to existing buildings.

However, the barriers to retrofit, particularly on domestic properties, remain high and it will be very hard to deliver the full quotient of renewable energy that is technically available. Homeowners tend to perceive it as expensive and disruptive, and as yet, it remains difficult to achieve uplift in property value as a result of the initial investment. Barriers include:

- Upfront investment required by homeowner
- Capacity of the supply chain
- Perceived disruption factor

Gwynedd Werdd has most control over its partner's own building stock. For example, Arup was commissioned by Carbon Trust Wales to conduct an assessment of the suitability for integrating renewable technology into 22 of Gwynedd County Council's existing buildings[66]. An extrapolation exercise across the Council's whole estate demonstrated that nearly 70% of sites are suitable for PV and Biomass, whilst approximately 40% and 20% would be suitable for Solar and wind respectively. By extrapolating the findings of the study across the whole estate an annual carbon emission saving of approximately 8,190 tonnes CO_2 can be made.

The UK government's Green Deal is designed to overcome some of the barriers described above for householders, but will focus on energy efficiency before micro-renewables.

[65] Brenda Boardman (November 2007) *Home Truths: A Low Carbon Strategy to Reduce UK Housing Emissions by 80%.* University of Oxford Environmental Change Institute.
[66] Arup for the Carbon Trust and Gwynedd Council., (2011), *Op Cit.*, Ref PO032639

The Green Deal is a product of the Energy Act 2011 and is a mechanism to provide funding for energy efficiency and low carbon technology for residential and commercial buildings across the UK, particularly as retrofit measures. The scheme launched in October 2012[67]. Whilst its emphasis is on energy efficiency first the Green Deal may provide a key opportunity for decreasing energy demand within Gwynedd and for providing funding streams for microgeneration. The Green Deal will work on the basis that measures are completed by a private accredited installer and the consumer will pay back the cost of the work through their energy bills for a period of time. The obligation to pay is tied to the property and therefore if a resident moves the obligation will move to the new resident[68]. Measures covered by the Green Deal include those shown in the table below, but will be assessed as part of the scheme for their suitability.

Table 6.5 Measures available through the Green Deal[69]

Measures	
Heating, ventilation and air conditioning	Condensing boilers Heating controls Under-floor heating Heat recovery systems Mechanical ventilation (non-domestic) Flue gas recovery devices
Building fabric	Cavity wall insulation Loft insulation Flat roof insulation Internal wall insulation External wall insulation Draught proofing Floor insulation Heating system insulation (cylinder, pipes) Energy efficient glazing and doors
Lighting	Lighting fittings Lighting controls
Water heating	Innovative hot water systems Water efficient taps and showers
Microgeneration	Ground and air source heat pumps Solar thermal Solar PV Biomass boilers Micro-CHP

Further funding will be available for these measures through the Energy Company Obligation (ECO) which will focus on lower income and vulnerable residents and hard-to-treat properties such as solid wall properties[70].

[67] ENDS Report Bulletin, Councils face up to the green deal challenge. [online].(18 April 2012), [Accessed 19 April 2012].
[68] DECC, (2010) *The Green Deal - A Summary of the Government's Proposals* [online]. [Accessed 19 April 2012].
[69] DECC, (2011) *What Measures does the Green Deal Cover* [online]. [Accessed 18 April 2012].

DECC hope that local authorities such as Gwynedd will play a key role in delivering the Green Deal and ECO either directly or through partnering with local organisations.

6.7.3 Solar PV

Solar PV saw a big surge in uptake over the last few years, due, in large part, to the Feed-in-Tariffs, which were particularly favourable for solar PV. As this rate has been reduced, it is assumed that uptake will slow down considerably.

We have therefore assumed that 30% of the total available PV capacity will be realised.

6.7.4 Solar Thermal

Solar thermal benefits from the new Renewable Heat Incentive, and as a result, we have assumed that uptake of solar thermal will increase from its current rate. In addition, with many properties in Gwynedd being off the gas grid, heat technologies may be more financially viable that in other parts of the UK. We have assumed that 40% of the total available capacity could be achieved in the next 5 years.

6.7.5 Heat Pumps

Heat pumps will also benefit from the Renewable Heat Incentive and from many properties in Gwynedd being off the gas grid. However, with ground source heat pumps in particular, the disruption will be considerable, with gardens needing to be dug up, and this may put many people off considering them, particularly as a retrofit option. The constraints may be physical as well as attitudinal, which may mean that the less efficient air source heat pumps will be more popular. Heat pumps use electricity to run, and the amount of electricity required per unit of thermal output varies according to heat pump type and a range of other factors relating to the physical environment and the design of the system.

We have therefore assumed just a 10% uptake of the total available in the next 5 years.

6.8 Anaerobic Digestion

6.8.1 Sewage Sludge

Dŵr Cymru Welsh Water (DCWW) has a Waste Water Treatment Works at Treborth near Bangor. DCWW is currently considering re-commissioning of the exiting digesters during the Asset Management Period (AMP) 6, between 2016 and 2020.

Dŵr Cymru has expressed positive interest in the option to operate the CHP as planned with a low flow side stream biogas upgrading plant and compressor.

DCWW considers that this site could process approximately 4,000 tonnes of solid waste, which is the total capacity of the county. It may be that some of this would be sourced out of county, but the economic impact is likely to be very similar.

[70] DECC, (2011) *Extra Help Where it is Needed: A New Energy Company Obligation*. [online]. [Accessed 18 April 2012].

Arup conducted an analysis of options to supply locally produced compressed biomethane gas (CBG) in and around the Môn a Menai region, for use by local transport fleets. The work was commissioned by Gwynedd Council, as part of the Welsh Government Sustainable Transport Centres program. Treborth is considered the most viable location for production of biogas in Gwynedd.

6.8.2 Food Waste

Biogreenfinch has been awarded a contract to build and operate an anaerobic digester at Llwyn Isaf former waste landfill site located near Clynnog Fawr some 8 miles south of Caernarfon.. The facility will deal with about 11,000 tonnes of food waste. About 8,500 tonnes collected from households by the Council and 2,500 tonnes from businesses in the area.

This means that there could still be over 20,000 tonnes of commercial food waste left untreated within Gwynedd. It is unlikely that much of this will be accessed in the current regulatory and commercial system, as the current commercial procurement process does not tie companies into long enough contracts to make this commercially viable.

It is therefore assumed that 40% of the potential food waste resource could be used within 5 years.

6.8.3 Animal Waste

Anaerobic Digestion plants that process animal waste are generally on farm digestors and AD plant development in the UK has been slow compared to some other EU member states. There are completing demands for waste streams, particularly from biofuels and use as fertilisers.

In addition, the technical complexity and associated capital and operational costs depend on the feedstock to be treated. This can make it an unattractive option for diversification for farmers in some instances.

However, it is a waste stream that has potential and should be considered further. We have assumed that 40% of the resource could be used by 2017.

6.9 Tidal

Tidal is perhaps the most nascent of all the technologies described in this report and an Arup report for DECC[71] suggested that there is likely to be limited deployment by 2020. This was based on the following factors:

- Supply chain constraints – industry is likely to be developed around existing offshore wind deployment facilities;
- Commercial – wave and tidal technologies are yet to be commercialised. Investment and R&D is still required to develop commercial technology and the infrastructure to aid deployment;
- Grid constraints – best sites for marine technology are located in remote areas where the availability of the grid capacity could prove to be a constraint; and
- Planning at this stage is not considered to be a major constraint. However, the current system has only dealt with a few demonstration projects. As deployment

[71] Arup for DECC, *Op Cit.*, October 2011

of marine technology increases, there is likely to be a conflict with other sectors for prioritisation.

The Welsh Marine Renewable Energy Strategic Framework[72] suggests that tidal stream is likely to be the most appropriate technology off the coast of Gwynedd. Tidal stream is seen as the most promising technology in the short term. However, the costs and funding gaps have been re-confirmed as still challenging. We have therefore assumed 20% chance of take up over the next 5 years or so.

6.9.1 Capital Costs

The 2010 report by Black and Veitch and Ernst and Young for DECC[73] sets out the average capital and operational costs for tidal stream projects as they develop for demonstration projects to commercial projects. These average costs are set out in table 6.6 below.

Table 6.6: Average costs for tidal stream development

	Pre-demonstration project	**Demonstration project (cost for developers first 10MW project**	**Commercial project costs (for developer's first 10MW project after 50MW deployed**
Tidal Stream Shallow			
Capex / MW	£11.2m	£4.3m	£3.2
Opex / MW / year	£0.47m	£0.31m	£0.15
Tidal Stream Deep			
Capex / MW	£8.6m	£3.5m	£3.3m
Opex / MW / year	£0.31m	£0.16m	£0.12m

[72] RPS for Welsh Government, *Op Cit*, March 2011,
[73] Ernst & Young and Black & Veitch for DECC and Scottish Government, *Cost of and financial support for wave, tidal stream and tidal range generation in the UK*, October 2011

7 Economic Impact Assessment

7.1 Introduction

This section assesses the potential economic impacts based on the outputs of the capacity assessment. The analysis has applied a range of sensitivities and sense checks to ensure that realistic results are provided. To help with action planning the direct job creation potential for renewable energy development, installation and operation are provided up to 2017 with a longer term consideration of the maximum employment potential if the all of the technically available renewable energy capacity is installed.

This analysis also provides forecasts of the total economic value, presented as gross impacts and net local impacts where sufficient evidence exists to translate this into economic value for Gwynedd. The principle methods include an assessment of the local employment potential utilising evidence developed by Mott Macdonald of the job potential per installed capacity of a given renewable energy technology.

Further analysis is also possible on the basis of turnover, income and gross added value to the local economy.

It is also important in framing the action plan to have a clear focus on the principal barriers, as well as the opportunities, to realising the economic potential that renewable energy offers to Gwynedd, its business, residents and visitors. This section also sets out some of the main economic barriers and opportunities for capturing benefits in Gwynedd.

7.2 Methodology

The economic analysis builds on the capacity analysis to quantify the economic impacts of renewable energy in Gwynedd; this impact is calculated both in terms of jobs and monetary impact.

7.2.1 Employment Impacts Methodology

This study uses benchmarks of jobs per MW in order to analyse the energy outputs of the capacity calculation (Mega Watts per technology) and convert this data into employment impacts, given in job years[74].

The jobs per MW benchmarks are taken from a 2004 Department for Trade and Industry report entitled *'Renewable Supply Chain Gap Analysis'.* The *Renewable Supply Chain Gap Analysis* formed the benchmarks based on interviews with over

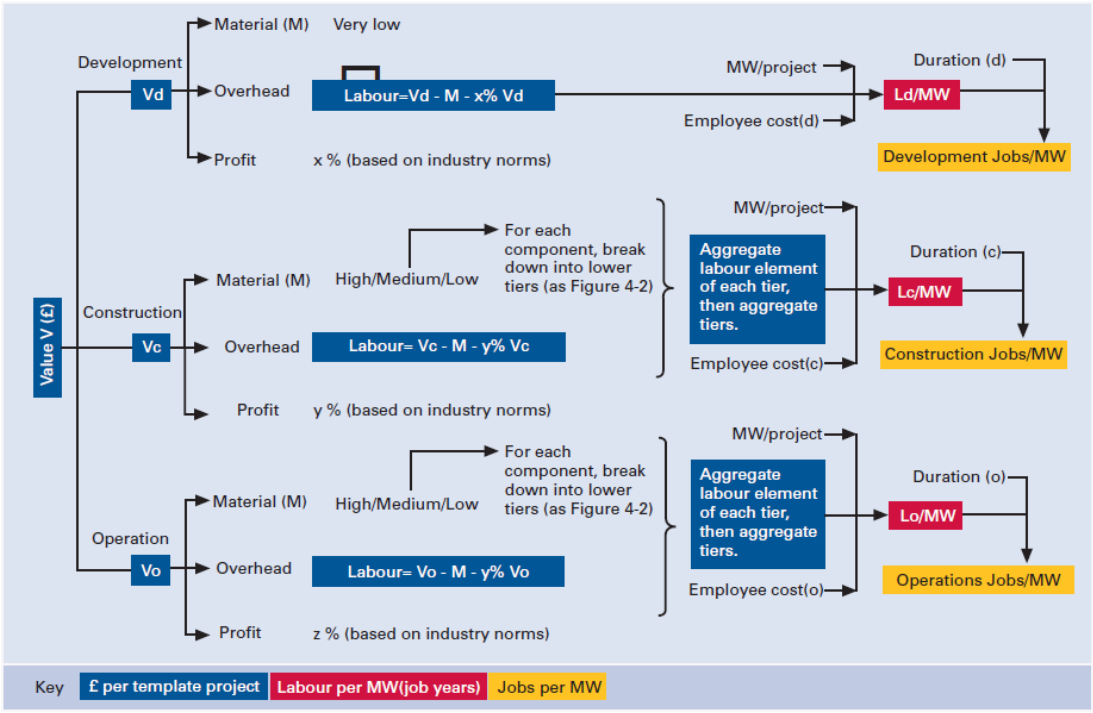
[74] A job year is the amount of time where one person is employed full time for a year. This time bound measure enables employment effects of the construction and manufacturing phases to be directly compared with the employment effects for the installation phase as the job year measure controls for the duration of employment. This is important too as the manufacturing and installation of a wind turbine for example is one off, in contrast to maintenance which is on-going for the life cycle of the equipment. Therefore, the quantum of employment is determined by repeat orders and is not continuous and hence is expressed in years as opposed to positions per se. However, accepted guidance on the persistence of benefits means that 10 job years duration of employment is equivalent to one full time equivalent position (FTE). This allows for a more realistic comparison of job creation.

550 companies across renewables technologies and remains the most comprehensive study of the employment impacts of renewables technology.

Other studies have identified different jobs benchmarks ranges. For example, the Zero Carbon Britain 2030 report finds solar thermal to have a total of 14 job years per MW whereas the *Renewable Supply Chain Gap Analysis* identifies 21 job years per MW. However, the Zero Carbon Britain 2030 report derives its benchmarks from a number of different sources and thus cannot provide the consistent methodology of calculation across technologies that the *Renewable Supply Chain Gap Analysis* approach provides. We have used the most specific data that can be built up from a local, ground assessment of renewable energy deployment potential to inform the economic assessment.

The methodology used in the study to estimate the job years per MW is shown in the below figure. The methodology is based on templates of typical projects which have been constructed for each of the technologies. These templates were built using data from developers along with intelligence from industry experts. The methodology disaggregates the impacts into three phases – development, construction and operation.

Figure 7.1 – Method to Estimate Jobs per MW



Note: Refer to Glossary for definition of terms, other terms defined above

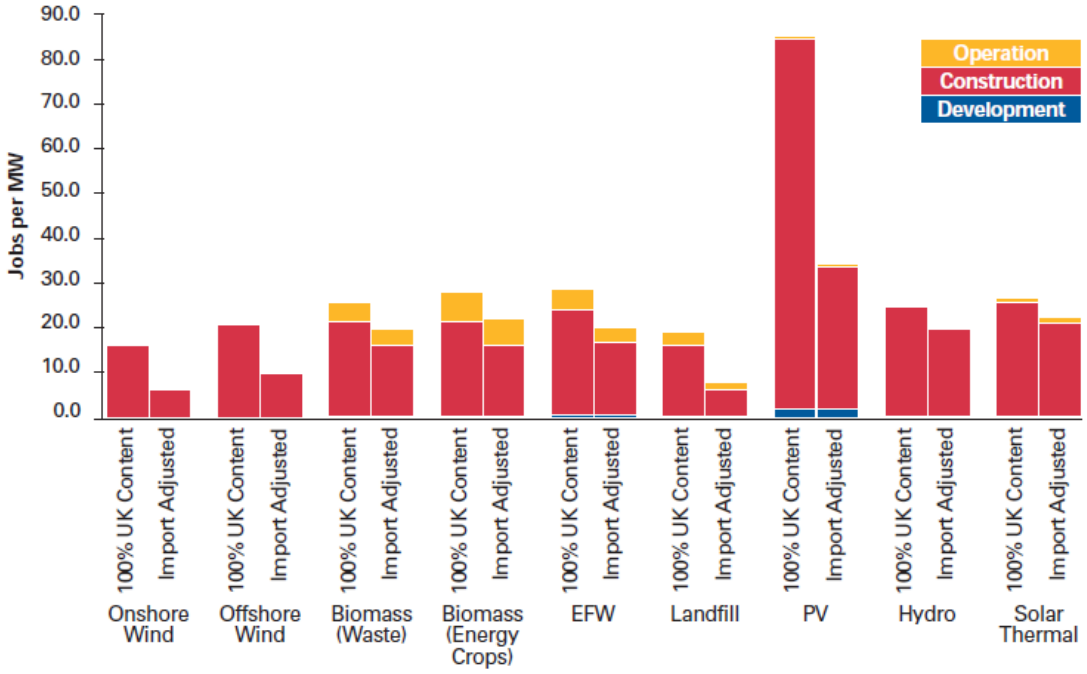
V	Total monetary value: as defined above
M	monetary value of material content
L	Labour content (in "job years")
L/MW	Labour content (in "job years") per MW
d, c, o	denote development, construction and operations respectively

Source: Renewable Supply Chain Gap Analysis, Department for Trade and Investment

The output of jobs per MW is calculated using two approaches – one which assumes 100% UK content of renewables projects and an import adjusted basis which is 'obtained from the study surveys, comment from participating companies and

industry knowledge of manufacturers and service providers to create a view on the current level of imports.' The results of these calculations are shown below.

Figure 7.2 – Jobs per MW by Phase of the Project Cycle and Technology



Note: PV is currently very capital and labour intensive. The market penetration of this technology is low

Source: Renewable Supply Chain Gap Analysis, Department for Trade and Investment

This study uses the import adjusted figures from the *Renewable Supply Chain Gap Analysis*. The raw data for the DTI study is not available, however the values are shown in the report graphs, Appendix D shows how values were taken from these graphs.

The benchmarks are then applied to the calculated capacity, both current and future, to find the employment impacts. However, it should be noted that these figures will reflect the employment impacts at a UK level. The degree to which this will impact upon Gwynedd will vary with technology with operation jobs more likely to be beneficial at a local level.

These data provide the most accurate empirical data for the UK. However, for technologies such as tidal or heat pump specific metrics do not exist so the closest proxy technology has been used to project the potential job creation.

Applying these benchmarks to the potential capacity indicates the employment potential which could be achieved assuming that the potential capacity would be fully realised. Thus, this represents the maximum potential renewables job impact.

However, it is important that an achievable scenario is also considered first and foremost, alongside the maximum potential and therefore a more realistic impact assessment is set out in the results below.

The methodology for the achievable scenario was that a likely deployment proportion was applied to each technology based on insights from the consultation and knowledge of renewables schemes elsewhere (as set out in chapter 6).

It is important to note that this analysis presents jobs years. Manufacturing and installations jobs require additional orders to maintain jobs year on year, this figures represent the peak that can be achieved in jobs years. However, operation and maintenance requires on-going employment and these jobs are more durable and have greater longevity and thus sustained local impact.

7.2.2 Economic Impacts Methodology

The employment impacts can be converted into economic impacts by combining the realistic jobs impact scenario with the average wages in Gwynedd and presenting results that are quantified in terms of economic value, of which gross value added (GVA) for Wales is £36,166.

The results below focus on employment and also present the economic value in terms of gross value added.

7.3 Results

The economic impact findings are presented in table 7.1 below. It is important to note that whilst the main focus of the study is on improving the local economy in Gwynedd, it is important to recognise that due to the spread of the actual supply chains for manufacturing renewable energy technologies and in some cases the installation of specific technologies not all of the benefits are captured locally. The analysis of the results in this section aims to distil the best available evidence base to understand the potential and likely magnitudes of economic impacts in Gwynedd.

In summary, the main finding is that the overall direct job creation potential is limited yet important. The potential to create manufacturing, construction and installation jobs is significant with in excess of 2,200 direct jobs possible if an additional 111.7 MW of renewable energy is invested in and deployed over the next five years. However, the majority of these jobs will not be local to Gwynedd as they will accrue in supply chains across the UK. Nonetheless, there is an important contribution to the overall total transition to a lower carbon economy which Gwynedd makes. It is recognised that developing renewable energy may have wider benefits than the direct job and income creation in Gwynedd, for example cost savings, increased energy resilience and wider efficiencies that can benefit local firms and householders.

In terms of local economic impact it is the combined operational jobs as well as the installation jobs that are more likely to directly benefit Gwynedd. The technologies which are most likely to generate direct new employment locally are biomass as well as the installation, maintenance and operation of solar PV and heat pumps.

Applying industry benchmarks indicates that approximately 18% of the total jobs for solar technologies (PV and solar heating) and 10 % for heat pumps are installation jobs. These relate to the actual fit of the technology for the company supplying the solution. These jobs will tend to be more local and within a reasonable travel time. This means that up to 95 job years of the heat pump jobs may be in Gwynedd, North West Wales, North East Wales and North West England. For solar technologies the installation jobs are approximately 108 job years.

The table below highlights that solar PV, solar thermal and biomass offer the greatest potential for direct job creation along with wind in respect of manufacturing and installation. In terms of local employment it is the operational and maintenance jobs which offer most for the workforce in Gwynedd. Achieving a roll out of 111.7 MW of renewable energy can generate 2,200 job years manufacturing, installation and related employment.

Table 7.1 – Peak Medium Term Job Creation Potential up to 2017

	Additional MW Deployed	Manufacturing and Installation Jobs	Operational and maintenance jobs
Wind (onshore)	**33.2**	**199**	**3**
Hydropower	1.0	20	**0**
Solar (PV and thermal)	**18.3**	**579**	**9**
Heat pumps	**30.4**	**964**	**15**
Anaerobic digestion	2.2	35	**10**
Energy from waste	0.0	0	-
Biomass	**18.6**	**335**	**123**
Tidal	8.0	76	**2**
Total	**111.7**	**2,207**	**162**

Source: Mott Macdonald data and Arup analysis, 2012

The economic impacts of adding 111.7MW would be £78 million of gross value added (GVA) for the manufacturing and installation phase and £5.8m for the operational phases. If these impacts are spread over the 5 years this equates to £15.6 million of GVA per year from manufacturing and installation with £1.2 million per year for the operational and maintenance employment.

The table below indicates the long term potential for creating manufacturing, installation and operational jobs beyond 2017 if the maximum deployment potential were to be achieved.

Table 7.2 – Peak Additional Job Creation Potential if the Extra Mega Watts of Renewable Energy are Deployed over the Long Term

	Additional MW Deployed	Manufacturing & Installation Job Years	Manufacturing & Installation Jobs
Wind (onshore)	269	1,614	161
Hydropower	0	-	-
Solar (PV and thermal)	37	1,171	117
Heat pumps	274	8,673	863
Anaerobic digestion	3	53	5
Energy from waste	3	45	5
Biomass	37	661	66
Tidal	32	304	30
Total	**654**	**12,522**	**1,252**

Source: Mott Macdonald data and Arup analysis, 2012

Over 12,500 job years could be achieved, the equivalent to 1,250 full time jobs for 10 years across the UK and its supply chains.

It is advisable to adopt a prudent approach as this level of renewable energy deployment will cost hundreds of millions. However, if it were achieved in the long term then an extra 450 local operational and maintenance jobs could be created at the peak deployment level.

A peak level of installation jobs years of 1,772 could also be achieved, predominantly if heat pump technology becomes embedded in domestic and business heating. With a persistence of benefits of 10 years this would represent 177 full time equivalent jobs once the peak is reached.

Should the maximum potential be achieved in the long term then this would equate to £455 million of GVA of manufacturing and installation with £16.6 million for the operational and maintenance employment.

7.3.1 Community Benefits

There are a wide range of 'spill-over' and community benefits that can be considered. Whilst a detailed exposition of these would have to be undertaken in a broader and extended study, it is illustrative to consider these in light of work undertaken for on-shore wind.

For example, a windfarm community benefit package has broadly set parameters which can deliver value locally and partially offset opposition to visual blight and loss of amenity. This could be used to support economic activities in Gwynedd, including for examples the deployment of microgeneration installations and energy efficiency schemes in the area of the windfarm.

Broadly the parameters are thus:

- Based on £3,000 – to £5,000 per MW of installed capacity, and 33.2 MW of additional installed onshore wind capacity this could represent between:
  - £99,600 – £166,000 per annum in community benefits locally; and
  - £2,490,000 - £4,150,000 over the 25 year lifetime of the windfarms for Gwynedd.
- If the 269 MW of wind noted in Table 7.2 was actually realised in practise these figure would rise to
  - £807,000 - £1,345,000 per annum; and
  - £20,175,000 - £33,625,000 over the 25 year lifetime of the windfarms.

Clearly the main caveat to achieving this level of potential community benefits is the commercial reality of being able to attract developers' interest and investment at substantial scale, in the order of £270 million for instance and overcome local opposition and planning as well as physical constraints in Gwynedd. Conversely, if local community groups could generate say 10% of the finance required and capital costs, potentially through support from government agencies for feasibility studies or capital through UK Green Investments / Green Investment Bank then a greater proportion of the direct income and quantum of benefits can be retained locally. There are effective examples[75] in Scotland[76] of how this can be achieved. However,

[75] For example 10% ownership of the potential 33.2 MW wind by local social enterprises through joint venture models (comparative evidence of the joint equity between Neilston Development Trust,

the ability to do so in Gwynedd would need to be subject to separate feasibility, design and implementation work.

7.4 Wider Economic Benefits and Competitive Advantage

There is a prime facie case that a stable, affordable energy supply will offer economic and competitive advantage for firms in Gwynedd and indeed provide household and organisation energy savings. In this respect, focusing solely on the projections of direct and indirect jobs created by the deployment of renewable energy, may underestimate the overall scale of local socio-economic impacts. Dependence on one or two sources of energy supply, which can be interrupted through natural, manmade or Geo-political reasons, does not provide energy security over the long-term, but it is possible that an increase in renewable energy could lead to an increase in cost in the short-term.

A significant increase in reliable renewable generation capacity in Gwynedd may help to ensure a stable supply of energy and lessen the susceptibility to external energy price shocks. Increasing local self-sufficiency, drawing up available resources and increasing resilience are important directions of travel. This would help to increase the competitive advantage for firms based in Gwynedd, assuming that the rest of the UK and EU does not progress renewables at a similar or increased rate, and could form a basis for attracting new firms into the county. Likewise, decarbonising the grind, providing stable energy prices and energy security (especially for off-grid heat generation) would benefit local residents for whom energy costs currently accounts for an increasing proportion of household expenditure. However, it should be noted that the magnitude of these benefits are subject to many macro and comparative local factors and thus cannot be accurately quantified unless a large scale study is undertaken that pinpoints the implications for each local area. However, it is difficult to discern distinct local differences for Gwynedd without a comprehensive assessment of all surrounding and comparative areas. This would be needed to pinpoint competitive advantage for Gwynedd and would be resource intensive and potentially expensive exercise to do so accurately. It is more likely that increased energy efficiency would provide resilience, than an increase in renewable energy.

In addition, it is possible that a local leading edge in renewable energy developments could lead to Gwynedd being perceived as an attractive place for businesses with a strong corporate social responsibility agenda, or with a significant 'green tinge'. However, a more detailed study would be required to understand how this translates (and quantifies) into the safeguarding of existing businesses, turnover and jobs and the extent to which this attracts new firms to locate in Gwynedd over an alternative area. However, we do need to recognise the drivers for both skills and businesses to relocate, and a green edge could be an attractor for many.

Whilst this is a reasoned line of argument; a wide range of work would be required to quantify the extent to which renewable energy developments in Gwynedd may

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Lanarkshire 28% equity in 8.2 MW windfarm – and virtual turbines – Huntly Development Trust, Cairnbarrow, Huntly, Aberdeenshire 1/9th of 22.5 MW windfarm), and schemes wholly owned by social enterprises (e.g Awel Aman Tawe 4 MW) could lead to substantially more income retained locally which could support economic activity. The Cairnbarrow scheme is expected to generate around £6,000,000 profit for the social enterprise Huntly Development Trust over the schemes 25 year lifetime.

[76] http://www.moray.gov.uk/downloads/file79844.pdf (slide 19) Equally local private ownership would also help retain economic benefits locally.

outstrip those in neighbouring authorities as well as compared to other local areas across Wales, the UK, EU and the global economy.

7.5 Economic and Market Barriers to Realising the Economic Benefits

This section addresses the barriers to realising the economic benefits and wider non-financial and environmental benefits of decarbonising power generation and use. The physical and environmental barriers have largely been addressed in section 6.

The main economic constraints include split incentives between landlords and tenants, market failures, the ability to raise capital and uncertain payback periods.

Split Incentives

Split incentives occur predominantly in respect of micro-renewable measures where the landlord may have to pay for the capital costs of installation and the benefits accrue largely to the tenant who is paying the running costs. This can create a disincentive to invest. Whilst energy service companies (ESCos) are designed to overcome this and share the cost savings (which are not the same as a cashable revenue stream) the use of ESCos tends to be in urban areas and municipalities and large commercial operators with large heat and power loads. The 'Green Deal' is partly designed to overcome this, the extent to which the 'golden rule' of paybacks in cost savings being greater than the capital costs will have to be tested in practice. It may also place a constraint of renewable generation, favouring energy efficiency measures instead. There is anecdotal evidence that passing on the cost and repayment of the loan to future owners may act as a disincentive if it is considered a liability rather than a long term benefit. In this respect, one of the main barriers to realising economic benefits across energy use is consumer behaviour where substantial efficiencies and savings can be achieved. A further barrier is the 'Jevons effect' otherwise known as the rebound effect whereby costs savings in one area leads to increased use and costs in another area.

Market Failures

The overriding economic barriers are market failures, predominantly those relating to the fact that current prices do not reflect all of the future costs. These negative externalities within harmful emissions from gas and coal fired plants and petrol engines and the potential adverse and exacerbated impacts of climate change on future generations, ecosystems and species represent the greatest market failure. This is a real barrier to realising economic benefits as the investment case is biased towards current cost considerations, projects which may well be viable and beneficial when viewed over a longer term horizon are ruled out on current economic and financial calculations and political perspectives.

The key market failure relates to externalities. An externality is an external impact which is not reflected in a market price. Renewable energy creates positive externalities by reducing emissions compared with burning hydrocarbon fuels. The value of impacts generated by this positive externality will not be captured when investors appraise the monetary value of a community renewables project. As such, the gap between the net monetary impact observed by lenders and the net social impact will result in an under provision of renewable energy under a free market.

Currently there are policy instruments which compensate for the provision of these externalities. These include market based interventions such as the Feed-in Tariff (FiT) and Renewable Heat Incentive (RHI) which offer long term contracts to renewable energy producers based on the cost of generation by technology. Whilst measures such as the FiT and RHI provide price certainty and long term contracts once agreed for a project, recent changes to rates demonstrates that projects which are in development can be adversely affected by changes if this occur before contracts are in place (or the project commences operation). Accordingly there is a tangible perceived risk of adverse policy changes occurring in project development which could compromise the viability of the project.

There can also be policy uncertainty attached with other measures which seek to create a market to encourage renewable energy. For example, the Renewables Obligation (RO) creates a market for Renewable Obligation Certificates (ROCs) which are acquired in return for electricity suppliers producing a proportion of their energy from renewable sources. The price of ROCs generated by this mechanism will vary according to the level of renewable generation in any given year or political judgement. As a consequence, if there is an excess of renewable generation, beyond the supplier obligation, the price of ROCs would fall below the official buy out price. This means that over a period, significant fluctuations may occur, adversely impacting on the financial viability in some schemes. The lack of UK political will can also reduce the level of the RO and undermine investment decisions.

Clearly policy and regulatory changes and evolution which impact upon tariffs under the Renewables Obligation and Feed-in Tariff will create real and perceived differences that materially impact upon returns and investor confidence. Whilst it is not the purpose of this study to identify the appropriate remedies to the market failures that exist, it is worthwhile noting current government responses to failures there are two basic strategies; use the price mechanism to incentivise action or use legislation and force action through regulations. In the majority of cases of market failure, a combination of remedies is most likely to succeed.

The government has introduced a series of market based policies relevant to renewable energy. These include the Feed-in Tariff (FiT) and Renewable Heat Incentive (RHI) which pay owners of renewable energy generation equipment an index-linked price above the wholesale price generated by the equipment over a period. However, there are several barriers to entry that exist with FiT and RHI:

- **Upfront capital** – some renewable energy projects, especially those led by community enterprises face a significant challenge in raising the up-front costs associated with demonstrating the feasibility of their projects. In most cases, these enterprises do not have significant own capital to invest or assets which they can borrow against;
- **Raising adequate equity** – to finance a project, renewable energy projects have to raise a substantial amount of equity to satisfy the requirements of lenders. The level of returns offered by FiTs and the RHI is frequently inadequate to raise this level of equity from investors; and
- **Scale** – while many financial institutions have funds available to finance renewable energy equipment taking advantage of the Feed-in-Tariff, many projects developed by community enterprises, organisations and other small to medium sized companies may well be too small for them to fund directly.

It is important when implementing the action plan to consider which of these are within the sphere of influence of Gwynedd County Council and its partners and

community in contrast to the overriding barriers which are determined at the national or global level or are regulatory, industry specific, driven by consumer behaviour or environmental requirements.

Ability to Raise Capital

Market failures in the provision of finance for renewable energy can be largely attributed to the relatively new, evolving and innovative nature of the renewable energy sector. There is information asymmetry which stems from lack of track record in many renewable energy technologies and as a result financial institutions tend to be cautious when pricing up risks associated with renewable energy investments.

Uncertain Payback Periods

The lack of a comprehensive evidence base identifying specific costs, payback periods, returns and non-financial benefits increases the perceived risks associated with investing in renewable energy. This is exacerbated by the organisational and governance structures, covenants and asset base which community groups' offer, as well as the general tightening of bank lending post the credit crunch which means that the sector is at a disadvantage when competing with mature sectors for commercial finance.

7.6 Capturing Economic Benefits

This section discusses the measures which can be taken to minimise the leakage of benefits from Gwynedd as well as the potential to capture benefits from opportunities in the surrounding area.

The main driver or direct economic benefits is the ability to start-up, grow and sustain local businesses, principally those involved in the manufacture, installation or operation and maintenance of renewable energy.

Therefore, it follows that the main economic channels[77] to capture and maximise economic benefits involves:

Encouraging business investment where there is a strong local environmental resources and economic rationale, for example in biomass or tidal stream R&D;

- Ensuring that existing businesses are able to meet the needs of the market and access the available incentives – including for example capital allowances to reduce the tax bills on the basis of investment in renewable energy technologies within the workplace;
- Raising capital for investment from government and European sources such as ERDF and the European Investment Bank, possibly in the form of public-private partnerships;
- Accessing funds for feasibility studies which contribute to technical exploration for community enterprises from sources such as the Big Lottery Fund and potentially UK Green Investments;

[77] It is recognised that there are a range of environmental and technical considerations and physical and other measures such as grid connections which are necessary enables to delivery local, economic benefits.

- Up skilling the labour force and helping create an adaptive workforce by working on the supply-side of the economy with young people, the unemployed and through the local FE and HE training base and working with existing businesses, for example with electrical and mechanical engineers and electricians who may currently work on domestic appliances or capital machinery in firms and who could adapt to work on renewable energy installations;
- A supportive incentives regime in terms of subsidies to bridge current market failures, whilst this is crucial to bring forward deployment it is beyond the influence of Gwynedd Werdd;
- To maximise economic impacts it is important for decisions makers to recognise externalities and the long term detrimental impacts of climate change in the pricing and investment decisions for renewable energy technologies; and
- Providing an enabling planning regime to ensure, within reason, that plans to bring forward the deployment of renewables are not unnecessarily hindered.

Supply chains do not conform to administrative boundaries, clearly the natural environment helps to determine the potential for harnessing renewable energy resources, and therefore it is prudent to consider how opportunities can be leveraged at a scale broader than the County boundary. For example with offshore wind and the grid connections in North West Wales present an opportunity for local economic benefits to be maximised.

The action plan sets out the options to maximise and capture the economic benefits in Gwynedd.

7.7 Summary of Findings

In summary, it is clear that there are a range of direct and wider economic benefits that can be realised if further investment and deployment in renewable energy is achieved in Gwynedd. There are also a range of barriers and market failures which need to be addressed, many of which are international in their nature and beyond the influence of the public or private sectors in Gwynedd to directly bring about changes. The action plan focuses on the areas which are most likely to bring about the greatest increase in renewable energy deployment, carbon reductions and economic benefits in Gwynedd. Whilst economic benefits are the focus for Gwynedd Werdd in this instance, an element of pragmatism is needed to ensure that renewable energy continues to meet its primary aim.

Whilst direct job creation is limited in its nature, it is still extremely valuable locally and provides the opportunity to offer reasonably secure private sector employment to local people over the medium to long term. Should the potential renewables capacity for 2017 be reached as analysed above, then up to 160 operational jobs would be created along with 2,200 job years of manufacturing and installation jobs, of which over 300 job years relate specifically to the installation of the renewable energy in Gwynedd. This is the equivalent to 220 full time manufacturing jobs and 30 full time, local installation jobs.

8 Conclusions

8.1 Introduction

This section sets out an overview of the main findings in relation to renewable resources, constraints and opportunities. It then sets out the technology priorities in preparation for the action plan.

8.2 Renewable Resource

As discussed in chapter 5, the largest technically available resources, based on the Welsh Toolkit and DECC methodologies are heat pumps, onshore wind, solar, tidal and biomass. However, as discussed in chapter 6, the likely deployment of all technologies is not evenly spread and there are issues that will impact on the deployment rates of each of these technologies, making the maximum achievable technical resource unlikely to be realised in the short to medium term. Section 8.4 sets out the priority technologies that can help to achieve the deployment potential in Gwynedd, reduce harmful emissions, create economic opportunities and help to alleviate the long term impacts of climate change.

8.3 Constraints and Opportunities

8.3.1 Opportunities

The opportunities relate to direct job creation in Gwynedd, wider indirect economic impacts across the UK and improving competitiveness locally through creating efficiencies and saving people and businesses from the cost of rising fossil fuel bills.

The main driver or direct economic benefits is the ability to start-up, grow and sustain local businesses, principally those involved in the manufacture, installation or operation and maintenance of renewable energy. Therefore, it follows that the channels to capture and maximise economic benefits involves:

- Encouraging business investment where there is a strong local environmental resources and economic rationale, for example in biomass or tidal stream R&D;
- Ensuring that existing businesses are able to meet the needs of the market and access the available incentives – including for example capital allowances to reduce the tax bills on the basis of investment in renewable energy technologies within the workplace;
- Raising capital for investment from government and European sources such as ERDF and the European Investment Bank, possibly in the form of public-private partnerships;
- Accessing funds for feasibility studies which contribute to technical exploration for community enterprises from sources such as the Big Lottery Fund and potentially UK Green Investments;
- Up skilling the labour force and helping create an adaptive workforce by working on the supply-side of the economy with young people, the unemployed and through the local FE and HE training base and working with existing businesses, for example with electrical and mechanical engineers and

electricians who may currently work on domestic appliances or capital machinery in firms and who could adapt to work on renewable energy installations;

- A supportive incentives regime in terms of subsidies to bridge current market failures, whilst this is crucial to bring forward deployment it is beyond the influence of Gwynedd Werdd;
- To maximise economic impacts it is important for decisions makers to recognise externalities and the long term detrimental impacts of climate change in the pricing and investment decisions for renewable energy technologies; and
- Providing an enabling planning regime to ensure, within reason, that plans to bring forward the deployment of renewables are not unnecessarily hindered.

Supply chains do not conform to administrative boundaries, clearly the natural environment helps to determine the potential for harnessing renewable energy resources, and therefore it is prudent to consider how opportunities can be leveraged at a scale broader than the County boundary. For example with offshore wind and the grid connections in North West Wales present an opportunity for local economic benefits to be maximised.

8.3.2 Constraints

The main constraints include:

- the ability to raise capital;
- uncertain payback periods;
- market failures;
- public perception;
- lack of local skills base;
- real and perceived grid constraints;
- difficulty in obtaining planning permission and environmental consents.

Market failures in the provision of finance for renewable energy can be largely attributed to the relatively new, evolving and innovative nature of the renewable energy sector. There is information asymmetry which stems from lack of track record in many renewable energy technologies and as a result financial institutions tend to be cautious when pricing up risks associated with renewable energy investments.

There remains 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 public perception of renewable energy schemes can lead to a negative response to developments locally, which can add to a delay in the consenting process. Working with the community, to get their buy-in and involvement in the design of new schemes may help to overcome this constraint in some instances.

Another key constraint, with regards to capturing the local benefits, relates to the local skills base. The most recent Skills Strategy for Gwynedd and Ynys Môn points towards difficulties recruiting engineers. Thus, it is crucial that local education resources are utilised to provide relevant skills to take full advantage of renewables employment opportunities.

There are perceived (and actual) difficulty in obtaining planning permission and environmental consents, particularly in and around the National Park. This is particularly an issue for larger scale developments. For micro-generation and community scale development is perceived to be less of an issue.

The real and perceived difficulties of connecting new development to the grid remain an important constraint. Some of this is related to perception; the DNO will explore options of how to connect to the grid for any proposed development. However, in more rural parts of the county and for smaller scale development, the cost of connection can appear prohibitive.

8.4 Technology Priorities

Based on the analysis set out in chapters 4-7 and on the outputs from the workshops with Gwynedd stakeholders, we have prioritised the renewable energy technologies that offer the greatest potential and justification to form the focus for Gwynedd Werdd over the coming months.

These have been scored based on three criteria:

- **MW of Renewable Energy:** the deployment potential up to 2017;
- **Local Influence**: This is the influence held by Gwynedd Werdd and its partners, including: Gwynedd Council, local business, community groups;
- **Scale of Economic Impact:** This is local economic impact, measured in terms of direct job potential.

The technologies are set out in broad order of priority to meet the aims of Gwynedd Werdd in the table below. This may not necessarily reflect the priorities of the market.

Table 8.1: Prioritised Technologies

Technology	MW of Renewable Energy	Local Influence	Scale of Economic Impact	Score
Heat Pumps	Medium **	Medium **	High ***	12
Solar PV	Medium **	Medium **	High ***	12
Hydro	Medium **	High ***	Medium **	12
Biomass	Medium **	Medium **	High ***	12
Solar thermal	Medium **	Medium **	Medium **	8
Pumped storage	Low *	Medium **	Medium **	4
Onshore wind	High ***	Low *	Low *	3

Anaerobic digestion	Low *	High ***	Low *	3
Tidal opportunities	Medium **	Low *	Low *	2
Micro wind installations	Low *	Medium **	Low *	2
Energy from waste	Low *	Medium **	Low *	2

8.5 Wider Opportunities for a Sustainable, Low Carbon Economy

It is recognised that whilst renewable energy has an important role to play in creating a sustainable, low carbon economy for Gwynedd, further work would be required to transform the economy to help create the sustainable future desired.

This could include looking at opportunities presented by the wider Environmental Goods and Services (EGS) sector, using the definition used by UK and Welsh Government, of including in addition to renewable energy, solutions for problems such as air, noise and marine pollution, land and water contamination, as well as activities such as environmental analysis and consultancy and waste management and recycling. It also includes a number of other Emerging Low Carbon activities (such as reduced emissions from within the transport and construction sectors, nuclear energy, energy management, carbon capture and storage and carbon finance).

It could also look more widely at key existing economic sectors, and consider opportunities for "greening" these. This could include researching the economic benefits of sustainable tourism, for example, or looking in more detail at how to value ecosystems services.

9 Action Plan

9.1 Overview

The aim of this report was to determine work streams and actions needed to maximise the economic potential of renewable energy opportunities in Gwynedd. The action plan that follows aims to help Gwynedd Werdd and its partners to work towards achieving this aim.

Based on the research above, the outcomes of the stakeholder workshops and experience from elsewhere, we have developed a long list of actions, as set out in table 9.1

This long list has been further prioritised, based on the same three criteria set out in section 8:

- **MW of Renewable Energy:** the deployment potential up to 2017;
- **Local Influence**: This is the influence held by Gwynedd Werdd and its partners, including: Gwynedd Council, local business, community groups;
- **Scale of Economic Impact:** This is local economic impact, measured in terms of direct job potential.

The priority actions are highlighted in yellow below. All actions are further expanded in the delivery plans that follow, with particular emphasis given to those priority actions identified.

Table 9.1: Prioritised Actions

Category	Headline Action	MW of Renewable Energy	Local Influence	Scale of Economic Impact	Score
1. Technology -Specific	The identified **hydro** potential is focused on small scale in line with the EA data. Larger scale potential for hydro should be explored further.	**Medium** **	**High** ***	**Medium** **	**12**
	Explore potential for a **biomass processing plant** in Gwynedd or North Wales	**Medium** **	**Medium** **	**High** ***	**12**
	Explore what further support could be given to **on-farm digestion**	**Low** *	**Medium** **	**Medium** **	**4**
	Work with the District Network operator to clarify and communicate more widely the **grid connection** options and process for distributed generation in Gwynedd	**Medium** **	**Medium** **	**High** ***	**12**
	Work with Biogreenfinch to maximise local employment from **Llwyn Isaf AD plant**	**Low** *	**Medium** **	**Medium** **	**4**

Category	Headline Action	MW of Renewable Energy	Local Influence	Scale of Economic Impact	Score
2. Skills and training	Increased support for **microgen installation training**, esp. heat pumps and PV	**Medium** **	**Medium** **	**High** ***	**12**
	Invite Grŵp Llandrillo Menai to join **GW board**	**Medium** **	**Medium** **	**Medium** **	**8**
	Scope out **R&D on tidal stream devices**	**Medium** **	**Low** *	**Medium** **	**4**
	Confirm business need, design and deliver **biomass harvesting training**	**Medium** **	**Medium** **	**Medium** **	**8**
	Develop and deliver **training to Planners**	**Medium** **	**Medium** **	**Medium** **	**8**
3. Economic Impact and Supply Chain	**Invest in new businesses** and growth in existing firms within the installation and wider deployment of renewable energy in Gwynedd.	**Low** *	**Medium** **	**High** ***	**6**
	Research to better understand the wider financial and economic impacts from harnessing a secure, affordable renewable energy supply offer cost savings and competitive advantages for local firms, organisations and households	**Low** *	**High** ***	**Medium** **	**6**
	Support for / promotion of microgeneration installer **accreditation schemes**	**Medium** **	**Low** *	**Medium** **	**4**
4. Finance and Governance	Identify and **pursue new capital and investment** from private funds, Welsh Govt, ERDF, UK Green Investment and the European Investment Bank for example	**Medium** **	**Medium** **	**High** ***	**12**
	Explore willing partners to engage in **Public Private Partnerships** to access funds and deliver schemes	**Medium** **	**Medium** **	**Medium** **	**8**
	Investigate whether **additional partners** are required to bring additional resource to realise the vision of Gwynedd Werdd	**Medium** **	**Medium** **	**Medium** **	**8**
	Provide political leadership to ensure the delivery of the Gwynedd Werdd Vision and Action Plan	**Medium** **	**High** ***	**Medium** **	**12**

Category	Headline Action	MW of Renewable Energy	Local Influence	Scale of Economic Impact	Score
	Provide resource to enable the delivery of the Gwynedd Werdd Vision and Action Plan	**Medium** **	**High** ***	**Medium** **	**12**
5. Planning and Sites	Use evidence to develop **renewable energy SPG for SNPA**	**Medium** **	**High** ***	**Medium** **	**12**
	Use evidence to develop policies and allocate sites in **JLDP**	**Medium** **	**High** ***	**Medium** **	**12**
	Maximise the potential of the **Snowdonia Enterprise Zone, Trawsfynydd**	**Medium** **	**Medium** **	**High** ***	**12**
	Explore the potential for use of **brownfield sites.**	**Medium** **	**Medium** **	**Medium** **	**8**
6. Community	**Develop and promote exemplar projects**	**Low** *	**High** ***	**Low** *	**3**
	Support local community groups working in partnership with Gwynedd Werdd to deploy renewable energy	**Medium** **	**High** ***	**Medium** **	**12**
	Explore potential to **support in delivery of Green Deal**	**Low** *	**Medium** **	**Medium** **	**4**

The actions above respond to both specific local opportunities (e.g. Snowdonia Enterprise Zone, strong local community), and to overcoming barriers and constraints. The barriers and constraints set out in section 8 have been transposed into table 9.2 below, which demonstrates how the proposed actions related to the constraints.

Table 9.2: How actions overcome barriers and constraints

Barrier or constraint	Proposed Actions
Real and perceived grid constraints	Work with the District Network operator to clarify and communicate more widely the **grid connection** options and process for distributed generation in Gwynedd
Lack of local skills base	Increased support for **microgen installation training**, esp. heat pumps and PV
	Invite Grŵp Llandrillo Menai to join **GW board**
	Scope out **R&D on tidal stream devices**
	Confirm business need, design and deliver **biomass harvesting training**
The ability to raise capital	Identify and **pursue new capital and investment** from private funds, Welsh Govt, ERDF, UK Green Investment and the European Investment Bank for example
Uncertain payback periods	**Invest in new businesses** and growth in existing firms within the installation and wider deployment of renewable energy in Gwynedd.
Market failures	Support for / promotion of microgeneration installer **accreditation**

	schemes
	Explore willing partners to engage in **Public Private Partnerships** to access funds and deliver schemes
Difficulty in obtaining planning permission and environmental consents	Use evidence to develop **renewable energy SPG for SNPA**
	Use evidence to develop policies and allocate sites in **JLDP**
	Maximise the potential of the **Snowdonia Enterprise Zone, Trawsfynydd**
	Explore the potential for use of **brownfield sites.**
	Develop and deliver **training to Planners**
Public perception	**Develop and promote exemplar projects**
	Support local community groups working in partnership with Gwynedd Werdd to deploy renewable energy
	Explore potential to **support in delivery of Green Deal**
	Investigate whether **additional partners** are required to bring additional resource to realise the vision of Gwynedd Werdd
	Provide political leadership to ensure the delivery of the Gwynedd Werdd Vision and Action Plan

Delivery Plan 1: Technology Specific

The objective of this area is to deploy more renewable energy whilst developing local skills and creating jobs.

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Explore **the potential for large scale and pumped storage hydro** through a detailed analysis of EA data and feasibility study of sites: • Define need for hydro – soft market testing with developers • Discussion with National Grid re pumped storage to identify need • Define required site characteristics • Review sites identified alongside Dinorwic for suitability today • Once site short list defined, identify key constraints and review with key stakeholders (e.g. EA, DNO) • Consider allocating sites with planning policy, or linking to renewable energy SPG	0-6 months	Gwynedd Council Existing hydro schemes Industry experts	Gwynedd Council Welsh Government	Clarity on hydro potential Specific sites identified for new, large scale hydro Long term outcome of investment achieved and new hydro scheme on-line
Further investigate the **feasibility of a biomass processing plant** within Gwynedd: • Take learning from Carbon Trust work in South Wales • Define need for biomass – soft market testing, add needs of LSB estate to possible private clients • Define preferred fuel type (e.g. pellets / chips) to support market • Apply for grant if possible / available • Produce marketing material to showcase opportunity in	6-12 months	Gwynedd Council Welsh government Other North Wales Local Authorities Forestry Commission Industry partners Carbon Trust	Carbon Trust Welsh Government	Feasibility of biomass processing plant determined

Gwynedd • Identify and discuss opportunity with potential operators				
Explore what further support could be given to **on-farm digestion**	12-24 months	Gwynedd Council Welsh government Other North Wales Local Authorities NFU WRAP Carbon Trust	Gwynedd Council	Support provided to farmers improves
Work with the District Network operator to clarify and communicate more widely the **grid connection** options and process for distributed generation in Gwynedd: • Consult with National Grid to confirm current generation capacity constraints in the National Grid network • Consult with SP Networks to confirm current generation capacity constraints in the local network • Work with DNO and community groups to "translate" existing guidance into an easy to follow step-by-step guide, with case studies, for feed-in-tariff scale generation. • Consider methods for communicating this guidance (e.g. annex to an SPG, community meetings etc.)	0-6 months	Gwynedd Council SP Networks National Grid Community Energy Wales Local community groups (e.g. Ynni Llyn)	Welsh Government SP Networks Gwynedd Council	
Work with Biogreenfinch to maximise local employment from **Llwyn Isaf AD plant**	0-6 months	Gwynedd Council Biogreenfinch Other North Wales Local Authorities	Biogreenfinch	No. of local jobs created.

Delivery Plan 2: Skills and Training

Providing the workforce of Gwynedd with access to the appropriate skills and training will be crucial in ensuring the maximum local economic value is retained within the County.

The objectives of this delivery plan are:

- To provide a coherent and coordinated set of actions which will underpin the technological deployment required.
- To provide Gwynedd with appropriate skills to serve a growing renewable energy sector

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Support for **microgen installation training**, esp. heat pumps and PV: • Review of existing courses in Gwynedd • Review of best practice from elsewhere • Communicate potential job numbers to lead partners • Identify all local installers in Gwynedd • Colleges to engage with local businesses to understand needs • Review / understand MCS requirements	6-12 months	Grŵp Llandrillo Menai Centre for Alternative Technology Summit Skills Energy Utility Skills	Skills Funding Agency	Number of people trained Number of jobs safeguarded / created Growth for local firms in microgen installation
Invite Grŵp Llandrillo Menai to join **GW board**	0-6 months	Gwynedd Werdd Grŵp Llandrillo Menai	N/A other than time commitment	Participation of training providers
Scope out **R&D** that could be carried out **on tidal stream devices** locally (consider needs of the resource available locally, the specialisms available at the Bangor University that could be built on)	12-24 months	Bangor University Industry Government research agencies (EPSRC and NERC) DECC	Framework Programme 7 (FP7 EU Funds) Technology Strategy Board	Technological breakthrough Commercialisation of R&D
Confirm business need, design and deliver **biomass**	6-12	Forestry Commission	Skills Funding	

harvesting training for the forestry industry.	months	Carbon Trust Gwynedd Council LANTRA Energy Utility Skills	Agency Forestry Commission Carbon Trust Gwynedd Council Welsh Government Snowdonia National Park Authority	
Diagnose, develop and deliver **training to planners:** • Work with planners and key stakeholders to establish need and gaps in knowledge or behaviours • Review training delivered elsewhere to ensure best practice design of training (e.g. by Arup across Yorkshire and Humber) • Select appropriate experts to deliver training	6-12 months	Gwynedd Council Planning Dept. Snowdonia National Park Authority Planning Dept. RTPI	Gwynedd Council Welsh Government Snowdonia National Park Authority	

Delivery Plan 3: Wider Economic Impact and Supply Chain

The objective is to help develop the local supply chain to maximise economic impacts. It is recognised that the majority of business benefits have to be driven by business investment, this is beyond the direct influence of the public sector locally, although UK based incentives and subsidies are an important consideration.

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Invest in new businesses and growth in existing firms within the installation and wider deployment of renewable energy in Gwynedd.	0-24 months Ongoing	Local firms Inwards investors	Business	New businesses
Research to better understand the wider financial and economic impacts from harnessing a secure, affordable renewable energy supply offer cost savings and competitive advantages for local firms, organisations and households	0-12 months	Gwynedd Council Welsh Government	Gwynedd Council Welsh Government	Improved understanding of wider economic impacts
Support for / promotion of microgeneration installer **accreditation schemes**	0-6 months	Local businesses Gwynedd Council Grŵp Llandrillo Menai Community Energy Wales	Gwynedd Council	No. of people who know and understand microgeneration accreditation schemes No. of installers in Gwynedd accredited.

Delivery Plan 4: Finance and Governance

The objectives are

- To raise finance and attract new partners to contribute additional resources
- To ensure a suitable structure for delivery of the Gwynedd Werdd Vision and Action Plan

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Identify and **pursue new capital / investment** from private fundsWelsh Govt, ERDF, UK Green Investment and the European Investment Bank (which could be used either by Gwynedd Werdd directly, or where Gwynedd Werdd would act as the grant holder, with funds to be used by private sector or community groups), for example: • Identify available funds • Review best practice funding models from elsewhere • Apply for funds • Communicate availability of funds to relevant groups	Ongoing 0-24 months	Gwynedd Council Welsh Government	ERDF UK Green Investment European Investment Bank	Secure funds
Explore willing partners to engage in **Public Private Partnerships** to access funds and deliver schemes	6-12 months	Gwynedd Werdd Board Gwynedd Council	Gwynedd Council	Appropriate Partnerships established
Investigate whether **additional partners** are required to bring additional resource to realise the vision of Gwynedd Werdd. This is likely to be dependent on the results of other actions.	0-6 months	Gwynedd Werdd Board Gwynedd Council	Gwynedd Council	Appropriate additional partners embedded into to Gwynedd Werdd delivery
Provide **political leadership** to ensure the delivery of the Gwynedd Werdd Vision and Action Plan. This should include **clearly publicised mandate and terms of Gwynedd Werdd.**	Ongoing	Gwynedd Council	Gwynedd Council	Identifiable political leader championing Gwynedd Werdd
Provide resource to enable the delivery of the Gwynedd Werdd Vision and Action Plan: • Identify external project manager to provide overview	0-6 months Ongoing	Gwynedd Council Gwynedd Werdd Board	Gwynedd Council	Dedicated resource in place

and drive project, providing independence from any internal politics. • Identify internal Council working group to deliver programme, with staff from key departments (e.g. planning, economic development, transport, estates, communications) • Identify overlap with other existing programmes (e.g. Anglesey Energy Island and Local Services Board carbon reduction group) • Consider forming sub-groups on specific topics (e.g. skills), either alone or in partnership with existing sub-groups as part of Anglesey Energy Island. • Gwynedd Werdd Board to continue to provide high level support and ensure that working group has sufficient time to be involved alongside their day job.				

Delivery Plan 5: Planning and Sites

The objectives are

- to secure the physical sites, including the most suitable land and property that will help to develop the renewable energy sector in Gwynedd. Critically, this includes agreeing and investing in an integrated solution at the Snowdonia Enterprise Zone in Trawsfynydd.
- To develop appropriate planning policy to act as enabler to renewable energy within Gwynedd.

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Develop evidence base to inform **policy and allocate sites in Gwynedd and Anglesey JLDP.** Sites could be allocated for wind, hydro and biomass processing, in particular: • Use evidence from this report • Review best practice in evidence based renewables policy • Develop positive criteria based policies and decide whether building regulations provide a sufficient delivery mechanism, or whether a 'Merton' type policy would be appropriate • Link policies to BREEAM / Code for Sustainable Homes requirements where appropriate • Consider spatial/land allocation • Consider need for SPG • Consider appropriateness and need for inclusion of case studies	0-6 months	Gwynedd Council	Welsh Government Gwynedd Council	Approved JLDP in place with appropriate policies and sites allocated on renewable energy.
Develop evidence base to inform **Snowdonia National Park Authority SPG,** including requirement for an energy strategy for appropriate developments: • Develop evidence base, using Welsh Government Toolkit methodology	0-6 months	Snowdonia National Park Authority	Snowdonia National Park Authority	Approved SPG in place with appropriate policies on renewable energy.

• Review best practice in evidence based renewables policy • Develop positive criteria based policies and decide whether building regulations provide a sufficient delivery mechanism, or whether a 'Merton' type policy would be appropriate • Link policies to BREEAM / Code for Sustainable Homes requirements where appropriate • Consider appropriateness and need for inclusion of case studies				
Maximise the potential of the **Snowdonia Enterprise Zone, Trawsfynydd** • Refine options for the use of the site • Agree criteria for appraisal of options and select appropriate option • Identify actions that need to be taken by the public sector to minimise development risk for developers'	0-12 months	Gwynedd Council Snowdonia National Park Authority Welsh Government Magnox	Welsh Government Gwynedd Council UK Government	No. of renewable energy jobs in enterprise zone No. of new companies
Explore the potential for **brownfield land** to be used for renewable energy generation (particularly wind and hydro) through detailed site appraisals.	0-12 months	Gwynedd Council Snowdonia National Park Authority Welsh Government Local developers	Gwynedd Council Snowdonia National Park Authority	Brownfield sites identified as suitable for renewable energy.

Delivery Plan 6: Community

The objective is to ensure that community renewable energy schemes are most effectively supported to ensure an approach to the deployment of renewable energy locally that harnesses business, residential and community investment working with the public sector.

Action	Timescale	Lead / Partners	Funding sources	Measure of success
Support local community groups working in partnership with Gwynedd Werdd to deploy renewable energy	0-12 months Ongoing	Community Energy Wales Gwynedd Council Local Community Groups (e.g. Ynni Llyn)	Big Lottery Fund Naturesave Trust Carbon Leapfrog	No of MW installed No of projects Kg Carbon saved
Develop and promote exemplar projects: • Work with Community groups to identify most appropriate and replicable exemplar projects (potentially through a competition if required) • Work with LSB to identify most replicable and appropriate projects from the public sector • Work with council communications staff to develop a standard format for reporting exemplar projects (to include e.g. partners involved; funding sources (and potentially unsuccessful funding applications), five key steps to delivery) • Interviews conducted with exemplar groups to draft case studies for review • Consider the need for different communications bringing together the lessons from across different case studies (e.g. leaflet on obtaining funding for community groups, or key "watch-its" on the road to successful renewable energy deployment) • Work with Council communications and community	0-12 months Ongoing	Community Energy Wales Gwynedd Council Local Community Groups (e.g. Ynni Llyn) Local Service Board	Community Energy Wales Gwynedd Council	No. of exemplar projects Increase in communities pursuing community owned energy generation

development staff, LSB and community groups to develop communications strategy to include e.g. web, word of mouth, local press, leaflets, guidance notes and 'top tips'				
Explore the potential for **support in the Green Deal delivery.**	6-12 months	Community Energy Wales Gwynedd Council Local Community Groups (e.g. Ynni Llyn)	DECC	Appropriate support delivered

Appendix A

Case Studies

A1 Cymdeithas Tai Eryri

Cymdeithas Tai Eryri is a social enterprise which provides affordable housing across Gwynedd and Ynys Môn. One of the aims included in the housing association's Vision is to provide high quality, affordable & energy-efficient housing, located in safe and attractive places where people want to live.

Cymdeithas Tai Eryri's application for £2.4m from the Arbed scheme was successful. Arbed is Wales's Strategic Energy Performance Investment programme which aims to improve domestic energy efficiency, reduce carbon emissions, lower fuel poverty and create jobs by installing and maintaining renewable energy. During Phase 1 in 2010-2011, the programme targeted 'hard to heat' social housing with the aim of eradicating fuel poverty, reducing carbon emissions and developing skills for 'green' jobs. The work involved 447 installations:

- 255 PV solar panels;
- 83 Solar thermal panels;
- 74 solid walled houses insulated; and
- 35 air source heat pumps

A key part of the scheme was giving contractors accredited training in installing renewable energy technology so as to maximise the economic benefit locally.

http://www.taieryri.co.uk/en/amdanom_ni/

A2 Burntisland Fabrications (BiFAB): adapting to a new market

BiFAB's background is mainly in the oil and gas sector, and that's where the company's strength has laid in the past. They recognised that there was a need to diversify into energy products, covering wind, wave and tidal.

"With the welding experience and manufacturing experience we have in the oil and gas sector, we have come up with a design concept that is ideally suited to the alternative energy sector for offshore wind. We have manufactured the two largest jacket subsea structures in the world to date. From that we see opportunities to extend our facilities to manufacture 30-100 structures per year. The challenges we face are based on the need to mass manufacture."

The mass manufacturing challenge is being given a helping hand by the public sector, with the Scottish Government working with both Scottish Enterprise and Highlands and Islands Enterprise to provide port-side facilities at suitable locations around Scotland, and to both attract inward investment and support local indigenous business.

One such facility is the Energy Park Fife, which is being developed for use by manufacturing, engineering and related supply chain companies. It provides fabrication facilities, quayside facilities, a good skills base in the area, and links to colleges who assist training to meet labour demand. Another important factor is

the link with universities: Edinburgh's universities deliver a range of multi-disciplinary research projects, backed by considerable funding.

Bifab has been awarded a £1.5 million grant by the government, which it will use to set up a manufacturing facility at the Energy Park in Fife that can deliver over 100 turbine jacket sub-structures per year by 2011, making BiFab one of the key providers for offshore substructures covering a range of 12 Mtr to 80 Mtr water depths.

A3 Eigg Electric: A community-led approach

The island of Eigg in Scotland has developed a community-owned renewable energy company, providing 24 hour power to all residents.

Prior to the development of Eigg Electric, in 2008, residents did not have constant access to electricity, and were largely reliant on expensive, inefficient generators. As well as the environmental and community benefits, this development has also had a positive economic impact on the island.

In 2010, Eigg's electricity grid supported four part-time maintenance jobs on the island. In addition, the start of organised harvesting of wood for heating has created several forestry jobs for residents. A part time 'green project manager' post has also been created, which employs two people on a job share basis and residents have also been employed for building work to improve Isle of Eigg Heritage Trust properties. This is on an island with just 43 households.

Wider economic benefits from having a reliable and affordable electricity supply have been achieved. This has enabled several new businesses to start up, including restaurants, shops, guest houses and self-catering accommodation. Furthermore, as Eigg has become known for cutting carbon emissions and protecting the environment, an increasing number of visitors have come to the island to learn about its work.

http://islandsgoinggreen.org/ [accessed May 2012]

www.ashdenawards.org/winners/Eigg10 [accessed May 2012]

A4 European Marine Energy Centre, Orkney: attracting young people

Many rural areas suffer from young people migrating out in search of employment opportunities.

EMEC, the European Marine Energy Centre Ltd, has counter-acted this phenomenon, providing an opportunity to attract more young people to Orkney. Heriot Watt university have set up a campus alongside EMEC (the ICIT - International Centre for Island Technology), which offers MSc courses in Marine Renewable Energy, Renewables Energy Development and Marine Resource Management. These facilities stimulate the economy and labour force of Orkney, with a number of students deciding to stay in the region. Some stay on to do PhD research, some are employed locally, for example by EMEC and the Orkney Islands Council, and some have set up or joined environmental consultancies in the area.

This has helped to contribute to the fact that 80 people in Orkney (of a total population of approx. 20,000) work directly in the renewable energy sector, with a further 200+ working in the wider energy business[78].

http://www.icit.hw.ac.uk/index.htm [accessed May 2012]

[78] http://www.emec.org.uk/orkney.asp [accessed May 2012]

Appendix B

Calculation details

Appendix C

Workshop Reports

C1 Workshop 1

C1.1 Aims of Study

Arup has been commissioned Gwynedd Council to carry out a study to scope the renewable energy opportunities for Gwynedd Werdd / Green Gwynedd. The primary objectives of this study are:

iv. To determine the economic potential of renewable energy opportunities in Gwynedd;

v. To highlight barriers to achieving the economic potential of renewable energy opportunities in Gwynedd; and

vi. To determine work streams and actions needed to overcome the barriers identified.

C1.2 Aims of Workshop

This workshop was the first of two planned workshops related to this study. The objectives of this workshop were:

- To test findings of Arup work so far for robustness, based on local knowledge and experience
- To gather local knowledge and experience of major barriers and opportunities in Gwynedd

A wide range of stakeholders were represented at the workshop:

Table 1: Attendees

Name	Job title	Organisation
Sioned E Williams	Head Economy & Community	Gwynedd Council
Grant Peisley	Project Manager	Gwynedd Werdd
Dewi Wyn Jones	Strategic Policy Manager – Sustainability and Environment	Gwynedd Council
Heledd Hughes	Planning	Gwynedd Council
David Mark Lewis	Manager Energy Conservation	Gwynedd Council
Ifer Gwyn	Principal Policy Officer	Snowdonia National Park
Allan Sharp		Conwy Council
Stuart Whitfield		Conwy Council
Rachel Shorney		Scottish Power Manweb (DNO)
Gareth Hall		Welsh Government (on behalf of Horizon)
Dr. Trefor Wyn Jones	Programme Management Office	Bangor University
Dr. Einir Young	Acting Director / Head of Sustainable Development	Bangor University
Keith Bellis		Tegni Cymru
Tom Vincent		AECOM

Dave Holmes		QBC
Chris Williamson		QBC
Ann Owen	Economic Policy Manager	Gwynedd Council
Dewi R Jones	Head of Education	Gwynedd Council
Gareth Lloyd		Snowdonia National Park Authority
Llyr B. Jones	Senior Manager	Gwynedd Council
Brian Thomas	Chair	Ynni Llŷn
Wil Parry	Co-ordinator	Cywaith
Bethan Gritten		EcoBro
Paul Allen	Development Director	Centre for Alternative Technology
Dafydd Watts	Sustainable Energy Project Manager	Severn Wye Energy Agency
Dewi Llywd Evans	Community Initiatives Manager	Tai eryri
Ann Cousins	Project Manager	Arup
Jamie Morgan	Associate Economist	Arup
Simon Power	Project Director	Arup

C1.3 Report of Workshop

C1.3.1 Renewable Energy Capacity

Arup presented the work that had been done so far assessing the renewable energy capacity in and around Gwynedd. The biggest opportunity in terms of MW is wind energy. A summary of the renewable energy available is shown in **table 2**, and copy of the presentation slides, which sets out the full details of the potential installed capacity.

Table 1: Renewable Energy Capacity Summary

Category	Sub-Category	Capacity (MWe) [Electricity]	Generation (GWh) [Electricity]	Capacity (MWt) [Heat]	Generation (GWh) [Heat]
Wind (onshore)	Wind Clusters	97.5	230.5	-	-
Hydropower	Small Scale Hydropower	1.1	3.7	-	-
Microgeneration	Solar *(Heat or Electricity)*	55.4	49	55.4	142.6
	Heat Pumps	-	-	230	-
Anaerobic Digestion	Sewage Sludge	0.3	2.4	0.5	2.0
	Poultry Litter	0.1	0.8	0.2	0.7
	Food Waste	0.2	1.7	0.3	1.4
	Animal Manure	0.9	7.1	1.4	5.9
Energy from Waste (EfW)	MSW and C&IW	0.9	7.4	1.9	8.3
Biomass	Managed Woodland	4	31.3	8	34.7
	Energy Crops	13.9	109.6	27.8	121.8
	Waste Wood	0.5	4.3	1.1	4.8
Tidal	Tidal	40	87.6	-	-
Total		**214.8 MWe**	**535.4 GWh**	**326.6 MWt**	**322.2 GWh**

Attendees were asked to reflect on the interim findings presented by Arup, in particular, whether the findings were what they might have expected, whether there were additional currently installed capacity or future opportunities that they were aware of, and whether all of the potential capacity would be desirable. A number of comments were made:

General
- No big surprises
- There are barriers to getting the benefits from the larger 'powerstations'
- Perception that change=Bad, not the case
- Predicable costs to industry and lower fuel costs...KEY Economic benefit that the study should consider as well as just jobs
- Strong support for community schemes, and local self sufficiency especially on the Llŷn. Fuel poverty, education into heat and transport minimisation
- Aware of similar reports – biomass supply and Llŷnpeninsular – ensure links made with existing data
- Is this means to an end – resilient communities – not just about supply driven targets
- Test beds for mix of technologies, novel devices
- Tap into Ecosystem approach – a new pilot vision.

Wind
- Hafoty Ucha Onshore wind 1,2,3 in Conwy
- A lot happening outside the unhelpful polarised wind/NP/AONB debate
- Favourable to Renewable energy as a concept; some concerns over large wind
- Does the methodology adequately address the potential for smaller turbines? (Arup confirmed that further work would be done to look at micro-wind opportunities). Larger wind farm location map could be controversial

Microgeneration
- Potential for Microgen a surprise, and should be encouraged
- More support for solar and hydro, lack of interest in air source heat pumps – why?
- Biomass systems in houses – too much emphasis on larger electricity?

C1.4 Barriers and Constraints

Attendees were asked to think of possible barriers and constraints to renewable energy deployment in Gwynedd, and to ensuring maximum local economic benefit. It was suggested barriers could include; physical; supply chain; competition; regulation; grid; public perception; finance.

General
- Lack of critical mass

Skills
- Lack of installation skills
- Need for unbiased advice on the right technology / Lack of advice at the community and domestic level on best technology
- Lack of technical awareness in determining planning applications
- Moving from feasibility studies to action

Public Perception
- Lack of awareness of the urgency of the issue esp. climate change

- Need to be open to accept new technologies / traditional thinking
- Education in its widest sense, awareness and perception and objectivity eg.
- Behavioural change esp in reducing energy usage in the first place
- Negative press
- Lack of confidence in off-grid solutions 24/7
- Lack of leadership and champions

Physical
- Grid – big barrier to generation at a range of scales, lack of critical mass of generation at the community scale / Grid not robust enough for community renewables
- Transport / infrastructure constraints

Supply Chain
- Large energy company procurement –local companies find it hard to compete

Regulation etc.
- Fragmented private grid ownership
- Outdated regulated system OFGEM
- Old planning restrictions to new evolving technology
- Environmental policies, may limit opportunities
- Lack of early engagement in planning system

Finance
- Access to finance, linked to community renewables
- Lack of finance
- Long payback not acceptable

C1.5 Opportunities

Skills
- To increase expertise and resource in Planning departments to set really positive and workable policies
- Development of specialist skill sets to develop successfully projects in very sensitive environmental areas
- Coleg Llandrillo – Dolgellau skills site
- Build on existing skills of local workforce
- Maintain links to Universities and latest research

Public Perception
- Communication / Education with communities and business
- Exemplar / test-bed/ blueprint projects
- Link community generation and use

Physical
- Local grid enhancements, smarter grid – any public investment needed to address a market failure
- Developing off-grid opportunities

Supply Chain
- Local authority to provide direct consumer advice?
- Local manufacturing opportunities?

Finance

- To get the right business cases in place, such as new ownership and financial systems e.g. GIB, European funding and community funds
- Capture local investment

Technology Specific Opportunities

- Electricity storage – developing exemplars linked to intermittent renewables at micro level
- On farm digestion and into hydrogen economy
- Biomass/forestry waste (though need more information first)
- Hydro / stream pumps (but need to investigate costs)

C1.6 Conclusions and Next Steps

A number of themes emerged as key opportunities for Gwynedd to maximise the economic opportunities of renewable energy.

Further consultation will be undertaken by Arup on a one-to-one basis with stakeholders who were unable to attend the workshop.

Following this, the second workshop will take place on **Thursday 24th May at Trawsfynydd from 9.30am (for a 10am start) until 1pm.** The aim of the second workshop will be to turn opportunities in actions.

C2 Workshop 2

C2.1 Introduction

C2.1.1 Aims of Study

Arup has been commissioned Gwynedd Council to carry out a study to scope the renewable energy opportunities for Gwynedd Werdd / Green Gwynedd. The primary objectives of this study are:

vii. To determine the economic potential of renewable energy opportunities in Gwynedd;

viii. To highlight barriers to achieving the economic potential of renewable energy opportunities in Gwynedd; and

ix. To determine work streams and actions needed to overcome the barriers identified.

C2.2 Aims of Workshop

This workshop was the second of two stakeholder workshops related to this study. The objectives of this workshop were:

- To understand local priorities for action
- To begin to develop an action plan for Gwynedd Werdd

A wide range of stakeholders were represented at the workshop:

Table 2: Attendees

Name	Job title	Organisation
Sioned E Williams	Head Economy & Community	Gwynedd Council
Grant Peisley	Project Manager	Gwynedd Werdd
Dewi Wyn Jones	Strategic Policy Manager – Sustainability and Environment	Gwynedd Council
Cllr John Wyn Jones	Portfolio Holder – Economy and Community	Gwynedd Council
David Mark Lewis	Manager Energy Conservation	Gwynedd Council
John Idris Jones	Head of Socio-Economic Development	Magnox
Allan Sharp		Conwy Council
Stuart Whitfield		Conwy Council
Rachel Shorney		Scottish Power Manweb (DNO)
Walis George	Chief Executive	Tai Eryri / Cywaith
Dr. Trefor Wyn Jones	Programme Management Office	Bangor University
Brian Thomas	Chair	Ynni Llŷn
Ann Owen	Economic Policy Manager	Gwynedd Council
Dave Holmes		QBC
Michael Philips		Community Energy Wales

Gareth Lloyd		Snowdonia National Park Authority
Iwan Evans		Snowdonia National Park Authority
Jeston Honitray		Sustainable Gwynedd Gynaladray
Dewi Llywd Evans	Community Initiatives Manager	Tai eryri
Ann Cousins	Project Manager	Arup
Jamie Morgan	Associate Economist	Arup
Simon Power	Project Director	Arup

C2.3 Report of Workshop

C2.3.1 Economic Analysis

Jamie Morgan presented an initial estimate of potential jobs created from investment in renewable energy. See table 2.

Table 3: Potential Job Creation

Technology	Construction Jobs		Operational Jobs	
Wind (onshore)	184 to	225	3 to	4
Hydropower	206 to	252	1 to	1
Solar	367 to	449	6 to	7
Heat pumps	867 to	1,060	14 to	17
Anaerobic digestion	78 to	95	22 to	27
Energy from waste	- to	-	- to	-
Biomass	348 to	425	128 to	156
Tidal	68 to	84	1 to	2

He presented scenarios for the economic impact (in terms of earnings and income that could be injected into the wider and Gwynedd economy) that this might have in Gwynedd:

Maximum potential:

- Manufacture and Construction: £321 million
- Operation and Maintenance: £14 million

Achievable scenario:

- Manufacture and Construction: £55 million
- Operation and Maintenance: £4.5 million over 5 years
  = c. £910,000 p.a

C2.3.2 Gwynedd Werdd Influence

In order to further refine possible areas for action, we began by thinking areas of influence for stakeholders and partners in Gwynedd Werdd. In groups, the full list that we came up with was as follows:

- Planning powers, development of planning policy (LDP, SPG) – both Gwynedd Council and Snowdonia National Park Authority
- Use of own assets (e.g. micro-hydro opportunities at Plas Tan yBwlch for SNPA)
- Education – under 16 and 16-19
- Access to Finance:
  - Cronfa Arbrofil Eryri (CAE) National Park Sustainable Development Fund for feasibility studies (limited to £250k pa)
  - Carbon Trust
  - European Funds (next round 2013 - 2020)
  - Welsh Government
- De-risking private sector investment
  - Shared intelligence
  - LDP allocations / identifying appropriate sites
- Development of expertise and high level skills (HE, R&D)
- Support (e.g. business planning, PM) and facilitation of community enterprises
- Community development officers
- Encourage, enable and influence industry
- Development of Community Strategy
- Procurement – maximising local benefit
- Community governance structures
- Co-ordination across public sector bodies

C2.3.3 Long List of Areas for Action

Using the output from workshop one as a starting point, we came up with a long list of potential areas of action, as follows:

Technology Specific
Explore energy storage opportunities
On-farm digestion
Hydrogen economy
Local use of municipal food waste (AD) and district heating (in off gas areas)
Biomass / forestry waste – develop biomass processing plant in Gwynedd
Identify sites for energy crops
Hydro / stream pumps
Wind /PV – improved design for local landscapes

Finance and Governance
To develop appropriate governance structures
Secure external funding, e.g. Green Investment Bank, European Funding
Capture local investment
Public-private partnerships, e.g. joint ventures
Community "key fund" for energy projects
Supply Chain
Local Authority to provide direct consumer advice
Local manufacturing opportunities
Specific programme to develop supply chain of local installers (e.g. accreditation, consortia)
Identify and Engage with local land owners – establish sustainable 'loops' for biomass
Facilitate 'bulk buying' in communities with high rate of fuel poverty
Physical
Local grid enhancements
Broadband development for local control of electricity use and production
Identify potential development sites
Exploration for 'local' or West Wales grid
Economic returns from joint-producer supply to National Grid
Public Perception
Communication with communities
Communication with business
Develop and promote exemplar projects
Link community generation and use
Opportunities for local communities to benefit from renewables – investment in saving energy
Skills
Increase expertise and resource in planning departments
Specialist skills for development of renewables in environmentally sensitive areas
Further develop Colleg Llandrillo skills site
Maintain links to universities and latest research
Develop low carbon generation / sustainable living entrepreneurial approach amongst children and young peoples
Develop skills for application and installation of smart meters

C2.3.4 Prioritisation

In order to prioritise the long list of areas for action, a list of potential prioritisation criteria was drawn up:

- Community benefits (£)
- Amount of Carbon saved
- MW produced

- Security of supply and local self-sufficiency
- Ability to deliver low cost electricity and encourage business competitiveness
- No. of local Jobs
  - Created / safeguarded
  - Direct /indirect
- Landscape protection / impact on the environment
- Impacts on tourism and other economic sectors
- Improved community cohesion
- Impact on fuel poverty
- Green leadership
- Cost
- Long-term educational opportunity

Everyone was able to use these criteria as they saw fit, to vote for their preferred areas for action

Technology Specific	**No. of votes**	**Priority**
Explore energy storage opportunities	2	
On-farm digestion	13	**1**
Hydrogen economy	2	
Local use of municipal food waste (AD) and district heating (in off gas areas)		
Biomass / forestry waste – develop biomass processing plant in Gwynedd	8	**5**
Identify sites for energy crops		
Hydro / stream pumps	3	
Wind /PV – improved design for local landscapes	3	
Finance and Governance		
To develop appropriate governance structures		
Secure external funding, e.g. Green Investment Bank, European Funding	6	**6**
Capture local investment	3	
Public-private partnerships, e.g. joint ventures	8	**4**
Community “key fund” for energy projects	3	
Supply Chain		
Local Authority to provide direct consumer advice	2	
Local manufacturing opportunties	2	
Specific programme to develop supply chain of local installers (e.g. accreditation, consortia)	6	**7**
Identify and Engage with local land owners – establish sustainable ‘loops’ for biomass	2	

Facilitate 'bulk buying' in communities with high rate of fuel poverty		
Physical		
Local grid enhancements	5	
Broadband development for local control of electricity use and production	3	
Identify potential development sites	6	**8**
Exploration for 'local' or West Wales grid	2	
Economic returns from joint-producer supply to National Grid		
Public Perception		
Communication with communities	5	
Communication with business	1	
Develop and promote exemplar projects	10	**2**
Link community generation and use	8	**3**
Opportunities for local communities to benefit from renewables – investment in saving energy	4	
Skills		
Increase expertise and resource in planning departments	2	
Specialist skills for development of renewables in environmentally sensitive areas		
Further develop Colleg Lllandrillo skills site	3	
Maintain links to universities and latest research	4	
Develop low carbon generation / sustainable living entrepreneurial approach amongst children and young peoples		
Develop skills for application and installation of smart meters		

C2.3.5 Refining Actions

The top eight areas for action were developed further and these have fed into the action and delivery plans in section 9 of the main report.

C2.4 Next Steps

It was agreed that a copy of the draft report would be sent to all stakeholders for comment the week of the 11th June.

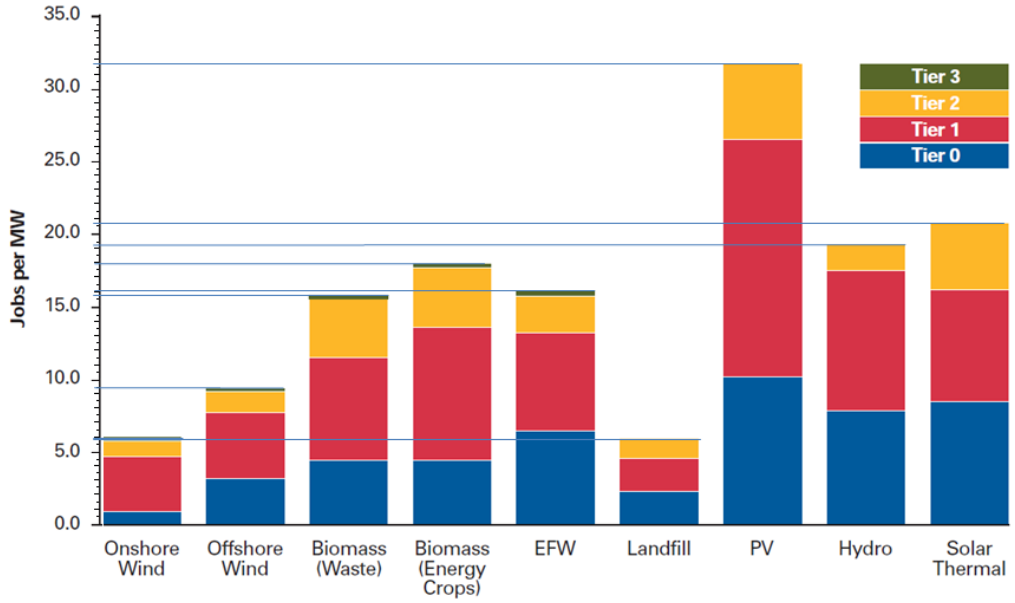
Appendix D

Employment Benchmarks

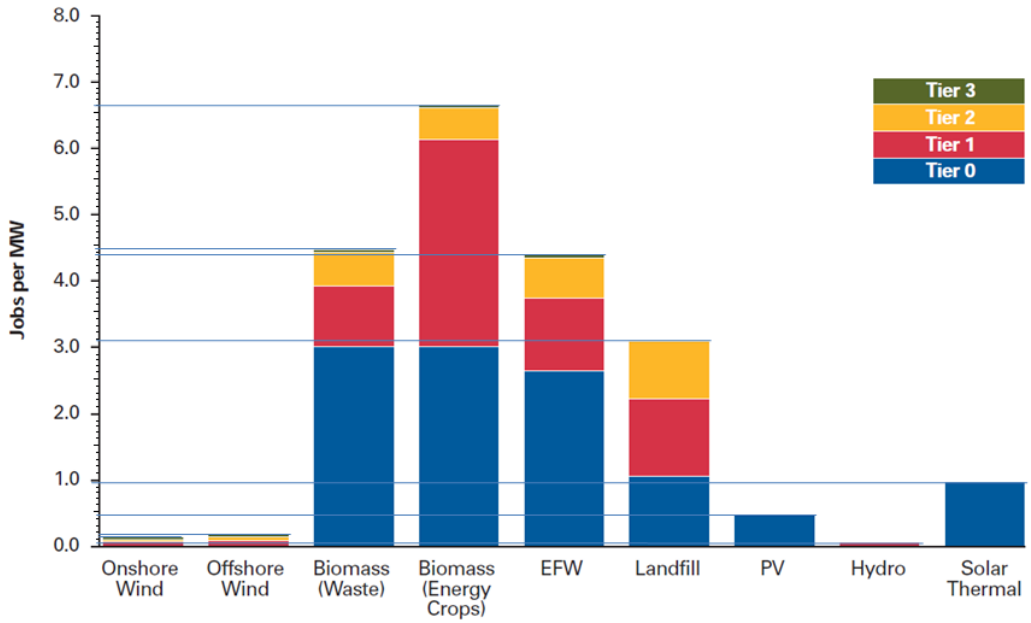
D1 Employment Benchmarks

As discussed in the methodology, the raw data from the 'Renewable Supply Chain Gap Analysis' from the Department for Trade and Industry (DTI) is not available. Instead, Arup analysis of the figures in the DTI study is used to find these values. In the interests of transparency these are shown below.

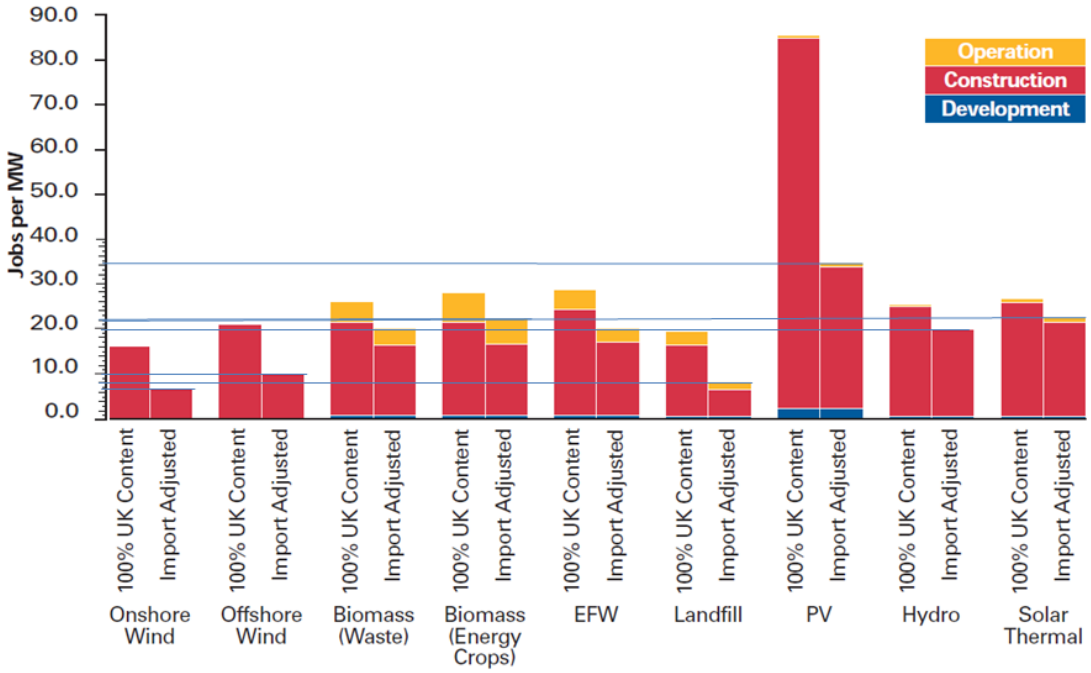
A2.1 – Jobs per MW for the Construction Phase



A2.2 – Jobs per MW for the Operation Stage



A2.3 – Jobs per MW by Phase of the Operation Cycle and Technology



Appendix E

Policy Background

E1 European Policy Context

E1.1 Europe 2020 Strategy

The Europe 2020 Strategy (EU2020) sets the objectives for European policy up until 2020 and, in this way, provides much of the overarching policy framework implementing local renewable energy investments with EU funds. EU2020 was launched in 2010 and outlines a 10-year strategy for smart, sustainable and inclusive growth in the EU.

The Europe 2020 Strategy sets out the European Commission's (EC) ambitious objectives on climate change and energy, with clear targets to be reached by 2020:

- To cut greenhouse gas (GHG) emissions by 20 per cent from 1990 levels;
- To deliver at least 20 per cent of Europe's energy from renewable sources; and
- To increase energy efficiency by 20 per cent.

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. It will Provide € 31 748 million to help address major concerns shared by all Europeans such as climate change, developing sustainable transport and mobility, making renewable energy more affordable, ensuring food safety and security, or coping with the challenge of an ageing population.

E1.2 Resource Efficient Europe

Resource Efficient Europe sets the focus for future investment, demand management and energy efficiency policies across the EU. It is a flagship initiative of EU2020 and includes a number of specific plans related to individual policy areas. The plans that are of relevance to shaping the development of, and securing, funding opportunities in North West Wales include the:

- **Low-Carbon Economy Roadmap 2050**[79] in which the EU has set out a strategy to meet the long-term target of reducing domestic emissions by 80 to 95 per cent across EU Member States. The roadmap demonstrates how the sectors responsible for Europe's emissions, namely, power generation, industry, transport, buildings and construction, as well as agriculture, can make the transition to a low-carbon economy;
- **Energy Efficiency Plan 2011**[80] which proposes measures aimed at closing the gap towards reaching the EU's 20 per cent energy efficiency target, helping to realise the vision of the Low Carbon Economy Roadmap, as well as aiming to increase energy independence and security of supply;
- **White Paper on the future of transport**[81] which introduces a roadmap of 40 initiatives for the next decade in order to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. At the same time, the proposals included are expected to dramatically reduce Europe's dependence on imported oil thereby leading to a 60 per cent reduction in carbon emissions from transport by 2050; and

[79] See: http://ec.europa.eu/clima/policies/roadmap/index_en.htm
[80] See: http://ec.europa.eu/energy/efficiency/action_plan/action_plan_en.htm
[81] See: http://ec.europa.eu/transport/strategies/2011_white_paper_en.htm

- **A Roadmap for a resource-efficient Europe**[82] which sets out a vision for the structural and technological change needed up to 2050, as well as the objectives to be reached by 2020 and suggestions about how they could be met.

E1.3 Fifth Cohesion Report on Economic, Social and Territorial Cohesion

The Fifth Cohesion Report on Economic, Social and Territorial Cohesion sets out the strategic direction for investing in sustainable development in the EU. One of the central challenges identified in the Cohesion Report is ensuring climate change resilience within Member States, in particular how to support investment in mitigation and adaptation measures in the transition to a lower carbon economy.

Public consultation on the future of cohesion policy highlighted that 25% of respondents across Europe (the highest response rate to date on such a consultation) want the future focus of the Structural and Cohesion Funds to be on sustainable development, the environment and energy. In this respect Gwynedd Werdd is firmly rooted within the appropriate agenda moving forward.

The 11 thematic areas / priorities for future Cohesion Policy, which provides capital funds through ERDF and financial instruments, are set out below:

1. Strengthening research, technological development and innovation
2. Enhancing access to, and use and quality of information and communication technologies
3. Enhancing competitiveness of SMEs, the agricultural sector and the fisheries and agriculture sector
4. Support the shift to a low- carbon economy in all sectors
5. Promote climate change adaptation, risk prevention and management
6. Protecting the environment and promoting resource efficiency
7. Promoting sustainable transport and removing bottlenecks in key network infrastructures
8. Promoting employment and supporting labour mobility
9. Promoting social inclusion and combating poverty
10. Investing in education, skills and lifelong learning
11. Enhancing institutional capacity and an efficient public administration

It will be important for Gwynedd to align with these priorities in order to maximise opportunities from these funding sources.

[82] See: http://ec.europa.eu/environment/resource_efficiency/index_en.htm

E2 UK Policy Context

At the UK level there is range of legislation, policy, guidance and initiatives that necessitate and encourage reduced carbon emissions from development and the deployment of renewable and low carbon energy generation technologies. Relevant primary legislation includes:

- **National Policy Statement on Energy (2011) and the National Policy Statement on Renewable Energy Infrastructure (2011).** These National Policy Statements provide a definition of projects which are considered to be nationally significant renewable energy infrastructure, and the prerequisites of such projects; and
- **Climate Change Act (2008).** The UK is introducing a long term legally binding framework to reduce greenhouse gas emissions. The Act which came into effect in 2008 puts into statute the framework to set the UK's targets to reduce carbon dioxide emissions through domestic and international action by at least 80 per cent by 2050 and at least 26 per cent by 2020, against a 1990 baseline.

UK Policy, Building Regulations and the Code for Sustainable Homes and Non-Domestic Buildings will all have important complementary roles to play in meeting the targets set out by the Climate Change Act. The key documents of relevance to the promotion of renewable and low carbon energy generation technologies:

- **UK Carbon Plan (2011).** This document sets out the UK government's plan for meeting the carbon budgets, including decarbonising electricity generation and increasing the deployment of renewable heat.
- **UK Renewable Energy Roadmap (2011).** This document sets out a shared approach to unlocking UK's renewable energy potential. It sets out a comprehensive suite of targeted, practical actions to accelerate renewable energy in the UK in order to achieve the UK's renewable energy target in the next decade – driving innovation and the deployment of a wide range of renewables. The document complements and strengthens parallel activity by Wales;
- **National Renewable Action Plan (2010).** This action plan was established by the Renewable Energy Directive 2009/28/EC, which proposes measures to enable the UK to meet its 2020 greenhouse gas reduction target;
- **Building Regulations (2010).** Is applicable in both England and Wales promoting energy efficiency in buildings and is set out in the Building Act 1984. Part 6 of the Building Regulations 2010, Energy Efficiency Requirements, outlines requirements on Energy Performance Certificates (EPCs), CO2 emission rate calculations, CO2 emission rate for new buildings, and consequential improvements to energy performance;
- **UK Renewable Energy Strategy (2009).** It sets out the path to ensure 15% of UK energy comes from renewable sources by 2020. The UK RES states that this would entail 30% of electricity, 12% of heat (including biomass, biogas, solar and heat pumps) and 10% of transport energy to be generated from renewable sources; and
- **Code for Sustainable Homes: Technical Guide, Version 2 (May 2009)**. The Code measures the sustainability of a new home against nine categories of sustainable design, using a one to six star rating system to communicate the overall sustainability performance. The technical guidance sets out the requirements of the Code and assessment method. Sustainable New Homes – The Road to Zero Carbon: Consultation on the Code for

Sustainable Homes and the Energy Efficiency Standard for Zero Carbon Homes (Dec 2009) – This consultation sought views on changes to the Code to align with changes to Part L of the Building Regulations, and the proposed approach to adopting the 2016 definition of Zero Carbon.

E3 Welsh Policy Context

Welsh Government policy also provides a steer on renewable energy; national policy guidance for renewable energy in Wales is based on four policy documents and a national scheme:

- **Energy Wales – A Low Carbon Transition (March 2012)** This documents sets out the Welsh Government's ambition to 'create a sustainable, low carbon, economy for Wales'. It recognises that whilst energy policy is not a devolved policy, a number of key enabling policies are. The document sets out how Welsh Government will provide leadership in this area, and the elements that it can deliver, such as improvements to the consenting regime. In addition, it sets out the need to maximise the benefits from energy developments to the economy and community, using a combination of technologies at different scales.

- **Planning Policy Wales – Edition 4 (February 2011).** This document provides the strategic policy framework for the current land use planning policy in Wales for the effective preparation of local planning authorities' development plans. The document is supplemented by 21 Technical Advice Notes (TANs). The assessment is to fulfil the Council's requirement under Planning Policy Wales (2011) section 12.9, "Development plans and renewable and low carbon energy". Chapter 12, [Infrastructure and Services], states:

  "*The Assembly Government's aim is to secure an appropriate mix of energy provision for Wales, whilst avoiding, and where possible minimising environmental, social and economic impacts. This will be achieved through action on energy efficiency and strengthening renewable energy production. This forms part of the Assembly Government's aim to secure the strongest economic development policies to underpin growth and prosperity in Wales recognising the importance of clean energy and the efficient use of natural resources, both as an economic driver and a commitment to sustainable development*"

- **The Wales Spatial Plan (2008).** People, Places, Futures – was originally adopted by the National Assembly for Wales in November 2004. The 2008 updated plan brings the Wales Spatial Plan into line with One Wales, the agreement between the Labour and Plaid Cymru Groups in the National Assembly to deliver a progressive, stable and ambitious programme for government over the Assembly term (One Wales, A Progressive Agenda for the Government of Wales, 2007). The 2008 updated plan provides the context for the direction of development for local plans and places the values of sustainability at the centre. It also aims to ensure that decisions are taken with due regard to their impact beyond immediate sectoral or administrative boundaries;

- **A Low Carbon Revolution: Wales Energy Policy Statement (2010).** The Government sets out the sustainable development framework for the acceleration in Wales of the transition to an efficient low carbon based economy and where most of our local energy needs can be met by low carbon electricity production. It builds on the 2008 Renewable

Energy Route Map. It indicates that Wales has the renewable potential able to produce at least twice as much electricity from renewable technologies by 2025 – with about 40% of this from marine wave and tidal, a third from wind, and the rest mainly from sustainable biomass (including waste, hydropower, and micro-generation);

- **Technical Advice Note 8 – Planning for Renewable Energy (TAN 8) (2005).** It is the key document for national renewable energy and planning policy in Wales. TAN 8 sets out supplementary guidance for renewable energy and planning, onshore renewable energy technologies, design and energy and development control in Wales;
- **One Wales, One Planet – The Sustainable Development Scheme for Wales (2009).** The scheme's vision requires all organisations in Wales to actively promote sustainable development. It sets out 18 Actions, across Ministerial Portfolios, to confirm the Welsh Government's intent. It advocates sustainable resource use in which more of our energy is produced at a community level and we are self-sustaining in renewable energy. Particularly encourage businesses to deploy renewable energy and new low-carbon technologies.

E4 Gwynedd Policy Context

E4.1 Gwynedd Council Unitary Development Plan (2009)

Gwynedd Council Unitary Development Plan (UDP) (2009) 2001 – 2016 was adopted on 16 July 2009. However the UDP will soon be replaced in April 2016 by the Anglesey and Gwynedd Joint Local Development Plan (Joint LDP).

The UDP aims to:

"*... achieve the appropriate mix of land uses to make the communities of Gwynedd sustainable and to improve the quality of life of the County's residents. In addition, an effort is made to enable the communities of Gwynedd to contribute to national and international obligations to safeguard the earth's wellbeing".*

Two of the UDP's objectives which aim to achieve this include:

- effective protection of the environment; and
- prudent use of natural resources.

The UDP looks to address this objective through the following policies:

Policy C26 [Wind Turbine Developments] states that proposals for wind turbines within the Llyn Area of Outstanding Natural Beauty (AONB) will be refused. In other locations, small-scale or community based wind developments will be approves provided that certain criteria is met.

Policy C27 [Renewable and Sustainable Energy Schemes] states that proposals for renewable energy and sustainable energy management schemes (e.g. hydroelectric, landfill gas, pumped water storage, anaerobic digestion, biomass) will be approved provided that all the criteria in Policy C27 is met.

Strategic Policy 9 [Energy] states that '*development proposals to provide energy from renewable sources will be approved provided that they do not significantly harm the environment or the amenities of nearby residents'.*

Policy C7 [Building in a Sustainable Manner] states that an Energy Design Advice Report will be required to accompany each planning application. The Energy Design Advice Report which is required in relation to planning applications for new non-residential buildings over 1000 square meters will be expected to contain recommendations regarding energy efficiency and appropriate renewable technologies which could be incorporated into the development.

The UDP also makes clear the importance of promoting a sustainable economy '*where employment will be a means of maintaining and enhancing the standard of living of local residents without compromising valuable environmental and cultural characteristics*.' While there is no direct mention of the renewables sector, clearly developing this sector fits well with the economic vision set out in the UDP.

E4.2 Anglesey and Gwynedd Joint Local Development Plan

Preliminary work on preparing and gathering the evidence base for the Joint LDP is currently taking place. The Joint LDP will be adopted in April 2016 and will replace the existing Gwynedd UDP. The Gwynedd Council Board along with the Isle of Anglesey County Council Executive Committee have set up a Joint Policy Unit to prepare a Joint LDP for the Gwynedd and Môn Local Planning Authority Areas. Both Authorities have also approved constitutional changes in order to create a Joint Planning Policy Committee, which will have the responsibility of making the decisions with regard to the Joint Local Development Plan.

Gwynedd Council and the Isle of Anglesey County Council Draft Supplementary Planning Guidance Onshore Wind Energy (January 2012)

Gwynedd Council and the Isle of Anglesey County Council have resolved to set up a Joint Planning Policy Unit (JPPU) to prepare a Joint Local Development Plan (JLDP) for the Anglesey and Gwynedd local planning authority areas. Prior to the adoption of the JLDP both Councils will continue to use their existing development plans.

A Draft Supplementary Planning Guidance (SPG) document has been prepared by the Anglesey and Gwynedd Joint Planning Policy Unit regarding onshore wind developments, *Draft Supplementary Planning Guidance Onshore Wind Energy* (January 2012). This document applies to the Gwynedd local planning area only and supports and supplements the relevant policies contained within the existing development plan for the Gwynedd Local Planning Authority area that apply to on-shore wind energy development.

E4.3 The Eryri Local Development Plan 2007 – 2022

The Eryri Local Development Plan was adopted by Snowdonia National Park Authority on the 13th of July 2011. A large proportion of land area in Gwynedd (63%) falls within Snowdonia National Park. Gwynedd Council's powers operate within areas outside Snowdonia National Park. The Eryri Local Development Plan consists of a Written Statement, Proposals, and national planning policies which help to guide decisions on planning applications on all future development and land use planning within the National Park.

"The Local Development Plan aims to reduce reliance on non renewable fuels and to achieve sustainable power production and consumption by*...the provision of appropriate householder and community renewable energy [and] ... reducing carbon emissions and the potential for 'fuel poverty' through improved efficiency of new and existing buildings".*

The Local Development Plan encourages, where appropriate the use of the National Park's natural resources for small scale renewable energy power generating schemes to meet local needs without harm to the 'Special Qualities' of the area.

Development Policy 3 [Energy] states "*Wherever possible all new buildings, including extensions, should consider the potential for maximising renewable energy technologies...Microgeneration and small-scale community renewable energy plant will be supported especially where they make a contribution to improving the quality of life in smaller communities."*

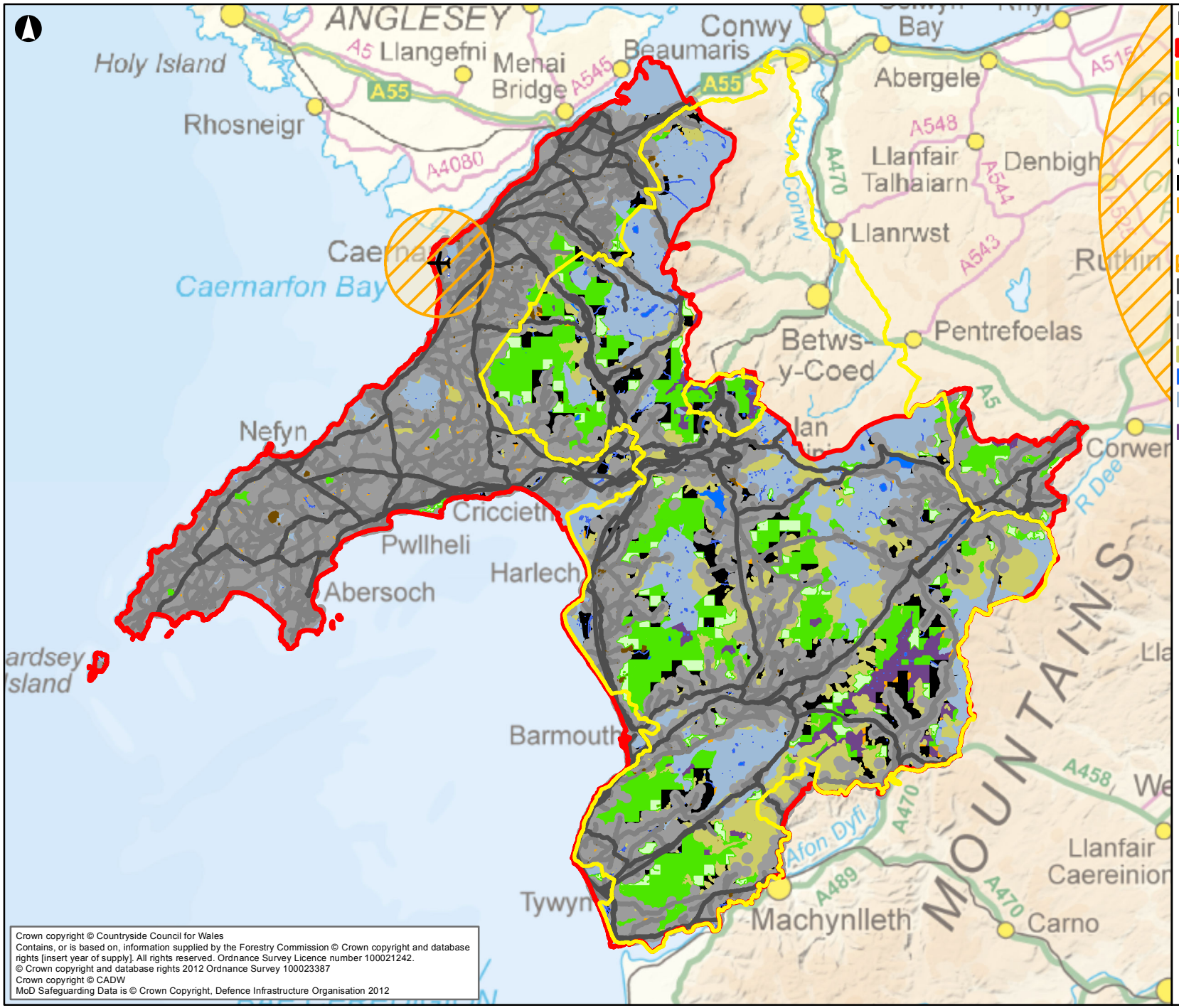
Development Policy 6 [Sustainable Design and Materials] states "*In order to promote sustainable development within the National Park all forms of new built development will attain at least the national sustainable building requirements. As an exception to the use of mineral slate roofing, alternative appropriately coloured and textured natural materials and appropriately designed and located renewable energy proposals will be considered."*

Development Policy 21 [Tourism and Recreation] states "*New tourism development and the enhancement of current facilities will be supported where... Current facilities will be improved or conversion of a vacant or underused building is proposed alongside efforts to improve its energy efficiency and/or provide a proportion of its energy requirements from appropriate renewable energy sources."*

Appendix F

Figures

A4



Legend

- Gwynedd Boundary
- Snowdonia National Park

Unconstrained wind resource

- Priority 1
- Priority 2

Constraints

- Unsuitable wind resource
- Land area not sufficient for wind resource
- Operational aerodromes
- Aerodrome traffic zone
- Primary Transport 170m buffer
- Secondary Tranport 170m + 10% buffer
- Dwellings 500m buffer
- Woodland
- Inland water
- Environmental constraints
- Potential interference with NERL infrastructure

Issue	Date	By	Chkd	Appd
P0	2012-05-03	JE	AC	SJP

Metres
0 6,000 12,000 24,000

ARUP
63 St Thomas Street
Bristol, BS1 6JZ United Kingdom
Tel +44 (0)117 976 5432 Fax +44 (0)117 976 5433
www.arup.com

Client
Gwynedd Council

Job Title
Scoping Renewable Energy Opportunities in Gwynedd

Wind Resources with constraints

Scale at A4
1:500,000

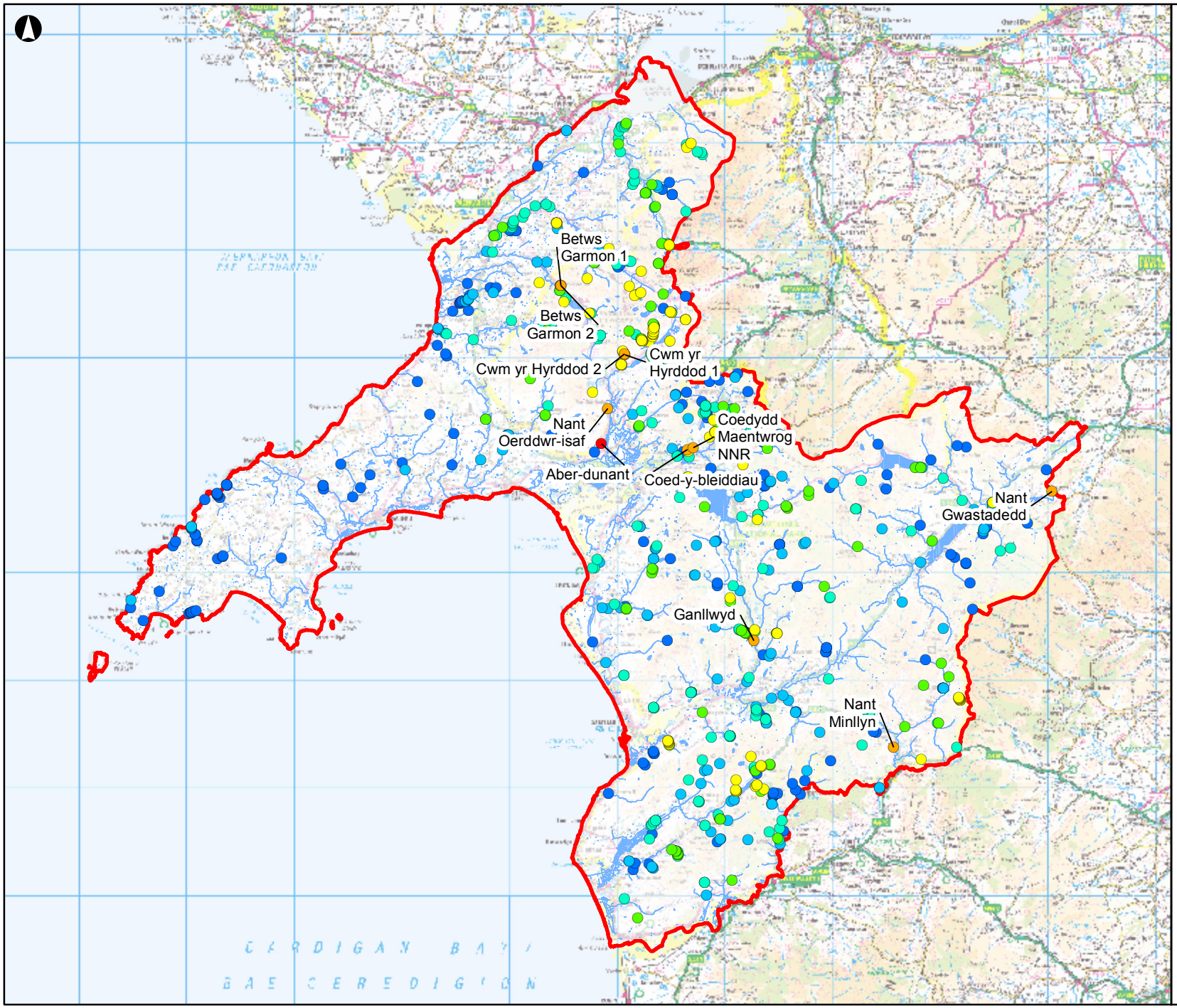
Job No	Drawing Status
224123-00	**Preliminary**

Drawing No	Issue
003	**P0**

04/05/2012 15:35:10

MXD Location

A4



Legend

- Gwynedd_Boundary
- Inland water

Power category

- 0 - 10 kW
- 10 - 20 kW
- 20 - 50 kW
- 50 - 100 kW
- 100 - 500 kW
- 500 - 1500 kW
- > 1500 kW

Issue	Date	By	Chkd	Appd
P0	2012-05-03	JE	AC	

Metres
0 6,000 12,000 24,000

ARUP

63 St Thomas Street
Bristol, BS1 6JZ United Kingdom
Tel +44 (0)117 976 5432 Fax +44 (0)117 976 5433
www.arup.com

Client
Gwynedd Council

Job Title
Gwynedd Renewables Study

Hydropower

Scale at A4
1:500,000

Job No	Drawing Status
224123-00	**Preliminary**

Drawing No	Issue
008	**P0**

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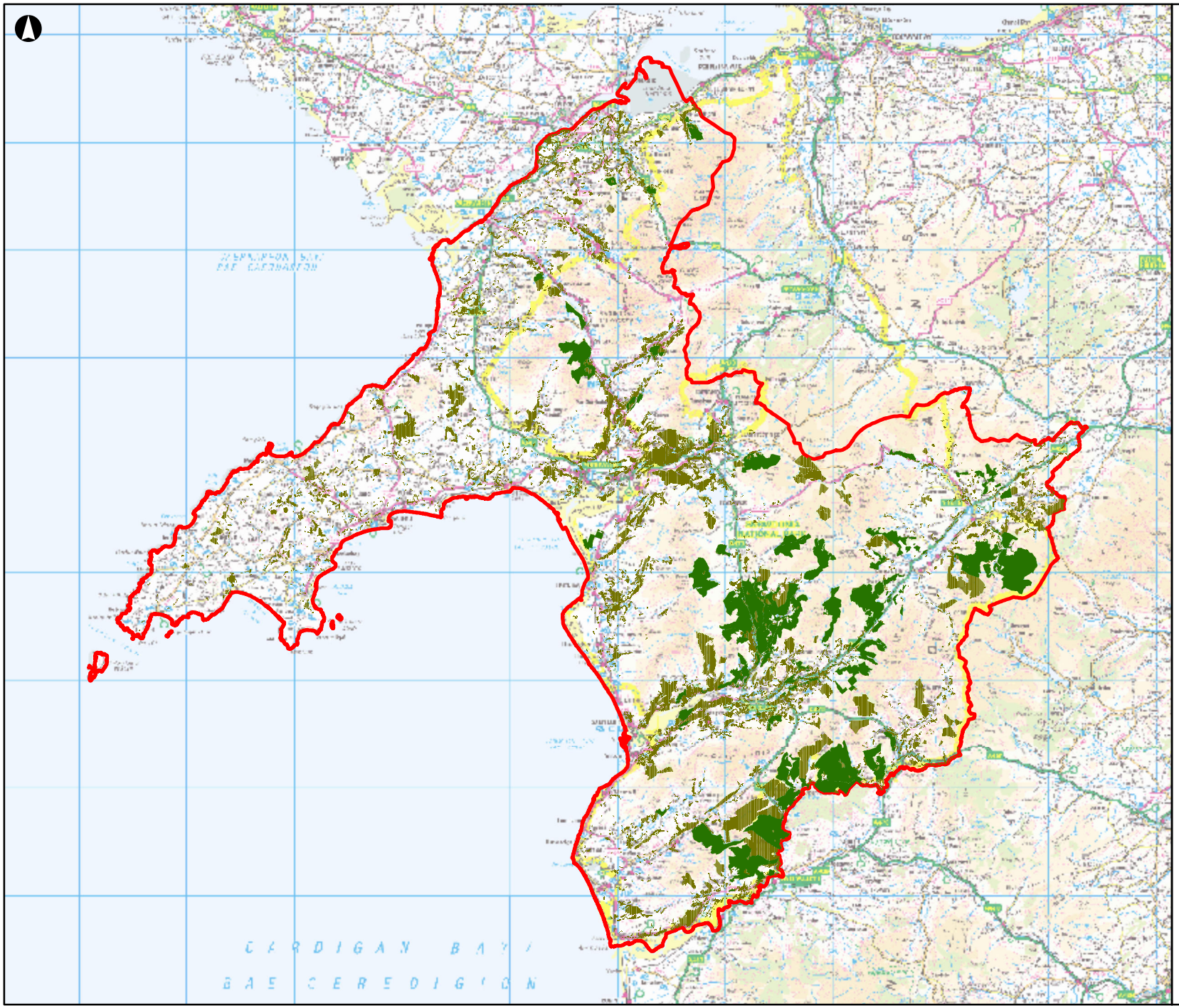
MXD Location

A4



Legend

Gwynedd Boundary

Wood fuel area

Woodland

Woodland within Forestry Commission Legal Boundary

Issue	Date	By	Chkd	Appd
P0	2012-04-23	JE	AC	

Metres

0 6,000 12,000 24,000

ARUP

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Tel +44 (0)117 976 5432 Fax +44 (0)117 976 5433
www.arup.com

Client

Gwynedd Council

Job Title

Gwynedd Renewables Study

Wood Fuel

Scale at A4

1:500,000

Job No	Drawing Status
224123-00	**Preliminary**

Drawing No	Issue
001	**P0**

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MXD Location

Appendix G

Consultees

G1 Full list of consultees

The list below sets out the full list of consultees who either attended a workshop, who we consulted with by telephone or who we held one-to-one meetings with.

Name	Organisation
Tom Vincent	AECOM
Dr. Trefor Wyn Jones	Bangor University
Dr. Einir Young	Bangor University
Lee Evans	Carbon Trust
Paul Allen	Centre for Alternative Technology
Michael Philips	Community Energy Wales
Allan Sharp	Conwy Council
Stuart Whitfield	Conwy Council
Wil Parry	Cywaith
Bethan Gritten	EcoBro
Sioned E Williams	Gwynedd Council
Dewi Wyn Jones	Gwynedd Council
Heledd Hughes	Gwynedd Council
David Mark Lewis	Gwynedd Council
Ann Owen	Gwynedd Council
Dewi R Jones	Gwynedd Council
Llyr B. Jones	Gwynedd Council
Cllr John Wyn Jones	Gwynedd Council
Grant Peisley	Gwynedd Werdd
Chris Green	Halcrow
John Idris Jones	Magnox
Dave Holmes	QBC
Chris Williamson	QBC
Llewllyn Rhys	Renewables UK
Russell Jordan	RPS
Jeremy Smith	RWE Npower
Billy Langley	RWE Npower
Rachel Shorney	Scottish Power Manweb (DNO)
Dafydd Watts	Severn Wye Energy Agency
Ifer Gwyn	Snowdonia National Park
Gareth Lloyd	Snowdonia National Park Authority
Iwan Evans	Snowdonia National Park Authority
Jeston Honitray	Sustainable Gwynedd Gynaladray

Dewi Llywd Evans	Tai eryri
Walis George	Tai Eryri / Cywaith
Keith Bellis	Tegni Cymru
Gareth Hall	Welsh Government (on behalf of Horizon)
Brian Thomas	Ynni Llŷn