Replacement Local Development Plan 2018-2033

Background Paper

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BP 33: Renewable Energy Assessment

CONWY
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1. Introduction

1.1 Background to this Assessment

The Welsh Government is required to make a contribution to the International, EU and UK targets for greenhouse gas emission reductions. The Climate Change Act 2008 provides the statutory framework for the reduction of greenhouse gas emissions in the UK. At the core of the Act is a requirement for the UK to reduce net UK greenhouse gas emissions by 80% by 2050 – and CO_2 emissions by at least 34% by 2020 – against a 1990 baseline. The Act also established a system of five-yearly carbon budgets, to serve as stepping stones on the way. Wales is currently in the process of establishing its own carbon budgets.

The UK is currently subject to the requirements of the EU Renewable Energy Directive to achieve 15% of energy from renewables by 2020. The UK Renewable Energy Roadmap sets the path for the delivery of these targets. Beyond 2020, the first five carbon budgets, leading to 2032, have been set in law. Meeting the fourth carbon budget (2023-27) will require that emissions be reduced by 50% on 1990 levels in 2025, and meeting the fifth (2028-32) will require that emissions be reduced by 57% on 1990 levels in 2030.

The Welsh Government is committed to playing its part by delivering an energy programme which contributes to reducing carbon emissions as part of its approach to mitigating anthropogenic 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).

The aims of The Environment (Wales) Act 2016 are to secure reduce reliance on energy generated from fossil fuels. Part 2 of The Act sets out a framework for emissions reduction, a long term target for emission reduction by 2050, with supporting interim targets and carbon budgets. The new targets for Wales are to:

- Generate 70% of electricity consumption from renewable energy by 2030;
- One Gigawatt of renewable electricity capacity in Wales is to be locally owned by 2030;
- New renewable energy projects to have an element of shared ownership.

The Well-being of Future Generations Act (Wales) 2015 places a duty on the Welsh Ministers (and other public bodies) to produce well-being objectives and take reasonable steps to meet those objectives in the context of the principle of sustainable development. The Welsh Government has resolved that the planning system will play an important role in mitigating anthropogenic climate change through reducing greenhouse gas emissions.

The Welsh Government's Climate Change Strategy was published in October 2010, and outlined a target to reduce greenhouse gas emissions in Wales by 3% each year from 2011, relative to a baseline of average emissions over 2006-2010. It has also committed to a reduction of 40% in greenhouse gases in all sectors levels by 2020 from 1990 levels.

The use of fossil fuels is seen as a major contributor to greenhouse gas emissions, a major cause of global climate change. Moving towards a low carbon energy based economy to mitigate anthropogenic climate change and improve energy security are Welsh Government priorities.

1.2 Purpose of this Assessment

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

- **Preparing planning policies** and allocating land in Local Development Plans (LDPs)
- **Development management** – taking decisions on planning applications submitted to the Local Planning Authority (LPA) for development; as well as preparing Local Impact Assessments.
- **Corporate** – taking action at a council wide level to achieve a low carbon economy.
- **Leadership** – taking forward wider community action and communicating the need to increase the uptake of renewable energy.

This Renewable Energy Assessment (REA) constitutes an evidence base informing the LDP. This enables decisions to be taken based on policies that support and facilitate the deployment of renewable and low and zero carbon energy systems. The REA consists of a high-level strategic assessment of the potential for different scales of renewable and low and zero carbon energy generation in different locations.

In terms of development management, the REA (used in conjunction with national planning policy guidance – 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners', Welsh Government (September 2015) ('the Toolkit') will be useful in three 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 and solar PV farm developments and other technologies, it can assist officers in understanding why a developer has chosen a particular location to develop a scheme.

As well as supporting Conwy County Borough Council (CCBC) planning officers, the intention is that the renewable energy opportunities identified will also be useful in assisting CCBC to fulfil its role as a community leader, leading by example through its actions.

1.3 Method employed by this REA

This REA was originally compiled based on the method set out in the Welsh Government guidance document 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners' July 2010. A revision of the 'Toolkit' was produced for September 2015 and, in response this REA has been updated to incorporate changes. Also, where appropriate, new methods have been introduced to meet the requirements of Planning Policy Wales and/or to better reflect local data / circumstances.
The method is based on a Geographic Information System (GIS) approach to enable spatial identification of renewable energy opportunities. The outputs of this approach are maps that accompany and support policies. The maps referred to in this REA can be located in the document 'Conwy Renewable and Low Carbon Energy Assessment 2017 – Maps'.

1.4 Why this REA is important

This REA will inform action to support the deployment and delivery of renewable and low and zero carbon energy installations on the ground. This is expected to assist in meeting the two key challenges for UK energy policy, namely:

i. Mitigating anthropogenic climate change by reducing carbon dioxide emissions, and;

ii. Improving energy security.

At a LPA strategic level, this REA provides an evidence base for the following policy[1] objectives, as follows:

- Identification and promotion of potential sites for renewable energy generation (not necessarily linked to new development);
- Development of area wide renewable energy contributions (e.g. installed megawatt of heat and electricity generation) as a stimulus for concerted local action;
- Informing the selection of land for development (allocation of sites), by identifying those sites with the greatest potential for sustainable energy and carbon reduction or sites that potentially could preclude renewable energy developments (e.g. by sterilising good wind power sites);
- Identification of opportunities for delivering strategic energy options that could link to an offset fund (i.e. some Council's, where land values may be less, view this as an opportunity to make sites more attractive to developers by making them "low and/or zero carbon enabled", rather than seeking to increase development burden by setting sustainability standards in excess of future Building Regulations.);
- To enable LPA exploration of requiring developers to connect to an existing or proposed district heating network (e.g. how much could they charge, how close would a development need to be and so on).

This REA delineates CCBC's evidence base in support of its approach to securing renewable energy developments. The policy mechanisms to be employed by CCBC have been developed through consideration of this study revision.

[1] Meant in the broad sense, i.e. not just planning policy

Within the REA, and at high level, the 'accessible' renewable energy resource has been identified. In addition, a high-level evaluation has been undertaken of opportunities relating to where renewable and low and zero carbon energy may be linked to new development via district heating networks (DHNs). The DHN analysis can be found in the report appended to this REA.

This REA presents information that is potentially useful to developers and wider stakeholders alike in facilitating partnerships and taking forward delivery of the opportunities identified for CCBC.

1.4.1 Wider corporate role

All local authorities including CCBC have objectives and requirements for mitigating the effect of and adapting to climate change. This REA enables CCBC to identify specific opportunities to facilitate renewable and low and zero carbon energy generation.

The opportunities identified can form the basis of more detailed implementation plans, feasibility studies and practical action to contribute towards a broader range of objectives. For instance, the opportunities may contribute to 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[2].

1.5 Scope of this Renewable Energy Assessment

1.5.1 Planning

The REA focuses on planning policy though there are associated implications for development management. This assessment has been developed primarily for CCBC as the local planning authority, as an evidence base to inform renewable and low and zero carbon energy contributions and policies in the LDP.

This REA, and the targets and policies that it informs, will necessitate procedures for use by development management officers to assess planning applications for stand-alone renewable energy generating systems: this assessment has informed Development Management policies with the detail supplied in Renewable Energy SPG to be developed.

The assessment excludes Snowdonia National Park (SNP) which is a planning authority in its own right and data has been amended accordingly. Where no accurate way has been found to apportion renewable energy resource, generation or future uptake, a 4% apportionment sourced from CCBC and based on relative population has been utilised.

1.6 Technology

This assessment is not an exhaustive guide to the different renewable and low and zero carbon energy technologies that are available. Technical Advice Note 8[3] provides an introduction to a range of renewable and low and zero carbon technologies that should be the first point of reference. Other technology is listed by The Department for Energy and Climate Change[4] and the Energy Saving Trust[5].

1.6.1 Energy Hierarchy

The REA focuses on renewable and low and zero carbon energy generation, and the opportunities for promoting this through the Local Development Plan (LDP), 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 the effects of anthropogenic climate change: it is at least as, if not more, important. However, it is not covered in this REA because there is only a limited amount that planning policy for new developments can contribute in this area, over and above the Approved Document Part L of the Building Regulations[6]. AECOM refers the reader to other sources of information on energy efficiency in buildings, existing and new, that already exist[7].

1.6.2 Transport

The REA does not include an assessment of the potential for renewable or low carbon fuels for transport.

1.6.3 Stand-alone electricity generating assets

Whilst Strategic Search Areas (SSAs) are alluded to (as they impact in the Conwy LPA area and effectively ring

[2] Low Carbon Wales, Sustainable Development Commission , 2009
[3] Technical Advice Note 8, Renewable Energy, http://wales.gov.uk/desh/publications/planning/technicaladvicenotes/ta n8/
[4] DECC http://www.planningrenewables.org.uk/page/index.cfm
[5] Energy Saving Trust at http://www.energysavingtrust.org.uk/EnergySaving-Trust-advice-centre-Wales
[6] Obviously, there is a lot that can be done to reduce energy use in existing buildings, but these do not generally fall with the remit of the planning system.
[7] E.g. from the Energy Saving Trust in Wales, as per the web-link given above.

fence land for on-shore wind development), the REA is not intended to duplicate the analysis carried out in TAN 8.

Rather, the REA is concerned with identifying ways in which to secure additional opportunities for electricity generation outside of SSAs that would be determined either by the Welsh Government under The Developments of National Significance Regulations (2016) (DNS) or by the local planning authority.

Additionally, the potential for Local Search Areas (LSAs) are identified for wind farm developments (of between 5MW and 25MW per wind farm) and for solar PV farms (of between 5MW and 50MW) that might be investigated further for such development.

1.6.4 Soundness

This REA is based upon use of the Welsh Government guidance 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners' (2015). However, the 'Toolkit' does not provide a definitive template for sound evidence and it remains the sole responsibility of the Local Planning Authority to prepare appropriate evidence in support of LDP policies and the decisions taken in the LDP.

Assumptions and data used in carrying out this REA have been sought from established sources, and these are either referenced as footnotes to the text or appropriately appended. Where there are no established source assumptions have been derived based on available evidence and through dialogue with the Local Planning Authority.

In the future, guidance, assumptions and data sources may change, particularly as technology and the policy and regulatory framework evolves.

1.7 Defining renewable energy and low / zero carbon energy

1.7.1 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 PPW[10] (Paragraph 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 carbon dioxide (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 solar water heating and photovoltaic panels (electricity). Ground source heat pumps[11] 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 from the oceans; and biomass energy (from burning organic matter), as all plants photosynthesise sunlight in order to fix carbon and grow.

As long as replanting occurs, the combustion of biomass fuel is acknowledged as 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.

Biomass is generally regarded as non-fossil fuel when at least 98% of the energy content is derived from plant or animal matter or substances derived thereof.

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.

[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] Planning Policy Wales (Edition 9, November 2016)

[11] 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.

Of all these resources, perhaps the most complex and multi-faceted is biomass energy, because it can take so many forms. Biomass energy can include:

- Burning of forestry residues;
- Anaerobic digestion of animal manures and food wastes;
- Combustion of straw and other agricultural residues and products;
- Methane produced from the anaerobic digestion of biodegradable matter in landfill sites (i.e. landfill gas)' and;
- Energy generated from the biodegradable fraction of waste going into an energy from waste plant.

1.8 Technologies addressed in this REA

This REA covers the following renewable energy technologies (considering both electricity and heat):

- **Wind energy** on-shore wind generating electricity only;
- **Biomass Combined Heat & Power (CHP) and/or biomass boilers**: simultaneous generation of heat and electricity, or just heat generation from sources including forestry residues, *Miscanthus* and short rotation coppice;
- **Incineration (Energy from Waste)**: generation of heat from sources including waste wood, municipal waste, industrial and commercial waste – can include CHP for simultaneous generation of heat and power;
- **Anaerobic Digestion**: generation of gas and/or heat and electricity if CHP enabled, from sources such as food waste, agricultural wastes, and sewage sludge;
- **Hydropower**: generation of electricity from inland (non-coastal) water courses only;
- **Solar PV farms**: generation of electricity only;
- **Building Integrated Renewable** (BIR), generation of heat and electricity utilising technologies such as biomass boilers; air and ground source heat pumps, photovoltaics; small and micro wind power.

1.8.1 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 employed;
- Stirling engine or fuel cell CHP, where the heat is usefully employed;
- The non-biodegradable fraction of the output from energy from waste plants.

This REA covers both renewable as well as low carbon forms of energy and the extent to which both can be considered has informed the policy objectives selected by CCBC.

1.8.2 Power vs. energy output

In the context of this Renewable Energy Assessment, power and heat is measured in either kilowatts (kW), or megawatts (MW), which is a thousand kW, or gigawatts (GW), which is a thousand MW. It is a measure of the electricity or heat output being generated (or used) at any given moment in time. The maximum output of a generator, when it is running at full load, is referred to as its installed capacity or rated power/heat 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 certain assumptions have been made to calculate both the potential installed capacity (or maximum power output) of different technologies, as well as the potential annual energy output.

1.8.3 Electricity vs. Heat output

In terms of the units used, to avoid confusion, it is 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 electricity and heat simultaneously when used in a Combined Heat & Power (CHP) plant.

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

2. Policy context and drivers for renewable energy

2.1 Introduction

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 mitigating the effect of anthropogenic 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).

The Welsh Government has resolved that all Local Planning Authorities will play the fullest possible part in meeting statutory UK and EU targets on greenhouse gas emission reduction.

The use of fossil fuels is seen as a major contributor to greenhouse gas emissions, a major cause of global climate change. Moving towards a low carbon energy based economy to mitigate anthropogenic climate warming and improve energy security are Welsh Government priorities.

2.2 UK and European energy 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. The UK Renewable Energy Strategy (UK RES)[12] suggests that by 2020, this could mean:

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

The UK RES sets out how the UK could 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.

The Roadmap confirms that approximately 90% of the energy generation necessary to meet the 15% target can be delivered as is set out in Table 1 below. The remaining renewable energy generation necessary to meet the 2020 target, will come from technologies such as hydropower, solar PV, and deep geothermal heat and power.

Table 1: *Technology breakdown (TWh) for central view of deployment in 2020.*

Technology	Central range for 2020 (TWh)
Onshore wind	24 to 32
Offshore wind	33 to 58
Biomass (electricity)	32 to 50
Marine	1
Biomass (heat)	36 to 50
Heat Pumps	16 to 22
Renewable transport	Up to 48
Other	14
Estimated 15% target	**234**

The information in Table 2 shows the Welsh Government's assessment of sustainable renewable energy potential for Wales as a whole from 2020 to 2025. ('A Low Carbon Revolution' – The Welsh Government Energy Policy Statement (March 2010) Appendix 1 (p19)).

[12] The UK Renewable Energy Strategy, DECC, May 2009

Table 2: *Wales' sustainable renewable energy potential 2020 to 2025*

Technology	Total capacity (GW)	Deliverable in main by
Onshore wind	2	2015 to 2017
Offshore wind	6	2015 to 2016
Biomass (electricity)	1	2020
Tidal range	8.5	2022
Tidal stream / wave	4	2025
Local electricity generation	1	2020
Total (MWe)	**22.5**	**2020 to 2025**

2.3 Wales' policy context for planning and renewable energy

Planning Policy Wales states that 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 Renewable Energy Directive[13] contains specific obligations to provide guidance to facilitate effective consideration of renewable energy sources, high-efficiency technologies and district heating and cooling in the context of development of industrial or residential areas, and (from 1 January 2012) to ensure that new public buildings, and existing public buildings that are subject to major renovation fulfil an exemplary role in the context of the Directive.

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 and Low Carbon Energy – A Toolkit for Planners[14].

'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners' sets out a method that local authorities might use to produce an evidence base in support of their Local Development Plans: this evidence base is referred to as a 'Renewable Energy Assessment'.

This Renewable Energy Assessment can assist CCBC planning policy officers deliver the national planning policy expectations as set out in PPW[15], namely:

- **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. Further advice is contained in Practice Guidance – Planning for Sustainable Buildings[16].

- **4.12.6** Applications that reflect the key principles of climate responsive developments and exceed the standards set out in Building Regulations should be encouraged.

- **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 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.

- **12.1.4** The Welsh Government aims to secure the environmental infrastructure necessary to achieve sustainable development objectives, while minimising adverse impacts on the environment, health and communities. New approaches to infrastructure will be needed in light of the consequences of climate change. The objectives are: to promote the generation and use of energy from renewable and low carbon energy sources at all scales and promote energy efficiency, especially as a means to secure zero or low carbon

[13] EU Renewable Energy Directive, 2009
[14] 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government 2015 Update
[15] Planning Policy Wales (Edition 9, November 2016)

[16] Practice Guidance – Planning for Sustainable Buildings (Welsh Government 2014)

developments and to tackle the causes of climate change;

- **12.1.5** The planning system has an important part to play in ensuring that the infrastructure on which communities and businesses depend is adequate to accommodate proposed development so as to minimise risk to human health and the environment and prevent pollution at source. This includes minimising the impacts associated with climate change.

- **12.1.6** The capacity of existing infrastructure, and the need for additional facilities, should be taken into account in the preparation of development plans and the consideration of planning applications. In general, local planning authorities should seek to maximise the use of existing infrastructure and should consider how the provision of different types of infrastructure can be co-ordinated.

- **12.1.7** Local planning authorities must develop a strategic and long-term approach to infrastructure provision when preparing development plans. They should consider both the siting requirements of the utility companies responsible for these services to enable them to meet community needs and the environmental effects of such additional uses. Development may need to be phased, in consultation with the relevant utilities providers, to allow time to ensure that the provision of utilities can be managed in a way consistent with general policies for sustainable development.

- **12.1.8** It is essential that local planning authorities consult utility companies and other infrastructure providers and Natural Resources Wales at an early stage in the formulation of land use policies. Welsh Government guidance in *Local Development Plan Manual Edition 2 (August 2015)* provides details of the bodies which must be consulted about particular issues to ensure that plan policies are realistic and capable of implementation. Local authorities are also required to consult appropriate bodies and to take their views into account when determining planning applications.

2.3.1 TAN8 & Ministerial letters

Technical Advice Note (TAN) 8 (2.13) is noted whereby:

> *'The Assembly Government would support local planning authorities in introducing local policies in their development plans that restrict almost all wind energy developments, larger than 5MW, to within SSAs and urban/industrial brownfield sites. It is acceptable in such circumstances that planning permission for developments over 5MW outside SSAs and urban/industrial brownfield sites may be refused'.*

However, it is also clarified in TAN8 that it is referring only to "most areas" and elaborates that, whilst a whole county should not be covered with wind turbines, a balance is required between the desirability of renewable energy and **landscape protection** that should not result in severe restriction on the development of wind power capacity. LPAs should consider the evidence as it relates to their localities and particularly where there is potential nearby to SSA boundary lines.

The Ministerial Letter (ref: SF/CS/2027/15) dated 10 December 2015 reflects the most up-to-date position of the Welsh Government in respect of planning for renewable energy. It is clear from the letter that the Welsh Government wishes local authorities to "formulate local policies (including allocations or areas of search) … for 5MW-25MW renewable energy schemes or other low carbon energy generation", subject to the evidence.

In relation to wind energy, this REA is therefore primarily concerned with identifying opportunities for wind development of between 5MW and 25MW outside of the SSAs: but in the interest of completeness, the assessment of maximum available/potential wind resource across the Conwy LPA includes areas of land both inside and outside of the SSA.

2.3.2 Permitted development rights

To encourage take-up, changes have been made in Wales to 'permitted development' rights to make provision for the installation of certain types of micro-generation by householders and for non-domestic buildings without the need for planning permission, namely solar photovoltaic and solar thermal panels, ground and water source heat pumps, flues for biomass heating and other technologies.

3. Calculating the energy consumption in the Conwy LPA area in 2022 and 2031

3.1 BEIS energy reporting

The Business Energy and Industrial Strategy Department of the UK Government (formerly the Department for Energy & Climate Change) publishes annual energy consumption (GWh) at a sub national level.

The electricity and gas consumption for Conwy during 2008 was reported as 430GWhe and 882GWht.

However, the BEIS dataset does not split consumption between the Conwy Local Planning Authority (LPA) area and Snowdonia National Park (SNP) LPA area and so, utilising population figures sourced from CCBC (circa 4%[17] of the population of Conwy live in the SNP) energy consumption has been apportioned accordingly.

This means that the energy consumption for the Conwy LPA area was 413GWhe and 847GWht (see Table 3).

Table 3: *Existing energy consumption (GWh) for the UK, Wales, and for Conwy in 2008 (DECC)*

	Electricity (GWh)	Thermal (GWh)
UK	304,625	815,624
Wales	16,267	55,657
Conwy	430	882
% energy consumed in the SNP	4	4
Conwy LPA	**413**	**847**

Electricity consumption across the Conwy LPA area represented circa 2.5% of Wales total reported electricity consumption, and circa 0.1% of the UK's total reported electricity consumption in 2008.

Natural gas consumption across the Conwy LPA area represents circa 1.5% of Wales total reported Natural Gas consumption, and circa 0.1% of the UK's total reported Natural Gas consumption in 2008.

3.2 Calculating future energy consumption

The UK Renewable Energy Strategy (UK RES) comprises detail of the energy consumption in 2008 and predicted future (2020) energy consumption across the UK for electricity and natural gas. The UK RES report confirms that within this period electricity energy consumption will contract by circa 0.3%, and that natural gas consumption will contract by circa 15.8%.

CCBC's current Local Development Plan period runs until 2022: it will then be extended to 2031. Using the UK RES to derive annual rate of change (from 2008 to 2020), this REA therefore comprises a projection of energy consumption in the Conwy LPA area to 2022 and 2031. Thus, the predicted electrical and thermal annual energy consumption across the Conwy LPA area in 2022 is 411GWhe, and 694GWht respectively (see Table 4).

Table 4: *Predicted energy consumption for the Conwy LPA area in 2022 and 2031.*

	Electricity (GWh)	Thermal (GWh)
Energy consumed in 2008	**413**	**847**
Projection to 2020[18]	99.7%	84.2%
Predicted energy consumed in 2020	412	713
Annual rate of change between 2008 and 2020	-0.025%	-1.32
Total percentage change from 2020 to 2022	-0.05%	-2.63%
Predicted energy consumption in 2022	**411***	**694***
Total percentage change from 2020 to 2031	-0.35%	-18.02%
Predicted energy consumption in 2031	**410***	**612***

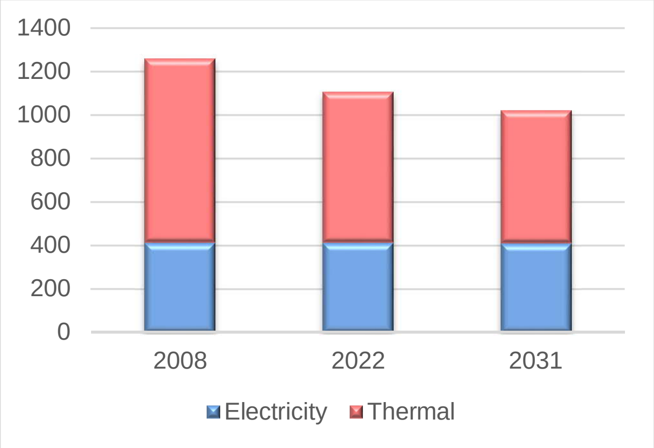
**Numbers are rounded down to whole GWh.*

[17] According to the Conwy Local Development Plan 2007-2022 adopted October 2012, section 1.9 (p17), c4% of the people of Conwy live in the Snowdonia National Park

[18] Based on projected change as identified in Table 2.1, of The UK Renewable Energy Strategy (2009)

Figure 1 below illustrates the predicted change in energy consumption in the Conwy LPA area between 2008, 2022 and 2031 with total electricity consumption reducing by circa 3GWh, and total heat consumption reducing by circa 235GWh.

Figure 1: *Predicted change in energy consumed in the Conwy LPA between 2008, 2022 and 2031 .*



3.3 LZC energy technologies in the Conwy LPA area in 2017

To understand the progress being made with the development of Low and Zero Carbon (LZC) technologies, the existing capacity (correct at 08/08/2017) of LZC technologies in the CCBC LPA area has been established. Where LZC energy technologies already exist (including both those consented and to be constructed; and those under construction), the installed capacities (measured in MW) were recorded to inform discussions about future contributions.

This assessment of existing capacity includes technologies generating electricity, heat and both electricity and heat simultaneously. The assessment includes 'stand-alone' generators (such as wind farms) as well as those installed in buildings (e.g. biomass boilers).

The locations of 'stand-alone' wind and solar PV generators (unconnected to buildings) have been plotted using GIS. The installed capacities of existing energy from waste schemes and biomass schemes have also been marked for their potential contribution to supply heat to strategic new development sites.

Data for existing large-scale projects has been derived from CCBC, BEIS (formerly DECC)[19] and Ofgem[20]. Data regarding LZC technologies that are providing energy to buildings are located within or on buildings, has been collected from the following sources:

- The Local Authority;
- Feed-in-Tariff (FiT) & Renewable Heat Incentive (RHI) Registers (Ofgem).

3.4 Capacity of LZC energy technology installations in 2017

3.4.1 'Stand-alone' LZC energy installations in 2017

The total capacity (including operational, under construction or consented, correct at the time of writing) of 'stand-alone' renewable energy technologies in the Conwy LPA area was calculated as 210.2MWe and 16.3MWt (see Table 5).

Table 5: *Renewable energy generation from 'stand-alone' installations in the Conwy LPA area at 08/08/ 2017*

Technology	Electricity (MWe)	Thermal (MWt)
Biomass	2	10
Hydropower	33.6	-
Landfill Gas	2.9	6
Wind Power	149.4[21]	-
Solar PV Farms	22.1	
Other (Sewage Gas)	0.2	0.3
Total	**210.2**	**16.3**

Of the above total for electricity generation, wind energy (including the SSAs) accounts for 149.4MWe, hydro 33.6MWe, biomass 2MWe, solar PV farms 22.1MWe, landfill gas 2.9MWe and sewage gas the remaining 0.2MWe. Of the 16.3MWt thermal generation, the CHP at Llandulas Landfill Site accounts for 6MWth, biomass CHP 10MWth and Sewage gas CHP 0.3 MWth.

[19] DECC (2011) *RESTATS Monthly Extract,* https://restats.decc.gov.uk/app/reporting/decc/monthlyextract

[20] Ofgem (2011) *Renewables & CHP – Accredited Stations,* https://www.renewablesandchp.ofgem.gov.uk/Public/ReportManager.a spx?ReportVisibility=1&ReportCategory=0 .

[21] Total wind power is 239.36MW when including off shore wind (Rhyl Flats Wind Farm-90MW).

In the context of overall Welsh Government renewable energy targets as set out in the Energy Policy Statement[22], and including operational, under construction and consented, the Conwy LPA area could be contributing approximately 11% of the target of 2GW of electrical energy associated with onshore wind.

3.4.2 Capacity of 'building-integrated' LZC installations in 2017

As outlined in Table 6, the total installed capacity of 'building-integrated' renewable energy installations in the Conwy LPA area (as at 08/08/2017) was calculated as 8.1MWe, and 8.7MWt (excluding the above-mentioned CHP at Llandulas). Photovoltaic systems accounted for circa 5.6MWe, with micro-wind generating 1.5MWe.

The breakdown of technology types is unknown for renewable heat generation but the RHI register identifies 88 'non-domestic' renewable heat installations with installed capacity of 7.8MWt. 138 domestic renewable heat installations are also identified but with no installed capacities: we have assumed 5kW per dwelling giving a total additional figure of 0.7MWt, giving a total of 8.5MWt under other.

Table 6: *Renewable energy generation from 'building-integrated' installations in the Conwy LPA area in 2017*

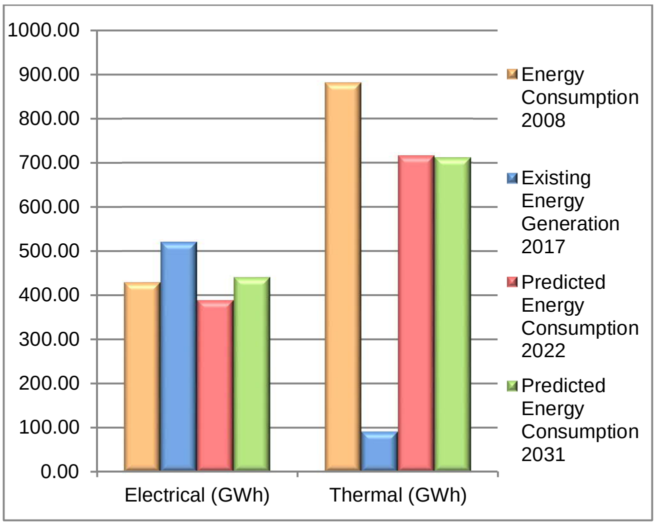
Technology	Electricity (MW)	Thermal (MW)
Hydropower	0.9	-
CHP	0.1	0.2
Photovoltaic	5.6	-
Other	-	8.5
Wind Power	1.5	N/A
Total	**8.1**	**8.7**

The total existing renewable installed capacity in the Conwy LPA area in 2017 was calculated as 218.3MWe of electrical power, and 25MWth of thermal energy.

The maximum amount of energy that could be generated from the above installations depends upon the capacity factor, which is discussed in the section of this report entitled 'Setting LPA Wide Renewable Energy Contributions'. Based on typical capacity factors, the total theoretical renewable energy generation in the Conwy LPA area as at 08/08/2017 is calculated as 520GWhe (520,467 MWhe), and 87GWht (86,636 MWht).

Figure 2 shows a comparison of the potential amount of energy that could be generated by currently installed renewable energy technologies and the predicted energy consumption across the Conwy LPA area in 2022 and 2031.

Figure 2: *Difference between the renewable energy generation (GWh) of current (2017) installations and predicted consumption (in 2022 and 2031)*



[22] A Low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement; March 2010

4. Wind Energy Resource

4.1 Introduction

The focus of this section of the REA is on establishing the potential wind resource across the Conwy LPA area.

For the purposes of planning policy in Wales large scale wind power has been defined in TAN 8 as wind farms of greater than 25MW. Wind farms with more than 25MW of generating capacity can only be sited in an SSA.

TAN 8 provides details of ‘Strategic Search Areas’ (SSA), sites identified as suitable and potential locations for large scale wind.

There is one large SSA in the south-east section of the Conwy County Borough Council, containing the Alwen Reservoir, Llyn Brenig reservoir, extending south to Pentrellyncymner, finishing before the A5. This SSA extends outside of the Conwy County Borough boundary into Denbighshire.

Technical Advice Note (TAN) 8 (2.13) is noted whereby:

> *‘The Assembly Government would support local planning authorities in introducing local policies in their development plans that restrict almost all wind energy developments, larger than 5MW, to within SSAs and urban/industrial brownfield sites. It is acceptable in such circumstances that planning permission for developments over 5MW outside SSAs and urban/industrial brownfield sites may be refused’.*

However, it is also clarified in TAN8 that it is referring only to “most areas” and elaborates that, whilst a whole county should not be covered with wind turbines, a balance is required between the desirability of renewable energy and **landscape protection** that should not result in severe restriction on the development of wind power capacity. LPAs should consider the evidence as it relates to their localities and particularly where there is potential nearby to SSA boundary lines.

The Ministerial Letter (ref: SF/CS/2027/15) dated 10 December 2015 reflects the most up-to-date position of the Welsh Government in respect of planning for renewable energy. It is clear from the letter that the Welsh Government wishes local authorities to “formulate local policies (including allocations or areas of search) for 5MW-25MW renewable energy schemes or other low carbon energy generation”, subject to the evidence.

In relation to wind energy, this REA is therefore primarily concerned with identifying opportunities for wind development of between 5MW and 25MW outside of the SSA: but in the interest of completeness, the assessment of maximum available/potential wind resource across the Conwy LPA includes areas of land both inside and outside of the SSA.

4.2 Mapping

Maps have been produced to illustrate at each stage the process of identifying spatial constraints and opportunities. Throughout, reference is made to titles and reference numbers to correspond with maps contained in the accompanying document ‘Conway Renewable and Low Carbon Energy Assessment – Maps’. The maps follow a series of steps as follows:

4.2.1 Step 1:

Map Reference & Title: W1 – Wind Resource in the Conwy LPA Area

A map has been produced to show wind speeds sufficient for the development of wind farms. The performance of wind turbines is a function of wind speed. Utilising Ordnance Survey maps and Meteorological Office data sourced via the Welsh Government, AECOM has created a 1.5km^2 grid GIS data layer for the Conwy LPA area showing average annual wind speed at 45m above ground level (agl) attributed to each respective 1.5km^2 cell.

Areas with wind speeds greater than 6.5m/s and those between 6.0m/s and 6.5m/s are differentiated in order to inform an area prioritisation exercise later in in the process. It has been assumed that there is no wind energy potential in areas with an average annual wind speed of less than 6.0m/s.

At this stage, the areas shown on the map are only constrained by the Conwy LPA and the SNP LPA boundaries.

4.2.2 Step 2:

Map Reference & Title: W2 - Environmental & Heritage Constraints

To establish the potential wind energy resource across the Conwy LPA area, consideration has been given to the spatial constraints associated with restrictions to wind energy development. A comprehensive table of the data sources and assumptions used is given in Appendix B: Wind Energy Resource Methodology.

There are numerous constraints when considering wind energy development to establish the maximum potential wind resource across the Conwy LPA area, and these are discussed below.

4.2.2.1 Statutory Designations

The wind constraints maps illustrate the principal constraints to the development/ deployment of wind energy. Many of the constraints can be attributed to statutory designations such as environmental and historic protected sites. The statutory designations utilised for this assessment are as follows:

- Special Protection Areas (SPA) and foraging buffers
- Special Areas of Conservation (SAC)
- Candidate Special Areas of Conservation (cSAC)
- RAMSAR sites
- National Nature Reserves (NNR)
- Sites of Special Scientific Interest (SSSI)
- Marine Nature Reserves (MNR)
- Scheduled Ancient Monuments (SAM)
- Areas of Outstanding Natural Beauty (AONB)
- National Parks (already constrained in Map 1)
- Historic Landscapes

4.2.2.2 Non-Statutory Considerations

The purpose of this assessment is to establish, through the identification of constrained areas, the maximum potential wind energy resource across the Conwy LPA area.

Many of the non-statutory designations are specifically linked to minimising potential impacts upon people or infrastructure through the application in the maps of buffer areas. The extent of the buffer areas are informed directly by the characteristics of the turbine (e.g. height of turbine; etc.).

This assessment is based on constraints associated with a typical 2 MW wind turbine[23] to maintain consistency with the Welsh Government guidance contained in 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners'[24]. For ease of reference, the assumptions about the wind turbine are:

- Rated output: 2MW
- Hub height: 80m
- Rotor diameter: 80m
- Height to blade tip at the highest point ("tip height"): 120m

Noise buffers have been applied by AECOM around existing buildings. Given the noise related impact that wind turbines can have on building occupants, particularly residents, and the spatial extent that such an impact can have on identifying potentially available wind resource, this study has assumed there will be no wind energy development within 500m distance of any buildings.

[23] It should be noted that this does not preclude the potential development / deployment of larger or smaller wind turbines across the Conwy LPA area.

[24] Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government 2015 Update

The non-statutory designations considered are:

- Ancient Woodlands
- Areas of historic and cultural importance
- Major transport infrastructure – Topple distance plus 50m
- Minor transport infrastructure – Topple distance plus 10%
- Existing buildings – 500m (Noise Buffer)
- Protected Landscapes (National Parks & AONBs 7km)
- Strategic Search Areas, existing and consented (but not yet constructed) wind farms and those proposed in the planning system as of 31/03/2017 (7km)[25]
- Watercourses – including major, secondary and minor rivers, canals and lakes.
- Woodlands – including broad leaved woodland and ancient woodlands.
- Aviation and radar – includes data supplied by Ministry of Defence (MOD), National Air Traffic Service (NATS), Civil Aviation Authority (CAA) and Low Flying Tactical Training Areas.
- Areas of thick peat

There are no remaining least constrained land parcels of sufficient area to identify wind LSAs for local authority wide schemes of installed capacity range 5-25MW.

4.2.3 Step 3

Map Reference & Title: W3 – Wind Resource Available

There is no map

At this stage of the assessment, land slivers, fire breaks and tracks, as well as parcels of land insufficient to support a wind farm of 5MW or more (this is a minimum of 0.5km^2 based on using 2MW turbines) are removed from the maps.

There are no remaining least constrained land parcels of sufficient area to identify wind LSAs for local authority wide schemes of installed capacity range 5-25MW.

4.2.4 Step 4

Map Reference & Title: W4 – Wind Resource Available within Grid Connection

There is no map

Onshore wind farms require a connection to the grid to which to export the electricity.
PPW[26] requires consideration of the electricity grid as part of the renewable energy evidence base to inform LDP policies.

A key constraint to the development of wind farms can be the cost of connecting to the electricity grid. A high-level cost analysis exercise has been undertaken.

Similar to the approach taken in the development of TAN8[27], areas that are considered likely to be too distant to connect to grid cost effectively have been constrained.

Electricity grid comprising 33, 66 and 132kV has been mapped with only sites with available resource within 10km of any line being considered accessible[28].

There are no remaining least constrained land parcels of sufficient area to identify wind LSAs for local authority wide schemes of installed capacity range 5-25MW.

4.2.5 Step 5 – Local Search Areas

There is no map.

There are no remaining least constrained land parcels of sufficient area to identify wind LSAs for local authority wide schemes of installed capacity range 5-25MW.

[25] This includes wind development outside of the boundary of the county where the 7km cumulative impact buffer extends inside the Conwy LPA area.
[26] Planning Policy Wales (Edition 9), Welsh Government November 2016
[27] 'Facilitating Planning for Renewable Energy in Wales- Meeting the Target - Final Report 'Welsh Assembly Government July 2004 Section 5.3.4

[28] Whilst grid information has been utilised to constrain some sites, it does not imply that remaining sites could connect: studies would need to be conducted in detail for each individual project.

There are no LSAs identified.

It should be noted that technology advances could enable single turbines which meet the policy thresholds to come forward anywhere there is potential resource and subject to site specific assessment.

It is also anticipated there will still be some wind contribution in the REA through smaller schemes and single turbines.

4.3 Maximum available wind resource

This report has assumed that a maximum of five 2 MW wind turbines can be installed on 1km^2 of land. Therefore, the minimum area for a 5MW wind farm is 0.5km^2.

The total area of unconstrained wind resource informs the calculation of the total potential capacity and informs the setting of renewable energy contributions from the Conwy LPA area. Assuming that over the course of a year a 2 MW wind turbine will only generate energy for 27%[29] of the time (2,365 hours), the total potential energy (GWh) has been calculated.

Table 7: *Theoretical maximum potential wind resource (km^2) for the Conwy LPA area excluding the SSA.*

Wind Resource	
Area (km^2)	0
Potential Capacity (MW)	0
Generating Time (hours /year)	8,760
Capacity Factor (%)	27
Potential Energy Generated (GWh)	**0**

The installed capacity figure represents the maximum accessible wind resource in the Conwy LPA area, excluding the SSA (which is counted as 'existing generation'). Therefore, the additional future potential is outlined in Table 7

[29] DUKES 2009, cited in Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government 2015 Update

4.4 Further constraints to wind energy sites

Further constraints to onshore wind development not considered within this REA include (and this is not meant to be an exhaustive list):

- Practical access to sites required for development;
- Landowner willingness for development to go ahead;
- Political will;
- Time to complete planning procedures.
- An economic distance to the nearest appropriate electricity grid connection.

4.5 Potential opportunities for future development

In relation to wind energy, potential opportunities for CCBC could be:

- Investment interest of Energy Services Companies (ESCOs);
- CCBC involvement with ESCO to secure greater community benefits;
- Wind farms can provide significant revenue streams.

5. Biomass Energy Resource

5.1 Introduction

The focus of this section of the REA is on establishing the potential biomass resource defined as either:

- Energy crops (miscanthus & short-rotation coppice), or;
- Wood fuel resource.

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

Unlike wind farms, biomass can be utilised for the generation of both electricity and heat & domestic hot water (DHW).

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 biodegradable elements from the waste stream;
- CO_2 savings if replanting occurs and long-distance transportation is avoided.

The Welsh Government's Energy Policy Statement (2010) confirms a target of 1,000MWe (1GWe) capacity from biomass by 2020. This is circa 7TWh per annum of electrical production coming from biomass.

There are currently 2 large woodchip biomass plants located at Mochdre Commerce Park and Tir Llwyd Enterprise Park. They are both identical and have 1MW electrical and 5MW heat capacity. There have also been a small number of domestic/residential applications to install biomass boilers.

5.2 Constraints to biomass energy resource

To establish the potential biomass energy resource across the local planning authority area, consideration has been given to the spatial constraints associated with restrictions to harvesting energy crops and wood fuel. The assessment used the following principal constraints to biomass energy to establish the maximum potential biomass energy resource across the Conwy county borough:

- Agricultural land classification;
- Areas of broadleaved woodland;
- Areas of environmental protection (including ancient woodlands);
- Areas of historic and cultural importance.

A comprehensive table of the sources and assumptions used is given in Appendix C: Biomass Energy Resource Methodology.

5.3 Energy Crops

5.3.1 Usable land and crop yield

The principal constraint to harvesting energy crops across the Conwy county borough is the availability of suitable agricultural land. This study has assumed that energy crops can only be potentially grown on agricultural land of Grade 4[30], which is not constrained by environmental or historical protected areas.

The majority (73%) of agricultural land across the Conwy LPA is classified as either Grade 4 or 5, the latter likely being unsuitable for growing energy crops.

Based on the above constraints the theoretical maximum area of land that could be planted with energy crops across the Conwy LPA is identified as 511.38 km^2. This gives consideration to existing agricultural land classifications, environmental and cultural constraints on the land.

For this assessment it is then assumed that only 10% of the suitable land area identified for energy crops could actually be planted with energy crops. This reflects a range of factors including, for example, competition with other

[30] The classification is Grade 4 - poor quality agricultural land. Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

crops, livestock grazing, solar PV farms as well as unsuitable topography. Therefore, the total usable area of land for energy crops across the Conwy LPA is 51.14 km^2.

'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners' (Welsh Government; 2015) confirms an average figure of 1,200 oven dried tonnes (odt) of energy crops can be delivered per km^2. Therefore, the total energy crop yield across the Conwy county borough is 61,366 odt per annum.

5.3.2 Technologies

5.3.2.1 Installed Power and Heat Generation Capacity

The amount of energy that the potential quantity of biomass could produce will be dependent on whether the fuel is burnt in facilities that only generate electricity (and the waste heat is not used), or produce Combined Heat and Power (where the heat is used), or is burnt in a boiler to produce heat only.

For the purposes of this assessment, it has been assumed that the energy crop resource is used to fuel a biomass CHP system to produce electricity and heat. A typical biomass CHP system will require about 6,000odt of energy crops for each 1MWe of installed power generation capacity. The biomass CHP system will also simultaneously produce about 2MWt

Table 8 confirms the maximum potential energy crop resource for the Conwy LPA.

Table 8: *Total potential energy crop resource for the Conwy LPA area.*

	Energy Crop
Available area (km^2)	511.38
Usable area (km^2)	51.14
Yield (odt per km^2)	1,200
Yield (odt)	61366
Required yield per MWe	6,000
Potential installed capacity (MWe)	**10.23**
Heat to power ratio	2:1
Potential installed capacity (MWt)	**20.46**

5.4 Wood Fuel

5.4.1 Usable land and yield

The total area of national forest across the Conwy LPA as identified by the National Forestry Inventory (NFI) database is 78.39 km^2, of which 23.48 km^2 is located on Natural Resources Wales (formerly Forestry Commission) owned land.

The Bioenergy Action Plan for Wales confirms that 60 oven dried tonnes (odt) of available wood fuel per km^2 of woodland per annum. Therefore, the total wood fuel yield from all national forest across the Conwy LPA area is 4,703odt per annum, of which 1,409odt per annum could be derived from Natural Resource Wales (formerly Forestry Commission) owned land.

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

5.4.2 Technologies

5.4.2.1 Installed Power and Heat Generation Capacity

The amount of energy that the potential quantity of biomass could produce will be dependent on whether the fuel is burnt in facilities that only generate electricity (where the heat is not used), or produce Combined Heat and Power (where the heat is usefully employed), or is burnt in a boiler to provide Space Heating (SH) and/or Domestic Hot Water (DHW).

For the purposes of this assessment, it is assumed that the energy resource from wood fuel is utilised for SH and/or DHW (i.e. a biomass boiler). Utilised in this way, a biomass boiler will require about 60odt of wood fuel for each 1MWt of installed capacity.

Table 9 confirms the maximum potential biomass resource for the Conwy county borough.

Table 9: *Total potential energy resource from wood fuel for the Conwy LPA area.*

	Wood fuel
Available area (km^2)	78.4
Usable area (km^2)	78.4
Yield (odt per km^2)	60.0
Yield (odt)	4,703
Required yield per MWt	660
Potential installed capacity (MWt)	**7.1**

Of the potential 7.1 MWt that could be derived from woodland residue across the Conwy LPA, 2.1 MWt could be derived from NRW owned land.

5.5 Further constraints to biomass energy resource

Although where areas of land have been indicated as having potential for the growing of energy crops, further detailed studies are required prior to action. Furthermore, market demand is likely to play a key role in what, and how much is planted.

Even where there is local demand for a biomass supply, constraints (not considered within this REA) can persist including, for example, the proximity of supply to the plant and practical access to sites required for the preparation and delivery of fuel.

In terms of biomass plant, landowner willingness, political will, the time involved in completing planning applications and an economic distance to the nearest appropriate electricity grid connection will all be key considerations but are not considered within this assessment.

Biomass is most usually utilised for electricity generation (normally situated away from residential development) or for heating non-domestic buildings where there is sufficient room for fuel storage and access for large delivery vehicles.

5.6 Potential opportunities for future development

In relation to biomass energy generation, potential opportunities for CCBC are:

- Investment interest of Energy Services Companies (ESCOs) may be secured through the identification of appropriate sites and heat demand;
- Biomass fed renewable installations can provide significant revenue streams to LA's, including from the Renewable Heat Incentive.

6. Energy from Waste

6.1 Introduction

Local Waste Planning Authorities (LWPAs) develop detailed plans on how to treat the Municipal Solid Waste (MSW) stream arising in the LWPA area. Some LWPAs, such as CCBC work with neighbours and Regional Waste Teams to investigate preferred options for the treatment of waste.

Regional Waste Strategies (RWS) comprise details of which particular technologies for treating waste will be employed, their capacities and preferred locations. Therefore, as well as informing this REA, the findings of this REA should be incorporated within the RWS to ensure that planned generation of energy from waste plant is considered to the fullest extent.

Whilst LWPAs manage the MSW stream, less is 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 energy from waste (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 biodegradable (BD) element).

Towards Zero Waste[31] describes the long-term framework for resource efficiency and waste management up to 2050. It proposed the following targets for municipal waste:

- A minimum of 70% of waste being reused, recycled or composted by 2025;
- A maximum level of 30% energy being created from waste by 2025;
- Wales to achieve zero waste by 2050.

Other targets for consideration include that waste fuelled CHP must achieve an operating efficiency of a minimum of 65%[32].

Additional potential energy sources derived from waste as reported on in the Bioenergy Action Plan for Wales include food waste; agricultural wastes; and sewage sludge. As such this section of the REA will report under the following subheadings:

- Commercial and Industrial Waste (C&I)
- Municipal Solid Waste (MSW)
- Agricultural Waste
- Sewage Sludge

A comprehensive table of the sources and assumptions used is given in Appendix D: Energy from Waste Resource Methodology.

6.2 Commercial and Industrial Waste

The total predicted C&I waste across Conwy in 2022 and 2031, derived from the North Wales Regional Waste Plan, has been calculated as 60,559 tonnes and 59,394 tonnes respectively.

The data utilised to inform this calculation was supplied by Natural Resources Wales and did not enable the identification of the origin of the waste. An apportionment[33] has been undertaken to remove the C&I waste element originating in the SNP. Snowdonia National Park (SNP) proportion is calculated utilising population figures (4% of the population of CCBC area live in the SNP), leaving a **total figure for C&I waste in the CCBC LPA area of 58,136 tonnes for 2022 and 57,018 tonnes for 2031.**

However, to avoid conflict with existing recycling targets, it has been assumed that only 30% of this waste stream would be available for energy recovery. Therefore, the total predicted C&I waste that could be used for energy recovery across the Conwy LPA area is 17,441 tonnes for 2022 and 17,105 tonnes for 2031.

Energy from Waste facilities in Wales are required to be at least 65% efficient[27] and

[31] Towards Zero Waste One Wales: One Planet, WAG March 2011

[32] Waste Framework Directive from Commission Directive (EU) 2015/1127

[33] The percentage figure is supplied by Conway County Borough Council

therefore cannot generate electricity without using some of the heat. It has therefore been assumed that C&I waste will be burnt in facilities that produce Combined Heat and Power where the heat is usefully employed.

Assuming that 10,320 tonnes of waste per annum are required for each 1MWe of electricity generating capacity in a CHP plant, and that a CHP facility will also produce about 2MWt of thermal output at the same time from the waste heat, the total potential capacity that could be supported by the C&I waste stream in the Conwy LPA area would be: 1.69MWe (17,441/10,320) and 3.38MWt for 2022 and 1.66 MWe and 3.32 MWt for 2031.

However, under the requirements of the EU Renewable Energy Directive[34], which is the basis for the UK's target of 15% of energy to come from renewable sources by 2020, only the Biodegradable (BD) fraction of energy generation from waste is eligible to count towards the target.

There is no specific guidance in Wales on what the BD 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%[35] [36].

Therefore assuming that 35% of the power and energy output of any waste facility count as renewable, **the renewable electricity and heat capacity across the Conwy LPA area for C&I waste would be: 0.59MWe and 1.18MWt for 2022; and 0.58MWe and 1.16MWt for 2031 respectively**, as shown in Table 10.

Table 10*: Commercial and Industrial waste resource for the Conwy LPA area in 2022 and 2031*

Commercial & Industrial Waste	2022	2031
Total waste (tonnes)	60,559	59,394
Total waste excluding 4% for SNP (tonnes)	58,136	57,018
Total residual waste (tonnes)	17,441	17,105
Required wet tonnes per 1MWe	10,320	10,320
Potential installed capacity (MWe)	1.69	1.66
Total renewable element (35%)	35%	35%
Potential installed capacity (MWe)	**0.59**	**0.58**
Heat to power ratio	2:1	2:1
Potential installed capacity (MWt)	**1.18**	**1.16**

[34] See http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

[35] See para. 9.10 of the Government Response to the Statutory Consultation on the Renewables Obligation Order 2009, December

[36] see http://www.berr.gov.uk/files/file49342.pdf

6.3 Municipal Solid Waste

The total predicted MSW across Conwy in 2022 and 2031, derived from the North Wales Regional Waste Plan has been calculated as 187,776 tonnes in 2022 and 267,264 tonnes in 2031. The data utilised to inform this calculation was taken from www.statswales.wales.gov.uk.

An apportionment[37] has been undertaken to remove the MSW waste element originating in the SNP. The proportion of waste originating in the SNP are of Conwy is calculated utilising population figures (4% of the population of Conwy live in the SNP), leaving a **total figure for MSW waste in the Conwy LPA area of 180,265 tonnes for 2022 and 256,573 tonnes for 2031.**

However, to avoid conflict with existing recycling targets, it has been assumed that only 30% of this waste stream would be available for energy recovery. Therefore, the total predicted MSW waste that could be used for energy recovery across the Conwy LPA area is 54,080 tonnes and 76,972 tonnes.

Energy from Waste facilities in Wales are required to be at least 65% efficient[27] and therefore cannot generate electricity without using some of the heat. It has therefore been assumed that MSW waste will be burnt in facilities that produce Combined Heat and Power where the heat is usefully employed.

Assuming that 10,320 tonnes of waste per annum are required for each 1MWe of electricity generating capacity in a CHP plant, and that a CHP facility will also produce about 2MWt of thermal output at the same time from the waste heat, the total potential capacity that could be supported by the MSW waste stream in the Conwy LPA area would be: 5.24MWe and 10.48MWt for 2022; and 7.46MWe and 14.92MWt for 2031.

However, under the requirements of the EU Renewable Energy Directive[38], which is the basis for the UK's target of 15% of energy to come from renewable sources by 2020, only the Biodegradable (BD) fraction of energy generation from waste is eligible to count towards the target.

There is no specific guidance in Wales on what the BD 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%[39 40].

Therefore assuming that 35% of the power and energy output of any waste facility count as renewable, **the renewable electricity and heat capacity across the Conwy LPA area for waste would be: 1.83MWe and 3.67MWt for 2022; and 2.61MWe and 5.22MWt for 2031 respectively**, as shown in Table 11.

Table 11: *Municipal Solid Waste resource for the Conwy LPA area in 2022 and 2031*

MSW	2022	2031
Total waste (tonnes)	187,776	267,264
Total waste excluding 4% for SNP (tonnes)	180,265	256,573
Total residual waste (tonnes)	54,080	76,972
Required wet tonnes per 1MWe	10,320	10,320
Potential installed capacity (MWe)	5.24	7.46
Total renewable element	35%	35%
Potential installed capacity (MWe)	**1.83**	**2.61**
Heat to power ratio	2:1	2:1
Potential installed capacity (MWt)	**3.67**	**5.22**

[37] The percentage figure is supplied by Conwy County Borough Council

[38] See http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

[39] See para. 9.10 of the Government Response to the Statutory Consultation on the Renewables Obligation Order 2009, December

[40] see http://www.berr.gov.uk/files/file49342.pdf

6.4 Food Waste

According to StatsWales data for 2015/2016, Food waste from the MSW stream for Wales accounts for 95,124t/yr of the 892,228t/yr of waste that is recycled or composted nationally: this equates to 10.66%.

The total quantity of MSW food waste composted in Conwy in 2015/16 was 4,284 tonnes. Conwy's population in 2015 was 116,200, producing 0.037 tonnes of composted food waste per annum per person. Given that Conwy's population is expected to rise by 0.3% per annum it has been estimated that Conwy will generate 4,375 tonnes of food waste in 2022 and 4,494 tonnes of food waste in 2031.

An apportionment[41] has been undertaken to remove the food waste element originating in the SNP. The proportion of food waste generated in the SNP part of Conwy is calculated utilising population figures (4% of the population of Conwy live in the SNP), leaving **a total figure for MSW food waste in the Conwy LPA area of 4,200 tonnes in 2022 and 4,314 tonnes in 2031.**

An Anaerobic Digestion plant would be suitable to use food waste to produce both electric and heat. With reference to the 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners (Welsh Government, 2015), it can be assumed that 20,000 tonnes of food waste are needed to produce 1MWe, and that the heat to power ratio of an Anaerobic Digestion plant is 1.5 to 1, the potential installed capacity therefore is: **0.21MWe and 0.31MWt for 2022; and 0.22MWe and 0.32MWt** (Table 12).

Table 12: *Potential installed capacity from total available food waste resource in the Conwy LPA area in 2022 and 2031.*

Resource from Food Waste	2022	2031
MSW food waste (tonnes)	4,200	4,314
Required tonnes per MWe	20,000	20,000
Potential installed capacity (MWe)	**0.21**	**0.22**
Heat to power ratio	1.5:1	1.5:1
Potential installed capacity (MWt)	**0.31**	**0.32**

[41] The percentage figure is supplied by Conwy County Borough Council

6.5 Agricultural Waste

6.5.1 Animal Manure

It is assumed that the farming mix will not change over the time period to 2031 and therefore energy generated from agricultural waste will be the same as the current scenario.

Utilising the latest statistics (2015), the total numbers of cattle and pig across the Conwy LPA area (i.e. excluding the SNP) have been calculated as 46,956 and 160 respectively[42].

Assuming that each cattle produces 1 tonne of slurry a month, and each pig produces 0.1 tonnes per month, and assuming that slurry is only collected for 6 months of the year[43] the total annual tonnage of available manure across the Conwy LPA area is: 281,829.

In practice however, 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.

This study has therefore assumed that 50% of the farms use a slurry based system and that of these, it would be feasible to capture the slurry from 50%. Therefore, the total available resource across the Conwy LPA area is: 70,457 tonnes/ annum.

An Anaerobic Digestion plant would be suitable to use animal slurry to produce both electric and heat. With reference to the 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners (Welsh Government, 2015), it can be assumed that 225,000 wet tonnes of slurry are needed to produce 1MWe, and that the heat to power ratio of an Anaerobic Digestion plant is 1.5 to 1, the potential installed capacity therefore is: **0.31 MWe and 0.47 MWt** (Table 13).

Table 13: Potential installed capacity from total available animal slurry resource in the Conwy LPA area in 2022 and 2031

Animal slurry	
Total livestock (Cattle & Pigs)	47,116
Total slurry (tonnes)	281,829
Usable slurry (tonnes)	70,457
Required wet tonnes per MWe	225,000
Potential installed capacity (MWe)	**0.31**
Heat to power ratio	1.5:1
Potential installed capacity (MWt)	**0.47**

[42] Welsh Governments Agricultural small area statistics - http://gov.wales/statistics-and-research/agricultural-small-area-statistics/?lang=en (May 2017).

[43] Assuming that livestock will only be kept under cover for, approximately, 6 months of the year.

6.5.2 Poultry Litter

It is assumed that the farming mix will not change over the time period to 2031 and therefore energy generated from agricultural waste will be the same as the current scenario.

Utilising the latest statistics (2015), the total number of poultry recorded across the Conwy LPA area (i.e. excluding SNP) have been calculated as 17,726[44].

To allow for losses due to the economics associated with wide spatial distribution of poultry farms across the Conwy LPA area, this report has assumed that 50% of poultry farms could provide poultry litter for conversion into energy.

Data is available from DEFRA which provides the amount of excreta produced by different types of poultry[45]. This suggests a figure of 42 tonnes of litter per year per 1,000 birds[46].

With reference to 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners (Welsh Government; 2015), assuming that 11,000 tonnes of litter per annum are needed to produce 1MWe, and that the heat to power ratio of a bespoke plant with CHP is 2 to 1, the potential installed capacity is: 0.034 MWe and 0.068 MWt respectively.

Table 14: *Potential installed capacity from poultry litter in the Conwy LPA area in 2022 and 2031*

Poultry litter	
Total poultry[47]	17,726
Accessible Poultry (50%)	8,863
Total litter (tonnes)	372
Required tonnes of litter per MWe	11,000
Potential installed capacity (MWe)	**0.034**
Heat to power ratio	2 :1
Potential installed capacity (MWt)	**0.068**

In practice, as the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant. However, given **the total combined resource from animal slurry and poultry litter is 0.344MWe and 0.538MWt, the resource could be combined with animal slurry to support an anaerobic digestion facility of 0.344MWe**, especially in partnership with neighbouring authorities.

[44] Welsh Governments Agricultural small area statistics - http://gov.wales/statistics-and-research/agricultural-small-area-statistics/?lang=en (May 2017).
[45] See the DEFRA leaflets on guidance to famers in Nitrate Vulnerable Zones, leaflet 3, table 3, see

http://www.defra.gov.uk/environment/quality/water/waterquality/diffuse/ nitrate/documents/leaflet3.pdf

[46] Based on the figure for laying hens, which is 3.5 tonnes per month
[47] The number of poultry was taken from the Welsh Governments Statistical Directorate Agricultural Small Areas spreadsheet - worksheet Regions'.

6.6 Sewage Sludge

The population of Conwy in 2022 and 2031, based on a population trend between 2005 and 2015 , is projected as 118,754 and 122,121 respectively. An apportionment has been applied to remove the population of the SNP[48], leaving 114,004 and 117,236.

Assuming that the average amount of sewage produced per person per year is 0.03tonnes (t) the total sewage sludge across the Conwy LPA in 2022 equates to circa 3,420 t and 3,517t in 2031.

An Anaerobic Digestion plant would be suitable for utilising sewage sludge to produce both electric and heat. Referring to 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners (Welsh Government; 2015), assuming that 13,000t of dry solids are needed to produce 1MWe, and that the heat to power ratio of an AD plant is 1.5, the potential installed capacity is 0.26MWe and 0.39MWt respectively in 2022; and 0.27MWe and 0.41MWt in 2031.

Given that 0.19MWe is already being generated the potential installed capacity is: 0.07MWe and 0.11MWt in 2022; and 0.08MWe and 0.12MWt in 2031.

Table 15: *Potential installed capacity from total available sewage sludge resource in the Conwy LPA area in 2022 and 2031*

Sewage Sludge	**2022**	**2031**
Conwy LPA Population[49]	114,004	117,236
Sewage per person (tonnes)	0.03	0.03
Total sewage (tonnes)	3,420	3,517
Required tonnes of sewage per MWe	13,000	13000
Potential installed capacity (MWe) less 0.19MWe already generated	**0.07**	**0.08**
Heat to power ratio	1.5:1	1.5:1
Potential installed capacity (MWt)	**0.11**	**0.12**

At present, about 0.19 MWe is already being generated in the Conwy LPA area, which is approximately two thirds of the available resource in 2022 and approximately half of the available resource in 2031. Given the dispersed settlement patterns across the rural Conwy LPA area, it may be that the remainder of the resource is too dispersed for generation to be practical: **as such it has been assumed that there is no additional resource currently available for sewage sludge**.

[48] Snowdonia National Park (SNP) proportion is calculated utilising population figures sourced from CCBC (4% of the population of Conwy live in the SNP).

[49] Based on a population of 116,200 in Conwy in 2015 (www.nomisweb.co.uk) and an average annual change in population of 0.311%
(average population change in Conwy between 2005 and 2015).

6.7 Waste Summary

A summary of the potential outputs from utilising the waste resource in the Conwy LPA area is provided below. There are a number of key issues which would impact on whether the resource can be exploited and/or counted towards RE contributions as follows:

- Viability, and therefore likelihood of building the necessary plant;
- Origin of the resource.

Along with Gwynedd County Council CCBC acts as a Local Waste Planning Authority (LWPA) on behalf of the Snowdonia National Park (SNP) and therefore has some control over the use of the resource generated in the SNP LPA area.

However, to avoid double counting, the Toolkit[50] takes the approach that the LPA contribution is counted in the LPA area where the resource originates unless that resource is being utilised in an existing technology elsewhere.

Given that the Conwy LPA area is neither the place of origin of the resource or is utilising the resource for generation, the Municipal Solid Waste (MSW) and Commercial & Industrial Waste generated in the SNP LPA area is removed from the Conwy LPA area resource.

In addition, when considering the LPA's contribution, high level consideration is given to the likelihood of the resource being exploited.

So, for instance, although there is available resource in the Conwy LPA area, there is currently no EfW plant, with or without CHP in the Conwy LPA area and no current plans to construct such a facility. It is likely that the location and construction of any such new facility would be discussed and agreed on a Regional basis. Currently this resource is exported to an EfW plant located in Deeside and is therefore counted as existing generation in Deeside.

Also, aside from the 2.9MWt digester processing sewage sludge, there is currently no other Anaerobic Digestion facility within the Conwy LPA area.

CCBC confirm that a supplier is appointed to which all domestic food waste is exported for processing via anaerobic digestion facilities that operate outside of the LPA area.

Some private collection of food waste was identified but it is understood that this resource is also currently exported out of county. Therefore, the only likely AD facility within the Conway LPA is likely to utilise slurries.

The economics of generating energy from a dedicated poultry litter power plant means that anything less than 10MWe is likely not to be viable.

When considering all of the above, the final potential for renewable energy from waste resource is shown in Table 16.

[50] Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government 2015 Update

Table 16: *Summary of Energy from Waste*

	Prior to consideration of likelihood of utilisation for RE Generation					Reason for adjustment / change of technology	Post consideration of likelihood of utilisation for RE Generation		
Resource	Technology	2022		2031			Technology	MWe	MWt
		MWe	MWt	MWe	MWt				
C&I Waste (Table 10)	EfW with CHP	0.59	1.18	0.58	1.16	Currently recycled. Non-recyclable material is exported out of county to EfW plant & therefore counted as existing generation elsewhere.	None	-	-
MSW (Table 11)	EfW with CHP	1.83	3.67	2.61	5.22	Currently recycled. Non-recyclable material is exported out of county to EfW plant & therefore counted as existing generation elsewhere.	None	-	-
Food Waste (Table 12)	AD with CHP	0.21	0.31	0.22	0.32	Food waste is currently exported out of county to AD & therefore counted as existing generation elsewhere.	None	-	-
Animal Slurry (Table 13)	AD with CHP	0.31	0.47	0.31	0.47	Combined with Poultry Litter	AD with CHP	0.34	0.54
Poultry Litter (Table 14)	Bespoke plant with CHP	0.03	0.07	0.03	0.07	Not likely to be enough resource for bespoke plant. Combines with Animal slurry.	None	-	-
Sewage Sludge (Table 15 + existing 1.9MWe)	AD with CHP	0.26	0.39	0.27	0.41	0.19MWe already generated: assumed the economically viable opportunities are already exploited.	None	-	-
Potential installed capacity		**3.23**	**6.09**	**4.02**	**7.65**			**0.31**	**0.47**

7. Hydro Power Energy Resource

7.1 Introduction

Existing hydro power installations across the Conwy LPA area have a combined total installed electrical capacity of 33.61MWe, of which the Dolgarrog and Alwen generate circa 33.38MWe and 0.04MWe respectively.

The Environment Agency published a study[51] into the potential for small scale hydro power generation across England and Wales in 2010[52]. This report was not used at the time of writing the original Conwy REA in 2012, therefore there are no results to review or compare. However, the results from the Environmental Agency study are included in this report and are detailed in the Table 17.

Table 17 confirms the total potential hydropower capacity according to each of the potential hydropower sites' sensitivity to exploitation, in the Conwy LPA area, excluding SNP. Where the sensitivity categories of a potential sites were not given; the worst-case scenario was assumed, and it was assigned to have High environmental sensitivities.

Table 17*: Potential hydropower capacity in Conwy LPA according to environmental sensitivity.*

Environmental sensitivity	Installed capacity (MWe)
Low	0
Medium	0
High	2.93
Total	**2.93**
Proportion High Sensitivity included	25%
Potential Hydro Power Resource	**0.73**

Taking into account the environmental constraints of the potential hydropower sites due to their sensitivities, it is suggested that the potential hydropower resource across Conwy could comprise those sites of low and medium sensitivity as well as 25% of the high sensitivity sites, **equating to 0.73 MWe in total.**

The existing (as of 08/08/2017) installed capacity of 34.48MWe (33.61MWe is standalone and 0.87MWe is part of BIR) has surpassed the generating capacity predicted in the Environmental Agency study. However, the Dolgarrog site has been operating for the last 100 years and has recently been upgraded/ refurbished. It would have therefore been left out of the Environmental Agencies-Potential Sites of Hydropower Opportunity database. If we were to include the Dolgarrog site to the potential capacity it would predict 36.31MWe and so the potential capacity prediction compared against the existing capacity (35.13MWe) shows that it is quite accurate.

The amount of hydropower development shows that the uptake of schemes in recent years is not constrained to just those sites which are of 'low' and 'medium' sensitivity.

It is considered that the Environmental Agency analysis remains valid but there is a need to revisit the contribution that can be made in the Conwy LPA area. Table 7 of the above-mentioned EA non-technical project report[53] (p20) identifies Conwy as one of the local authorities with the lowest potential for hydropower. The report confirms that "*almost all of these opportunities are in areas of high environmental sensitivity*".

Table 7 of the EA report states that there is a total power potential of 38MW. If we add the potential identified in the Environmental Agency Study applied to the Conwy LPA (2.93) we arrive at a total of 40.93MW which seems to verify the available resource total.

[51] Mapping Hydropower Opportunities and Sensitivities in England and Wales: Technical Report, Entec UK on behalf of Environment Agency (2010)

[52] Potential Sites of Hydropower Opportunity, Environment Agency, revised 2015 [https://data.gov.uk/dataset/e0f5a751-f4f3-4d04-a7ae-89d2dcc0c5f5]

[53] Opportunity and environmental sensitivity mapping for hydropower in England and Wales: Non-technical project report

Figure 3: *Excerpt from Hydropower Opportunities report by the Environment Agency[52] (p.20)*

Table 7 shows the Local Authority areas with the most opportunities. Almost all of these opportunities are in areas of high environmental sensitivity and hydropower developments in these areas will need to be designed to allow proper fish passage.

Table 7 - Local Authority areas with the highest theoretical power potential

Local Authority	Number of barriers	Total power potential/ MW	% of power potential classified as high sensitivity	% of power potential classified as potential win-win
Powys	1008	148	93%	7%
South Lakeland	842	76	85%	32%
Northumberland Unitary Authority	956	56	98%	51%
Neath Port Talbot	324	49	100%	28%
Richmondshire	583	49	82%	35%
Gwynedd	735	47	98%	24%
Conwy	283	38	96%	3%
Durham Unitary Authority	490	35	97%	70%
Allerdale	204	31	89%	48%
Denbighshire	111	30	100%	97%

However, if it is assumed that the total potential resource is 40.93MW, that this figure was arrived at post hydropower development in Conwy, and that the 3% ‘win-win’ figure identified in the EA report is correct, we arrive at an **additional accessible hydropower development figure for the Conwy LPA area of 1.23MW.**

8. Solar PV Farms

8.1 Introduction

This section provides a summary assessment of the potential for Solar PV Farms in the CCBC LPA area.

Photovoltaic (PV) solar cells/ panels generate renewable electricity from the direct conversion of solar irradiation. PV 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 and this figure is expected to increase due to a high level of interest in larger stand-alone (ground-mounted) installations.

The Department for Business Energy and Industrial Strategy (BEIS) -formerly the Department for Energy and Climate Change (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 of the electricity generated”: this is typically a PV farm greater than 5MWe installed capacity (though dependent upon the electricity use of the building it is wired to). This definition is important as it defines the qualifying rate of Feed-in-Tariff.

As a relatively new phenomenon there is no standard agreed approach to constraints mapping for solar PV farms. This section therefore provides an approach, developed by AECOM on behalf of the Welsh Government (Planning for Renewable and Low Carbon Energy – A Toolkit for Planners; 2015), as to how to undertake a high-level assessment of the potential solar resource for ‘stand-alone’ PV farms.

8.2 Mapping

Maps have been produced to illustrate at each stage of the process the application of the method to identify spatial constraints and opportunities. Throughout the methodology description, titles and reference numbers are mentioned. The titles / references correspond with maps contained in the accompanying document ‘Conwy Renewable and Low Carbon Energy Assessment 2017 – Maps’

As with the analysis of the wind resource, the identification of potential sites for solar PV farms follows a series of steps as follows:

8.2.1 Step 1:

Map Reference & Title: S1 – Solar Resource in the Conwy LPA Area

The performance of a photovoltaic panel system is directly related to the inclination, orientation and degree of shading of the panels. For the purposes of identifying the areas suitable for PV farm development, assumptions have been made on the suitability of slope gradient and orientation for PV deployment.

Using data from Ordnance Survey[54], AECOM has created a data layer for the Conwy LPA area showing orientation of slope and potential for shading. The following assumptions have been applied in this study:

Suitability of sites	Inclinations
All suitable:	0-3º from the horizontal
Only south-west to south east facing areas are suitable. All other orientations are considered constrained	Inclinations between 3-15º from the horizontal
All constrained	Inclinations >15º from the horizontal

All areas with inclinations 0-3º from the horizontal are assumed suitable and optimum. Only south-west to south east facing areas are suitable where there are inclinations between 3-15º from the horizontal: all other areas are deemed unsuitable. At this stage, the areas shown on the map are only constrained by the Conwy LPA boundary and the Snowdonia National Park.

8.2.2 Step 2:

Map Reference & Title: S2 – Environmental & Heritage Constraints

Constraints were applied to establish the maximum potential resource for solar PV farms across the Conwy LPA area. A comprehensive table of the sources and assumptions used is given in Appendix E. The constraints applied in the maps are discussed below.

8.2.2.1 Statutory Designations

The solar PV farm constraints maps illustrate the principal constraints to the development/ deployment of solar PV farms. Many of the constraints can be

[54] Ordnance Survey, Terrain 50 dataset

attributed to statutory designations. The constraints, except where specifically stated, relate to the extent of the designation only with no additional *constraint buffer* applied. The statutory designations utilised for this assessment are as follows:

- Special Protection Areas (SPA) and foraging buffers;
- Special Areas of Conservation (SAC);
- Candidate Special Areas of Conservation (cSAC);
- RAMSAR sites;
- National Nature Reserves (NNR);
- Sites of Special Scientific Interest (SSSI);
- Marine Nature Reserves (MNR);
- Scheduled Ancient Monuments (SAM);
- Areas of Outstanding Natural Beauty (AONB) - a 3.5km buffer is applied;
- Registered Historic Landscapes;

8.2.2.2 Non-Statutory Considerations

Many of the non-statutory designations are specifically linked to minimising potential impacts upon people or infrastructure through the application in the maps of buffer areas. The extent of the buffer areas are informed directly by the nature/extent of the natural/built environment and the characteristics of the generating technology. This assessment is based on constraints associated with a typical 5MW solar PV array[55].

Unlike wind farms, solar PV development has little height. However, aviation buffers are retained in respect of interference from other factors such as glare, etc.

The other non-statutory designations considered are:

- Ancient Woodlands
- Areas of historic and cultural importance
- Major and minor transport infrastructure – No buffer is applied - extent only;
- Existing buildings – a 500m buffer is applied. Whilst noise from the operation of a solar PV farm is minimal, the construction / maintenance noise is sometimes not, hence the buffer;
- National Parks – a 3.5km buffer is applied;
- Strategic Search Areas and all other existing and consented (but not yet constructed) wind farms, including those proposed through the planning system[56];
- All existing and consented (but not yet constructed) solar PV farms – and those proposed through the planning system as at 08/08/2017: a 3.5km buffer is applied;
- Watercourses – including major, secondary and minor rivers, canals and lakes: extent only – no additional buffer is applied;
- Woodlands extent only – no additional buffer is applied;
- Some aviation and radar buffers – includes data supplied by Ministry of Defence (MOD) and Civil Aviation Authority (CAA).
- Areas of thick peat.

8.2.3 Step 3

Map Reference & Title: S3 – Solar PV Farm Resource Available

At this stage of the assessment, land slivers, fire breaks and tracks, as well as parcels of land insufficient to support a solar PV farm of 5MW or more are removed from the maps. Land of Agricultural Grades 1 and 2 have been constrained and only land of Agricultural Grades 3, 4 and 5 have been considered for use for solar PV farms.

'Stand-alone' PV farms >5MW must be appropriately sited. However, with the large number of potential sites and areas of relatively low-grade land within the Conwy LPA, the aim of this constraint is to protect the best and most versatile agricultural land (Grades 1 and 2).

[55] It should be noted that this does not preclude the potential development / deployment of larger or smaller PV farms across the Conwy LPA area.

[56] This includes wind development outside of the boundary of the county where the development/proposals extend inside the Conwy LPA area.

However, it is understood diversification helps to support agriculturally based businesses, promoting multi-functional use of land, etc. In all cases potential for benefits is to be weighed against this criterion.

Map S3 shows the remaining available land for solar PV development after combining maps S1 (showing suitable land inclination and orientation) and S2 (statutory and non-statutory constraints) as well as the removal of land parcels of higher quality and insufficient size.

The remaining land available for solar PV farms at this stage of the assessment equates to 8.69km^2

8.2.4 Step 4

Map Reference & Title: S4 – Solar PV Farm Resource Available within Grid Connection

Solar PV farms require a connection to the grid in order to export the electricity. PPW[57] requires consideration of the electricity grid as part of the renewable energy evidence base to inform LDP policies.

A key constraint to the development of solar PV farms can be the cost of connecting to the electricity grid. A high-level cost analysis exercise has been undertaken.

Similar to the approach taken in the development of TAN8[58], areas that are considered likely to be too distant to connect to grid cost effectively have been constrained.

Electricity grid comprising 33, 66 and 132kV has been mapped with only sites with available resource within 10km of any line being considered accessible[59].

The remaining land available for solar PV farms at this stage of the assessment equates to 8.13km^2

8.2.5 Step 5

Map Reference & Title: S5 – Solar PV Farm land to be assessed for landscape impact

Remaining land parcels, following steps 1, 2, 3 and 4, are grouped together to inform parcels subject to landscape assessment. Map S5 shows the land areas provided to landscape consultants to undertake the assessment.

To define **initial** solar LSA's for landscape assessment, a set of criteria were applied to the remaining least constrained solar resource as follows:

- An initial LSA must contain at least one red area (as defined by map S4 i.e. >0.12 sq km = 5 MW) and preferably at least one amber area (<5 MW) of potential resource. Initial LSAs cannot be defined by amber areas alone;
- Initial LSAs must have a minimum size of 0.5 sq km);
- Initial LSAs should not be intersected by a class 1 or class 2 highway. Minor roads can intersect land parcels;
- Initial LSAs should not include a statutory environmental designation (e.g. SPA, SAC, SSSI), although non-statutory designations may be included (such as woodland and buildings). Statutory heritage designations can be included as setting can be considered at site specific development proposal stage;
- Initial LSAs should reflect topography e.g. two hilltops separated by a valley should not be joined together;
- Boundaries have been drawn "tight" to clusters of least constrained land parcels so some "outliers" have been excluded but it may be possible to draw them into refined initial LSA boundaries provided constraints are not included or the other criteria above broken;
- It may be possible to cluster some of the initial LSAs together following landscape susceptibility assessment.

Having applied the above criteria, 2 initial LSAs have been identified for landscape assessment

[57] Planning Policy Wales (Edition 9), Welsh Government November 2016

[58] 'Facilitating Planning for Renewable Energy in Wales- Meeting the Target - Final Report 'Welsh Assembly Government July 2004 Section 5.3.4

[59] Whilst grid information has been utilised to constrain some sites, it does not imply that remaining sites could connect: studies would need to be conducted in detail for each individual project.

8.2.6 Step 6

Map Reference & Title: S6 – Solar PV Farm – Landscape Assessment

The assessment of landscape sensitivity is a combination of determining landscape value and landscape susceptibility. The interaction of four categories of landscape value and four categories of landscape susceptibility enable the generation of a sixteen-box matrix (Table 18) from which, six categories of overall landscape sensitivity have been identified.

Table 18: *Landscape Sensitivity Assessment Matrix*

		Landscape Susceptibility			
		Very High	High	Medium	Low
Landscape Value	Very High				
	High				
	Medium				
	Low				

Each category of overall sensitivity has been defined as set out in Table 19.

Table 19: *Landscape Sensitivity Categories*

Sensitivity Level	Definition
Very High	Key characteristics and qualities of the landscape are highly vulnerable to change from the development type. No potential for locating the development type.
High	Key characteristics and qualities of the landscape are vulnerable to change form the development type. Highly limited potential for locating the development type.
Medium-High	Most of the key characteristics and qualities of the landscape are vulnerable to change form the development type. Limited potential for locating the development type.
Medium	Some of the key characteristics and qualities of the landscape are vulnerable to change from the development type. Some potential for locating the development type.
Medium-Low	Few of the key characteristics and qualities of the landscape are vulnerable to change from the development type. Potential for locating the development type.
Low	None of the key characteristics and qualities of the landscape are vulnerable to change from the development type. Clear potential for locating the development type.

The capacity assessment is very broad in its approach and is not definitive. It is based on assessment of a potential area, for example part of a particular valley floor, and a calculation of the area of solar farm development within this area that could be undertaken without unacceptable landscape and visual effects.

The results of the landscape assessment are as follows:

Table 20: *Landscape Assessment Results*

Assessment of Landscape Value

LANDMAP Criteria	Low	Moderate	High	Outstanding
Geological Landscape - Rarity/ Uniqueness (SNWGL092)			✓	
Geological Landscape - Classic Example (SNWGL092)			✓	
Landscape Habitats - Priority Habitats (CNWLH070)		✓		
Landscape Habitats - Significance (CNWLH070)		✓		
Visual and Sensory - Scenic Quality (CNWVS011)		✓		
Visual and Sensory - Integrity (CNWVS011)			✓	
Visual and Sensory - Character (CNWVS011)		✓		
Visual and Sensory - Rarity (CNWVS011)		✓		
Historic Landscape - Integrity (CNWHL020)		✓		
Historic Landscape - Survival (CNWHL020)			✓	
Historic Landscape - Condition (CNWHL020)		✓		
Historic Landscape - Rarity (CNWHL020)		✓		

Value: **Medium**

Comment:
A pleasing, undulating landscape generally in good condition, largely improved land with patches of unimproved land and small woodlands, Elwy formations and drumlins on higher slopes, with consistent character which is typical to much of Conwy. Therefore, the value of Area D is considered to be Medium.

Assessment of Landscape Susceptibility

Susceptibility Criteria	LANDMAP Reference	Characteristics	Susceptibility
Scale	VS8: Scale	Medium scale regular improved pastoral fields on ridges. Small irregular fields on slopes.	Medium
Landform	VS4: Topographic Form	Hills and valleys, undulating landscape	Medium
Land Cover Pattern	VS3: Land cover VS5: Land cover Pattern	Diverse land cover mosaic and field pattern. Semi natural, traditional field boundaries. Deciduous woodland	Medium-Low
Built Environment	VS6: Settlement Pattern VS27: Condition	Mix of intensive and traditional farming. Scattered farmsteads with occasional small settlements and A and B roads.	Medium-Low
Remoteness/ Tranquillity/ Movement	VS24: Perceptual and Sensory Qualities VS18: Level of Human Access	Attractive and settled with a moderate sense of place. Generally tranquil and unspoilt but with some human influence. Infrequent human access. Some open access land to the north-east of area	Medium
Visibility, Key Views and Vistas/ Visual Enclosure	VS9: Enclosure	Enclosed fields on slopes. Enclosed views in wooded valleys to more open views at hilltops. Long views from upper slopes to lower land and the moors	Medium-Low
Aesthetics	VS25: Sense of Place/Local Distinctiveness VS46: Scenic Quality	Pleasing landscape of good condition, unspoilt. Wind farm at Moel Maelogen visible on the skyline	Medium-High

Susceptibility: **Medium**

Comment:
Compared with the surrounding landscapes, this area has the most human influence, namely farming practices, and is enclosed in places with a variety of land cover and uses, although the area is generally of a tranquil nature. Therefore, the susceptibility of Area D is considered to be Medium.

Assessment of Landscape Sensitivity

Low	Medium -Low	Medium	Medium -High	High	Very High

Sensitivity: **Medium**

Comment:
Limited potential for a small scale solar PV farm within enclosed and lower, gentler slopes, such as fields to the south of the area. Although there would need to be exceptionally careful micrositing so it doesn't interfere with adjacent landscapes. Due to the woodland and hedgerow cover, there is more scope for mitigation planting, which is in character with the landscape. Whilst this indicates there is capacity from a landscape sensitivity perspective, the REA would need to be taken into consideration to establish whether these sites are viable in terms of the physical landscape characteristics. Therefore, the sensitivity of Area D is considered to be Medium.

Recommendation: **Limited potential for small scale solar PV farm.**

Assessment of Landscape Value

LANDMAP Criteria	Low	Moderate	High	Outstanding
Geological Landscape - Rarity/ Uniqueness (SNWGL091)		✓		
Geological Landscape - Classic Example (SNWGL091)		✓		
Landscape Habitats - Priority Habitats (CNWLH070 & CNWLH063)			✓*	
Landscape Habitats - Significance (CNWLH070 & CNWLH063)		✓		
Visual and Sensory - Scenic Quality (CNWVS008 & CNWVS011)			✓	
Visual and Sensory - Integrity (CNWVS008 & CNWVS011)			✓	
Visual and Sensory - Character (CNWVS008 & CNWVS011)			✓	
Visual and Sensory - Rarity (CNWVS008 & CNWVS011)			✓	
Historic Landscape - Integrity (CNWHL082)			✓	
Historic Landscape - Survival (CNWHL082)		✓		
Historic Landscape - Condition (CNWHL082)			✓	
Historic Landscape - Rarity (CNWHL082)		✓		

*where there are two units, the highest value has been used

Value: **Medium-High**

Comment:
Forms a backdrop for many of the surrounding landscapes. Landforms are rare within the County and Region and are dramatic and attractive with wooded valleys and medieval remains. Therefore, the value of Local Search Area 2 is considered to be Medium-High.

Assessment of Landscape Susceptibility

Susceptibility Criteria	LANDMAP Reference	Characteristics	Susceptibility
Scale	VS8: Scale	Small scale	High
Landform	VS4: Topographic Form	Mixture of land cover. Dramatic rugged hills form a backcloth to adjacent valleys. Rock outcrops	High
Land Cover Pattern	VS3: Land cover VS5: Land cover Pattern	Small scale pasture. Mosaic of moorland, rough grassland.	Medium-Low
Built Environment	VS6: Settlement Pattern VS27: Condition	Housing is encroaching. Settlement limited to bottom of slops and is small scale, rural and scattered	Medium
Remoteness/ Tranquillity/ Movement	VS24: Perceptual and Sensory Qualities, VS18: Level of Human Access	Attractive, exposed, wild and remote (remote hilltops). Diverse, unified and unspoilt character. Occasional human access. Open access land on the steeper hills	Medium-High
Visibility, Key Views and Vistas/ Visual Enclosure	VS9: Enclosure	Exposed. Prominent skylines enclose adjacent valleys. Some areas are less visible from the surrounding landscape	Medium-High
Aesthetics	VS25: Sense of Place/Local Distinctiveness VS46: Scenic Quality	Attractive, dramatic landscape, provides a positive backcloth with scenic views. Diverse, unified and consistent character and distinctive sense of place.	High

Susceptibility: **Medium-High**

Comment: Although there is some evidence of human influence, this landscape is generally unspoilt. Therefore, the susceptibility of Local Search Area 2 is considered to be Medium-High. There are however, some patches of land which are less susceptible, such as the land to the south-west of the Local Search Area which is farmed as has a level of degradation in comparison to the surrounding landscape.

Assessment of Landscape Sensitivity

Low	Medium -Low	Medium	Medium -High	High	Very High

Sensitivity: **Medium-High**

Comment:
This area is located within a Special Landscape Area, where the landscape character is both locally and regionally rare and important. Generally the introduction of a solar PV farm would be detrimental to the character of the area, although, there is the possibility for some small scale solar PV farm surrounding existing farmsteads and degraded land, such as to the south-west of the Search Area. This area was inaccessible, however it was assessed from the nearest possible accessible location and informed by aerial imagery. A solar PV farm in this location would have to be exceptionally carefully microsited so it does not interfere with the general landscape character of the rest of the area and its surroundings. Due to the woodland and hedgerow cover, there is more scope for mitigation planting, which is in character with the landscape. Whilst this indicates there is capacity from a landscape sensitivity perspective, the REA would need to be taken into consideration to establish whether these sites are viable in terms of the physical landscape characteristics. Therefore, the sensitivity of Local Search Area 2 is considered to be Medium-High.

Recommendations: **Limited potential for a solar PV farm, however small pockets of land within the area have more potential than others.**

8.2.7 Step 7

Map Reference & Title: S7 – Solar PV Farm – Local Search Areas

There is no map

There are no remaining least constrained land parcels of sufficient area to identify Solar PV Farm LSAs for local authority wide schemes of an installed capacity of 5MW or more.

There are no LSAs identified.

8.2.8 Step 8

Map Reference & Title: S8 – Solar PV Farm Prioritisation Model

There is no map

There are no remaining least constrained land parcels of sufficient area to identify Solar PV Farm LSAs for local authority wide schemes of an installed capacity of 5MW or more.

There are no LSAs identified.

8.2.9 Step 9

Map Reference & Title: S9 – Solar PV Farm Cumulative Impact

There is no map

There are no remaining least constrained land parcels of sufficient area to identify Solar PV Farm LSAs for local authority wide schemes of an installed capacity of 5MW or more.

There are no LSAs identified.

8.3 Further constraints to solar PV farm sites

Further constraints to solar PV farm development not considered within this REA include (and this is not meant to be an exhaustive list):

- Practical access to sites required for development;
- Landowner willingness for development to go ahead;
- Political will;
- Time to complete planning procedures;

8.4 Potential opportunities for future development

In relation to solar PV farm energy, potential opportunities for CCBC could be:

- Investment interest of Energy Services Companies (ESCOs);
- CCBC involvement with ESCO to secure greater community benefits;
- Solar PV farms can provide significant revenue streams.

9. Building Integrated Renewable Energy Uptake

9.1 Introduction

This section provides a summary assessment of the potential building integrated renewable (BIR) energy technology uptake in the CCBC LPA undertaken in 2012. More detailed assumptions utilised in the BIR analysis can be found in **Appendix F**. The assessment is based on the method detailed in 'Planning for Renewable and Low Carbon Energy – A Toolkit for Planners (2015)[60]'.

9.2 Definition of 'micro-generation' and 'building integrated renewables'

The official definition of micro-generation is given in the Energy Act 2004 as electricity generating capacity of 50kW or less, and heat generating capacity of 45kW or less. However, for the purposes of this study, we are using the broader term Building Integrated Renewable (BIR).

BIR can include systems that are larger than micro-generation, such as biomass boilers for schools, which can be up to 500kW of heat output or more. However, 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.

The term BIR also excludes those micro-generation technologies that are not renewable, such as fuel cells (where the hydrogen is produced from mains gas) and small-scale CHP, using mains gas as the fuel source. This is because, for the potential purpose of setting area wide renewable energy contributions, we are only interested in the potential uptake of those micro-generation technologies that are renewable.

BIR are therefore taken to cover the following technologies:

- Solar photovoltaic (PV) panels
- Solar hot water panels
- Micro building-mounted wind turbines
- Small free-standing wind turbines
- Micro scale biomass heating (i.e. wood chip or pellet boilers or stoves)
- Ground source heat pumps
- Air source heat pumps
- Water source heat pumps

9.3 Calculation method

The calculation method includes consideration of the uptake of non-renewable micro-generation in order to account for those buildings which choose to take a non-renewable option, but these are excluded from the contribution.

The potential BIR uptake analysis is formed of two distinct calculations:

- The uptake of BIR in the **existing** building stock (residential and non-residential)
- The uptake of BIR in **future new** buildings (residential and non-residential)

The uptake of BIR in the ***existing*** building stock (residential and non-residential) is primarily driven by the financial attractiveness of installing BIR and the ease of retrofit.

This section is based on statistical data from National databases (see the Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government (2015) and the accompanying document to the 2010 Toolkit – Case Study of Pembrokeshire County Council - Welsh Government (2010).

The uptake of BIR in ***future new*** buildings (residential and non-residential) is predominantly driven by future Building Regulations and planning policies.

This section utilises the Conwy County Borough Council Housing Topic Paper and the adopted Unitary Development Plan (for a detailed explanation of the method see Planning for Renewable and Low Carbon Energy – A Toolkit for Planners – Welsh Government (2015) and the accompanying document to the 2010 Toolkit – Case Study of Pembrokeshire County Council - Welsh Government (2010)).

These two calculations are brought together to report the total predicted new and existing BIR RE capacity for the Conwy LPA broken down as follows:

60 http://wales.gov.uk/topics/planning/policy/guidanceandleaflets/toolkitfor planners/?lang=en

- By 2015, 2022 and 2031
- Renewable heat and electricity.

The SNP[61] proportion (4%) of the total housing stock is removed to calculate the potential BIR capacity across the Conwy LPA area.

9.4 BIR uptake in existing buildings

9.4.1 Existing building stock

Using Census 2001 data and Welsh Statistics a year by year timeline of the building stock in the Conwy LPA area from 2001 to 2011 was developed. A similar timeline was also generated for nondomestic buildings (Bulks and Non-Bulks) based on hereditaments data and council-owned property databases. This information has been used to establish the age of the base case 2008 building stock, and hence make an assumption on the heat demand of the 2008 base case stock. By understanding the age of the existing stock, and their heat demand, the modelling can recognise the increased benefits of installing renewable heat to older properties that are not as well insulated, for example.

A further analysis was required to establish the proportion of pre-1980 housing in the 2008 base case. This is because the Building Regulations requiring new constructions to reduce their energy consumption[62] was not in force before 1980 and a higher heating demand is attributed to this proportion of the 2008 base case housing stock. Welsh Statistics provided a breakdown of the age of the building stock as it was in 2008, shown in the pie chart below.

Figure 4 shows that 79% of the 2008 housing stock was built before 1981. Combined with the anticipated number of new homes in the Conwy LPA in the LDP plan period[63], by the end of the plan period in 2022, the pre-1980 homes will account for 70% of the Conwy LPA housing stock. If the average increase in house building out is extrapolated to 2031 the pre-1980 homes will still account for 65% of the Conwy LPA housing stock. Therefore, finding a low carbon solution for the older homes in the Conwy LPA will be vital in reducing the overall CO_2 emissions of Conwy LPA by both 2022 and 2031.

Figure 4: *Age of residential stock in the Conwy LPA area (2008)*

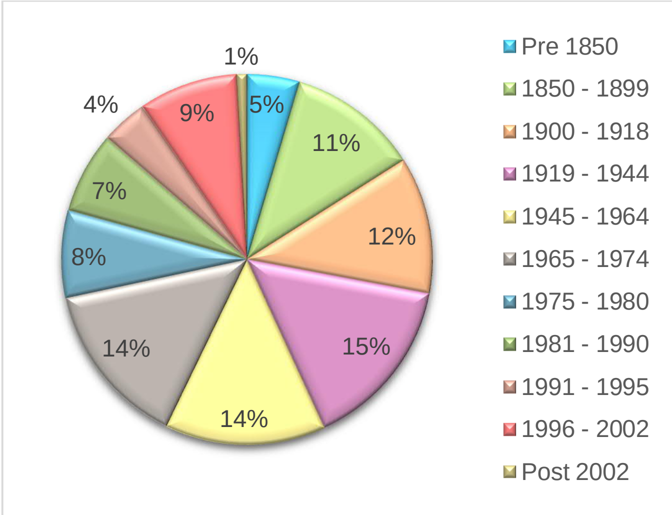
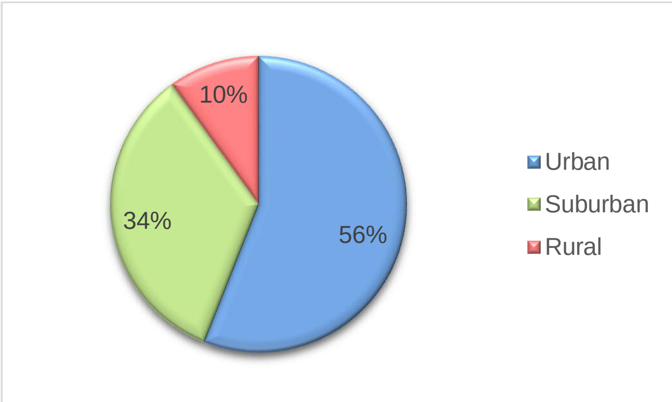


Figure 5: *Rural / Urban residential split in the Conwy LPA area (2004)*



The calculation for existing building uptake also takes into account the proportion of buildings in the Conwy LPA which are in urban, suburban or rural locations, as well as those which are flats or houses. The BIR calculation model uses this information to make assumptions on the sizes of the homes, as well as their potential for renewable energy such as ground source heat pumps, which may require a significant amount of outdoor space. Figure 5 shows the split of housing by urban, suburban or rural classification[64].

[61] Snowdonia National Park (SNP) proportion of population is calculated utilising figures sourced from CCBC.
[62] UK Building Regulations Part L (2010): Conservation of fuel and power
[63] Approximately 6,350 new homes between 2007-2022 bases on Strategic Policy HOU/1 from Conwy Deposit Local Development Plan (2007-2022).
[64] Rural and Urban Area Classification for Super Output Areas, 2004

Figure 6: *BIR uptake (cumulative) in existing buildings*

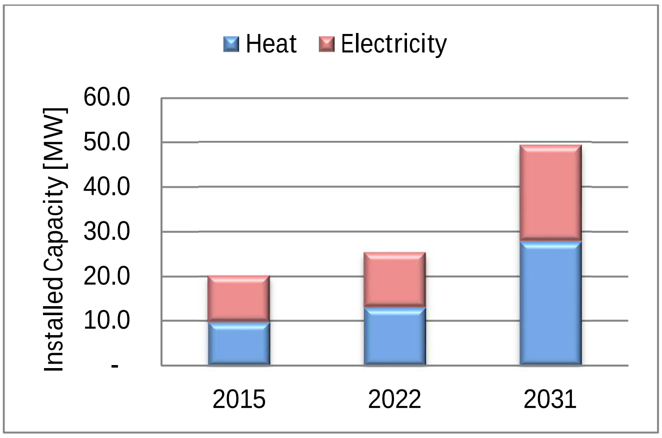


Table 21: *BIR uptake (cumulative) in existing buildings*

Building	2015	2022	2031
Heat (MW)			
Residential	0.8	1.0	2.2
Non Residential	8.9	11.9	25.5
Sub-total	**9.7**	**12.9**	**27.7**
Electricity (MW)			
Residential	0.8	1.0	1.7
Non Residential	9.6	11.4	19.7
Sub-total	**10.4**	**12.4**	**21.4**
Total	**20.1**	**25.3**	**49.1**

9.4.2 Results: BIR uptake in existing buildings

The results show that by 2022, the uptake of BIR in existing buildings in the Conwy LPA area would equate to 25.3MW, which consists of 12.9MWt from renewable heat and 12.4MWe from renewable electricity. By 2031, the uptake of BIR in existing buildings in the Conwy LPA area would equate to 49.1MW, which consists of 27.7MWt from renewable heat and 21.4MWe from renewable electricity.

Table 21 summarises this uptake over the key years of 2022 and 2031.

9.5 Future new buildings

For the future new buildings, the uptake will be predominantly driven by future Wales Building Regulations (Part L) and planning policies, requiring new buildings to reduce carbon dioxide emissions.

The Building Regulations Wales 2014 (Part L) AD1A (new homes) can currently be met through the design of fabric and services alone: compliance does not require the installation of low and zero carbon energy technologies.

For AD2A (non-domestic buildings) however, is likely to require either improvements to fabric, services and/ or low and zero carbon energy technologies sufficient to produce an equivalent to CO_2 savings from the installation of PV panels covering an area of 5.3% of GIA of each building in order to comply.

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.

For Conwy, the Revised Deposit Local Development Plan[65] sets out a total of 6,800 homes to be built over the LDP period 2007 to 2022. This equates to around 453 homes per year.

9.5.1 Results – BIR uptake in future new buildings

The results of the assessment show that by 2022, the uptake of BIR in new buildings in the Conwy LPA area could equate to 50.9MW, which consists of 9.0MWt from renewable heat and 41.9MWe from renewable electricity. By 2031, the uptake of BIR in new buildings in the Conwy LPA area could equate to 116.4MW, which consists of 20.6MWt from renewable heat and 95.8MWe from renewable electricity.

Figure 7 and Table 22 summarise this uptake over the key years of 2022 and 2031 for a build out rate of 453 homes per year.

[65] Strategic Policy HOU/1 from Conwy Deposit Local Development Plan 2007-2022 (Revised edition 2011)

Figure 7: *BIR uptake (cumulative) in future new buildings*

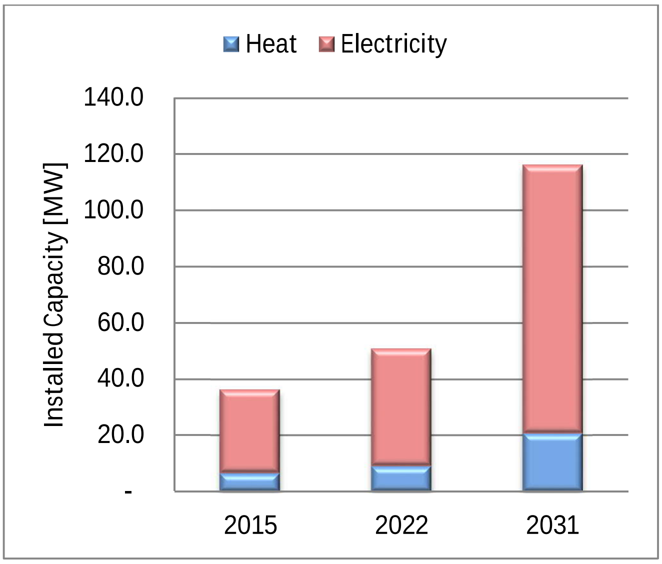


Table 22: *BIR uptake (cumulative) in future new buildings*

Building	**2015**	**2022**	**2031**
Heat (MW)			
Residential	3.3	4.7	10.7
Non Residential	3.1	4.3	9.9
Sub-total	**6.4**	**9.0**	**20.6**
Electricity (MW)			
Residential	3.4	4.7	10.8
Non Residential	26.6	37.2	85.0
Sub-total	**30.0**	**41.9**	**95.8**
Total	**36.4**	**50.9**	**116.4**

9.5.2 Overall total for BIR uptake

This study has found that there is the potential to exploit a range of micro-generation technologies across the region. Based on the modelling assumptions used, the economically viable capacity for micro-generation technologies in the Conwy LPA is circa 22.0MWt and 54.3MWe for 2022 and 48.3MWt and 117.3MWe for 2031. In most cases the potential is not spatially determined but is instead constrained by the size of the existing and future building stock.

The breakdown of estimated potential uptake in installed capacity and generated energy for the Conwy LPA in years 2022 and 2031 is shown in Table 23.

Table 23: *Total potential BIR uptake (cumulative) across the CCBC LPA area*

Building	**2015**	**2022**	**2031**
Heat (MW)			
Existing building (Table 21)	9.7	13.0	27.7
Future new building (Table 22)	6.4	9.0	20.6
Sub-total	**16.1**	**22.0**	**48.3**
Electricity (MW)			
Existing building (Table 21)	10.4	12.4	21.4
Future new building (Table 22)	30.0	41.9	95.8
Sub-total	**40.4**	**54.3**	**117.3**
Total	**56.5**	**76.3**	**165.5**

9.6 2015 BIR uptake review

Since undertaking this analysis in 2012, data extracted from Ofgem datasets relating to FiT and RHI, as well as data from CCBC has revealed that the uptake predictions are reliable for renewable electricity but have been optimistic for the uptake of renewable heat. Uptake of renewable electricity up to the end March 2016 has been 5.1MWe (compared with 5MWe predicted by 2015 in the 2012 report) and 8.5MWt of renewable heat (compared with 21MWt predicted in the 2012 report).

The full analysis has not been re-run but rather the following method applied. The FiT and RHI figures have been used instead of the 2015 'predicted' figure and then the modelled yearly increases (the actual increases in MW, not percentages from the 2012 assessment) added to give a revised 2022 and 2031 prediction. The revised figures are as shown in Table 24 and Table 25.

Table 24: *2016 Revision of total potential BIR uptake (cumulative) across the Conwy LPA area*

Building	2015	2022	2031
Heat (MW)			
Existing building	8.5	11.8	26.5
Future new building	-	2.6	14.1
Sub-total	8.5	14.4	40.6
Electricity (MW)			
Existing building	5.1	7.1	16.1
Future new building	-	14.0	65.8
Sub-total	5.1	21.1	81.9
Total	**13.6**	**35.5**	**122.5**

Table 25: *2016 Revision of total potential BIR uptake across the Conwy LPA area*

Building	2022	2031
Heat (MW)		
Existing building	3.3	18.0
Future new building	2.6	14.1
Sub-total	**5.9**	**32.1**
Electricity (MW)		
Existing building	2.0	11.0
Future new building	14.0	65.8
Sub-total	**16.0**	**76.8**
Total	**21.9**	**108.9**

10. Summary of Potential Renewable Energy Solutions

The maximum potential renewable electrical and thermal installed capacity across the Conwy LPA excluding that which is already installed, was calculated as circa 30.6MWe and circa 39.6MWt. for 2022 and circa 92.2MWe and circa 67.4MWt for 2031. These figures exclude the consideration of deliverability.

The total potential electrical capacity is dominated by potential building integrated renewable technologies (e.g. roof-mounted solar PV) with contributions from Biomass CHP, Anaerobic Digestion plants and hydro power sites.

However, the figures represent a theoretical maximum potential resource and assumes that all potential areas would be developed.

The total potential thermal capacity across the Conwy LPA in 2031 is dominated by building integrated renewables, primarily this will be biomass boilers and heat pumps for heating at circa 32.1MWt. Potential energy crops for CHP could equate to a further 20.5MWt of renewable heat generation.

Table 26: *Potential renewable energy resource in the Conwy LPA area in 2022 and 2031*

Resource	2022		2031	
	Electricity (MWe)	**Thermal (MWt)**	**Electricity (MWe)**	**Thermal (MWt)**
Biomass Energy Crop (CHP) (Table 8)	10.2	20.5	10.2	20.5
Biomass Boilers, Wood (Table 9)	-	7.1		7.1
Energy from Waste with CHP (Table 16)	2.4	4.9	3.2	6.4
Hydropower (page 39)	1.2	-	1.2	-
Landfill Gas	-	-	-	-
Wind	-	-	-	-
Solar PV Farms	-	-	-	-
Other including food waste, animal slurry, poultry litter and sewage sludge. (AD with CHP) (Table 16)	0.8	1.2	0.8	1.3
Building Integrated (Table 25)	16.0	5.9	76.8	32.1
Total	**30.6**	**39.6**	**92.2**	**67.4**

11. Identifying the Local Planning Authority Wide Contribution to the National Targets

The results of the area wide resource assessment provide an indication of the potential installed capacity for different technologies (in MW) that can be supported by the available resource.

The UK renewable energy target for 2020 is expressed in terms of a percentage of energy demand. In order to identify the potential contribution of the Conwy LPA area to meeting this target, estimation is required of how much energy the potential capacity might generate.

As referred to in Planning for Renewable and Low Carbon Energy – A Toolkit for Planners - Welsh Government (2015), a simple and well-established way of doing this is to use capacity factors (as referred to as load factors).

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, 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.

The annual energy output can be calculated by multiplying the installed capacity by its capacity factor and the number of hours in a year (8,760).

A summary of the different capacity factors for different technologies is given in Table 27.

Table 27: *Capacity factors for renewable and low and zero carbon technologies*

Technology	Capacity Factor[66]
Onshore wind	0.27
Biomass (electricity)	0.90
Biomass (heat)	0.50
Hydropower	0.37
Energy from Waste (electricity)	0.90
Energy from Waste (heat)	0.50
Landfill gas	0.60
Sewage gas	0.42
Solar Farm	0.1
BIR (electricity)	0.10
BIR (thermal)	0.20

[66] Capacity factors derived from the Planning for Renewable and Low Carbon Energy - A Toolkit for Planners (2015).

11.1 Energy generated from existing renewable sources

The total electrical energy that is currently being generated across the Conwy LPA (or will be when all currently consented projects and those under construction are built) from renewable and low and zero carbon energy technologies is circa 520GWhe.

This equates to circa 126% of the total electrical consumption across the Conwy LPA in 2008; 156% of the total predicted electrical consumption across the Conwy LPA in 2022 and 171% in 2031.

Electricity generation from large scale wind accounts for circa 353GWhe, 68% of total electrical consumption across the Conwy LPA area in 2008; 85.9% of predicted electrical consumption across the Conwy LPA area in 2022 and 86.1% in 2031.

The total thermal energy that is currently being generated across the Conwy LPA area from renewable and low and zero carbon energy technologies is circa 87 GWht, which equates to circa 10% of the total thermal consumption across the Conwy LPA in 2008 and 35% of the total predicted thermal consumption across the Conwy LPA in 2022 and 49% in 2031.

11.2 Energy generated from existing and potential renewable sources

The maximum potential electrical energy that could be generated across the Conwy LPA from renewable and low and zero carbon energy technologies (including existing and potential) in 2022 is circa 641GWhe and in 2031 circa 700GWhe. For 2022 and 2031 this equates to circa 4% of the total electrical consumption across Wales in 2008.

The maximum potential thermal energy that could be generated across the Conwy LPA from renewable and low and zero carbon energy technologies in 2022 is circa 245GWht and in 2031 circa 297GWht.

Table 28: *Existing and consented large scale renewable energy generated in the Conwy LPA area*

Technology	Electricity (MWh)	Thermal (MWh)
Wind Power	353,261	
Biomass CHP	15,768	43,800
Hydropower	108,904	
Landfill Gas	15,242	26,280
Solar PV Farms	19,360	
Other (Sewage Gas)	736	1,314
Total	**513,371**	**71,394**

Table 29: *Existing small-scale renewable energy generated in the Conwy LPA area*

Technology	Electricity (MWh)	Thermal (MWh)
Hydropower	788	
CHP	88	350
Photovoltaic	4,920	
Other	-	14,892
Wind Power	1,314	
Total	**7,096**	**15,242**

Table 30: *Existing and potential renewable electricity generated in the Conwy LPA area in 2022*

Resource	2022		2031	
	Electrical Capacity (MWe)	MWh generated	Electrical Capacity (MWe)	MWh generated
Wind	149.4	353,361	149.4	353,269
Biomass Energy Crop (CHP)	12.2	96,185	12.2	96,185
Energy from Waste with CHP	2.4	18,922	3.2	25,229
Hydropower	34.8	112,794	34.8	112,794
Landfill Gas	2.9	15,242	2.9	15,242
Solar PV Farms	22.1	19.360	22.1	19.360
Other including food waste, animal slurry, poultry litter, sewage sludge and sewage gas. (AD with CHP)	1.0	3,679	1.0	3,679
Building Integrated	24.1	21,112	84.9	74,372
Total	**248.9**	**640,655**	**310.5**	**700,222**

Table 31: *Existing and potential renewable heat generated in the Conwy LPA area in 2022*

Resource	2022		2031	
	Thermal Capacity (MWt)	MWh generated	Thermal Capacity (MWt)	MWh generated
Biomass Energy Crop (CHP)	30.5	133,590	30.5	133,590
Biomass Boilers, wood	7.1	31,098	7.1	31,098
Energy from Waste with CHP	4.9	21,462	6.4	28,032
Other including food waste, animal slurry, poultry litter, sewage sludge and sewage gas. (AD with CHP)	1.5	6,570	1.6	7,008
Landfill Gas (with CHP)	6.0	26,280	6.0	26,280
Building Integrated	14.6	25,579	40.8	71,482
Total	**64.6**	**244,579**	**92.4**	**297,490**

11.3 Setting LPA wide renewable energy contributions

11.3.1 Summary

For larger scale electricity generation only the existing Strategic Search Area (SSA) that encourages wind development has been identified.

In accordance with the evidence, building integrated renewables will be the primary strategy for delivering renewable energy generation in the Conwy LPA area.

Renewable heat is, by nature dependent upon a demand for its use. The demand for heat in the Conwy LPA area is limited and dispersed and therefore does not lend itself to the generation of large quantities of renewable heat in the Conwy LPA.

The Conwy LPA does however have considerable potential to produce energy crop and woody biomass which could facilitate neighbouring areas of Wales to generate renewable heat where there is demand.

The Conwy LPA could gear up for this role by developing its supply chain to deliver biomass generated heat to its building stock wherever appropriate: this could be secured through an invitation by the Council for developers to consider these options as part of the planning process.

11.3.2 Rationale for the setting of contributions

11.3.2.1 Electricity

The totals in Table 30 and Table 31 represent the theoretical maximum renewable energy resource that could be delivered by 2022 and 2031, it may be that developers will not come forward to deliver or more detailed individual site studies will constrain the figures further.

Table 32 and Table 33 below detail the realistic renewable energy contributions that could be made towards meeting a proportion of the total demand for energy in the Conwy LPA area in 2022 and 2031. The rationale is as follows:

- Whilst there is resource to supply biomass CHP there is insufficient heat demand in the county to justify the construction of the plant and ancillaries – hence the contribution is set to zero;
- Whilst there is potential to generate energy from the incineration of waste with electricity generation and heat recovery, there is:
  - o Non-recyclable waste is exported out of county to EfW plant & therefore counted as existing generation elsewhere.
  - o There is no demand for the heat;
  - o Decisions on waste infrastructure are made on a regional basis

  -hence the contribution is set to zero;
- The hydropower contribution is based on the (2010) Environment Agency report referring to win-win schemes in the county of Conwy;
- Given that there is already recovery of landfill gas that is utilised for electricity generation in the county, it is assumed that all economic opportunities have already been exploited – hence the contribution is set to zero;
- It is assumed that the small number of opportunities identified will be realised in full during the plan period;
- It is assumed that an Anaerobic Digestion plant will be constructed in the county utilising available animal slurry, with the heat usefully employed;

11.3.2.2 Heat

- Whilst there is resource to supply biomass CHP there is insufficient heat demand in the county to justify the construction of the plant and ancillaries – hence the contribution is set to zero;
- It is assumed that reasonably sized biomass boilers (e.g. 100kW) are installed in two non-domestic buildings each year in the CCBC LPA;
- Whilst there is potential to generate energy from the incineration of waste with electricity generation and heat recovery, there is:
  - o Non-recyclable waste is exported out of county to EfW plant & therefore counted as existing generation elsewhere.
  - o There is no demand for the heat;
  - o Decisions on waste infrastructure are made on a regional basis

-hence the contribution is set to zero;

- It is assumed that an Anaerobic Digestion plant will be constructed in the county utilising available animal slurry, with the heat usefully employed;

- It is assumed that 25% of the uptake of the microgeneration of renewable heat predicted via modelling will be achieved over the plan period.

Table 32: *Resource summary table for renewable electricity in the Conwy LPA area in 2022 and 2031.*

Energy Technology	Capacity Factor Assumed	Existing		Additional Potential 2022		Additional Potential 2031		Total Installed Capacity		Total Energy Generated	
		Installed Capacity (MW)	Energy Generated (MWh)	Installed Capacity (MW)	Energy Generated (MWh)	Installed Capacity (MW)	Energy Generated (MWh)	2022 (MW)	2031 (MW)	2022 (MWh)	2031 (MWh)
Wind Power (existing includes SSAs)	0.27	149.4	353,361	-	-	-	-	149.4	149.4	353,361	353,361
Existing Biomass (CHP)	0.90	2.0	15,768	-	-	-	-	2.0	2.0	15,768	15,768
Energy from Waste with CHP	0.90	-	-	-	-	-	-	-	-	-	-
Hydropower	0.37	33.6	108,904	1.2	1,945	1.2	2,917	34.8	34.8	110,849	111,821
Landfill Gas	0.60	2.9	15,242	-	-	-	-	2.9	2.9	15,242	15,242
Solar PV Farms	0.10	22.1	19,360	-	-	-	-	22.1	22.1	19,360	19,360
Other including animal slurry, poultry litter and sewage gas. (AD with CHP)	0.42	0.2	736	0.3	625	0.3	938	0.5	0.5	1,361	1,674
BIR	0.10	8.1	7,096	16.0	14,016	76.8	67,277	24.1	84.9	21,112	74,373
Total	**-**	**218.3**	**520,467**	**17.5**	**16,586**	**78.3**	**71,132**	**235.8**	**296.6**	**537,053**	**591,599**
Electrical energy demand 2008			412,800	**Projected electrical energy demand**						**411,356**	**410,430**
Percentage electricity demand met by renewable energy resource			126%							**131%**	**144%**

Table 33: *Resource summary table for renewable heat in 2022 and 2031*

Energy Technology	Capacity Factor Assumed	Existing		Additional Potential 2022		Additional Potential 2031		Total Installed Capacity		Total Energy Generated	
		Installed Capacity (MW)	Energy Generated (MWh)	Installed Capacity (MW)	Energy Generated (MWh)	Installed Capacity (MW)	Energy Generated (MWh)	2022 (MW)	2031 (MW)	2022 (MWh)	2031 (MWh)
Existing Biomass (CHP)	0.50	10.0	43,800	-	-	-	-	10	10	43,800	43,800
Biomass Boilers, Wood	0.50	-	-	7.1	31,098	7.1	31,098	7.1	7.1	31,098	31,098
Energy from Waste with CHP	0.50	-	-	-	-	-	-	-	-	-	-
Other including animal slurry, poultry litter and sewage gas. (AD with CHP)	0.50	0.3	1,314	0.5	1,183	0.5	1,774	0.8	0.8	2,497	3,088
Landfill Gas (with CHP)	0.50	6.0	26,280	-	-	-	-	6.0	6.0	26,280	26,280
BIR	0.20	8.7	15,242	5.9	10,337	32.1	56,239	14.6	40.8	25,579	71,481
Total	**-**	**25.0**	**86,636**	**13.5**	**42,618**	**39.7**	**89,111**	**38.5**	**64.7**	**129,254**	**175,747**
Thermal energy demand 2008			846,720	**Projected electrical energy demand**						**694,164**	**611,906**
Percentage thermal demand met by renewable energy resource			10%							**19%**	**29%**

12. Heat opportunity assessment

12.1 Introduction

This component of the REA considers some of the issues associated with mapping opportunities for the utilisation of renewable and low carbon heat. 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 district heating networks
- Assessing the technical and financial viability of district heating networks

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 provides sufficient levels of detail for sieving candidate sites and to set a policy requiring a developer to investigate a District Heat Network (DHN).

Any policy requiring specific site/building CO_2 reduction targets, or connections to DHN, will require a more detailed economic and technical appraisal.

12.2 Background

There are multiple reasons for identifying and understanding the nature of existing and future energy demand and infrastructure, some of which are:

- Identification of public sector buildings to act as anchor 'heat' loads (AHLs);
- To establish the energy densities of particular areas. New CHP/District Heating technology installations are more likely to be economically viable in areas of high density energy demand but can be more complex to install. This dataset 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 Low and Zero Carbon (LZC) technologies 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 identify 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.

12.2.1 Identifying anchor "heat" loads (AHLs) and "clusters"

'Anchor heat loads' pertain to buildings with a high and continuous demand that could provide economically viable and practical opportunities for utilising heat. It is known as an 'anchor' load because further opportunities may arise for connecting nearby buildings to the original anchor load. An 'AHL' therefore refers to a building energy load that can act as a base for a District Heating (DH) schemes.

Buildings that are located near to an AHL (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 AHLs 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, and;

- Planned new development/ refurbishment by the 'anchor heat load' organisation. New development is likely to be the catalyst for such change. DH schemes are most cost-effective when installed as part of new development rather than retro-fitting.

- Social housing schemes. These organisations are often tasked with achieving greater than the minimum environmental performance standards. The inclusion of such developments in DH schemes often enhance the energy profile to provide further evening, weekend and night time energy demands.

AHLs can help a DH scheme to become a realistic prospect and there are usually particular conditions that need to be in place, such as planned new development and/ or an AHL building/ group of buildings with a significant demand for heat and/ or with an energy profile suitable for the installation of a particular technology.

Given the responsibilities placed upon local authorities and the public sector in general for driving the climate change mitigation agenda (particularly in light of the 'Well-being of Future Generations (Wales) Act – Welsh Government (2015), the many District Heating enabling roles that are the responsibility of the local authority, and the ability that local authorities have to accept lesser returns on investment than private sector in order to obtain wider social value, AHL's 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.

Privately owned buildings are less often utilised as AHLs due to more attractive returns from competing investments, reduced willingness to commit to long term energy procurement contracts and other issues such as a greater tendency for private companies to rent property rather than own it. In the residential market, it is preferable to for district heating schemes to connect to social housing, and in particular with apartment blocks due to the increased heat demand density offered. It is often impractical for developers to have to negotiate with many individual private householders whereas social landlords can more readily act on behalf of their tenants.

12.2.2 Social Housing Associations in Conwy

Housing Associations active in the Conwy LPA area include (this list is not intended to be exhaustive):

- Cartrefi Conwy
- Clwyd Alyn Housing Association
- Grwp Cynefin
- North Wales Housing
- Wales & West Housing Association

12.2.3 Identifying 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 often utilise less economic and more polluting fuels for heat and Domestic Hot Water (DHW). In the case of dwellings, this can be a contributing factor to fuel poverty.

There are several important reasons for identifying these areas, namely:

- The use of fuels other than natural gas for heat and DHW often incur additional cost to the user. Whereas the economic case (at the time of writing) for the installation of renewable heat 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 building integrated LZC technologies.

- The reason DHN 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.

- DHN schemes fed 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-locate complementary businesses.

The maps within this Renewable Energy Assessment do not show off-gas areas due to lack of access to data. However, it is recognised that given the rural nature of Conwy, a significant number of properties outside of larger settlements are likely to be 'off-gas'. GIS mapping of these areas could be completed by Conwy County Borough Council.

12.2.4 Mapping residential heat demand and density

A report for BEIS (formerly DECC[67]) suggests that DHNs are not feasible unless a heat demand is present of at least 3MW/km^2.

'Density' of heat demand refers to kilowatt hour (kWh) / square kilometre (km^2) of heat energy consumed in dwellings.

Information relating to heat densities can be used to inform:

- The identification of AHLs 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.

When allocating quantities of energy to dwellings or other types of buildings it is a useful check to look at national sources of data to ensure figures are broadly supported and to check whether annual energy consumptions are above or below national averages. Above national average consumption may indicate a lack of energy saving education or a higher proportion of poorly insulated buildings, etc.

When allocating energy consumptions to buildings the Chartered Institute of Building Services Engineers Technical Memorandum TM46 conversions used are average figures for particular buildings assuming particular fuels are employed (e.g. natural gas is used for heating). Outputs from this REA achieve greater accuracy than TM46 as the age and type of dwellings is considered and energy demands amended accordingly.

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 AHLs;
- Feeding into the analysis of potential LZC solutions.

12.2.5 Residential heat demand across the Conwy LPA area

Based on the BEIS (formerly DECC) energy consumption data for the Conwy LPA, there were two Lower Level Super Output Areas [LLSOA] that had a heat density that would be considered sufficient (i.e. greater than 3MW/km^2) for viable connection to district heating networks. The two LLSOAs are located in Colwyn Bay. The LLSOA just south of the Colwyn Bay centre has a residential heat density greater than 6 MW/km^2, and the other LLSOA is located in the eastern portion of Colwyn Bay, with a residential heat density of between 3 and 6 MW/km^2. There are more LLSOAs with 2-3 MW/km^2 heat density in Conwy: one west of the Abergele centre, and three along the seaside in Colwyn Bay. The existing heat demand map for Conwy does not display LLSOAs with a heat density below the threshold of 2MW/km^2.

12.2.6 Identifying areas of high fuel poverty

Fuel poverty is a key concern of national governments and local authorities alike. Local authorities, including Conwy County Borough Council, 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

[67] The Potential and Costs of District Heating Networks. A Report to the Department of Energy and Climate Change, April 2009

constitute a greater proportion of the household costs than for many urban households.

A contributory factor 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.

12.3 Energy Efficiency Retrofit Programmes

Over the next decade, investment into the sector in Wales will also come from:

- Nest – Wales' demand led fuel poverty scheme
- The Welsh Housing Quality Standard
- Feed-In-Tariffs
- Renewable Heat Incentive
- Green Deal
- Energy Act – giving landlords the responsibility of improving the energy efficiency of the private rented sector by 2018
- Energy Supplier Obligations.

Around £1bn over the next decade is likely to be invested into the energy performance of Welsh homes.

12.4 Identifying existing DHN & CHP schemes and sources of waste heat

It is important to establish the nature of the existing energy infrastructure as it may provide opportunities for expanded connectivity or increased efficiency/ viability. Identification of current utilisation of renewable energy resources is covered by this Renewable Energy Assessment.

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 the viability of a particular scheme.

12.4.1 What is a DHN

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

Heat can be transmitted as hot water, or in some cases steam, along buried pipes to a number of buildings in the local area. The pipes are known as heat mains. A heat exchanger located in each building enables the delivery of heat. New controllers are provided (very similar to those fitted and linked with gas boilers) to operate the system and buildings can usually retain their internal distribution system (e.g. radiators).

Heat is metered and billed to consumers in much the same way that gas or electricity is. This is combined with a service charge to cover maintenance of the shared distribution system (electricity and gas bills also incorporate a charge for these services).

12.4.2 What is CHP?

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 "tri-generation" or CCHP (Combined Cooling Heat and Power).

12.4.3 Existing DHN and CHP schemes in Conwy

There is no existing DHN scheme in Conwy, however, there are a few large heat loads which could serve as anchor loads for a district heating network. The buildings and their annual heat demands are as follows: the Leisure Centre in Colwyn Bay with circa 1.36 GWh/yr, Colwyn Bay Community Hospital circa 0.7 GWh/yr, Abergele Leisure Centre circa 0.7 GWh/yr, Ysgol Emrys Ap Iwan in Abergele with circa 0.68 GWh/yr, Sarn Mynach Welsh Assembly Government in Llandudno

Junction with 0.86 GWh/yr, and greatest of all is the Bryn y Neuadd Hospital in Llanfairfechan with circa 5.8 GWh/yr.

CHP boilers could be considered to be fitted in the hospitals or leisure centres which would have a large constant heat demand 24/7.

The UK Heatmap produced by BEIS (formerly DECC) confirms that there are no large-scale heat loads (including CHP sites) in the Conwy LPA area. This is further confirmed by the Ofgem (Renewable Obligation Certificates) database.

12.5 Heat Opportunity Plan for DHNs

The bringing together of various data layers described above, together with the location of candidate sites for new development, informs the development of a 'Heat Opportunities Plan'.

12.5.1 Evaluation of District Heating Network Opportunities

The development of the energy opportunity plans for Conwy County Borough Council has enabled the identification of clusters of sites with potential to be technically feasible and economically viable. Five scenarios were identified that have potential for a heat network, namely:

- Colwyn Bay 1
- Colwyn Bay 2
- Colwyn Bay 3
- Abergele
- Llandudno Junction

An evaluation of district heating network opportunities for the above scenarios is given in the supporting document titled: Evaluation of District Heating Network Opportunities.

13. District Heating Networks Evaluation of Site Clusters

13.1 Introduction

This section of the report follows on from the wider Renewable and Low Carbon Energy Assessment for Conwy County Borough Council, and is intended to provide an evaluation of district heating network opportunities at five strategic sites across the local planning authority. The five strategic sites were identified by CCBC as part of the ongoing progression of CCBC Local Development Plan.

The five strategic sites as identified by CCBC included:

- Abergele
- Colwyn Bay
- Kinmel Bay
- Llandudno Junction
- Llanfairfechan.

The methodology used for this assessment is fully compliant with the Welsh Government Renewable Energy Toolkit (2015 revision). For each district heating network opportunity, existing buildings and future new developments are considered. For each site/ area a high-level assessment is carried out of the technical and financial viability of combined heat and power (CHP) and district heating covering gas engine CHP and biomass heat only technologies.

For each option the potential carbon savings, costs and revenues were calculated, and the potential gap funding required to make a scheme commercially viable have been identified. The analysis considered two rates of return, or discount rates, namely: a typical public-sector discount rate (6%) and a typical private sector commercial rate (12%).

13.2 Stakeholder Workshop

A stakeholder workshop was held at Conwy County Borough Council, Colwyn Bay, on the 14th June 2013. The full list of attendees is included in **Appendix G**.

13.3 Limitations of this Study.

The more detailed assessment of viability set out in this report, based on cashflow modelling, is based on a desk top review of the sites only. The scope of our study has not included site visits to any of the buildings included in the model, nor has it included any monthly or hourly modelling of energy demands. Also, CCBC were not able to provide us with a schedule of existing boiler plant showing rated capacity and condition. Therefore, we have had to make estimates of the peak heating demand for each building based on floor area. Therefore, our estimates of plant and network sizing, capital costs and operating costs and revenues should be treated as indicative concept stage values only.

Where we have given cost assessments, these are approximate based on information available at the time of conducting the study and no allowance has been made for inflation, currency exchange rates, or other conditions which may result in future price fluctuations. A QS has not been consulted in preparing these costs. For those options that look most promising, we strongly recommend that CCBC conduct a more detailed assessment of the technical and financial viability before proceeding with any investment decision.

14. Overview of Sites

14.1 Introduction

This section presents the results of a high-level assessment of the potential for district heating and CHP for clusters of candidate sites within towns in the County. This resulted in focus on three areas of Conwy, namely:

- Abergele;
- Colwyn Bay
- Kinmel Bay
- Llandudno Junction
- Llanfairfechan

For each site and scenario, the analysis presents the following information:

- *Heat Opportunity Plan (HOP):* A HOP showing cluster of candidate sites in the context of the surrounding area.
- *General Overview:* Introduction to the option outlining the building typology and any specific details relating to any existing features that are of interest as well as proposed development plans.
- *SWOT Analysis:* Covering existing and proposed buildings including any phasing and timing issues. In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network, as well as the potential for future expansion of a heat network.
- *List of key existing buildings:* Using the data provided by the Council and from the Community and Local Government (CLG) database, we have identified a number of key existing buildings within the sites, and listed their heat demands. These heat demands are from gas consumption data supplied by Council, DEC data compiled by the Centre for Sustainable Energy [CSE] or additional data sought from Council contacts.
- *List of potential new development:* The proposed new buildings within the site have been identified from the proposed Local Development Plan allocated employment, housing or mixed-use development parcels. Specific information on the size, type and phasing of development sites have been derived from the following datasets:
    - Conwy Deposit Local Development Plan 2007-2022 (Rev. 2011) Background Paper 30 Phasing Plan – August 2012.
    - Conwy Deposit Local Development Plan 2007-2022 (Rev. 2011) Background Paper 42 Employment Land Demand and Supply – August 2012.
- *Potential District Heating Network Routes:* A marked up GIS Map that confirms the indicative district heating network route[s] that could be taken forward for further review based on an evaluation of site opportunities and constraints as identified above.
- *Viability Appraisal:* Detailed financial analysis of the five options taken forward from the client progress meeting dated 14/06/2013. Within this section the assumed pipe routing is also presented.

14.2 Overview- Abergele

14.2.1 General Overview

Abergele is a town located on the north coast of Conwy and has a population of circa 10,000 people. The A55 North Wales Expressway is routed around the northern and eastern boundaries of the town.

Housing sites 79/80/21/82, located nearby to junction 24 of the A55, would see approximately 600 new dwellings being built over the period 2012-2022. Further south in Abergele, 100 dwellings could be built as part of a contingency plan at Allocated Housing site 78. To the east of Abergele there is a significant proportion of Cartrefi Conwy owned existing dwellings, which could potentially be included within a district heating network installed at the site.

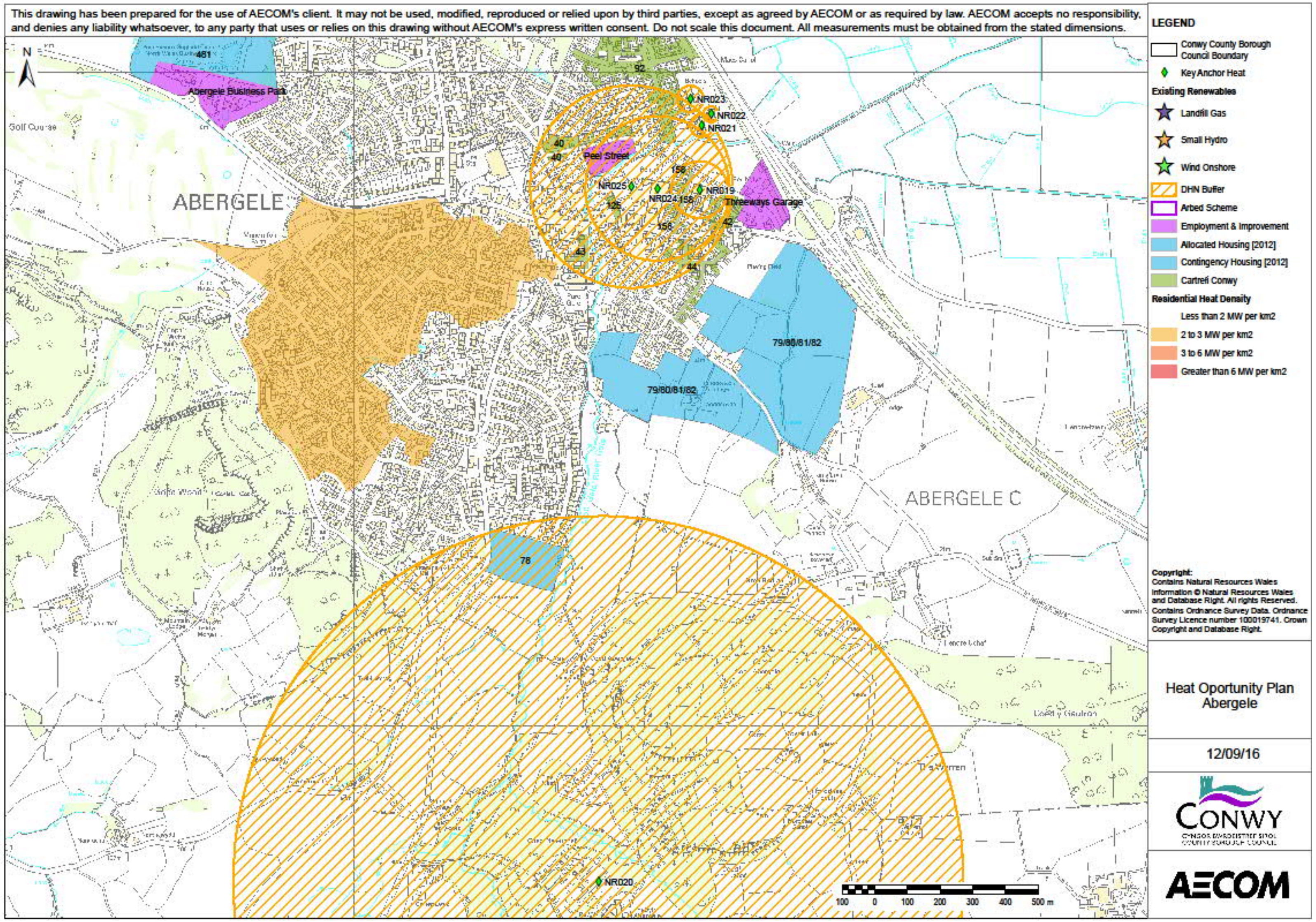
Situated approximately half a mile south of Abergele, Abergele Community Hospital could act as a key anchor heat load for any district heating network in the south of the town. Further potential key anchor heat loads have been identified at Abergele Community College [NR019], Ysgol Emrys Ap Iwan [NR024] and Abergele Leisure Centre [NR025].

Two areas around Peel Street and Threeways Garage have been identified as areas allocated as Employment & Improvement areas.

14.2.2 Heat Opportunity Plan

The Heat Opportunity Plan for Abergele is given overleaf.

Figure 8: *Abergele - Heat Opportunity Plan*



14.2.3 SWOT Analysis

Table 34 below provides an overview of existing and potential buildings at Abergele, including any phasing and timing issues. In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network are summarised, as well as the potential for future expansion of a heat network.

Table 34: *Overview of existing and potential buildings at Abergele*

SWOT Analysis		
Existing buildings	**Potential Buildings**	**Phasing /timing issues**
Key potential anchor heat loads: ▪ Abergele Community Hospital ▪ Abergele Community College ▪ Ysgol Emrys Ap Iwan ▪ Abergele Leisure Centre Other non-residential public buildings: ▪ Glangele Infant School ▪ Glan Morfa Junior School ▪ St Elfod Junior School	Key sites: ▪ Site 78: 100 dwellings [contingency] ▪ Site 79/80/81/82: 600 dwellings	▪ Coordination required with the development of the proposed sites. Anticipated development periods are as follows: ▪ Site 79/80/81/82: 150 units 2014-2017, 295 units 2017-2022 ▪ Site E3: 3.5ha employment land & 155 units 2017-2022
Site opportunities		
The close proximity of Cartrefi Conwy existing dwellings and the Abergele Community College and leisure centre may provide an opportunity to sell heat. Cartrefi Conwy Site 92, located on and around Maes Canol, consists of 107 dwellings. Expansion of the heat network to include Glangele Infant School [NR021], Glan Morfa Junior School [NR022] and St Elfod Junior School [NR023] to the north of the site could be possible. Contingency employment land adjacent to the allocated housing sites 79/80/81/82 could allow for future expansion of heating network but has not been included within this study.		
Site constraints		
Connection of heat network from community hospital to the allocated housing site 79/80/81/82 may be too long. River Afon Gele runs south-north through the site and the A55 is routed alongside the eastern and northern boundaries of the town.		
Next steps		
Investigate the extent of site E3 within allocated housing sites 79/80/81/82		

14.2.4 List of key existing buildings

Table 35: *Summary of key existing buildings at Abergele*.

AECOM ID	Name	Annual Heat Demand (MWh)	Source
NR020	Abergele Community Hospital	3,781	CSE Data
NR019	Abergele Community College	181	CSE Data
NR024	Ysgol Emrys Ap Iwan	728	Conwy County Council
NR025	Abergele Leisure Centre	762	Conwy County Council
NR021	Glangele Infant School	124	CSE Data
NR023	St Elfod Junior School	255	Conwy County Council
	Total	**4,586**	

14.2.5 List of potential buildings

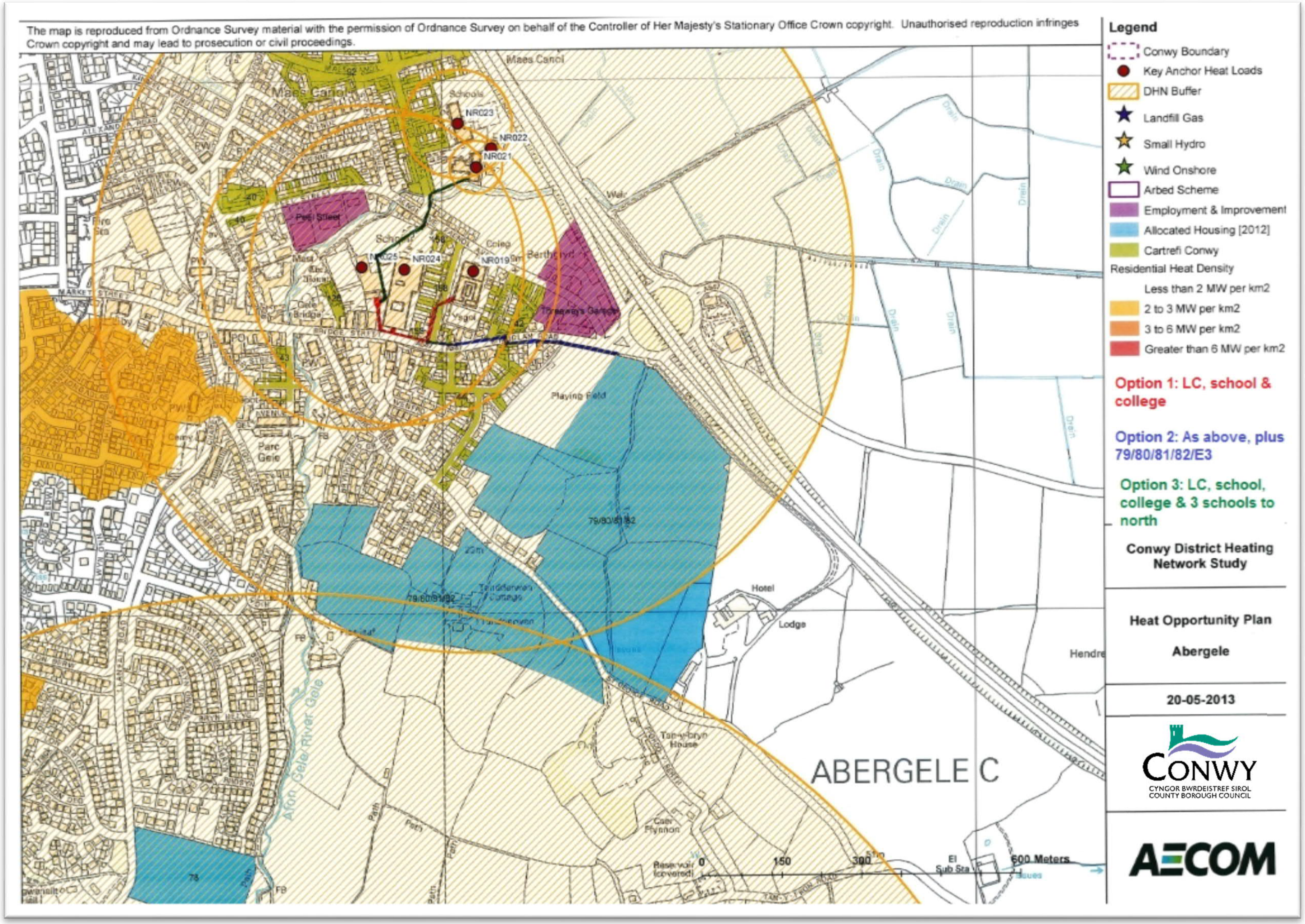
Table 36: *Proposed buildings and estimated year of build out at Abergele.*

Reference	Name	Maximum number of dwellings	Non residential floor area (m^2)	Estimated build out year
78	Llanfair Road	100	0	Unknown
79/80/81/82	Rhuddlan Road / Tandderwen Farm	600	2 ha	2012-2022
Total	**-**	**700**	**2 ha**	**-**

14.2.6 Potential District Heating Network Routes

Indicative district heating network route[s] that could be taken forward for further review based on an evaluation of site opportunities and constraints as identified above are illustrated in the GIS map overleaf.

Figure 9: *Abergele - Potential District Heating Network Routes*



14.3 Overview-Colwyn Bay

14.3.1 General Overview

The town of Colwyn Bay is located on the north coast of Conwy and has a population of circa 10,000 people. There is an existing leisure centre with a swimming pool and a hospital located within the Glyn and Eirias wards of Colwyn Bay. Clusters of Cartrefi Conwy residential properties are located nearby.

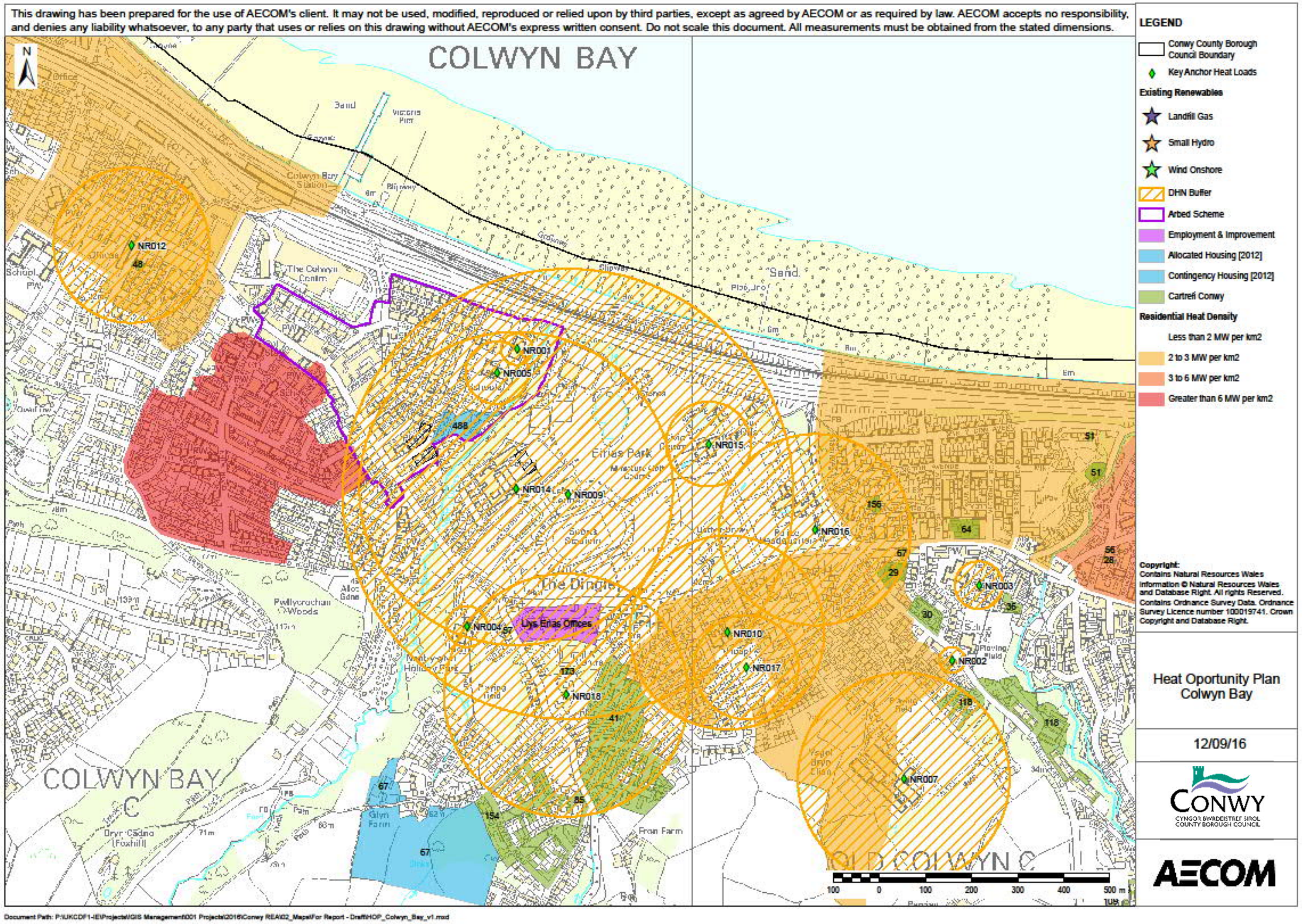
Connecting existing non-residential buildings could be a catalyst for district heating. Eirias High School [NR006] and Eirias Park Leisure Centre [NR009] have been identified as key anchor heat loads, alongside Colwyn Bay Community Hospital [NR010]. Connection of these three heat loads could allow for further expansion of a network to include the police headquarters [NR016], council offices [NR015], Ysgol Bod Alaw [NR004] and Llys Elian Care Home [NR018].

The relatively low heat demand of Ysgol Glan Y Mor [NR001] and Ysgol Pendorlan [NR005] (which are now amalgamated to form Ysgol Nant y Groes) coupled with the river Nant y Groes running south-north through the town has meant that expansion of a potential of heat network westwards from the key anchor heat loads may be prohibitive.

14.3.2 Heat Opportunity Plan

The Heat Opportunity Plan for Colwyn Bay is given overleaf.

Figure 10: *Colwyn Bay- Heat Opportunity Plan*



14.3.3 SWOT Analysis

Table 37 below gives an overview of existing and potential buildings at Colwyn Bay, including any phasing and timing issues.

In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network are summarised, as well as the potential for future expansion of a heat network

Table 37: *Overview of existing and potential buildings at Colwyn Bay*

SWOT Analysis		
Existing buildings	**Potential Buildings**	**Phasing /timing issues**
Key potential anchor heat loads: ▪ Colwyn Leisure Centre ▪ Colwyn Bay Community Hospital ▪ Eirias High School Other non-residential buildings: ▪ Ysgol Nant y Groes ▪ Ysgol Iau ▪ Ysgol T Gwynn Jones ▪ Ysgol Bryn Ilian ▪ Ysgol Bod Alaw ▪ Llys Elian Care Home ▪ Llys Eirias Offices ▪ Awel y Mynydd ▪ North Wales Police Headquarters ▪ Conwy County Borough Council ▪ Benefits Agency ▪ Cartrefi Conwy Sites	Key sites: • Site 488: 35 new dwellings. • Site 67: Up to 130 new dwellings (contingency).	It is anticipated that 100% of Site 488's new dwellings will be completed by 2017.
Site opportunities		
Multiple Cartrefi Conwy social housing sites are within the vicinity of the study area that may be integrated into a district heating scheme. Of particular note is Cartrefi Conwy site 41, centred on Fford Bugail and consisting of 152 dwellings. There is the possibility that the sports stadium located adjacent to the leisure centre will be developed to accommodate events and hospitality, as set out in the Invitation to Tender by Conwy County Borough Council. An alleyway adjacent to the Child Health Clinic on Abergele Road has been identified as part of a potential heating network pipe work route used to connect the Colwyn Bay Community Hospital to the leisure centre.		
Site constraints		
A wooded valley with river running through nearby to the leisure centre and Eirias High School could make expansion of the heat network westwards unviable. No obvious large customers for electricity output close to the new development sites, therefore financial model assumes all electricity from any gas engine CHP is exported to the grid.		
Next steps		
Investigate redevelopment of sports stadium and possible inclusion within heat network.		

14.3.4 List of key existing buildings

Table 38: *Summary of key existing buildings at Colwyn Bay*

AECOM ID	Name	Annual Heat Demand (MWh)	Source
NR009	Leisure Centre, Eirias Park	1,443	Conwy County Council
	Ysgol Awel y Mynydd	1,202	Conwy County Council
NR006	Eirias High School	884	Conwy County Council
NR010	Colwyn Bay Community Hospital	770	Conwy County Council
NR007	Ysgol Bryn Elian	679	Conwy County Council
NR018	Llys Elian Care Home	679	CSE Data
NR016	North Wales Police Headquarters	546	CSE Data
NR012	Benefits Agency	420	CSE Data
NR012	Benefits Agency	420	CSE Data
NR015	Conwy County Borough Council	259	CSE Data
NR005	Ysgol Nant y Groes	224	Conwy County Council
NR004	Ysgol Bod Alaw	142	Conwy County Council
NR003	Ysgol Iau	101	Conwy County Council
NR002	Ysgol T Gwynne Jones	78	Conwy County Council
	Total	**7,427**	

14.3.5 List of potential buildings

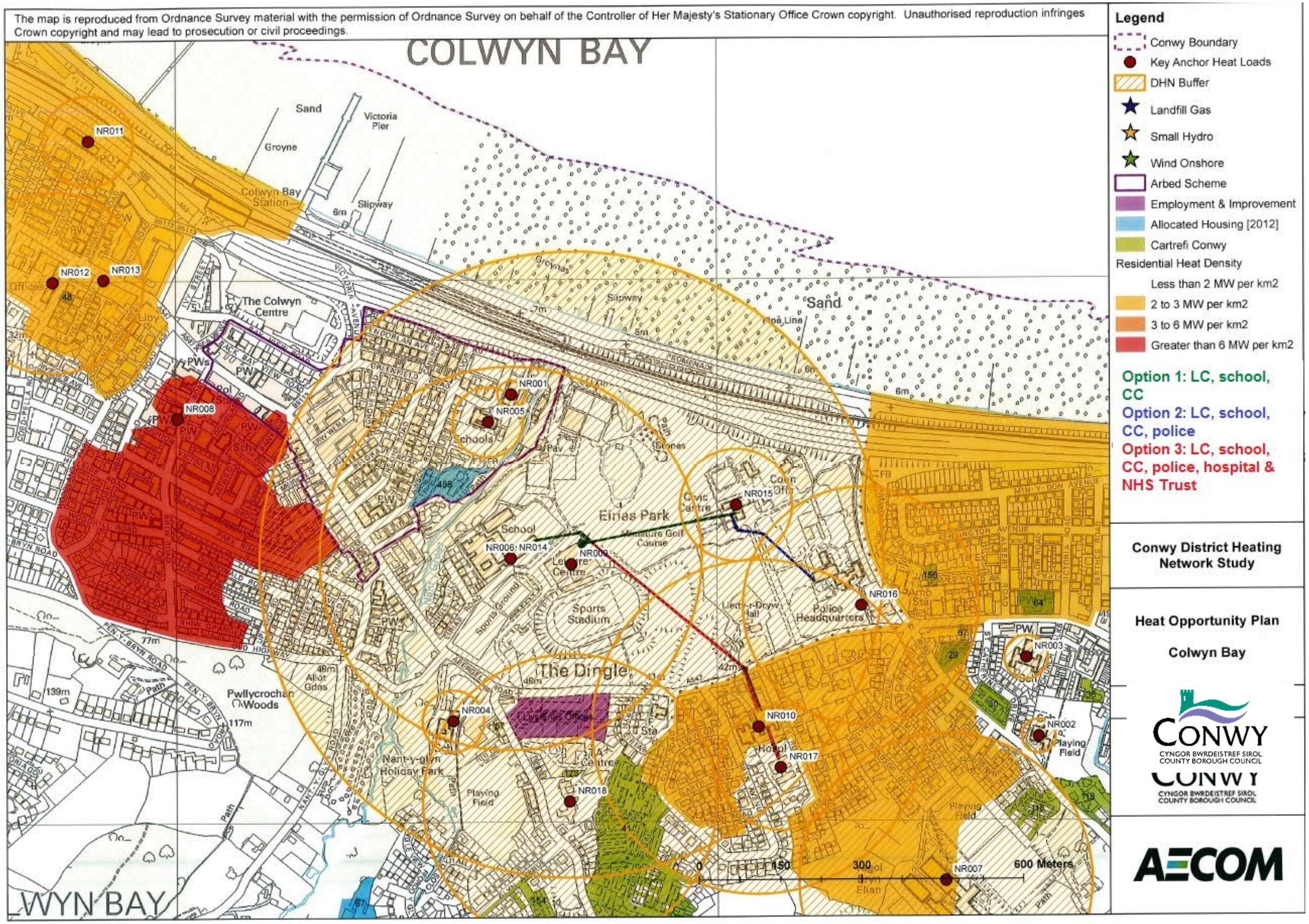
Table 39: *Summary of proposed buildings and estimated year of build out at Colwyn Bay*.

Reference	Name	Maximum number of dwellings	Non residential floor area (m^2)	Estimated build out year
488	Lawson Road	35	6,500	2012-2017
67	Glyn Farm (Contingency)	130	56,000	Unknown
Total	**-**	**165**	**62,500**	**-**

14.3.6 Potential District Heating Network Routes

Indicative district heating network route[s] that could be taken forward for further review based on an evaluation of site opportunities and constraints as identified above are illustrated in the GIS map overleaf.

Figure 11: *Colwyn Bay - Potential District Heating Network Routes*



14.4 Overview- Kinmel Bay

14.4.1 General Overview

Kinmel Bay is a small suburb located to the west of the main town of Rhyl on the north coast of Conwy. Together with neighbouring Towyn, Kinmel Bay has a population of circa 8,500 people.

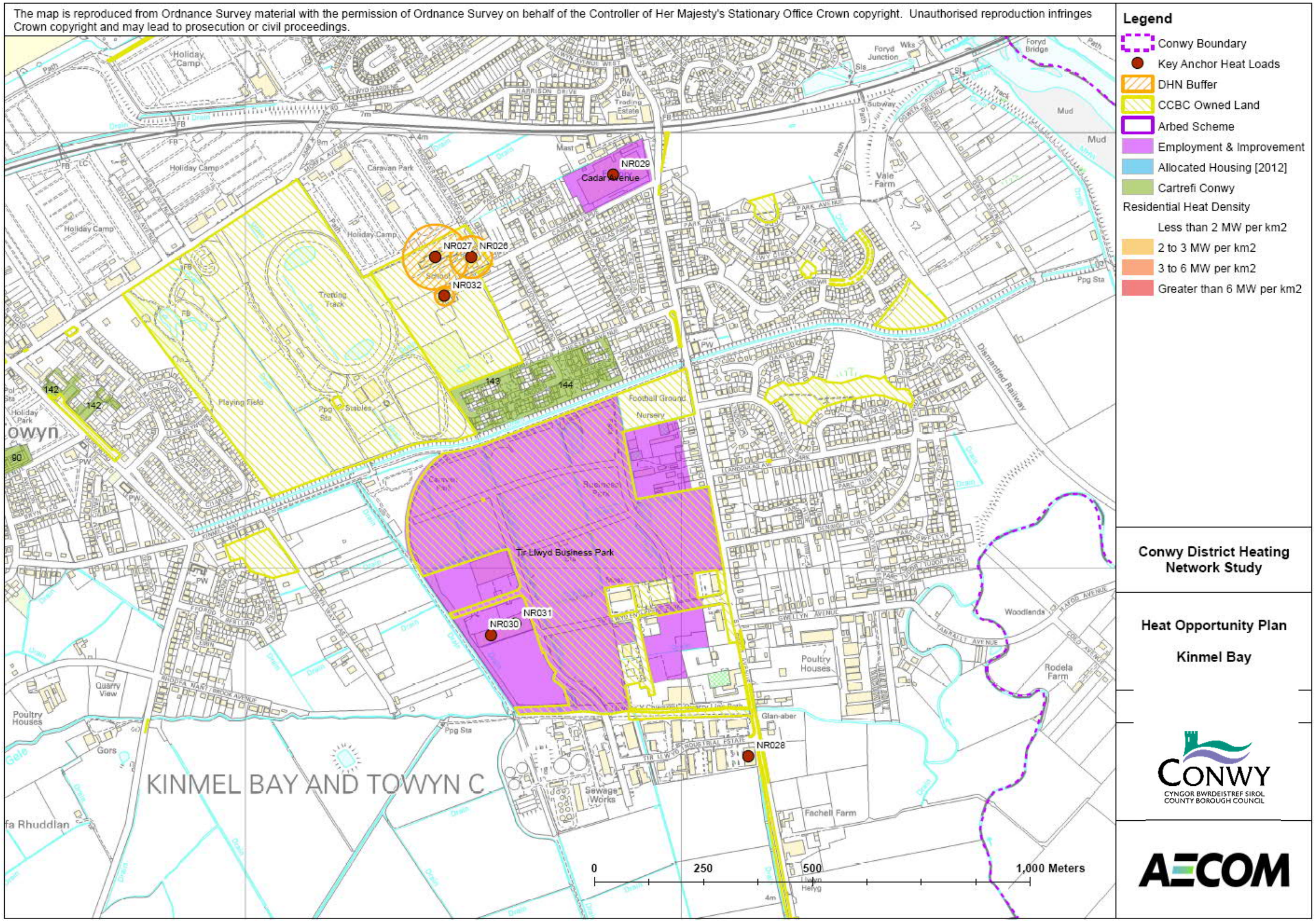
Tir Llwyd Business Park, situated towards the south of Kinmel Bay, is a large area allocated for employment & improvement development that could potentially provide heat customers for any district heating network in the area. Just north of the business park are Cartrefi Conwy sites 143 & 144, containing 91 dwellings.

Ysgol Maes Owen [NR027] and Ysgol Babanod Y Foryd [NR026] are located towards the centre of Kinmel Bay. Y Morfa Leisure Centre [NR032] is located within close proximity of both education buildings. A further employment & improvement area has been allocated at Cadar Avenue, within the centre of Kinmel Bay.

14.4.2 Heat Opportunity Plan

The Heating Opportunity Plan for Kinmel Bay is given overleaf.

Figure 12: *Kinmel Bay - Heat Opportunity Plan*



14.4.3 SWOT Analysis

Table 40 below gives an overview of existing and potential buildings at Kinmel Bay including any phasing and timing issues. In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network are summarised, as well as the potential for future expansion of a heat network

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Table 40: *Overview of existing and potential buildings at Kinmel Bay*

<table>
<tr><th colspan="3">SWOT Analysis</th></tr>
<tr><th>Existing buildings</th><th>Potential Buildings</th><th>Phasing /timing issues</th></tr>
<tr><td>Key potential anchor heat loads:
▪ Tir Llwyd Business Park
Other non-residential public buildings:
▪ Ysgol Maes Owen
▪ Ysgol Babanod y Foryd
▪ Morfa Leisure Centre</td><td>Key sites:
▪ Tir Llwyd Business Park</td><td>Coordination required for the development of Tir Llwyd Business Park. Anticipated phasing of business park is currently unknown.</td></tr>
<tr><th colspan="3">Site opportunities</th></tr>
<tr><td colspan="3">A potential site for a council owned energy centre has been identified in the northwest corner of Tir Llywd Business Park, providing heat to Cartrefi Conwy housing sites 143 & 144 and existing buildings on the estate[68]. This heating network could potentially be expanded as the business park develops further in the future.
The close proximity of both schools and the leisure centre could make expansion of a heating network to include these sites viable.</td></tr>
<tr><th colspan="3">Site constraints</th></tr>
<tr><td colspan="3">No major physical constraints identified.</td></tr>
<tr><th colspan="3">Next steps</th></tr>
<tr><td colspan="3">Further information required regarding Tir Llwyd Business Park.</td></tr>
</table>

[68] Conwy County Borough Council, Renewable Energy Assessment, August 2012

14.4.4 List of key existing buildings

Table 41: *Summary of key existing buildings at Kinmel Bay*

AECOM ID	Name	Annual Heat Demand (MWh)	Source
NR026	Ysgol Babanod y Foryd	120	Conwy County Council
NR027	Ysgol Maes Owen	186	CSE Data
NR032	Y Morfa Leisure Centre	55	Conwy County Council
	Total	**361**	

14.4.5 List of potential buildings

No buildings are proposed within the site area at Kinmel Bay.

14.4.6 Potential District Heating Network Routes

Based on an evaluation of site opportunities and constraints as identified above, no indicative DHN opportunities have been identified.

14.5 Overview- Llandudno Junction

14.5.1 General Overview

Llandudno Junction is located in northwest Conwy and has a number of candidate employment & improvement sites to the south of the town. There is a leisure centre located to the south of the town alongside a large supermarket. Potential development sites include the mixed-use site 176 to the east of the town and 439 located in the centre of the town.

Located to the east of the town within an employment & improvement area is Sarn Mynach Welsh Government office [NR047]; Sarn Mynach has an existing 0.3MW wood pellet biomass boiler installed.[69] Marle Hall Outdoor Education Centre [NR045] is located to the north of the town.

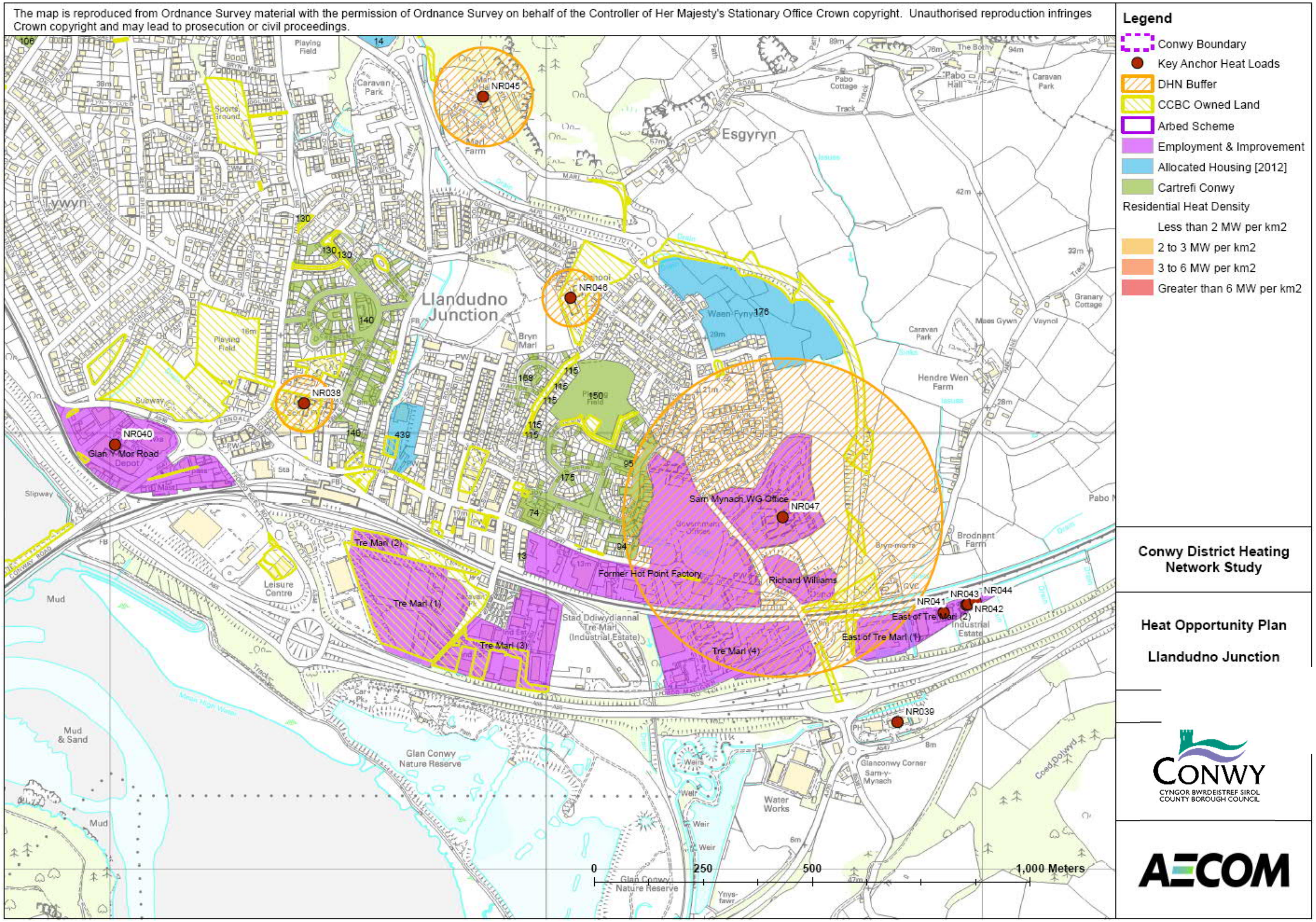
Cartrefi Conwy owns a number of dwellings within the centre of the town.

14.5.2 Heat Opportunity Plan

The Heat Opportunity Plan for Llandudno Junction is given overleaf.

[69] Conwy County Borough Council, Renewable Energy Assessment, August 2012.

Figure 13: *Llandudno Junction - Heat Opportunity Plan*



14.5.3 SWOT Analysis

Table 42 below gives an overview of existing and potential buildings at Llandudno Junction including any phasing and timing issues. In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network are summarised, as well as the potential for future expansion of a heat network

Table 42:-*Overview of existing and potential buildings at Llandudno Junction*

<table>
<tr><th colspan="3">SWOT Analysis</th></tr>
<tr><th>Existing buildings</th><th>Potential Buildings</th><th>Phasing /timing issues</th></tr>
<tr><td>Key potential anchor heat loads:
▪ Sarn Mynach WG Office
Other non-residential buildings:
▪ Marle Hall Outdoor Education Centre</td><td>Key sites:
▪ Site 176: mixed use; 120 units, 5.2ha B1 employment land
▪ Site 439: 40 units
▪ Site 14: 75 units
▪ Ysgol Awel Y Mynydd</td><td>Coordination required with the development of the proposed sites. Anticipated development periods are as follows:
• Site 176: 70 units & 4.2ha B1 employment 2012-2017, 50 units & 1ha B1 employment 2017-2022,
• Site 439: 100% of units 2012-2017
• Site 14: 100% of units 2017-2022</td></tr>
<tr><th colspan="3">Site opportunities</th></tr>
<tr><td colspan="3">Expand and extend Sarn Mynach heating to proposed mixed use development 176.
An area to between Site 176 and the existing Sarn Mynach WG Offices has been flagged as a possible site for a new school development (Ysgol Awel Y Mynydd), as outlined in the Invitation to Tender by Conwy County Borough Council. However, the school will not have a network connection the WG Offices.</td></tr>
<tr><th colspan="3">Site constraints</th></tr>
<tr><td colspan="3">Railway running east-west through the town. The feasibility of crossing the railway and connecting the leisure centre to a district heating network would need to be reviewed.</td></tr>
<tr><th colspan="3">Next steps</th></tr>
<tr><td colspan="3">Investigate potential development of site to the west of Sarn Mynach WG offices.</td></tr>
</table>

14.5.4 List of key existing buildings

Table 43:-*Summary of key existing buildings at Llandudno Junction*

AECOM ID	Name	Annual Heat Demand (MWh)	Source
NR047	Sarn Mynach WG Offices	914	DEC [11/09/2012]
NR045	Marle Hall Outdoor Education Centre	283	CSE Data
	Total	**1,197**	

14.5.5 List of potential buildings

Table 44:-*Summary of proposed buildings and estimated year of build out at Llandudno Junction.*

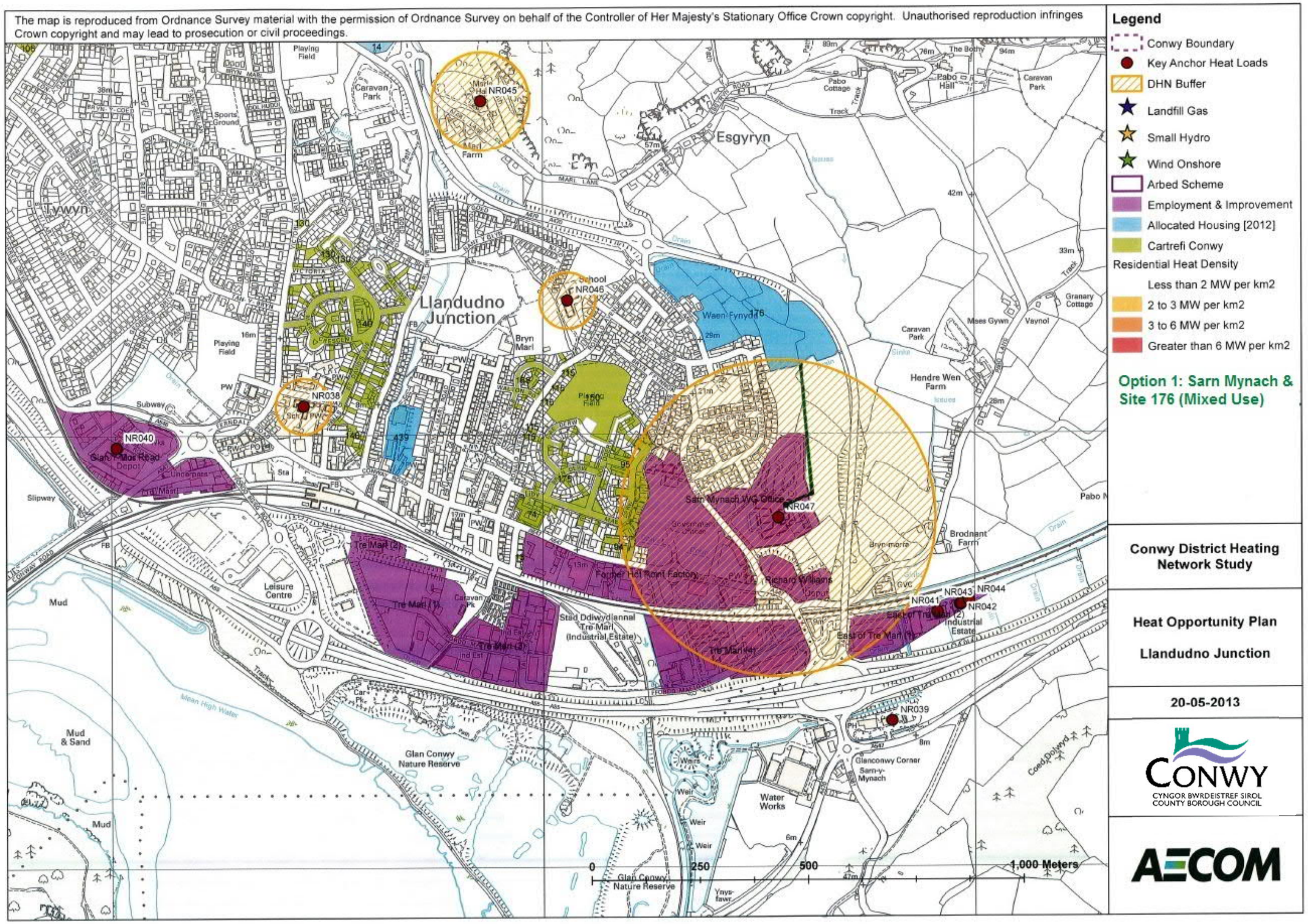
Reference	Name	Maximum number of dwellings	Non residential floor area (m^2)	Estimated build out year
14	Woodland	75	0	2017-2022
176	Esgyryn (Mixed Use)	120	5.2 hectares of B1 employment	2012-2022
439	Social Club/Youth Club	40	0	2012-2017
-	Ysgol Awel y Mynydd[70]	-	-	2017/2018
Total	**-**	**235**	**62,500**	**-**

14.5.6 Potential District Heating Network Routes

Indicative district heating network route[s] that could be taken forward for further review based on an evaluation of site opportunities and constraints as identified above are illustrated in the GIS map overleaf.

[70] Gas input capacity of 464KWh-CCBC

Figure 14: *Llandudno Junction- Potential District Heating Network Routes*



14.6 Overview- Llanfairfechan

14.6.1 General Overview

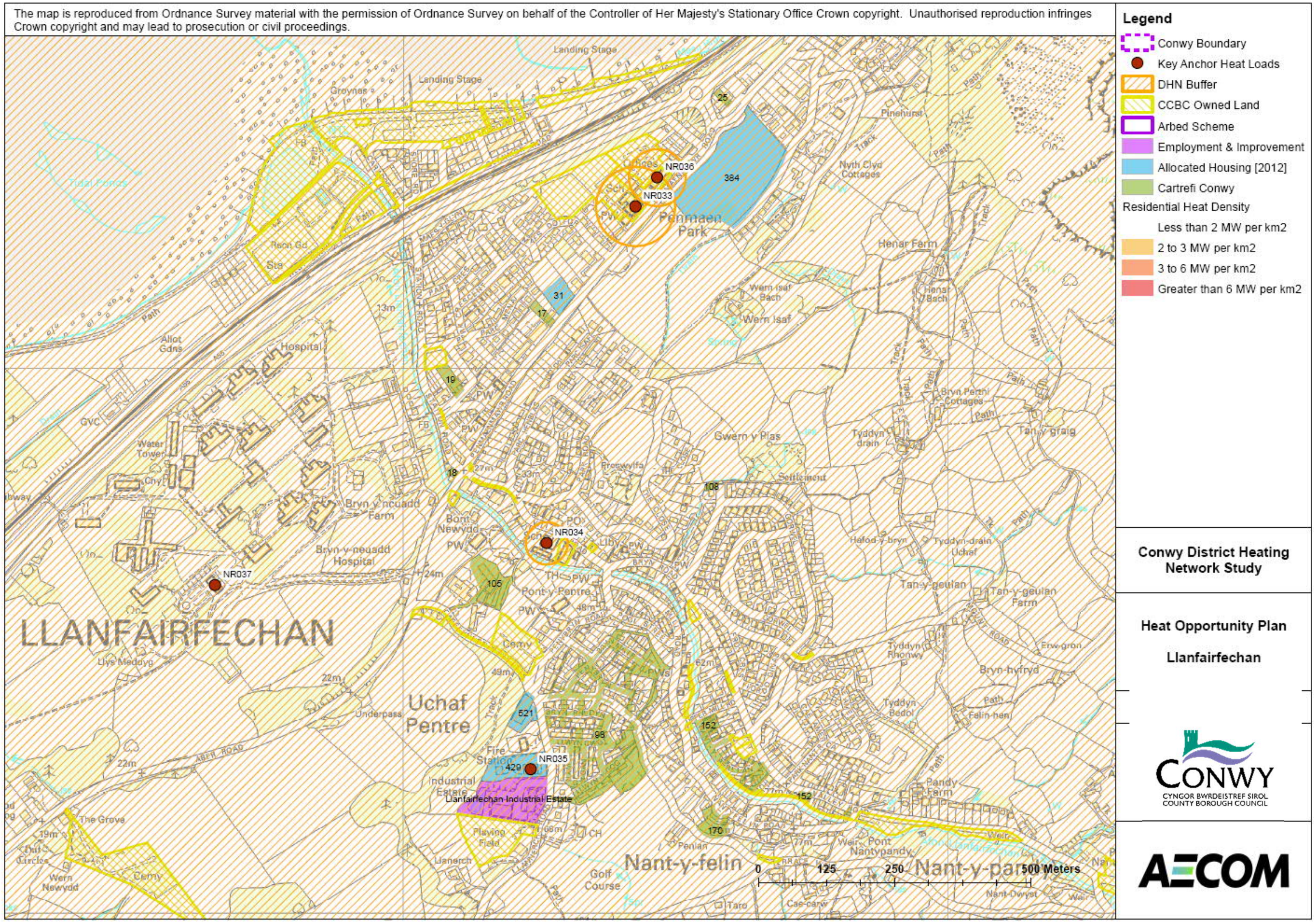
Llanfairfechan is located on the north coast of Conwy and has a population of circa 4,000 people. Bryn y Nuedadd Hospital [NR037] is located to the west of Llanfairfechan and is the main key anchor heat load at the site. Other substantial heat loads at the site have been identified at Ysgol Pant y Rhedyn [NR033] to the north of the town, Ysgol Babanod [NR034] in the centre of Llanfairfechan and Conwy County Borough Council offices [NR036] also to the north of the town.

Two proposed allocated housing sites [site 384 and site 31] are located nearby to the council offices and Ysgol Pant y Rhedyn. Two further proposed allocated housing sites are located in the south of Llanfairfechan [521 & 429]. Existing Cartrefi Conwy owned housing is predominantly located in sites to the south of the town.

14.6.2 Heat Opportunity Plan

The Heat Opportunity Plan for Llanfairfechan is given overleaf.

Figure 15: *Llanfairfechan - Heat Opportunity Plan*



14.6.3 SWOT Analysis

Table 45 below gives an overview of existing and potential buildings at Llanfairfechan including any phasing and timing issues. In addition, details of the key opportunities and constraints within the site that could have an impact on the technical or commercial viability or the practical delivery of a network are summarised, as well as the potential for future expansion of a heat network.

Table 45:-*Overview of existing and potential buildings at Llanfairfechan*

<table>
<tr><th colspan="3">SWOT Analysis</th></tr>
<tr><th>Existing buildings</th><th>Potential Buildings</th><th>Phasing /timing issues</th></tr>
<tr><td>Key potential anchor heat loads:
▪ Bryn y Neuadd Hospital
Other non-residential public buildings:
▪ Ysgol Babanod
▪ Ysgol Pant y Rhedyn
▪ Conwy County Borough Council</td><td>Key sites:
▪ Site 31: 15 dwellings
▪ Site 384: 45 dwellings
▪ Site 429: 15 dwellings
▪ Site 521: 10 dwellings</td><td>Coordination required with the development of the proposed sites. Anticipated development periods are as follows:
• Site 31: 2017-2022
• Site 429: 2012-2017
• Site 521: 2012-2017</td></tr>
<tr><th colspan="3">Site opportunities</th></tr>
<tr><td colspan="3">Bryn y Nueadd Hospital currently runs on oil boilers and as such there is potential for significant savings in carbon by heating the hospital by means of district heating.
Sites 521 and 429 are in close proximity to both each other and Cartrefi Conwy site 98 [36 dwellings in the vicinity of Llwyn Gwgan] and a proposed employment & improvement site and as such pipe lengths could be minimised. Bryn Castell Care Home [site 105] may have a consistent heat demand that could make connection to a district heating network viable.
An opportunity may exist in the future to connect to a potential school and commercial area development located west of Site 521, as set out in the Invitation to Tender by Conwy County Borough Council.</td></tr>
<tr><th colspan="3">Site constraints</th></tr>
<tr><td colspan="3">Afon Llanfairfechan runs through the town southeast to northwest.
Proposed site 384, the largest proposed candidate site, is a contingency site.</td></tr>
<tr><th colspan="3">Next steps</th></tr>
<tr><td colspan="3">Determine likelihood of involvement in any proposed network by Bryn y Neuadd Hospital.</td></tr>
</table>

14.6.4 List of key existing buildings

Table 46:-*Summary of key existing buildings at Llanfairfechan*

AECOM ID	Name	Annual Heat Demand (MWh)	Source
NR037	Bryn y Neuadd Hospital	6,224	Conwy County Council
NR036	Conwy County Borough Council	131	CSE Data
NR033	Ysgol Pant y Rhedyn	182	Conwy County Council
NR034	Ysgol Babanod	97	Conwy County Council
	Total	**6,634**	

14.6.5 List of potential buildings

Table 47:-*Summary of proposed buildings and estimated year of build out at Llanfairfechan.*

Reference	Name	Maximum number of dwellings	Non residential floor area (m^2)	Estimated build out year
NR037	Bryn y Neuadd Hospital	6,224	Conwy County Council	2017-2022
NR036	Conwy County Borough Council	131	CSE Data	2012-2022
NR033	Ysgol Pant y Rhedyn	182	Conwy County Council	2012-2017
NR034	Ysgol Babanod	97	Conwy County Council	
	Total	**6,634**		**-**

14.6.6 Potential District Heating Network Routes

Based on an evaluation of site opportunities and constraints as identified above, no indicative DHN opportunities have been identified. As such, Llanfairfechan will not be analysed further within this report.

15. Viability Appraisal

15.1 Overview

This section provides an analysis of the potential costs and benefits of the proposed district heating options described in section 14. It concentrates on the financial performance of five options; three across Colwyn Bay and further options in Abergele and Llandudno Junction.

These presented options are the agreed upon result of the client progress meeting held in Colwyn Bay on 14/06/2013.

15.2 Technology options

Two technologies have been modelled to show the comparison between using gas engine CHP and Biomass heat-only. This is to show the different benefits of the two technologies such as RHI incentives for biomass fuel, revenue from electricity sales with CHP, and lower carbon emissions factor for use of biomass.

15.3 Measuring financial performance

For the financial analysis, two key measures of financial performance have been presented, for the various options, namely:

Net Present Value (NPV) for two discount factors, 6% and 12%. The former equates to a typical value used for public sector, or public/private projects, such as Private Financial Initiative (PFI), whilst the latter equates to a typical rate of return that would be sought by commercial organisations.

These two values give an indication of whether scheme options could be delivered on a purely commercial basis or whether there would need to be public sector involvement, with potential access to lower cost sources of finance. The NPV is a useful indicator as it shows, for any given discount factor and length of contract, how much gap funding may be required (if any) in order to make a project viable.

Internal Rate of Return (IRR). The actual rate of return achieved is also shown, as this provides a quick way of assessing whether a scheme is likely to exceed either the 6% or the 12% rate of return thresholds discussed above.

For the NPV and IRR calculations, two project lifetimes, of 15 and 30 years, have been considered, given that the heat network and the energy centre are long term investments: in the case of the network, this may have a lifetime in excess of 30 years. This is done as it is important to understand not only the values of the NPV and IRR but also the time period over which they are calculated. A public-sector entity generally can take a longer term view of returns, whereas commercial organisations may not be interested in a project with a 12% rate of return, if that is over 30 years, rather than 15.

However, it is important to note that for options with significant levels of new housing development, there is the potential for developer contributions towards the cost of the network, as it will help them meet their future mandatory requirements for zero carbon new homes[71]. These developer contributions could provide the level of gap funding needed to make the district heating network viable. Therefore, the commercial viability of a heating network for new development areas needs to be viewed as a combination of the NPV and IRR analysis described above, and the potential developer contributions.

It must be stressed that this contribution would not necessarily increase the developer's build costs, as it is a cost they would have to bear anyway through whatever option they choose to meet zero carbon. This is explained in more detail below.

15.4 Cash flow analysis

The cash flow analysis graph shown at the end of each capital expenditure (CAPEX) and cash flow section confirms the revenue and costs over a period of time. For example, the cash flow analysis will show where there are sudden outgoing costs, and this could indicate additional pipe may have been added to connect to a new development, or additional plant added to the energy centre.

The steady increase of a cumulative cash flow graph shows the rate of net revenue each year taking into account operating costs. Therefore, if the cumulative cash flow has a steep incline, then the incoming revenue from sales or incentives is significantly greater than the operating costs. However, if there is a shallow incline, then the incoming revenue will be closer in value to the

[71] This is also true to a certain extent for non-residential buildings, although this is harder to quantify as the definition of zero carbon for non-dwellings is currently less well defined, and there is also a very wide variety of different building types

outgoing costs. If there is no increase, then the net revenue is zero.

The year that the cumulative cash flow crosses the zero x-axis, indicates the year at which the project would breakeven. The figures are undiscounted, which means that the future costs have not been discounted and are fixed at prices at the time of producing the study.

15.5 Potential developer contributions

From 2016, it had been assumed that all new housing would need to be "zero carbon". The guidance was that in addition to meeting a base level of energy efficiency, this will consist of providing a certain level of carbon reduction on-site through on-site low carbon energy generation, which is referred to as "Carbon Compliance".

At the time of writing, the most recent work on this was published by the Zero Carbon Hub, in February 2011[72]. This work modelled the costs of meeting the Carbon Compliance element using photovoltaic panels (PV) and gas boilers for each dwelling. PV was used as a benchmark for the costs of meeting the Carbon Compliance target, as it can be readily applied to most dwellings, and with the fall in cost of PV panels over the few years preceding the study, is now one of the most cost-effective on-site generation technologies.

The study also calculated the contribution that district heating technologies could make to achieving Carbon Compliance, using either gas (engine) CHP or biomass heating, and the amount of PV that may still be required in each case to achieve compliance. Using this information, it was possible to deduce the potential capital cost savings that could arise from using district heating as a result of needing less, or no PV.

This estimated cost saving provides a value for the potential capital contribution that a developer could make towards connection to a district heating network. This assumes that a developer would not see any increase in their build costs beyond what they would incur through the use of the most cost-effective alternative solution (to district heating) to meeting the zero-carbon requirement, which is assumed to be PV.

For each technology option an estimate of avoided cost is presented for each house type. The costs are based on the estimated price of the PV element in 2016, allowing for expected learning rates, but with no inflation added in. The cost of Carbon Compliance for PV is the cost of the PV element only, and does not include the cost of the gas boiler. The avoided costs and potential developer contribution are presented for each option within this report.

However, even at the time of writing, the significant uncertainty about the potential costs to developers of achieving Carbon Compliance, and hence the level of potential developer contributions described above was noted. This was because the Government had yet to finalise the level of the Carbon Compliance target, and there was also uncertainty around the future costs of PV. If the Government decides to relax the Carbon Compliance target, or if PV costs fall faster than anticipated, then the potential developer contribution could reduce.

It was possible that developers would also see significant avoided costs for new non-domestic buildings from connecting to a DHN, particularly for mixed use developments, where the cost of the infrastructure could be shared with new housing. However, this could only be quantified as part of a more detailed assessment for individual sites.

15.5.1 Allowable Solutions

Once a developer had met the Carbon Compliance requirement on-site, the definition of zero carbon at that time required that they deal with the remaining carbon emissions through so-called Allowable Solutions. The Government impact assessment for the Zero Carbon Homes policy had estimated that the cost of Allowable Solutions would be £49 per tonne of CO_2 per annum, totalled over 30 years. That figure was in present value terms, and assumed, in effect, that it would be the cost that the developer would pay upfront on completion of each new dwelling.

One of the potential Allowable Solutions, at the time of writing, could have been to fund the connection of district heating networks to reduce the carbon emissions of existing buildings. This could potentially assist with the overall viability of a district heating scheme, and thereby help reduce the cost to a developer of connecting the new homes, as explained above. However, this solution may well have required a local authority to have a policy mechanism in place to require payments into a local fund, rather than a developer paying into a national fund.

It was possible to estimate the approximate level of Allowable Solutions which may have been raised in

[72] "Carbon Compliance, setting an appropriate limit for zero carbon new homes, findings and recommendations", February 2011

Conwy through future development, based on the estimates of the costs of Allowable Solutions from the Zero Carbon Hub. This is why, for each option, an estimate of the value of allowable solution fund is presented.

It should be noted, that as with the Carbon Compliance costs described above, at the time of writing there was significant uncertainty about the potential costs to developers of meeting Allowable Solutions. The Government has yet to confirm what the cost of Allowable Solutions will be, which solutions will be eligible and whether local authorities will be able to require payments into a local fund, or whether all payments will be made via a national scheme.

15.6 Key assumptions for assessment of costs and revenues

The cost assessments presented in this report are approximate only, and are based on budget prices from suppliers as well as typical industry benchmarks. The heat network costings have been based only on a desktop assessment of potential pipe routes, and make no allowance for actual ground conditions, buried services or other constraints. A Quantity Surveyor has not been involved in the preparation of these costings and therefore they should not be relied upon for detailed project costing.

Other key assumptions are as follows:

- All capital costs are shown in 2012 prices, with no allowance for inflation, or technology learning rates that may reduce capital costs in the future;
- All ongoing revenues and costs are shown in 2010 prices, with no allowance for inflation or real price increases over time;
- All revenues are pre-tax;
- All capital costs include an allowance of 10% for professional fees and a contingency of 10% for heat network costs and 10% for energy centres and plant;
- The heat network can meet 80% of the annual heat demand on the network. The other 20% is assumed to be met by back up gas boilers at the energy centre, due either to plant downtime (about 10% of the year), or because peak heat demand exceeds the peak heat output from the plant;
- For existing developments, the costing of the heat network only includes the primary backbone routing; it does not allow for the secondary network to run along streets to serve buildings. Costing also does not allow for the cost of heat exchangers or meters, the costs of final connections, or the costs of any internal pipe work to buildings;
- For Council properties, no account of CRC savings has been included in the cash flow analysis as these savings would not typically be seen by the network operator;
- The cash flow model allows for the fact that future, and some existing, developments will be connected in different points in the future and not in year 1.

All other cost and technology assumptions used in these calculations are included in **Appendix F.**

16. Colwyn Bay – Option 1

16.1 General overview

Colwyn Bay Option 1 focuses on the connection of Eirias High School [NR006] to the nearby Colwyn Leisure Centre [NR009]. No other loads will be connected to the heating network. Connection would occur on day one of the scheme.

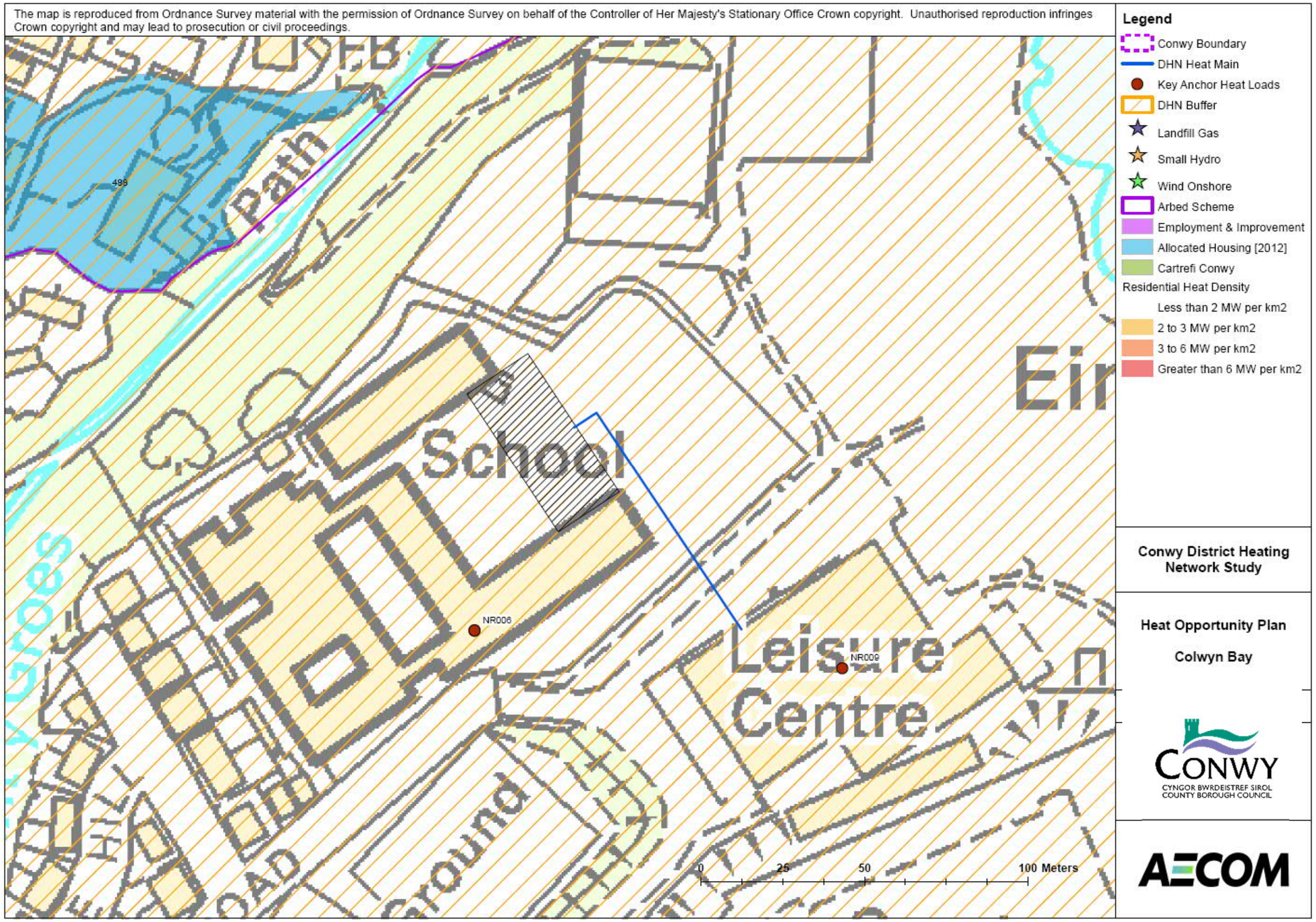
Key assumptions:

The location of the energy centre is assumed to be in the leisure centre [NR009], located in close proximity to the existing plant room. The length of backbone pipe required to connect the leisure centre to the school was based upon an indicative pipe routing, as shown on the following page of this report.

It is assumed within the model that 50% of electricity generated by the CHP system is consumed at either the leisure centre or the school, with the remaining 50% exported to the grid.

It is assumed that all heat demand supplied by the district heating would be delivered to the school via the eastern boiler room.

Figure 16: *Colwyn Bay - Option 1 - Heat Opportunity Plan*



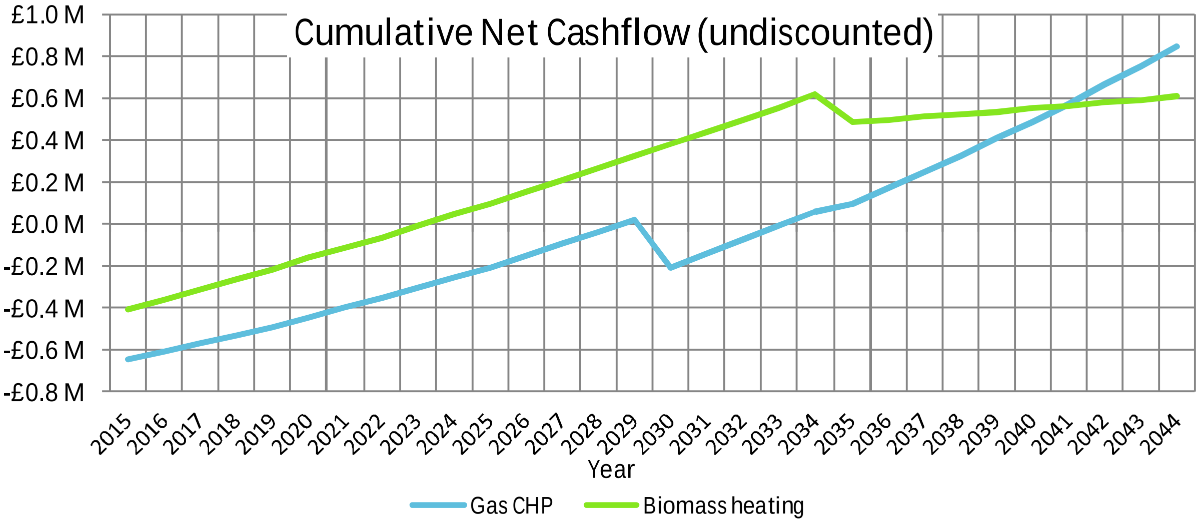
16.2 CAPEX and Cashflow

Table 48: *Colwyn Bay – Option 1 Technical & Financial Assessment.*

Technical assessment			
Annual heating & hot water demand		2,329 MWh	
Total backbone trench length		88 m	
District heating CAPEX		£86,675 m	
Peak load at the energy centre at full build out (thermal)		1.5 MW	
Financial assessment			
CHP option financial viability		**Biomass option financial viability**	
System size (thermal output)	0.4MW x 1	System size (thermal output)	0.4MW x 1
First year of operation	2015	First year of operation	2015
Total Construction Cost	£0.69 m	Total Construction Cost	£0.46 m
Year 1 net revenue	£0.04 m	Year 1 net revenue	£0.05 m
Year 30 net revenue	£0.09 m	Year 30 net revenue	£0.02 m
Simple payback (years)	18	Simple payback (years)	8
Without developer contribution		**Without developer contribution**	
15 yr NPV @ 6%	-£0.22 m	15 yr NPV @ 6%	£0.05 m
15 yr NPV @ 12%	-£0.33 m	15 yr NPV @ 12%	-£0.09 m
15 yr IRR	0.4%	15 yr IRR	7.9%
30 yr NPV @ 6%	-£0.04 m	30 yr NPV @ 6%	£0.15 m
30 yr NPV @ 12%	-£0.29 m	30 yr NPV @ 12%	£0.05 m
30 yr IRR	5.5%	30 yr IRR	9.9%

Table 49: *Colwyn Bay - Option 1 Cashflow.*

Cash flow analysis



16.3 Potential developer contributions

This option does not take into account any new development and as such no potential developer contribution need to be calculated.

16.4 Allowable Solutions

This option does not take into account any new development and as such no allowable solutions need to be calculated.

17. Colwyn Bay – Option 2

17.1 General overview

Colwyn Bay Option 2 connects the leisure centre and high school, as in Option 1, and extends westwards over the Dingle to Ysgol Pendorlan [NR005] and Ysgol Glan y Mor [NR001] and to a proposed development Plot 488 on Lawson Road. This plot is assumed to contain 35 flats.

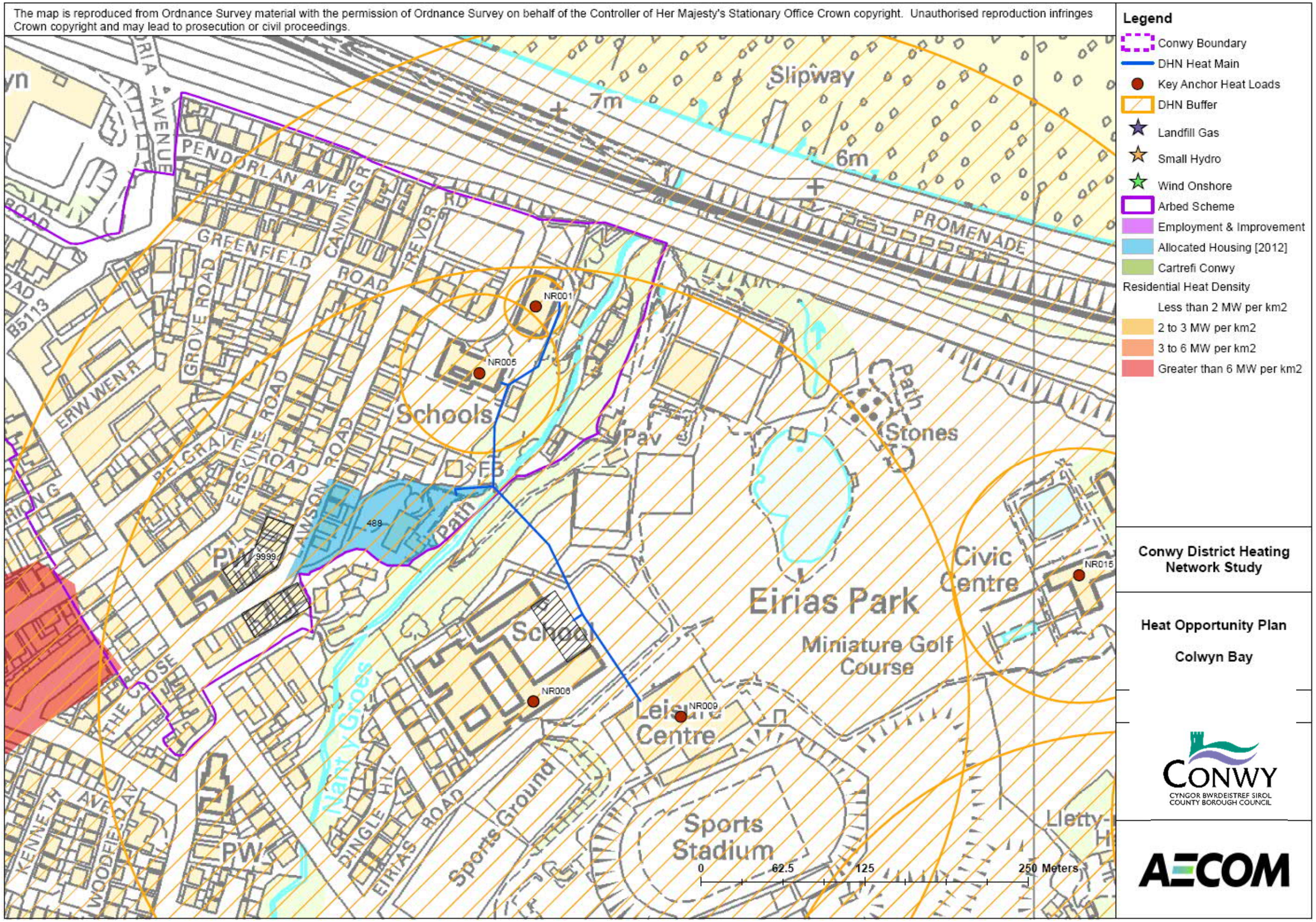
Key assumptions:

All destinations for the heating network are assumed to be added to the network from day one.

The location of the energy centre is assumed to be situated at Colwyn Leisure Centre, as per Option 1. The assumed routing of the network is set out on the following page.

As per Option 1, it is assumed that 50% of electricity generated by the CHP system would be consumed at the leisure centre or Eirias High School. The remaining 50% would be exported to the national grid.

Figure 17: *Colwyn Bay - Option 2 - Heat Opportunity Plan*

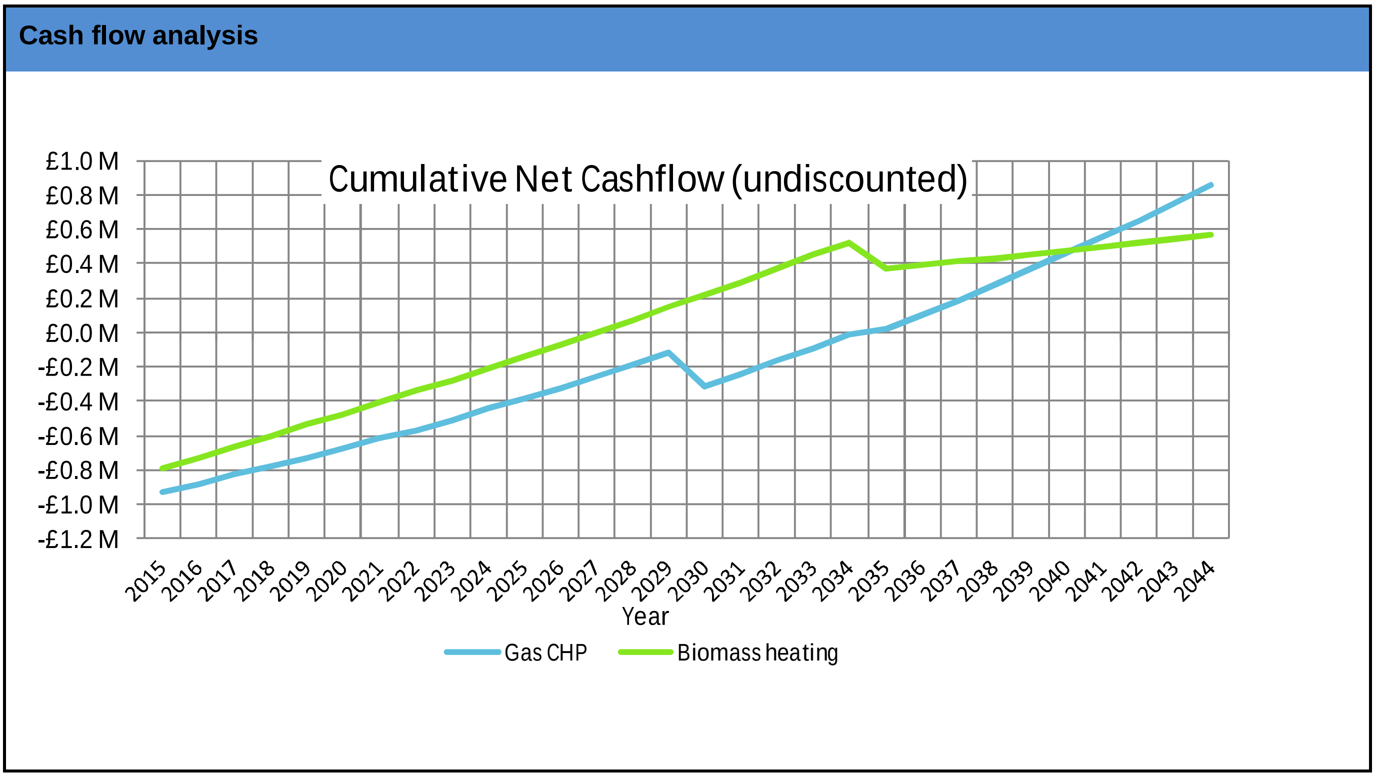


17.2 CAPEX and Cash flow

Table 50: *Colwyn Bay - Option 2 Technical & Financial Assessment*

Technical assessment			
Annual heating & hot water demand		2,761 MWh	
Total backbone trench length		494 m	
District heating CAPEX		£405,768 m	
Peak load at the energy centre at full build out (thermal)		1.9 MW	
Financial assessment			
CHP option financial viability		**Biomass option financial viability**	
System size (thermal output)	0.5MW x 1	System size (thermal output)	0.5MW x 1
First year of operation	2015	First year of operation	2015
Total Construction Cost	£0.97 m	Total Construction Cost	£0.85 m
Year 1 net revenue	£0.05 m	Year 1 net revenue	£0.06 m
Year 30 net revenue	£0.1 m	Year 30 net revenue	£0.03 m
Simple payback (years)	19	Simple payback (years)	12
Without developer contribution		**Without developer contribution**	
15 yr NPV @ 6%	-£0.39 m	15 yr NPV @ 6%	-£0.18 m
15 yr NPV @ 12%	-£0.52 m	15 yr NPV @ 12%	-£0.34 m
15 yr IRR	No return achieved	15 yr IRR	2.2%
30 yr NPV @ 6%	-£0.17 m	30 yr NPV @ 6%	-£0.05 m
30 yr NPV @ 12%	-£0.47 m	30 yr NPV @ 12%	-£0.3 m
30 yr IRR	4.3%	30 yr IRR	5.3%

Table 51: *Colwyn Bay - Option 2 Cashflow*



17.3 Potential developer contributions

It is assumed that the development of Lawson Road will be completed by 2016 and as such no potential developer contribution calculations were required for this option.

17.4 Allowable Solutions

As above, it is assumed that the development of Lawson Road will be completed by 2016 and as such no allowable solution calculations were required for this option.

18. Colwyn Bay – Option 3

18.1 General overview

Colwyn Bay Option 3 connects the proposed development site 488, Lawson Rd, to adjacent rented social housing properties [Plot 9999].

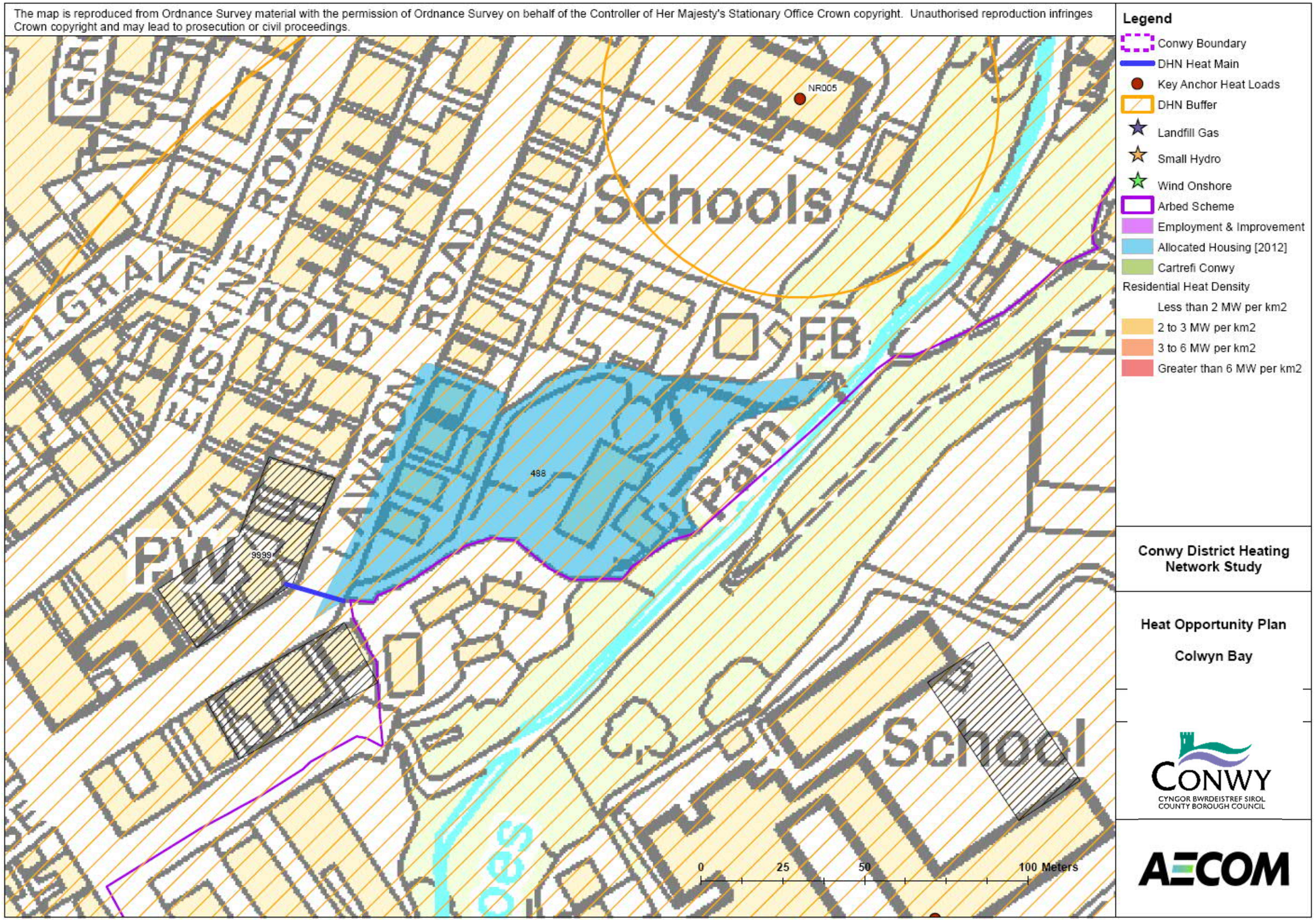
Key assumptions:

It is assumed that 8 properties are included within Plot 9999, based upon RSL data obtained from client – 7 properties are located within postcode LL29 8HE and 1 within LL29 8HB. These properties were identified as part of the client progress meeting, dated 14/06/2013.

It is assumed that all electricity generated on site will be exported to the grid.

It is assumed that an energy centre will be located in the south-west corner of the Plot 488, so as to minimise pipe work costs.

Figure 18: *Colwyn Bay - Option 3 - Heat Opportunity Plan*



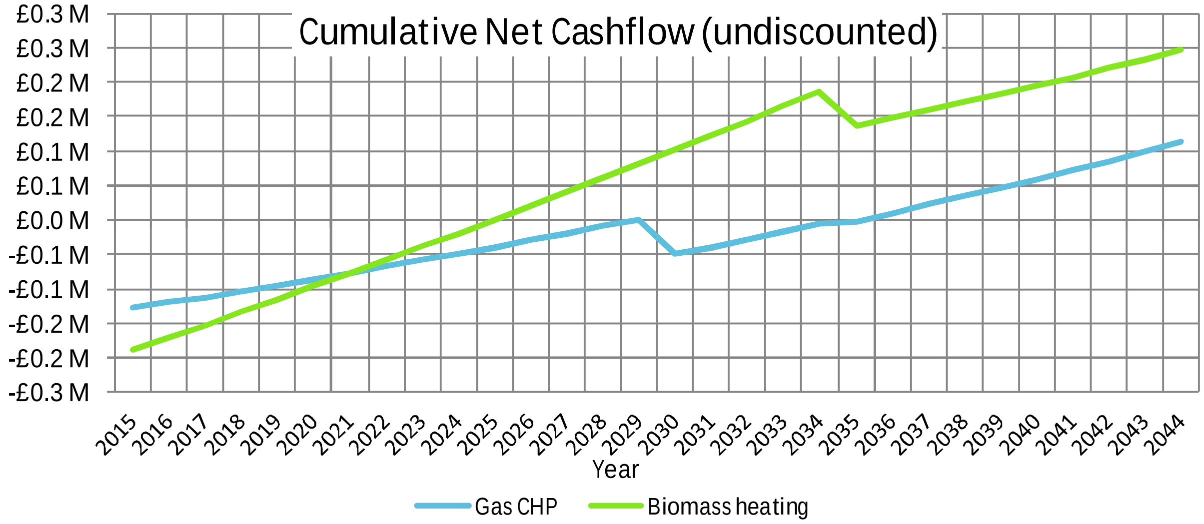
18.2 CAPEX and Cashflow

Table 52: *Colwyn Bay - Option 3 Technical & Financial Assessment*

Technical assessment			
Annual heating & hot water demand		313 MWh	
Total backbone trench length		18 m	
District heating CAPEX		£39,582 m	
Peak load at the energy centre at full build out (thermal)		0.3 MW	
Financial assessment			
CHP option financial viability		**Biomass option financial viability**	
System size (thermal output)	0.1MW x 1	System size (thermal output)	0.2MW x 1
First year of operation	2015	First year of operation	2015
Total Construction Cost	£0.14 m	Total Construction Cost	£0.22 m
Year 1 net revenue	£0.02 m	Year 1 net revenue	£0.03 m
Year 30 net revenue	£0.01 m	Year 30 net revenue	£0.01 m
Simple payback (years)	14	Simple payback (years)	10
Without developer contribution		**Without developer contribution**	
15 yr NPV @ 6%	-£0.04 m	15 yr NPV @ 6%	-£0.02 m
15 yr NPV @ 12%	-£0.06 m	15 yr NPV @ 12%	-£0.07 m
15 yr IRR	0.1%	15 yr IRR	4.7%
30 yr NPV @ 6%	-£0.02 m	30 yr NPV @ 6%	£0.03 m
30 yr NPV @ 12%	-£0.06 m	30 yr NPV @ 12%	-£0.05 m
30 yr IRR	4.4%	30 yr IRR	7.7%

Table 53: *Colwyn Bay - Option 3 Cashflow*

Cash flow analysis



18.3 Potential developer contributions

It is assumed that the development of Lawson Road will be started in 2014 and completed by 2016 and as such no potential developer contribution calculations were required for this option.

18.4 Allowable Solutions

It is assumed that the development of Lawson Road will be completed by 2016 and as such no allowable solution calculations were required for this option.

19. Abergele – Option 1

19.1 General overview

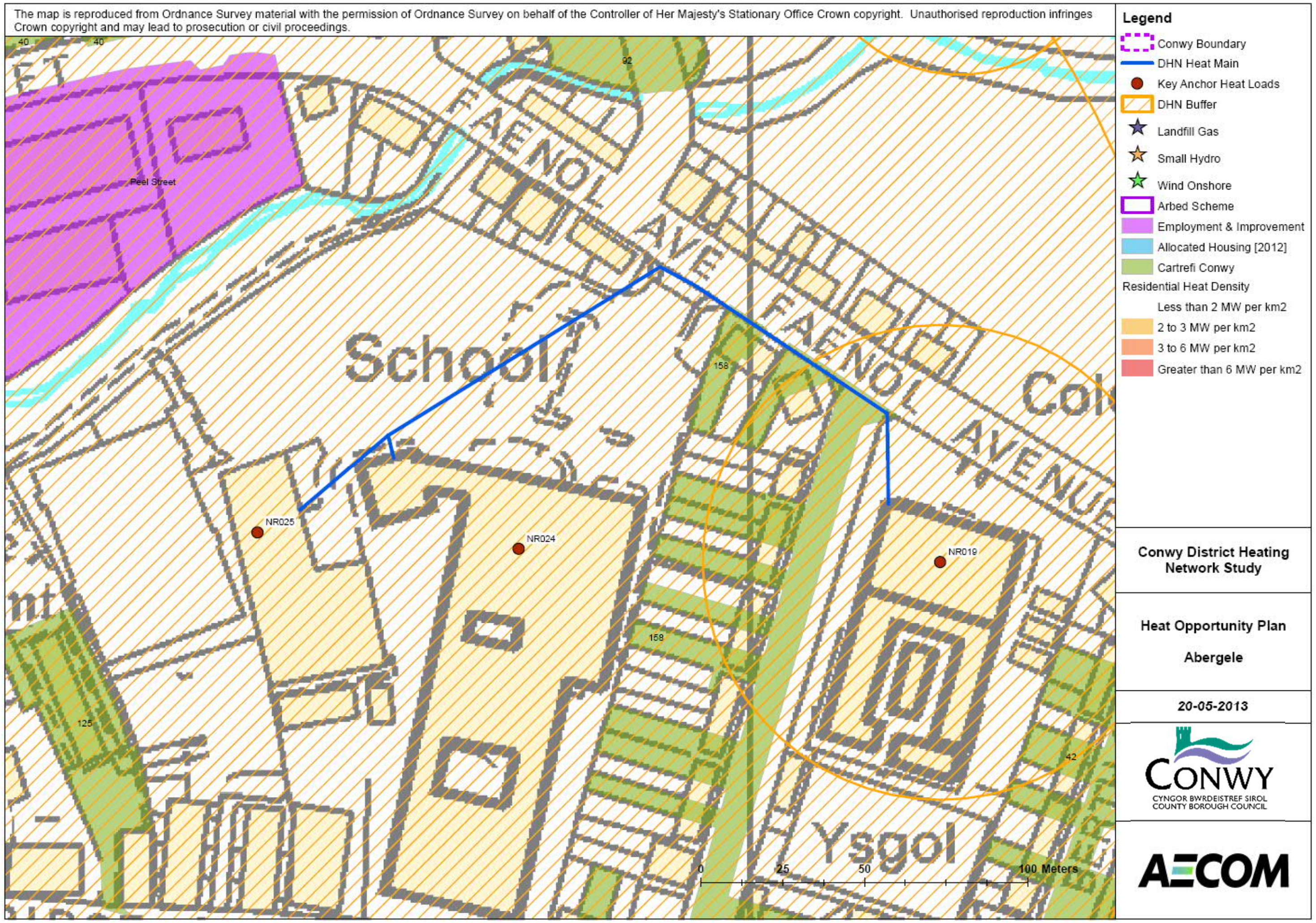
Abergele Option 1connects together the key anchor heat loads located adjacent to Faenol Avenue; Llandrillo College [NR019], Ysgol Emrys Ap Iwan [NR024] and the leisure centre [NR025]. Expansion of the heating network to include the three schools towards the north, Glangele Infant, Glan Morfa Junior and St Elfod Junior was ruled out due to a lack of heat demand warranting the length of pipe work required to connect the southern cluster to the northern schools.

Key assumptions

It is assumed that the energy centre would be located close to leisure centre, and therefore the model assumes that 50% of the electricity generation from any CHP system would be used on site at either the leisure centre, college or Ysgol Emrys Ap Iwan. The remainder of the electricity generated not consumed by these three buildings would be exported the grid.

The assumed routing of the network is set out on the following page.

Figure 19: *Abergele - Option 1 - Heat Opportunity Plan*



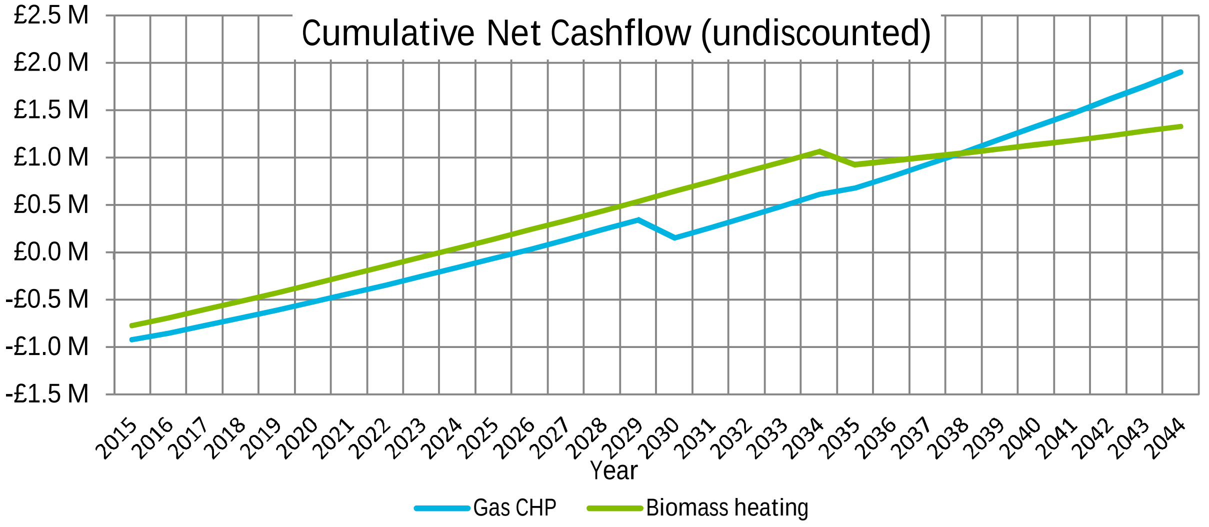
19.2 CAPEX and Cash flow

Table 54: *Abergele - Option 1 Technical & Financial Assessment*

Technical assessment			
Annual heating & hot water demand		1,685 MWh	
Total backbone trench length		251 m	
District heating CAPEX		£217,919 m	
Peak load at the energy centre at full build out (thermal)		1.5 MW	
Financial assessment			
CHP option financial viability		**Biomass option financial viability**	
System size (thermal output)	0.3MW x 1	System size (thermal output)	0.3MW x 1
First year of operation	2015	First year of operation	2015
Total Construction Cost	£0.73 m	Total Construction Cost	£0.5 m
Year 1 net revenue	£0.03 m	Year 1 net revenue	£0.03 m
Year 30 net revenue	£0.08 m	Year 30 net revenue	£0.01 m
Simple payback (years)	21	Simple payback (years)	13
Without developer contribution		**Without developer contribution**	
15 yr NPV @ 6%	-£0.3 m	15 yr NPV @ 6%	-£0.14 m
15 yr NPV @ 12%	-£0.4 m	15 yr NPV @ 12%	-£0.23 m
15 yr IRR	No return achieved	15 yr IRR	1.0%
30 yr NPV @ 6%	-£0.15 m	30 yr NPV @ 6%	-£0.08 m
30 yr NPV @ 12%	-£0.37 m	30 yr NPV @ 12%	-£0.21 m
30 yr IRR	4.0%	30 yr IRR	3.7%

Table 55: *Abergele - Option 1 Cashflow*

Cash flow analysis



19.3 Potential developer contributions

This option does not take into account any new development and as such no potential developer contributions need to be calculated.

19.4 Allowable Solutions

This option does not take into account any new development and as such no allowable solutions need to be calculated.

20. Llandudno Junction – Option 1

20.1 General overview

This option connects the key anchor heat load, Sarn Mynach Welsh Assembly Government building [NR047] to the proposed mixed-use development site of Esgyryn [Site 176] to the north. It is proposed that Site 176 is formed of 120 new dwellings and B1 commercial premises.

Key assumptions

It is assumed that the energy centre would be located at the key anchor heat load, Sarn Mynach Welsh Assembly Government building.

It is assumed that 50% of electricity generated by the CHP system would be consumed at Sarn Mynach. The remainder would be exported to the grid.

An indicative pipe route is shown on the next page of this report.

From the client progress meeting it was ascertained that a potential new school could be situated on land between Sarn Mynach and plot 176. For the purpose of this report, any prospective school development has been ignored.

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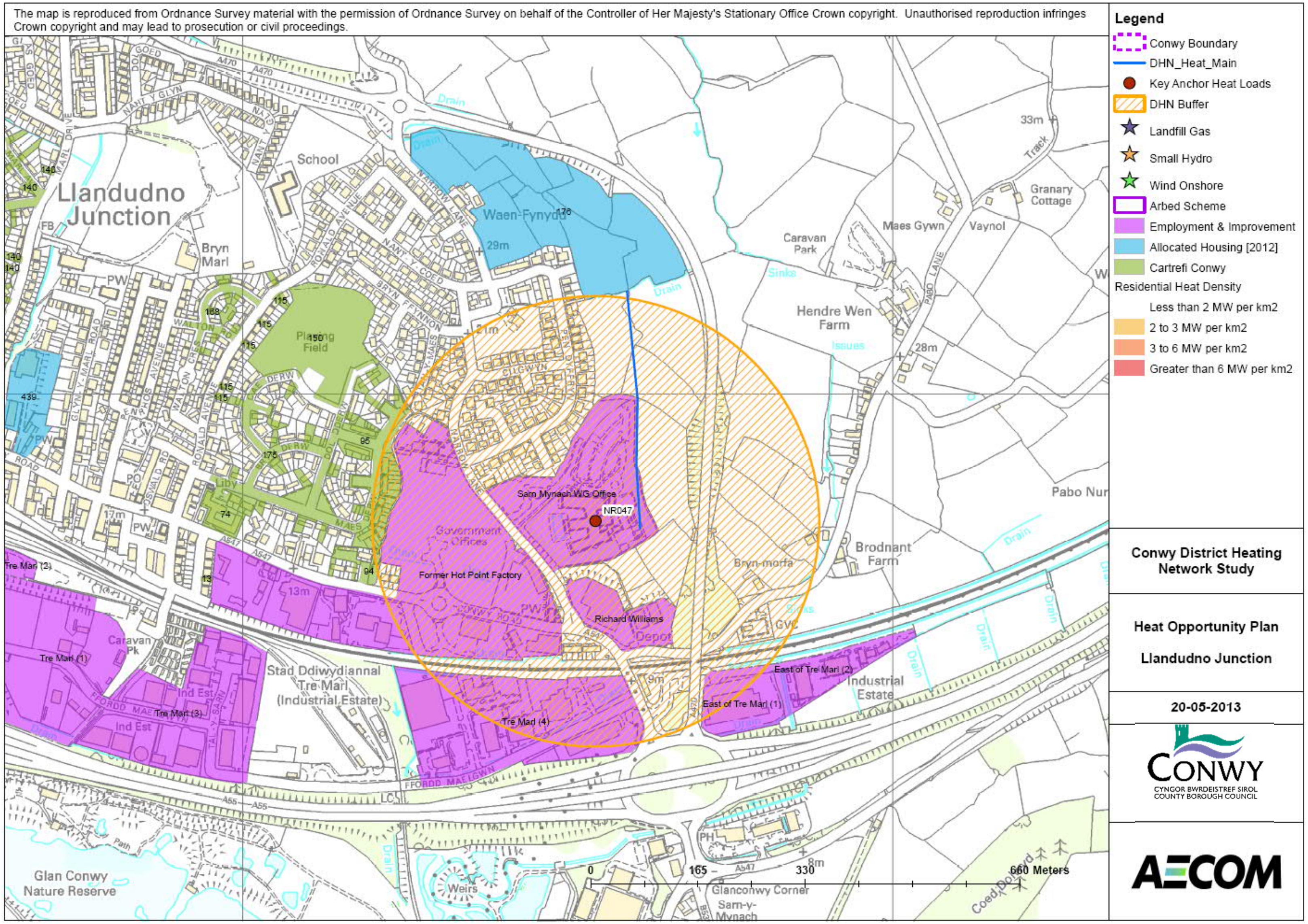
Figure 20: *Llandudno Junction - Option 1 - Heat Opportunity Plan*



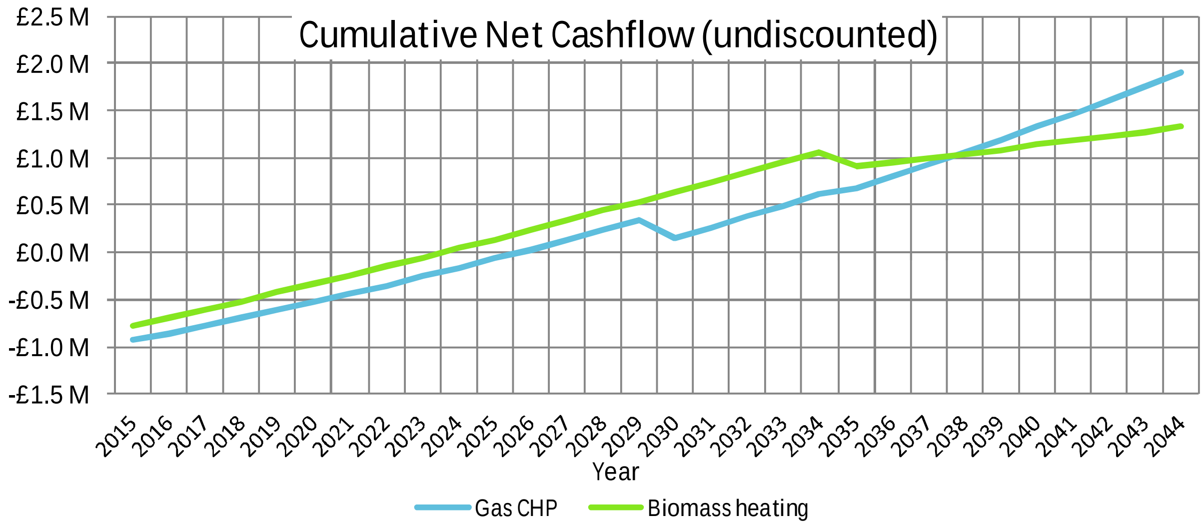
20.2 CAPEX and Cash flow

Table 56: *Llandudno - Option 1 Technical & Financial Assessment*

Technical assessment			
Annual heating & hot water demand		3,127 MWh	
Total backbone trench length		364 m	
District heating CAPEX		£350,529 m	
Peak load at the energy centre at full build out (thermal)		2.3 MW	
Financial assessment			
CHP option financial viability		**Biomass option financial viability**	
System size (thermal output)	0.5MW x 1	System size (thermal output)	0.5MW x 1
First year of operation	2015	First year of operation	2015
Total Construction Cost	£1.0 m	Total Construction Cost	£0.86 m
Year 1 net revenue	£0.07 m	Year 1 net revenue	£0.08 m
Year 30 net revenue	£0.15 m	Year 30 net revenue	£0.05 m
Simple payback (years)	11	Simple payback (years)	9
Without developer contribution		**Without developer contribution**	
15 yr NPV @ 6%	-£0.11 m	15 yr NPV @ 6%	£0.07 m
15 yr NPV @ 12%	-£0.34 m	15 yr NPV @ 12%	-£0.18 m
15 yr IRR	4.1%	15 yr IRR	7.3%
30 yr NPV @ 6%	£0.26 m	30 yr NPV @ 6%	£0.3 m
30 yr NPV @ 12%	-£0.24 m	30 yr NPV @ 12%	-£0.1 m
30 yr IRR	8.4%	30 yr IRR	9.9%

Table 57: *Llandudno Junction - Option 1 Cashflow*

Cash flow analysis



20.3 Potential developer contributions

This datasheet presents an estimate of the avoided costs to the developer for installing DHN, compared with PV, in order to meet the Carbon Compliance element of the zero carbon homes policy.

For Llandudno Junction, Option 1, we have assumed the following breakdown of house types to be built post 2016, based on information provided by the Council and assumed build out dates:

Table 58- *Llandudno Junction - Option 1 - breakdown of house types to be built post 2016***.**

House types assumed	
Flat	4
Semi	16
Terrace	16
Detached	4
Total	40

In practice, the actual numbers of new dwellings suggested for the candidate sites may be less, which would reduce the level of potential developer contributions.

The following table shows the potential cost saving per dwelling to the developer from connecting to a district heating system and avoiding the costs of installing PV to meet Carbon Compliance. More PV would be avoided if a biomass option is chosen rather than a gas CHP option, because biomass has a lower carbon emissions rate than gas and would be able to save more carbon. The figures below are shown in assumed 2016 costs.

Table 59: *Potential Avoided Cost of PV from using DH*

Total potential avoided photovoltaic cost from district heating solution (per dwelling)			
Gas engine CHP option		**Biomass option**	
Flat	£1,332	Flat	£1,332
Semi	£726	Semi	£3,004
Terrace	£1,637	Terrace	£3,444
Detached	£1,134	Detached	£4,033

The following table shows how this relates to the Llandudno Option 1 in terms of potential contributions from the developers connecting to any DHN, based on the assumed levels of total housing development post 2016.

Table 60: *Llandudno Junction - Option 1 Total Potential Developer Contributions*

Total potential developer contributions (2016 costs)[73]			
Gas engine CHP option		**Biomass option**	
Flat	£5,328	Flat	£5,328
Semi	£11,616	Semi	£48,064
Terrace	£26,192	Terrace	£55,104
Detached	£4,536	Detached	£16,132
Total	**£47,672**	**Total**	**£124,628**

This analysis shows that a greater potential developer contribution could be achieved with a biomass heat only scheme compared to gas engine CHP because the biomass option saves more carbon.

[73] These costs are undiscounted. They also make no allowance for how the costs of Photovoltaics systems may fall after 2016, and therefore may be an overestimate for those development sites to be built out in the longer term.

20.4 Allowable Solutions

This datasheet presents an estimate of the value of Allowable Solutions fund which could potentially be generated by the new homes, in order to meet the Allowable Solution element of the zero carbon homes policy. This figure is calculated by summing the total residual carbon emissions to be saved for each dwelling built after 2016, over 30 years for that dwelling.

Table 61: *Llandudno Junction - Option 1 - Allowable Solutions Value*

	No. of new homes (post 2016)	Total value of AS @ £49/tonne carbon over 30 years per dwelling	Potential value of Allowable Solutions (@£49/tonne)
Flat	4	£1,122	£4,488
Semi	16	£1,229	£19,664
Terrace	16	£1,229	£19,664
Detached	4	£1,735	£6,940
Total	**40**	**-**	**£50,756**

21. Summary table for financial assessment

Table 62 on following page summarises the financial assessment of each district heating option.

Notes on table

1. The heat demand shown is the demand at the energy centre, after allowing for network losses
2. The capital cost for the energy centre includes the energy centre building, and internal plant, including the lead low carbon plant (gas engine CHP or biomass boiler), supplementary gas boilers to meet peak loads and for back up, and thermal storage.

Table 62: *Options Financial Assessments Summary*

Option	Network size		CAPEX (£ million)				IRR		Net Present Value (£ million)				Payback
	Annual heat demand (MWh)	Peak thermal demand (MW)	Heat network	Technology	Energy Centre	Total	15 year	30 year	15 years @ 6%	15 years @ 12%	30 years @ 6%	30 years @ 12%	Simple Payback- (Years)
Colwyn Bay 1	2,329	1.5	£0.07	Gas	£0.50	£0.69	0.4%	5.5%	-£0.22	-£0.33	-£0.04	-£0.29	18
				Biomass	£0.31	£0.46	7.9%	9.9%	£0.05	-£0.09	£0.15	-£0.05	8
Colwyn Bay 2	2,761	1.9	£0.34	Gas	£0.47	£0.97	N/A	4.3%	-£0.39	-£0.52	-£0.17	-£0.47	19
				Biomass	£0.37	£0.85	2.2%	5.3%	-£0.18	-£0.34	-£0.05	-£0.3	12
Colwyn Bay 3	313	0.3	£0.03	Gas	£0.09	£0.14	0.1%	4.4%	-£0.04	-£0.06	-£0.02	-£0.06	14
				Biomass	£0.15	£0.22	4.7%	7.7%	-£0.02	-£0.07	£0.03	-£0.05	10
Abergele 1	1,685	1.5	£0.18	Gas	£0.43	£0.73	N/A	4.0%	-£0.3	-£0.4	-£0.15	-£0.37	21
				Biomass	£0.24	£0.50	1.0%	3.7%	-£0.14	-£0.23	-£0.08	-£0.21	13
Llandudno Junction 1	3,127	2.3	£0.29	Gas	£0.53	£1.00	4.1%	8.4%	-£0.11	-£0.34	£0.26	-£0.24	11
				Biomass	£0.42	£0.86	7.3%	9.9%	£0.07	-£0.18	£0.30	-£0.1	9

22. Key Findings

22.1 Overview

This section provides a summary of the financial analysis of the options and key findings for each of the sites.

22.2 Colwyn Bay

Colwyn Bay Option 1 achieved simple payback within 18 years and 8 years for the gas engine CHP and biomass heating options respectively. An internal rate of return [IRR] was achieved at both 15 years and 30 years for both technologies. This is largely due to the substantial total heat load and the close proximity of the school to the leisure centre.

Colwyn Bay Option 2 also achieved simple payback for both technologies; 19 years and 12 years for gas CHP and biomass heating respectively. Biomass achieves an IRR of 2.4% at 15 years whereas gas engine CHP does not achieve a return; within 30 years both technologies achieve IRR.

Modelling Colwyn Bay Option 3 produces a simple payback of 14 years for gas engine CHP and 10 years for biomass heating. Furthermore, biomass heating achieves significantly greater internal rates of return at both 15 and 30 years.

Financial viability for these options could be increased by maximising the revenue of the Renewable Heat Incentive [RHI] and selecting a total system size of less than 200kW. For the purpose of this modelling, this level of detailed plant sizing has not been carried out, as for some heat demand profiles, selecting a smaller system can reduce the overall performance of the system and hence would need to be assessed in more detail.

Based upon the indicative results detailed above within this report, this site is recommended for further analysis.

22.3 Abergele

Abergele Option 1 achieves a simple payback within 13 years with biomass and 21 years with a gas engine CHP system. This is primarily due to the reduced plant and energy centre capital costs associated with biomass, relative to CHP. A biomass system installed at the site is predicted to achieve more viable internal rates of return; 1.0% and 3.7% respectively at 15 years and 30 years.

It is recommended that this site is not considered for further analysis

22.4 Llandudno Junction

Abergele Option 1 achieves a simple payback within 13 years with biomass and 21 years with a gas engine CHP system. This is primarily due to the reduced plant and energy centre capital costs associated with biomass, relative to CHP. A biomass system installed at the site is predicted to achieve more viable internal rates of return; 1.0% and 3.7% respectively at 15 years and 30 years.

It is recommended that this site is not considered for further analysis

22.5 Conclusion

Overall, all three options at Colwyn bay could be considered viable and could form the basis of a heat network. We recommend these options for further analysis. Llandudno Junction Option 1 could also be considered viable, yet it could become even more so in the future if the proposed school between Site 176 and Sarn Mynach Welsh Assembly Government building comes to fruition, or additional incentives for district heating were introduced.

A heating network installed at Abergele as proposed within this report is the least viable option and it is recommended that this option is not considered further.

Appendix A: Existing Low and Zero Carbon Energy Technologies

Technology	Site	Installed Capacity [MWe]	Installed Capacity [MWt]	Source
Hydro	Dolgarrog	33.38	-	Restats
Hydro	Brenig NFFO Site	0.06	-	Ofgem
Hydro	Ty Draw	0.006	-	Ofgem
Hydro	Alwen	0.037	-	Ofgem
Hydro	Bryniog Isa	0.03		CCBC
Hydro	Fedw	0.02		CCBC
Hydro	Nant Y Graig	0.081		CCBC
Sewage Gas	Kinmel Bay CHP	0.19	0.29	Ofgem
On shore wind	Moelogan Wind Farm	15.6	-	CCBC
On shore wind	Mawla Greenlane Farm	1.285	-	Ofgem
On shore wind	Pen y Bryn	0.5	-	CCBC
On shore wind	Hendre Llwyn y Maen	0.45	-	CCBC
On shore wind	Land at Winllan Bach	0.1	-	CCBC
On shore wind	Ty Gwyn Llangym	0.5	-	CCBC
On shore wind	Land at Bryn Ffynnon (Hafotty Ucha)	0.5	-	CCBC
On shore wind	Bodwrach	0.5	-	CCBC
On shore wind	Land at Disgarth Ucha	0.5	-	CCBC
On shore wind	Land at Mwdwl Eithin (Nant Bach)	27.5	-	CCBC
On shore wind	Hafotty Ucha	1.4	-	Ofgem
On shore wind	Hafoty Ucha '2' and '3' Wind Turbine	2.6	-	Restats (REPD)
On shore wind	Clocaenog Forest Wind Farm (in SSA)	96	-	Restats (REPD)
On shore wind	Bodtegir (Clean Earth Energy)	1.5	-	CCBC

Technology	Site	Installed Capacity [MWe]	Installed Capacity [MWt]	Source
On shore wind	Fron Bella	0.05		CCBC
On shore wind	Gaerfechan	0.05		CCBC
On shore wind	Pentre Du Isaf	0.05		CCBC
On shore wind	Ty Isa	0.055		CCBC
On shore wind	Cefnhirfynydd Isa	0.05		CCBC
On shore wind	Pentre Draw	0.05		CCBC
On shore wind	Ty Isa	0.075		CCBC
Solar PV	Tyrdan Farm (LL29 8YU)	12	-	CCBC
Solar PV	Kinmel 1 CIC	5	-	Restats (REPD)
Solar PV	Kinmel 2 CIC	5	-	Restats (REPD)
Solar PV	Capel Nebo	0.0105		CCBC
Solar PV	National Trust, Bodnant Garden	0.05		CCBC
Landfill Gas	Llandulas Landfill Scheme	2.9	6.00	CCBC
Biomass CHP	Mochdre	1	5	CCBC
Biomass CHP	Tir Llwyd	1	5	CCBC

Appendix B: Wind Energy Resource Methodology

The detailed data sources and assumptions can be found in the table below.

Wind Energy Resource Methodology							
Constraint Category	**Constraints**	**Name of SPA**	**Buffer for LSA (m)**	**Constraint Dataset**	**Source**	**Date of Publication**	**Comment**
Environmental	National Nature Reserves		Extent Only	National Nature Reserves (NNRs) Metatdata Resource Identifier: 98778	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesNationalNatureReserves/?lang=en
	RAMSAR Sites		Extent Only	Ramsar Siteds - Wetlands of International Importance: 98759	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesRamsarWetlandsOfInternationalImportance/?lang=en
	Special Areas of Conservation [SAC]		Extent Only	Special Areas of Conservation (SACs): 98766	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialAreasOfConserva
	Special Protection Areas [SPA]			Special Protection Areas (SPA): 98775	NRW	06/10/2014	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialProtectionAreas/
		Conwy & Clwyd Estaurys	4km				
	Sites of Special Scientific Interest [SSSI]		Extent Only	Sites of Special Scientific Interest (SSSIs): 98776	NRW	19/04/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSitesOfSpecialScientificI
	Broad Leaved Woodland [based on National Forest Inventory]		Extent Only	National Forest Inventory: 116293	NRW	18/09/2015	http://lle.gov.wales/catalogue/item/NationalForestInventory2014/?lang=en
	Local Nature Reserves		Extent Only	Local Nature Reserves (LNRs): 98746	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/LocalNatureReserves/?lang=en
	Woodlands		Extent Only	OS Open Map - Local	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	AONBs		7km	Areas of Outstanding Natural Beauty (AONBs): 98736	NRW	22/11/2011	http://lle.gov.wales/catalogue/item/ProtectedSitesAreasOfOutstandingNatu
	National Parks	Snowdonia	7km	National Parks: 98777	NRW	31/12/2010	http://lle.gov.wales/catalogue/item/NationalParks/?lang=en
Heritage	Scheduled Monuments [CADW]		Extent Only	Scheduled Monunments in Wales	NRW	01/01/2007	http://lle.gov.wales/catalogue/item/ScheduledAncientMonumentsInWales/?
	Listed Buildings [CADW] Landscape of Outstanding Historic Interest [CADW]		500m	Listed Buildings in Wales Point Dataset	NRW	01/01/2004	http://lle.gov.wales/catalogue/item/ListedBuildings/?lang=en
	Landscape of Special Historic Interest [CADW]		Extent Only	Registered Landscapes Of Outstanding Historic Interest in Wales	NRW	01/01/2001	http://lle.gov.wales/catalogue/item/RegisteredLandscapesOfOutstandingHistoricInterestInWales/?lang=en
Physical	Motorways [based on OS Strategi]		170m [tip height plus 50m]	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Primary Roads [based on OS Strategi]		170m [tip height plus 50m]	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Railway Lines [based on OS Strategi]		170m [tip height plus 50m]	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	A-Roads [based on OS Strategi]		132m [tip height plus 10%]	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	B-Roads [based on OS Strategi]		132m [tip height plus 10%]	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
Other Physical	Major River [based on OS Strategi]		Extent Only	Strategi	OS Open Data	01/01/2015	Assumed 10m wide where only linear features were available
	Secondary River [based on OS Strategi]		Extent Only	Strategi	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Minor River [based on OS Strategi]		Extent Only	Strategi	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Canals [based on OS Strategi]		Extent Only	Strategi	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Lakes [based on OS Strategi]		Extent Only	Strategi	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Peat		Extent Only		Conwy County Borough Council		Supplied by Conwy County Council
Noise	Buildings [as defined by the LLPG]		500m				
Aviation and Radar	Restricted Airspace - including UK Aerodrome Traffic Zones and Aerodromes with instant approach procedures outside controlled airspace		Extent Only	navigation_aids.kmz_	NATS		http://www.nats.aero/services/information/wind-farms/self-assessment-maps/
	Areas Constrained by NATS Aviation & Radar Safeguarding Zones including Military Aerodrome Traffic Zones, High Intensity Radio Transmission Areas		Extent Only - using 120m safeguarding zone	NATS_Safeguarding_SHP	NATS		http://www.nats.aero/services/information/wind-farms/self-assessment-maps/
	Civil Aviation Authority - Aerodrome Locations		Point	Strategi	OS Open Data	42005	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
SSAs	SSAs and all existing wind farms (in county as well as those outside which impact upon Conwy LPA area		7km	Technical Advice Note 8: Planning For Renewable Energy - Strategic Search Areas	NRW	01/01/2015	http://lle.gov.wales/catalogue/item/TechnicalAdviceNote8PlanningForRenewableEnergyStrategicSearchAreas/?lang=en
	Consented wind farms treated as if built		7km		Conwy County Borough Council		Supplied by Conwy County Borough Council
Electricity Grid	33, 132, 66KV electricity grid		within 10Km only		Conwy County Borough Council		Supplied by Conwy County Borough Council

Appendix C: Biomass Energy Resource Methodology

The detailed data sources and assumptions can be found in the table below:

Biomass Energy Resource Methodology							
Constraint Category	**Constraints**		**Buffer for LSA (m)**	**Constraint Dataset**	**Source**	**Date of Publication**	**Comment**
Environmental and Heritage	Grades 1, 2, 3 & 5 Agricultural Land		Extent Only	Provisional_ALC_250k	WG	2012	Welsh Government Cartographics
	National Forest		Extent Only	National Forest Estate Ownership	NRW	08/12/2016	http://lle.gov.wales/catalogue/item/NationalForestEstateOwnership/?lang=
	Scheduled Monuments [CADW]		Extent Only	Scheduled Monumnents in Wales	NRW	01/01/2007	http://lle.gov.wales/catalogue/item/ScheduledAncientMonumentsInWales/?
	National Nature Reserves		Extent Only	National Nature Reserves (NNRs) Metatdata Resource Identifier: 98778	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesNationalNatureReserves/?lang=en
	Special Areas of Conservation [SAC]		Extent Only	Special Areas of Conservation (SACs): 98766	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialAreasOfConserva
	Special Protection Areas [SPA]		Extent Only	Special Protection Areas (SPA): 98775	NRW	06/10/2014	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialProtectionAreas/
	Sites of Special Scientific Interest [SSSI]		Extent Only	Sites of Special Scientific Interest (SSSIs): 98776	NRW	19/04/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSitesOfSpecialScientificI

Appendix D: Energy from Waste Resource Methodology

Total Waste for North Wales

The table below confirms the reported waste arising by waste stream for North Wales up to and including 2013. The average annual change in waste consumption was used to project the total waste arising up to 2026.

Table C.1: *Total MSW, and C&I Waste arising across North Wales*[74]

Year	Municipal Solid Waste	Industrial	Commercial
2004	504,973	546,663	291,208
2005	525,172	530,263	297,032
2006	546,179	514,355	302,973
2007	568,026	498,924	309,032
2008	590,747	483,957	315,213
2009	614,377	469,438	321,517
2010	638,952	457,233	326,661
2011	664,510	447,174	330,581
2012	691,090	439,124	333,226
2013	718,734	432,977	334,559
2014	*747,483*	*421,912*	*339,763*
2015	*777,383*	*411,130*	*345,048*
2016	*808,478*	*400,623*	*350,416*
2017	*840,817*	*390,385*	*355,867*
2018	*874,450*	*380,409*	*361,403*
2019	*909,428*	*370,687*	*367,024*
2020	*945,805*	*361,214*	*372,734*
2021	*983,637*	*351,983*	*378,532*
2022	***1,022,983***	***342,988***	***384,420***
2023	*1,063,902*	*334,223*	*390,400*
2024	*1,106,458*	*325,681*	*396,473*
2025	1,150,716	317,359	402,640
2026	1,196,745	309,248	408,903
2027	1,244,615	301,345	415,264
2028	1,294,399	293,644	421,264
2029	1,346,175	286,140	428,284
2030	1,400,0322	278,,828	434,946
2031	1,456,023	271,702	441,712

Total Waste for Conwy

The North Wales Regional Waste Plan confirmed that the proportion of MSW and C&I waste that was allocated to Conwy in 1998/99 as 18.36% and 8.33% respectively. Thus, the total MSW across Conwy is: 187,776 tonnes in 2022; and 267,264 tonnes in 2031. The total C&I waste in Conwy is: 60,559 tonnes in 2022 and 59,394 tonnes in 2031.

[74] North Wales Regional Waste Plan 1 Review

Waste							
Constraint Category	**Constraints**		**Buffer for LSA (m)**	**Constraint Dataset**	**Source**	**Date of Publication**	**Comment**
Agricultural	Agricultural Small Areas		Extent Only	Agricultural small area statistics		20/07/2016	Spatial Boundaries provided my Adrian Humpage (PCC), with statistics added from Welsh Government - http://gov.wales/statistics-and-research/agricultural-small-area-statistics/?lang=en

Appendix E: Solar PV Farms

The detailed data sources and assumptions can be found in the table below:

Solar PV Farms

Constraint Category	Constraints		Buffer for LSA (m)	Constraint Dataset	Source	Date of Publication	Comment
Environmental	National Nature Reserves		Extent Only	National Nature Reserves (NNRs) Metatdata Resource Identifier: 98778	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesNationalNatureReserves/?lang=en
	RAMSAR Sites		Extent Only	Ramsar Siteds - Wetlands of International Importance: 98759	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesRamsarWetlandsOfInternationalImportance/?lang=en
	Special Areas of Conservation [SAC]		Extent Only	Special Areas of Conservation (SACs): 98766	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialAreasOfConservation/?lang=en
	Special Protection Areas [SPA]		Extent Only	Special Protection Areas (SPA): 98775	NRW	06/10/2014	http://lle.gov.wales/catalogue/item/ProtectedSitesSpecialProtectionAreas/?lang=en
		Conwy & Clwyd Estaurys	4km				
	Sites of Special Scientific Interest [SSSI]		Extent Only	Sites of Special Scientific Interest (SSSIs): 98776	NRW	19/04/2016	http://lle.gov.wales/catalogue/item/ProtectedSitesSitesOfSpecialScientificInterest/?lang=en
	Grades 1, &2 Agricultural Land		Extent Only	Provisional_ALC_250k	WG	2012	Welsh Government Cartographics
	Broad Leaved Woodland [based on National Forest Inventory]		Extent Only	National Forest Inventory: 116293	NRW	18/09/2015	http://lle.gov.wales/catalogue/item/NationalForestInventory2014/?lang=en
	Local Nature Reserves		Extent Only	Local Nature Reserves (LNRs): 98746	NRW	01/01/2016	http://lle.gov.wales/catalogue/item/LocalNatureReserves/?lang=en
	Woodlands		Extent Only	OS Open Map - Local	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	AONBs		3.5km	Areas of Outstanding Natural Beauty (AONBs): 98736	NRW	22/11/2011	http://lle.gov.wales/catalogue/item/ProtectedSitesAreasOfOutstandingNaturalBeauty/?lang=en
	National Parks	Snowdonia	3.5km	National Parks: 98777	NRW	31/12/2010	http://lle.gov.wales/catalogue/item/NationalParks/?lang=en
Heritage	Scheduled Monuments [CADW]		Extent Only	Scheduled Monumnents in Wales	NRW	01/01/2007	http://lle.gov.wales/catalogue/item/ScheduledAncientMonumentsInWales/?lang=en
	Listed Buildings [CADW] Landscape of Outstanding Historic Interest [CADW]		500m	Listed Buildings in Wales Point Dataset	NRW	01/01/2004	http://lle.gov.wales/catalogue/item/ListedBuildings/?lang=en
	Landscape of Special Historic Interest [CADW]		Extent Only	Registered Landscapes Of Outstanding Historic Interest in Wales	NRW	01/01/2001	http://lle.gov.wales/catalogue/item/RegisteredLandscapesOfOutstandingHistoricInterestInWales/?lang=en
Physical	Motorways [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Primary Roads [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Railway Lines [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	A-Roads [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	B-Roads [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
Other Physical	Major River [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	Assumed 10m wide where only linear features were available
	Secondary River [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Minor River [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Canals [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	Assumed 5m wide where only linear features were available
	Lakes [based on OS Strategi]		Extent Only	Strategic	OS Open Data	01/01/2015	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
	Peat		Extent Only		Conwy County Borough Council		Supplied by Conwy County Borough Council
	Buildings [as defined by the LLPG]		500m				
Aviation and Radar	Restricted Airspace - including UK Aerodrome Traffic Zones and Aerodromes with instant approach procedures outside controlled airspace		Extent Only	navigation_aids.kmz_	NATS		http://www.nats.aero/services/information/wind-farms/self-assessment-maps/
	Areas Constrained by NATS Aviation & Radar Safeguarding Zones including Military Aerodrome Traffic Zones, High Intensity Radio Transmission Areas		Extent Only - using 120m safeguarding zone	NATS_Safeguarding_SHP	NATS		http://www.nats.aero/services/information/wind-farms/self-assessment-maps/
	Civil Aviation Authority - Aerodrome Locations		Point	Strategic	OS Open Data	42005	https://www.ordnancesurvey.co.uk/opendatadownload/products.html
SSAs	SSAs and all existing wind farms (in county as well as those outside which impact upon Conwy LPA area		Extent	Technical Advice Note 8: Planning For Renewable Energy - Strategic Search Areas	NRW	01/01/2015	http://lle.gov.wales/catalogue/item/TechnicalAdviceNote8PlanningForRenewableEnergyStrategicSearchAreas/?lang=en
	Existing and Consented PV farms treated as if built		3.5km		Conwy County Borough Council		Supplied by Conwy County Borough Council
Electricity Grid	33, 132, 66KV electricity grid		within 10Km only		Conwy County Borough Council		Supplied by Conwy County Borough Council

Appendix F: Building Integrated Renewable Energy Uptake Modelling

This Appendix sets out the methodology and assumptions behind the micro generation uptake modelling. Renewable and low and zero carbon technologies are included in the calculation methodology in order to represent the decisions made by the building owners. However, the non-renewable uptakes are excluded from the totals presented in the main report.

Micro generation uptake in existing stock

The potential uptake of renewable micro generation technologies in the existing housing stock and in the bulk of the existing non-residential building stock in was projected using a spreadsheet model developed by AECOM. This forecasts the uptake of micro generation technologies based on information about:

- The rates at which 'Primary' systems come up for necessary replacement and at which 'Discretionary' purchases are considered;
- The current housing stock and non-residential building stock;
- The identity and attributes of 'Primary' heating system options (including some renewable energy) and of 'Discretionary' renewable energy systems, and;
- The relationship between system attributes (including cost and 'nuisance' factors) and purchasing decision-making – the Choice Model.

Installations in new homes and new non-residential buildings are subject to different drivers and were considered separately in this Appendix.
The system attributes assumed to influence purchasing decisions are:

- Capital cost;
- Net annual energy costs: electricity & heating fuel costs (after any renewable energy savings) minus any incomes from feed in tariffs, renewable heat incentive and exports of electricity to the grid;
- Annual maintenance costs;
- Whether fuel storage is required (e.g. for biomass pellets or woodchip);
- Whether the garden needs to be dug up (for ground source heat pumps installation in homes); and
- Whether additional indoor 'cupboard' space is needed (for micro-CHP units in homes, as the technology is typically larger than the generator being replaced).

The model accounts for projected real (i.e. excluding inflation) changes in costs and prices over time.

Rate of consideration for Primary and Discretionary systems

It is assumed in the model that householders or landlords may purchase micro generation technologies in one of two situations:

Firstly, as the 'Primary' heating system for a home, as a necessary replacement for a previous heat generator that has reached the end of its life. Once homes reach an age equal to the typical service life of a boiler, it is assumed that a fixed percentage of homes need a new primary heat generator each year. The replacement rate is assumed to be 6% per year. As the replacement is 'of necessity', it is assumed that one of the list of suitable heating options must be selected;

- Condensing gas boiler,
- Condensing oil boiler,
- Condensing LPG boiler,
- Direct electric heating,
- Ground source heat pump,
- Air source heat pump,
- Stirling engine CHP,
- Fuel cell CHP (non-residential only),
- Biomass pellet boiler, or
- Biomass woodchip boiler.

Secondly, as a 'Discretionary' purchase where the status quo is not to have a micro generator, and therefore one of the 'system' options is not to install one. By definition, Discretionary systems may be purchased at any time. The assumption made in the model is that 10% of households and businesses consider purchasing a microgeneration system each year.

The following Discretionary generator options are included in the model:

- Micro-wind turbines;
- Small wind turbines;
- Solar water heating;
- Solar PV.

Existing building stock

The rates of consideration are combined with data on the building stock to determine the number of primary heat generator replacements being selected and the number of discretionary purchases of micro generators being considered each year.

System suitability for non-residential buildings is assumed to depend only on building type. For homes, the suitability of technology options depends on:

- Home type (house or flat);
- Age (pre-1980, 1981 – 2005 or 2006 – 2016);
- Tenure (owner occupied, private rented, or social rented);
- Rurality (urban, suburban, or rural), and
- Gas connectivity (connected to mains gas or off-gas).

As such, the model requires data on:

- The current total number of homes, and the breakdown by type, age, tenure, rurality and gas connection, and;
- The number (and where possible the floor area) of non-residential buildings by type.

Housing stock data

The modelling uses the most up to date and comprehensive data on house numbers and typology that were identified. Data on the numbers of homes were obtained from Welsh Statistics 'Dwelling Stock Estimates' (2010)[75] as well as the Appendix 2 Draft Population and Housing Topic Paper (August 2011) PCDC. NB.

For the purpose of this calculation, caravans were removed from the total. From the LSOA Household Spaces and Accommodation Type (KS16) Census (2001) data, caravans in Conwy equate to 0.7% of the total household spaces. However, the total does include vacant and second homes which accounts for 9% of the total household spaces.

The breakdown of the housing stock was arrived at as follows:

- The percentage split by home type (house or flat) was based on Household Spaces (UV56) Census 2001 data for Conwy County Borough Council;
- The percentage split by age was based on information provided directly from Welsh Statistics[76] for the 2008 dwelling stock in Conwy;
- Percentage by tenure was based on Households (UV63) Census 2001 data for Conwy County Borough Council, and compared against similar statistics reported in the Draft Population and Housing Topic Paper;
- The percentage split by rurality was based on rural-urban designation of Middle Super Output Areas obtained through a custom query on the Neighbourhood Statistics portal of the Office of National Statistics website;
- The percentage split by gas network connectivity was based on data published on http://www.energyefficiencywales.org.uk/targetwales.php for the Targeting Energy Efficiency in Wales project.

The housing stock classification adopted in the model results in 144 housing sub-types. The number of homes of each sub-type is assumed to be the total number of homes multiplied by the respective percentages for type, age, tenure, rurality and gas connectivity.

The total number of homes in the stock is assumed to decline at 0.02% per year, reflecting historical rates of demolition across Wales.

Non-residential building stock data

The modelling uses available data on non-residential buildings, accepting that with the possible exception of Valuation Office Agency data on Bulk classes, the data

[75] http://www.statswales.wales.gov.uk/TableViewer/tableView.aspx?ReportId=18911

[76] Email from Huw Jones (SPF&P - SRD) on 30.08.11

are not comprehensive. The numbers of non-residential buildings by type were obtained as follows:

Bulk class types (Valuation Office Agency) [77]

- Retail
- Offices
- Warehouses
- Factories

Other types (LPA data, as available)

- Hospitality
- Health
- Schools
- Leisure centres

The total number of non-residential buildings is assumed to be constant for the purposes of the model.

The Choice Model for projecting purchasing decisions

At the heart of the AECOM take-up model is a choice model for forecasting purchasing decisions given the attributes of alternative, competing system options. In outline, the choice model is based on the theory that consumers make decisions to maximise 'utility' – the net benefits as perceived by the consumer, and that consumers' utility calculations are based on differences in specific attributes of the available options.

Day-to-day utility calculations are largely implicit and evaluation varies from consumer to consumer. A particular type of market survey called a 'conjoint survey' was used to collect data in a way that can reveal the implicit utility calculations, given a set of what are assumed to be the key attributes. A statistical technique called 'conditional logit', a form of regression analysis, was then used to calculate the coefficients of the formulas that each group of consumers is implicitly using to make choices.

The survey distinguished owner-occupiers from landlords and non-domestic building owners and, as expected, found they valued attributes differently. The survey and analysis also distinguished between 'Primary' and 'Discretionary' choices and hence developed independent uptake models. The coefficients derived were highly statistically significant, showing that within the groups identified, consumer survey responses suggested strong similarity in the implicit calculation of utility.

The benefit of the use of conditional logit analysis is that the results can be used to forecast purchasing decisions given the attributes of alternative system options. For Primary decisions, the model calculates the proportion of consumers that will select each of the suitable system options, given their attributes. (Costs, fuel prices, etc. vary over time, while non-cost attributes stay constant.) The modelling principles are identical for Discretionary decisions with the notable inclusion of "do nothing" among the system options.

A detailed mathematical explanation of the choice model is outside the scope of this report but further information on the conjoint survey and conditional logit analysis underpinning the modelling is available in the original Element Energy research report used as the basis for the model. [78]

[77] Hereditaments Floorspace and Rateable Value Statistics (2005 Revaluation), 2008

[78] The growth potential for Microgeneration in England, Wales and Scotland, Element Energy, TNS, Willis, K., Scarpa, R., Munro, A., 200

Micro generation uptake in new development

Our analysis was based on standard assumptions about the renewable energy output that a range of technologies could deliver for different types of building. The micro generation technologies considered for new development were:

- Solar PV
- Solar water heating
- Air source heat pumps
- Ground source heat pumps
- Biomass boilers
- Small scale wind

We have assumed that 478 homes will be built annually across Conwy, based on the predicted increase over LDP plan period 2007 to 2022 of 6,520 homes.

Typical development scenarios were derived from CLG research analysing the cost of Code for Sustainable Homes compliance.[79] These were used to break down homes in to different development types and estimate the mix of homes compared to flats.

Expected employment/job numbers were taken from the LDP. These were converted into potential area (in m^2) of new commercial development per building type.

The calculation model builds in a 2-year lag for the influence of the policy and regulation changes to affect the uptake of renewable energy e.g. for the increased BIR uptake due to the 2013 Part L changes are not applied until 2015.

For the purpose of assigning house types, an assumption is made on the different types of growth sites within Conwy. Namely, Brownfield, Greenfield, Edge of town or Urban (mixed) sites. This is based on our assessment of the growth strategy for Conwy. For each of these types of growth sites, a housing split is assumed as shown in table E1.

Table E.1: *Assumed housing split*

Size	Type	No. per ha	Flats	Ter	Semi	Det
Small	Brown	80	10%	65%	20%	5%
Small	Green	40	10%	60%	20%	10%
Small	Edge of town	40	0%	40%	20%	40%
Med	Urban (mixed)	80	10%	65%	20%	5%

The table below shows the assumed gross internal area per workspace (Source: Planning for employment land, translating jobs into land, Roger Tyms and Partners, April 2010; and Employment Densities: A Full Guide, Arup Economics and Planning, July 2001.

Table E.2: *GIFA per workspace*

Type of building	Area (m^2)
Offices B1	255
Retail & Leisure	187
Industry	1,050
Storage	818
Health & Education	5,000
Other	426

[79] Code for Sustainable Homes: A Cost Review, CLG, March 2010

Appendix G: Modelling Assumptions

Introduction

This appendix lists the assumptions used in calculating the heat demands, CO_2 savings and cash flow analysis. It includes the following sections:

- Technical
- Revenue

Technical Assumptions

Carbon emissions factors

Based on Building Regulations Part L 2010 figures as given below

:

Table F.1: Carbon Emission Factors

Fuel	Carbon factor (kgCO$_2$/kWh)
Gas	0.198
Electricity	0.517
Grid displaced electricity	0.529

Estimated Heat demands

The area heat demand (MWh/year) were based on CIBSE TM46 benchmarks adjusted with Degree Days to the Wales (-3 % from table A1.1). These were based on building types and building areas.

Pipework costs

Based on previous quotes by PPSL providing Logstor Ror pipework increased in line with inflation

Table F.2: *Pipework Costs*

Size (mm)	Rate per meter (£)	Size (mm)	Rate per meter (£)
DN25/90	£ 132.30/m	DN150/250	£ 271.95/m
DN32/110	£ 140.70/m	DN200/315	£ 341.25/m
DN40/110	£ 147.00/m	DN250/400	£ 512.40/m
DN50/125	£ 53.30/m	DN300/450	£ 657.30/m
DN65/140	£ 158.55/m	DN400/520	£ 803.25/m
DN80/160	£ 169.05/m	DN500/710	£ 941.85/m
DN100/200	£ 191.10/m	DN600/800	£1,092.00/m
DN125/225	£ 219.45/m		

Notes

- *Rates are per single pipe and need to be doubled for flow and return.*
- *Operating Temperatures up to 140ºC.*
- *All-inclusive means there is an allowance in the rates for fittings, site joints and termination seals.*
- *Rates exclude for associated civil works.*

Civil engineering costs (trenching)

Based on previous quotes by PPSL providing Logstor Ror pipework increased in line with inflation.

Table F. 3: *Civil Engineering Trenching Costs*

Size (mm)	Hard Dig £/m	Soft Dig £/m
DN25/90	315	220.5
DN32/110	325.5	231
DN40/110	346.5	241.5
DN50/125	367.5	257.25
DN65/140	378	273
DN80/160	409.5	294
DN100/200	441	315
DN125/225	504	357
DN150/250	619.5	441
DN200/315	682.5	477.75
DN250/400	735	514.5
DN300/450	840	588
DN400/520	897.75	674.1
DN500/710	955.5	677.25
DN600/800	1018.5	729.75

Notes

Civil work all inclusive of:

- *excavation and reinstatement per meter of trench*
- *exclude special surfaces, close shoring, dewatering & traffic management*
- *Civil engineering costs for energy centres*

Energy Centre costs for civils based on 0.4m2/kWe and a Capex of £1000/m2.

Contingency and design fees

Multiple of 1.265 on the overall network costs. This assumes 15% contingency and 10% to cover professional fees.

Plant assumptions

Table F.4: *CHP Units and Gas Boiler Specs*

	Size (MWth)	Heat Efficiency	Electrical Efficiency	CAPEX per kW	Maintenance per kWhth	Lifespan (Years)
Gas CHP	0.5	42%	32%	£864	0.5 pence	15
Gas CHP	0.9	42%	32%	£864	0.5 pence	15
Gas CHP	1.2	40%	35%	£657	0.5 pence	15
Gas CHP	2.2	42%	38%	£657	0.5 pence	15
Gas Boiler	any	90%	n/a	£60	0.0 pence	20

CHP plant operation

Fraction of load met by CHP: 80%

CHP Load Factor: 50%

Heat network operation

Network losses: 6% of total heat demand

Pumping electricity: 1% of total heat demand

Heat standing charge: £100 per household

Network maintenance: 1% of heat network CAPEX

Business Rates: 0% - Assumed that all heating networks are operated by the Council

Revenue Assumptions

Cash flow assumptions

No inflation included;

All costs based on 2012 costs;

Full plant replacement included at year 15 for gas fired CHP and 20 years for biomass boilers.

Table F.5: *Renewable Heat Incentive (RHI) Tariff for Biomass Boilers*

	Size (MWth)	Price (p/kWh)
Small commercial biomass	< 0.2 MWth	Tier 1: 8.6
		Tier 2: 2.2
Medium commercial biomass	0.2 to 1.0 MWth	Tier 1: 4.9p
		Tier 2: 2.0p
Large commercial biomass	> 1.0 MWth	1.0p

Fuel Costs for energy centre

Table F.6: *Fuel Costs*

Fuel	Commercial Price (p/kWh)	Relative Inflation [%]
Gas	2.00p	1.0%
Electricity	8.50p	2.0%
Woodchip	1.29p	0%
CCL (gas)	0.16p	0%

Heat Sales

Heat sale to customers is based on typical boiler efficiencies with a 10% discount to incentivise connecting to the network.

Table F.7: *Heat Sale Prices*

Customer	Heat sale price (p/kWh)	Relative Inflation [%]
Residential	5.25p	1.0%
Commercial	3.20p	1.0%

Appendix H: Attendees of the Stakeholder Workshop

List of attendees at stakeholder workshop held at Conwy County Borough Council, Colwyn Bay, dated 14-06-2013. The workshop was attended by the following stakeholders and project team members:

- Robin Sandham [Senior Planning Officer, Conwy County Borough Council]
- Allan Sharp [Regeneration, Conwy County Borough Council]
- Ivor Jones [Housing Improvements Manager, Conwy County Borough Council]
- Ross Hughes [Energy Officer, Conwy County Borough Council].
- Stephen Ward [AECOM]
- Jonathan Milne [AECOM]

Appendix I: Detailed methodology for developer contributions and Allowable Solutions

This appendix sets out the methodology used in calculating the potential developer contributions and value of allowable solutions. The aim of this calculation is to set out an estimate of the additional cost of district heating networks (DHNs) for new developments, over and above the cost of what would be required from an alternative microgeneration solution to meet future Building Regulations, and in particular the future requirements for zero carbon new homes by 2016.

This estimate of costs is based on the latest information available from published studies, and these are referenced below, as appropriate. However, we would stress that these figures can only be treated as a rough guide at this stage, as there are many uncertainties. The main one of these is that the definition of the requirement for zero carbon homes by 2016 has yet to be fully defined, and has already been subject to several changes over the last 2-3 years.

The estimate of costs given here is for new dwellings only. In terms of non-domestic buildings, it is far harder to come up with generic indicative costs for DHNs, or to estimate the avoided costs for meeting the requirement for zero carbon non-domestic buildings. For the former, this is because non-domestic buildings are far more varied in their size and layout on a site and therefore do not lend themselves to generic modelling in the same way as homes. For the latter, the detail of what zero carbon will actually mean is far less developed and the level of cost analysis that exists for zero carbon homes does not exist for nondomestic buildings.

It is possible that developers could see significant avoided costs for new non-domestic buildings from connecting to a DHN, particularly for mixed use developments, where the cost of the infrastructure could be shared with new housing. However, this could only be quantified as part of a more detail assessment for individual sites.

The cost to a developer of meeting the on-site carbon compliance element of zero carbon

The most recent work on this was published by the Zero Carbon Hub, in February 2011[80]. This work modelled the costs of meeting the carbon compliance element using PV and gas boilers for each dwelling. The study also calculated the contribution that district heating technologies could make to achieving Carbon Compliance, using either gas (engine) CHP or biomass heating, and the amount of PV that may still be required in each case. Using this information, it is possible to deduce the potential capital cost savings that could arise from using district heating as a result of needing less, or no PV. A summary of this data is shown in the table below, for each dwelling type.

[80] “Carbon Compliance, setting an appropriate limit for zero carbon new homes, findings and recommendations”, February, 2011

Table H.1: *Potential Avoided Cost of PV from using DH*

Type of dwelling	Floor area (m2)	Carbon compliance level (kgCO2 per m2 per year)	Cost of carbon compliance with PV (2016 prices) excluding fabric	PV required if no district heating (m2)	PV required with district heating (m2)		Cost saving from district solution (in 2016 prices) per dwelling	
					Gas CHP	*Biomass heating*	*Gas CHP*	*Biomass heating*
Flat	54.5	14	£1,332	4.92	0.0	0	£1,322	£1,332
Semi	76	11	£3,004	11.4	5.8	0	£726	£3,004
Terrace	76	11	£3,444	9.4	3.6	0	£1,637	£3,444
Detached	118	10	£4,033	14	8.7	0	£1,134	£4,033

Notes on table:

- *Where the table says 2016 prices, this means the estimated price of the PV element in 2016, allowing for expected learning rates, but with no inflation added in.*
- *The cost of carbon compliance for PV is the cost of the PV element only, and does not include the cost of the gas boiler.*

The cost saving shown for the district heating solution relates only to the avoided cost of needing less PV, it does not allow for any other cost savings from a district solution

From this table it can be seen that by 2016 (when PV costs are expected to be less than they are now, in real terms), the potential avoided cost of meeting Carbon Compliance to a developer from connecting to a district heating system could be in the range of £726-£3,444 per dwelling, depending on the technology and the dwelling type, for higher density developments consisting of flats, or terraced and end-of-terrace/ semi-detached homes.

The cost of district heating networks

A relatively recent, and robust source of data for this is the report for DECC by Poyry and AECOM on the potential for DHNs in the UK, from 2009[81]. The data in the Poyry report was based on installing DHNs to supply existing dwellings. This is generally more expensive than for new dwellings. This is because for the latter, the heat demands are lower, and therefore a smaller heat main size can be used, and also the trenches for the heat mains can be dug in unmade, or softer ground, rather than having to excavate and re-instate a section of existing road or pavement.

The table below shows a summary of the estimated costs for a DHN to serve new dwellings, derived from the Poyry report. Based on data held by AECOM on heat main costs, we have estimated that the DHN infrastructure cost for new build would be roughly 30% less than that for existing dwellings, and the cost for DNH branches would be 20% less. The figures shown are for the network only, and exclude any costs for the energy centre, and for the heat exchanger and heat meter for each dwelling. The cost for the latter two items is roughly equivalent to the installed cost for a gas boiler, and therefore the net cost of these can be assumed to be zero, assuming the comparison is with a dwelling with its own gas boiler.

[81] "The Potential and Costs of District Heating Networks, a report to the Department of Energy and Climate Change, April 2009

Table H.2: *Estimated Costs of DHNs for New Dwellings*

Dwelling	DHN infrastructure cost (Poyry)	With reduction for new build (30%)	DHN branch cost (Poyry)	With reduction for new build (20%)	Total DHN cost (excluding energy centre) for new build
Flat	£712	£498	£752	£602	£1,100
Terrace	£2,135	£1,495	£1,912	£1,530	£3,024
Semi (Dense)	£2,719	£1,903	£2,598	£2,078	£3,982
Semi (Less Dense)	£2,719	£1,903	£3,198	£2,558	£4,462

Notes on table:

- *All costs shown are in 2009 prices.*
- *The DHN branch cost relates to the cost of pipe braches to serve residential streets and spurs off to serve individual dwellings.*
- *The DHN infrastructure cost relates to the heat mains that would run down the main roads to connect the streets together and to the energy centre, assuming the energy centre was located within or in close proximity to the development.*
- *These figures exclude any costs for an energy centre.*
- *These costs do not allow for the potential avoided cost for a developer if they do not provide a gas supply to each dwelling.*

The table shows that the cost of the DHN network could be in the range of £1,100 to just under £4,000 per dwelling for higher density developments, consisting of flats, terraced homes and end-of-terrace/ semi-detached homes.

A comparison of these costs with the avoided costs for carbon compliance, and the resulting net cost, is shown summarised in the table below. This shows that the net cost is actually negative (i.e. a net cost saving) for flats, and for high density housing is about £500 for biomass heating, and up to about £2,300 for gas CHP. These costs could potentially be reduced further if a) as mentioned above, the developer chooses not to provide a gas supply to each dwelling [82], and therefore sees a saving in gas infrastructure and b) if the developer or ESCo is able to share trenches with other infrastructure being installed on site (such as water, electricity and fibre optic cabling) which could reduce the costs of installation.

[82] Some ESCOs may require this anyway, if they are investing capital in a scheme, to help provide a long term guarantee of heat supply to the dwellings to support their efforts to obtain finance

Table H.3: *Net Costs for DHNs to Meet Zero Carbon*

Type of dwelling	Cost saving from district solution (in 2016) per dwelling		Secondary DHN costs per dwelling	Net cost for district heating	
	Gas CHP	Biomass heating		Gas CHP	Biomass heating
Flat	£1,332	£1,332	£1,100	-£232	-£232
Semi	£726	£3,004	£3,024	£2,298	£20
Terrace	£1,637	£3,444	£3,982	£2,345	£538
Detached	£1,134	£4,033	£4,462	£3,328	£429

The proportion of this net cost, if there is one, that will be passed on to the developer will depend on a range of factors including:

- Whether the energy centre already exists to serve other heat loads, or whether a new energy centre needs to be provided specifically for the new development. The costs shown above are for the DHN only, so if a new energy centre was required, this would be an additional cost per dwelling.
- The overall financial viability of the DHN and the energy centre.
- The mix and density of heat loads.
- The actual predicted carbon savings for each dwelling.
- The level of financial return required by the ESCo.
- For gas engine CHP, (or in fact for any form of CHP) the ability of the ESCO to sell the electricity at retail prices to a large electricity user, rather than at wholesale prices to the grid.

Allowable Solutions

Once a developer has met the Carbon Compliance requirement on-site, the current definition of zero carbon requires that they deal with the remaining carbon emissions through Allowable Solutions. The most recent Government impact assessment for the Zero Carbon Homes policy[83] has estimated that the cost of Allowable Solutions would be £49 per tonne of CO2 per annum, totalled over 30 years. This figure is in present value terms, and assumes, in effect, that this is the cost that the developer would pay upfront on completion of each new dwelling. The table below shows the potential value (or cost) of the Allowable Solutions for different dwelling types.

[83] CLG, Zero Carbon Homes, Impact Assessment, May 2011

Table H.4: *Allowable Solutions Value*

Type of dwelling	Floor area (m2)	Carbon compliance level (kgCO2 per m2 per year)	Cost of Allowable Solutions per dwelling (discounted) @£49 per tonne over 30 years
Flat	54.5	14	£1,122
Semi	76	11	£1,229
Terrace	76	11	£1,229
Detached	118	10	£1,735

One of the potential Allowable Solutions, at the time of writing, could be to fund the connection of district heating networks to reduce the carbon emissions of existing buildings. This could potentially assist with the overall viability of a district heating scheme, and thereby help reduce the cost to a developer of connecting the new homes, as explained above. However, this solution may require a local authority to have a policy mechanism in place to require payments into a local fund, rather than a developer paying into a national fund.