Llywodraeth Cymru
Welsh Government

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Practice Guidance

Planning for Renewable and Low Carbon Energy – A Toolkit for Planners

September 2015

This practice guidance was prepared for the Welsh Government by AECOM.

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 WG26961 Digital ISBN 978 1 4734 5070 7

Table of Contents

List of Tables

List of Figures

Executive summary

Planning Policy Wales sets out the Welsh Government's commitment to tackling climate change which includes achieving annual carbon reduction-equivalent emissions reductions of 3% per year in areas of devolved competence.

Considerable responsibility for delivery of a low carbon Wales rests with the various departments within local authorities, with key roles in planning, waste management, land-ownership and energy procurement. This update of the toolkit seeks to reconfirm this role and emphasise the need for the inclusion of robust, spatially based polices within Local Development Plans. To this end, the 'Policy' section of the toolkit has been extended to six options to take account of the different nature of development and the processes by which they are assessed and allocated.

The "Planning for Renewable and Low Carbon Energy: A Toolkit for Planners" project was originally commissioned by the Welsh Government in November 2008. Supported by a steering group comprised of the Welsh Government and the Energy Saving Trust, the toolkit was developed by AECOM, with Pembrokeshire County Council selected for a pilot study. Environment Agency Wales and Countryside Council for Wales (now Natural Resources Wales) were key providers of data.

Research associated with the development of the toolkit was divided into three components: the toolkit; a Renewable Energy Assessment for Pembrokeshire County Council (the output of the application of the toolkit to the Pembrokeshire County Council area and circumstances); and a Recommendations Report to the Welsh Government.

The original challenge of developing the toolkit was to develop methods for assembling a robust evidence base whilst minimising very technical exercises and ensuring that sources of data were readily available to all local authorities in Wales.

There are a number of other key features to this 2015 refresh of the toolkit. Many of the data sources have been updated and a list is now provided electronically through the Welsh Government website. In addition, Active Templates are now provided that enable easier calculation of some of the required information such as 'Residential Heat Demand Density' and 'Uptake of Building Integrated Renewables'.

A further change is the inclusion of a consideration of Solar Photovoltaic (PV) Farms as a 'stand-alone' technology which has come about due to the significant increase in interest in this technology. Detail about the technology has been integrated into the toolkit method and a new Project Sheet has been developed to enable local authority planners to identify the potential 'accessible resource'.

As a result of continuing to ensure uniformity of approach and comparability of outputs, it is still the case that some local authorities may find they have, or require, more detailed data on which they might base their assessments. Refinement of the generic approach outlined in the toolkit is encouraged, though in a controlled way to ensure comparability and continued dissemination of best practice.

This toolkit is part of a selection of tools upon which local authorities might draw in developing spatially based renewable energy policies for inclusion within Local Development Plans. "Planning for Renewable and Low Carbon Energy – A Toolkit for Planners" is specifically designed, through the provision of information and method, to facilitate the production of a relevant and robust evidence base -a Renewable Energy Assessment for this purpose.

Whilst the specific outputs of the toolkit is LDP policies and related evidence, due to the wide variations in the nature and timing of proposed development, the toolkit itself could be employed on a regular basis. For instance, it is recognized that discussion regarding strategic sites begin well in advance of site allocations and it is imperative that these discussions do not by-pass the toolkit process.

Early use of the toolkit within the Local Development Plan process is therefore strongly recommended though this will be dependent upon the stage in the process reached by different local authorities: however, it is better to employ the toolkit at a later stage in the process than not at all.

In addition to informing requirements for strategic sites, the toolkit will provide an evidence base to inform land allocations for particular 'stand-alone' renewable energy generation (as with TAN8 for wind energy), the sieving of candidate sites and the allocation of sites for new development.

Renewable Energy Assessments will vary between local authorities dependent upon the nature of the available renewable energy resource, existing character of the local authority area and the nature of new development opportunities. The toolkit provides examples of some of the exercises that might be undertaken in order to compile a robust evidence base to support your local authority's spatial policies on renewable energy.

Whilst predominantly a "toolkit for planners", it is strongly recommended that the toolkit is employed by local authorities and other public sector bodies to develop and align corporate estate, property and energy strategies with the findings of the Renewable Energy Assessment. Use of the toolkit is not therefore restricted to the LDP process but should be employed during development of, for instance, Regional Waste Strategies, etc.

The involvement of professionals from a range of disciplines is encouraged in the use of the toolkit. Different sections will require greater or lesser input from planners, energy managers/technicians, waste management officers, etc. In order to avoid unnecessary time and resources, and given the nature of some of the activities included in the toolkit, there is considerable potential for cooperation between local authorities and other public sector bodies in completing various exercises (e.g. wind and biomass resource mapping).

Included within the toolkit pack are methods, and in some cases Active Templates to appraise the energy efficiency of current building stock, for both commercial and domestic use, and to predict future energy demand in-line with current UK targets. The public sector, tasked with a leadership role, should be pro-active in discussing cost-effective approaches to meeting such targets and facilitating the success of others. Following this 2015 update, the toolkit better provides the methods to contribute to the fulfilment of this role.

List of Abbreviations

ATZ	Aerodrome Traffic Zones
ALC	Agricultural Land Classification
ATC	Air Traffic Control
AD	Anaerobic Digestion
AONB	Area of Outstanding Natural Beauty
BIR	Building Integrated Renewables
CSAC	Candidate Special Area of Conservation
CO_2	Carbon Dioxide
CIBSE	Chartered Institute of Building Services Engineers
CAA	Civil Aviation Authority
C(C)HP	Combined [Cooling] Heat & Power
CHP	Combined Heat and Power
C & I	Commercial and Industrial
DH	Decentralised Heating
DCLG	Department for Communities & Local Government
DECC	Department for Energy and Climate Change
DHN	District Heat Network
EfW	Energy from Waste
EST	Energy Saving Trust
ESCo	Energy Services Company
EDR	Existing Dwelling Ratio
FUW	Farmers Union of Wales
FIT	Feed in Tariff
FNR	Future Non-residential Ratio
GIS	Geographical Information Systems
GW	Giga Watt (1,000,000kW)
GWh	Giga Watt hours
kW	kilowatt (a unit of power equivalent to 1000watts or 1000 Joules/second
kWh	kilowatt hour (a unit of energy equivalent to the work done by one kilowatt constantly for one hour)
JHLAS	Joint Housing & Land Availability Studies
LPG	Liquefied Petroleum Gas
LA	Local Authority
LDP	Local Development Plan
LLPG	Local Land & Property Gazetteer
LNR	Local Nature Reserves
LZC	Low and Zero Carbon
LSOA	Lower Super Output Area

MNR	Marine Nature Reserves
MJ	Mega Joule
MW	Mega Watt (1,000kW)
MWe	Mega Watt electrical
MW[h]	Mega Watt hour
MWt	Mega Watt thermal
MATZ	Military Aerodrome Traffic Zones
MoD	Ministry of Defence
MUSCo	Multi Utility Services Company
MSW	Municipal Solid Waste
NATS	National Air Traffic Service
NFU	National Farmers Union
NNR	National Nature Reserve
NRW	Natural Resources Wales
NERL	NATS En Route Plc
NDR	New Dwelling Ratio
OS	Ordnance Survey
PV	Photovoltaic
PPW	Planning Policy Wales
Part L	Part L of the Building Regulations relating to the Conservation of Fuel and Power
RE	Renewable Energy
REA	Renewable Energy Assessment
RES	Renewable Energy Strategy
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
SAM	Scheduled Ancient Monuments
SSSI	Site of Special Scientific Interest
SAC	Special Area of Conservation
SPA	Special Protection Area
SAP	Standard Assessment Procedure
SEA	Strategic Environmental Assessment
SSA	Strategic Search Area
TAN	Technical Advice Note
TM	Technical Memorandum
UPRN	Unique Property Reference Number
UDP	Unitary Development Plan
VOA	Valuation Office Agency
WHE	Welsh Health Estates

1 Introduction

1.1 Background and purpose of this toolkit

1.1.1 Climate change and energy security are key priorities of both the UK and Welsh Governments. The use of fossil fuels is a major contributor to greenhouse gas emissions and a major cause of global climate change. Wales is moving towards a low carbon energy based economy to tackle the causes of climate change and secure more sustainable sources of energy. The generation and use of renewable and low carbon energy sources has a key role to play in this and the UK Government is committed to meeting the EU target of 15 percent of energy demand from renewable sources by 2020.

In 2014, the European Commission set a target of at least 27% of EU energy consumption to be sourced from renewable energy by 2030, although there will be no binding targets set for member states. The Climate Change Act 2008 introduces a carbon budget of at least 26% up to and including 2020 and a legally binding target of at least an 80% reduction by 2050, against a 1990 baseline.

1.1.2 The Welsh Government has made a commitment to tackling climate change, resolving that the Government and the people of Wales will play the fullest possible part in reducing its carbon footprint and meeting statutory UK and EU targets on greenhouse gas emission reduction[1].

Local Authorities have several key roles to play that can facilitate the use and generation of renewable and low carbon energy. These are:

1. Planning policy – preparing planning policies which guide appropriate renewable and low carbon energy development through their Local Development Plans (LDPs).
2. Development management – taking decisions on planning applications submitted to the local planning authority for development; as well as preparing Local Impact Assessments for schemes which are determined by the Planning Inspectorate[2].
3. Corporate – taking action at a council wide level to achieve a low carbon economy.
4. Leadership – taking forward wider community action and communicating the need to increase the uptake of renewable energy.

This toolkit has been prepared by AECOM for the Welsh Government to, primarily, support local authority planning officers with the first of these. It sets out how a local authority can prepare a robust evidence base to underpin a number of LDP spatial policies that can support and facilitate the deployment of renewable and low carbon energy systems. The evidence base, which is the outcome of this toolkit, consists of an assessment of the potential for renewable and low carbon energy generation, at different scales, and at different levels of detail.

In terms of development management, completing the assessment can be useful in several ways. Firstly, when assessing applications for new development sites, it can aid officers in discussions with developers around opportunities for district heating and making use of waste heat. Secondly, when assessing applications for larger scale new generation schemes, it can enable officers to identify whether there is the potential for those schemes to supply heat to new or existing development. Thirdly, in the case of wind or solar farm developments, it can assist officers in understanding why a developer has chosen a particular location to develop a scheme.

However, as well as supporting planning officers with their LDPs, the intention is that the renewable energy opportunities that can be identified by applying the toolkit will also be useful in assisting local authorities to fulfil the third and fourth roles identified above.

1.2 Why should local authorities use the toolkit?

Meeting Welsh Government Requirements for Planning Policies

Planning Policy Wales (PPW), (edition 7, July 2014) www.gov.wales/topics/planning/policy/ppw/?lang=en and supporting Technical Advice Notes (TAN 12 and 8) and practice guidance, set out a number of areas of evidence gathering and policy making for renewable and low carbon energy generation that local authorities are expected to consider when developing their LDPs. These requirements cover two principal areas of policy making: planning for renewable and low carbon energy (chapter 12.8 in PPW), and planning for sustainable buildings (PPW chapter 4) and covers the overlap between these two areas, where renewable and low carbon energy generators supply energy to new developments and buildings. Section 12.8.2 of PPW specifically mentions this Toolkit, and states:

Planning policy at all levels should facilitate delivery of both the ambition set out in Energy Wales: A Low Carbon Transition and UK and European targets on renewable energy…… The issues at the heart of these duties are an established focus of planning policy in Wales, and in this context both local planning authorities and developers should have regard in particular to the guidance contained in Technical Advice Note 8: Planning for Renewable Energy and Planning for Renewable Energy – A Toolkit for Planners.

The Welsh Government's key requirements and expectations for local authority plan making for these aspects as set out in PPW are as follows:

Renewable and Low Carbon Energy (PPW Chapter 12.8)[3]

- *(12.8.18) Local planning authorities should facilitate local authority-wide scale renewable energy in development plans by undertaking an assessment of the opportunities and potential for renewable energy in the area. They should also look for opportunities to co-locate major developments in order to optimise renewable energy potential and to promote district heating schemes (see 12.9).*

- *(12.9.2) Local planning authorities should guide appropriate renewable and low carbon energy development by undertaking an assessment of the potential of all renewable energy resources and renewable and low carbon energy opportunities within their area and include appropriate policies in development plans. Local planning authorities are encouraged to work collaboratively in order to gather evidence on a sub-regional basis wherever possible.*
- *(12.9.5) Policies for strategic renewable energy development in areas outside SSAs, if appropriate, should be included in development plans informed by local authority renewable energy assessments.*
- *(12.9.8) Local planning authorities should also seek to maximise the opportunities for district heating and generation schemes in their development plan by co-locating new proposals and land allocations with existing developments and heat suppliers and users.*

Planning for Sustainable Buildings (PPW Chapter 4)[4]

(4.12.5) Local planning authorities should assess strategic sites to identify opportunities to require higher sustainable building standards (including zero carbon) to be required. In bringing forward standards higher than the national minimum, set out in Building Regulations, local planning authorities should ensure that what is proposed is evidence-based and viable. Such policies should be progressed through the Local Development Plan process in accordance with relevant requirements of legislation and national policy.

(4.12.7) Particular attention should be given to opportunities for minimising carbon emissions associated with the heating, cooling and power systems for new developments. This can include utilising existing or proposed local and low and zero carbon energy supply systems (including district heating systems), encouraging the development of new opportunities to supply proposed and existing development, and maximising opportunities to co-locate potential heat customers and suppliers.

In addition to the above, TAN 12 states (in section 6.7):

PPW sets out guidance on the selection of sites in order to deliver sustainability. The potential for strategic sites to contribute to the delivery of sustainable buildings (including zero carbon) should form part of this assessment. New development can be located so as to maximise opportunities for delivering higher sustainable building standards. This may, for example, include locating sites of specific uses together so as to make community heating schemes more viable by providing a sufficient heat load.

This toolkit is designed to assist planners to fulfill these requirements in preparing their LDPs, and in section 3 we set out in detail how each of the different parts of this toolkit relate to meeting the requirements set out above.

Wider corporate role

In terms of their wider role, local authorities may have objectives or requirements in relation to tackling climate change that they need to meet, stemming from either Single Integrated Plans, national strategies (such as those listed in chapter 2) or their own corporate strategies. Applying the toolkit will enable local authorities to identify specific opportunities for taking forward renewable and low carbon energy generation in their area. This can then form a basis for more detailed implementation plans, feasibility studies and practical action.

As well as climate change mitigation, using the toolkit to identify renewable and low carbon energy opportunities can also assist in developing measures to tackle fuel poverty, through the promotion of DHNs which serve existing as well as new developments. These opportunities can also help in delivering local economic benefits either in terms of locally grown fuel supplies, or by enabling a proportion of expenditure on energy to be retained within the local economy, from local generation, rather than going out to external energy companies[5].

1.3 Scope of this toolkit

What this toolkit does, and does not cover is set out below

Planning

- The toolkit focuses on planning policy, rather than development management. As explained above, this toolkit is primarily aimed at policy planners, to guide them on how to prepare an evidence base to support renewable and low carbon energy policies and site allocations in their LDPs. It also aims to give some guidance on how planners can translate the evidence base into spatial policies which guide appropriate renewable and low carbon energy development.
- It is not intended to be a toolkit for use by development management officers to assess planning applications for either strategic new development sites that are incorporating renewable energy, or for stand-alone renewable energy generating systems. However, the information that applying the toolkit can produce (such as the Energy Opportunities Plan, described in Chapter P) can potentially be very useful to inform pre-application discussions between development management officers and developers.

The toolkit provides guidance on how to identify opportunities for using low carbon as well as renewable energy sources, because sources of energy that emit less carbon dioxide (CO_2) can contribute to overall carbon targets. This is because, in the context of strategic new development sites, either can contribute to meeting any enhanced carbon reduction or Sustainable Building Standards that a local authority may wish to set.

Technology

- This toolkit is not meant to be an exhaustive guide to the different renewable and low carbon energy technologies that are available. TAN 8[6] (www.gov.wales/topics/planning/policy/tans/tan8/?lang=en) provides an introduction to a range of renewable and low carbon technologies and should be first point of reference.
- The Welsh Government has also produced Practice Guidance: Planning Implications of Renewable and Low Carbon Energy – www.gov.wales/topics/planning/policy/guidanceandleaflets/planningimplications/?lang=en
- Energy Hierarchy – The toolkit focuses on renewable and low carbon energy generation, and the opportunities for promotion through LDPs, rather than on improving energy efficiency in new or existing buildings. This is not to imply that the latter is less important in terms of mitigating climate change: it is at least as, if not more, important. However, efficiency measures are addressed by the existing Building Regulations Wales Part L (2014), TAN 12: Design and Practice Guidance – Planning for Sustainable Buildings –
  www.gov.wales/topics/planning/buildingregs/publications/part-l-energy/?lang=en
  www.gov.wales/topics/planning/policy/tans/tan12/?lang=en
- Transport – The toolkit covers how to assess the potential for generating renewable electricity, or heat (for use in buildings or processes) but does not include guidance on how to assess the potential for renewable or low carbon fuels for transport.
- On-shore – In terms of renewable energy options and resources, the toolkit only provides guidance on how to assess the potential for on-shore renewable energy. It does not cover the potential for offshore renewable energy, such as wave, offshore wind and tidal[7].
- Large scale on-shore wind – The toolkit is not intended to duplicate the analysis carried out in TAN 8, which identified Strategic Search Areas (SSAs) for large scale on-shore wind power. Rather, in the case of wind power, it is intended to help identify smaller scale opportunities outside of SSAs.
- Test of Soundness – Whilst this toolkit provides a framework for how an assessment can be carried out, and policies proposed, it does not provide a definitive template for sound evidence. The responsibility of preparing evidence for LDP policies and decisions taken in the LDP is the sole responsibility of the LPA. In the majority of cases assumptions and data used in carrying out the assessment have been sought from established sources, and these are listed in the text. Where there is no established source AECOM has derived assumptions based on the best evidence available. In future, guidance, assumptions and data sources may change, particularly as technology and the policy and regulatory framework evolves.

1.4 Defining renewable energy and low carbon energy

Renewable energy

There are many definitions of renewable energy[8]. A useful one is:

> **"Renewable energy is that which makes use of "energy flows which are replenished at the same rate as they are used[9]"**

The definition employed in Planning Policy Wales; Edition 7, July 2014 (Para 12.8.7) is as follows:

> **"Renewable energy is the term used to cover those sources of energy, other than fossil fuels or nuclear fuel, which are continuously and sustainably available in our environment.**
>
> **This includes wind, water, solar, geothermal energy and plant material (biomass)"**

Another important characteristic of renewable energy, which will be explained in more detail below, is that unlike fossil fuels, it produces little or no net CO_2 – which is one of the main greenhouse gas emissions.

Most forms of renewable energy stem directly or indirectly from the sun. The direct ones include, obviously, solar water heating, and photovoltaics. This also includes ground source heat pumps and air source heat pumps[10], which make use of solar energy stored in the ground. The indirect forms are: wind power, as wind is caused by differential warming of the earth's surface by the sun; hydropower, as rainfall is driven by the sun causing evaporation of the oceans; and biomass energy (from burning organic matter), as all plants photosynthesise sunlight in order to fix carbon and grow.

The combustion of biomass fuel is carbon neutral, because although the combustion releases CO_2, the same amount of CO_2 was taken out of the atmosphere when the biomass was growing. Research informing PPW confirms "Biomass is generally regarded as fuel (other than fossil fuel), at least 98 per cent of the energy content of which is derived organically from plant or animal matter. This includes agricultural, forestry or wood waste or residues, sewage and energy crops"[11].

The other two forms of renewable energy are tidal power, which relies on the gravitational pull of both the sun and the moon, and geothermal energy, which taps into the heat generated in the Earth's core.

Of all these, perhaps the most complex and multi-faceted are biomass energy, as it can take so many forms. It can include: burning of forestry residues; anaerobic digestion of animal manures and food wastes; combustion of straw and other agricultural residues and products. It also includes the methane produced from the anaerobic digestion of biodegradable (BD) matter in landfill sites (i.e. landfill gas), as well as any energy generated from the BD fraction of waste going into an energy from waste (EfW) plant.

This toolkit does not cover the assessment of the resource for all renewable energy options. It is focused on onshore renewable energy options only. It also does not cover renewable energy options that are unlikely to be generally accessible at a local authority level, for sites in Wales, such as geothermal energy, or tidal barrages. It does cover the following renewable energy technologies (considering both electricity and heat):

Table 1 – Renewable Energy Technologies covered by the Toolkit

- Wind energy (on-shore wind and community scale development)
- Biomass energy: including forestry residues, miscanthus, short rotation coppice and straw
- Energy from Waste (EfW) including:
  - Waste wood
  - Municipal waste
  - Industrial and commercial waste
- Centralised Anaerobic Digestion, covering:
  - Food waste
  - Agricultural wastes
  - Sewage sludge
- Hydropower energy
- Larger-scale stand-alone solar photovoltaic (PV) farms
- Building Integrated Renewables (BIR), covering: biomass boilers; air and ground source heat pumps, photovoltaics; small and micro wind power.

Low carbon energy options

Low carbon energy options cover a range of energy sources that are not renewable, but can still produce less carbon than use of the conventional electricity grid or gas network, and are therefore considered an important part of decarbonising the energy supply. These options include:

- Waste heat, e.g. from power stations, or industrial processes
- Gas engine or gas turbine Combined Heat and Power (CHP), where the heat is usefully used
- Stirling engine or fuel cell CHP, where the heat is usefully used
- The non-biodegradable fraction of the output from EfW plants

As explained above, this toolkit covers both renewable as well as low carbon forms of energy, but the extent to which both can be considered depends on which policy objective you wish to pursue (see sections P1-6 for a description of some of these). If you are looking at developing an evidence base for area wide renewable energy targets (in support of meeting the UK 15% renewable energy target for 2020) then you should only include renewable energy options.

On the other hand, if you are considering the opportunities for carbon reduction on strategic new development sites, then you should consider both renewable and low carbon energy options. This is because either can contribute to carbon reductions, as measured by Part L of the Building Regulations.

1.5 Explanation of energy terms: the difference between power and energy and electricity and heat

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 Giga Watts (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.

This distinction is important, because in carrying out the renewable energy resource assessment set out in E1, you will need to calculate both the potential installed capacity (or maximum power output) of different technologies, as well as the potential annual energy output.

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 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 in this toolkit 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.

References

1 Climate Change Strategy for Wales, Welsh Assembly Government, 2010

2 On 1 April 2012, under the Localism Act 2011, the Planning Inspectorate became the agency responsible for operating the planning process for nationally significant infrastructure projects (NSIPs). NSIPs are ususally large scale developments such as power generating stations and electricity transmission lines, which require a type of consent known as a 'development consent' under procedures governed by the Planning Act (2008) (and amended by the Localism Act 2011). The 2008 Act sets out thresholds above which certain types of infrastructure development are considered to be nationally significant and require development consent

3 PPW; Edition 7, July 2014, Chapter 12 Infrastructure and Services

4 PPW; Edition 7, July 2014, Chapter 4 Planning for Sustainability

5 Low Carbon Wales, Sustainable Development Commission 2009

6 TAN 8: Planning for Renewable Energy, 2005

7 This is because, apart from the cable footfall onshore, offshore renewables are not within the planning jurisdiction of local planning authorities

8 More specifically, the EU Renewable Energy Directive (see chapter 2) gives guidance on which technologies are eligible to qualify for meeting the UK's renewable energy target for 2020

9 Sorensen, B. (1999) Renewable Energy (2nd Edition), Academic Press, ISBN 0126561524

10 Strictly speaking, these technologies are only partially renewable, as they also make use of, most commonly, grid electricity to power a compressor. However, if they have a good efficiency, they can provide a form of heating, in the UK, that produces less carbon per unit of output than using a gas condensing boiler

11 The Renewables Obligation Order 2002

2 Policy context and drivers for renewable energy

2.1 Introduction

2.1.1 In its programme for government[12], the Welsh Government restates the commitment to reduce greenhouse gas emissions in Wales, with an aim to achieve annual carbon reduction-equivalent emission reductions of 3% per year by 2011 and a 40% reduction by 2020 in areas of devolved competence, including actions on diversified renewable energy generation.

2.1.2 The Welsh Government has a legal obligation to promote sustainable development and has embarked on an ambitious and long-term programme of cross cutting policy initiatives to address the issues. A key initiative is the introduction of the Well-being of Future Generations (Wales) Act (2015) which strengthens existing governance arrangements for improving the well-being of Wales to ensure that present needs are met without compromising the ability of future generations to meet their own needs. A facet of the new legislation will be the need for local authorities to demonstrate how they are meeting well-being goals.

2.1.3 PPW; Edition 7, July 2014 [12.8.1] states: 'The UK is subject to the requirements of the EU Renewable Energy Directive. These include a UK target of 15% of energy from renewables by 2020. The UK Renewable Energy Roadmap sets the path for the delivery of these targets, promoting renewable energy to reduce global warming and to secure future energy supplies. The Welsh Government is committed to playing its part by delivering an energy programme which contributes to reducing carbon emissions as part of our approach to tackling climate change whilst enhancing the economic, social and environmental wellbeing of the people and communities of Wales in order to achieve a better quality of life for our own and future generations. This is outlined in the Welsh Government's Energy Policy Statement *Energy Wales: A Low Carbon Transition (2012).*
www.gov.wales/topics/environmentcountryside/energy/energywales/?lang=en

2.2 UK and European policy context

EU Renewable Energy Directive: The UK has signed up to the Directive, agreeing to legally binding targets of 15% of energy from renewable sources by 2020.

Modelling undertaken on behalf of the Department for Energy and Climate Change (DECC) suggests that by 2020, this could mean:

- More than 30% of our electricity generated from renewable energy sources
- 12% of our heat generated from renewable energy sources
- 10% of transport energy from renewable energy sources

The UK Renewable Energy Strategy (RES) (2009) sets out how the UK will increase the use of renewable electricity, heat and transport to meet this target and address the urgent challenges of climate change and national security of energy supply.

2.3 Wales policy context for planning and renewable energy

The planning system's role in shaping places with lower carbon emissions and resilience to climate change is set out in PPW. The Welsh Government has shown leadership by providing a framework in PPW and TAN 8 for the positive planning for all forms of renewable energy development.

1. In July 2014, the Welsh Government made changes to Part L of the Building Regulations which set the requirements to reduce CO_2 emissions for new homes by 8% and non-domestic buildings by 20% in the aggregate across the building stock (against 2010 standards).
2. To coincide with these changes the Welsh Government withdrew the national planning policy requirement for sustainable building standards (TAN22) and amended TAN12: Design to include elements of the removed guidance. In particular, information on the energy hierarchy; allowable solutions; and sustainable buildings policies on strategic sites in LDPs (including retention of the expectation for local planning authorities to assess opportunities for strategic sites to require higher sustainable building standards).
3. In September 2009 changes were made to 'permitted development' rights to make provision for the installation of certain types of micro-generation by householders without the need for planning permission, namely solar photovoltaic (PV) and solar thermal panels, ground and water source heat pumps and flues for biomass heating. These rights were extended in 2012[13] to include air source heat pumps and stand-alone wind turbines (including anemometry masts for testing wind speeds). Permitted Development rights were also extended to non-domestic premises (including non-domestic buildings; agricultural and/or forestry land) in 2012 including solar panels, stand-alone solar panel arrays, ground and water source heat pumps and flues forming part of either a biomass heating system or a CHP system.

2.4 Wales wider policy context

Energy Wales: A Low Carbon Transition (2012) sets out how the Welsh Government will 'create a sustainable, low carbon economy for Wales', working in partnership with private, public and social sectors to secure investment in infrastructure and simplifying the regulatory framework.

Climate Change Strategy for Wales (2010) Wales has set a target to reduce its emissions of greenhouses gases by 3% per year from 2011 from areas of devolved competence. The strategy sets out in more detail the actions the Welsh Government are proposing to deliver their climate change objectives. Progress is reported annually with the latest version, at the time of writing, being December 2014. The link to this report is: www.gov.wales/topics/environmentcountryside/climatechange/publications/2014-climate-change-annual-report/?lang=en

Building Regulations and Nearly Zero Energy: Future changes to the Wales Building Regulations Part L are expected to bring in even more challenging dwelling (CO_2) emissions rate targets for residential development and for commercial development. The EU Energy Performance in Buildings Directive Recast (2012) requires that all new buildings are 'Nearly Zero Energy' by 2018 for public buildings and 2020 for all buildings www.zerocarbonhub.org/sites/default/files/resources/reports/ZCHomes_Nearly_Zero_Energy_Buildings.pdf.

For large sites, DH from a low carbon source is likely to be one of the most cost-effective ways of achieving this. There will be a review of Part L in 2016 in Wales.

2.5 Other UK Drivers for Renewable Energy

Feed in Tariffs (FITs). The 2008 Energy Act contains powers for the introduction of FITs in Great Britain to incentivise renewable electricity installations up to a maximum capacity, at the time of writing, of 5 MW. The introduction of FITs in 2010 has significantly increased revenue for small-scale generators of renewable electricity, such as PV systems and small wind turbines.

Renewable Heat Incentive (RHI). The Energy Act 2008 also enabled the setting up of a RHI, which provides financial assistance to generators of renewable heat and to some producers of renewable heat, such as producers of biomethane. RHI was introduced in 2011. The incentive payments are funded by a levy on suppliers of fossil fuels for heat. RHI covers a wide range of technologies including biomass, solar hot water, air and ground source heat pumps, biomass CHP, biogas produced from anaerobic digestion and injection of biomethane into the gas grid.

The introduction of the RHI has made generation of renewable heat more financially viable than it was previously.

The Renewables Obligation (RO). The RO is the main current financial support scheme for renewable electricity in the UK, and is administered by Ofgem. It obliges electricity suppliers in the UK to source a proportion of their electricity from renewable supplies. They demonstrate this has been achieved by showing they have the required quantity of Renewable Obligation Certificates (ROCs), which renewable electricity generators are awarded for their output.

If suppliers fail to meet their target, they have to pay a fine and also the value of the fine "pot" is, on an annual basis, split among those suppliers who do meet their targets. This creates a market for the ROCs and means that generators of renewable electricity can sell the ROCs that they receive for significantly more than they receive for their electricity output. The intention is that RO will continue to incentivise electricity generation from larger scale renewable energy installations, whilst the FIT will be aimed at smaller generators. The scheme will close in 2016, to be replaced with feed-in tariffs with Contracts for Difference (CfD).

Contract for Difference (CfD). CfDs provide long-term price stabilization to low carbon plant, allowing investment to come forward at a lower cost of capital and therefore at a lower cost to consumers. CfDs require generators to sell energy into the market as usual but, to reduce exposure to fluctuating electricity prices and provide a variable top-up from the market price to a pre-agreed 'strike price'. At times when the market price exceeds the strike price, the generator is required to pay pack the difference, thus protecting consumers from over-payment.

The CfD for renewable energy is a key mechanism of Electricity Market Reform, the delivery body of which is the National Grid who is responsible for publishing guidelines and running the CfD allocation process. A CfD is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government owned company. A generator party to a CfD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price' – a measure of the average market price for electricity in the GB market. The first CfD Allocation Round was undertaken in 2014 with first results, including applicants, technologies, capacities, clearing price and delivery year, published in February 2015. The first CfDs were signed in March 2015.

The Microgeneration Certification Scheme (MCS). The Low Carbon Buildings Programme is open to all products and installer companies registered on the Microgeneration Certification Scheme. The Microgeneration Certification Scheme is an independent scheme that certifies microgeneration products and installers in accordance with consistent standards. It is designed to evaluate microgeneration products and installers against robust criteria providing greater protection for consumers. The web addresses below can be used for further information:

- www.microgenerationcertification.org/
- www.eca.gov.uk/etl/find
- www.estif.org/solarkeymarknew/index.php

References

12 Programme for Government – www.gov.wales/about/programmeforgov/?lang=en

13 Welsh Government, Generating Your Own Renewable Energy: Homes (3A) and Non-domestic (3B). Available at www.gov.wales/topics/planning/policy/guidanceandleaflets/generaterenewable/?lang=en

3 How to use this toolkit

3.1 Structure of the toolkit

We have laid out this toolkit in such a way that, depending on which policy objectives or options your local authority wishes to pursue in relation to renewable energy, you can quickly choose which of the evidence base options could support this policy option. You can then navigate to the relevant chapter for that evidence base option to find detailed guidance on how to prepare the evidence base. This is designed to avoid you having to read chapters that are not relevant to you or, more to the point, to avoid preparing elements of the evidence base when they are not relevant for the policy objectives or options you are aiming towards.

There are six potential policy options, and four evidence base options, and these are shown in the navigation table on the next page. Each of the evidence base options has its own chapter, (E1 to E4), whilst the policy options are all covered in chapters P through to P6. For each of the six policy options, one or more of the evidence base options would support it. The aim of the table is to show you, for any given policy options, which combination of the evidence base options may be suitable. In support of the evidence base there are 11 different projects set out in individual Project Sheets at the back of this document.

The areas of dark shading in the navigation table indicate those elements of the evidence base that will be relevant in supporting a particular policy option shown in the left hand column. The lighter coloured squares indicate those aspects of the evidence base that are less relevant to supporting a particular policy option, but will be useful in informing it. The white squares indicate that an evidence base option is not needed for that policy option. If you are not clear at this stage on which policy options you are interested in, you can go straight to chapter P to review these in more detail. A brief summary of the policy options is given below.

Local Development Plan – Planning for Renewable Energy Policy Scenarios

P1. Develop area wide RE targets and monitor progress. This involves setting authority wide targets for installed capacity and energy generation from both renewable electricity and renewable heat.

P2. Inform site allocations for new development. This involves making use of the area wide renewable energy assessment (REA), and the heat opportunities map as a factor in assessing the suitability of candidate sites for new building developments. These can identify whether the sites may be in conflict with potential sites for renewable energy deployment, or whether there may be an opportunity to consolidate sites together in terms of new development providing potential heat loads for renewable energy generation.

P3. Identify suitable areas for stand-alone renewable energy development. This covers the identification of strategic sites for stand-alone, local authority-wide scale renewable energy schemes, not necessarily linked to any new developments. This would relate to onshore wind projects between 5 and 25MW (i.e. outside of the SSAs of TAN 8), and between 5 and 50MW for all other technologies[14]. In practice, it may also be possible for some of these schemes to be linked to existing or new buildings and developments through the supply of heat via DHNs.

P4. Identify opportunities and requirements for renewable or low carbon energy generation linked to strategic new build development sites. This may involve developing specific policy requirements for major new development sites, to consider the use of, for example, CHP and DH, where the assessment shows that there is significant potential for renewable or low carbon energy generation or use.

P5. Develop policy mechanisms to support District Heating Networks (DHNs) for strategic sites. For new development sites where there is the potential for DHNs to be fuelled by renewable or low carbon energy sources, local authorities can consider setting requirements to connect to DHNs, or perhaps to pay into a fund to support DHN infrastructure in the locality. For P3, P4 and P5, a key output from the evidence base assessment is an Energy Opportunities Plan, which is a visual, spatial depiction of the opportunities. This is discussed in detail in chapter P.

P6. Identify further actions for LA, public sector and wider stakeholders. This follows on from P3, P4 and P5, and involves the identification of actions wider than just planning policy to assist in the delivery of strategic opportunities for renewable or low carbon energy generation.

Figure 1: Navigating your way through the toolkit

Evidence base options →

Policy options ↓

Policy options	Chapter	E1. Area wide RE assessment	E2. BIR uptake assessment	E3. Heat opportunities mapping	E4. Detailed viability appraisal for strategic sites
	Chapter	E1 Project Sheets A-F and I-K	E2 Project Sheets H-K	E3 Project Sheet G	E4
P1. Develop area wide RE targets and monitor progress	P1				
P2. Inform site allocations for new development	P2				
P3. Identify suitable areas for stand-alone renewable energy development	P3				
P4. Identify opportunities and requirements for renewable or low-carbon energy generation linked to strategic new build development sites	P4			Energy Opportunities Plan	
P5. Develop policy mechanisms to support District Heating Networks (DHN) for strategic sites	P5				
P6. Identify further actions for LA, public sector and wider stakeholders	P6				

RE = Renewable Energy; BIR = Building Integrated Renewables

Table 2: Example policy scenario

Example Policy Scenario

A local planning authority wants to identify an authority wide renewable energy target to support their approach to facilitating renewable energy in their LDP. To do this they would need to

1. Carry out an area wide renewable energy assessment (E1)

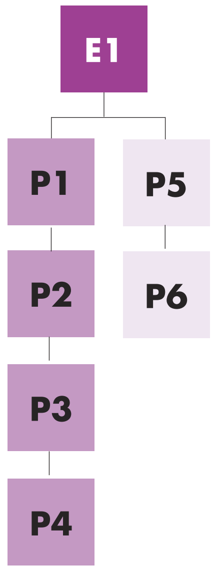
   To prepare this evidence they would need to read chapter E1, and then complete
   Project Sheet A: identify existing and proposed LZC energy technologies
   Project Sheet B: assess wind energy resource
   Project Sheet C: assess wood fuel and energy crops resource
   Project Sheet D: assess the energy from waste resource
   Project Sheet E: assess the energy resource from anaerobic digestion
   Project Sheet F: assess the hydropower resource
   Project Sheet I: calculate the current and future energy baseline
   Project Sheet K: assess solar PV resource

2. Carry out a 'Building Integrated Renewables' uptake assessment (E2).

   To prepare this evidence they would need to read chapter E2 and complete the simplified method given in that section. Project Sheet H is provided for reference as to how the simplified method was created.

In order that you do not have to constantly revisit the main toolkit structure diagram, at the beginning of each section a summary diagram is provided showing the policy objectives (in dark purple) for which completing the section is recommended and (light purple) where it is optional but would be useful to inform such policy objectives. An example of the section header diagram is shown below.

Figure 2: Example of the evidence base sections header diagram



For the example above, the evidence base chapter is E1: Area Wide Resource Assessment, which is shown as the top box. The darker shaded boxes to the left are those policy objectives for which completion of the component is strongly recommended. The boxes to the right show policy objectives for which completion of the evidence base would be useful to inform them.

3.2 Tasks and steps

Within each evidence base, there may be a series of tasks that need to be completed. A table at the start of each section lists the tasks involved, and also indicates the questions that completing that task will enable you to answer about the renewable or low carbon energy potential in your area.

Within each task, we provide a series of steps that must be followed in order to complete the task. Where appropriate, we provide examples of the outputs of key steps or tasks, to give you a better understanding of what is required.

3.3 Who should carry out the work outlined in this toolkit?

The toolkit is designed for use by local authorities although there is a requirement for officers with certain skill sets. The toolkit uses a Geographical Information Systems (GIS) approach and therefore requires significant input from a GIS officer. In addition to the use of GIS, the involvement of an energy officer, preferably with knowledge of renewable energy generation, is desirable. It is our understanding that all or most local authorities in Wales have access to such skills however collaboration between local authorities and officers, particularly those who have already undertaken the exercise is likely to yield significant benefits.

The identification of opportunities and the translation of potential resource into potential targets will require input from a wider stakeholder group (e.g. waste manager, estates manager, education officer, etc). This is to ensure that all relevant information is captured and that decision making is integrated across the local authority. Further, the setting of any targets/requirements, whether on a local authority or sub-local authority scale is likely to require engagement with the wider public sector and community, and potentially developers and the private sector.

Lastly, for detailed analysis, particularly in relation to the economic and technical feasibility of DHNs and other technologies, it is likely that consultants will be required to undertake such work. Where this is the case, this toolkit provides information on the issues that LA's should incorporate within a work brief and that should be addressed in detail by the consultant.

3.4 At what stage in the LDP development process should this toolkit be used?

The toolkit can be used at various stages of the planning process (from development of LDPs to informing pre-application discussions, depending on the policy objective). However, as the primary aim of the toolkit is to assist local planning authorities to develop and include spatial policies within their LDPs relating to renewable energy, it is important that this toolkit is utilised at a very early stage in the process in order that full consideration of issues associated with renewable energy sites can be considered alongside other candidate sites (through the sieving process) and, more importantly, in order that discussions can be held with developers regarding what will be considered and delivered on strategic sites.

If a local authority wishes to develop area wide renewable energy targets then, as long as the local authority has a rough idea about potential future dwelling numbers and non-residential development (to inform the BIR uptake assessment) then this element of the evidence base can be completed. This should assist with reporting requirements as part of plan implementation monitoring.

3.5 The use of GIS

Identifying opportunities for renewable energy as part of an LDP process is best done using a GIS database approach. This is because GIS allows the imposition of constraint layers to identify specific locations where certain renewable energy technologies are more likely to be deliverable and viable. The GIS approach also enables easy identification of topics for further investigation.

In the vast majority of cases local planning authorities will be using a GIS database to inform the LDP process anyway. This toolkit provides guidance on additional layers of useful information with which to inform decisions of the LDP growth strategy, identification of sites and preparation of spatial planning policies.

Mapping opportunities and constraints through GIS also provides a useful visual tool with which to engage with the community, developers and potential energy suppliers in the delivery of renewable and low carbon energy developments. Local authorities can update this tool over time to continue to inform the delivery of specific opportunities as they develop.

3.6 The case study approach

In preparing the original version of this toolkit, Pembrokeshire County Council was chosen as a case study authority to demonstrate worked examples of the evidence, tasks and projects carried out in implementing the toolkit. The case study was produced as a separate report and is available at www.gov.wales/docs/desh/publications/100717pilotstudyen.pdf

Where still applicable, the outputs from the case study have been presented throughout this toolkit to provide an illustration of the level of detail needed.

However, this update has introduced significant changes to the content and structure of the toolkit hence much of the introductory and contextual narrative in the case study will have been superseded. In addition, some new elements have been added – such as the PV Resource Project Sheet which will not be included within the case study.

In many cases, the data sources utilised by a number of the calculation methods have changed since producing the case study. This update amends the information/data source references and contains hyperlinks.

3.7 Mapping the toolkit against the requirements of PPW

In section 1.2 of this toolkit we set out the key requirements in PPW for policy making for renewable and low carbon energy. The tables below shows how each of the policy and evidence base options described above assist in meeting these requirements.

Renewable and low carbon energy generation

Policy requirement	How does toolkit support this?
(12.9.2) Local planning authorities should guide appropriate renewable and low carbon energy development by undertaking an assessment of the potential of all renewable energy resources and renewable and low carbon energy opportunities within their area and include appropriate policies in development plans. Local planning authorities are encouraged to work collaboratively in order to gather evidence on a sub-regional basis wherever possible.	Evidence base All sections, E1 to E4 Policy development Policy sections P2, P3 and P4
(12.9.5) Policies for strategic renewable energy development in areas outside SSAs, if appropriate, should be included in development plans informed by local authority REAs.	Evidence base E1, E3 and E4 Policy development Policy sections P2, P3
(12.9.8) Local planning authorities should also seek to maximise the opportunities for DH and generation schemes in their development plan by co-locating new proposals and land allocations with existing developments and heat suppliers and users.	Evidence base E3 Policy development P2, P3, P4 and P5

Planning for Sustainable Buildings

Policy requirement	How does toolkit support this?
(4.12.5) Local planning authorities should assess strategic sites to identify opportunities to require higher sustainable building standards (including zero carbon) to be required. In bringing forward standards higher than the national minimum, set out in Building Regulations, local planning authorities should ensure that what is proposed is evidence-based and viable. Such policies should be progressed through the LDP process in accordance with relevant requirements of legislation and national policy.	Evidence base E3 and E4 Policy development Policy sections P2, P4 and P5
(4.12.7) Particular attention should be given to opportunities for minimising carbon emissions associated with the heating, cooling and power systems for new developments. This can include utilising existing or proposed local and low and zero carbon (LZC) energy supply systems (including DH systems), encouraging the development of new opportunities to supply proposed and existing development, and maximising opportunities to co-locate potential heat customers and suppliers.	Evidence base E3 Policy development Policy sections P2, P4 and P5

References

[14] See figure 12.2 in chapter 12.8 of Planning Policy Wales

E1 Area wide renewable energy assessment

This section provides an introduction to renewable energy resource assessments and provides an example taken from the renewable energy resource assessment completed for Pembrokeshire County Council using the original toolkit method.

The potential for larger scale solar PV farms was omitted from the original method hence its omission from the Pembrokeshire Case Study. However, due to the rapid emergence of solar PV technology since 2009, we have included a method and assessment for solar PV farms including a Project Sheet (K) for this update of the toolkit.

This section will lead you to explore 'accessible' renewable energy resources, the variation in technologies employed to utilise such resources and the different outputs [electricity/heat] of each technology. The following table indicates the tasks that are associated with this component and the questions that this toolkit helps you answer.

Reference is made to various appended Project Sheets. Each Project Sheet contains a method for completing a task. Completion of these tasks will provide a supporting evidence base relevant to the section heading [e.g. "Area wide renewable energy assessment"].

Table 3: Tasks associated with the 'area wide renewable energy assessment' section

Area Wide Renewable Energy Assessment		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
1. Calculate existing and future energy baseline	What is the current energy demand in your local authority area? What will be the energy demand in your local authority area in 2020?	**Complete Project Sheet I**
2. Existing and proposed LZC energy technologies	What is the existing capacity of LZC energy technologies in your local authority area? Are any LZC energy technology installations being proposed in your local authority area?	**Complete Project Sheet A**
3. Wind Energy Resource	What is the potential for medium and large scale wind in your local authority area? What are the potential sites for stand-alone wind energy development in your local authority area?	**Complete Project Sheet B**

Area Wide Renewable Energy Assessment (Cont'd)		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
4. Biomass Energy Resource	What is the potential energy from biomass in your local authority area?	**Complete Project Sheet C**
5. Energy from Waste	What is the potential energy from municipal solid waste in your local authority area?	**Complete Project Sheet D**
	What is the potential energy from commercial and industrial waste in your local authority area?	**D**
	What is the potential energy from energy from food waste in your local authority area?	**E**
	What is the potential energy from energy from animal manure and poultry litter in your local authority area?	**E**
	What is the potential energy from energy from sewage sludge in your local authority area?	**E**
6. Hydropower Energy Resource	What is the potential energy [MW] from hydropower in your local authority area?	**Complete Project Sheet F**
7. Solar PV Farms	What is the potential for medium and large scale PV Farms in your local authority area?	**Complete Project Sheet K**
	What are the potential sites for stand-alone PV Farm development in your local authority area?	
	What is the potential energy [MW] from 'stand-alone' solar PV farms in your area?	

E1.1 Task 1: Calculate existing and future energy baseline

This section addresses the method employed for base-lining area wide energy consumption. The detailed method can be found in Project Sheet I. The method relies upon:

- Welsh Government derived data and statistics currently published by DECC.

A comprehensive methodology for calculating your local authority energy baseline is given in Project Sheet I. The following table indicates the reported total energy annual demand [GigaWatt hour [GWh]] for the UK, Wales and the Case Study Authority for 2006 by energy sector.

Table 4: Annual energy demand [2006] for the UK, Wales and Pembrokeshire

	Total Energy 2006 [GWh]		
Sector	**UK**	**Wales**	**Case Study Authority**
Electricity	328,393	17,394	**1,042**
Heat	898,287	55,489	**9,735**
Transport	504,871	25,319	**919**

Future energy demand

Future energy demand should be established in order to:

- Provide indicative figures to inform area wide renewable energy installed capacity targets.

The basis of the analysis is the UK Renewable Energy Strategy (2009) from which we have derived a projected Final Energy Consumption for 2020, to which the UK share of the EU target applies. This is based on forecast demand across the different energy use sectors – electricity, heat and transport, from the lead DECC energy model.

The following table indicates an example of predicted future energy demand by key energy sector for Pembrokeshire in 2020. A comprehensive methodology for calculating your local authority future energy demand is given in Project Sheet I.

Table 5: An example of future energy demand for Case Study 1

	Case Study		
Sector	Total Energy 2006 [GWh]	Predicted % change to 2020	Total Energy 2020 [GWh]
Electricity	1,042	-0.3	1,039
Heat	9,735	-18.7	7,915
Transport	919	1.2	930

Updated data

The figures published above in Tables 4 and 5 relate to data available at the time of publication of the initial toolkit, and thus correspond to the Pembrokeshire County Council Renewable Energy Assessment – Pilot Study. Tables 6 and 7 below have been produced to reflect the most recent published figures. This data has been taken from; Sub-national total final energy consumption statistics: 2005-2012 and can be found via the following link: www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2010

Table 6: Annual energy demand (2012) for the UK, Wales and Pembrokeshire

	Total Energy 2012 [GWh]		
Sector	UK	Wales	Case Study Authority
Electricity	290,864	15,285	1,046
Heat	724,799	50,750	12,985
Transport	436,112	21,458	773

Table 7: An example of future energy demand for Case Study 1 (2012 data)

	Case Study		
Sector	Total Energy 2006 [GWh]	Predicted % change to 2020	Total Energy 2020 [GWh]
Electricity	1,046	-0.3	1,043
Heat	12,985	-18.7	10,557
Transport	773	1.2	782

E1.2 Task 2: Existing and proposed LZC energy technologies

Establishing the capacity of any LZC technologies already installed for an area can demonstrate the progress being made and establish a baseline of installed capacity to inform future potential and target setting. Where LZC energy technologies already exist, the installed capacities [measured in MW] can be recorded and incorporated as a contribution to overall final targets. Project Sheet A sets out a method for establishing how much generation you already have in your local authority area.

Example output

Based on the method as described in Project Sheet A, an example of the total existing and proposed LZC energy technology installations for Pembrokeshire County Council is given in the tables below.

Table 8: Existing renewable electricity capacity

*The technologies highlighted in light purple refer to BIRs. It is important to note the technology categories of current installed capacity, but particularly the combined installed capacities of BIR electricity generating technologies in order to populate Figure 3 (the Active Template) and the 'Accessible Resource Summary Table' 33.

Name of scheme	Technology	Capacity [MWe]	Status	Source
Castle Pill Farm	Wind Onshore	3.2	Operational	Ofgem
Withyhedge	Landfill Gas	1.74	Operational	Ofgem
Narbeth Waste Water Treatment Works	Sewage Gas	0.11	Operational	Ofgem
Preseli Hydro	Hydro	0.07	Operational	Ofgem
Cerrig Hydro	Hydro	0.01	Operational	Ofgem
Y Gaer Hydro	Hydro	0.00	Operational	Ofgem
Caerfai Farm	Wind Onshore*	0.02	Operational	Ofgem
-	PV*	0.03	-	Grant bodies
-	Wind Onshore*	0.06	-	Grant bodies
Total	**-**	**5.24**	**-**	**-**

Table 9: Existing renewable heat capacity

Name of scheme	Technology	Capacity [MWt]	Status	Source
Bluestone holiday park	Biomass Boiler (District Heating)	1.60	Operational	Council Staff
Pembrokeshire College	Biomass Boiler*	0.35	Operational	Council Staff
Pembrokeshire Technium	Biomass Boiler*	0.15	Operational	Council Staff
Pembrokeshire Schools	Biomass Boiler*	0.45	Operational	Council Staff
-	Solar water heating*	0.50	-	Grant bodies
-	Heat pump*	0.04	-	Grant bodies
-	Biomass Boiler*	0.05	-	Grant bodies
Total	**-**	**3.14**	**-**	**-**

*The technologies highlighted in light purple refer to BIRs (<0.5MW). It is important to note the technology categories of current installed capacity, but particularly the combined installed capacities of BIR heat generating technologies in order to populate Figure 4 (heat generating BIR uptake Active Template) and the 'Accessible Resource Summary Table' 34.

E1.3 Task 3: Wind Energy Resource

As mentioned in the Introduction to this toolkit, for the purposes of planning policy in Wales strategic scale wind power has been defined in PPW as wind farms of between 25MW and 50MW. Those above 50MW are the responsibility of the UK Government. TAN 8 provides details of 'Strategic Search Areas' [SSAs], sites identified as suitable and potential locations for large scale wind. These should be investigated and noted as part of any evidence base developed with the toolkit.

Further constraints to onshore wind development not included within the toolkit include the practical access to sites required for development, landowner willingness for development to go ahead, the time to complete planning procedures, landscape character and an economic distance to the nearest appropriate electricity grid connection.

None of these constraints were considered in estimating the available resource.

Wind farms, by nature, are most usually situated in rural settings away from residential development and where the wind resource is least constrained. This can mean that there is often no opportunity to utilise on-site the outputs from wind farms leaving export of electricity to grid as the only option. The toolkit has not utilised national grid data but the local authority may wish to investigate overlaying GIS layers of the energy networks data if and where available to them.

The impact of wind farms on landscape character was not taken into account. Whilst a detailed methodology for undertaking these assessments is outside of the scope of this toolkit, it should be noted that a GIS approach can be utilised to constrain sensitive areas and local authorities wishing to adopt a robust approach should seek to undertake such works.

Some key issues to note in relation to wind farms and opportunities to local authorities are:

- Investment interest of Energy Services Companies [ESCOs] may be secured through the identification of appropriate sites.
- Some organisations are actively marketing support services to enable local authorities to exploit their estates through installation of renewable energy technologies.
- Large scale renewable installations can provide significant revenue streams to local authorities or off-set significant carbon emissions to assist with meeting their obligations under the Carbon Reduction Commitment Energy Efficiency Scheme.
- Renewable energy generation offer local authorities opportunities to facilitate community-led schemes.

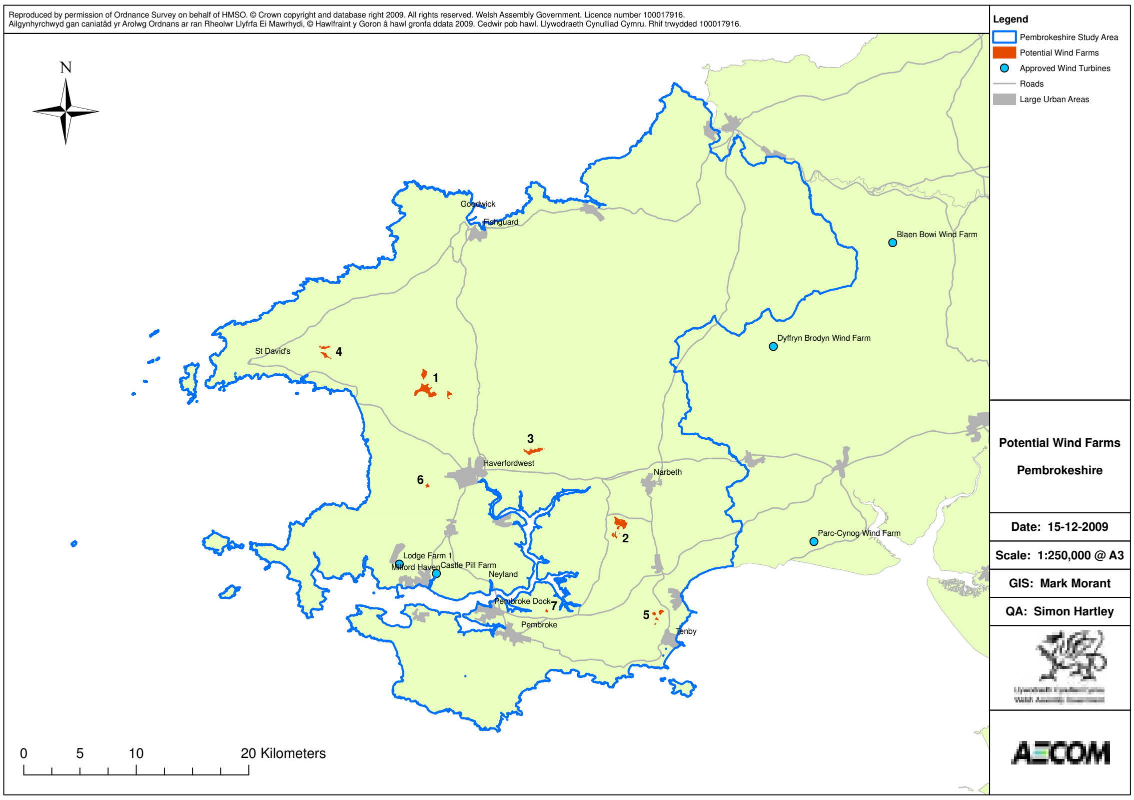
For the purposes of this assessment it was considered that 6m/s at 45m above ground level is a minimum economic wind speed, that there should be maximum economic use of the resource in line with constraints; the notional turbine used was a 3rd generation 2MW, 120m diameter, 80m hub height unit, there is a maximum capacity of 5 x 2MW turbines per km^2 of available land and that the distribution grid capacity would not be a significant constraint. Topple distance and buffer distances are included within the method description, which is set out in Project Sheet B.

Example output

The table below shows the total land area [km²], capacity [MW] and annual energy generated [MWh] that is potentially available for wind turbine development across Pembrokeshire County.

Table 10: Example of accessible wind resource output for Pembrokeshire County, allowing for cumulative impact buffer

Potential wind farm	Area (km²)	Potential capacity (MW)
1	1.17	11.68
2	0.68	6.84
3	0.36	3.55
4	0.24	2.37
5	0.19	1.91
6	0.05	0.53
7	0.03	0.28
Total	**2.72**	**27.17**



E14 Task 4: Biomass Energy Resource

The publication of the Bio-Energy Action Plan for Wales [2009] revealed targets of 5TWh of energy generation incorporating a minimum of 2.5TWh thermal by 2020 from bio-energy resources.

According to the National Assembly Sustainability Committee "The [Renewable Energy] Route Map … predicts Wales could produce approximately 6TWhr per year of electricity from sustainable biomass sources by 2025".

Unlike wind farms, biomass can be utilised for the generation of both electricity and heat & domestic hot water. The use of energy crops, forestry residues and recycled wood waste for energy generation can have a number of advantages:

- Provide opportunities for agricultural diversification
- Encourage increased management of woodland
- Can have positive effects on biodiversity
- Remove bio-degradable elements from the waste stream
- CO_2 savings if replanting occurs and long distance transportation is avoided

There is no consideration of the utilisation of straw as an energy source as Wales is a net importer.

Example Output

Table 11: Example output of total available biomass resource for Pembrokeshire

Outputs	Energy crops	Woodland	Total
Available area [ha]	70,335	13,934	84,269
Percentage of area that can be used	10%	n/a	-
Usable area [ha]	7,034	13,934	20,968
Yield [oven dry tonne per ha]	12	0.6	-
Yield [oven dry tonne]	84,402	8,360	90,762
Electricity			
Required oven dry tonne per 1MWe	6,000	n/a	-

Outputs	Energy crops	Woodland	Total
Installed capacity [MWe]	**14.0**	**n/a**	**14.0**
Heat from CHP			
Required oven dry tonne per 1MWt	3000	n/a	-
Installed capacity [MWt] from CHP	**28.0**	**n/a**	**28.0**
Heat from boilers			
Required oven dry tonne per 1MWt	660	660	-
Installed capacity [MWt] from boilers	**0.8**	**13.0**	**13.8**

Ha: hectares

E1.5 Task 5: Energy from Waste

Policy context

The overarching waste strategy for Wales ('Towards Zero Waste' 2010) aims to achieve a 27% reduction in waste by 2025 (against a 2007 baseline). In order to meet this target, Wales needs to reduce its waste by approximately 1.5% each year across all sectors. This will require all sectors in Wales to recycle, compost or anaerobically digest at least 70% of their waste by 2025, with the remaining 30% treated through 'high-efficiency Energy from Waste treatment facilities'.

By 2025 it is expected that:

- The minimum proportion of preparing for resue/recycling/composting from source separation will be 80%
- Maximum levels of municipal waste to landfill will be no more than 5%
- A minimum of 1% of municipal waste will be re-used, and
- A maximum level of EfW of municipal waste for individual local authorities of 30%

Targets may be revised in the future. In such circumstances the accessible resource will require amending as appropriate.

Methodology

The detailed method for calculating the potential energy from Municipal Solid Waste (MSW) and Commercial and Industrial (C&I) waste streams can be found in Project Sheet D.

Individual or groups of Local Waste Planning Authorities will have developed detailed plans on how to treat the MSW stream arising in the Local Waste Planning Authorities area. Some Local Waste Planning Authorities will have worked with neighbours and Regional Waste Teams to investigate preferred options for the treatment of waste. It is these plans that will inform which particular technologies will be employed, their capacities and preferred locations. The toolkit should be utilised for the development of future waste strategies to ensure that planned generation of EfW plant is utilised to the fullest extent.

Less will be known about the plans of commercial waste operators to treat commercial and industrial waste streams. Organisations involved in such activity should be fully engaged to ensure that opportunities to utilise energy are not lost.

Further guidance should be sought from the Welsh Government in relation to whether EfW from some or all EfW technologies is, or will be, considered to be 'renewable' energy and, where it is confirmed to be 'renewable', for what proportion of the residual waste stream [the proportion usually refers to the proportion of residual waste deemed to be the biogenic element].

Additional potential energy sources derived from waste include:

- Food waste
- Agricultural wastes
  - Animal manure
  - Poultry litter
- Sewage sludge

Given the nature of the energy sources mentioned above, with a higher water content than Refuse Derived Fuels (RDF), the sources would be best utilised through anaerobic digestion facilities (discussed in Project Sheet E 'Centralised Anaerobic Digestion').

Example outputs taken from the Pembrokeshire County Council pilot study for each of the waste resources mentioned are provided in the tables below:

Table 12: Predicted MSW and C&I waste resource to 2020 for Pembrokeshire County Council area

Outputs	MSW	C & I	Total
Total Waste [tonnes]	74,463	123,548	198,011
Total residual [30%]	22,339	37,064	59,403
Total Biodegradable [renewable] element [35%]	7,819	12,972	20,791
Electricity			
Required wet tonnes per 1MWe	10,320	10,320	-
Potential installed capacity [MWe]	-	-	-
Heat			
Required wet tonnes per 1MWt	1,790	1,790	-
Potential installed capacity [MWt]	**4.4**	**7.2**	**11.6***

*Assumes the BD element of residual waste is utilised by heat generating plant only.

There is no output table for Pembrokeshire County Council landfill gas as no capacity, additional to what is already installed (identified in Table 8), was identified. With policy in place to prevent further BD material being sent for landfill, no further opportunities for energy from landfill gas are anticipated. Some authorities may have identified additional capacity and discussions should take place with waste management to identify future plans.

Table 13: Potential installed Centralised Anaerobic Digestion capacity from total available MSW and C&I food resource

Current MSW food waste	Predicted tonnes per annum [2019/2020]
Total waste	5,761
Electricity	
Required tonnes for 1MW	32,000
Potential installed capacity [MW]	**0.2**
Heat	
Required tonnes for 1MW	10,667
Potential installed capacity [MW]	**0.3**

Table 14: Potential installed capacity from total available animal manure resource

Livestock	Number	Available resource per head/yr (t)
Cattle	188,500[15]	1.50
Pigs	0	0.15
Electricity		
Total wet tonnes required per MWe		225,000
Potential installed capacity [MWe]		**1.3**
Heat from CHP		
Total wet tonnes required per MWt		150,000
Potential installed capacity [MW]		**1.9**

Table 15: Potential installed capacity from total available poultry litter resource

	Existing Resource
No. birds from mass producing farms[16] (>10,000)	143,600
Litter (tonnes)/1,000 birds/year	42
Total available litter (tonnes)	6,031.2
Electricity	
Required tonnes for 1MW	11,000
Potential installed capacity [MW]	**0.5**
Heat	
Required tonnes for 1MW	7,333
Potential installed capacity [MW]	**0.8**

Table 16: Potential installed capacity from total available sewage sludge resource

	Existing Resource	Predicted tonnes per annum [2019/2020]
Total sewage sludge	2,471	3,969
Electricity		
Required dry solid (tonnes) for 1MW	13,000	13,000
Installed capacity [MW]	**0.2**	**0.3**
Heat		
Required tonnes for 1MW	8,667	8,667
Installed capacity [MW]	**0.3**	**0.5**

The heat is currently used by the AD plant and is not an 'accessible' resource.

E1.6 Task 6: Hydropower Energy Resource

This toolkit seeks to facilitate an assessment of the accessible resource of large (circa10MW) and small scale (circa hundreds of kilowatts) hydro sites and potential micro-hydro schemes, through the identification of existing feasibility studies.

This toolkit does not provide guidance in relation to wave power, tidal stream or tidal barrage. Constraints upon the use of sites for hydropower schemes include the seasonality of water flows, financial viability of projects, the willingness of landowners and riparian rights of owners to advance projects. However, the major constraint is environmental issues and the need for Natural Resources Wales acceptance and permitting.

Method of Calculation

Once a site is identified for investigating a hydropower scheme, the following method of calculation can be used. The potential for power generation is determined primarily by two variables; the head (height of the fall), and the flow rate (quantity of water passing a given point per second). The generated electric power of a hydro scheme can be estimated with the following equation:

P = QHZ

Where:

P = electric power output generated by an installation (W)

Q = volumetric flow rate of water (m3/s)

H = difference in height between upstream and downstream water level of an installation (m)

Z = constant[17], to be taken as 7848

Example Output

As indicated in Project Sheet F, there is currently no fully satisfactory way for local authorities to assess the potential hydropower resource in their areas, however it is recommended that the 2010 hydropower assessment by the British Hydropower Association should be consulted (see Project Sheet F). As such there is no table with installed capacity in this section. The fundamental reason for this is each individual location has a varying number of circumstances and criteria; thus each project requires site specific planning and feasibility design. Additional considerations for potential hydro scheme sites not only include finding a suitable location such as a weir but also proximity to load, or grid connection; landowner permission, environmental and ecological constraints and sufficient access to enable construction. The above equation used for estimating electric power output will form one part of this assessment.

The quantity of existing hydropower that exists in Pembrokeshire, as referred to in Project Sheet A, is given in section 'E1.1: Existing and proposed LZC energy technologies' (Table 8) under existing renewable electricity capacity.

E1.7 Task 7: Solar PV Resource

As part of their REA, local authorities should identify and allocate areas for potential PV farm projects. Solar PV farms, by nature, are most usually situated in rural settings away from residential settlements and where the solar resource is least constrained. This can mean that there is often no opportunity to utilise the power generated in buildings, therefore, an economically viable (relatively short distance from the solar array to an appropriate connection point) route to the electricity grid is required.

Further constraints to PV farm development not included within the toolkit include the practical access to sites required for development, landowner willingness for development to go ahead, the time to complete planning procedures and landscape character. None of these constraints were considered in estimating the available resource.

However, it should be noted that, whilst the toolkit has not utilised National Grid information, local authorities may wish to investigate overlaying GIS layers of energy networks data, if and where available to them.

Similarly, the impact of solar PV farms on landscape character has not been taken into account. Whilst a detailed methodology for undertaking these assessments is outside of the scope of this toolkit, it should be noted that a GIS approach can be utilised to constrain sensitive areas and local authorities wishing to adopt a robust approach should seek to undertake such works.

Some key issues to note in relation to solar PV and the opportunities available to local authorities are:

- Investment interest of ESCos may be secured through the identification of appropriate sites.
- Some organisations are actively marketing support services to enable local authorities to exploit their estates through installation of renewable energy technologies.
- Renewable installations can provide significant revenue streams to local authorities or off-set significant carbon emissions to assist with meeting their obligations under the Carbon Reduction Commitment Energy Efficiency Scheme.
- Renewable energy generation offers local authorities opportunities to facilitate community-led schemes.

The assessment of the potential for Solar PV farms was excluded from the original toolkit and hence there is no example in the case study. For consistency, we have produced an example of a PV farm constraints map and resource assessment based on Pembrokeshire.

For the purposes of this assessment it was considered that:

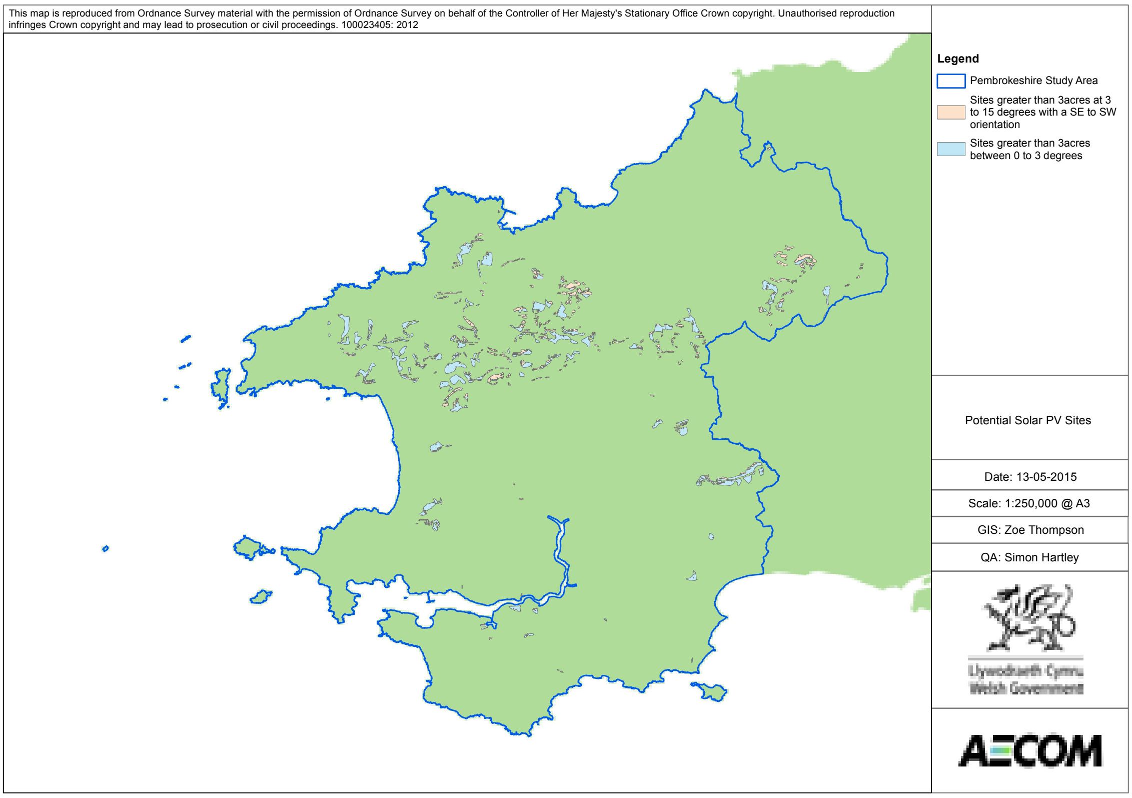
- 1MW of fixed tilt array solar panels requires approximately 6 acres of land, as per DECC's UK Solar PV Strategy located at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/249277/UK_Solar_PV_Strategy_Part_1_Roadmap_to_a_Brighter_Future_08.10.pdf
- Due to the large quantity of suitable land, only land of Agricultural Land Classification (ALC) 5 was included within the assessment.

Example Output

The table below shows the total land area [acres], capacity [MW] and annual energy generated [MWh] that is potentially available for a solar PV farm development across an example local authority area.

Table 17: Example of accessible solar PV resource output for Pembrokeshire County

Potential solar PV farm	Area (acres)	Potential capacity (MW)
1	322	53.6
2	258	43.0
3	252	42.0
4	231	38.5
5	222	37.0
Total	**1,285**	**214.1**


This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. 100023405: 2012
Legend
Pembrokeshire Study Area
Sites greater than 3acres at 3 to 15 degrees with a SE to SW orientation
Sites greater than 3acres between 0 to 3 degrees
Potential Solar PV Sites
Date: 13-05-2015
Scale: 1:250,000 @ A3
GIS: Zoe Thompson
QA: Simon Hartley
Llywodraeth Cymru
Welsh Government
AECOM

References

15 Based on an average of 130 cattle per farm. Total number of cattle farms, including dairy farms in Pembrokeshire, circa 1,450. Information provided by Animal Health, Pembrokeshire County Council

16 Information provided by Animal Health Department, Pembrokeshire County Council

17 The constant Z has been created for use in this toolkit and includes the parameters of water density, gravitational potential energy and an assumed overall system efficiency of 80%

E2 Building integrated renewables uptake assessment

This section provides an introduction to BIR energy technology uptake assessments and provides an example taken from an uptake assessment completed for Pembrokeshire County Council based on the updated method detailed in this toolkit. The following table indicates the tasks that are associated with this component and the questions that this toolkit helps you answer.

Reference is made to various appended sections. Each Project Sheet contains a method for completing a task. Completion of these tasks will provide the necessary evidence base relevant to the section heading (e.g. "Building integrated renewable energy technology uptake assessment").

Table 18: Tasks associated with the BIR Uptake Assessment section

Building Integrated Renewables Uptake Assessment		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
1.Introduction	What is the role of microgeneration in the energy mix of Wales? How is 'microgeneration' defined in this toolkit? What is the difference between 'microgeneration' and 'BIR'? How much energy is generated from BIR currently installed? What is the potential energy generated by BIR in your local authority area in 2020?	Read E2.1 Complete Project Sheet H
2. Modelling BIR uptake – overview	What are the 2 key sectors to consider in modelling BIR uptake?	Read E2.2

Building Integrated Renewables Uptake Assessment (Cont'd)		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
3. Modelling BIR uptake – simplified method	What are the assumptions on which the 'Simplified Method' is based? What is the level of new residential development in your local authority area? What is the level of non-residential new development in your local authority area? What is the number of existing dwellings in your local authority area? What is the existing BIR capacity in your local authority area? What will the level of BIR uptake for electricity be for your area by 2020? What will the level of BIR uptake for heat be for your area by 2020?	Read E2.3 Project Sheet A Complete Table 19 Complete Table 20

E2.1 Task 1: Introduction

The Welsh Government believes microgeneration technologies play a key role within the energy mix of Wales. In 2012 the Welsh Government reduced the need to obtain planning permission for the installation of small/micro scale renewable energy development by extending and introducing new Permitted Development Rights for domestic and non-domestic properties.

There is likely to be an increasing emphasis on the uptake of microgeneration technologies. It is considered that microgeneration technologies, for the most part can be installed on a variety of buildings, but unlike the other renewable energy technology types highlighted in this report it is demand led[18], rather than supply led. Predictions should be made on the take-up of microgeneration technologies in an area, however to do this accurately is relatively complex.

The official definition of microgeneration is given in the Energy Act 2004 (www.legislation.gov.uk/ukpga/2004/20/contents#pt2-cf1-l1g82) as electricity generating capacity of 50kW or less, and heat generating capacity of 45kW or less. However, for the purposes of this toolkit, and the uptake modelling, we are using the broader term BIR. BIR can include systems that are larger than microgeneration, such as biomass boilers for schools, which can be up to 500kW of heat output or more. In this definition, although there are grey areas, BIR technologies are still linking to existing or new buildings and are therefore distinct, in terms of how their potential can be modelled, from the larger scale stand-alone technologies that are covered elsewhere in this toolkit.

Also, we are excluding those microgeneration technologies that are not renewable from our BIR definition. Such technologies are fuel cells (where the hydrogen is produced from mains gas) and small scale CHP (where mains gas is used as the fuel source). This is because, we are only interested in the potential uptake of those microgeneration technologies that are renewable.

BIR are taken to cover the following technologies:

- Solar photovoltaic (PV) panels (excluding solar PV farms that are land mounted and covering an area >3acres (or 0.5MW) and providing <10% of a buildings electricity demand via a private electricity wire)
- Solar hot water panels
- Micro building-mounted wind turbines
- Small free standing, normally single wind turbines
- Micro scale biomass heating (i.e. wood chip or pellet boilers or stoves)
- Ground source heat pumps
- Air source heat pumps

E2.2 Task 2: Modelling BIR uptake – Overview

There are two key sectors to consider when modelling the uptake of BIR technologies, and each has to be modelled differently owing to different factors influencing the level of uptake.

The first sector is that of future new buildings, both residential and non-residential. For this sector, uptake is likely to be predominantly driven by the Building Regulations, where many non-domestic buildings will already require some form of LZC technology to be compliant, and LDP planning policies requiring higher sustainable building standards (including zero carbon) on strategic sites.

In particular, this agenda will be driven by the EU Energy Performance of Buildings Directive for Nearly Zero Energy Buildings. All new buildings are required to be nearly zero by 31 December 2020, with new buildings occupied and owned by public authorities required to be nearly zero energy buildings after 31 December 2018. The key factors affecting uptake of any particular technology for this sector are likely to be the combination of technical viability, carbon savings, and the level of capital cost to a developer.

The second sector is that of existing buildings, both residential and non-residential. For this sector, the uptake is likely to be driven more by how financially attractive installing a system would be to a building owner or occupier and how easy they perceive it would be to install such a system, i.e. it has a significant dependence on consumer attitudes and willingness to adopt new technology.

As part of developing the toolkit, AECOM carried out a study to model the uptake of BIR technologies in Pembrokeshire. Example outputs from this exercise can be found in Tables 19 and 20 later in section E2.

E2.3 Task 3: Modelling BIR uptake

BIR Active Template

An 'Active Template' accompanies this toolkit to help planners model the level of BIR in your local authority area. By following the steps laid out within this section you will be able to produce key figures for your local authority that can be imported into the template. The template will then calculate the predicted level of BIR uptake in your area.

In this section we present a simplified method for you to estimate the level of BIR uptake in your local authority area (updated for the 2015 revision). This method is based on scaling the uptake results for Pembrokeshire, for BIR heat and electricity technologies, on a pro-rata basis depending on the level of existing and projected new build development in your area compared to that assumed for Pembrokeshire.

The Pembrokeshire modelling that underpins the assessment of BIR uptake in your local authority area has been updated since the original publication of this toolkit and the method used within has also been updated in light of this. The initial uptake model for Pembrokeshire was based on a number of assumptions that, although based on the best available information at the time of writing the original toolkit, have now changed to reflect real-world historical trends and data. The assumptions used for Pembrokeshire relate to the following:

- The level of financial support available for generation from BIR, in terms of the FITs (introduced in 2010), and the RHI (2011 for non-domestic buildings and 2014 for domestic buildings)
- Part L of the Wales Building Regulations
- BIR technologies, in terms of their performance, and future capital costs

For the 2015 update of this toolkit, we have revisited the above assumptions and updated them to better reflect real-world conditions. In particular, changes have been made to the building-mounted solar PV uptake assessment, whereby the technology has seen strong growth due at least in part to FIT contributions and decreasing capital costs which were not foreseen when the toolkit was originally published. More detail on the assumptions that have been used for the modelling for Pembrokeshire is given in Project Sheet H.

In modelling the level of BIR uptake, the uptake of non-renewable forms of microgeneration was also included, as this in effect displaces the potential uptake for renewable forms of microgeneration. Therefore, the figures for BIR uptake for Pembrokeshire that we present below are net of any uptake of non-renewable microgeneration that is predicted by the model.

A BIR 'Active Template' has been provided to help quantify the level of BIR uptake in your local authority area. This template is consistent with the methodology set out within this section and can be used to easily calculate key output figures using data inputs obtained using the steps outlined below:

The original toolkit included a more detailed assessment method of BIR uptake which enabled the user to define the different market segments for BIR uptake and that you engage an external consultant to carry out the modelling for your area. It was decided that, due to the need for local authorities to be able to easily undertake these assessments, the very complex original method has been withdrawn.

Step 1: Quantify the level of new residential development in your area

You will have this information already from targets for new housing that you are required to meet, and you are likely to already have a target (or some options for targets) for new net dwelling completions for your draft LDP. The figure that you need to calculate is the net completions per annum. If you have different targets for different timeframes, calculate the average annual completions up to 2020.

Once you have this figure, you should calculate the ratio of your target (to be referred to as NDR) for annual completions compared to the target assumed in our modelling for Pembrokeshire assumed in the BIR uptake model. Therefore, you can calculate the NDR as follows:

NDR = (average planned net annual completions for your local authority)/(average planned net annual completions assumed for Pembrokeshire uptake model)

Avoiding double counting

Note – if you are also assessing the potential for DH and CHP at strategic sites (see section E1), and including the output from CHP at those sites as part of area wide installed capacity targets, then the new buildings included in these sites should not be included in the BIR uptake assessment. Otherwise, the strategic sites will be assumed to have DH/CHP and microgeneration, which would overstate the potential. This caution does not apply to existing buildings, as any supply of renewable heat to them via heat networks is likely to be additional to any BIR uptake.

Step 2: Quantify the level of non-residential new development

For the purposes of this simplified approach, the key number that is required is an average figure for the amount of new non-residential floor area (m2) of gross internal floor area to be built each year up to 2020. You may have figures for this already as part of the emerging LDP evidence base. If not, you can develop a figure for this from a combination of some or all of the following:

- Looking at historical levels of new development, from planning consents and employment land and retail studies

- Employment land and retail studies that may have been carried out in relation to future land requirements for your area
- The capital spend programme for your local authority to give an indication of the level of public sector new build
- Discussion with other public sector stakeholders in relation to their proposed capital spend programmes

You may wish to consult with colleagues who are responsible for economic development who may have some useful data on this topic. Project Sheet G gives details of how you can convert land areas to gross internal floor area of different use classes.

Once you have a figure, you then need to calculate the ratio of this number (to be referred to as the FNR), to the figure that was assumed for the Pembrokeshire analysis. Therefore, you can calculate FNR as follows:

FNR = (predicted annual new floor area (in m^2 to gross internal floor area) for your local authority)/(level of annual new floor area assumed for Pembrokeshire analysis)

NB – the note on avoiding double counting given for step 1 also applies to step 2.

Step 3: Quantify the number of existing dwellings in your local authority area

You can readily obtain this information from the Census 2011 data for your local authority. Once you have this figure, you should then calculate the ratio of this number (to be referred to as EDR) to the number of existing dwellings assumed for the Pembrokeshire uptake model. Therefore, you can calculate EDR as follows:

EDR = (number of existing dwellings in your local authority)/(number of existing dwellings assumed in Pembrokeshire model)

For this simplified approach, we have assumed that the level of existing non-residential buildings is proportional to the level of existing dwellings. Therefore, you do not need to estimate the floor area, and type, of existing non-residential buildings in your area.

The BIR active template which accompanies this toolkit draws upon Census 2011 data to provide a number of existing dwellings in your local authority area.

Step 4: Quantify the existing BIR capacity in your local authority area

Assess the amount of existing BIR capacity that is already in your area. A method for doing this is set out in Project Sheet A.

Step 5: Calculate level of BIR uptake for renewable electricity for your area by 2020

Based on the information you have collated as part of the previous steps, you should complete the table below to derive an uptake figure for your area. The table has the relevant number and results for Pembrokeshire already inserted. A worked example for a local authority is given after the table. The total for renewable energy electricity is an aggregate covering PV, micro wind and small wind. The total for renewable energy heat is also an aggregate, covering solar water heating, heat pumps and biomass boilers.

The same table is included within the BIR Active Template accompanying this toolkit, with calculations performed automatically based upon your data inputs derived as part of Steps 1-4. Below is a screenshot of a spreadsheet from the Active Template.

Figure 3: Screenshot from the BIR renewable uptake by 2020 - Active Template

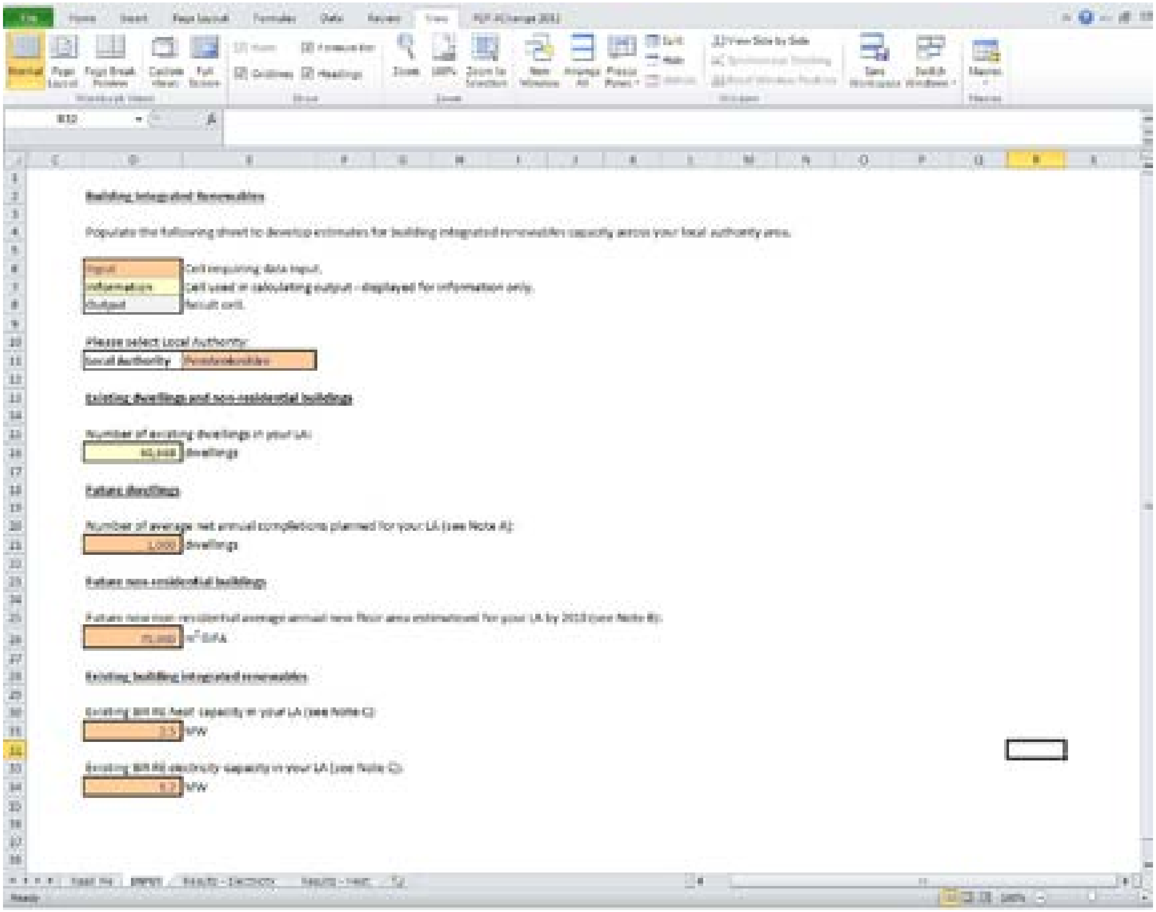


Table 19: Predicting level of BIR electricity uptake by 2020 - worked example

Figure 3 illustrates the screenshot of the Active Template used for calculating the BIR electricity uptake for 2020 for the Pembrokeshire County Council area. Table 19 provides an example of the output demonstrating how other local authorities can predict their level of BIR electricity uptake for 2020 utilising the template.

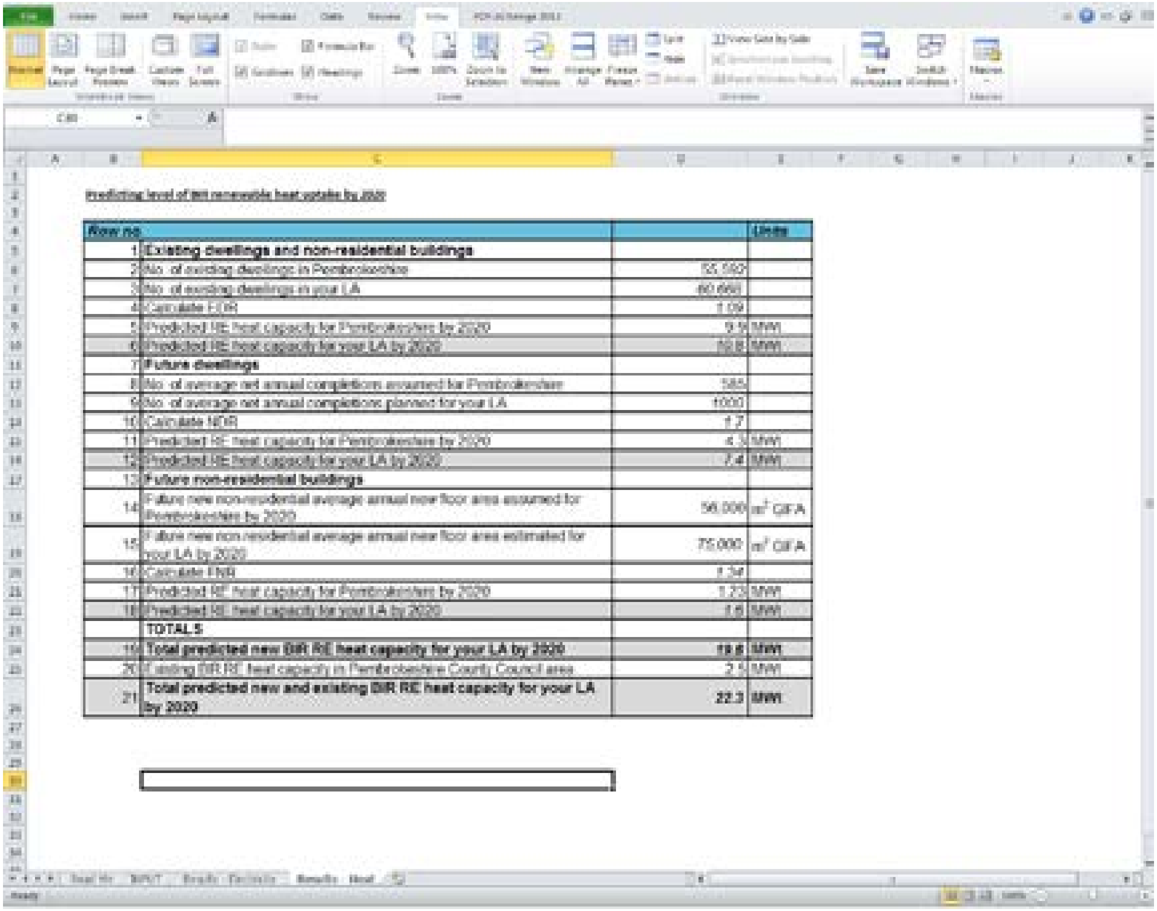
Row no.			Units
1	**Existing dwellings and non-residential buildings**		
2	No. of existing dwellings in Pembrokeshire	55,592	
3	No. of existing dwellings in your LA	100,000	
4	Calculate EDR (divide row 3 by row 2)	1.80	
5	Predicted RE electricity capacity for Pembrokeshire by 2020	4.2	MWe
6	Predicted RE electricity capacity for your LA by 2020 (multiply row 5 by row 4)	7.56	MWe
7	**Future dwellings**		
8	No. of average net annual completions assumed for Pembrokeshire	585	
9	No. of average net annual completions planned for your LA	1,000	
10	Calculate NDR (divide row 9 by row 8)	1.71	
11	Predicted RE electricity capacity for Pembrokeshire by 2020	4.3	MWe
12	Predicted RE electricity capacity for your LA by 2020 (multiply row 11 by row 10)	7.35	MWe
13	**Future non-residential buildings**		
14	Future new non-residential average annual new floor area assumed for Pembrokeshire by 2020	56,000	m^2 gross internal floor area

Row no.			Units
15	Future new non-residential average annual new floor area estimated for your LA by 2020	75,000	m^2 gross internal floor area
16	Calculate FNR (divide row 15 by row 14)	1.34	
17	Predicted RE electricity capacity for Pembrokeshire by 2020	10.6	MWe
18	Predicted RE electricity capacity for your LA by 2020 (multiply row 17 by row 16)	14.2	MWe
	TOTALS		
19	**Total predicted new BIR RE electricity capacity for your LA by 2020 (sum of rows 6, 12, 18)**	**29.11**	**MWe**
20	Existing BIR RE electricity capacity in your LA	1.5	MWe
21	**Total predicted new and existing BIR RE electricity capacity for your LA by 2020 (row 19 plus row 20)**	**30.61**	**MWe**

Step 6: Calculate level of BIR uptake for renewable heat for your area by 2020

To do this, follow a similar approach as for step 5, using the Active Template, a screenshot from which is shown below:

Figure 4: Screenshot from the BIR renewable heat uptake by 2020 - Active Template



Predicting level of BIR renewable heat uptake by 2020

Row no			Units
1	**Existing dwellings and non-residential buildings**		
2	No. of existing dwellings in Pembrokeshire	55,590	
3	No. of existing dwellings in your LA	60,660	
4	Calculate EDR	1.09	
5	Predicted RE heat capacity for Pembrokeshire by 2020	9.9	MWt
6	Predicted RE heat capacity for your LA by 2020	10.8	MWt
7	**Future dwellings**		
8	No. of average net annual completions assumed for Pembrokeshire	585	
9	No. of average net annual completions planned for your LA	1000	
10	Calculate NDR	1.7	
11	Predicted RE heat capacity for Pembrokeshire by 2020	4.3	MWt
12	Predicted RE heat capacity for your LA by 2020	7.4	MWt
13	**Future non-residential buildings**		
14	Future new non-residential average annual new floor area assumed for Pembrokeshire by 2020	56,000	m^2 GIFA
15	Future new non-residential average annual new floor area estimated for your LA by 2020	75,000	m^2 GIFA
16	Calculate FNR	1.34	
17	Predicted RE heat capacity for Pembrokeshire by 2020	1.23	MWt
18	Predicted RE heat capacity for your LA by 2020	1.6	MWt
	TOTALS		
19	**Total predicted new BIR RE heat capacity for your LA by 2020**	**19.8**	**MWt**
20	Existing BIR RE heat capacity in Pembrokeshire County Council area	2.5	MWt
21	**Total predicted new and existing BIR RE heat capacity for your LA by 2020**	**22.3**	**MWt**

Table 20: Predicting level of BIR renewable heat uptake by 2020 – worked example

Figure 4 illustrates the screenshot of the Active Template used for calculating the BIR renewable heat uptake for 2020 for the Pembrokeshire County Council area. Table 20 provides an example of the output demonstrating how other local authorities can predict their level of BIR renewable heat uptake for 2020 utilising the template.

Row no.			Units
1	**Existing dwellings and non-residential buildings**		
2	No. of existing dwellings in Pembrokeshire	55,592	
3	No. of existing dwellings in your LA	100,000	
4	Calculate EDR (divide row 3 by row 2)	1.8	
5	Predicted RE heat capacity for Pembrokeshire by 2020	9.9	MWe
6	Predicted RE heat capacity for your LA by 2020 (multiply row 5 by row 4)	17.82	MWe
7	**Future dwellings**		
8	No. of average net annual completions assumed for Pembrokeshire	585	
9	No. of average net annual completions planned for your LA	1,000	
10	Calculate NDR (divide row 9 by row 8)	1.71	
11	Predicted RE heat capacity for Pembrokeshire by 2020	4.3	MWe
12	Predicted RE heat capacity for your LA by 2020 (multiply row 11 by row 10)	7.4	MWe
13	**Future non-residential buildings**		
14	Future new non-residential average annual new floor area assumed for Pembrokeshire by 2020	56,000	m^2 gross internal floor area

Row no.			Units
15	Future new non-residential average annual new floor area estimated for your LA by 2020	75,000	m^2 gross internal floor area
16	Calculate FNR (divide row 15 by row 14)	1.34	
17	Predicted RE heat capacity for Pembrokeshire by 2020	1.23	MWe
18	Predicted RE heat capacity for your LA by 2020 (multiply row 17 by row 16)	1.7	MWe
	TOTALS		
19	**Total predicted new BIR RE heat capacity for your LA by 2020 (sum of rows 6, 12, 18)**	**26.92**	**MWe**
20	Existing BIR RE heat capacity in your LA	2.5	MWe
21	**Total predicted new and existing BIR RE heat capacity for your LA by 2020 (row 19 plus row 20)**	**29.42**	**MWe**

E3 Heat opportunities mapping

Heat opportunities mapping Active Template

'Active Templates' accompany this toolkit to help planners model the energy demand of 'anchor heat loads' and the residential heat density in your local authority area. The templates are to be used in conjunction with the processes set out in Project Sheet G.

This component considers some of the issues associated with mapping opportunities for the utilisation on new development sites of renewable heat via a DHN.

A DHN is the term given to a system providing multiple individual buildings with heat generated from a single source. The source is generally a building known as an energy centre in which heat can either be generated from traditional fossil fuels (from a boiler) or from a low carbon source such as biomass.

The practical realisation is a centrally located energy centre building transmitting heat (as hot water) along buried pipes to a number of buildings in the local area. The pipes are known as heat mains. The scale can be anywhere from a few blocks of flats to a significant proportion of a city. The practicalities for building owners are limited: the heat exchanger in each building is controlled and operated in the same way as a gas boiler it replaces, and buildings can retain a conventional distribution system, such as radiators.

Heat is sold to consumers in the same way that gas or electricity is sold traditionally, i.e. by metering of end use and regular billing. This is combined with a service charge to cover maintenance of the shared distribution system.

Combined heat and power (CHP) is simply where the energy centre produces heat as a by-product of electricity generation. The heat is used to supply the DH network in the conventional way, whilst the electricity is either sold locally or onto the wholesale electricity market. The heat from CHP units can also be used to meet cooling demands via the use of absorption chillers. This can involve either a centralised chiller, distributing "coolth" via a chilled water network, or decentralised absorption chillers in individual buildings. This approach is sometimes referred to as "trigeneration" or Combined Cooling Heat and Power (C(C)HP).

The analysis of the extent to which the utilisation of heat is viable, or likely to be viable, comprises a number of levels of complexity ranging from:

- Heat opportunities mapping
- Developing an Energy Opportunities Plan for DHNs
- Assessing the technical and financial viability of DHNs

The reason for the different levels of complexity relates to the timing of when each level of analysis should be employed. For instance, heat opportunities mapping should provide sufficient levels of detail for sieving candidate sites. Candidate sites generally tend to be the smaller sites where the developers are yet to engage with the local planning authority. The mapping should enable sufficient detail to be able to identify the location of public sector buildings, areas of existing heat demand and existing or potential renewable energy resource. This level of detail is typically sufficient in order to understand the better opportunities for candidate sites to take advantage of LZC energy generation.

Assessing the opportunities for stand-alone renewable energy generation will require an Energy Opportunities Plan. Local authorities should encourage developers to submit proposals for stand-alone renewable energy generation as part of the LDP allocations process, however, it is often not the case and applications may be brought forward following pre-application discussions with planners. In order to inform decision making within the planning authority and to improve developer certainty, an Energy Opportunities Plan should be produced, detailing spatially preferred and appropriate locations for renewable and LZC energy technologies.

Setting higher targets for strategic sites or to set a policy requiring a developer to connect to a DHN will require in addition to the heat opportunities map, a more detailed economic and technical appraisal. Strategic sites tend to be larger and developers will generally have begun negotiating with the local planning authority well in advance of the site's inclusion in the LDP. The need for the additional detail is based upon the need for the policy not to compromise site viability or to present an unrealistic technical challenge.

This section outlines the process for "heat opportunities mapping" and the development of an Energy Opportunities Plan which is most relevant to achieving the policy objective of sieving and allocating sites for development. The method for the detailed technical and financial assessment of DHN assessments is contained within the next section (E4).

The following table indicates the tasks that are associated with the component 'heat opportunities mapping' and the questions that this toolkit helps you answer. Reference is also given to the relevant appendices that should be referred to for further technical guidance.

Table 21: Tasks associated with the 'Heat Opportunities Mapping' section

Heat Opportunities Mapping		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
1. Background	Why is it important to understand the nature of existing and future energy demand and infrastructure?	**Read E3.1** **Project Sheet G**
2. Identify anchor heat loads	What and where are the key anchor 'heat' loads in your local authority?	**Read E3.2** **Project Sheet G**
3. Identify off gas areas	Where are the areas not served by the gas mains network in your local authority?	**Read E3.3** **Project Sheet G**
4. Map residential heat demand and density	What is the residential heat demand and density for your local authority?	**Read E3.4** **Project Sheet G**
5. Identify areas of high fuel poverty	Where are the areas of fuel poverty in your local authority?	**Read E3.5** **Project Sheet G**
6. Identify existing DH & CHP schemes and sources of waste heat	Where are the existing district heating and combined heat and power schemes and sources of waste heat in your local authority?	**Read E3.6** **Project Sheet G**
7. Map the location of strategic new development sites	Where are the proposed strategic development sites in your local authority?	**Read E3.7** **Project Sheet G**
8. Develop an Energy Opportunities Plan for DHNs	What is the nature of new development on proposed strategic sites in your local authority? How do you develop an energy opportunities plan for an area/site in your local authority?	**Read E3.8** **Project Sheet G**

E3.1 Task 1: Background

There are a number of reasons for identifying and understanding the nature of existing and future energy demand and infrastructure:

- Identification of public sector buildings to act as anchor 'heat' loads.
- It is useful to know the energy densities of particular areas. New LZC technology installations are more likely to be economically viable in areas of high density energy demand but can be more complex to install. This data assists with the identification of sites with significant potential.
- The proportions of the relative demand for electricity and heat are also useful indicators as to what type of LZC technology might be appropriate in a particular area.
- Areas of high density energy demand may not always present the greatest opportunities. Energy density data needs to be combined with other data, such as the nature of energy demand, the composition of building types and uses, the accessible renewable energy resource, land and building ownership, existing infrastructure and any proposed development in order to isolate the greatest opportunity: these opportunities should also be reviewed against community priorities to align delivery to local requirements.
- Energy demand can be estimated from the types of proposed buildings, the quantity of development and the energy efficiency level. Energy efficiency can reduce the energy consumption, so it is important to estimate the future requirements in this regard.
- The locations of new development will be needed for assessments of strategic opportunities.

This section of the report addresses the following main tasks:

1. Identify anchor 'heat' loads
2. Identify off gas areas
3. Map residential heat demand and density
4. Identify existing DH and CHP schemes and sources of waste heat
5. Map spatially the location of the strategic new development sites

Items 1 to 4 are covered in more detail in Project Sheet G.

E3.2 Task 2: Identify anchor heat loads

'Anchor heat loads' or 'point loads' pertain to existing buildings with an energy demand that could provide economically viable and practical opportunities for utilising heat. It is known as an 'anchor' load because further opportunities (e.g. from nearby buildings) may arise for connecting nearby buildings to the original anchor heat load.

A 'point load' therefore refers to a non-residential energy demand that can act as a base for a DH scheme.

Buildings that are located near to a point load (such as social housing, etc) and which may benefit from and contribute to the viability of DH schemes are known as a 'cluster'. A 'cluster' usually refers to a mix of social housing and non-residential buildings which, together, represent opportunities due to their:

- Complementary energy demand profile
- Planned development programme
- Commitment to reduce CO_2 emissions

The identification of point loads and clusters requires the mapping of:

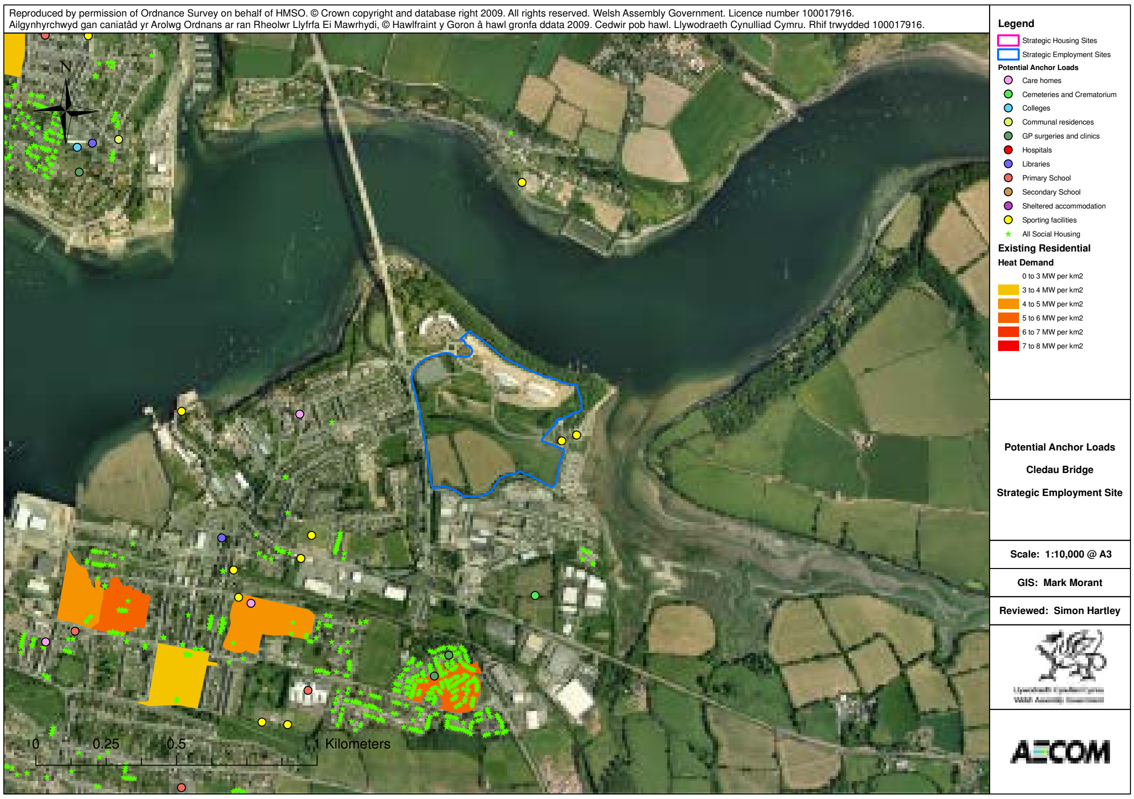
- Buildings owned by organisations with corporate climate change mitigation policies and an active commitment to reducing their carbon footprint: this more often than not, but not always, means the public sector, and
- Planned new development/refurbishment by the 'anchor heat load' organisation. New development is likely to be the catalyst for such change. CHP/DH schemes are most cost-effective when installed as part of new development rather than retro-fitting (this is covered under "energy demand from proposed development and infrastructure")
- Social housing schemes. These organisations are often tasked with achieving greater than the minimum environmental performance standards. The inclusion of such developments in DH/CHP schemes often enhance the energy profile to provide further evening, weekend and night time energy demands

Anchor heat loads are required in order for a CHP/DH schemes to become a realistic prospect and there are usually particular conditions that need to be in place, such as planned new development and/or a commercial building/group of buildings with a significant demand for heat and/or with an energy profile suitable for the installation of a CHP unit.

Given the responsibilities placed upon local authorities and the public sector in general for driving the climate change mitigation agenda, anchor heat loads are often provided by buildings such as council administration centres, leisure buildings (particularly those with swimming pools) and hospitals; although shopping arcades and precincts have also been utilised in this way.

Investment interest of ESCOs may be secured through the identification of an anchor 'heat' load with the intention of development into DH scheme.

Figure 5: Key property types considered to be potential anchor heat loads as identified within the LLPG:



E3.3 Task 3: Identify off gas areas

Off gas areas refer to those areas not served by the gas mains network with the result being that many residents and, less often, businesses utilise less economic and more polluting fuels for heat and domestic hot water. In the case of dwellings, this can be a contributing factor to fuel poverty.

There are several important reasons for identifying off gas areas.

The use of fuels other than natural gas for heat and domestic hot water often incur additional cost to the user. Whereas the economic case for the installation of renewable energy technologies may not be particularly attractive in relation to natural gas, these increased costs may enable the development of a solid business case for the installation of BIR LZC technologies.

The reason DH schemes are often not developed in rural locations is often the same as the reason why the gas network has also not been extended – financial viability. It is the case however that rural housing can contribute to providing a useful energy demand profile to counterbalance the energy demands of commercial organisations (daytime requirement only) that may have installed CHP or plant large enough to supply DH scheme.

CHP/DH fired by alternative fuels such as waste or biomass are often located in rural areas or on the urban fringe due to the space requirements necessitated by storage and vehicle access. They also tend to be located on industrial estates which offer opportunities to co-located businesses.

Unfortunately local authorities have relinquished much of their stake in industrial estates although they still tend to retain highways depots in such locations. The difficulty with the energy demand of industry is that they often require energy delivered in a particular way e.g. high pressure steam, etc. The heating of water to high temperature reduces the potential for electricity generation in CHP units, detracting from the economic case for DH/CHP due to the comparative lack of value of heat compared with electricity.

This scenario may also detract from the appeal to ESCOs of investing in the plant or necessary infrastructure.

Local authorities should have access to gas infrastructure maps but, if not, should be obtained from the relevant utilities providers. By incorporating a GIS layer showing the gas network, off-gas areas can be readily identified.

E3.4 Task 4: Map residential heat demand and density

'Density' of heat demand refers to Megawatt (MW)/square kilometre (km^2) of energy consumed in dwellings. Information relating to heat densities can be used to inform:

- The identification of anchor heat loads by providing, or adding to, a viable opportunity for the introduction of renewable heat
- A mix of buildings and energy uses which, together, represent a potential complementary energy demand profile (dwellings providing evening, weekend and night time energy demands as opposed to the normal weekday energy demands of commercial organisations)
- The identification of opportunities relating to social housing providers who are often tasked with achieving greater than the minimum environmental performance standards

'Active Templates' have been produced and are available as accompanying tools for calculating:

- **Residential heat demand in your local authority area**
  An Active Template accompanies the 2015 update of this toolkit to enable planners to easily quantify the residential heat density of each output area in their study area. This template makes use of publically available domestic gas consumption estimates per Lower Super Output Area (LSOA) for 2012 to allocate each output area a heat density figure. This method simplifies the method previously employed in the original toolkit which required Standard Assessment Procedure (SAP) modelling based upon a number of different dwelling types and locations. It is intended that this data is then fed into a GIS system to allow for visual interpretation when mapping heat opportunities. To quantify heat demand we have assumed in the Template an average system efficiency.

- **Heat demand and electricity consumption of non-domestic buildings within your local authority area.**

The importance of identifying residential heat demand and density pertains to:

- the potential demand for heat in any one particular area
- contributing to the identification of anchor heat loads
- feeding into the analysis of potential LZC solutions
- contributing to the identification of energy and carbon baselines to inform area wide target setting

Example output

Table 22: Residential heat density by Output Area

	Output Area Code	Average Consumption/ Dwelling [kWh]	Dwellings In Output Area	Heat Density [MW/km²]
Pembrokeshire	W00003203	11,937	152	0.4

E3.5 Task 5: Identify areas of high fuel poverty

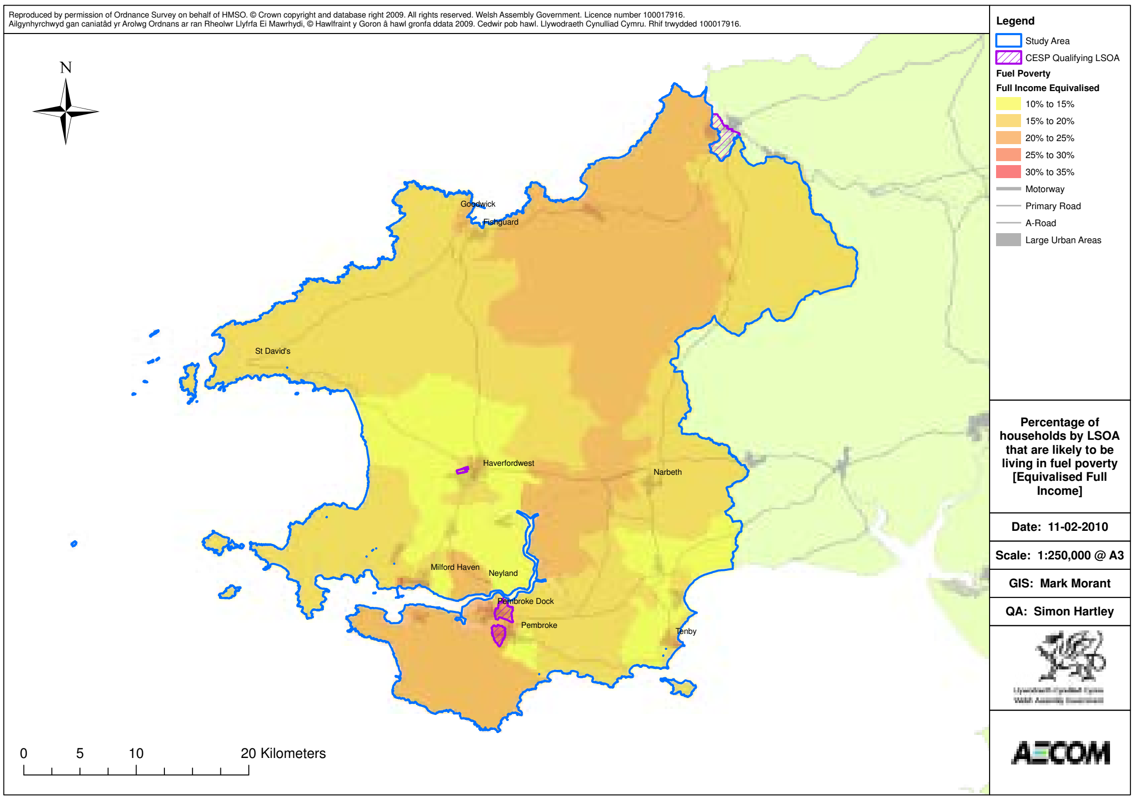
Fuel poverty is a key concern of national governments and local authorities alike. Local authorities produce reports relating to the number of people or households regarded as 'fuel poor'.

Often, it is those living in rural parts of the country who suffer disproportionately from fuel poverty and this is attributable to a number of factors. For example, typically, wages are lower than for those employed in more urban areas, there is often a higher proportion of unemployed and fewer job opportunities, etc. A greater proportion of households are not connected to mains services and pay higher prices for fuels such as Liquefied Petroleum Gas (LPG) and heating oil. The combination of factors means that energy bills can constitute a greater proportion of the household costs than for many urban households.

A contributory of fuel poverty can also be the lack of energy infrastructure in rural locations. Often gas networks have not been connected in very rural areas due to high capital cost in relation to revenue generated. This means that residents of rural locations are forced to seek alternatives to natural gas such as LPG, heating oil or some form of solid fuel. The upside is that where the installation of a renewable energy technology is considered in such locations the economic payback and the potential CO_2 reductions are proportionately better than when considered against natural gas.

The inclusion of an analysis of fuel poverty adds value to the toolkit by assisting local authorities in their targeting of resources and to integrate this with the tools to assess potentially effective ways of addressing the issue.

Figure 6: Fuel Poverty Map for Pembrokeshire County Council area



E3.6 Task 6: Identify existing DH & CHP schemes and sources of waste heat

This section delineates the methods employed for identifying relatively large scale existing commercial LZC energy capacity. This exercise currently involves researching a number of disparate data sources.

It is important to establish existing energy infrastructure as it may provide opportunities for expanded connectivity or increased efficiency/viability. Identification of current utilisation of renewable energy resources can be included in the assessment and reporting of current proportion of area wide targets being met.

Identifying existing CHP of any size can relatively easily be achieved through analysis of the ROCs register and through discussion with relevant local authorities officers (energy & planning). Similar incentives and therefore record keeping has not been available until now (with the introduction of the RHI) for renewable heat. However, the extensive nature of DH schemes means that LPA officers will likely have details of any existing DH scheme in its area.

It can be difficult to identify waste heat without direct questioning of organisations. A number of website based resources have been identified and included within the useful references. Local Land and Property Gazetteer (LLPG) data, although providing categories of industrial, warehouse, manufacturing, etc, is not specific about the particular activity or the energy efficiency practices. Discussions with the local authorities Energy Manager and planners revealed some further sources of waste heat.

The utilisation of current sources of waste heat can provide opportunities to improve fuel efficiency and secure CO_2 emission reductions. Extending existing infrastructure to additional users can increase viability of a particular scheme. In order to maximise current CHP/DH installations and/or utilise any waste heat capacity, locations of existing infrastructure should be cross-referenced against:

- Existing public sector/social housing development
- Planned public or private sector development
- Accessible renewable energy resource
- Potential for co-location of complimentary activities
- Planned infrastructure (energy networks or significant plant/transport) upgrades

Table 23: Example of existing District Heat, CHP or sources of waste heat for Pembrokeshire County Council

Name	LZC Energy Technology	LC Fuel Source	Capacity (MW)
Bluestone Holiday Park	District Heating	Biomass	1.6
Milford Haven Oil Refinery	Waste Heat?	Unknown	Unknown
Haverfordwest Cheese Ltd	Waste Heat?	Unknown	Unknown
Pembroke Oil Refinery	Waste Heat?	Unknown	Unknown
Narberth Waste Water Treatment	CHP	Sewage Sludge	0.1
Withyhedge	Electricity Generator	Landfill Gas	1.74
Total	**-**	**-**	**3.44**

E3.7 Task 7: Map the location of strategic new development sites

This involves mapping the location of the strategic sites using GIS. This task may already be carried out as part of the LDP site sifting and candidate site selection process. If you do not have a "red line" plan yet available for the sites, you can map the location of areas of search. The key objective is that this spatial mapping means that you can superimpose the location of the sites on GIS layers showing existing anchor heat loads in close proximity to the sites, as well as areas of existing high heat density.

By "strategic" we mean the largest sites that you have already allocated or are considering allocating. It is for you to define and select which sites are "strategic" in your context.

E3.8 Task 8: Develop an Energy Opportunities Plan for DHNs

The bringing together of the various data layers described above, together with the location of your strategic sites for new development, creates what we are calling an Energy Opportunities Plan.

The process for identifying key spatial opportunities for DHNs is set out below.

Step 1: Produce GIS heat map

The key to producing this Plan is the use of GIS heat mapping, as described in the section above. The heat map should produce a visual spatial representation of all of the opportunities for DH. This in turn draws together all of the information gained from the processes which relate to understanding existing and future heat demand. The table below describes what the heat map should (ideally) include, and also explains the rationale for including each item, in terms of the opportunity that it creates for a DHN.

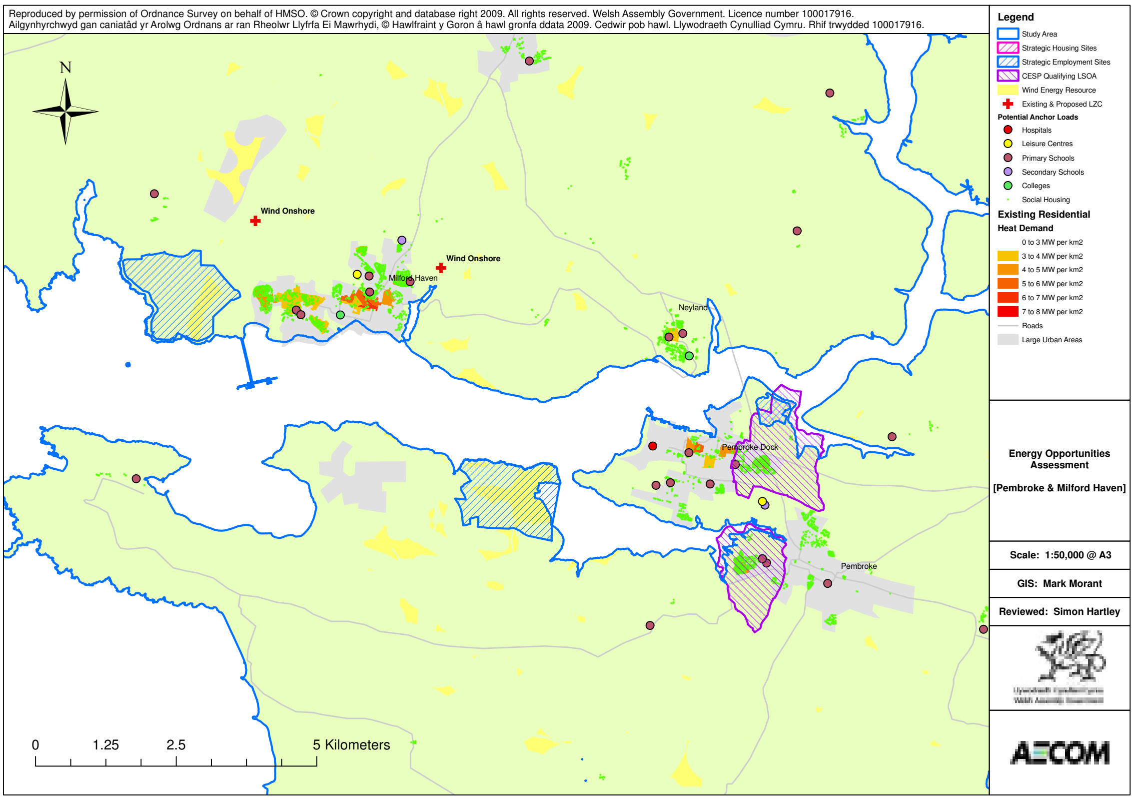
Table 24: Opportunities to maximise the viability of district heating

Opportunity areas to map	Rationale for identifying
Public buildings such as schools, hospitals and leisure centres	Secure heat loads and early revenues.
Social housing	Secure heat loads and early revenues, typically higher heat density, fuel poverty issues.
Existing housing heat density	High density housing may have sufficient return on investment to allow connection of DHN giving large carbon savings.
Areas of high fuel poverty/areas with a high index of multiple deprivation	These areas may attract funding under the Green Deal, Energy Companies Obligation (ECO), Arbed &/or NEST.
Existing or proposed CHP/DHNs	Existing CHP or DHNs may benefit from the addition of heat loads such as new development.
Existing or proposed waste heat sources including: • Power stations • Landfill gas stations • Industries with waste heat including: • Food • Paper and pulps • Chemicals • Petroleum • Stone, clay and glass • Primary metals (steel works) • Potential energy from waste sites	Co-location of waste heat and development can give large carbon savings. For instance: typical electrical generating efficiencies are around 35% – with an additional 40% of potentially useful heat wasted. This heat can potentially be used to supply a DHN, raising the overall efficiency from 35% to 75%.
• Existing large industrial buildings with heating or cooling demands	Industrial buildings can potentially have large heating or cooling demands, for process use, that can be served by a DHN. The benefits are both in the size of heat load and the added diversity (i.e. time of day).

Opportunity areas to map	Rationale for identifying
Off mains gas sites	By displacing the most carbon intensive fuels (direct electric heating, oil and solid fuel) DH can achieve the greatest carbon savings. A DHN could also be more attractive to potential customers relative to more expensive fuels.
Large commercial buildings such as: offices, hotels, department stores	The heat and/or cooling loads for these buildings can potentially be served by a DHN.
Strategic new development sites	Whereas DHNs may be hard to retrofit to existing building stock, new development may act as a 'spring board' to located energy centres, establish heat revenues and aid acceptability. Planning policy can also be used in these areas to encourage DHNs.
Local authority/Welsh Government land ownership	Control of development on publically owned land gives potentially greater leverage to encourage DHN.

The heat map should clearly show the strategic new development sites, and other opportunities, such as potential anchor heat loads, either within or in close proximity to the sites should also be clearly visible on the map.

Figure 7: Example of an Energy Opportunities Plan



Step 2: Test Energy Opportunities Plan with Key Stakeholders

At this stage, we recommend testing the accuracy of the heat map with other key stakeholders within the local authority, outside of the planning team. Some of these may have been involved already with providing the information required in chapter 2. We suggest that these stakeholders would include officers responsible for the following:

- Energy management in the corporate estate, including schools, public buildings, leisure centres, etc
- Waste management (due to the potential connection with EfW)
- Procurement and delivery of new development (e.g. a "project champions" team)
- Housing
- GIS

These stakeholders can provide a sense check of the heat map. They may identify additional opportunities or they may identify particular constraints. Following these discussions, the heat map can be revised to account for any new opportunities or constraints.

E4 Detailed viability appraisal of strategic sites

There are a number of different types of policies that a local planning authority may wish to consider including in their LDP to help facilitate the delivery of strategic (i.e. larger scale) renewable energy projects in specific locations. Section P of this toolkit sets out each of these policy options and the evidence base required to support them. Key elements of the evidence base may include:

- Modelling potential energy demand (to facilitate the setting of enhanced targets for strategic new development sites)
- The identification of broad areas suitable for wind or solar PV development and/ or other technologies which may produce heat and power (such as power stations using a variety of technologies (e.g. gasification; pyrolysis) and feed-stocks (e.g Refuse Derived Fuel, etc))
- Assessing technical and financial viability of DHNs

This component sets out a process to enable the identification of opportunities for renewable energy on strategic sites as part of the planning process.

The following table indicates the tasks that are associated with the component and the questions that this toolkit helps you answer. Reference is also given to the relevant appendices that should be completed in order to develop the necessary evidence base.

Table 25: Tasks associated with the 'E4: strategic sites' section

Detailed viability appraisal of strategic sites		
Task	**Questions that this toolkit helps you answer**	**Local Authority Action Required**
1. Background	What processes does this section outline?	**Read E4.1**
2. Assessing energy demands of strategic new development sites	What is the potential energy demand (MW) for each proposed strategic site in your local authority?	**Read E4.2**
3. Identify areas for strategic stand-alone renewable energy development	Which areas might be suitable for strategic stand-alone renewable energy development?	**Read E4.3** **Complete** **E1, E3**
4. Assessing the technical feasibility and financial viability of DHNs	How do you assess the technical feasibility and financial viability for a district heat network for an area/site in your local authority?	**Read E4.4** **E1, E3 & Project Sheet J**

E4.1 Task 1: Background

This section outlines a process for:

- Estimating the future energy demands that would arise from strategic new development sites. This is necessary in order to be able to assess the technical and financial viability of renewable energy technologies for those sites
- Identifying areas for strategic (larger-scale) stand-alone renewable energy development
- Assessing technical feasibility and financial viability of DHNs

E4.2 Task 2: Assessing energy demands of strategic new development sites

If you want to consider setting higher environmental sustainability standards for strategic new development sites (see chapter P3), or if you want to assess the viability of DHNs (see chapter P4), the starting point is to assess the potential energy demands of the new development.

We do not expect that local authorities will complete this task without external support. Therefore, we have set out below the baseline information that the local authority would need to provide to a consultant to do this analysis, as well as the issues to be covered by the consultant and the nature of the outputs they should produce.

Step 1: Quantify the nature of new development in each strategic site (local authority)

Step 1a: New residential development

Ideally, for each strategic site, you should estimate:

- The total number of new dwellings for each site (if any).
  This will be informed by:
  - Joint Housing Land Availability Studies (JHLAS)
  - Our emerging LDP site assessment process
  - An indicative number provided by a submitted candidate site
- The split of dwelling types (broadly, whether detached, semi-detached, terraced or flats)

This is important because the type of dwelling affects the energy demand, both in terms of floor area, but also because detached dwellings have a higher heat demand per unit of floor area as they have more exposed external walls.

The estimated split of dwelling types can be based on other recent sites in similar geographical areas that may have received planning consent or already started construction, such as those allocations already in the Unitary Development Plan (UDP). It may also be informed by any density standards that you may be considering setting for some sites, or from discussion with local agents and house builders. The split is usually set out in percentage terms (i.e. 20% terraced).

- The expected start date for construction and number of annual completions

This is important, as it will affect what energy standards it will be expected to meet under future Building Regulations, and hence energy efficiency standards. You will also need to take into account the phasing of buildings within the development. This, in turn, will affect the energy demand.

The start date for construction will need to be a best guess, based on what is known about current developer interest in any site and infrastructure requirements.

For annual completions, when there is strong demand, a typical build out rate is 50-100 dwellings per year for a single developer or house builder.

The output from this step should be a table or spreadsheet similar to the one below:

Table 26: Table showing split between cumulative number of completions and timings

Development reference	Cumulative number of completions			
	2010	2011	2012	Years ... to final date i.e. 2020
e.g. Smith Lane site				
Detached	10	20	30	N
Semi	40	80	120	N
Terrace	40	80	120	N
Flat	10	20	30	
Total	100	200	300	Etc.

Step 1b: Non-residential new development

As with step 1a, ideally you should provide the following information for each strategic site:

- Expected floor areas for each type of development, at least in terms of use class (e.g. B1, B2, B8, etc.) for non-residential development to be provided on the site.

In practice, you may only know the potential hectares for each use class. Information on this would be informed by any employment land studies or retail studies that you may have had carried out for your area. These may provide historical data that you could project forward, or they may provide future projections and requirements.

If the areas (in hectares) of sites with the potential to be developed are known, but floor areas are not, Department for Communities and Local Government (DCLG) ratios between site area and floor space for various building types can be used to estimate potential floor space developed.

Table 27: Plot ratios for employment use (gross floor-space to site area) from (D)CLG Employment Land Reviews – Guidance Note

	Roger Tym (1997)[19]	Other Studies
Business Park	0.25 to 0.30	0.25 to 0.40
Industrial	0.42	0.35 to 0.45
Warehouse	-	0.5
Town Centre Office	0.41	1.05

For example, if 1ha (10,000m²) land on a site is proposed for B1 use (office, light industrial), then from the table, a typical floor space to plot ratio would be 0.3, giving a gross floor space of 0.3 x 10,000 = 3,000m².

- Details of any proposed major public buildings, such as schools and leisure centres that may go on the strategic sites.
  - If possible, it would be useful to know whether it would be a primary or secondary school and the estimated number of pupils (as the energy demand can be deduced from this).
  - If a leisure centre, it would be useful to know whether or not it would have a swimming pool, as this would be a significant heat load.
- The expected start date for construction for each significant building or use class and when the non-residential plots would be expected to be built out.
  - Based on this, a reasonable assumption would be that the completion of different floor areas of different use classes would be spread evenly over time.

The output from this step should be, for each strategic site, a table or spreadsheet similar to the one below:

Table 28: Typical floor space per proposed use class

Build Start	Build End	Gross internal floor areas						
		A1	A3	B1	B8	C1	D1	D2
2010	2020	1,000m²	3,000m²	N	5,000m²	n/a	n/a	n/a

Step 2: Estimate potential energy demand of strategic new development sites (Consultant)

New buildings will use energy for heating and electrical services, and this new energy demand will increase the energy consumption of an area and its associated carbon emissions. EU Directive 2010/31/EU states that all new buildings will be required to be 'nearly zero energy' by 2021.

The Building Regulations Wales Part L (2014) sets minimum standards for the energy performance of buildings. These standards will reduce the demand for energy and associated carbon emissions generated by these new buildings. TAN12: Design, in addition to this toolkit, provides guidance to local planning authorities on sustainable buildings. While this toolkit does not consider the potential for all the range of sustainability features covered in a new building, it is expected that meeting the higher energy and carbon requirements will play an integral part in realising any opportunities.

A concentration of future heat demand, either isolated or near existing buildings can present the opportunity for strategic renewable energy development.

Energy demand can be estimated from the types of proposed buildings, the quantity of development and the energy efficiency level. Energy efficiency can reduce the energy consumption, so it is important to estimate the future requirements in this regard. The locations of new development will be needed for assessments of strategic opportunities.

For dwellings, assess cumulative heat demand for each year, allowing for the impact of future energy efficiency standards (which are likely to reduce heat demand).

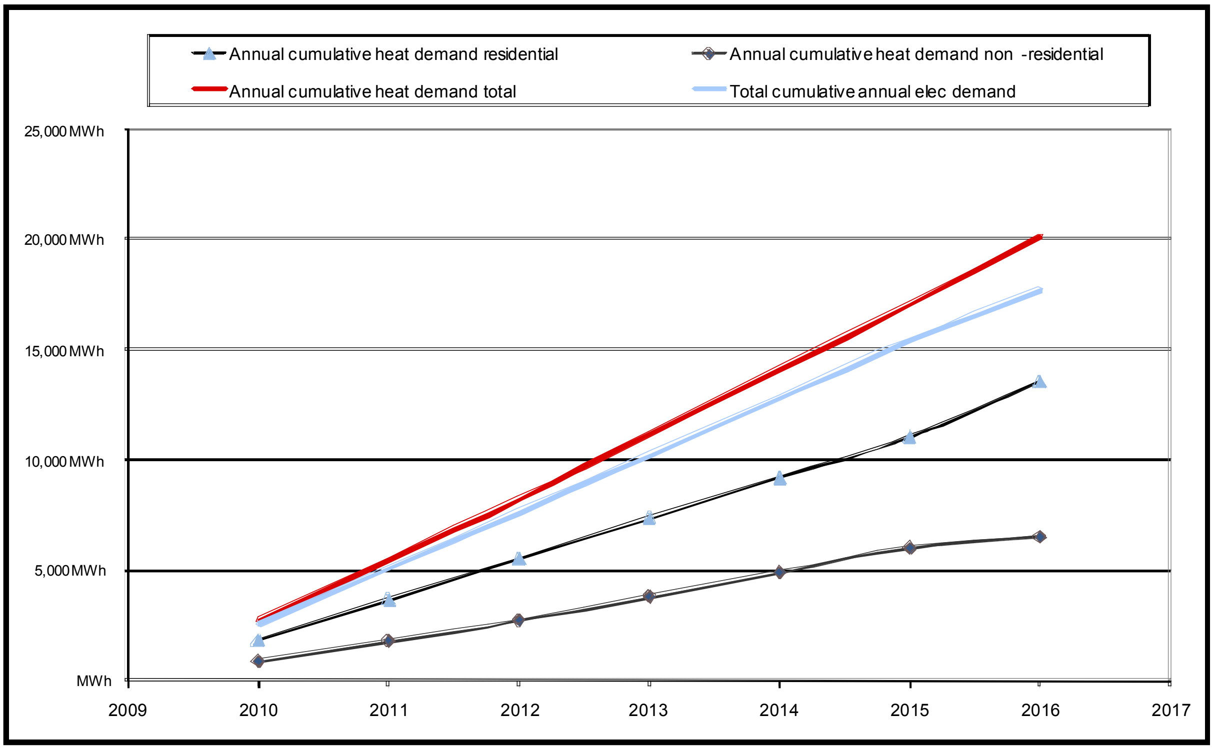
The consultant will need to assume standard floor areas for each of the four dwelling types and estimate the energy demand using the output from SAP models.

For non-residential buildings, the consultant would base the energy demands on published benchmarks for energy use per metre squared floor area for different building types, such as published in Guide F: Energy Efficiency in Buildings produced by Chartered Institute of Building Services Engineers (CIBSE).

The heat demands for both dwellings and non-residential buildings should be "degree day" adjusted to the region of Wales you are located in. Degree days are defined by the Carbon Trust as a 'measure of the difference between the baseline and the actual outdoor temperature multiplied by the number of days'; please: see: www.carbontrust.com/resources/guides/energy-efficiency/degree-days. This allows for the fact that the north of Wales has colder winters than the south as an example.

As an output, the consultant should produce a profile of the estimated annual heating, cooling and electricity demand for each site, over the full build out period, showing how the energy loads build up over time. An example of the sort of output required is shown below:

Figure 8: A profile of the estimated annual heating, cooling and electricity demands



E4.3 Task 3: Identify areas for strategic stand-alone renewable energy development

Based on the analysis carried out in sections E1 and E3 (and the associated Project Sheets), a local authority should identify spatially, areas that may be particularly suitable for larger scale renewable energy development.

The value in doing this is that it sends an invitation to potential developers that the local authority is interested in seeing suitable development in those sites and that there is a greater likelihood of securing planning consent for applications in those areas[20].

For example, this could include the following:

- Least constrained areas for solar PV farms and wind development. The wind mapping described in section E1.3 would identify certain areas that had the greatest potential for wind development. However, we would recommend that a local authority should also carry out a separate assessment of landscape sensitivity for those areas (as described in TAN 8) if in rural areas. If the mapping shows potential in brownfield or industrial areas, this may be less of an issue.
- Potential areas for locating biomass power generating plant, where they may be close to large heat loads, as well as having good transport infrastructure and potentially in close proximity to possible sources of fuel[21].
- The above point could also be applied to potential areas for locating EfW plants, although the local authority may be identifying these anyway as part of preparing a waste development plan.

E4.4 Task 4: Assessing the technical feasibility and financial viability of DHNs

Step 1: Define the boundary of the DHN areas to be analysed (local authority)

Based on the Energy Opportunities Plan produced as part of applying section E3, you are then in a position to define the geographical boundary of each DHN area that you wish to analyse in more detail. This should show the geographical extent of the DHN area on a map, as well as providing details of the existing and new buildings that could be connected.

It is assumed that the energy demand for these buildings will be known already from the processes carried out in chapters E3 and above. The table below summarises the information that should be provided for each area.

The number of areas to be analysed will depend on the number of strategic development areas that a local authority is considering. However, we would recommend that about five areas would be a manageable number. Within each of these areas there may be two or more options, such as a core and extended extent of connection, or variations in future housing numbers, for example.

Table 29: Information to be provided for each DHN area

Data type	Format	Source	Data required
1. Future new development	Table, e.g. Excel	See section E4 above	a list of the new build sites that are considered within the opportunity the cumulative annual heat demand for each year until the site is complete (to be developed by consultant)
2. Existing dwellings to be connected	Table, e.g. Excel	See section E3	a list of the output areas (OAs) that are considered within the opportunity the total annual heat demand of each OA the number of social homes in each OA
3. Existing non residential buildings to be connected	Table, e.g. Excel	See sections E3	a list of the buildings that could connect to the DH scheme the annual heat demands of the buildings

Data type	Format	Source	Data required
4. Geographical boundary of the DH opportunity	Plan	Taken from GIS heat map	spatial extent of new development listed in (1) spatial extent and location of output areas which are potentially connectable, as listed in (2) location of any existing non residential buildings anchor heat loads, as listed in (3) any other important features such as EfW sites, existing DH or CHP

In terms of existing non-residential buildings that could act as potential anchor heat loads, we assume that you should be able to obtain information on annual heat demand for public buildings within the DHN boundary either direct from your own local authority manager, or from discussion with stakeholders such as Welsh Health Estates (WHE), for hospitals.

If the DHN boundary includes potential non-public anchor heat loads, then we suggest that the energy demands for these buildings can either be modelled by the consultant (see Project Sheet G), or for a small number of large buildings, obtained directly from the building occupant.

Step 2: Carry out detailed technical and financial viability of each of the DHN areas (Consultant)

The next stage is to carry out a high level assessment of the technical and financial viability of each of the DHN opportunity areas. This exercise should distinguish between sites that may be viable purely commercially and more marginal sites that may be viable with other sources of funding (or the involvement of delivery partners with a higher risk tolerance).

This process is unlikely to be practical for the local authority to complete internally and so no detailed method is set out. More likely it will involve the local authority supplying the data described above to a consultant or potential delivery partner (such as an ESCo) with the required technical and in-house cash flow modelling skills.

Therefore, this section sets out the scope of what you would expect the analysis to cover so that you could prepare a consultant's brief. The table below shows a list of the key parameters and variables that the analysis should consider.

Table 30: Summary of key parameters for DHN viability assessment

Parameter (inputs)	Detail
Lead low carbon energy generation technologies	Gas CHP Biomass boiler Biomass CHP
Capital costs of DHN	Energy centre – lead plant, building, auxiliary services DHN connection to buildings
Lead plant replacement capital	Expected lifetime of lead plant The fraction of the initial capital that is required for replacement
Revenue streams	Heat sales: to residential/non-residential customers – benchmarked to current gas prices Electricity sales: either to wholesale market or via private wire directly at retail prices[22] Standing charges – benchmarked to annual gas boiler service Contracts for Difference (CfD) or FITs on renewable generated electricity RHI on renewable generated heat Climate change levy exemption certificates Connection charges to developers in lieu of gas connection, heat provision and individual renewable generation Connection charges to householder in lieu of gas connection

Parameter (inputs)	Detail
Ongoing costs	Fuel costs for lead/top-up plant Electricity costs for pumping DHN Maintenance of plant Metering of customers Administration including billing Insurance Business tax
Capital funding	Possibly – Green Deal, Enhanced Capital Allowances. ECO, Arbed, NEST
Discount factor for NPV	6% for public sector viability 12% for commercial sector viability
Parameter (inputs)	**Detail**
Carbon emissions reductions	In new and connected existing buildings
Financial metrics	Net Present Value (NPV) Internal Rate of Return(IRR) Gap funding Sensitivity analysis

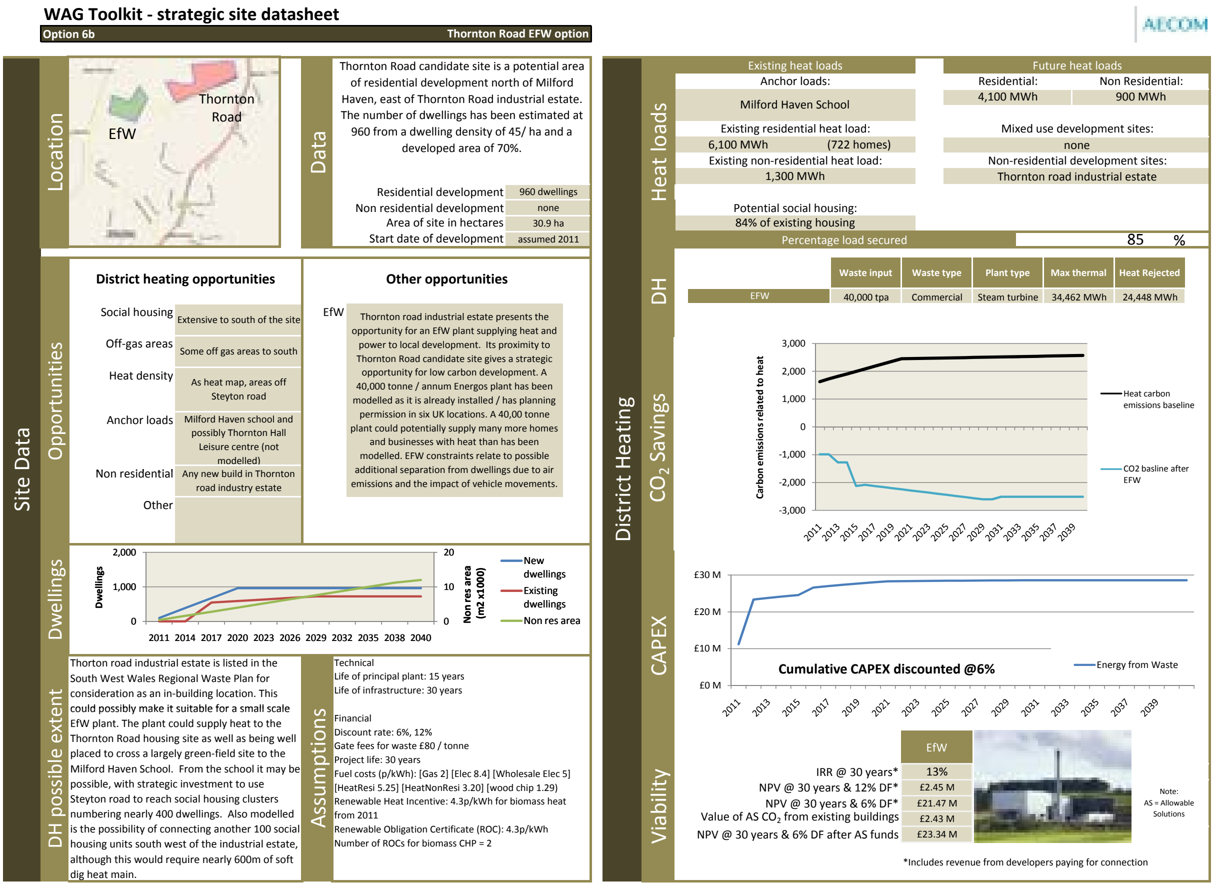
A key output from the financial analysis will be an assessment of whether the schemes are commercially viable, or whether gap funding is required. If the latter, then there are two potential sources of gap funding that a local authority, or an ESCo, may be able to secure from developers of new buildings to provide this funding. These are:

- Connection charges
- Allowable Solutions fund

Each of these is covered in more detail below, after step 3, and, where appropriate, they should be factored in to the financial analysis set out in the above section.

An example of what the output from the consultant's assessment for a DHN area might look like is shown on the next page, taken from the Pembrokeshire case study.

Figure 9: Example output from consultant detailed assessment of viability of DHN area



Step 3: Test results of more detailed viability assessment with key stakeholders (local authority and consultant)

Once the detailed technical and financial assessment has been carried out, we recommend that you should then consult with internal and external stakeholders to test out the results, but also to inform any actions for helping to deliver the opportunities (see section P5).

The choice of external stakeholders will depend on which opportunities are highlighted on the heat map. These stakeholders could include:

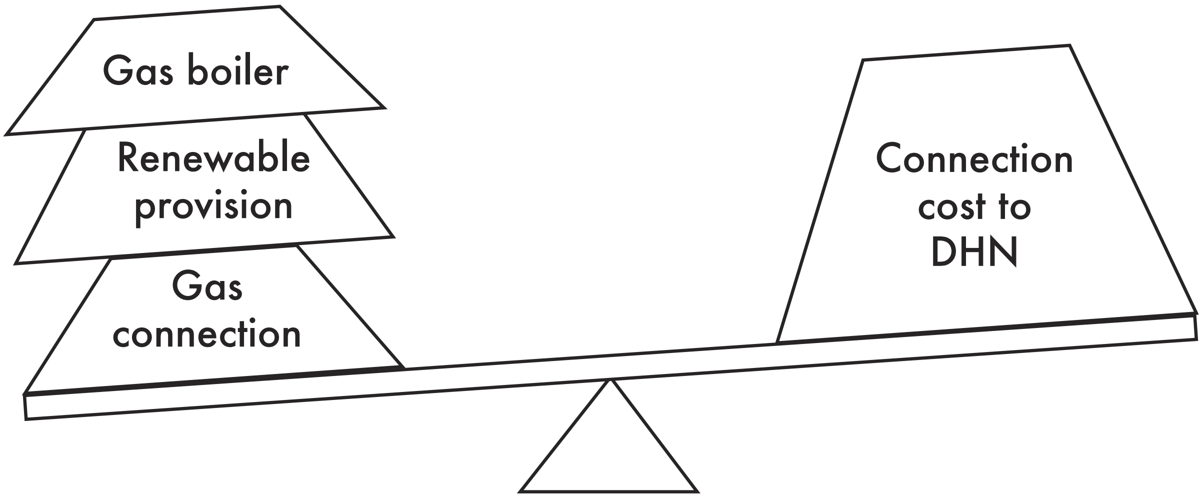
- Key stakeholders for other public sector anchor heat loads, such as: Health Trusts, social housing providers, further and higher education establishments, courts, prisons
- Key stakeholders for potential private sector anchor heat loads, such as industrial users, large retail or office developments
- Potential ESCos, who could operate and potentially invest in such schemes. This could include utility companies as well as specialist ESCo providers

Funding from connection charges for new buildings

This is a charge to developers for connecting up new buildings to the heat network. There are two justifications for this, namely:

- In connecting up to the DHN, developers will avoid the cost of individual gas boilers in each building, as well as potentially also the cost of a gas connection[23]
- In connecting to a DHN fuelled from low carbon sources, the carbon savings will enable the developer to meet the carbon reductions required by Part L of the Building Regulations Wales, which avoids the cost of having to achieve this in some other way[24]

Figure 10: Illustration of the balance between DHN connection cost levied to developers and the avoided costs allowed by the DHN



Funding from connection charges for existing buildings

It may also be possible to secure revenue from charges to existing building owners who connect up to the network. There are two broad categories of existing buildings where connection charges could be paid, namely:

- Existing owner occupied housing. It is reasonable to assume that when their existing boilers reach the end of their working life (after 15-20 years, typically), they will consider connecting to a DHN if there is one in their vicinity. The amount they will pay will be driven by the opportunity cost of having to pay for the installation of a new boiler
- Existing businesses. As with owner occupied housing, businesses are likely to consider connecting up to a DHN when their boiler plant reaches the end of its useful life. In some circumstances, they may also be keen to secure the carbon reduction benefits. However, the avoided cost from connecting to the DHN may be hard to quantify, unless this can be discussed directly with the businesses concerned

The role of ESCos

Delivery will almost certainly involve the creation of a legal entity to contain the commercial risk and raise capital for the DHN and energy centre. This entity is generally known as an ESCo, and its nature will shape the delivered scheme and which of the aims are prioritised. The Council and other delivery partners may take a degree of ownership/representation in the ESCo, as may the local community, or the ESCo may be a purely private sector entity.

The advantage of the former is that a local authority, or a public/private partnership, can take a longer term view of the investment and accept a lower rate of return and may also be able to take advantage of prudential borrowing. A purely private ESCo may prioritise financial return over carbon savings, community involvement, fuel poverty issues and so on, whereas, a partially community owned ESCo may focus on the social benefits and retaining the community's wealth in the area.

A large Multi-Utility Services Company (MUSCo) is a specialist organisation which has licenses to operate a number of utilities. It may be able to offer cost effective, fully serviced sites for the developers. This may include the energy centre and heat mains, gas supplies, water mains, waste water, electricity and fibre optic broadband. The infrastructure would be funded partly by the MUSCo and partly by the developers. Therefore capital investment for the developer may be minimised.

Other funding sources

As well as connection charges there are other potential funding sources that a local authority or ESCo may be able to tap into, that should be factored in to the financial model, where appropriate.

- **The Green Deal:** The initiative replaces the Community Energy Saving Programme and Carbon Emissions Reductions Target, and is designed to assist home owners and businesses make energy efficiency improvements at no initial cost; the expenditure is then retrieved from the consumer via a number of instalments on the energy bill. The aim of the deal is not only to save consumers money but also to increase the nation's energy efficiency and thus mitigate climate change. There are a number of criteria for all Green Deal plans, primarily the 'golden rule'; "the expected financial savings must be equal to or greater than the costs attached the energy bill" amongst others. For more information please see: www.gov.uk/government/uploads/system/uploads/attachment_data/file/47978/1010-green-deal-summary-proposals.pdf

- **The Energy Companies Obligation (ECO):** Introduced in 2013, the ECO replaces two previous schemes; the Carbon Emissions Reductions Target and the Community Enery Saving Programme, annually funding approximately £1.3billion worth of energy efficiency improvements for low income households. The ECO functions alongside the Green Deal and is intended to support those living in fuel poverty. The ECO is funded by energy suppliers, who determine how much subsidy each consumer achieves. There are three obligations under the ECO; Carbon Saving Community Obligation, Affordable Warmth Obligation and Carbon Saving Obligation www.gov.uk/government/policies/helping-households-to-cut-their-energy-bills/supporting-pages/energy-companies-obligation-eco
- **Enhanced Capital Allowances:** enable a business to claim 100% first-year capital allowances on their spending on qualifying plant and machinery, including energy efficiency and low-carbon technologies. Businesses can write off the whole of the capital cost of their investment in these technologies against their taxable profits of the period during which they make the investment. The UK Government introduced the Enhanced Capital Allowance scheme in 2001 to encourage businesses to invest in low carbon, energy-saving equipment. There are three Enhanced Capital Allowance schemes which provide enhanced tax relief for spending on equipment which has environmental benefits: energy-saving equipment, water-efficient equipment and low (CO_2) emission cars. www.gov.uk/government/uploads/system/uploads/attachment_data/file/368320/ECA272_A_guide_to_equipment_eligible_for_Enhanced_Capital_Allowances__6_.pdf
- **The Renewable Heat Incentive (RHI):** In 2011, the UK Government launched the Non-domestic RHI for generators of renewable heat (industrial, commercial, public sector, not for profit organisations and heat networks). In 2014, the UK Government launched the Domestic RHI, to provide payments to homeowners, private landlords, social landlords and self-builders. This is a financial incentive aimed to encourage the heating of buildings via renewable technologies such as solar thermal panels, biomass boilers, air source heat pumps as well as ground and water source heat pumps. It should be noted installations using biomass fuels must meet the UK Government's sustainability requirements from October 2015. www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi#history
- **Arbed:** *arbed* is a Welsh Government led strategic energy performance investment programme concentrated on the Strategic Regeneration Areas (SRAs). Arbed provides Wales wide funding for social housing providers to help fund home energy efficiency/renewable energy retrofit projects. www.adjudicationpanelwales.org.uk/topics/environmentcountryside/energy/efficiency/arbed

References

18 By 'demand led' we are referring to a technology that is dependent upon sufficient demand for its energy generation being in place

19 Roger Tym & Partners, 1997 and ERM Review

20 I.e. this could function in much the same way as site allocations for new housing or commercial development

21 E.g. food waste, wood waste, energy crops

22 If private wire is assumed then the cost of operation private wire should also be included

23 If they choose to use all electric cooking, as opposed to the most common option of gas hob and electric oven

24 Which is likely to be some combination of energy efficiency and microgeneration

Policy options: Translating the evidence base into policies and targets

Introduction

It is the expectation of the Welsh Government that policies will be included within LDPs as a result of developing a renewable energy evidence base. The aim of this section is to give you guidance on how to translate an evidence base for renewable and low carbon energy potential (as covered in sections E1 to E4) into spatially based policies in your LDP's, and also into wider action that is required to help deliver some of the opportunities identified. Therefore, this section is split into six sub-headings, each of which covers the six policy options set out in the navigation table in chapter 3. These are as follows:

1. Develop area wide renewable energy targets and monitor progress.
2. Inform site allocations for new development.
3. Identify suitable areas for stand-alone renewable energy development.
4. Identify opportunities and requirements for renewable or low carbon energy generation linked to strategic new build development sites.
5. Develop policy mechanisms to support DHNs for strategic sites.
6. Identify further actions for local authority, public sector and wider stakeholders.

Each of these is covered in detail in the remainder of this section.

P1 Develop area wide RE targets and monitor progress

Introduction

As well as assessing the RE resource and potential, a local authority may wish to develop indicative authority wide targets for installed capacity and energy generation from both renewable electricity and renewable heat. The Welsh Government regard the assessment of the potential RE resource as an important evidence base for developing LDPs. The development of such indicative targets is not required in national planning policy but could form part of an LDP monitoring framework.

Local Authorities are required to report on a quarterly basis to Welsh Government on Sustainable Development Indicator 2 (SD2) which is the number of, and installed capacity of, renewable energy projects granted planning consent. Developing indicative targets or "achievable potential" figures for renewable energy would enable a local authority to use the SD2 information to track their progress with facilitating renewable energy deployment.

For those local authorities and wider public sector (Local Service Board) that have considered and explored in more detail the significant opportunity offered by renewable energy generation, both from their estates and the wider local authority area, the setting of area wide renewable energy targets should now be able to be progressed with confidence. The key role of local authorities and members of the LSBs is outlined in more detail in P5.

In order to set targets, all of the steps outlined in this section should be undertaken. This task consists of the following five steps:

- Step 1: Define scenarios
- Step 2: Prepare summary tables
- Step 3: Test and discuss with stakeholders
- Step 4: Refine and select preferred scenario

Each step is described in detail below.

Step 1: Define scenarios

For each technology, the extent to which the maximum accessible resource can be delivered by a target date (e.g. 2020) is likely to be determined by a combination of the following:

- Technical maturity, covering both the extent to which new technologies prove to be viable[25], as well as the extent to which capital costs are expected to fall over time
- Commercial viability, driven by future energy prices, and levels of Government subsidy and financial incentives, and other Government support
- Extent of institutional and infrastructural support, covering the likelihood of securing planning consent (i.e. issues of political and social acceptability), as well as the availability of suitable grid infrastructure, transport infrastructure and so on

Clearly, trying to predict the impact of these different variables is not a precise science, and trying to make such predictions will involve a combination of expert knowledge of the technologies and the policy context they operate in, together with detailed local knowledge of the local politics, infrastructure and projects in the pipeline.

We recommend that the best way to approach this is to use target scenarios to test the impact and feasibility of different assumptions for these key variables.

The precise nature of the variables to be covered under each scenario is likely to be specific to each local authority area, and therefore the description of the assumptions for each scenario should be tested with key stakeholders in each authority. This could include, for example, knowledge about whether there are proposals for a waste to energy facility to be located in the area, or it could be that a local authority was considering two housing growth scenarios, that would affect the levels of uptake of microgeneration depending on which was adopted.

We recommend that, based on the maximum accessible resource, the approach should present two or three scenarios for deployment of LZC energy generation. Typically, these could represent "Low" and "High" deployment scenarios, i.e. the latter representing the case where a high proportion of the accessible renewable energy resource is harnessed.

These scenarios can then be tested with stakeholders, and a preferred scenario identified, which may well be a combination of, or modified version of the original scenarios. This approach enables stakeholders to discuss the scenarios and understand the key assumptions and parameters that will affect the level of deployment for each technology. This in turn should improve the robustness of assumptions, as well as help to achieve some buy-in to any targets, as stakeholders are not presented with a single target figure as a fait accompli.

We present in the table below, as a rough guide only, some of the assumptions that could make up different target scenarios. We have split this into two categories, for renewable heat and electricity.

Step 2: Prepare resource summary tables

For setting area wide targets, the defined scenarios can be fed into summary tables for each target scenario. These would draw on the accessible resource information that would be gathered as described in components E1 & E2. We suggest having two sets of summary tables, one for renewable heat and the other for renewable electricity. For ease of use an empty table has been reproduced below containing an illustration of where the results of your assessment should be located within the summary table.

Table 31: Resource summary for renewable electricity

Energy technology	Capacity factor (Project Sheet J)	Accessible resource		Current installed capacity		Target scenarios for 2020			
						Low		High	
		MWe	GWh/yr	MWe	GWh/yr	MWe	GWh/yr	MWe	GWh/yr
Onshore wind	0.27	**Project Sheet B**							
Energy crops	0.9	**Project Sheet C**							
EfW	0.9	**Project Sheet D**							
Landfill gas	0.6	**Project Sheet A**							
AD (animal and food)	0.9	**Project Sheet E**		**Project Sheet A**		**From discussion with key stakeholders**			
Sewage	0.42	**Project Sheet E**							
Hydropower	0.37	**Project Sheet F**							
Building integrated	0.1	**Project Sheet H**							
Stand alone PV	0.1	**Project Sheet K**							
Total	-								
Local authority projected electricity demand in 2020						**Project Sheet I**			
Percentage electricity demand in 2020 potentially met by renewable energy resources						-	%	-	%

Table 32: Resource summary for renewable heat

Energy technology	Capacity factor (Project Sheet J)	Accessible resource		Current installed capacity		Target scenarios for 2020			
						Low		High	
		MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr
Biomass CHP or large scale heat only[26] (energy crops/AD)	0.5	**Project Sheet C and E**							
Heat from EfW (CHP or heat only)	0.5	**Project Sheet D**		**Project Sheet A**		**From discussion with key stakeholders**			
BIR (solar water heating, biomass boilers, heat pumps)	0.2	**Project Sheet H**							
Total									
Local authority projected heat demand in 2020						**Project Sheet I**			
Percentage heat demand in 2020 potentially met by renewable energy resources						**-**	**%**	**-**	**%**

Examples of how these should look when they are populated with the resource for a particular local authority area, in this case Pembrokeshire County Council, are shown below. As well as showing the installed capacity and the potential annual energy output, these should also show the annual energy output as a % of heat or electricity demand in 2020.

Table 33: Example resource summary for renewable electricity for Pembrokeshire

Energy technology	Capacity factor	Accessible resource		Current installed capacity		Target scenarios for 2020			
						Low (50%)		High (75%)	
		MWe	GWh/ yr	MWe	GWh/ yr	MWe	GWh/ yr	MWe	GWh/ yr
Onshore wind	0.27	30.4	64.3	3.2	7.6	13.5	31.9	20.3	48.0
Energy crops	0.90	14.0	110.4	-	-	7.0	50.4	10.5	75.6
EfW	0.90	-	-	-	-	-	-	-	-
Landfill gas	0.60	1.7	8.9	1.7	8.9	1.7	8.9	1.7	8.9
Anaerobic Digestion	0.90	1.8	14.2	-	-	0.9	7.1	0.9	7.1
Sewage gas	0.42	0.3	1.0	0.1	0.4	0.1	0.4	0.3	1.1
Hydropower	0.37	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3
BIR	0.10	12.9	11.3	0.1	0.1	6.4	5.6	9.7	8.5
Stand-alone PV	0.10	214.1	187.6	159.7	139.9	266.8	233.7	320.3	280.6
Total	**-**	**275.3**	**398**	**164.9**	**157.2**	**296.5**	**338.3**	**363.8**	**430.1**
Local authority electricity demand projected in 2020						-	1,039.0	-	1,039.0
Percentage electricity demand in 2020 potentially met by renewable energy resources						**-**	**32.6%**		**41.4%**

Table 33 Clarifying Notes

Current installed capacity from wind turbines was removed when producing the accessible wind resource maps. Therefore, for the summary table, the installed capacity is added to the accessible resource.

There is currently no electricity generation utilising energy crops in Pembrokeshire. However, should plant be installed using this resource, the capacity figure should not be added to the accessible resource.

The currently installed 1.6MWt capacity relates to Bluestone DH system. We have assumed 50% of fuel from energy crops and 50% fuel from woodland resource. The appropriate tonnage of energy crops has been removed from the accessible energy crop resource and allocated to heat generation.

The potential 0.2MWe generation from the AD of MSW and C&I food waste is excluded as it is anticipated that any new AD facility using this resource as a fuel will be located out of county.

The accessible resource figures for landfill gas, sewage gas, hydropower and BIR should and do include the currently installed capacity.

Table 34: Target summary for renewable heat

Energy technology	Load Factor	Accessible resource		Current installed capacity		Targets for 2020			
						Low (50%)		High (75%)	
		MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr
Biomass CHP or large scale heat only (energy crops/AD)	0.5	32.0	140.2	1.6	7.0	16.0	70.1	24.0	105.1
Heat from EfW (CHP or heat only)	0.5	11.6	50.8	-	-	5.8	25.4	8.7	38.1
BIR (solar water heating, biomass boilers, heat pumps)	0.2	10.7	18.7	1.5	2.6	5.3	9.3	8.0	14.0
Total	**-**	**54.3**	**209.7**	**3.1**	**9.6**	**27.1**	**104.8**	**40.7**	**157.2**
Predicted local authority heat demand in 2020						-	7,915.0	-	7,915.0
Percentage heat demand in 2020 potentially met by renewable energy resources						**-**	**1.3%**	**-**	**2.0%**

Table 34 Clarifying Notes

The heat from CHP will be informed by how much installed electricity capacity there is for each of the technologies given in the first table. How much heat will be produced for every unit of electricity generated will vary by technology[27], but a typical figure to use would be 2MW of heat for each 1MW of electricity. Realistically, not all of this heat output could be utilised all of the time, therefore a load factor of 0.5 (or 50%) has been assumed in the table.

The currently installed 1.6MWt capacity relates to Bluestone DH system. We have assumed 50% of fuel from energy crops and 50% fuel from woodland resource. The appropriate tonnage of energy crops has been removed from the accessible energy crop resource and allocated to heat generation.

The 1.6MWt installed capacity figure is included within the "CHP or large scale heat only (energy crops/AD)" accessible resource figure. No heat generation has been assumed for the current sewage plant as the resource is employed by the sewage plant and is not therefore a usable resource.

No heat generation has been assumed for the currently installed landfill gas recovery engine.

The potential 0.3MWt generation from the AD of MSW and C&I food waste is excluded as it is anticipated that any new AD facility using this resource as a fuel will be located out of the county.

The accessible resource figure for BIR should and does include the currently installed capacity.

In using these tables, it is important to not interpret the technology mix for each target as targets for each technology. The technology breakdown is used only to demonstrate that an overall level of energy production is deliverable and only the overall target (for either heat or electricity) will be used in any planning document. This is an important point, because otherwise stakeholders can become too focused on the detail of the technology mix. It will also be easier to build support for an overall target, rather than individual technology targets, as some stakeholders may have concerns about particular technologies.

Step 3: Test and discuss with stakeholders

For setting area wide targets, once the scenarios and summary tables have been produced, these should then be tested with stakeholders, ideally as part of the LDP process. As a minimum, this could be a workshop held internal to a local authority, involving officers from relevant departments, such as officers responsible for:

- Planning policy and development management
- Waste
- Energy management
- Landscape/conservation
- Economic development/regeneration
- Sustainable development
- Property/estates

The local authority may also wish to involve a wider range of stakeholders to help ensure buy-in from key stakeholders. These could include:

- Elected Members
- Statutory agencies, such as Natural Resources Wales (NRW)
- Other local stakeholders, such as developers, National Farmers' Union (NFU), local energy agencies, etc
- Local Service Board representatives (e.g. NHS Trust, Police, Fire, NGOs, not for profit organisations, faith organisations plus UK Government Departments (e.g. MoD), and so on
- Utilities, ESCos and MUSCOs
- Prospective developers

The aim of the workshop would be to:

- Test the key assumptions
- Build understanding of the target scenarios, and support for the need for targets and whichever target is adopted

Step 4: Refine and select preferred scenario

Following the stakeholder engagement, preferred targets can be chosen. These may be based on one of the original scenarios, or a modified scenario based on the discussions. The target would then be tested with wider stakeholders as part of the standard LDP consultation and approval process.

References

25 e.g., such as biomass CHP, using gasification, or the widespread growing of energy crops, or use of gasification/pyrolysis technology for waste to energy

26 Over 1MWt

27 Depending on whether a steam turbine or gas engine technology is used for the generating plant

P2 Inform Site Allocations for New Development

Introduction

This policy option involves making use of the information developed out of the area wide renewable energy resource assessment (E1) and the heat opportunities mapping (E3) to inform the selection of land for development (allocations of sites for a development plan). The purpose is threefold, as follows:

- To identify, from the heat opportunities map, whether any candidate sites (singly, or in clusters), are located in proximity to clusters of existing high heat demand or key potential anchor heat loads, or existing sources of waste heat. These sites could enhance the potential to develop DH or CHP schemes for existing and proposed development and the site assessments should reflect this potential in the scoring
- To identify whether any of the non-residential candidate sites lie in close proximity to potential sites for wind power. Such development could potentially be connected by private wire and therefore receive ongoing benefit from preferential electricity prices
- To identify where a significant potential wind resource may conflict with residential candidate sites

In selecting a preferred strategy approach as part of preparing an LDP, local planning authorities will be identifying broad locations for development and areas including substantial growth areas and locations for specific types of development (i.e. housing, leisure, employment and waste). LDP guidance states that the identification of sites for specific uses (including mixed use) should be founded on a robust and credible assessment of the suitability and availability of land for particular uses or a mix of uses and the probability that it will be developed.

Whilst there will be a variety of factors[28] to be taken into account in identifying these broad locations for development and specific sites, the role of this policy option is to build in the spatial information on renewable and low carbon energy potential into the assessment of new development sites that may be incorporated into the plan (candidate sites).

The renewable energy toolkit can be used at the initial stage in identifying candidate sites or developing a strategy for distribution of development. There may be situations where in meeting local and/or national renewable energy or carbon targets, a local planning authority would identify a broad development area, or cluster sites together (of mixed energy and heat demand) so as to make the inclusion of renewable or low carbon energy technologies more likely and viable.

Clearly there is some potential overlap between this policy option and P3, identifying areas for stand-alone renewable energy development, and therefore it may make sense for a local authority to carry out both options in parallel.

Method

Step 1: Map candidate sites in GIS onto wind and solar constraints maps developed from E1

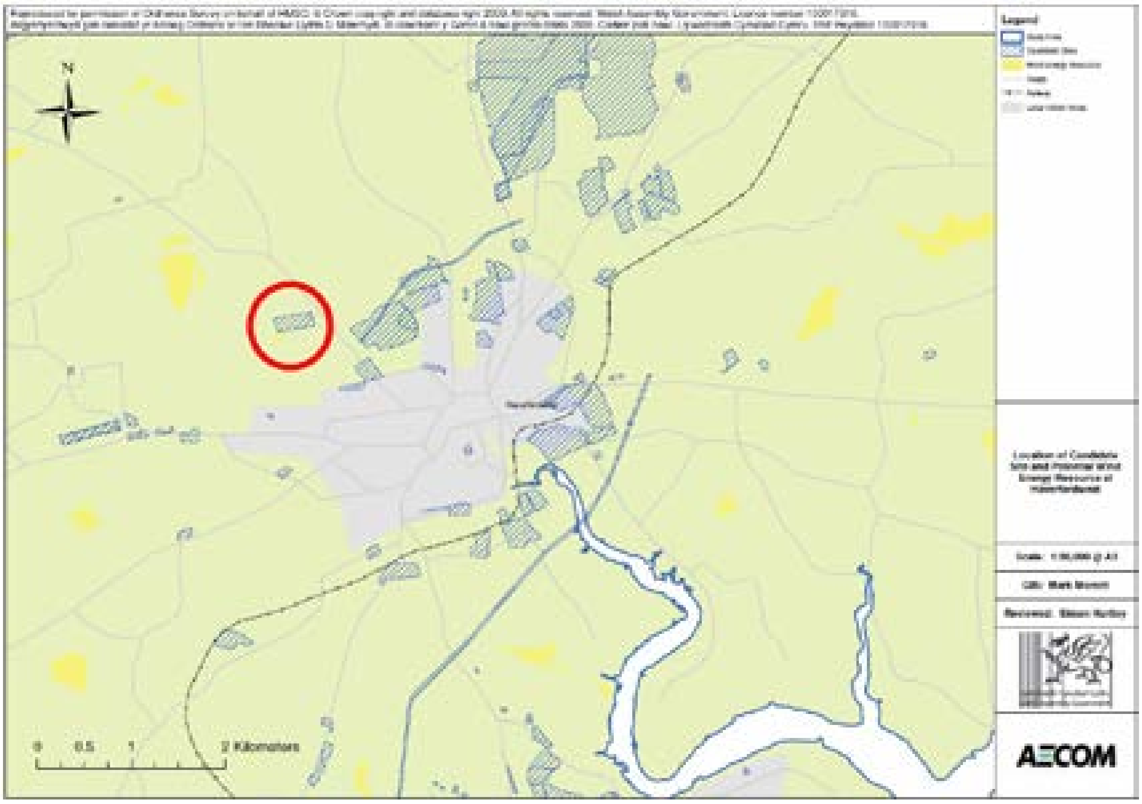
This mapping should indicate which sites are purely residential, and which are mixed, and which are non-residential. The mapping should show the geographical extent of each candidate site. Once you have mapped these sites onto the wind and solar constraints maps, you can then identify whether:

- Any of the non-residential or mixed use sites are within 500m of an area of wind or solar resource. This means that these sites may have the potential for achieving significant carbon reductions by installing one or more wind turbines, as 500m represents as a rough guide a typical maximum distance, for cost reasons, to install a private wire connection from a large scale wind turbine or solar farm to a proposed development site. The potential will be greatest where part or all of the potential resource area sits within the candidate site
- If the potential resource site sits outside the candidate site, this means that another landowner would need to be involved in taking forward any opportunity, which would add complexity
- Any of the residential sites are within 500m of a potential wind site. If this is the case, large scale wind power development, for noise reasons, may preclude the potential for any residential development on this site. How significant the loss of this potential wind site would be would depend on its size and its location in relation to other potentially more favourable wind sites, as well as the feasibility of developing that site for wind power, given other constraints. The same constraint may not however apply for solar resource and this scenario should be assessed for cumulative impact as outlined in Project Sheet K

Once you have completed this assessment, you can then use this information to form criteria in the assessment of candidate sites. The weight that you give to this is for you to decide.

An example of the output from this step, from the Pembrokeshire case study, is given below.

Figure 11: Example of using a wind constraints map to inform the assessment of candidate sites



It can be seen from the above map that there is little overlap between the unconstrained wind sites (yellow) and the candidate development sites (blue hatched) except at the location circled in red.

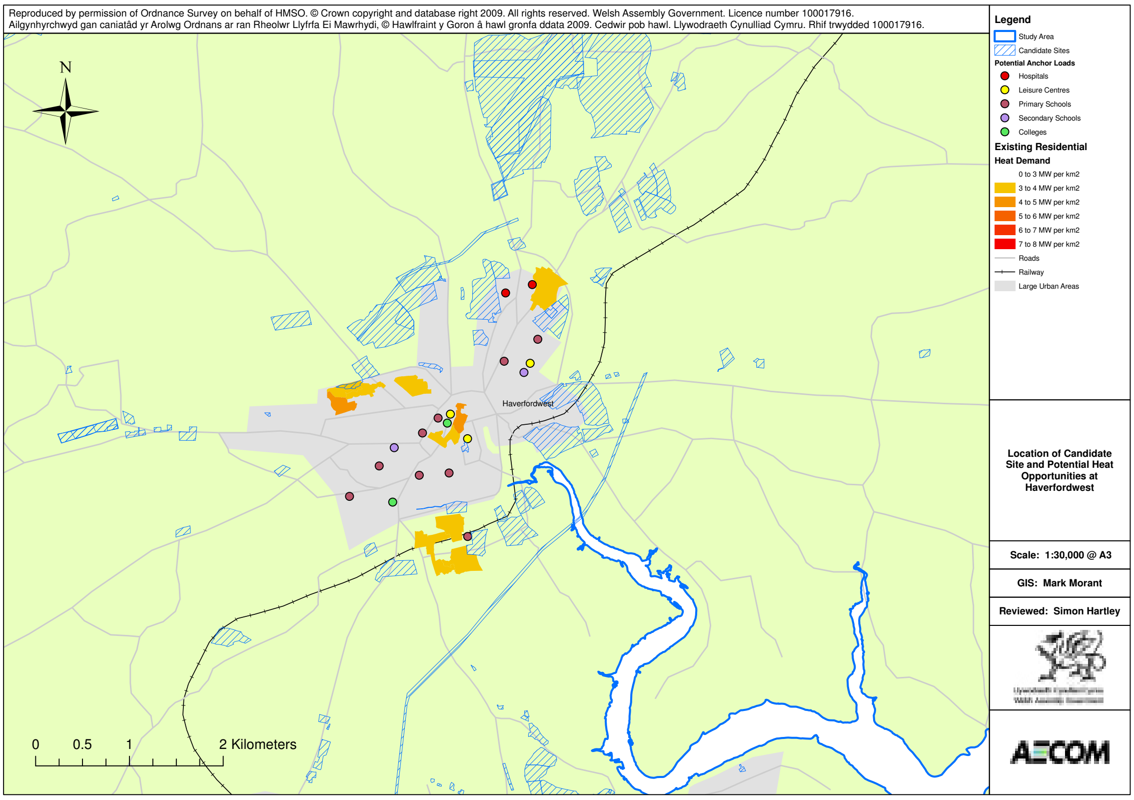
Zooming in (see the figure below) reveals that only a small proportion of the potential wind resource lies within the proposed development parcel, with the main proportion sitting within a further two separate adjoining fields. Should these fields be in the ownership of the local authority or wider public sector then consideration should be given to exploring generation and linking with proposed new development by way of a developer brief, if the parcel is allocated.

Step 2: Assess proximity to potential heat opportunities, identified in E3

You should overlay the map showing the location of candidate sites onto the heat opportunities map. You should clearly indicate whether the candidate sites are residential, non-residential, or mixed. As the opportunities for DH are greater for larger sites, you may want to focus this assessment only on larger candidate sites, of over 0.5ha. The output of this will clearly show those candidate sites that have the greatest potential synergy with areas of DH potential, either because they have high residential heat demand, are close to sources of waste heat, potential anchor heat loads, existing CHP, or potential EfW sites. As a guide,we suggest that candidate sites would need to be within about 1km, and preferably 0.5km, of these opportunities for them to be of interest.

You can then use this proximity to heat opportunity areas as a criterion in your assessment of candidate sites. The weight that you give to this is for you to decide. An example of the resulting map is shown in the Pembrokeshire case study.

Figure 12: Example of using a heat opportunities map to inform the assessment of candidate sites



This map suggests that there are a number of candidate sites for which DH potential might be a consideration.

References

28 Including requirements for SEA

P3 Identify Suitable Areas for Stand-Alone Renewable Energy Development

Introduction

This section relates to the Welsh Government planning policy expectations pertaining to opportunities and site allocations for 'stand-alone' renewable and low carbon electricity generating technologies (e.g. wind turbines, solar PV farms and biomass CHP schemes).

National planning policy expects local planning authorities to facilitate local authority-wide scale renewable energy in development plans by undertaking an assessment of the potential of renewable and low carbon energy opportunities within their area and include policies in development plans which guide appropriate renewable energy and low carbon energy development.

This section provides guidance on how to translate an evidence base into spatial policies which guide appropriate renewable and low carbon energy development.

National policy defines "local authority-wide scale" renewable energy to be onshore wind projects between 5 and 25MW (i.e. outside of the SSAs of TAN 8), and between 5 and 50MW for all other technologies. The implication of this is that this threshold is likely to exclude hydropower, as most new "run-of-river" sites are likely to fall below this output. However, it could include small clusters of wind turbines[29], larger PV farms, waste to energy schemes and biomass CHP projects.

The corollary of this is that local authorities should not seek to identify areas or allocate sites for schemes smaller than this, and PPW sets out that at the sub-local authority scale (between 50kW and 5MW) renewable energy projects are applicable in all parts of Wales and development plans should encourage such development and clearly set out the local criteria against which such proposals will be evaluated.

The term "stand-alone" is a slight misnomer for some technologies in that CHP EfW or biomass CHP technologies could potentially be linked to other existing or new buildings or developments by supplying heat via a DHN.

Context

The development of (relatively) large, stand-alone electricity generating assets can be more contentious than proposals for building homes or even non-domestic buildings. In addition, it is becoming increasingly important that local authorities maximise and secure the potential of their renewable energy resources, meaning that increased levels of involvement and co-ordination within local authorities is required.

This policy option involves making use of the information developed out of the area wide renewable energy resource assessment (E1) and the heat opportunities mapping (E3) to inform the identification of spatial areas potentially suitable for locating local authority-wide scale renewable energy projects.Where the outputs of Project Sheets B (wind constraints), and K (solar PV) indicate relatively unconstrained areas for the development of such technologies, local authorities should consider the opportunities to identify or allocate these areas in their LDPs.

As part of the LDP development process, the local authority should also consider inviting renewable energy developers to submit candidate sites for suitable scale renewable energy projects that could inform the process of identifying suitable areas.

Local authorities may wish to undertake further assessments (outside the scope of this toolkit) prior to allocating or identifying such areas in their LDPs. Such assessments might include landscape sensitivity, an investigation of the capacity of the electricity grid and suitable connection points and/or cumulative impact assessment (considering potential wind, and possibly solar sites together).

Local authorities should identify spatially, potentially suitable areas or sites for the above technologies as part of the LDP proposals map. This would signify to developers that planning applications for certain technologies in those areas would be welcomed, as long as they do not cause significant adverse impacts[30]. Some options for this approach, and the evidence that would be required, are suggested in the table below.

Table 35: Type of evidence base required to identify strategic sites for 'stand-alone' renewable electricity generating assets

Example planning policies	Evidence base required
Identify and allocate potential broad areas or sites for wind, solar PV, or biomass CHP The methodology used for TAN 8 is a good example of the approach that can be used to identify spatial areas for potential wind energy. Although TAN 8 is for schemes over 25MW, a similar approach could be used to identify broad areas suitable for wind energy clusters in the 5-25MW range. Another example of this approach of identifying "broad areas of search", i.e. spatial areas potentially more suitable for wind energy development, is that of Fife Council in Scotland – see www.fife.gov.uk/topics/index.cfm?fuseaction=page.display&p2sid=8044AA26-1CC4-E06A-52A4F2F250955548&themeid=2B482E89-1CC4-E06A-52FBA69F838F4D24	Completed wind, and solar PV constraints assessment (part of E1), to show areas of least constraint For biomass CHP, completed heat opportunities mapping (E3) to identify potential sources of significant heat demand in close proximity Potential sites tested with relevant stakeholders (such as renewable energy developers) as part of the process of preparing the constraints maps The local authority may also wish to carry out a more detailed constraints assessment for potential sites (as set out in E4), before identifying them on a proposals map.

Clearly, identifying sites in this manner has the potential to cause opposition from the public or other stakeholders. However, this can be tested as part of the LDP consultation and examination processes.

References

[29] For example a cluster of two 2.5MW turbines, or three 2MW turbines

[30] Which would be assessed as part of the normal Environmental Impact Assessment and planning application determination process

P4 Identify opportunities and requirements for renewable or low carbon energy generation linked to strategic new build development sites

These opportunities could include DHNs, which could be fuelled from a range of sources including: biomass[31] heat only, gas engine CHP, biomass CHP, EfW and fuel cell CHP. Potentially, for some sites, they could also include one, or more, large scale wind turbines[32] or a solar farm.

For this category, it is worth noting that some of the opportunities could involve existing development and energy uses, as well as new developments. In fact, the viability, carbon reduction potential and wider benefits that can come from DHNs are likely to be maximised where new and existing development can be linked. Although planning can have a role to play in helping to deliver such schemes, through new development, it will require local authorities to play a wider role (for example, through their Corporate estate) to help deliver some of these opportunities, and this is covered further in section P6.

In order to identify whether there is significant potential for renewable or low carbon energy in close proximity to strategic new development sites, you should complete the area wide renewable energy assessment of E1, and the heat opportunities map of E3 and then produce an Energy Opportunities Plan.

If there does appear to be significant potential, then a key way that you can encourage or require developers to harness this potential is to set a carbon reduction target for the strategic site. We recommend that you should frame such targets in terms of a reduction in regulated CO_2 emissions, compared to the current (2014) edition of Part L of the Building Regulations[33].

In order to set such a target, however, you will need to demonstrate that the level of carbon saving is achievable, and that the cost will not represent an undue burden to a developer. To do this, you should also commission a more detailed assessment of the viability for the site, as set out in E4.

The evidence required to set such targets is summarised in the table below.

As well as setting targets, or instead of, there are a range of other policy options for encouraging DHNs on strategic sites, which are set out in section P5.

Table 36: Type of evidence base required in relation to example planning policies for strategic new development sites

Example planning policies	Evidence base required
Set higher sustainable building standards, through carbon reduction targets, for strategic new development sites[34] Examples of such a policy would be to specify a minimum Energy Efficiency Rating (as indicated on an Energy Performance Certificate (EPC)) for all new developments to achieve, or a minimum uplift in the EPC rating already obtained by complying with (Part L) of the Building Regulations	Energy opportunities plan made up of the output of the area wide REA (E1) and the heat opportunities mapping (E3). For non-wind sites, evidence to show that DHNs are financially and technically viable in these areas and that the level of carbon savings required can be delivered by a range of DH/CHP technologies and fuels (section E4).

References

31 This could include anaerobic digestion

32 Where a sufficient separation distance from existing or proposed dwellings could be achieved to meet noise guidelines. This is typically in the range of 4-600m, depending on the size of turbine

33 Which is a 31% reduction in regulated CO_2 emissions for new dwellings, and an EPC rating of 40 or less for larger non-domestic buildings

34 Planning Policy Wales, Chapter 4 Planning for Sustainability

P5 Develop policy mechanisms to support District Heating Networks (DHNs) for strategic new development sites

The long-term ambition of pursuing this policy option is to deliver a strategic DHN across the DH priority areas, identified as part of E3 and E4. To this end, encouraging DH on new developments can provide a catalyst for developing wider DHNs to serve existing buildings. For this to succeed, your local authority is likely to need to take a strong lead in developing such networks, fulfilling some of the roles set out in section P6 below.

Some of the potential policy options for encouraging DHNs on new development sites, and how they relate to the evidence base options, are set out in the table below.

Table 37: Potential policy options for DHNs and associated evidence base options

Example planning policies	Evidence base required
Designate areas as strategic (or priority) DH areas (SDHAs). Policies like this can be important to attract ESCos and to give them the confidence to invest in such sites An example of the use of this type of policy is by Bristol City Council in their local plan policy BCS14, which includes a map showing DH priority areas See: www.bristol.gov.uk/sites/default/files/documents/planning_and_building_regulations/planning_policy/local_development_framework/Core%20Strategy%20WEB%20PDF%20%28low%20res%20with%20links%29_0.pdf	Energy opportunities plan (from E3) Evidence to show that a DHN may be financially and technically viable in these areas (from E4) Evidence to show that the connection cost may not be an undue burden

Example planning policies	Evidence base required
Within the SDHAs, set requirements that large and mixed-use developments (over 100 dwellings) should consider installing a district heating network to serve the site. This, in turn can act as a springboard for supplying heat to any surrounding heat loads in the SDHA in the future Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve existing or new development In addition, new development should be designed to maximise the opportunities[35] to accommodate a DH solution, considering: density, mix of use, layout and phasing An example of this type of policy is given by policy CS4 in the South Gloucestershire adopted local plan. See: www.southglos.gov.uk/documents/cleanversionforinterimpublication2.pdf	Energy opportunities plan (from E3) Evidence to show that DHNs are financially and technically viable in these areas and that the level of carbon savings required can be delivered by a range of DH/CHP technologies and fuels (from E4)
Within the SDHAs, you could require small developments (less than 100 dwellings or non-residential developments less than 10,000m²) to connect to any available DHNs. Where a DHN does not yet exist, applicants should consider installingheating and cooling equipment that is capable of connection at a later date	As above
Establish a Carbon Buyout Fund. Where applicants can show that achieving these policy requirements is unviable on a particular site, they will be subject to a financial payment	Financial modelling to assess what level of payment into the fund would not represent an undue burden to developers (see section E4)

References

35 Within the constraints of meeting other council policy requirements, and principles of good urban design

P6 Identify further actions for local authority, public sector and wider stakeholders

Developing and implementing planning policies is one way in which a local authority can facilitate the delivery of renewable energy projects. However, there is a wide range of other actions that a local authority can (and will need to) take at a wider corporate level to facilitate the delivery of the renewable energy opportunities that would be identified as part of forming the evidence base for targets. A summary of some of these actions, which is not exhaustive, is provided in the table below.

Table 38: Local authority corporate actions to deliver renewable energy opportunities

Role of Local Authority	Examples of potential actions
Land owner	Develop wind power and other stand-alone renewable energy resources on council land Host energy centres for DH/CHP networks on council land or within council buildings
Procurement of energy services for existing corporate estate	Commit to installing biomass boilers when boiler plant is being refurbished, particularly in off-gas areas Commit to connecting up large public buildings, or council housing to DHNs as key anchor loads
Financing and delivery mechanisms	Consider forming a public/private ESCo to develop DHNs Use status to help lever in additional sources of funding for renewable energy or DHN projects – e.g. from Convergence funds or the Energy Company Obligation (ECO)
Property developer	For new council buildings, such as schools, commit to connect to DHNs or set targets for using renewable energy systems
Procuring and maintaining transport infrastructure	When new roads are being designed or existing roads upgraded, consider the potential for installing heat mains

Role of Local Authority	Examples of potential actions
Procuring and managing waste management services	Ask bidding contractors for waste management to consider the use of advanced thermal treatment options, and the linking of heat output to sources of local heat demand Consider the potential for biomass waste (e.g. wood waste at civic amenity sites, arboricultural residues from park trees, municipal food waste), to be used as a resource for energy production
Leadership and facilitation	Play a leadership role to encourage other public bodies (e.g. Health Trusts, Universities) to also commit to the sort of actions listed above. This could be, for example, through developing a wider climate change or renewable energy strategy for the area Local service boards could also act as a forum where local authorities could play this role

The process of developing these actions, to form a delivery plan, can be started as part of the stakeholder meetings and workshops held as part of developing the evidence base, and, if strategic sites are involved, as part of the engagement process. As a basic starting point, completing a heat opportunities map, as set out in section E3, will identify some of the opportunities for DH and the potential role that the local authority could play in developing those further.

However, a more useful basis for informing corporate action would be to combine the heat opportunities map with an area wide renewable energy assessment (as set out in E1), and to produce an Energy Opportunities Plan. This would also identify potential wind or solar power sites where the local authority, or other public sector agencies, may have land holdings. It would also identify the potential for other larger scale renewable energy options where the local authority may have a key role to play, such as EfW, or anaerobic digestion of food waste.

Finally, and this may be an initial corporate action to come out of the above, the local authority may wish to commission more detailed information on the viability of certain strategic sites (as set out in E4) identified in the Energy Opportunities Plan. Completing this will provide more detailed information on the key actions required to develop renewable or low carbon energy opportunities (if they are still shown to be viable) and the role that the local authority can or should play in that.

Project Sheets

Project Sheet A: Existing and proposed LZC energy technologies

Before embarking on a resource assessment for renewable energy in your area, a useful starting point is to first establish what renewable energy capacity already exists. In some cases, the presence of existing capacity will affect the resource assessment. For example, you may already have an 'EfW' scheme in your area, which would preclude any further contribution from that resource. In the case of an existing wind farm, this would have an impact on the resource assessment itself, as set out in Project Sheet B.

This assessment of existing capacity should cover electricity and heat generation, and large scale as well as BIR generation. For larger schemes, it should also include those that have received planning consent, but are not yet built.

We have broken this task into two stages. The first is the assessment of existing large scale renewable energy capacity and the second is for smaller scale and BIR generation capacity. Each is set out in detail below.

Identifying existing larger scale renewable energy capacity

There are two data sources that you can use to identify this capacity. The first is the Renewable Energy Statistics Database for the UK (www.gov.uk/government/statistics/renewable-energy-planning-database-monthly-extract) which is compiled on behalf of the UK Government. The database is the result of DECC's renewable project monitoring work, whereby statistics are recorded each month. You should download the latest Excel file and you can then add filters in Excel to show only projects in Wales, and then filter again to show only projects for your area. You should then filter again by the "Development Status (Short)" column, to only show projects that are "Operational", "Under Construction" or "Awaiting Construction". This is because the database also includes details of projects that did not receive planning consent and therefore did not proceed further.

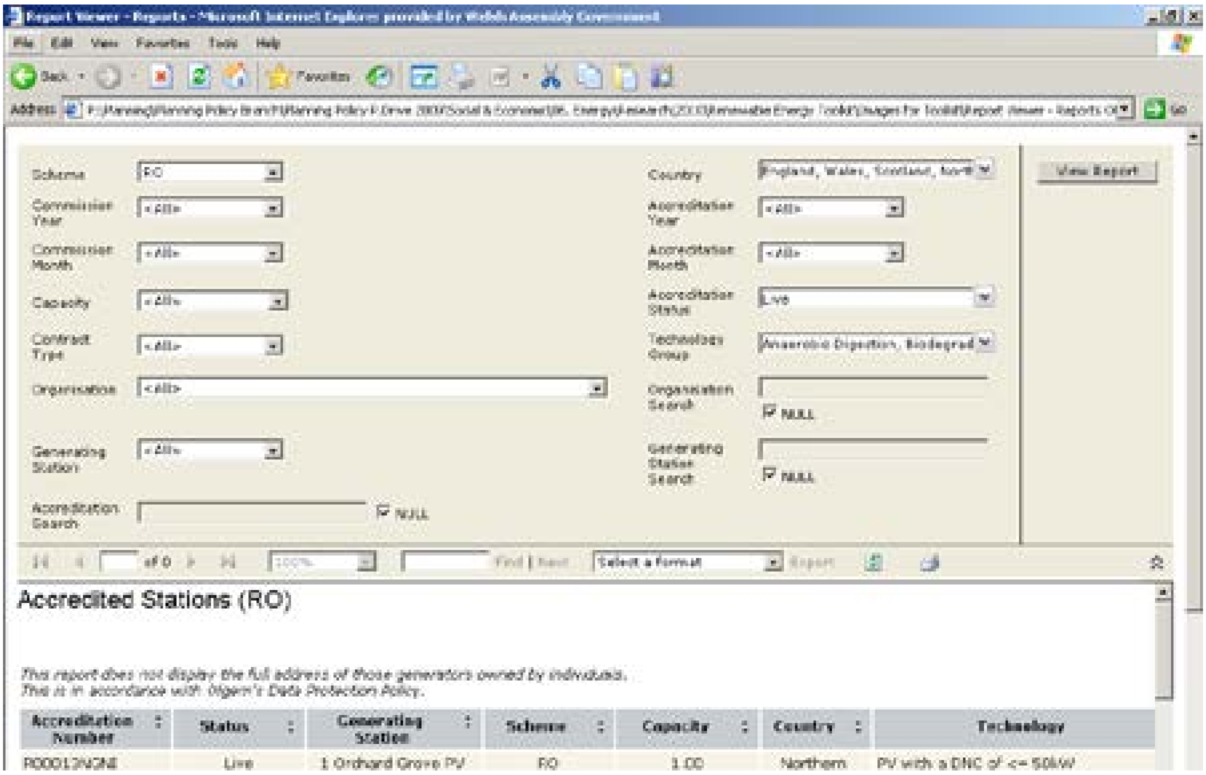
The database will give you information on the installed capacity for different technology types (note that this is given in MW, not kW), as well as the location, in terms of easting and northings[36].You may find that the easiest way to identify theschemes in your area, or close to your boundaries, will be to plot the location of all the schemes shown for Wales, using the grid co-ordinates given in the database. This should be a quick and straightforward exercise using GIS software.

Sometimes a site may appear more than once, but with slightly different names and installed capacities. This can happen if, for example, a wind farm is repowered.

If you are in any doubt, you should review the planning applications of the schemes concerned, which you can obtain from the council website, under the planning section, or from discussion with your development management colleagues.

The Ofgem renewable and CHP register (www.ofgem.gov.uk/environmental-programmes/information-renewables-and-chp-register) can act as a cross-reference against the planning database information suggested above. This provides a list of accredited generating stations that are, or are soon to be, operational, and eligible for Renewables Obligation Certificates (ROCs)[37].From the home page, you should go to the "View Public Reports" section of the webpage, on the right hand side. You should then view the list of Accredited Stations. You will then be taken to a database page. Make sure that the options are set as per the screen shot below, and then click on "View Report".

Figure 13: Screen print of database page of OFGEM's renewable and CHP Register



Ofgem Renewables and CHP Register. www.renewableschp.ofgem.gov.uk/

This will then generate a report, for all renewable energy technologies in your area. You can then export this by first selecting a format (e.g. CSV file) and then clicking on the word "Export". This will then allow you to save the file as an Excel file. You can then review the Generating Station Address to see which schemes are in your area.

For those schemes that don't give an address, you will need to review the name given to the scheme under the column headed "Generating Station" to see if you can identify whether this is in your area. You should note that this file gives the installed capacity for the scheme in kW and not in MW. This database records all schemes that are, or wish to claim ROCs, and therefore it will also include some microgeneration renewable electricity projects, as well as larger scale installations. However, it will only include schemes that generate renewable electricity and therefore will not include details of any renewable heat-only generation capacity (e.g. such as wood chip boilers).

Finally, once you have compiled these lists, we recommend that you should also consult internally with your development management colleagues to identify whether there are any more recent planning applications for renewable energy projects that they are aware of, that may have received consent, either by the planning authority, or at appeal.

Once you have this full list of projects, you may wish to plot the location of the larger scale projects using GIS. In particular, it would be useful to plot the location of existing or consented wind farms as this will inform the wind resource assessment. If you are carrying out an assessment of the potential for renewable energy linked to strategic new development sites, it would also be useful for you to plot the location of existing EfW schemes and biomass schemes as these may potentially be able to supply heat to new development.

Identifying existing smaller scale and microgeneration capacity

The data sources described above will not provide information (at a local authority level) on any installed renewable heating capacity (such as wood chip boilers, heat pumps and solar water heating), and may also not include small scale electricity generation if the generator is not claiming ROCs. Most of these projects are likely to be smaller scale schemes, or microgeneration. In order to obtain information on these schemes, we suggest that you use the following sources of information:

1. Obtain data from grant making bodies. Microgeneration will have been historically installed by householders or organisations, including businesses, the public sector and community groups. Some will have been installed by early adopters without grants, but the majority will have been grant funded to some extent[38]. To obtain information on the number of grant funded installations in your area, we suggest you contact Energy Saving Trust (EST) Wales: (www.energysavingtrust.org.uk/organisations/wales).

2. You need to make sure that you do not double count any smaller scale renewable electricity installations that may have been identified from both this source and the Ofgem database described earlier.Talk to your local authority energy manager and officer responsible for schools, to identify whether renewable energy systems have been installed in Council buildings. You need to make sure that these installations are not double counted with the information provided from (1).

Example of Toolkit Output

Table 39: Existing renewable electricity capacity

Name of scheme	Technology	Capacity (MWe)	Status	Source
Castle Pill Farm	Wind Onshore	3.2	Operational	Ofgem
Withyhedge	Landfill Gas	1.74	Operational	Ofgem
Narbeth Waste Water Treatment Works	Sewage Gas	0.11	Operational	Ofgem
Preseli Hydro	Hydro	0.07	Operational	Ofgem
Cerrig Hydro	Hydro	0.01	Operational	Ofgem
Y Gaer Hydro	Hydro	0.00	Operational	Ofgem
Caerfai Farm	Wind Onshore	0.02	Operational	Ofgem
-	PV	0.03	-	Grant bodies
-	Wind Onshore	0.06	-	Grant bodies
Total	**-**	**5.24**	**-**	**-**

Note: The column "heat available" refers to those technologies that potentially have the ability to produce waste heat. If there was the possibility of any renewable heat that could be used, this should be included in the table below.

Table 40: Existing renewable heat capacity

Name of scheme	Technology	Capacity (MWe)	Status	Source
Bluestone holiday park	Biomass Boiler	1.60	Operational	Council Staff
Pembrokeshire College	Biomass Boiler	0.35	Operational	Council Staff
Pembrokeshire Technium	Biomass Boiler	0.15	Operational	Council Staff
Pembrokeshire Schools	Biomass Boiler	0.45	Operational	Council Staff
-	Solar water heating	0.50	-	Grant bodies
-	Heat pump	0.04	-	Grant bodies
-	Biomass Boiler	0.05	-	Grant bodies
Total	**-**	**3.14**	**-**	**-**

References

[36] Note that the location given is sometimes that of the applicant/landowner, rather than the precise location of the generating station (s). You can obtain the latter, if required, by referring to the original planning application

[37] Note that this database will not include EfW incinerators without CHP or large hydro schemes as these are not eligible for ROCs

[38] There have been several schemes, both national and Wales specific. The national ones include Clear Skies, the PV Major Demonstration Programme, the Bio-Energy Capital Grants Programme and the current Low Carbon Buildings Programme. In Wales, there is, for example, the Wood Energy Business Scheme

Project Sheet B: Wind energy resource

Introduction

A strategic, high level assessment of the accessible wind power potential for an area can be made using GIS to map a variety of different constraints, such as wind speed, national environmental designations, proximity to dwellings and so on. This process is referred to as "constraints mapping". The outcome of this process is to identify the total area of land that is potentially suitable for wind development. This area can then be converted to a potential installed capacity and energy output. A further refinement on this is then to reduce this resource further to allow for cumulative visual and landscape impact.

We ask you to note that this approach is really only suitable for a high level assessment, for the purpose of informing an area wide target. In particular, you should bear in mind the following:

- Firstly, even though the mapping may show that the locating of wind turbines may be constrained in a particular area, this does not mean that turbines could not be located there in practice. This is because, for example, environmental designations in those areas may not be impacted on by a wind development (e.g. if the designation is for flora or invertebrates), or it may be possible to achieve a "technical fix" for radar interference at a particular site. Therefore, the constraints maps should not be used to preclude wind development in constrained areas. It is for each planning applicant to demonstrate whether the impacts are within acceptable limits, and meet relevant policy and guidance.
- Secondly, although this high level process can inform the potential for individual sites, it is not in itself enough to fully assess their technical viability. Some of the further site level constraints that would need to be assessed (and this is not meant to be an exhaustive list) include:
  - site slope
  - the practical access to sites required for development
  - proximity to power lines, public rights of way, bridle ways
  - landowner willingness for development to go ahead
  - the distance to the nearest appropriate electricity grid connection
  - consultation with telecommunications operators to identify whether any links were passing over the site
  - formal consultation with the MoD and Civil Aviation Authority (CAA) to identify any potential objections in relation to radar interference
  - impact on birds, bats and other ecology
  - issues of cumulative impact in relation to other existing or proposed wind power installations

It is not appropriate, or possible, to consider all site level issues as part of a high level assessment to inform area wide targets.

The method set out below is for assessing the potential wind resource outside of the TAN 8 SSAs. The resource assessments for the SSAs have already been carried out, and therefore there is no need to repeat this. If a local authority has an SSA within its boundaries, either entirely or partly, then the potential contribution from the SSA should be added on at the end of the assessment set out below.

It should be noted that the method set out below does not include any assessment of the sensitivity of landscapes to wind farms, although it does make an allowance for cumulative impacts (see step 9), as this was outside the scope of the work to develop the toolkit. However, local authorities may wish to commission work in this area to support their assessments, if landscape is likely to be a key issue.

Methodology

You can access the accessible wind resource for your local authority area, using GIS constraints mapping, by following the steps below:

Step 1: Decide on typology of wind turbine to use for the assessment

Step 2: Map average annual wind speeds

Step 3: Map environmental and heritage constraints

Step 4: Map transport infrastructure constraints

Step 5: Map existing dwellings and a noise buffer

Step 6: Map existing aviation and radar constraints

Step 7: Prioritise available wind resource

Step 8: Assess potential installed capacity and energy output

Step 9: Assess cumulative visual and landscape impact issues and reduce resource accordingly

Step 1: Decide on typology of wind turbine to use for the assessment

Before starting the assessment, you should first decide on the size of wind turbines to be used for the assessment. This is because this will affect the size of different buffers used in the constraints mapping. The standard size of commercial wind turbines is constantly changing and wind turbines have become increasingly larger over the last few years. At the time of writing this toolkit, a typical size of onshore wind turbine, and the one we propose you use for this assessment is as follows:

- Rated output: 2MW
- Hub height: 80m

- Rotor diameter: 80m
- Height to blade tip at highest point ("tip height"): 120m

All of the buffers set out in the steps below are based on this size of turbine. You may need to revise this typology in the future, as the technology evolves.

Step 2: Map average annual wind speed

The average annual wind speed has been estimated at various heights for each 1.5km^2 throughout the UK by The Met Office. The data reported at 45m above ground level has been made available for inclusion within this toolkit as a GIS data layer; once at this stage, data requests should be directed to the Planning Directorate of the Welsh Government planning.directorate@wales.gsi.gov.uk

The level of average annual wind speed that is required to make a site commercially viable changes over time, depending on the size and height of available machines, the costs of construction and grid connection and the value that developers can achieve from their generation. The latter is influenced by the value of ROCs, or, for smaller installations, FITs. There is no established guidance on this. However, at the time of writing this toolkit, the standard industry approach is, for 80m hub height machines, to look for a minimum average annual wind speed of 6.0m/s at 45 above ground level, and ideally in excess of 6.5m/s.

You should establish a 1.5km^2 grid GIS data layer for your study area and associated average annual wind speed at 45m above ground level attributed to each respective 1.5km^2 cell. Grid cells with an average annual wind speed of less than 6.0 m/s, between 6.0 and 6.5 m/s, and greater than 6.5 m/s should be classified as 'low', 'moderate' and 'high' wind speed respectively. You should then assume, for the assessment, there is no wind potential in areas with an average annual wind speed of less than 6.0m/s.

Step 3: Map environmental and heritage constraints

The location of potential wind turbines can be restricted by existing environmental and heritage constraints and as such could be refused planning approval if they fall within such areas. You should therefore map in GIS the geographic extent of the following national environmental and heritage constraints:

Special Protection Area (SPA)

Special Area of Conservations (SAC)

Candidate Special Area of Conservation (cSAC)

RAMSAR sites

National Nature Reserves (NNR)

Site of Special Scientific Interest (SSSI)

Marine Nature Reserves (MNR)

Scheduled Ancient Monuments (SAM)

Area of Outstanding Natural Beauty (AONB)

You should assume, for the purposes of the assessment, that there is no potential for wind development in these areas, although in practice some of these sites may not be particularly sensitive to wind power.

It is recognised that the above list is not exhaustive and where additional environmental and/or heritage constraints exist they should also be taken into consideration.

Step 4: Map transport infrastructure and other physical constraints

To minimise potential disruption to transport infrastructure in the unlikely event that a wind turbine should 'topple' you should apply minimum exclusion zones, depending on the classification of transport infrastructure. These exclusion zones are referred to as 'topple distances' (hub height plus rotor radius) and can be defined as follows:

Table 41: Transport infrastructure constraints

Transport Classification	Minimum exclusion zone	Source
Principal transport network (motorways, trunk roads and rail network)	Topple distance (the same as tip height) plus 50 metres	Highways Agency See www.gov.uk/government/uploads/system/uploads/attachment_data/file/237412/dft-circular-strategic-road.pdf We are not aware of any specific guidance from Network Rail in relation to separation distance from railways, but we have assumed it to be the same as that for trunk roads
Secondary transport network (other local authority transport network)	Topple distance plus 10%	The PPS 22[39] companion guide (see: www.waveney.gov.uk/site/scripts/download.php?fileID=822) states that "Although a wind turbine erected in accordance with best engineering practice should be a stable structure, it may be advisable to achieve a set-back from roads and railways of at least fall over distance, so as to achieve maximum safety." For non-trunk roads we have assumed a separation distance of topple distance plus 10% which is slightly more conservative than PPS 22

You should use Ordnance Survey (OS) MasterMap® to establish the geographic extent of transport infrastructure, and then apply the appropriate exclusion zones around each transport network. OS MasterMap does not differentiate between principal and secondary transport classifications. Therefore, you will need to manually identify the principal transport network elements in GIS, and apply the larger buffer.

As an alternative, if you hold the OS Strategi® dataset, this can be used to differentiate between principal and secondary transport networks.

In addition you should also map the following physical constraints:

- Woodland (Natural Resources Wales)
- Inland waters (lakes, canals, rivers, reservoirs)

Again, for the purposes of the assessment, you should assume that there is no potential for wind development in these areas.

Step 5: Map existing dwellings and a noise buffer

Large wind turbines are further restricted in their location due to the potential impact of night time noise concerns associated with the aerodynamic noise of blades moving through the air and mechanical rotation of the gear box within the hub. The definitive guidance on this for planning applications does not provide a separation buffer, but rather gives a noise threshold[40]. However, a number of rules of thumb are used in the industry for the early assessment of sites to translate this guidance into the size of separation buffers to avoid noise becoming an issue. The size of buffer required increases with the size of machine.

For the purposes of this assessment, we suggest that for a 2MW machine, you should assume an exclusion buffer of 500m around existing dwellings[41].

You can use the LLPG dataset to identify which buildings are dwellings, and then apply the noise exclusion zone.

Consideration should also be given to properties that could be affected by noise outside of the local authority area. Assuming that the location of building types cannot be established outside of the local authority boundary, we recommended that you should assume a noise constraint on all land that is within the first 500m of an adjacent local authority boundary.

Step 6: Map existing aviation and radar constraints

Wind turbines can have negative impacts on radar systems and can represent obstructions for low flying aircraft. The Ministry of Defence (MoD), the Civil Aviation Authority (CAA) and the National Air Traffic Service (NATS) have a statutory duty to safeguard certain sites and airspace from radar interference in the interests of national security and for the safe operation of passenger and military aviation.

Individual airports can also be affected by wind development[42]. The potential for impacts on stationary radar for civil and military sites can only really be established through consultation with the MoD and CAA on specific sites. Therefore, we do not propose that this is mapped as part of this toolkit. Data on the potential impacts on en-route radar for civilian aircraft is available and can be mapped and a method for doing this is presented below. Information on flight approach and take off safety zones around airports can also be mapped, and again a method for doing this is presented below.

Civil Aviation Authority (CAA) VFR Charts

The CAA Visual Flight Rules (VFR) Charts indicate the location and extent of CAA and MoD aviation exclusion zones to avoid any physical obstruction to air traffic. These maps are available as hard copy maps for different areas of the UK. You will need to purchase the relevant map from a relevant stockist, and you can find a list of stockists for VFR maps on the CAA website. You will then need to digitally scan and georeference the hard copy map against your OS base layer. The VFR maps show the following constraints which can then be digitised and displayed as a separate constraint on your GIS:

- Controlled airspace (including military aircraft low flying zones, or Tactical Training Areas)
- UK aerodrome traffic zones (ATZ)
- Military aerodrome traffic zones (MATZ)
- High intensity radio transmission areas
- Aerodromes with instant approach procedures outside controlled airspace.

The maps will show relevant buffers or exclusion zones around each of these. For the purposes of this assessment, you should assume no wind development within these exclusion zones.

National Air Traffic Service

NATS is the United Kingdom's main air navigation service provider. It provides air traffic control to all en-route aircraft in UK airspace.

NATS En Route Plc (NERL) is responsible for the safe and expeditious movement in the en-route phase of flight for aircraft operating in controlled airspace in the UK. To undertake this responsibility NERL has a comprehensive infrastructure of radars, communication systems and navigational aids throughout the UK, all of which could be compromised by the establishment of a wind farm. In this respect NERL is responsible for safeguarding this infrastructure to ensure its integrity to provide the required services to Air Traffic Control (ATC).

NERL has produced GIS data layers that identify areas which will, or may affect NERL operation, depending on the blade tip height of the project. Blade tip heights range from 20 to 140 metres which are believed to be representative of the heights of the majority of potential developments. Based on step 1, you should download the GIS layer that relates to the tip height for the turbine size you have selected.

Figure 14: Potential Interference with NERL Infrastructure

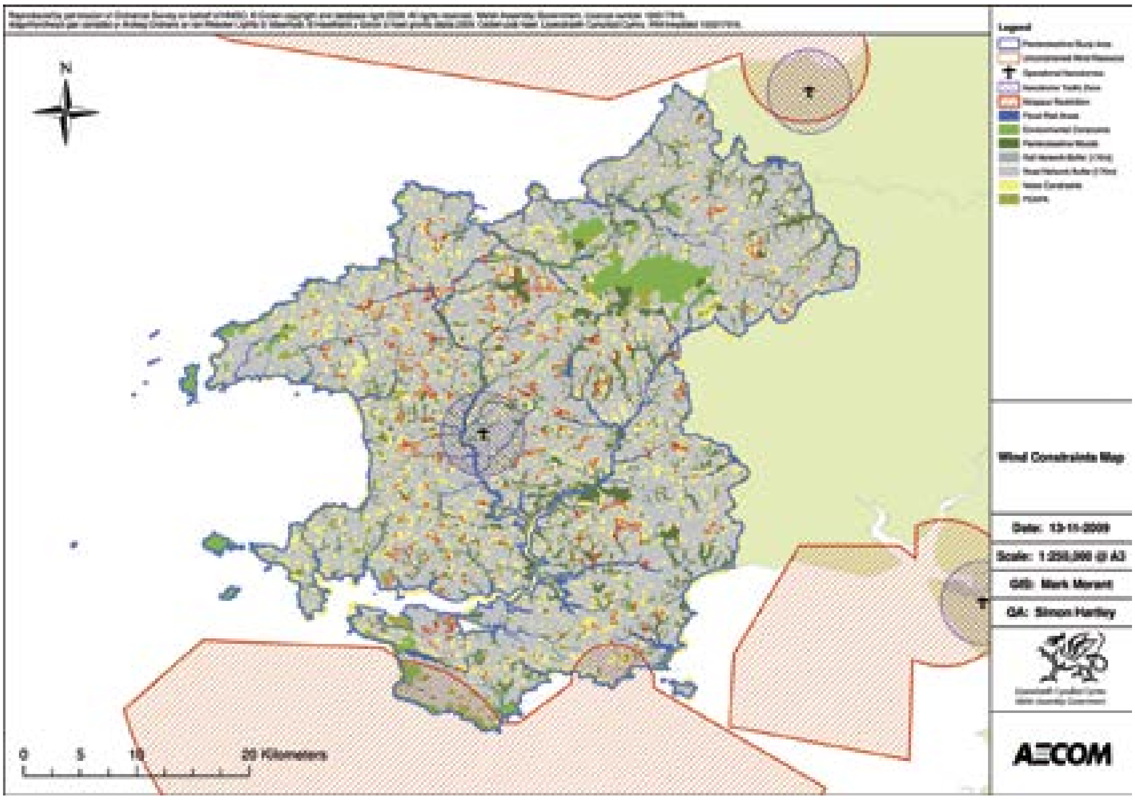
NATS www.nats.aero/services/information/wind-farms/self-assessment-maps/NERL-Self-assessment-maps

The GIS data layer identifies 'high risk areas', which are those where wind farm developments are likely to interfere with the operational infrastructure of NERL, and 'moderate risk areas' where there remains a potential to interfere with this infrastructure. Based on this dataset, we suggest that you classify the available wind resource into low, moderate and high risk areas for en-route radar interference.

The image above indicates an example of the NATS En Route Plc safeguarding map for a wind turbine with a blade tip height of 120m. 'High risk areas' are referenced blue and moderate risk areas are referenced yellow.

Figure 15 below provides an example of a completed wind constraints map including environmental, cultural heritage, transport infrastructure, noise, and aviation and radar constraints across Pembrokeshire.

Figure 15: Example of a completed wind constraints map for Pembrokeshire



Step 7: Prioritise available wind resource

We suggest that you prioritise the unconstrained wind resource according to the following categories.

Table 42: Wind resource priority

Wind Resource Priority	Average Annual Wind Speed	Potential disruption to the National Air Traffic Service
Priority 1	High (>6.5m/s)	Low
Priority 2	Moderate (6.0-6.5m/s)	Low
Priority 3	High	Moderate
Priority 4	Moderate	Moderate
Priority 5	High	High
Priority 6	Moderate	High

Step 8: Assess potential installed capacity and energy output

The above step will have provided a figure for the total area of unconstrained land potentially available for wind power development, broken down into different categories of wind speed and potential NATS radar interference. You now need to convert this to a potentially installed generating capacity (in MW), and a potential annual energy output (in MWh). Guidance on the capacity factors utilised for this toolkit is provided in Project Sheet J and use of the relevant capacity factor for on-shore wind summarised below.

1. To assess the potential installed capacity

Based on the use of 2MW turbines (see step 1), it is possible to fit 5 turbines of this size into 1km^2 (or 100ha)[43], which equates to a potential installed capacity of 10MW/km^2. Therefore, you should multiply the land areas in the table in step 7 by 10, to give the potential MW installed capacity for each category.

2. To assess the potential annual energy output

The installed capacity figure given above represents the maximum power output that a particular turbine can produce. However, for much of the year, depending on the wind speed at any given moment, a turbine may be generating less than its maximum, or, on very clam days, not generating at all. A simple way to estimate the potential annual energy output from a wind turbine is to use an assumed **capacity factor**. This factor is a measure of how much energy a wind turbine typically produces in a year, compared to what it would produce if it were to run at full power all of the time. A typical capacity factor for onshore wind turbines is 0.27 (or 27%)[44].

To estimate the annual energy output from a wind turbine, you multiply the installed capacity by the number of hours in a year times the capacity factor. For example, for a 2MW wind turbine, assuming a capacity factor of 0.27, the annual energy output would be:

2 x 24 x 365 x 0.27 = 4,730MWh

The table below shows what the output from this step should look like, taken from the Pembrokeshire County Council case study.

Table 43: Example of unconstrained wind resource output for Pembrokeshire County Council

Wind Resource Priority	Unconstrained Area (km²)	Potential Energy Generated (MWh)	Capacity (MW)
Priority 1	3.9	92,243	39.0
Priority 2	0.9	21,050	8.9
Priority 3	5.5	131,032	55.4
Priority 4	1.1	26,254	11.1
Priority 5	13.0	307,476	130.0
Priority 6	4.7	111,637	47.2
Total	**29.1**	**589,692**	**291.5**

Step 9: Assess cumulative visual and landscape impact issues and reduce resource accordingly

The output from the above steps will give an estimate of the maximum accessible wind resource in your local authority area, outside of the SSAs. However, in reality, harnessing all of that resource may cause significant cumulative visual and landscape impacts, particularly in more rural areas. Therefore, this potential impact needs to be incorporated as a constraint and the accessible resource revised accordingly. We set out below a potential method for doing this, which culls the wind resource to assume a minimum separation distance between wind farms. We propose the use of a 7km separation, which has been used in a number of other wind studies[45], the rationale being that beyond this distance, wind farms no longer appear dominant in the landscape. However, we suggest that local authorities may wish to use different figures for this if this is informed by local assessments of landscape sensitivity to wind power. If your area has relatively low landscape value or low landscape sensitivity to wind power, you may choose to use a lower separation distance, or none at all, or vice versa if your area has higher landscape sensitivity.

Again, it is important to note that this separation distance is considered for the purposes of this high level resource assessment only, and should not be used for assessing individual planning applications. For the latter, the cumulative impacts of an application will need to be assessed on a case by case basis, supported by the relevant landscape and visual assessments. The proposed method is as follows:

1. The first step is to amalgamate all unconstrained wind resource parcels (or "clusters") in priority areas 1 to 6 that are within 4 times the rotor diameter (see step 1) of one another to establish potential wind farm areas. You should start with the biggest parcel first, and amalgamate it with adjacent parcels. You should then move on to the next biggest parcel, until all parcels have been amalgamated.

2. Once you have identified the potential wind farm clusters, consideration should be given to existing and consented wind turbine developments (as identified in Project Sheet A) that may visually constrain potential sites based on their spatial location and proximity. A simple way of representing the visual impact of wind farm clusters is to place a constraint on all wind farm clusters that are located within 7km distance of an existing or consented wind development. You should also include existing and consented wind development outside of your local authority area as visual impacts are likely to transcend local authority boundaries. Consideration could also be given to expanding existing wind development where appropriate.

3. You should then rank the remaining unconstrained wind resource clusters by area (km^2). The wind resource cluster with the greatest area should then be selected as a potential wind farm. Any other clusters within 7km should then be discounted. Then repeat the process with the next largest remaining cluster until all the clusters have been accounted for.

4. Convert the land area of each cluster identified as the output from step 3 above to an installed capacity and energy output (see step 8).

The above steps included priority areas 5 and 6, which are identified as high risk in terms of impacts on NATS en-route radar. You can regard the accessible resource figure that this produces as an upper bound for your area. As a refinement, you may wish to re-run the assessment just for priority areas 1 to 4. The output from that process you could take as a lower bound for the wind power resource.

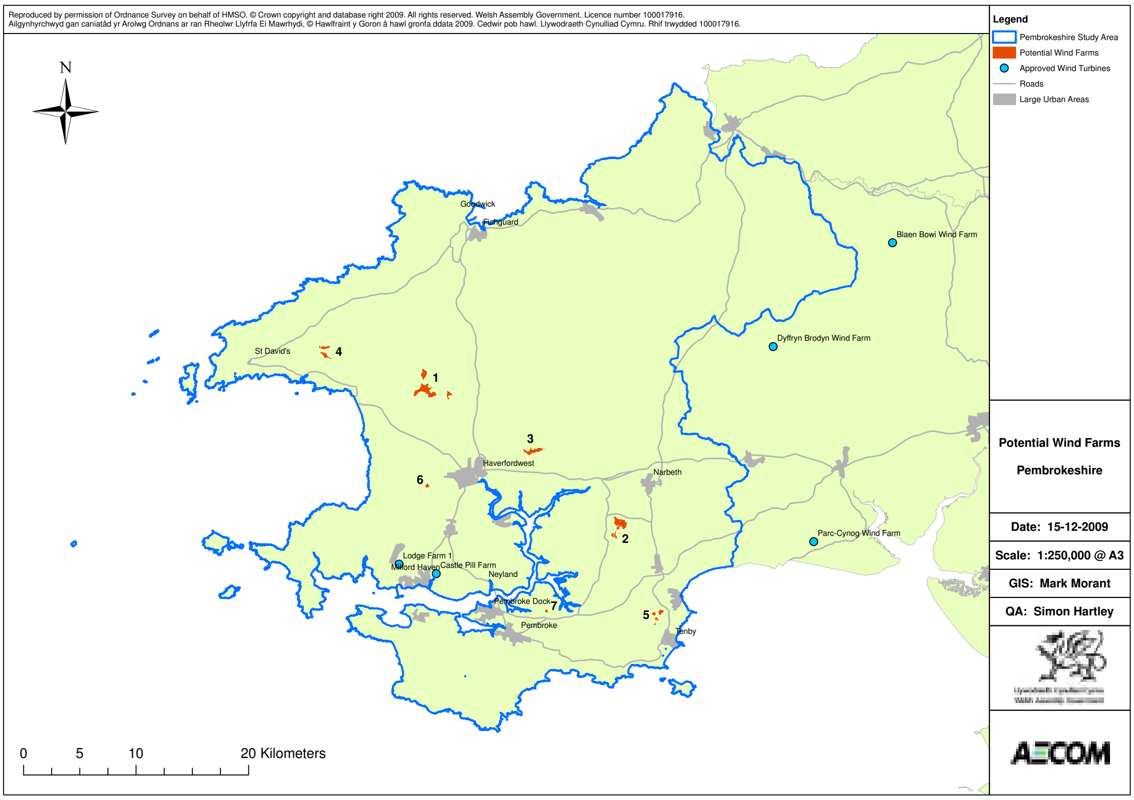
Based on the methodology as described in Step 9 above, seven potential wind farm locations were identified across Pembrokeshire. The table and figure below illustrates the outputs from step 9, based on considering priority areas 1 to 4 only. As explained above, this could be taken as a lower bound for the accessible resource.

Sheet B

Table 44: Potential wind farms across Pembrokeshire County Council

Potential wind farm	Area (km²)	Potential capacity (MW)
1	1.17	11.68
2	0.68	6.84
3	0.36	3.55
4	0.24	2.37
5	0.19	1.91
6	0.05	0.53
7	0.03	0.28
Total	**2.72**	**27.17**

Figure 16: Potential wind clusters – priority areas of least constraint



References

39 This document has since been superseded by the NPPF however the assumptions stated within this exercise are still seen to remain valid

40 See "The Working Group on noise from wind turbines (1996) assessment and rating of noise from wind farms" (ETSU-R-97)

41 500m was the figure used by Arup for the analysis of the SSAs for TAN 8

42 For more information on this issue, see "Wind Power in the UK", by the Sustainable Development Commission, May 2005, and the BWEA website www.bwea.com/aviation/index.html

43 Assuming a 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 – now superseded yet valid for this exercise

44 See "Wind Power in the UK", by the Sustainable Development Commission, May 2005, for a discussion of wind capacity factors

45 See Revision 2010 study, for the South West of England region, and Entec, 2008, "Review of Guidance on the Assessment of Cumulative Impacts of Onshore Windfarms", for BERR

Project Sheet C: Wood fuel and energy crops resource for heat and power generation

Introduction

This section provides you with guidance on how to assess the potential available resource in your area for harvesting wood fuel from sustainable forestry and woodland management and the growing of "woody" energy crops. This section does not consider the potential for growing energy crops to provide liquid biofuels for transport, as this is outside the scope of this toolkit.

In terms of wood fuel, in the context of this resource assessment, we have taken that to cover virgin wood harvested from the sustainable management of forestry and woodland. This could cover small roundwood from thinnings, as well as so-called "lop and top" from timber trees. The energy crops that are considered in this section are miscanthus (elephant grass) and short rotation coppice willow.

Energy crops

The proposed method for you to assess the resource for your area for growing energy crops is as follows:

Step 1: Establish the area (in hectares) of existing agricultural land

Step 2: Identify any constraints to planting energy crops from environmental and heritage designations

Step 3: Establish the percentage of suitable agricultural land that could be planted with energy crops

Step 4: Establish the potential annual fuel yield from the total available land

Step 5: Establish the potential installed power and heat generation capacity

Each of these steps is set out in detail below.

Step 1: Establish the area (in hectares) of existing agricultural land

There are two nationally available GIS datasets that you can use to establish the location and extent of available agricultural land in Wales, namely:

Agricultural Land Classification data

National Forest Inventory

Each is described in more detail below.

Agricultural Land Classification[46]

The ALC dataset identifies all agricultural land across Wales according to five grades. Grade one is best quality and grade five is poorest quality. Generally speaking, miscanthus and short rotation coppice can be grown on land grades 1 to 4. You should download the GIS information and bring it in as a GIS layer superimposed onto the OS base for your area.

National Forest Inventory[47]

The NFI is a GIS data layer that confirms the type and geographic extent of all woodland in Britain. The data layer was derived from automated imaging analysis of 2006 aerial photography and is matched directly to OS MasterMap® for an accurate geographic reference. The NFI dataset can be supplied by the NRW You should download the GIS information and bring it in as a GIS layer superimposed onto the OS base for your area.

You should then calculate the total area (in hectares) of land grades 1 to 4, minus any woodland that may be within those areas, as this would preclude the planting of energy crops.

Step 2: Identify any constraints to planting energy crops from conservation and heritage designations

You will have established the total available agricultural land from step 1 above. However, for the purposes of this assessment exercise, consideration needs to be given to protecting existing environmentally designated sites. You should remove the following conservation and heritage designated sites from the total available biomass resource area where they overlap in geographic extent:

- Site of Special Scientific Interest
- Scheduled monument

As for step 1, you should then calculate the new total area (in hectares) of suitable land minus these designated areas.

You may also wish to exclude additional environmentally sensitive areas if you, or other local stakeholders feel that it would not be feasible to plant energy crops in those areas, and if you have data on the size and location of those areas. Such areas could include: common land, permanent pasture/grassland and biodiversity action plan areas.

Step 3: Establish the percentage of suitable agricultural land that could be planted with energy crops

Although step 2 establishes the theoretical maximum area that could be planted with energy crops, in reality only a proportion of that would be achievable. This is for a range of factors, including:

- 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
- Unsuitable topography, in terms of steep slopes, which would make harvesting of energy crops problematic

There is no firm guidance on what proportion of suitable land could be planted with energy crops. As a starting point, for estimating the available resource for 2020, we suggest that you assume that 10% of the suitable land area identified from step 2 could be planted with energy crops[48].

However, we recommend that you should consult with relevant stakeholders in your area, such as NFU Cymru, and FUW to gain a local assessment on the feasibility of planting energy crops, and the % uptake that is likely to be viable.

Step 4: Establish the potential annual fuel yield from the total available land

Once you have established the total available area for planting energy crops, from step 3, you then need to estimate the potential quantity of energy crops that could be harvested, and, therefore, the amount of heat and power generation that this could support.

In terms of yield, an average figure between miscanthus and short rotation coppice is about 12 oven dry tonnes per year per hectare[49]. 'Oven dry tonnes' is a theoretical figure which is used for this type of assessment, and means the weight of crop if it had 0% moisture content.

Therefore, if the total available land area was 5,000 ha, the annual fuel yield would be:

5,000 x 12 = 60,000 oven dry tonnes/annum

Step 5: Establish the potential installed power and heat generation capacity

You now need to work out how much energy the potential quantity of fuel identified from step 4 could produce. This will depend on whether the fuel is burnt in facilities that only generate electricity (and the waste heat is not usefully used), or produce CHP (where the heat is usefully used), or is burnt in a boiler to produce heat only. The amount of fuel required in each case will depend on the efficiency of the combustion process as well as the number of hours in a year a facility is operating. To work this out, you can use the following assumptions:

1. For electricity generation, a biomass facility will require about 6,000 oven dry tonnes of energy crops for each 1MWe of installed power generation capacity[50].
2. A CHP facility will require the same amount of fuel as (1) for each 1MWe of electricity generation capacity, but will also produce about 2MWt of thermal output at the same time[51] from the waste heat.
3. A heat only facility (i.e. a biomass boiler) will require about 660 oven dry tonnes of energy crops for each 1MWt of installed thermal generation capacity[52].

We recommend that, for the purposes of this resource assessment, you should assume that the energy crop resource is used to fuel either electricity only or CHP biomass facilities[53].

Therefore, to give a worked example, based on the 60,000 oven dry tonnes/annum of fuel available, given from step 4, you would calculate the amount of biomass electricity and/or CHP generation this could support as follows:

60,000/6,000 = 10MWe (and a further 20MWt of heat, if CHP)

To convert this installed capacity to an annual energy output, in MWh, use the relevant capacity factor, as set out in Project Sheet J.

Wood fuel

You can use an assessment of the potential wood fuel resource in your area to inform the potential contribution of wood fuelled heating to any renewable heat target. However, the renewable heat target is likely to be informed more by the results of any assessment of uptake in existing and new buildings as set out in Project Sheet G. Nonetheless, an assessment of the wood fuel resource can be a useful sense check for any renewable heat target and an important component of the evidence base.

The section explains how to assess the potential wood fuel resource from forestry residues and woodland management. More specifically, this concerns the resource that is available from the management of existing woodland, by the extraction of "thinnings", and the residues produced from the extraction of timber trees, the so-called "lop and top" (i.e. tips and branches) and small roundwood.

This section does not cover the wood fuel resource from the following sources, as this is outside the scope of this toolkit:

- Arboricultural residues. This is residues from tree surgery and Council management of street and park trees
- Clean wood waste. This is the residue from sawmills, and may also include that from joinery workshops

The first could be established by a survey of the local authority's operations as well as a survey of tree surgeons in the local authority area. In practice, this resource may be difficult to harness, due to the low quality of the fuel, and inconsistencies over chip size.

The second could be established, again, from a survey of relevant local businesses. This resource may be more viable to collect, but there are likely to be competing alternative markets for the offcuts (such as particle board manufacture).

A method for you to establish the available resource from forestry residues is as follows:

Step 1: Establish the location and extent of the total available forestry and woodland resource in your area

Step 2: Establish the potential wood fuel yield from this area

Each of these is set out in more detail below.

Step 1: Establish location and extent of total available resource

Two nationally available GIS datasets can be used to establish the location and extent of woodland in Wales:

- National Forest Inventory
- NRW Legal Boundaries

National Forest Inventory

The National Forest Inventory (NFI) is a GIS data layer that confirms the type and geographic extent of all woodland in Wales and is owned and maintained, and can be supplied, by the NRW.

The data layer was derived from automated imaging analysis of 2006 aerial photography and is matched directly to OS MasterMap® for an accurate geographic reference.

You can use this data layer to establish the total area (in hectares) of woodland in your area.

Natural Resources Wales

The geographic location and extent of NRW owned and managed land can be provided by NRW as a GIS data layer and is referred to as NRW Legal Boundaries.

Using a GIS the total available biomass resource can be split established for forested areas owned and managed by NRW and those areas that are not.

Strictly speaking, you don't need this data to assess the resource, but you may want to collate to provide additional context and analysis for the evidence base.

Step 2: Establish the potential wood fuel yield from this area

Once you have established the area of available woodland you then need to estimate how much wood fuel could be usefully and sustainably extracted on an average annual basis. Based on data contained in the Bio-Energy Action Plan for Wales, we recommend that you assume a figure of 0.6 oven dry tonnes of available wood fuel per ha of woodland, per annum, for the maximum accessible resource.

This is a long term, annually averaged sustainable yield, based on wood fuel that can be harvested from the small roundwood stems, tips and branches of felled timber trees and thinnings, as well as poor quality roundwood. This figure takes accountof competition from other markets in Wales, such as particle board manufacturing[54]. The figure also takes into account technical and environmental constraints.

To give a worked example, if you identified a total area of woodland for your area of 10,000 ha, then you would calculate the potential wood fuel resource as follows:

10,000 x 0.6 = 6,000 oven dry tonnes/annum

Step 3: Establish the potential installed power and heat generation capacity

You now need to work out how much energy the potential quantity of fuel identified from step 2 could produce. This will depend on whether the fuel is burnt in facilities that only generate electricity (and the waste heat is not usefully used), or produce CHP (where the heat is usefully used), or are burnt in a boiler to produce heat only. The amount of fuel required in each case will depend on the efficiency of the combustion process as well as the number of hours in a year a facility is operating.

To work this out, you can use the same assumptions as given in step 5 of the Energy Crops section.

For example, 660 oven dry tonnes of wood fuel is required for each 1MW of heat power output. Therefore, this resource could support:

6,000/660 = 9.1 MWt of wood fuel heating

This is equivalent to about 30 x 300kW wood chip boilers, which is an approximate size for a large new secondary school.

References

46 This dataset can be obtained from the Welsh Government by emailing LUPUnit@Wales.GSI.Gov.uk

47 Natural Resources Wales, see www.naturalresources.wales/?lang=en

48 This figure is mentioned in the executive summary of the Bio-Energy Action Plan for Wales, February, 2009. It was also used as the basis of the energy crops resource assessment for the South West of England region in the Revision 2020 project, which developed regional renewable energy targets for 2020

49 This figure was used in the Bio-Energy Action Plan for Wales. The Biomass Energy Centre website (www.biomassenergycentre.org.uk/) gives a figure of 9 oven dry tonnes/ha/annum for short rotation coppice and 13 oven dry tonnes/ha/annum for miscanthus. However, in reality, the actual yield will vary within a range, depending on a number of factors such as: land grade, crop species, soil types, how many years a particular crop has been established at a site, and so on

50 This is an average figure to cover a range of different technology types, and sizes, with different efficiencies. For example, a smaller scale facility (about 2MWe) using a steam turbine with an efficiency of about 20%, might require up to 8,000 oven dry tonnes/annum. However, a larger facility (5-10MWe), using gasification, with an efficiency of up to 30%, might require about 5,000 oven dry tonnes per annum. For all options, the facility is assumed to generate at full power for about 8,000 hours per annum. The energy content of the fuel is assumed to be 5MWh/oven dry tonnes (taken from the Biomass Energy Centre website which gives a figure of 18MJ/oven dry tonnes)

51 Again, this is only a rough average, for a range of technology types and scales

52 Assuming a boiler efficiency of 80% and a capacity factor of 0.3 (see Project Sheet J)

53 In practice, of course, energy crops, particularly short rotation coppice (as it takes the form of wood chip rather than bales), may be used to also fuel biomass boilers

54 See section 5.1.2 in the draft Bio-Energy Action Plan for Wales. The figure of 0.6 is based on a potential resource of 153 oven dry tonnes/yr from stemwoo (7-14cm diameter), poor quality stemwood, stem tips and branches, in the presence of competing markets, from a total area of woodland in Wales of just over 270,000 ha. The latter figure is taken from table 6 of the National Inventory of Woodland and Trees, Wales, Forestry Commission, 2002

Project Sheet D: Energy from waste

This section, and Project Sheet E, considers the potential energy sources derived from waste. This section addresses:

- Municipal waste
- Commercial & industrial waste

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

The steps for estimating the energy resource from MSW and C&I are as follows:

Step 1: Establish the quantity of residual MSW and C&I waste

Step 2: Establish the installed capacity this could support

Step 3: Establish the biodegradable fraction that would qualify as renewable energy

Each of these steps is set out in more detail below.

Step 1: Establish the quantity of residual MSW and C&I waste

Your waste officer should be able to provide you with figures for the total MSW produced annually for your authority area, in tonnes per annum[55]. They should also be able to provide you with projections for the projected quantity of waste in 2020. Based on the proposed targets set out in the Wales Waste Strategy[56], you can assume that 30% of the total MSW would be available for energy recovery. At this level, there should be no conflict with recycling targets.

NRW should be able to provide two datasets relating to commercial and industrial waste in. The two datasets will comprise details of tonnes per annum of:

Hazardous wastes

NRW Permitted Site Data

Data on projections for commercial and industrial waste are available from Regional Waste Strategies 2020 but only for the region as opposed to individual local authority areas. There is inherent uncertainty in the robustness of future waste projections, particularly as far ahead as the year 2020. However, either the regional projections, if available, can be adopted or the growth rates as per the Municipal Waste Stream. It can also be assumed that 30% of the total Commercial & Industrial waste would be available for energy recovery.

As a worked example, if your total MSW and Commercial & Industrial waste for 2020 was projected to be 150,000 tonnes per annum, the amount available for energy recovery would be:

0.3 x 150,000 = 45,000 tonnes/yr

When compiling data on tonnages of waste, make a note of the food waste from both the MSW stream and from Commercial and Industrial waste in order to populate the table in the next section on Centralised Anaerobic Digestion.

Step 2: Establish the potential installed power and heat generation capacity

You now need to work out how much energy the potential quantity of fuel identified from step 1 could produce. EfW facilities in Wales are required to be at least 65% efficient and therefore cannot generate electricity without using some of the heat. The fuel will therefore be burnt in facilities that produce CHP (where the heat is usefully used or burnt in a boiler to produce heat only. The amount of fuel required in each case will depend on the efficiency of the combustion process as well as the number of hours in a year a facility is operating. To work this out, you can use the following assumptions:

1. To estimate the potential installed energy generating capacity, you should assume that 10,320 tonnes of waste per annum are required for each 1MWe of electricity generating capacity in a CHP plant[57].
2. A CHP facility will also produce about 2MWt of thermal output at the same time[58] from the waste heat.
3. A heat only facility will require about 1,790t of waste for each 1MWt of installed thermal generation capacity[59].

We recommend that, for the purposes of this resource assessment, you should consult with the local authority waste manager to establish what technologies are planned for the area. If CHP is planned then follow steps 1 & 2 above and populate the table accordingly leaving out any figures for "heat only" generating plant and vice versa if heat only generating plant is planned for your area.

For example, if CHP is planned the potential capacity that could be supported by the waste stream would be:

45,000/10,320 = 4.4.MWe that could also generate:

4.4MWe x 2MW of heat = 8.8MWt

It is important to note that this would be the total capacity that could be supported, but the renewable energy element of that would be smaller as it would be only the biodegradable fraction (see step 3 below).

Step 3: Establish the biodegradable element (the renewable energy fraction)

Under the requirements of the EU Renewables Directive (www.eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF), which is the basis for the UK's target of 15% of energy to come from renewable sources by 2020, only the biodegradable fraction of energy generation from waste is eligible to count towards the target. There is no specific guidance in Wales on what the biodegradable fraction should be assumed to be in future. The UK Government consultation on the re-banding of the Renewables Obligation suggested that the anticipated future biodegradable fraction, by 2020, would be about 35%, compared to a current nominal level of about 50%[60].

Therefore, we suggest that in developing targets for 2020, you use the assumption that 35% of the power and energy output of any waste facility would count as renewable. Therefore, based on the output of step 2 above, the renewable electricity capacity would be:

4.4MWe x 0.35 = 1.5MWe and;

8.8MWt x 0.35 = 3.1MWt

To convert this installed capacity to an annual energy output, in MWh, use the relevant capacity factor, as set out in Project Sheet J.

References

[55] This should exclude construction and demolition waste

[56] "Towards Zero Waste, One Wales: One Planet, A Waste Strategy for Wales", June 2010

[57] This assumes an electricity generation efficiency of 25%, based on a net calorific value of the fuel of 11MJ/kg, and a capacity factor of 0.9 (see Project Sheet J). This assumed calorific value of the fuel is a rough average as the actual value can vary widely depending on the composition of the waste, the extent to which recyclables and wet biodegradable waste has been removed or source separated, and whether the fuel has already been processed into RDF pellets

[58] Again, this is only a rough average, for a range of technology types and scales

[59] Assuming a boiler efficiency of 80% and a capacity factor of 0.5 (see Project Sheet J)

[60] See para. 9.10 of the Government Response to the Statutory Consultation on the Renewables Obligation Order 2009, December 2008, see http://webarchive.nationalarchives.gov.uk/20090609003228/http://www.berr.gov.uk/files/file49342.pdf

Project Sheet E: Anaerobic Digestion

Introduction

This section considers the following potential energy sources that would be best utilised through anaerobic digestion facilities:

- Animal manure (cattle and pigs)
- Food waste
- Poultry litter
- Sewage sludge

As 100% of the waste resource discussed in this section is biodegradable you can count it in its entirety as renewable energy.

Animal manure

This section covers how to assess the potential energy resource from slurry collected from cattle and pigs kept under cover in the winter months.

You should carry out the following steps to establish the total available energy resource from animal manure in your area:

Step 1: Establish number and location of cattle and pigs

Step 2: Establish potential energy yield from total available resource

Step 1: Establish location and extent of total available resource

The Welsh Government records the number of livestock within geographical locations, usually by local authority area.

Step 2: Establish total tonnages

Once the total number of cattle and pigs has been identified, the tonnage of available manure can be established. You can assume that livestock will produce the following amounts of slurry per month (http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=251225&id=251492)

Cattle: 1 tonne per month per head[61]

Pigs: 0.1 tonnes per month per head[62]

Because the livestock will only be kept under cover for, approximately, 6 months of the year, you should assume that the slurry can only be collected for 6 months of the year. Therefore the annual quantity of slurry available is:

Cattle: 1 x 6 = 6 tonnes/head

Pigs: 0.1 x 6 = 0.6 tonnes/head

In practice, it will not be possible or practical to collect all of this potential resource. This will be because many farms will not use a slurry system, but will collect the excreta as solid manure mixed with bedding which is then spread on the fields. Furthermore, it will not be practical to collect the slurry from some of the farms, because they may be too small or too dispersed for this to be economically viable.

We recommend that you should consult with the NFU Cymru and FUW to identify what the split between the use of slurry and non-slurry systems on farms in your area. We suggest that you should also test with them what the future projections are for livestock numbers in your area up to 2020, as this may affect the resource. As a starting point we suggest that you assume that 50% of the farms use a slurry based system and that of these, it would be feasible to capture the slurry from 50%. This means that the available resource per head of livestock per annum would be as follows:

Cattle: 6 x 0.5 x 0.5 = 1.5 (wet) tonnes/head

Pigs: 0.6 x 0.5 x 0.5 = 0.15 (wet) tonnes/head

Step 3: Establish potential energy yield from total available resource

To estimate the potential installed capacity of generation that could be supported by animal slurry in your area, you should assume the following:

For electricity generation, 225,000 wet tonnes of slurry will be needed per 1MWe[63].

The AD plant can act as CHP, and therefore the waste heat can be usefully used, if there is a suitable heat load[64]. For a gas engine of this size, the typical heat to power ratio[65] is about 1.5 to 1, therefore a 1MWe engine would also produce about 1.5MWt.

The AD plant could also be used to just produce heat. In this case, the biogas is just burnt directly in a boiler. In this case, you should assume the following:

For heat only generation, 47,000 wet tonnes of slurry will be needed per 1MWt[66]

Example output

As an example, you have established that the number of cattle in your area is 200,000. You have spoken to the local Farmers Union and established that about 60% of the farms in your area with livestock use a slurry system, and they feel that you could realistically collect the slurry from 50% of these. Therefore the wet tonnes slurry, available for an AD facility each year, are calculated as follows:

Annual slurry = 200,000 x 6 x 0.6 x 0.5 = 360,000 tonnes

From this, the potential installed capacity of electricity generation is:

Potential installed capacity = 360,000/225,000 = 1.6MWe

This installation, if CHP, could also potentially provide the following amount of heat output:

Heat output = 1.6 x 1.5 = 2.4MWt

If all of the slurry were to go to heat only facilities, then the potential installed heat capacity could be:

Heat capacity = 360,000/47,000 = 7.7MWt

You will need to decide, from discussion with local stakeholders in your area, such as your waste officer, and local agricultural experts, whether the resource is likely to go to fuel CHP facilities or heat only facilities. As a default assumption, we suggest that you should assume that it would go into a CHP facility.

You should note that if you know that the animal resource in your area is currently going to a facility outside of your local authority, or there are firm plans for an AD plant in the near future in an adjacent authority that would take this resource, then you should not count this resource as contributing to your renewable energy targets.

Food waste

National context

Towards Zero Waste has identified minimum levels of recycling and composting for local authorities of 58% in 2015/16, 64% in 2019/20 and 70% in 2024/25, see: www.gov.wales/docs/desh/publications/100621wastetowardszeroen.pdf

This section covers how to assess the potential energy resource from harvesting both:

Food waste from the MSW stream (domestic)

Food waste from Industrial and commercial waste streams.

Step 1: Establish Annual Food Waste Arisings from MSW and C&I waste stream

From discussion with your waste officer, you should be able to obtain estimates on the quantities of household food waste that are produced each year, as well as an idea of how much food waste is currently collected (i.e. as part of a kerbside collection scheme), or may be collected in the future if there are plans for kerbside collection. If your authority does not have any plans for kerbside collection of household food waste, you should disregard this as an energy resource.

In terms of commercial food waste (e.g. from restaurants or food processing companies) tonnages of food waste can be extracted from the data supplied by NRW under European Waste Catalogue Code No. 2, and again your waste officer should be able to provide you with this information. Projections for increases in food waste can either be extracted from the relevant Regional Waste Strategy or figures recorded by your local authority waste management team for your local authority area.

Step 2: Establish potential energy yield from total available resource

You now need to work out how much energy the potential quantity of fuel identified from step 1 could produce.

1. To estimate the potential installed energy generating capacity, you should assume that 20,000 tonnes of food waste per annum is required[67] for each 1MWe of electricity generating capacity.
2. As for animal waste, a CHP facility will also produce about 1.5MWt of thermal output at the same time from the waste heat.

It is unlikely that any centralised facility for the AD of food waste would be heat only rather than CHP therefore we suggest that you consider this resource as being for electricity generation and CHP only.

Example output

You have established, from discussion with your waste officer, that by 2020 there are projected to be 30,000 tonnes of household food waste collected per annum, along with a further 30,000 tonnes of commercial food waste. Therefore, the total quantity of food waste available for an AD facility is 60,000 tonnes/annum. Therefore, the potential electricity generating capacity this could support would be:

60,000/20,000 = 3.0MWe

This installation, if CHP, could also potentially provide the following amount of heat output:

Heat output = 3.0 x 1.5 = 4.5MWt

Poultry litter

You should carry out the following steps to establish the total available energy resource from poultry litter:

Step 1: Establish the number and location of mass producing farms (>10,000 birds) in your area. Other farms located nearby (within a few kilometres might also contribute)

Step 2: Establish the potential energy yield from the total available resource

Step 1: Establish location and extent of total available resource

The Welsh Government and local authority record the number of farms with bird numbers in excess of 400. For each farm over this threshold the number of birds is recorded. Where the number of birds exceeds 10,000 from farms which are within a few kilometres of each other, then the sum total of birds from these farms is also included.

Step 2: Establish total tonnage of poultry litter available

Once the total number of usable birds has been identified, the tonnage of available litter can be established. For mass producing farms, 75% of the litter can be assumed to be utilised.

Note: It should be noted that for turkey farms, the amount utilised will be dramatically less due to the seasonal nature of this particular industry.

Data is available from DEFRA which provides the amount of excreta produced by different types of poultry[68]. This suggests a figure of 42 tonnes of litter per year per 1000 birds[69].

Therefore, if the output from step 1 was a figure of 1 million birds, then you would estimate the annual amount of poultry litter available as follows:

(1,000,000/1,000) x 42 * 0.75 = 31,500 tonnes/yr

Step 3: Establish potential energy yield from total available resource

You can assume that about 11,000 tonnes of litter per annum are required for each 1MWe of electricity generating capacity[70]. Therefore, based on the output from step 2, you would work out the potential installed capacity as follows:

31,500/11,000 = 2.9MWe

In practice, if the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant. However, if less than this figure the resource could go towards supporting anaerobic digestion facilities.

To convert this installed capacity to an annual energy output, in MWh, use the relevant capacity factor, as set out in Project Sheet J.

Example output

The example given below is based on the pilot study for Pembrokeshire where data was obtained directly from the local authority, though it is believed that the Welsh Government collects, collates and maintains the database.

For Pembrokeshire, the total number of poultry on intensive farms is 144,000 birds. Therefore, the total quantity of litter available is:

(144,000/1,000) x 42 *0.75 = 4,536 tonnes per year

Therefore, the potential installed capacity this could support is as follows:

4,536/11,000 = 0.4MWe

This resource would be insufficient to support a dedicated poultry litter energy plant.

It should be noted that where a renewable energy resource is supplied to a plant located in a different area, the area where the energy is generated should claim the generation towards targets.

Sewage sludge

The following steps should be undertaken to establish the total available energy resource from sewage sludge:

Step 1: Establish location and extent of total available resource

Step 2: Establish potential energy yield from total available resource

Step 1: Establish location and extent of total available resource

This data is only available from the water utility company but may not be publicly available.

An energy or plant manager may provide details about the installed capacity and/or energy generation from generating plant utilising sewage sludge as the primary fuel.

Local authorities may wish to contact the water utility company to discuss the potential of sewage for energy recovery and any plans for the construction of further energy generating plant.

National context

According to the Consultation on a Bio-Energy Action Plan for Wales (February 2009), there is likely to be over 100,000 tonnes of dry sewage solids[71], available annually, for the generation of energy utilising anaerobic digestion plant. If the local authority is unable to obtain the necessary information from the water utility company then the following method might be employed:

Regional context

Using the figure quoted in the Consultation on a Bio-Energy Action Plan for Wales (February 2009), use the figure of 100,000 tonnes quoted and assume an equal split of sewage based on population by unitary authority.

Table 45: Proportion of national sewage sludge by local authority based on assumed population split

Local Authority	Population[72]	Sewage sludge (tonnes)
Anglesey	69,000	2,305
Blaenau Gwent	69,100	2,308
Bridgend	134,800	4,503
Caerphilly	172,400	5,760
Cardiff	324,800	10,851
Carmarthenshire	180,500	6,030
Ceredigion	78,000	2,606
Conwy	112,000	3,742
Denbighshire	97,600	3,261
Flintshire	151,000	5,045
Gwynedd	118,200	3,949
Merthyr Tydfil	55,700	1,861
Monmouthshire	88,400	2,953
Neath Port Talbot	137,600	4,597
Newport	140,700	4,700
Pembrokeshire	118,800	3,969
Powys	132,600	4,430

Local Authority	Population[72]	Sewage sludge (tonnes)
Rhondda Cynon Taf	234,100	7,821
Swansea	229,100	7,654
Torfaen	91,100	3,043
Vale of Glamorgan	124,900	4,173
Wrexham	132,900	4,440
Wales	**2,993,300**	**100,000**

Step 2: Establish potential energy yield from total available resource

To estimate the potential installed capacity of generation that could be supported by sewage sludge in your area, you should assume the following:

For electricity generation, 13,000 tonnes of dry solids will be needed per 1MWe[73].

As for animal slurry, the AD in CHP mode can also produce 1.5MWt of heat.

Example output

For Pembrokeshire, based on Table 45, the potential amount of dry tonnes of sewage sludge available per annum is 3,969. Therefore, the potential installed capacity this could support would be:

3,969/13,000 = 0.3MWe

To convert this installed capacity to an annual energy output, in MWh, use the relevant capacity factor, as set out in Project Sheet J.

Potentially, this could also produce 0.3 x 1.5 = 0.45MWt, although this may well be used a part of the drying process to treat the sludge.

At present, about 0.11MWe is already being generated in the County, which is just under half the available resource. It may be that the remainder of the resource is too dispersed for generation to be practical, but this would need to be discussed with the local water company.

References

61 This assumes a typical average figure of 1m^3 per month, and that 1m^3 of slurry has an approximate weight of 1 tonne

62 As for above, but assuming a typical average figure of 0.1m^3 per month per animal

63 This assumes the following: each wet tonne of slurry produces 20m^3 of biogas; 1m^3 of biogas has an energy content of 5.8kWh; an electricity generation efficiency of 30% and a capacity factor of 0.9 (see Project Sheet J). The biogas production figure is taken from the Andersons report for the National Non Food Crops Centre 2nd Edition "A detailed economic assessment of anaerobic digestion technology and its suitability to UK farming and waste systems", March 2010, and is an average figure

64 The gas would normally be burnt in a gas engine (which is an internal combustion engine), and the waste heat comes from the flue gases and the cooling jacket for the engine

65 See www.gov.uk/government/uploads/system/uploads/attachment_data/file/345189/Part_2_CHP_Technology.pdf

66 Assuming a boiler efficiency of 80% and a capacity factor of 0.5 (see Project Sheet J)

67 This assumes the following: 1 tonne of wet food waste produces 140m^3 of biogas; 1m^3 of biogas has an energy content of 5.8kWh; an electrical generating efficiency of 30% and a capacity factor of 0.9 (see Project Sheet J). The figure for biogas production is taken from a report by Eunomia for WRAP, "Dealing with Food Waste in the UK", March, 2007, table 10, and is an average of the high and low figures

68 See aforementioned DEFRA Nitrate Vulnerable Zones Guidance Leaflet 3

69 Based on the figure for laying hens, which is 3.5 tonnes per month

70 Based on the poultry litter plant at Westfield, in Scotland, which has a power output of 9.8MWe and consumes 110,000 tonnes of litter per annum

71 Or rather dry tonnes "equivalent" as the solids in the sewage will not actually be dry

72 www.nomisweb.co.uk

73 This assumes the following: 1 tonne of dry solids produces 340m^3 of biogas; 1m^3 of biogas has an energy content of 5.8kWh; an electricity generation efficiency of 30% and a capacity factor of 0.9 (see Project Sheet J). The biogas production figure was provided by AECOM engineers who are specialists in designing AD plants for the water industry

Project Sheet F: Hydropower energy resource

You can assess the quantity of existing hydropower that may exist in your area, using the approach set out in Project Sheet A (hence there is no table with installed capacity in this section). To assist with that, you can also use the British Hydropower Association Hydropower Map, to identify the location of hydro schemes in your area, see: (http://www.british-hydro.org/downloads/UK_Installations/BHA%202011.pdf). The location of any schemes identified in the map can be used to cross-reference against the Ofgem database described in Project Sheet A.

The British Hydropower Association published the England and Wales Hydropower Resource Assessment in 2010 (see: http://www.british-hydro.org/hydro_in_the_uk/uk_hydro_resource/2010_england__wales_hydro_resource_study.html) to more easily quantify potential hydropower opportunities. The underlying data utilised within the BHA report is presented in Annex 3 of the previous hyperlink and will provide a starting point so as to assess the hydropower resource in your area. It should however be noted that site identification (as per the 2010 British Hydropower Association assessment) does not guarantee suitability; there will be a large number of constraints ranging from grid connection to access and landownership. For this reason, the actual number of suitable sites is likely to be far smaller than the number of sites identified.

You can also gain more information about the potential for hydropower in your area by finding out whether any site or area-specific feasibility studies have been carried out. Potential sources for this information are as follows:

- Your local NRW officers, particularly those dealing with watercourses, and abstraction licensing
- Local hydropower companies, both installers and suppliers. You can find a list of installers on the British Hydropower Association website (http://www.british-hydro.org/)
- Local energy agencies

Project Sheet G: Heat opportunities mapping

This section of the report addresses the following main headings:

Identify anchor heat loads

Residential heat demand and density

Existing DH and CHP schemes and sources of waste heat

Identifying anchor "heat" loads

There are a minimum of two steps (Option 1) to identifying 'anchor' heat loads though a more detailed and comprehensive three step (Option 2) process can be adopted.

The three steps are as follows:

1. Establish geographic location and types of property within study area
2. Establish energy demand of anchor heat loads
3. Identify potential 'heat' clusters

Option 1: Follow steps 1 & 3 only

Option 2: Follow all 3 steps

Step 1: Establish geographic location and types of property within study area

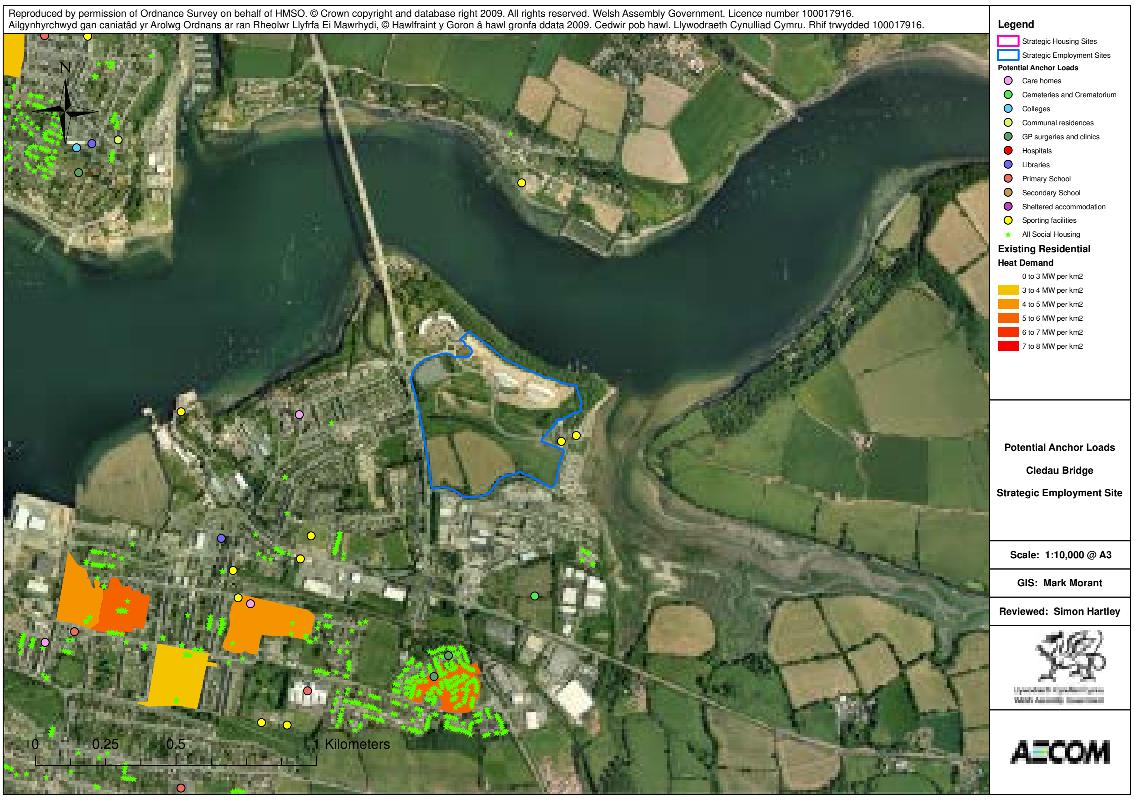
The LLPG is used to establish the exact geographic location and property type of all buildings within a defined area.

The following key property types were considered to be potential anchor heat loads as identified within the LLPG:

- Care Homes
- Colleges
- Factories and Manufacturing
- Fire, Police, and Ambulance Stations
- Hospitals
- Law Courts
- Leisure Centres
- Libraries
- Museums
- Offices
- Power Stations/Energy Production
- Primary, Junior, Infants or Middle School

- Secondary School
- Theatres/Arenas/Stadium
- Water/Sewerage Treatment Works
- Zoos and Theme Parks

Figure 17: Example of an anchor heat load map for an area in Pembrokeshire



Step 2: Establish energy demand of anchor heat loads

Once the type and geographic extent of potential anchor heat loads has been identified the next step is to establish the energy demand.

There are a number of datasets that can be used to establish energy demand. These include:

Public sector data

Private sector data

Public sector data

Energy data should be available for all public buildings as collated by the local authority Energy Manager in order to contribute to their duty in relation to the Carbon Reduction Commitment Energy Efficiency Scheme.

Should energy data not be available then estimates can be made based on known gross internal floor area of each building. CIBSE Technical Memorandum (TM) 46 Energy Benchmark data can then be used to establish a proxy for each building.

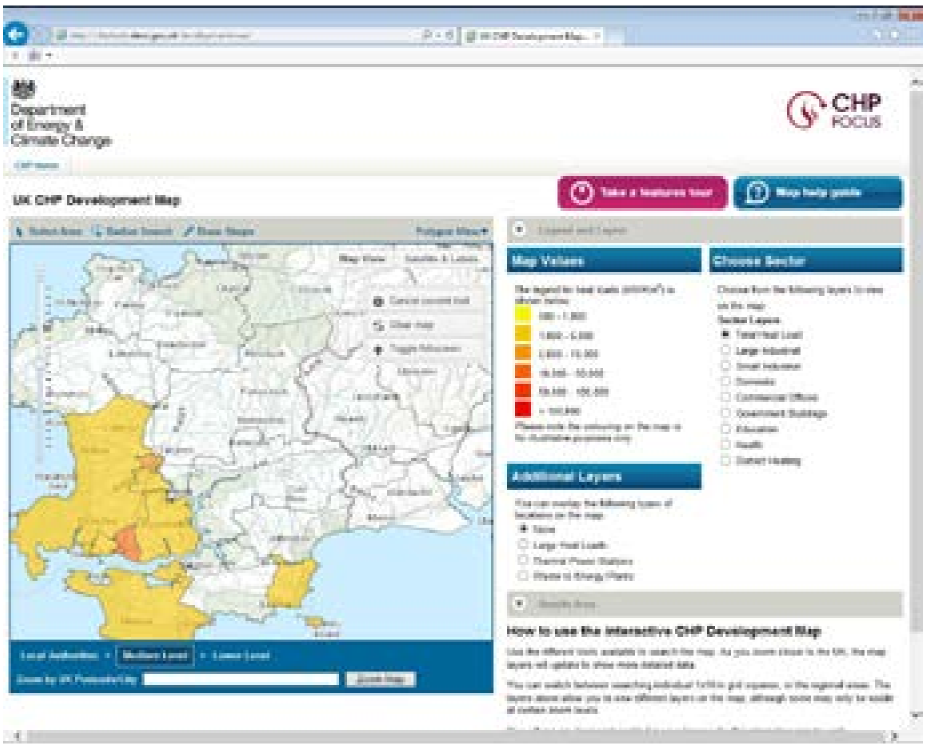
Annual energy consumption data for hospitals can be derived from WHE.

Private sector data

The Valuation Office Agency (VOA) records detailed information on gross internal floor area of private assets. Each asset/building is given a Unique Property Reference Number (UPRN) which can be directly cross referenced to the LLPG to provide a geographic reference. CIBSE TM46 Energy Benchmark data can then be used to establish a proxy for each building.

Another method to identify large existing heat users is to refer to the DECC Heat Map website (http://tools.decc.gov.uk/nationalheatmap/). This identifies large heat users and estimates the size of the heat demand. It also tells you whether that user already has CHP installed or not, an example output from the map is shown below.

Figure 18: Example of heat map output for Pembrokeshire



UK Heat Map, Department of Energy and Climate Change

Step 3: Identify potential 'heat' clusters

Clusters of offices and social housing can also be established as a potential heat demand in their own right. The location of offices can be derived from the LLPG. Social housing data typically is retained by the LA. Where this is not the case social housing providers may be approached directly for data. Detailed information on energy consumption/ demand was not assessed for potential 'heat' clusters.

Residential heat demand and density mapping

2015 Toolkit Update

As part of the 2015 update to this toolkit an 'Active Template' has been produced to easily estimate the residential heat demand and density in your area. You can use the template to filter by local authority as necessary and use the relevant columns within a GIS system to display heat density by either Output Area or Lower Super Output Area.

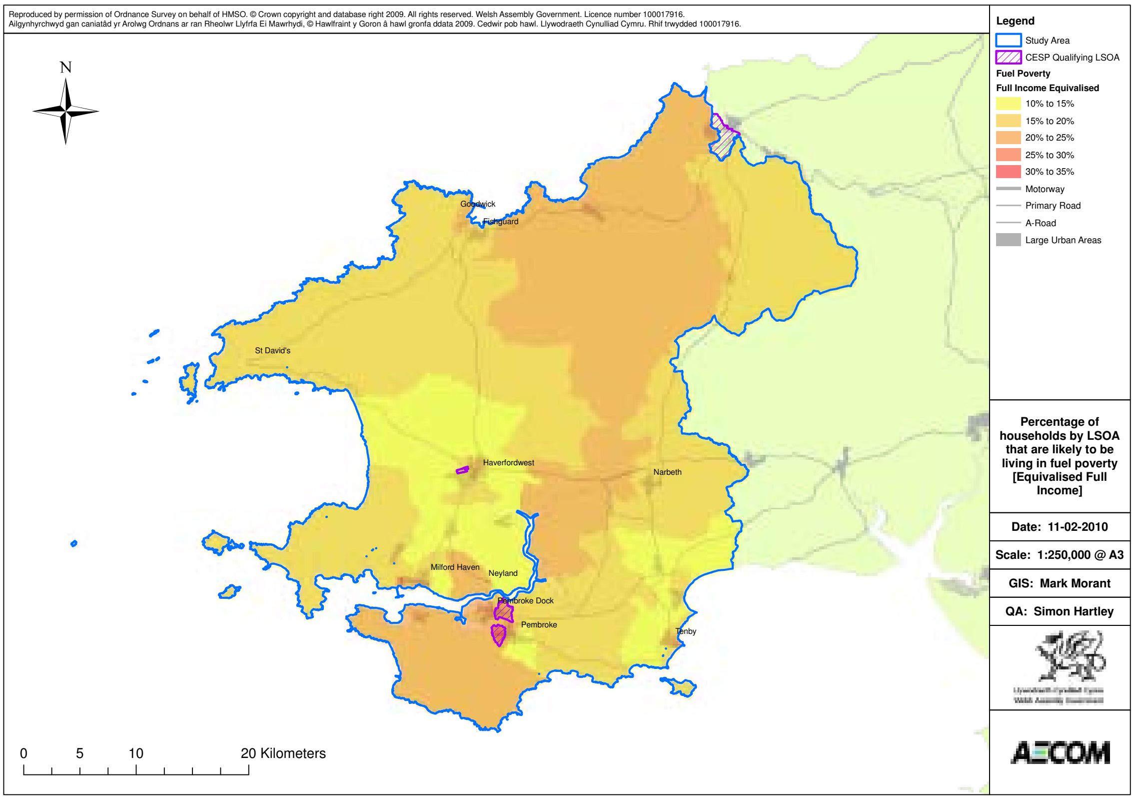
Areas of high fuel poverty

The difficulties of measuring fuel poverty are acknowledged and this is compounded by the use of data to produce the fuel poverty maps originating from the 2001 census and 2004 'Living in Wales' survey. We acknowledge the maps are unlikely to reflect the extent of fuel poverty as it stands today. However, the maps do demonstrate how current data might be used to inform site selection and consideration of LZC technologies.

Step 1: Establish fuel poverty data

You can identify the geographic extent of areas of high fuel poverty by using the Local Fuel Poverty Maps for Wales[74] as indicated in the 'A small area fuel poverty indicator for Wales (Sept 2008)'. You can download the raw data for this from the Welsh Government website, which gives the number of households in each LSOA in fuel poverty. You can then plot on a map the % of households in each LSOA in fuel poverty. This will enable you to identify if any areas are in areas of opportunity for DH.

Figure 19: Fuel poverty for Pembrokeshire



Existing DH & CHP schemes and sources of waste heat

Step 1: Establish location of existing DH & CHP schemes

The geographic location, size and type of existing and approved LZC energy technologies, including DH and CHP schemes are reported on behalf of DECC at the Renewable Energy Planning Database for the UK (www.gov.uk/government/collections/renewable-energy-planning-data). The database reports on all planning applications and currently installed LZC technologies and is updated monthly. At the time of writing the latest available version of the data was April 2015.

Eastings and Northings are given for each LZC planning application allowing the dataset to be geo referenced using a GIS.

Existing and approved LZC energy technologies are assumed to be all records that are defined under the category 'pre consent' as 'application approved' or 'no application required', and have 'post consent' that is either 'awaiting construction', 'operational' or 'under construction.'

This information should then be confirmed and/or updated through consultation with the local authority planning department.

Step 2: Establish location of sources of waste heat

The LLPG can be used to identify the location and type of properties that could potentially be sources of waste heat. These include: landfill, quarries, power stations, recycling sites and water treatment works.

The local authority Energy Manager should also be able to provide information on individual properties that could potentially be identified as sources of waste heat. The geographic location of such properties can be established using the LLPG.

Reference should also be made to the Ofgem ROC database (www.ofgem.gov.uk/environmental-programmes/information-renewables-and-chp-register). By viewing Public Reports and Accredited Stations, it will generate a list of all CHP schemes in the UK that you can download to a spreadsheet. This dataset gives the postcode for each generating station which enables you to map its location. Further reference should be made to the UK Emissions Trading Scheme and Defra Industrial Heat Maps to establish existing EfW facilities and potential sources of waste heat.

All datasets should be checked with the relevant local authority planning department to establish the status of existing and proposed schemes.

References

[74] You can download the raw data at: www.gov.wales/topics/environmentcountryside/energy/fuelpoverty/local-fuel-poverty-maps-for-wales/?lang=en

Project Sheet H: Building integrated renewables (BIR)

Overview

2015 Toolkit Update

As part of the 2015 update to this toolkit it is no longer recommended that the method set out within this project sheet is used to quantify in detail the level of BIR uptake in your local authority area. For ease, it is instead recommended that the simplified method set out within Section E2 of the toolkit is solely used. This project sheet has been retained to provide reference to the original detailed methodology which forms the basis of the simplified methodology.

Section E2 of the toolkit sets out a simplified method for estimating the level of uptake of BIR in your local authority by 2020, based on modelling carried out for Pembrokeshire. This Project Sheet sets out the methodology used to complete the Pembrokeshire assessment for reference so as to better understand the methodology used within the simplified assessment. This project Sheet aims to:

- Explain the process undertaken by specialist experts to enable the use of a simplified methodology
- State outputs achieved in the Pembrokeshire County Council assessment and thus provide detail on key assumptions used within the detailed methodology

Method

The approach used to assess the microgeneration potential for Pembrokeshire County Council consisted of the following steps:

Step 1: Quantifying existing dwellings market segment

Step 2: Quantifying future new build dwellings segment

Step 3: Quantifying existing non-residential market segment

Step 4: Quantifying future new non-residential development market segment

Step 5: Predicting microgeneration uptake for new residential and non-residential development

Step 6: Predicting microgeneration uptake for existing residential and non-residential development

Each of these steps is described in more detail below.

Since the original toolkit was published in 2010, the constants within the modelling application have been updated to better reflect historic uptake in BIR. The simplified methodology set out in Section E2 of this toolkit makes use of these updated results.

Step 1: Quantifying existing dwellings market segment

The sub-categories of existing dwellings were identified and quantified, based on parameters as follows:

Dwelling type: house or flat. This effects the size of energy demand for the dwelling, as well as roof area, and hence size of microgeneration system that can be installed.

The information used in the Pembrokeshire County Council example was collated from the 2001 census data, and Council tax band data to assess the number of new dwellings built since 2001. The method utilised is set out in Project Sheet G.

Type of tenure: owner occupier, private landlord or Council/social rented. This effects the likelihood of installing any given microgeneration system and the nature of the consumer group. Groups who are likely to see a benefit from installing microgeneration, such as owner occupiers, will be more likely to proceed with an installation than a private landlord.

Local authorities in Wales typically have access to data on this for their own area.

The information demonstrated that the majority (73%) of dwelling stock for Pembrokeshire was owner occupied as of 31 March 2008. A further 10% was rented from local authorities, 10% was privately rented and 7% was rented from RSLs.

Location: urban, suburban or rural. This affects the extent to which wind power technologies will be viable.

Local authorities typically retain information on the proportion of households that are in rural or urban areas.

Utilities: on or off gas. Off gas sites are not suitable for gas micro-CHP. Conversely, heating from renewable energy fuels is more attractive in these areas as oil and LPG fuels are more expensive than mains gas.

Individual local authorities may have information on the proportion of households that are off-gas, as part of fuel poverty monitoring. Final energy consumption for each local authority is available from DECC at www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2010

The data illustrates the number of domestic consumers purchasing gas. It is possible to compare this information with the total number of households within the local authority area to give a rough estimate of how many are off gas.

Dwelling age: a proxy for the level of thermal performance of a dwelling, i.e. its annual heating demand. A key break point in time is between those dwellings built prior to 1919, and those after. Primarily this is due to the majority of dwellings built prior to 1919 having solid walls, which therefore cannot be fitted with cavity wall insulation. Data regarding the age composition of the areas housing stock can be retrieved from the local authority officer, or alternatively, information on the age breakdown of the stock for Wales as a whole is available from the Welsh House Condition Survey 1998 (www.gov.wales/statistics-and-research/welsh-house-condition-survey/?lang=en).

Step 2: Quantifying future new build dwellings segment

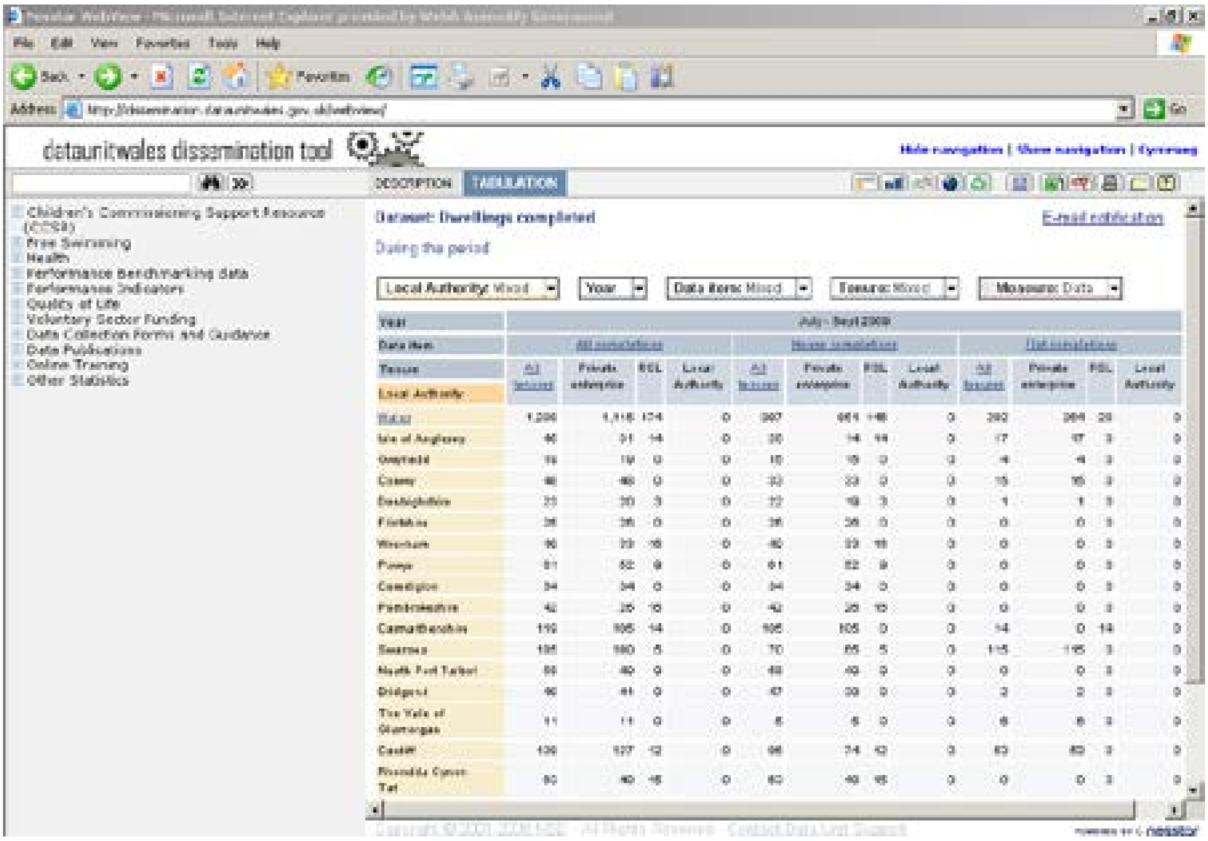
The first figure required is the number of dwellings to be built out in each year. The method undertaken is described in step 1 of Chapter E2 in the main body of the toolkit.

As with existing dwellings, there are a number of similar factors which can come into play in determining which technologies are suitable for a particular dwelling. The sub-categories identified are the same as step 1, without the need to assess the type of tenure. Future Building Regulations apply to all new dwellings equally, regardless of tenure.

The split between houses and flats is based on data regarding new housing completions which are retained by each individual local authority and can also be obtained on-line for each local authority from the Wales Data Unit (see example below).

For the detailed analysis of Pembrokeshire, used to form the basis of the simplified methodology, an average of the last three years' data was used to estimate the split going forwards.

Figure 20: Screen print of new housing completions from Wales Data Unit



The split for urban/rural can be based on the strategy proposed in the LDP for how much development is occurring in rural areas. Alternatively, if no split in the LDP is suggested, the same split as used in step 1 is applied. To identify the proportion of new dwellings to be on or off gas, the data is assumed to be the same as step 1.

The amalgamation of steps 1 and 2 provides an output table, as illustrated below, the data of which was used to feed into an uptake model.

Table 46: Example Layout of Outputs from LA Toolkit steps 1 & 2, Project Sheet H fed into renewable energy technologies uptake model

Viable	Category	Existing dwellings	Future dwellings
Tenure	LA/RSL	Insert % here	n/a
	Owner Occupier	Insert % here	n/a
	Private Landlord	Insert % here	n/a
Location	Suburban	Insert % here	Insert % here
	Rural	Insert % here	Insert % here
	Urban	Insert % here	Insert % here
Type	House	Insert % here	Insert % here
	Flat	Insert % here	Insert % here
Gas Supply	Yes	Insert % here	Insert % here
	No	Insert % here	Insert % here
Age/thermal performance of existing stock	e.g. % pre-1919, 19-1919-1945, 1945-1965, 1965+	Insert % breakdown here	n/a
Total number		Insert number here	Insert number here (average per annum)

Avoiding double counting

Note – if the potential for DH and CHP at strategic sites (see chapter E4), and the output from CHP at those sites as part of area wide installed capacity targets is also being considered, new buildings included in these sites cannot be included in the BIR uptake assessment. Otherwise, the strategic sites will be assumed to have both DH/CHP and microgeneration, which would overstate the potential. This caution does not apply to existing buildings, as any supply of renewable heat to them via heat networks is likely to be additional to any BIR uptake.

Step 3: Quantifying existing non-residential market segment

In order to estimate the potential uptake in non-residential buildings, the buildings are broken down into different categories for modelling purposes, followed by an estimatation of the number of buildings within the category and the typical annual energy demands, for gas, oil and electricity. Typical categories can be separated as follows:

- Public sector
  - Schools
  - Leisure centres
  - Offices
  - Health facilities
- Private sector
  - Retail
  - Warehouses
  - Offices
  - Factories
  - Hospitality/hotels

Data regarding the number of buildings, floor area and the energy use for schools, leisure centres and council offices is typically available from the officer responsible for energy management or facilities, or the WHE. Much of this data will have been collected as set out in Project Sheet G.

For non-public buildings, data for a local authority on floor areas for non-residential buildings can be obtained from the Valuations Office Authority (VOA) who administer business rates. The VOA breaks down non-residential buildings into five "bulk class" sectors, covering: retail, factory, warehouses, commercial offices, and other offices (which includes local authority offices). This data can be downloaded at a local authority level from the neighbourhood statistics website (www.neighbourhood.statistics.gov.uk/dissemination/Download1.do?&nsjs=true&nsck=false&nssvg=false&nswid=1082).

When the list of topics appears, click on the '+' sign of the Physical Environment topic to show the list of datasets available under this topic. The Commercial and Industrial Floorspace and Rateable Value Statistics datasets can be accessed by clicking on the associated button to the right of the screen and then 'Next' in the bottom right corner. This links to a page where the datasets can be viewed online for specific geographies for specific years, or the full set of data for each year can be downloaded in a .csv format.

This dataset shows the total number of businesses in a particular bulk class, and also the total rateable floor area for the bulk class. From that information, for each bulk class, an average floor area for each business is calculated.

For hospitality businesses, which are not included in the VOA dataset, information from the LLPG dataset to identify the number of hotels within the authority area is applied.

Information regarding the typical floor area or number of beds for the hotels within the area is typically available from the tourism officer.

As well as knowing the number of buildings, as with the residential sector, it is also useful to know whether the buildings are located in urban or rural areas, and also whether they are on or off the mains gas network. For public buildings; information is gathered from the relevant authority officers. For non-public buildings, this information is unlikely to be readily available. Therefore, it is assumed the same proportional split between on and off gas, and rural and urban as used for dwellings.

In order to provide input data for an uptake model, a table similar to the one overleaf was utilised:

Consumer groups	**Sub-sectors**	**No. of businesses/ units**	**Typical floor areas (m^2)**
Private ownership buildng types	Retail		
	Office		
	Warehouse		
	Factory		
	Hospitality		
Public ownership building types	Health		
	School		
	Leisure centre without pool		
	Leisure centre with pool		

Step 4: Quantifying future new non-residential development market segment

As for the existing non-residential segment, there are two key sectors in this segment, namely the public sector and commercial development.

For the public sector, information for procuring new buildings, to identify the pipeline of planned new schools, leisure centres, and any other new Council buildings (if any) is acquired from the local authority officer. Information required includes the estimated proposed floor area of each, as well as a description of the building type, e.g. whether a primary or secondary school and the anticipated year of completion. For other public sector buildings, information is obtained from the WHE to identify the pipeline of proposed new health buildings within the area.

For commercial development, an estimation is made of expected floor areas for each type of development, at least in terms of use class (e.g B1, B2, B8, etc.) for non-residential development to be provided over the Plan period. This should be broken down into each year.

In practice, you may only know the potential hectares for each use class. Information regarding the potential hectares for each use class is gathered from previous employment land studies or retail studies undertaken within the area. This provided historical data for forward projections, and enables future projections and requirements to be considered.

If the areas in hectares of sites with the potential to be developed are known, but floor areas are not, ratios between site area and floor space for various building types are used to estimate potential floor space developed. The ratios used to calculate floor area from the projection of annual development in hectares are given in Table 47.

Table 47: Plot ratios for employment use (gross floor space to site area)[75]

	Roger Tym (1997)[76]	Other Studies	Suggested value to use[77]
Business Park	0.25 to 0.30	0.25 to 0.40	0.275
Industrial	0.42	0.35 to 0.45	0.4
Warehouse	-	0.40 to 0.60	0.5
Town Centre Office	0.41	0.75 to 2.00	1.05

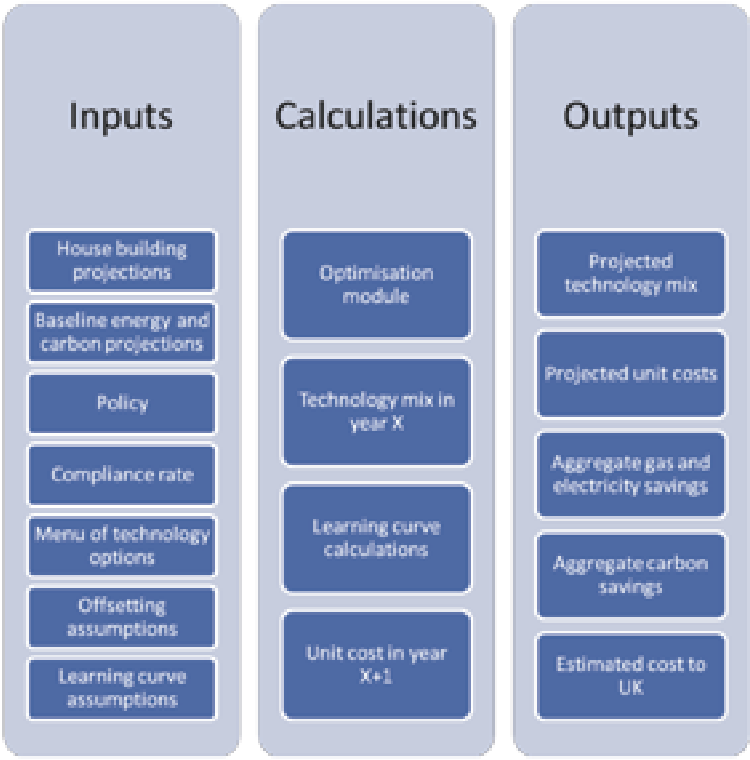
Step 5: Predicting microgeneration uptake for new residential and non-residential development

As mentioned above, this task was carried out by AECOM using Pembrokeshire as the study area. Essentially, it involved building a model that assessed the least (capital) cost technology option for any given building type in any given year to comply with regulatory carbon reduction requirements.

The key outputs that were produced as part of the exercise are as follows:

- Two or three scenarios to account for uncertainty over level of uptake due to uncertainty over future regulatory requirements and technology costs
- For each scenario, a breakdown of the cumulative number of installations for each technology type, the total installed kW for each technology and the kWh of energy generated from each technology for key years, e.g. 2015, 2020 and 2025
- For each scenario, a breakdown of the cumulative installed capacity (in kW) and energy output (kWh) in terms of renewable heat, and renewable electricity, not including low carbon (but not renewable) energy technologies, as these will not contribute to the Wales or UK renewable energy targets

Figure 21: Schematic of cost model used for UK Government's zero carbon homes policy research



Step 6: Predict microgeneration uptake for existing residential and non-residential development

This section addresses the projected uptake of microgeneration in existing buildings. Microgeneration uptake in existing buildings is not currently driven by policy, unlike uptake in new buildings. Instead uptake is driven by consumer choice, incentivised by:

- Energy cost savings and maintenance
- Grants
- Revenue incentives – i.e. FIT
- Versus: unfamiliarity, capital costs, inconvenience

Two modelling approaches have been used by national studies:

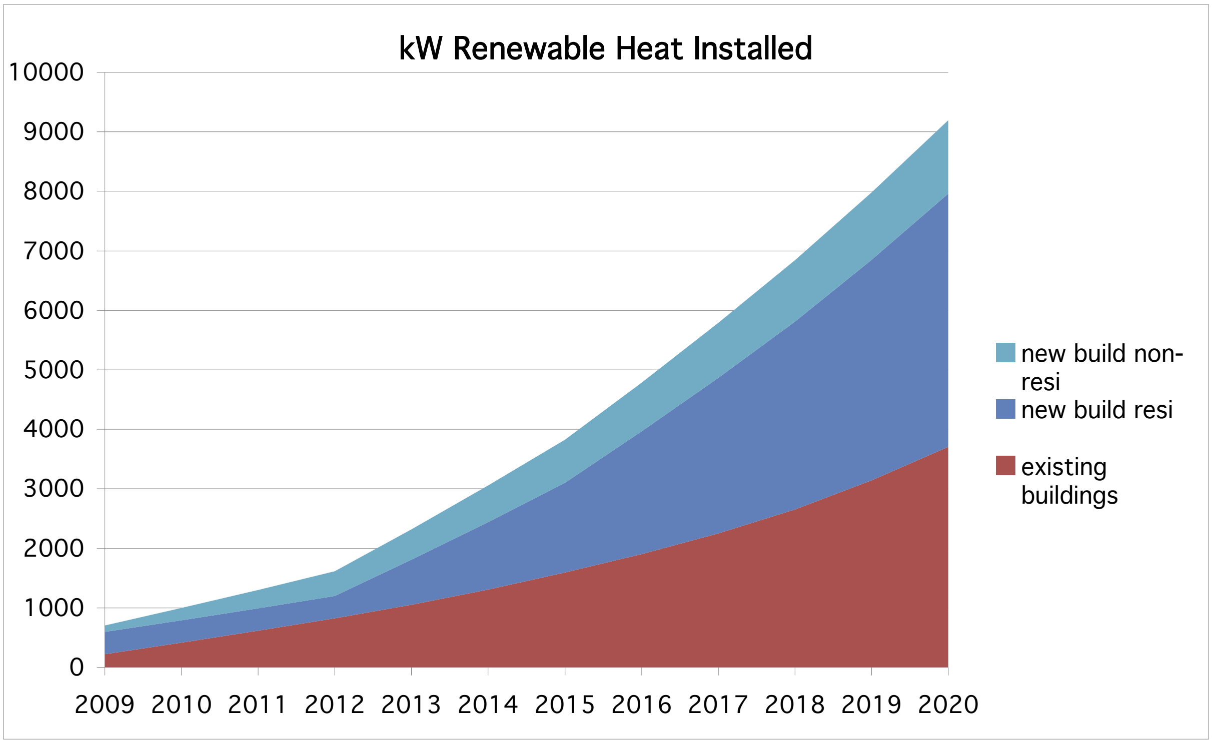
1. Determine the potential capacity for each technology based on estimated uptake rate, growing to an estimated limiting capacity.
2. Discrete consumer choice model as used by Element Energy in their 2008 report.[78]

The first method is useful to determine the maximum uptake of a given technology, but the technology totals cannot be added together to find a total installed capacity (as householders would be double counted). This limitation led Element Energy to develop a discrete choice model for their 2008 report. A discrete choice model attempts to simulate uptake based on consumer's values versus technology attributes. The consumer's values are represented by coefficients based on extensive survey results.

For the Pembrokeshire pilot study AECOM developed its own discrete choice model based on the survey coefficients from Element Energy's 2008 report.

The final outputs should be as for step 5 and should give the cumulative total installed renewable power (kWe) and heat (kWh) each year and the cumulative number of installations. An example of the output that might be produced by a consultant, covering the combined output from steps 5 and 6 is given below[79].

Figure 22: Example output (from Pembrokeshire case study) from BIR uptake model



References

75 Employment Land Reviews: Guidance Note, (D)CLG, December 2004

76 Roger Tym & Partners, 1997 and ERM Review

77 These values are averages of the previous two columns. Area data on historical plot ratios specifically was considered where available and used in preference to the values in the table

78 The growth potential for Microgeneration in England, Wales and Scotland, Element Energy, June 2008, available at http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file46003.pdf

79 As mentioned above, for informing area wide renewable energy targets, it is only the uptake of renewable energy BIR that are of interest, therefore the uptake of non-renewable BIR (i.e. micro-CHP) needs to be netted off

Project Sheet I: Energy baseline/future target guidelines

Existing energy baseline

This section delineates the method employed for base-lining area wide energy consumption. The method relies upon:

- Predicted future energy demand as indicated in the UK Renewable Energy Strategy.
- Welsh Government derived data and statistics currently published by DECC.

Step 1: Establish future energy consumption

The UK Renewable Energy Strategy (RES) reports the 2008 and future [2020] energy consumption across the UK for the three main energy sectors: electricity, heating and transport. It also reports the proportion that is met, and that will need to be met in the future, by renewable energy sources.

Table 48: Final UK energy consumption in 2008 and projected for 2020

	2008		2020	
	All Energy (TWh)	Renewable Energy (TWh)	All Energy (TWh)	Renewable Energy (TWh)
Electricity	387	22	386	117
Heat	711	7	599	72
Transport	598	9	605	49
Total Final Energy Consumption	1,695	39	1,590	239

The above table indicates that total final energy consumption will contract by circa 6.6% between 2008 and 2020, with electricity consumption reducing by 0.3%, heat consumption reducing by 18.7%, and transport consumption increasing by 1.2%.

The total proportion of renewable energy generated by each key energy sector is anticipated to increase by a total of 612.8%, with renewable electricity generation increasing by 531.8%, renewable heat generation increasing by 1,028.6%, and renewable energy from transport increasing by 612.8%.

Step 2: Establishing existing energy consumption

Total annual energy consumption data is currently reported at a national, regional and local authority level by DUKES (www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes). An example of energy data from DUKES is given below.

Table 49: Total energy 2006 (GWh) by DUKES energy sector for the UK, Wales and for Pembrokeshire

	Total Energy 2006 (GWh)		
Sector	**UK**	**Wales**	**Pembrokehsire**
Coal (Industrial/Commercial)	26,754	1,454	72
Coal (Domestic)	4,838	632	42
Manufactured fuels (Industrial/ Commercial)	6,720	1,586	0
Manufactured fuels (Domestic)	2,585	155	2
Petroleum products (Industrial/ Commercial)	189,176	16,555	8,726
Petroleum products (Domestic)	39,481	2,707	220
Petroleum products (Road Transport)	496,244	24,757	907
Petroleum products (Rail)	8,628	562	13
Natural gas (Industrial/ Commercial)	229,555	12,803	128
Natural gas (Domestic)	399,179	19,599	543
Electricity (Industrial/ Commercial)	203,346	11,794	782
Electricity (Domestic)	125,048	5,600	260
Renewables & Waste	6,939	609	25

Note: Natural gas (industrial/commercial) and natural gas (domestic) figures are reported on a Great Britain level only and do not include Northern Ireland.

Additional datasets are available from 2002 to 2012.

As recommended in the UK RES, energy consumption data should be split into the following energy sectors: Electricity, Heating, and Transport. The energy sectors as identified within the DECC 2005 and 2006 total final energy consumption datasets should be classified as follows:

Table 50: Classification of DECC Energy Sector to UK RES Sector

DECC Energy Sector	UK RES Sector
Coal (Industrial/Commercial)	Heat
Coal (Domestic)	Heat
Manufactured fuels (Industrial/Commercial)	Heat
Manufactured fuels (Domestic)	Heat
Petroleum products (Industrial/Commercial)	Heat
Petroleum products (Domestic)	Heat
Petroleum products (Road Transport)	Transport
Petroleum products (Rail)	Transport
Natural gas (Industrial/Commercial)	Heat
Natural gas (Domestic)	Heat
Electricity (Industrial/Commercial)	Electricity
Electricity (Domestic)	Electricity
Renewables & Waste	n/a

Note: Natural gas (industrial/commercial) and natural gas (domestic) figures are reported on a Great Britain level only and do not include Northern Ireland.

Once the key energy sectors have been collated, the total energy for the reported period can be calculated. The table below provides an example of the split between electricity, heat and transport for the UK, Wales and for Pembrokeshire for 2006; updated data is included for your consideration in Tables 52 and 53.

Table 51: Total DECC Energy 2006 (GWh) data reported by UK RES energy sector for the UK, Wales and for Pembrokeshire

	Total Energy 2006 (GWh)		
Sector	**UK**	**Wales**	**Pembrokehsire**
Electricity	328,393	17,394	1,042
Heat	898,287	55,489	9,735
Transport	504,871	25,319	919

Step 3: Monitoring Progress

As indicated by the UK RES, energy consumption for electricity, heat and transport can be predicted up to 2020 for both total energy consumed and for the proportion met by renewables. Using the same growth predictions, local authorities can establish their predicted 2020 energy consumption and proportion that should be met by renewables. Annual monitoring using the DECC data provides a robust framework in which to assess overall energy consumption.

Updated Information

The figures published above in the Tables 49 and 51 relate to data available at the initial time of publication, and thus correlate to the Pembrokeshire County Council Renewable Energy Assessment Pilot Study. Tables 52 and 53 below provide the most recent data for your consideration, all information is available from; Sub-national total final energy consumption statistics: 2005-2012 www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2010

Table 52: Total energy 2012 (GWh) by DUKES energy sector for the UK, Wales and for Pembrokeshire

	Total Energy 2012 (GWh)		
Sector	**UK**	**Wales**	**Pembrokehsire**
Coal (Industrial/Commercial)	18,633	1483	18
Coal (Domestic)	5,866	763	38
Manufactured fuels (Industrial/ Commercial)	33,676	7825	2633

Sector	Total Energy 2012 (GWh) UK	Wales	Pembrokehsire
Manufactured fuels (Domestic)	3,838	273	6
Petroleum products (Industrial/ Commercial)	121,762	12,816	9424
Petroleum products (Domestic)	31,511	2,983	347
Petroleum products (Road Transport)	428,019	21,084	762
Petroleum products (Rail)	8,094	374	11
Natural gas (Industrial/ Commercial)	186,899	9,674	108
Natural gas (Domestic)	322,615	14933	410
Electricity (Industrial/Commercial)	180,814	10,055	803
Electricity (Domestic)	110,050	5,230	243
Renewables & Waste	16,561	2326	51

Note: Natural gas (industrial/commercial) and natural gas (domestic) figures are reported on a Great Britain level only and do not include Northern Ireland.

Table 53: Total DECC Energy 2012 (GWh) data reported by UK RES energy sector for the UK, Wales and for Pembrokeshire

Sector	Total Energy 2012 (GWh) UK	Wales	Pembrokehsire
Electricity	290,864	15,285	1,046
Heat	724,799	50,750	12,985
Transport	436,112	21,458	773

Project Sheet J: Calculating Annual Energy Output using Capacity Factors

The results of the area wide resource assessments, for different technologies, as described in section E1 will give an indication of the potential installed capacity (in terms of MW of power output) that can be supported by the available resource.

However, the UK renewable energy target for 2020 is expressed in terms of a % of energy demand. Therefore, in order to be compatible with this target, as well as knowing the potential installed renewable energy capacity in an area, you also need to be able to estimate how much energy this capacity could generate.

A simple and well established way of doing this is to use capacity factors[80]. These factors, which vary by technology, are a measure of how much energy a generating station will typically produce in a year for any given installed capacity. This reflects the fact that the installed capacity is a measure of the maximum amount of power that a generating station can produce at any given moment. However, for reasons to do with either fuel availability[81], the need for maintenance downtime, or, for heat generating plant, a lack of heat demand at certain times of day or year, the capacity factor is always less than 1.

For any particular technology, the capacity factor (CF) is defined as follows:

CF = (typical annual energy output)/(annual energy output if plant generated at full capacity for the entire year)

Therefore, for any given generating station, its annual energy output can be calculated by multiplying its installed capacity by its capacity factor and the number of hours in a year.

For example, a biomass power station with an installed capacity of 5MWe, and a CF of 0.9 the annual energy output would be:

$$5 \times 0.9 \times 365 \times 24 = 39,420 \text{ MWhe}$$

Those forms of renewable electricity generation that rely on intermittent natural flows of energy (such as wind, PV and hydropower) inevitably have lower capacity factors than those that are fuelled by biomass (or waste), in its various forms, as the biomass can be stored to ensure a continuity of supply. A summary of different capacity factors for different technologies is given below:

Table 54: Renewable electricity generation capacity factors

Technology	Capacity factor	Comments and source
Onshore wind	0.27	DUKES 2009, figure for 2008
Biomass (animal and plant matter)[82]	0.9	typical for gas and coal fired power stations[83]
Hydropower	0.37	DUKES 2009, figure for 2008
EfW	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
BIR electricity	0.1	this is an average for PV and micro and small wind
Solar Farm	0.1	Regen SW

Table 55: Renewable heat generation capacity factors

Technology	Capacity factor	Comments and source
Heat from CHP (from biomass or EfW, or from large scale heat only biomass or EfW)	0.5	This allows for the fact that not all of the waste heat can be usefully used 100% of the time
BIR 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

References

80 These are also sometimes referred to as load factors

81 Which, in the case of renewable energy, includes natural energy flows such as the wind, sun and water, as well as solid fuels such as biomass

82 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

83 Markal energy model, 2007, chapter 5 Project Sheet of model documentation, www.ucl.ac.uk/energy-models/models/uk-markal/uk-markal-manual-chapter-5 The Markal energy model was used for the projections in the 2007 UK Energy White Paper

Project Sheet K: Assessing Solar Photovoltaic (PV) Farm Resource

Introduction

Completion of this Project Sheet should enable local authorities to identify and allocate areas for potential PV Farm projects. The method enables spatial identification of the land parcels to accompany LDP policy.

Photovoltaic (PV) solar cells/panels generate renewable electricity from the direct conversion of solar irradiation. It is recognised as one of the key technologies in helping to meet the UK target of 15% renewable energy from final consumption by 2020. In 2012, 84% of all new renewable installations across Wales were solar PV; this figure is expected to increase due to high level interest in larger stand-alone installations.

DECC defines a "stand-alone" installation as a "solar photovoltaic electricity generating facility that is not wired through a building, or if it is wired through a building, the building does not have the ability to use 10% or more if its electricity generating on site", typically greater than 5MW. www.regensw.co.uk/blog/2015/01/member-update-decc-announce-important-changes-to-feed-in-tariff-for-communities/

As a relatively new phenomena, there is currently no standard agreed approach to constraints mapping for Solar PV Farms. This section therefore provides a potential approach on how to undertake a high level assessment of the potential solar resource from 'stand-alone' PV farms in your local authority area.

Constraints mapping facilitates a visual representation of 'usable' land resource for large-scale 'stand-alone' PV developments. This remaining area can then be assessed to establish the potential installed capacity and electricity generation potential.

- It is worth noting, detailed assessment of a particular site may reveal proposed PV farm impacts to be manageable and to meet regulatory and policy requirements
- Conversely, land indicated as suitable through GIS mapping may prove to be technically and/or financially unviable

It is not appropriate to consider all site level issues as part of this high level assessment of potential resource. Other more detailed steps may be best assessed at the planning application stage for an individual site. Such activities might include:

- landscape sensitivity analysis
- distance to the nearest appropriate electricity grid connection, if electricity is to be exported
- proximity to public rights of way, bridle ways

Alternatively, local authorities may wish to commission work to understand landscape and cumulative impacts to support their assessments, if these are likely to be persistent issues.

Examples of items that may be more difficult to include might be:

- Where formal consultations are held, for example with the MoD and Civil Aviation Authority to identify any potential objections to certain sites in relation to glare and glint disruption
- the practical access to sites required for development
- landowner willingness for development to go ahead

Methodology

You can assess the available solar PV resource for your local authority area, using GIS constraints mapping, by following the steps below:

- Step 1: Map locations of built-up areas and infrastructure
- Step 2: Map further environmental and heritage constraints
- Step 3: Map areas of suitable slope and topology
- Step 4: Addressing cumulative impact
- Step 5: Assess potential installed capacity and energy output
- Step 6: Map locations of suitable Agricultural Land Classification and apply further constraints as necessary

Step 1: Map built-up areas and locations of other infrastructure

The location of built-up areas and existing infrastructure will significantly constrain any deployment of large-scale stand-alone PV farms. Data on urban regions and infrastructure, including motorways, A-roads and B-roads and railway stations and tracks can be obtained using the Strategi dataset from Ordnance Survey at the following location: (www.ordnancesurvey.co.uk/opendatadownload/products.html)

Please note that by following this step potentially suitable areas within urban regions (e.g. warehouse yards) are not identified. It is therefore recommended that a high-level assessment of your local authority's major towns/cities is conducted using a satellite-imagery tool so as to identify any areas that should be included for further, more detailed analysis. As a guide, these sites should be greater than 3 acres in area.

Step 2: Map environmental and heritage constraints

The location of woodland areas, as well as the extent of lakes and rivers, can be obtained from the Strategi dataset above. Flood Warning Areas should be mapped with data available from the Welsh Government as follows: (http://data.wales.gov.uk/apps/floodmapping/)

Existing environmental and heritage constraints can restrict the location of potential large scale solar PV farms. You should therefore map in GIS the geographic extent of the following national environmental and heritage constraints:

- Special Protection Area (SPA)
- Special Area of Conservations (SAC)
- Candidate Special Area of Conservation (cSAC)
- RAMSAR sites
- National Nature Reserves (NNR)
- Local Nature Reserves (LNR)
- Site of Special Scientific Interest (SSSI)
- Marine Nature Reserves (MNR)
- Scheduled Ancient Monuments (SAM)
- Areas of Outstanding Natural Beauty

The above constraints can be mapped using data obtained from NRW at the following location: (http://lle.wales.gov.uk/)

You should assume, for the purposes of the assessment, that there is no potential for large scale solar PV farm developments in these areas; although in practice some of these sites may not be constrained. The above list is not intended to be exhaustive and where additional environmental and/or heritage constraints exist they should also be taken into consideration.

Step 3: Map areas of suitable slope and topology

The performance of a photovoltaic panel system is directly related to the inclination, orientation and shading and thus individual site surveys are ideal when determining site suitability. For the purposes of this high level assessment however, it is necessary to make assumptions on the suitability of slope gradient and orientation for large-scale PV deployment.

The terrain information used to establish slope orientation is contained within the Terrain 50 dataset, available from Ordnance Survey at the same website as that specified within Step 1 above.

It is suggested that for inclinations of 0-3° from the horizontal, all orientations can be considered suitable, whilst for inclinations between 3-15° only south-west to south-east facing areas should be included and all other orientations should be included as constraints. All slope inclinations above 15° should be added as a constraint.

Step 4: Addressing cumulative impact

The output from the above steps will give an estimate of the maximum accessible solar PV resource in your local authority area. However, in reality, harnessing all of that resource may cause cumulative impacts (these might include visual, landscape or be constrained by capcity to feed into nearest grid point), particularly in more rural areas. Therefore at this point, if your local authority has identified any cumulative issues, this potential impact needs to be incorporated as a constraint and the accessible resource revised accordingly.

Should the local authority decide upon restricting the development of stand-alone PV farms within close proximity of each other, it is recommended, when compiling maps that larger sites are assumed to be the ones that will be built out. Dependent upon the restriction decided upon, the surrounding land should be excluded from the assessment and the next largest site selected outside of the exclusion zone and so on until all remaining sites are accounted for.

Step 5: Assess potential installed capacity and energy output

According to the DECC UK Solar PV Strategy Part 1: Roadmap to a Brighter Future (see: www.gov.uk/government/uploads/system/uploads/attachment_data/file/249277/UK_Solar_PV_Strategy_Part_1_Roadmap_to_a_Brighter_Future_08.10.pdf) the land area required for a 1MW fixed-tilt PV array is approximately 6 acres (or 2.4Ha or 0.024km^2). This figure should be used to determine the potential installed capacity of each site. It is recommended that a cut off equivalent to 0.5MW (i.e. 3 acres, 1.2Ha or 0.012km^2) is applied, as any sites smaller than this are less likely to be viable (commercially speaking) for development.

In order to assess the annual energy output from each identified site, a capacity factor of 0.1 has been assumed (see Project Sheet J). This can be used to calculate the total annual generation in much the same way as other technologies included within this toolkit; that is to say the annual energy output is a product of its installed capacity, the capacity factor and the number of hours in a year.

For example, solar farm 2 from Table 56, with an installed capacity of 43MW and a CF of 0.1 would have the following annual energy output:

43 x 0.1 x 365 x 24 = 37,668 MWh

Step 6: Map locations of suitable Agricultural Land Classification and apply further constraints as necessary

Large-scale solar PV farms must be appropriately sited; this means utilising lower grade agricultural land (preferably of Agricultural Land Classification 3b, 4 or 5), or promoting the effective use of contaminated land, brownfield land, and previously developed/industrial land under national planning policy recommendations (see section 4.9 and 4.10 of Planning Policy Wales). The aim of this proposal is to protect the best and most versatile agricultural land; however it is understood diversification helps to support agriculturally based businesses, promoting multi-functional use of land in some cases. Once at this stage, discussion should take place with Welsh Government to determine suitability on a case-by-case basis where necessary (correspondence directed towards LUPUnit@Wales.GSI.Gov.UK).

By carrying out the above steps, you will be able to ascertain a number of areas of unconstrained land potentially available for large-scale solar PV farm development. Should this not limit the number of sites to a manageable number for further, more detailed study (say 20-30), the following steps could be considered:

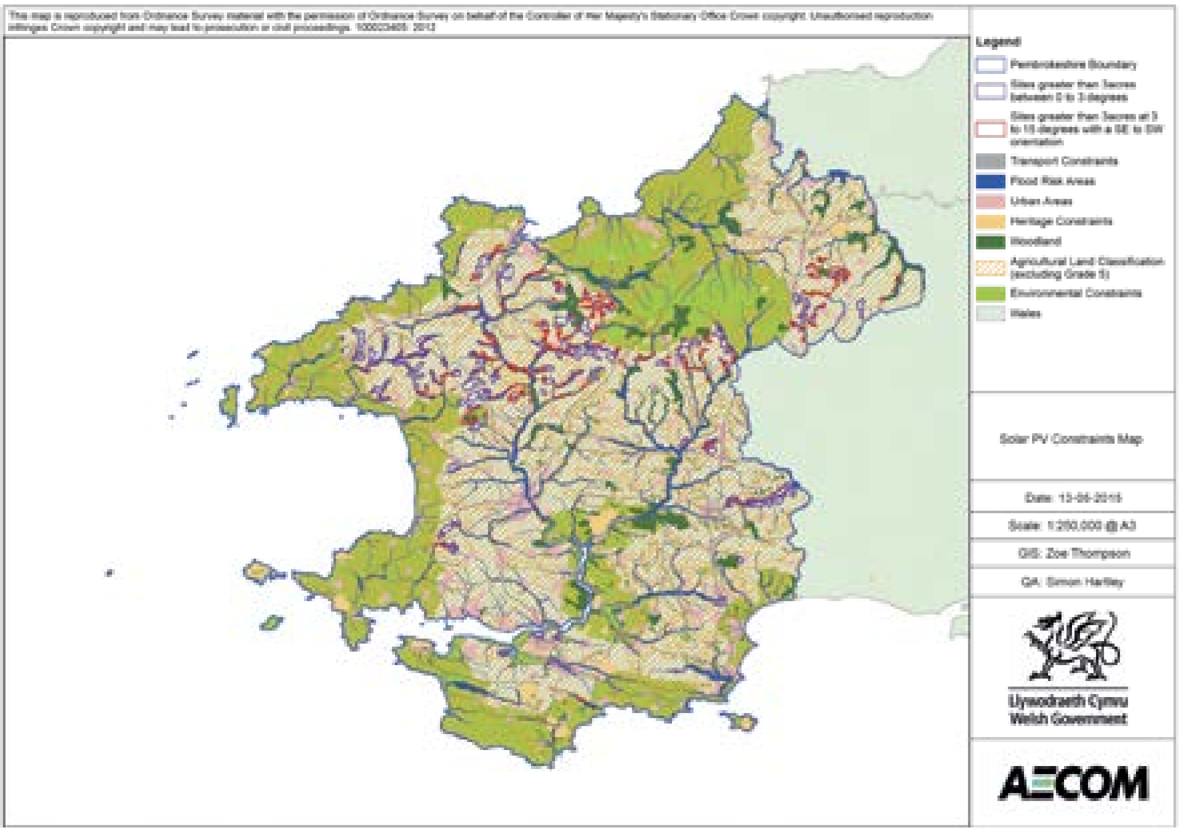
- Further constrain the Agricultural Land Classification (for example, to grades 4 and 5 only), ensuring that only the poorest quality agricultural land is utilised (on consultation with the Welsh Government)
- Apply further constraints based upon LANDMAP data, at the planners discretion. Refinements could include constraining suitable areas to certain higher quality grasslands, for example. The LANDMAP dataset is retrievable from NRW, at the same location as that set out for Step 2

As part of the 2015 toolkit revision, an example exercise has been carried out for Pembrokeshire using the steps 1-6 described above. A tabulated output of the five largest sites identified within the assessment can be seen below, whilst the results of the mapping exercise can be seen in the figure opposite. Please note that in this instance without consulting with the Welsh Government only land of ALC Grade 5 (i.e. poorest quality) has been assumed suitable.

Table 56: Example of accessible solar PV resource output for Pembrokeshire County

Potential solar PV farm	Area (acres)	Potential capacity (MW)
1	322	53.6
2	258	43.0
3	252	42.0
4	231	38.5
5	222	37
Total	1,285	214.1

Figure 23: PV constraints map for Pembrokeshire



Sheet K

Figure 24: Estimate of potential solar PV sites in Pembrokeshire