Cardiff Local Development Plan
2006 - 2026

Renewable Energy Assessment

September 2013

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CARDIFF DEPOSIT LOCAL DEVELOPMENT PLAN

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Section 1: Introduction

Background and Purpose of this Renewable Energy Assessment (REA)

1. The use of fossil fuels is seen as a key contributor to greenhouse gas emissions, a major cause of global climate change. Moving towards a low carbon energy based economy to tackle the causes of climate change and improve energy security are key priorities of both the UK and Welsh Assembly Governments. The generation and use of renewable and low carbon energy sources has a key role to play in this and the UK Government is committed to meeting the EU target of 15% of energy from renewable sources by 2020. The Climate Change Act 2008 introduces a legally binding target of at least a 34% cut in greenhouse gas emissions by 2020, and at least an 80% cut by 2050, against a 1990 baseline.

2. In terms of the land use planning system the Welsh Government has shown strong leadership by producing policy guidance in Planning Policy Wales and associated Technical Advice Notes (TANs): TAN 8 – 'Renewable Energy' (2005) and TAN 22 – 'Sustainable Buildings' (2010). In its "One Wales" commitments the Assembly Government has stated that "following the production of the Energy Route Map and an Energy Strategy, it will review TAN 8, revising upwards the targets from renewable energy, drawn from a variety of sources".

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

    - Preparing planning policies and allocating land in their Local Development Plans
    - Development management - taking decisions on planning applications submitted to the local planning authority for development; as well as preparing Local Impact Assessments for schemes which are determined by the Infrastructure Planning Commission
    - 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

4. This REA has been prepared to, primarily, support Cardiff Council with the first of these, it constitutes an evidence base to underpin Local Development Plan policies that can support and facilitate the deployment of renewable and low carbon energy technologies.

Why is this REA important?

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

dioxide emissions and improving energy security. At a more detailed level, this REA provides an evidence base to explore a number of policy objectives:

- Identification and promotion of sites for renewable energy generation
- Informing the selection of land for development (allocation of sites), by identifying those sites with the greatest potential for sustainable energy and carbon reduction
- To enable local authority exploration of requiring developers to connect to an existing or proposed district heating network

6. Within the REA, the 'accessible' renewable energy resource has been identified and an initial heat opportunities analysis undertaken of 8 LDP strategic sites. The opportunities relate particularly to where renewable and low carbon energy may be linked to new development via district heating networks (DHNs).

7. 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.

Planning Policy

8. This Renewable Energy Assessment can assist Cardiff Council in meeting two national planning policy expectations as set out in Planning Policy Wales[1], namely:

- Development plans and renewable and low carbon energy (Section 12.9)

  This indicates that: "Local planning authorities should guide appropriate renewable and low carbon energy development by undertaking an assessment of the potential of all renewable energy resources and renewable and low carbon energy opportunities within their area and include appropriate policies in development plans".

- Planning for Sustainable Buildings (Section 4.12)

  This states that as part of preparing their LDPs: "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 … local planning authorities should ensure that what is proposed is evidence-based and viable."

9. In order to achieve higher standards, it is highly likely that at some point some form of renewable or low carbon energy generation will be required: this REA has employed the method detailed in 'Renewable energy: A toolkit for planners' for identifying and assessing potential.

[1] Planning Policy Wales (Edition 5, November 2012)

Wider Corporate Role

10. In terms of wider roles, all local authorities including Cardiff Council have objectives or requirements in relation to tackling climate change that they need to meet, stemming from either Sustainable Community Strategies, national strategies or their own corporate strategies. This REA enables Cardiff Council to identify specific opportunities for taking forward renewable and low carbon energy generation.

Scope of this Renewable Energy Assessment

Planning

11. The REA focuses on planning policy rather than development management. As explained above, this REA has been developed primarily for Cardiff Council's Planning Policy Team, as part of the evidence base to support renewable and low carbon energy policies and site allocations in the LDP. However, parts of the REA could potentially be useful to inform pre-application discussions between development management officers and developers.

Technology

12. This assessment is not meant to be an exhaustive guide to the different renewable and low carbon energy technologies that are available. Technical Advice Note 8 provides an introduction to a range of renewable and low carbon technologies and should be first point of reference. Further detail and practical guidance can also be found in 'Planning Implications of Renewable and Low Carbon Energy Development'[2].

Energy Hierarchy

13. The REA focuses on renewable and low carbon energy generation, and the opportunities for promoting this through the 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 climate change: it is at least as, if not more, important. However, it is not covered in this REA, partly to keep the document to a manageable size, but also because there is only a limited amount, if anything, that planning policy for new developments can contribute in this area, over and above the existing sustainable buildings standards in Wales, and future changes to part L of the Building Regulations. Again, we refer the reader to other excellent sources of information on energy efficiency in buildings, existing and new, that already exist.

Transport

14. The REA covers the potential for generating renewable electricity or heat (for use in buildings or processes) but does not include an assessment of the potential for renewable or low carbon fuels for transport.

[2] Welsh Assembly Government, 2011

On-shore

15. In terms of renewable energy options and resources, potential has only been assessed for on-shore renewable energy. It does not cover the potential for offshore renewable energy, such as wave, offshore wind and tidal.

Large Scale On-Shore Wind

16. The REA is not intended to duplicate the analysis carried out in TAN 8, which identified Strategic Search Areas (SSAs) for large scale on-shore wind power (none of which are located in Cardiff). Rather, in the case of wind power, it intends to identify smaller scale opportunities.

Data Sources

17. Assumptions and data used in carrying out this REA have been sought from established sources, and these are listed in the text. Where there is no established source, Cardiff Council has derived assumptions based on the best evidence available. In future, guidance, assumptions and data sources may change, particularly as technology and the policy and regulatory framework evolves, and it may be necessary to revise the REA accordingly.

Defining Renewable Energy and Low Carbon Energy

18. There are many definitions of renewable energy. The definition employed in Planning Policy Wales (Para 12.8.7) is as follows:

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

19. 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 photovoltaics, and air source heat pumps, which make use of solar energy stored in the ground. The indirect forms are: wind power, as wind is caused by differential warming of the earth's surface by the sun; hydropower, as rainfall is driven by the sun causing evaporation of the oceans; and biomass energy (from burning organic matter), as all plants photosynthesise sunlight in order to fix carbon and grow.

20. The combustion of biomass fuel is carbon neutral, because although the combustion releases CO_2, the same amount of CO_2 was taken out of the atmosphere when the biomass was growing. Research informing Planning Policy Wales confirms "Biomass is

generally regarded as fuel (other than fossil fuel), at least 98% of the energy content of which is derived organically from plant or animal matter. This includes agricultural, forestry or wood waste or residues, sewage and energy crops".

21. The other two forms of renewable energy are tidal power, which relies on the gravitational pull of both the sun and the moon, and geothermal energy, which taps into the heat generated in the Earth's core. Of all these, perhaps the most complex and multi-faceted are biomass energy, as it can take so many forms. It can include: burning of forestry residues; anaerobic digestion of animal manures and food wastes; combustion of straw and other agricultural residues and products. It also includes the methane produced from the anaerobic digestion of biodegradable matter in landfill sites (i.e. landfill gas), as well as any energy generated from the biodegradable fraction of waste going into an energy from waste plant.

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

Table 1.1: Renewable energy technologies covered by the Toolkit

- **Wind energy** (on-shore wind and community scale development)
- **Biomass energy**: including:
  - Forestry residues
  - Miscanthus
  - Short rotation coppice
  - Straw
- **Energy from Waste** (EfW) including:
  - Waste wood
  - Municipal waste
  - Industrial and commercial waste
- **Centralised Anaerobic Digestion**, covering:
  - Food waste
  - Agricultural wastes
  - Sewage sludge
- **Hydropower energy**
- **Building Integrated Renewables** (BIR), covering:
  - Biomass boilers
  - Air and ground source heat pumps
  - Photovoltaics
  - Small and micro wind power

Low carbon energy options

23. Low carbon energy options cover a range of energy sources that are not renewable, but can still produce less carbon than use of the conventional electricity grid or gas

network, and are therefore considered an important part of decarbonising the energy supply. These options include:

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

Explanation of Energy Terms: The Difference between Power and Energy and Electricity and Heat Power vs. Energy Output

Power vs. Energy Output

24. In the context of this Renewable Energy Assessment, power is measured in either kilowatts (kW), or Megawatts (MW), which is a thousand kW, or gigawatts (GW), which is a thousand MW. It is a measure of the electricity or heat output being generated (or used) at any given moment in time. The maximum output of a generator, when it is running at full power, is referred to as its installed capacity or rated power output. Energy, on the other hand, is the product of power and time. It has the units of kWh (the h stands for "hour") or MWh, or GWh. As an example, if a 2MW wind turbine ran at full power for 1 hour, it would have generated 2 x 1 = 2MWh of energy. If it ran at full power for one day (24 hours), it would have generated 2 x 24 = 48MWh.

25. This distinction is important, because in carrying out the renewable energy resource assessment, certain assumptions have been made to calculate the potential installed capacity (or maximum power output) of different technologies, as well as the potential annual energy output.

Electricity vs. Heat Output

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

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

Section 2: Policy Context and Drivers for Renewable Energy

Introduction

28. In One Wales: One Planet[3], the Assembly Government set out a commitment to reduce greenhouse gas emissions in Wales, with an aim to achieve annual carbon reduction-equivalent emission reductions of 3% per year by 2011 in areas of devolved competence, including actions on diversified renewable energy generation. The Assembly Government has reiterated the recognition that climate change is the greatest threat facing humanity and is committed to ensuring that Wales plays a full part in meeting the challenges which this presents.

29. The Assembly Government has a legal obligation to promote Sustainable Development and has embarked on an ambitious and long-term programme of cross cutting policy initiatives to address these issues. This is contained in One Wales: One Planet which sets out a vision where within the lifetime of a generation we want to see Wales using only its fair share of the earth's resources. Renewable energy plays an integral part in achieving this vision. The draft Climate Change Strategy set out a vision for Wales in 2050. Within this vision it states *"The energy intensity of society has decreased significantly. There has been a major consistent drop in energy and water demand. There has been a major increase in renewable energy generation, offshore and onshore"* Moving towards a low carbon energy based economy is a national priority. The UK Government is committed to meeting the EU target of 15% of energy from renewable sources by 2020, and the Welsh Assembly Government will deliver its fair share towards these targets as set out in the draft Climate Change Strategy (2009).

UK and European Policy Context

30. EU Renewable Energy Directive: The UK has signed up to the Directive, agreeing to legally binding targets of 15% of energy from renewable sources by 2020. Modelling undertaken on behalf of the Department for Energy and Climate Change (DECC) suggests that by 2020, this could mean:

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

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

Wales Policy Context for Planning and Renewable Energy

32. Planning's wider role in shaping places with lower carbon emissions and resilience to climate change is set out in Planning Policy Wales (PPW), 2012. The Assembly

[3] "One Wales: One Planet", Welsh Assembly, 2009

Government has shown leadership by producing policy guidance in PPW and the associated Technical Advice Note (TAN) 8 on renewable energy. In its "One Wales" commitments the Welsh Assembly Government has stated that: "following the production of the Energy Route Map and an Energy Strategy it will review TAN 8, revising upwards the targets from renewable energy, drawn from a variety of sources". In September 2009 and 2011 changes were made to 'permitted development' rights to make provision for the installation of certain types of micro-generation by householders without the need for planning permission, namely solar photovoltaic and solar thermal panels, ground and water source heat pumps and flues for biomass heating. Further Permitted Development rights relating to wind turbines were made in 2011.

33. The Planning and Energy Act, 2008, enables local planning authorities in Wales to set reasonable requirements in the LDP for the generation of energy from local renewable sources and low carbon energy and for energy efficiency. The Act is complemented by the policies contained in PPW that cover such issues and provides a legal basis for the implementation of LDP policies against the national framework. The Act requires that LDP policies must not be inconsistent with relevant national policies, and the new powers of local planning authorities under the 2008 Act are also subject to the requirements of section 62 of the Planning and Compulsory Purchase Act 2004. As stated PPW and the supporting TAN 22, as part of preparing their LDP's, "Local planning authorities (LPA's) should assess strategic sites to identify opportunities for higher sustainable building standards (including zero carbon) to be required. In bringing forward standards higher than the national minimum ... LPA's should ensure that what is proposed is evidence-based and viable".

Wales Wider Policy Context: The Renewable Energy Route Map for Wales (Consultation) (2008)

34. The Renewable Energy Route Map for Wales sets out proposals for moving Wales towards self-sufficiency in renewable electricity in a generation whilst at the same time driving towards increased energy efficiency and a greater level of heating requirements being supplied from renewable sources. The route map envisages that microgeneration and other small scale technologies can play a significant role in delivering these proposals, as supported by the Microgeneration Action Plan for Wales (2007). This is supported by the actions in One Wales: One Planet (2009) and the draft Climate Change Strategy (2009) to remove barriers to the installation of microgeneration.

The Bioenergy Action Plan (BAP) (Consultation) (2009)

35. This proposes targets of 5TWh of electricity and 2.5TWh of usable heat energy from renewable biomass by 2020.

Wales Low Energy Policy Statement (2010)

36. In early 2010, the Assembly Government published "A Low Carbon Revolution" which provides the sustainable development framework for the acceleration, in Wales, of the transition to an efficient low carbon energy based economy. The statement builds on the results of the Renewable Energy Route Map and the Bioenergy Action Plan for Wales consultation documents outlined above.

National Energy Efficiency Savings Plan (Consultation) (2009)

37. This proposes practical short term actions that aim to reduce greenhouse gas emissions, tackle fuel poverty in Wales with a particular emphasis on improving the energy efficiency of the most inefficient homes in Wales, and support 'green' jobs and development of the supply chain for energy efficiency and microgeneration technologies. The Plan will sit below the Energy Statement which will provide the overall framework for energy policy in Wales.

Climate Change Strategy (Consultation) (2009)

38. Wales has set a target to reduce its emissions of greenhouses gases by 3% per year from 2011 from areas of devolved competence. In June 2009, the Welsh Assembly Government published its Climate Change Strategy - Programme of Action consultation. The consultation sets out in more detail the actions the Assembly Government are proposing to deliver their climate change objectives.

Other UK Drivers for Renewable Energy Building Regulations and Zero Carbon

39. Future changes to the Building Regulations are expected to bring in challenging dwelling (CO_2) emissions rate targets for residential development and for commercial developments. By 2016, new homes will need to achieve a 70% reduction in CO_2 emissions on or near site from energy efficiency and the use of Low and Zero Carbon (LZC) energy options. For large sites, district heating (DH) from a low carbon source is likely to be one of the most cost-effective ways of achieving this. Developers will then have to deal with their residual carbon emissions through the use of Allowable Solutions (AS). One AS proposed would allow credit for carbon emissions where heat is exported from the site to nearby existing buildings via a DHN.

Feed in Tariffs (FITs)

40. The 2008 Energy Act contains powers for the introduction of FITs in Great Britain to incentivise renewable electricity installations up to a maximum capacity of 5 MW. The impact of FITs will be significantly increased revenue for small-scale generators of renewable electricity, such as photovoltaic systems or small wind turbines. The FITs may also make it easier to obtain finance for such projects as it provides a guaranteed price for the electricity generated.

Renewable Heat Incentive (RHI)

41. The Renewable Heat Incentive (RHI) is a Government environmental programme that provides financial incentives to increase the uptake of renewable heat. It provides a subsidy, payable for 20 years, to eligible, non-domestic renewable heat generators and producers of biomethane. The incentive payments will be funded by a levy on suppliers of fossil fuels for heat. The proposal is that the RHI will cover a wide range of technologies including biomass, solar hot water, air and ground source heat pumps, biomass CHP, biogas produced from anaerobic digestion and injection of biomethane into the gas grid. The impact of the RHI is that it will make generation of renewable heat more financially viable than it is currently.

The Renewables Obligation (RO)

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

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

Welsh Assembly Government's Community Scale Renewable Energy Generation Programme

44. The Welsh Assembly Government's Community Scale Renewable Energy Generation Programme uses European Structural Funds to provide advice and grants to support the development of community-sized renewable energy schemes, through the Energy Saving Trust.

Wood Energy Business Scheme (WEBS)

45. Grants for Welsh SME businesses and community groups installing wood fuelled heating systems; plus support for setting up clean wood fuel supply businesses in Wales. The Wood Energy Business Scheme (WEBS) is a £17 million pound capital grant scheme. It draws down its funding from European ERDF funds via the Welsh European Funding Office (WEFO), and will run until 2013. The funding is made up of £7.9 million pounds of ERDF funding; the remainder will be from various match funding sources.

46. This is a pan Wales project, although different levels of support apply in the convergence and Competitiveness areas of Wales. Its prime aim is to provide capital grant support to micro-businesses, SMEs and social enterprises to further develop the sustainable and renewable wood heat market across Wales. Three types of project are eligible for grant support:

- Wood fuel heating systems
- Small scale electricity generation using wood - Combined Heat and Power (CHP)
- Wood fuel supply businesses – Enabling high quality equipment and fuel supply chains to be developed.

Section 3: How to Use this Renewable Energy Assessment (REA)

Structure of the Renewable Energy Assessment

47. In developing each element of the evidence base, a series of tasks have been completed as set out in "Renewable Energy: A Toolkit for Planners". The start of each section of this REA indicates the questions about the renewable or low carbon energy potential in the Cardiff area that have been addressed by each element of the evidence base.

Who has developed this Renewable Energy Assessment?

48. This REA has been developed by Cardiff Council, in line with the Assembly Government's Practice Guidance: "Planning for Renewable and Low Carbon Energy – A Toolkit for Planners", using the Pembrokeshire County Council Pilot Study (prepared by AECOM) as a basis. The REA has been compiled using a Geographical Information Systems (GIS) approach and methods as set out in the above mentioned 'toolkit'.

Section 4: Cardiff Council Area Wide Renewable Energy Assessment

49. This section details the 'accessible' renewable energy resources in the Cardiff Council area, the variation in technologies that may need to be employed to utilise such resources and the different outputs (electricity and/or heat) of each technology. Issues and questions addressed by this element of the REA include:

Calculating Existing and Future Energy Baseline

- What is the current energy demand in Cardiff?
- What will be the energy demand in Cardiff in 2020?

Existing and Proposed LZC Energy Technologies

- What is the existing capacity of low and zero carbon energy technologies in Cardiff?
- Are any low and zero carbon energy technology installations being proposed in Cardiff?

Wind Energy Resource

- What is the potential for medium and large scale wind in Cardiff?
- What are the potential sites for stand-alone renewable energy development in Cardiff?

Biomass Energy Resource

- What is the potential energy from biomass in Cardiff?

Energy from Waste

- What is the potential energy from municipal solid waste in Cardiff?
- What is the potential energy from commercial and industrial waste Cardiff?
- What is the potential energy from energy from food waste in Cardiff?
- What is the potential energy from energy from animal manure and poultry litter in Cardiff?
- What is the potential energy from digestion of sewage sludge in Cardiff?

Hydropower Energy Resource

- What is the potential energy from hydropower in Cardiff?

Calculating Existing and Future Energy Baseline

50. The method employed for base-lining the Cardiff area wide energy consumption was as detailed in 'Renewable Energy: A toolkit for Planners'. The method relies upon:

- Predicted future energy demand as indicated in the UK Renewable Energy Strategy.
- Welsh Government derived data and statistics currently published by DECC.

51. Table 4.1 below shows the split between electricity and heat for the UK, Wales and for Cardiff County Council for 2008. Table 4.2 shows the predicted electricity and heat demand for Cardiff County Council for 2020.

52. Table 4.1: Total DECC Energy 2008 (GWh) data reported by UK Renewable Energy Strategy energy sector for the UK, Wales and Cardiff.

	Total Energy 2008 (GWh)		
Sector	**UK**	**Wales**	**Cardiff**
Electricity	304,627	16,267	1,722
Heat	828,788	60,388	3,813

Table 4.2: Predicted Energy Demand for Cardiff (2020)

Sector	Total Energy Consumption 2008 (GWh)	Predicted % Change to 2020	Predicted Total Energy 2020 (GWh)
Electricity	1,722	-0.3	1,717
Heat	3,813	-15.8	3,213

Section A: Existing and Proposed LZC Energy Technologies

53. To demonstrate the progress being made and establish a baseline of installed capacity to inform future potential, the capacity of Low and Zero Carbon (LZC) technologies already installed in the Cardiff area has been established. Where LZC energy technologies already exist, the installed capacities (measured in MW) were recorded and incorporated as a contribution to overall final targets.

54. This assessment of existing capacity covers electricity and heat generation, and large scale as well as 'Building Integrated Renewables' (BIR) generation. For larger schemes, it also includes those that have received planning consent, but are not yet built.

55. The locations of the larger scale projects have been plotted using GIS for their potential contribution to supply heat to strategic new development sites.

Identifying Existing Smaller Scale and Microgeneration Capacity

56. Data has been collected at the local authority level on installed renewable heating capacity (such as wood chip boilers, heat pumps and solar water heating), and small scale electricity generation. Care has been taken to ensure no double counting has taken place.

Table 4.3: Existing and Proposed Renewable Electricity Capacity:

Name of Scheme	Technology	Capacity (MWe)	Source
Trident Park	Energy from Waste	30	Council records
Radyr Weir Hydro Scheme	Hydro	0.48	Council records
GR24i	Wind (Onshore)	2.3	Council records
Ikea	Photovoltaic	0.1	Council records
Cardiff Dock Heat and Power	Biomass - Dedicated	2.5	DECC
Cardiff East Waste Water Treatment Works CHP	Sewage gas	4.04	Offgem
Ferry Road Landfill Scheme	Landfill Gas	0.97	Offgem
Lamby Way Landfill Site	Landfill Gas	5	Offgem
	Large Scale Total	**45.39**	
Low Carbon Building Programme	Mixed (Wind, Solar PV, Air Source Heat Pump)	0.0001	DECC
Feed in Tariff	Micro CHP (Domestic)	0.003	Offgem
Feed in Tariff	Photovoltaic (Community)	0.01	Offgem
Feed in Tariff	Photovoltaic (Domestic)	4.37	Offgem
Feed in Tariff	Photovoltaic (Commercial/Industrial)	0.30	Offgem
Feed in Tariff	Wind (Domestic)	0.01	Offgem
	Small Scale Total	**4.69**	
	GRAND TOTAL	**50.08**	

Table 4.4: Existing and Proposed Renewable Heat Capacity

Name of Scheme	Technology	Capacity (MWt)	SOURCE
Trident Park	CHP	20	Council records
Senedd	Biomass	0.36	Council records
Companies House	Biomass	0.2	Council records
	Large Scale Total	**20.56**	
Domestic Schemes			
	Air Source Heat Pump	0.01	DECC
	Small Scale Total	**0.01**	
	GRAND TOTAL	**20.57**	

57. In addition to the schemes identified above, the following Council schemes are noted, though the output is not presently recorded:

- Electric ground sourced heat pump at Ty Gwyn Special School, consumption & output data not available.
- 8 solar hot water systems on 8 sites, output not measured.
- 2 biomass boiler systems (Cardiff Bay Environment Building & Cathays Cemetery Mess Room), fuel consumption not recorded.
- 2 solar PV systems on Primary Schools, installed early 2012, output data not available to Energy Team at present.

Section B: Wind Energy Resource

58. This section follows the methodology for undertaking a strategic assessment of accessible wind power potential as set out in the 'Toolkit for Planners'.

59. It is noted that this methodology is only suitable for a strategic, high level assessment. However, though the exercise may show that the locating of wind turbines might be constrained in a particular area this does not mean that turbines could not be located there in practice. This is because, for example, environmental designations in those areas may not be impacted on by a wind development (e.g. if the designation is for flora or invertebrates), or it may be possible to achieve a "technical fix" for radar interference at a particular site. Therefore, the constraints maps should not be used to preclude wind development in constrained areas. It is for each planning applicant to demonstrate whether the impacts are within acceptable limits, and meet relevant policy and guidance.

60. Secondly, although this high level process can inform the potential for individual sites, it is not in itself enough to fully assess their technical viability. Some of the further site level constraints that would need to be assessed (and this is not meant to be an exhaustive list) include:

- Site slope
- Practical access to sites required for development
- Proximity to power lines, public rights of way, bridle ways
- Landowner willingness for development to go ahead
- Distance to the nearest appropriate electricity grid connection
- Consultation with telecommunications operators to identify whether any links were passing over the site
- Formal consultation with the MoD and Civil Aviation Authority to identify any potential objections in relation to radar interference
- Impact on birds, bats and other ecology
- Issues of cumulative impact in relation to other existing or proposed wind power installations.

61. For the purposes of planning policy in Wales, large scale wind power has been defined in TAN 8 as wind farms of between 25MW and 50MW. Those above 50MW are the responsibility of the Independent Planning Commission under the Electricity Act. TAN8 provides details of 'Strategic Search Areas, (SSAs), sites identified as suitable and potential locations for large scale wind. TAN8 states that 'outside of SSAs wind farms are allowed up to 25MW capacity on urban brown field sites and less than 5MW elsewhere'.

62. Wind farms, by nature, are most usually situated in rural settings away from residential development and where the wind resource is least constrained. This can mean that there is often no opportunity to utilise on-site the outputs from wind farms leaving export of electricity to grid as the only option. This REA has not utilised national grid data.

Typology

63. The following wind turbine typology was used in the study, since this is considered to represent a typical current onshore wind turbine:

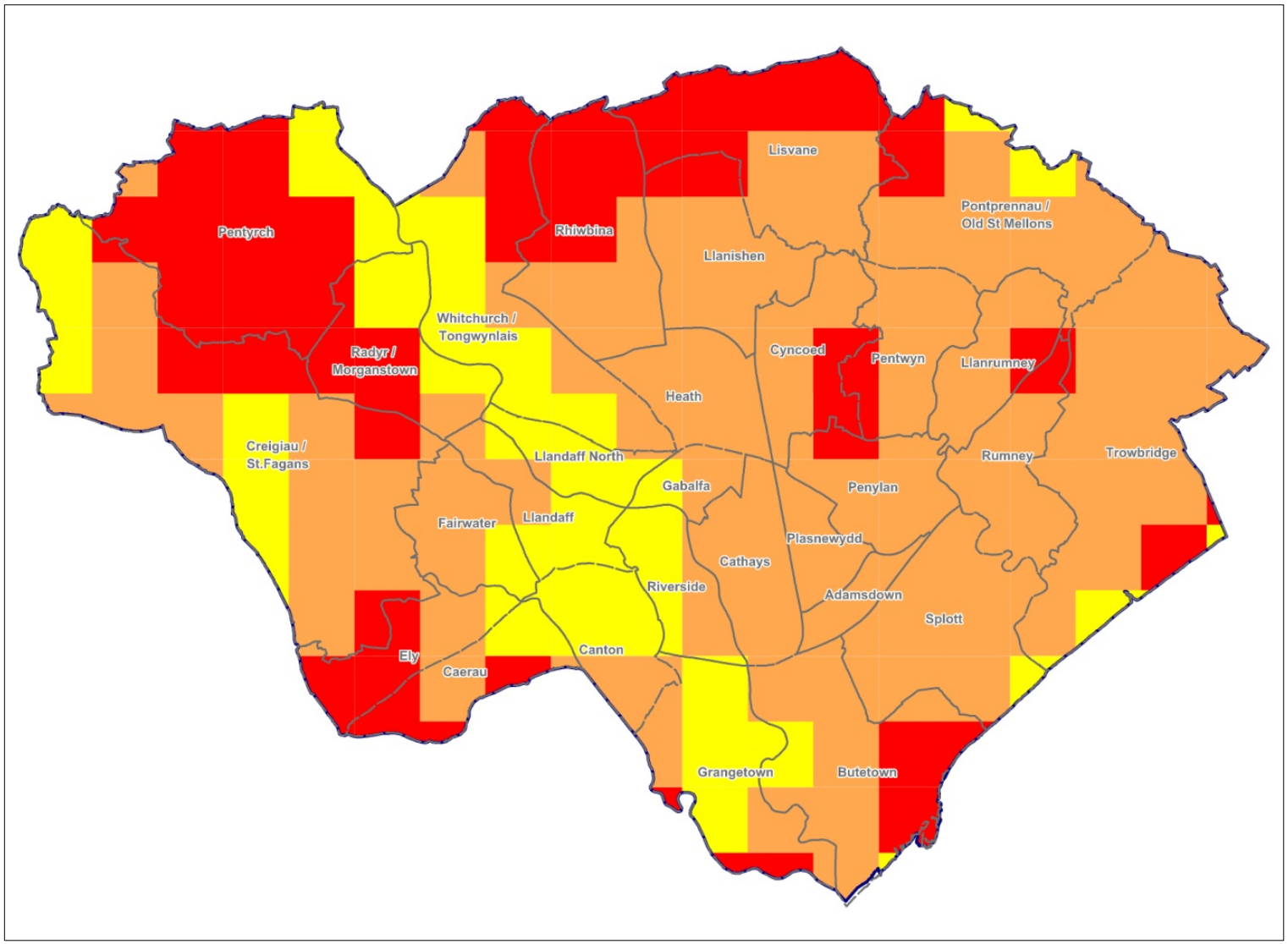
- Rated output: 2MW
- Hub height: 80m
- Rotor diameter: 80m
- Height to blade tip at the highest point ("tip height"): 120m

Average Annual Wind Speed

64. Average Annual Wind Speed (AAWS) has been estimated for each $1km^2$ across the UK, using an air flow model which estimates the effects of topography on wind speed. This archived database is available from the DECC website and has been mapped for Cardiff on a $1km^2$ grid OS base (see Figure 4.1, below).

65. There is no established guidance on minimum AAWS for locating wind farms, but the standard industry approach is to look for a minimum AAWS of 6m/s at 45m above ground level, and ideally in excess of 6.5m/s. Accordingly, grid cells with an AAWS of less than 6m/s, between 6m/s and 6.5m/s, and greater than 6.5m/s, have been classified as 'low', 'moderate' and 'high' wind speed areas respectively. In order to conform to current industry practice for the chosen turbine typology, it has been assumed that areas with low AAWS have no wind potential for the purposes of this study.

Figure 4.1: Average Annual Wind Speed in Cardiff 45m above ground level



Constraint Mapping

Environmental & Heritage

66. Wind turbines may be restricted by nearby existing environmental and heritage constraints which might lead to the refusal of planning consent. These constraints have been mapped accordingly and it has been assumed that there is no strategic scale potential for wind power development in areas where the following are present:

- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Candidate Special Area 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)

Transport Infrastructure & Other Physical Constraints

67. To minimise disruption and potential incidents in the unlikely event that a wind turbine should 'topple', a minimum 'exclusion zone' is necessary around key transport infrastructure known as a 'topple distance' (i.e. the hub height plus rotor radius, equal to 120m). The following exclusion zones have therefore been mapped:

Transport Classification	Minimum Exclusion Zone	Source
Principal transport network (motorway, trunk roads and rail network)	Topple distance (same as height) plus 50 metres.	Highways Agency plus assumption for rail
Secondary transport network (other local authority transport network)	Topple distance plus 10%.	PPS22

68. In addition to the transport infrastructure constraints listed above, the following physical constraints have also been mapped, and again, it has been assumed that there is no wind development potential within these areas:

- Woodland areas
- Inland waters
- Mineral zones and quarries

Noise Buffer for Existing Residential Development

69. The location of turbines is further restricted by the potential impact associated with the noise they generate; both aerodynamic noise from the blades moving through the air and mechanical noise from the gear box within the hub. In order to mitigate the potential noise impact of wind turbines, a 'noise buffer' has been applied around all existing dwellings. An exclusion zone of 500 metres has been utilised, in line with typical industry practice. Bearing in mind the impact that a turbine may have on neighbouring authorities, outside of the development management system of Cardiff, a noise buffer has also been added from the edge of the county boundary.

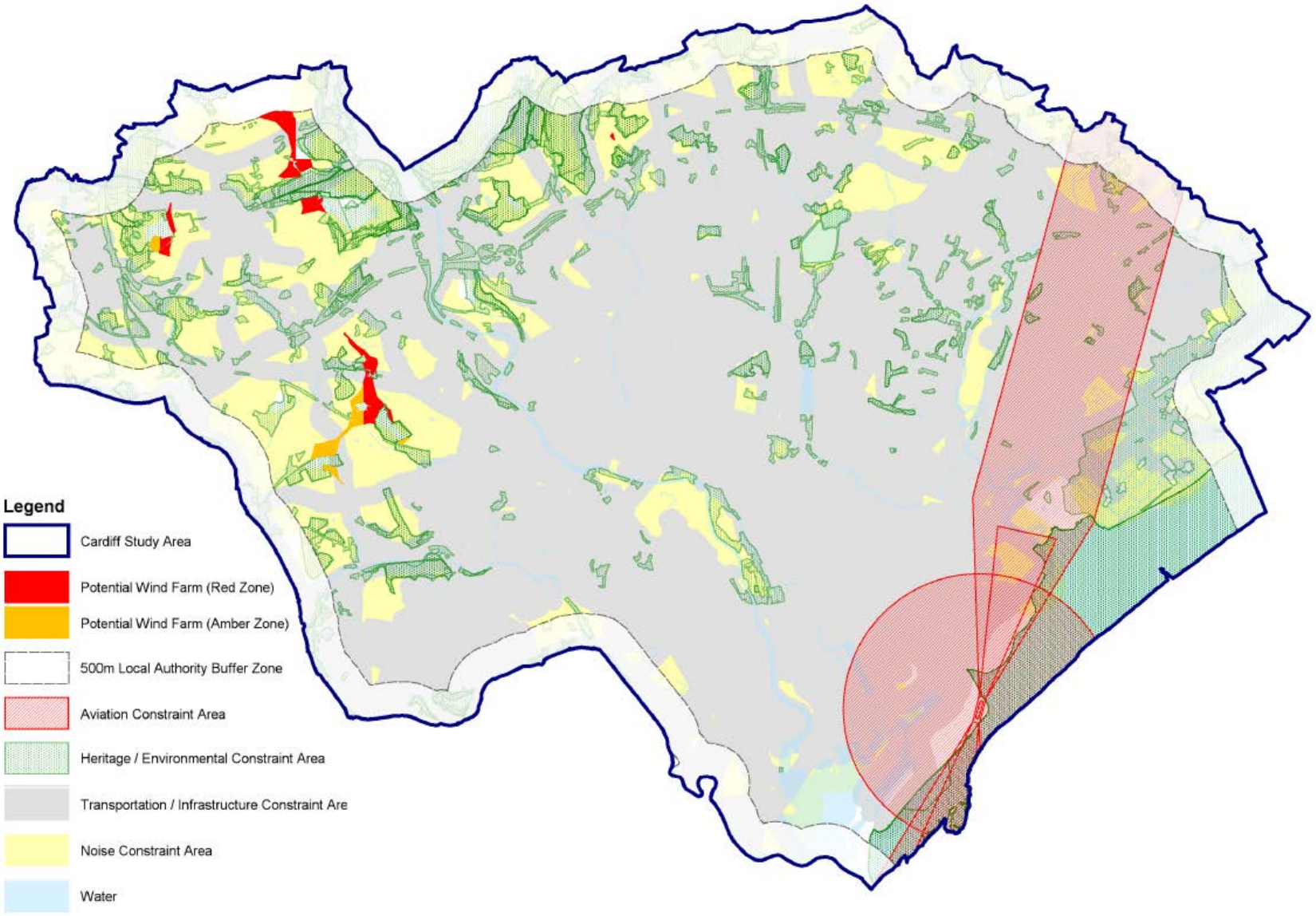
Existing Aviation & Radar Constraints

70. Larger wind turbines can cause interference with radar systems and also represent obstructions to low flying aircraft. The following constraints were mapped (where applicable) and it is assumed that no wind development takes place:

- Controlled airspace (including military aircraft low flying zones, or Tactical Training Areas).
- UK aerodrome traffic zones (ATZ)
- Military aerodrome traffic zones (MATZ)
- High intensity radio transmission areas
- Aerodromes with instant approach procedures outside controlled airspace
- Potential interference with National Air Traffic Service/NATS En Route Plc (NERL) radar infrastructure

Figure 4.2, below provides the wind constraints map including environmental, cultural, heritage, transport infrastructure, noise, and aviation and radar constraints across Cardiff.

Figure 4.2: Wind Constraints Map



Wind Resource Priority

71. Figure 4.2 above identifies land which is presently unconstrained and potentially available for wind power development, broken down into categories of wind speed. It is possible to fit five 2MW turbines into 1km^2, which equates to a potential installed capacity of 10MW/km^2. However, this figure represents the maximum power output that turbines could produce, in reality, a turbine will often be generating at less than maximum energy, or sometimes no energy at all (for instance on a very calm day). To estimate a more realistic potential annual energy output in these areas an assumed capacity factor of 0.27 (27%) has been applied in line with advice in the Toolkit. The potential capacity for each priority area is presented in table 4.5 below:

Table 4.5: Unconstrained Wind Resource Output for Cardiff

Wind Resource Priority	Unconstrained Area (km^2)	Potential Energy Generated (MWh)	Capacity (MW)
Priority 1 (high AAWS)	0.467	11,054	4.67
Priority 2 (moderate AAWS)	0.191	4,529	1.91
TOTAL	**0.659**	**15,582**	**6.59**

Cumulative Visual and Landscape Impact Issues

72. Table 4.5 provides an estimate of the potential energy output for wind areas in Cardiff. However, in reality harnessing all of that energy may cause significant cumulative visual and landscape impact. This potential impact needs to be considered as a further constraint and the potential resource revised accordingly. Welsh Government guidance proposes using a 7km separation distance between wind farms (the rationale being that beyond this distance, turbines do not appear dominant the landscape). Given that the identified areas are all within close proximity to each other it is unlikely that all of the identified resource could be harnessed without having a negative impact on the landscape.

Further Considerations – Cardiff Deposit LDP (2006-2026)

73. The above methodology identifies the potential wind resource for Cardiff by mapping present constraints. It is however necessary to consider a number of potential future constraints which can be identified in relation to Cardiff's proposed Deposit LDP, which may impact on the identified resource.

Green Belt Allocation

74. The Cardiff Deposit LDP proposes a Green Belt to strategically manage the urban form of Cardiff and protect the setting of the urban area. The most important attributes of Green Belts are their permanence and their openness. National policy contained in PPW (Chapter 4) states that a presumption against inappropriate development applies within Green Belts and inappropriate development should not be granted planning permission.

75. The proposed Green Belt covers land to the north of the M4 and presents a further constraint to part of the wind resource identified in the above assessment and so the element has been included in this section for information purposes only. Should national policy in regards to development within Green Belts change in future revisions to Planning Policy Wales, enabling this resource to become accessible then the identified resource may be included in the summary tables.

Special Landscape Area Allocations

76. Cardiff's Deposit LDP proposes to designate significant areas of land as Special Landscape Areas (SLAs). The aim of this Policy is to ensure that those features of the landscape that contribute to its character, value, distinctiveness, sense of place, and quality are protected from inappropriate development. Part of the identified wind resource identified above falls within the proposed Special Landscape Areas and therefore any strategic scale wind development is unlikely to be considered appropriate. Accordingly, areas of wind potential within proposed SLAs have not been included in the summary tables.

Strategic Site Allocations

77. The Deposit LDP proposes a number of Strategic Sites for development. Two of these sites: Land at North West Cardiff and Land at North East Cardiff include extensive residential proposals and occupy land within areas of potential wind resource identified above. The provision of a 500 metre noise buffer to safeguard proposed residential development may therefore effectively constrain the identified potential wind resource. Accordingly, this resource has been excluded from the REA and summary tables. It might be possible to incorporate smaller scale wind turbines on these sites to exploit the identified resource, depending on the eventual design and layout.

Section C: Biomass Energy Resource

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

- Wood fuel resource
- Energy crops (Miscanthus & short-rotation coppice)

79. Although 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.

80. Even where there is local demand for a biomass supply, constraints, not considered within this REA include (and this is not meant to be an exhaustive list) the proximity of plant and practical access to sites required for preparation and delivery of fuel. In terms of plant, landowner willingness, political will, the time to complete planning procedures and an economic distance to the nearest appropriate electricity grid connection will all be key considerations but are not included within this assessment.

81. Biomass energy generation (whether generating heat, power or both), by nature, is most usually situated a small distance away from residential development (though close enough to supply heat), where there is room for the development including fuel storage and access for large delivery vehicles.

82. In relation to biomass energy generation, potential opportunities for Cardiff are:

- Investment interest of Energy Services Companies (ESCOs) may be secured through the identification of appropriate sites and heat demand
- Some organisations are actively marketing support services to enable LAs to exploit their estates through installation of renewable energy technologies.
- Large scale renewable installations can provide significant revenue streams to LAs or off-set significant carbon emissions to assist with meeting their obligations under the Carbon Reduction Commitment Energy Efficiency Scheme.

83. For the purposes of this REA, the method detailed in 'Renewable energy: A toolkit for planners' was utilised. It is suggested that the biomass resource is identified in the following way: 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.

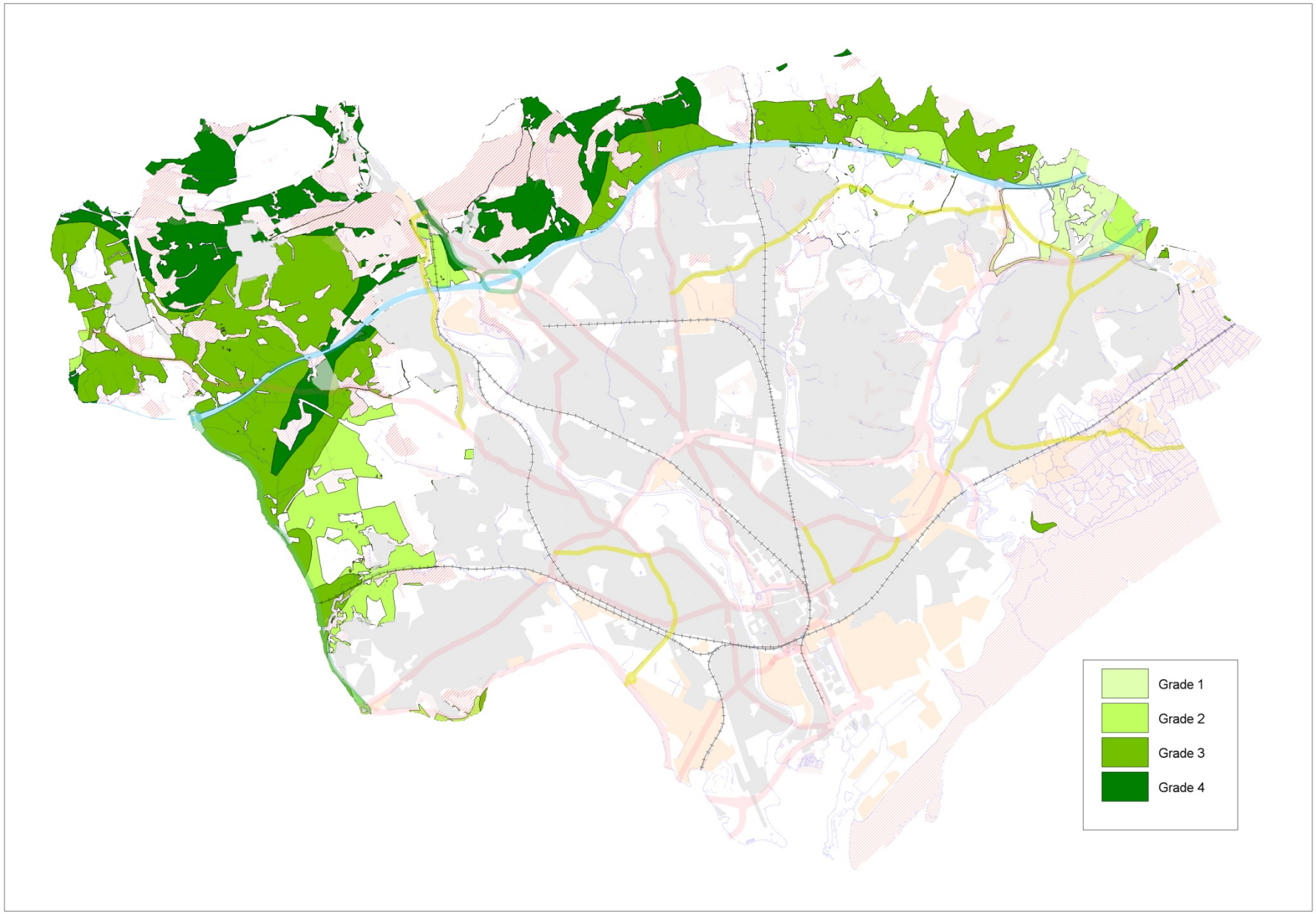
84. There is no consideration of the utilisation of straw as an energy source as Wales is a net importer.

Table 4.6: Total Potential Available Biomass Resource for Cardiff

Outputs	Energy Crops	Woodland	Total	
Unconstrained area (ha)	2,460	469	2,929	
Percentage of area that can be used	10%	n/a		
Useable area (ha)	246	469	715	
Yield (odt per ha)	12	0.6		
Annual Fuel Yield (odt)	2,953	281	3,234	
Electricity				
Required odt per 1MWe	6,000	n/a		
Potential installed capacity (MWe)	**0.5**	**n/a**	**0.5**	**MWe**
Heat from CHP				
Potential installed capacity (MWt)	**1**	**n/a**	**1**	**MWt**
Heat-only option				
Required odt per 1 MWt	n/a	660		
Potential installed capacity (MWt) from boilers	**n/a**	**0.4**	**0.4**	**MWt**

85. Figure 4.3 on the following page provides a completed biomass resource map for Cardiff.

Figure 4.3: Biomass Resource



Section D: Energy from Waste

Background

86. In order to comply with targets contained in the national waste strategy for Wales: 'Towards Zero Waste', (2010), it will be necessary to increase recycling rates of all main waste streams (household, commercial and industrial) to a minimum of 70% by 2025. Residual waste will be phased out of landfill sites and sent instead to high efficiency 'energy from waste' plants in accordance with the waste hierarchy in order to deliver the best sustainable outcomes for this waste fraction.

87. Local Waste Planning Authorities have subsequently developed detailed plans on how to treat the Municipal Solid Waste (MSW) stream arising in their area. In south east Wales, a regional partnership has been formed between Cardiff, Vale of Glamorgan, Newport, Caerphilly and Monmouthshire. "Prosiect Gwyrdd" has been established to consider the future arrangements for the management of residual waste – after recycling and composting has been maximised. The scheme will deal with residual waste amounting to approximately 35% of MSW arising; the remainder being managed locally by each authority through its own collection and disposal arrangements.

88. In March 2013, it was announced that all five local authorities agreed to the Joint Committee's recommendation that Viridor be appointed for a 25 year residual waste contract. Viridor's waste facility is a merchant facility, in that the company would have built the infrastructure regardless of winning the Project Gwyrdd contract. The facility is currently being built at Trident Park in Cardiff and obtained a permit to operate from the Environment Agency in 2010. The size of the facility (350,000 tonnes per year) has been proposed by the company themselves and is based on their own commercial assumptions on the amount of waste which they believe will require waste treatment. Accordingly, the maximum capacity of the plant is included in Cardiff's REA.

89. Table 4.7, below, provides an indication of Cardiff's Municipal Solid Waste and Commercial and Industrial waste resources to 2020 using the methodology set out in the Toolkit. It is important to note that the Municipal Solid Waste figure is provided for information purposes only since the capacity of the Viridor plant is considerably higher. The Commercial and Industrial figure is based on figures provided by Environment Agency Wales, and uses the commercial and industrial growth assumptions agreed in the Regional Waste Plan 1st Review.[4]

[4] South West Wales Regional Waste Group (August 2008), Appendix C

Table 4.7: Predicted Municipal Solid Waste and Commercial & Industrial waste resources for Cardiff to 2020. Assumes the biodegradable element of residual waste is utilised by heat generating plant only.

Outputs	MSW	C&I	Total
Total waste (tonnes per annum)	221,610.0	346,739.4	568,349.4
Total residual waste by 2020 (30%)	66,483.0	104,021.8	170,504.8
Total biodegradable (renewable) element by 2020 (35%)	23,269.1	36,407.6	59,676.7
Electricity			
Required wet tonnes per 1MWe	10,320	10,320	20,640
Potential installed capacity (MWe)	2.25	3.53	5.78
With CHP Facility (an extra 2 MWt thermal output each MWe)	4.51	7.06	11.57
Heat only option			
Required wet tonnes per 1MWt	1,790	1,790	3,580
Potential installed capacity (MWt)	13.00	20.34	33.34

Note: Assumes latest MSW waste growth assumptions for Cardiff provided in the Prosiect Gwyrdd Outline Business Case and Commercial & Industrial growth assumptions from the Regional Waste Plan 1st Review.

Section E: Anaerobic Digestion

90. Additional potential energy sources derived from waste as reported on the Bioenergy Action Plan for Wales include:

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

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

Food Waste

MSW Food Waste

92. Cardiff Council currently has an interim contract to process up to 30,000 tonnes per annum of mixed food and green waste at the New Earth Solutions, In Vessel Composting (IVC) plant in Sharpness, Gloucestershire. However, Cardiff Council and the Vale of Glamorgan Council are currently working on a procurement project to treat source-separated food and green/garden waste, collected from the kerbside, household waste sites, parks/gardens and businesses.

93. In July 2013, two final bidders were selected from a shortlist of four competitive bids, both of which propose Anaerobic Digestion to process the organic waste produced by Cardiff and the Vale. The procurement is due to be completed by early 2014 and the facilities should become operational by early 2016. It should be noted that one bidder may utilise their plant in Pontypool.

94. Forecasts published in the Initial Outline Business Case which take into account Cardiff Council's new collection system (introduced in September 2011) estimate that Cardiff's pure organic waste will be approximately 52,965 tonnes in 2019/2020.

Commercial and Industrial Food Waste

95. Figures obtained from the Environment Agency Wales (2007) have been used to inform the Commercial and Industrial Food Resource.

Table 4.8: Potential Installed Anaerobic Digestion Capacity from Total Available MSW and Commercial & Industrial Food Resource

MSW Food Waste (tonnes)	52,965
Commercial & Industrial Food Waste (tonnes)	32,190
Total Food Waste (tonnes)	85,155
Electricity	
Required tonnes for 1MW	32,000
Potential Installed Capacity (MWe)	**2.66**
Additional Heat from CHP	
Potential Installed Capacity (MWt)	**3.99**

Animal Manure

96. The Welsh Government records the number of livestock at Local Authority area in Wales (Welsh Agricultural Small Area Statistics)[5]. 2010 survey data reports that there were approximately 1,788 cattle and 115 pigs on farms in Cardiff.

97. The REA 'Toolkit' estimates that cattle and pigs produce 1 tonnes, and 0.1 tonnes of slurry per month respectively. Since livestock will generally only be kept under cover for approximately 6 months of the year, it has been assumed that it is only possible to collect slurry for 6 months. Furthermore, many farms do not have a slurry system due to economic / area constraints and so it has been assumed that only 50% of farms actually use a slurry system.

Table 4.9: Potential Installed Capacity from Animal Manure

Livestock	**Cattle**	**Pigs**
Number	1,788	115
Available resource per head (tonnes)	1.5	0.2
Total resource per annum (tonnes)	2,682	17.3
Electricity		
Total wet tonnes required per MWe	225,000	225,000
Potential Installed Capacity (MWe)	**0.01**	**0.00**
Heat from CHP		
Potential Installed Capacity (MWt)	**0.02**	**0.00**

SOURCE: Welsh Agricultural Small Area Statistics (Welsh Government 2012)

[5] Website: http://wales.gov.uk/topics/statistics/headlines/agriculture2012/120906/?lang=en

Poultry Litter

98. The Toolkit sets out a methodology for assessing the available energy resource from poultry litter. However, since there are no mass producing farms which accommodate above 10,000 birds in Cardiff, the potential capacity generated from this resource is considered minimal and it is therefore not considered relevant to include this data in Cardiff's assessment.

Sewage Sludge

99. Using figures derived from WAG's consultation Bio-energy Action Plan for Wales (WAG, 2009) it is possible to estimate the potential dry tonnes of dry sewage sludge available for generation of energy through anaerobic digestion. It is estimated that in Cardiff the sludge available per annum in Cardiff is 10,851. Table 4.10 below indicates the potential energy capacity yield from this resource:

Table 4.10: Potential installed capacity from total available sewage sludge resource

	Predicted Resource
Total sewage sludge (dry solid tonnes per annum)	10,851
Electricity	
Required dry solid (tonnes) for 1MW	13,000
Potential installed capacity (MW)	**0.83**
Heat from CHP	
Potential installed capacity (MW)	1.25

Note that the heat element may be required as part of the drying process to treat the sludge and is therefore not an accessible resource.

Section F: Hydropower Energy Resource

100. This section has sought to assess the accessible resource of hydro sites (under 10MW) and potential micro-hydro schemes, through the identification of existing feasibility studies. It does not consider the potential contribution of wave power, tidal stream or tidal barrage. Constraints upon the use of sites for hydropower schemes include the seasonality of water flows, financial viability of projects, the willingness of landowners and riparian rights of owners to advance projects. Additional constraints include environmental issues and the need for Environment Agency acceptance and permitting.

101. In 2009, the Environment Agency published: "Opportunity and Environmental Mapping Sensitivity Mapping for Hydropower in England and Wales". This project assesses and maps opportunities for hydropower and estimated the flow available, the maximum power potential, and the basic environmental sensitivity associated with exploiting them. It is the first phase of a wider programme of work that aims to make information available to developers and stakeholders, and to develop a more strategic approach to the sustainable deployment of hydropower.

102. The data presented here is based on the first phase, and is not intended to give site-specific data. It should be noted that the project was intended to provide a national and regional level overview, and the results are not intended to replace any part of an individual site assessment, which is necessary for a full scheme appraisal.

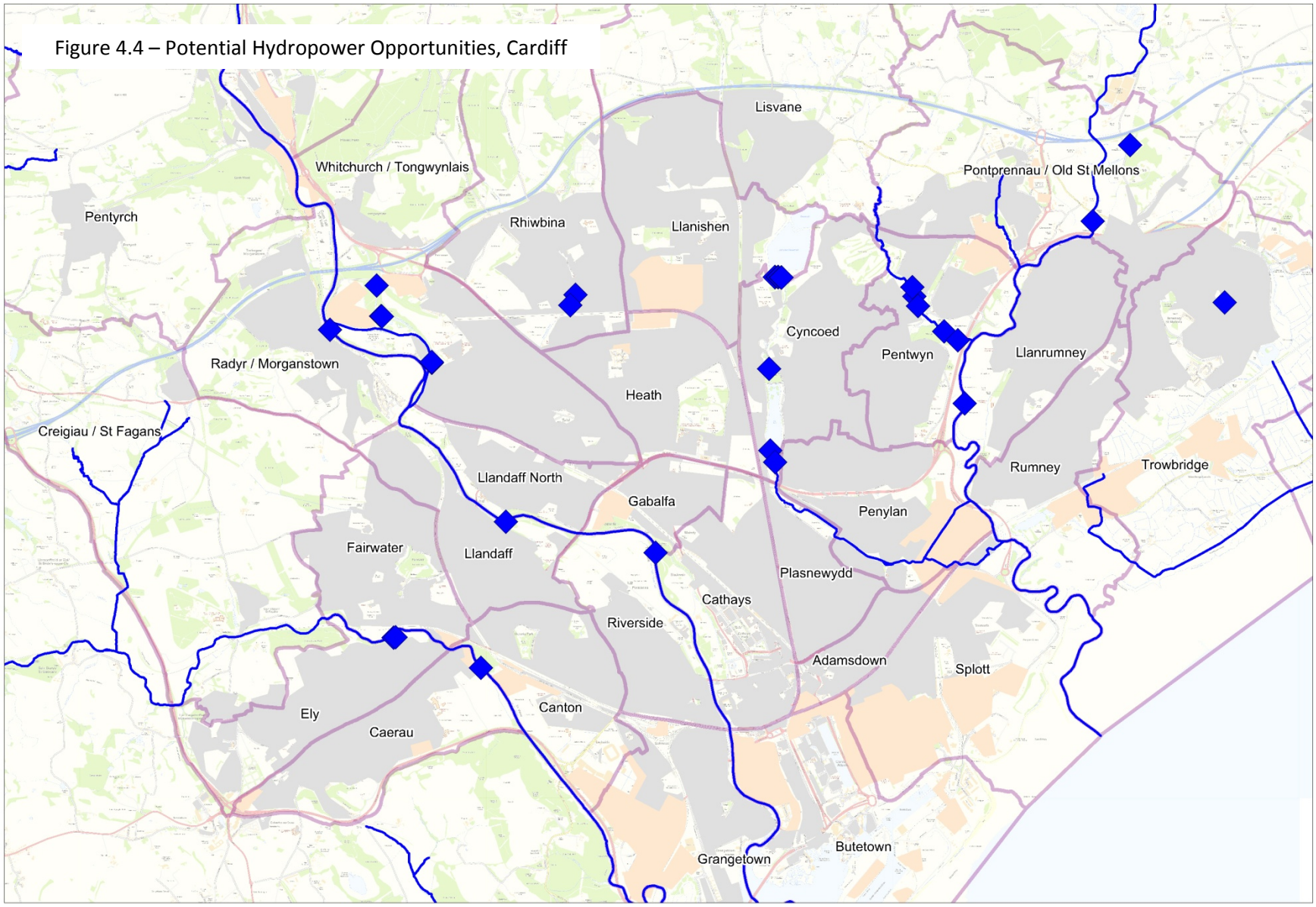
103. A total of thirty-four 'barriers' are identified within the Cardiff administrative boundary. The term barrier describes sites where there is sufficient height in river level to provide a hydropower opportunity. These sites are mostly weirs, but could be other man-made structures, or natural features such as waterfalls. This initial phase considers two environmental sensitivities: the presence of different fish species and whether the site has been designated as a Special Area of Conservation (SAC).

104. Twenty-two barriers (64%) are classified as "highly sensitive", mostly because of the presence of migratory fish species, such as salmon. Eight of these are also estimated to have a power potential of less than 10kW and are unlikely to be attractive to developers as the potential income will be low, whilst the costs of designing, installing and maintaining a scheme are likely to be high. Accordingly the potential output from these eight sites has been omitted from this study. The environmental sensitivity of the 12 remaining barriers is currently unclassified, due to a lack of data. Table 4.11 sets out the potential hydropower capacity for Cardiff and Figure 4.6 shows the location of these barriers identified by the Environment Agency's study:

Table 4.11: Theoretical Maximum Potential Hydropower Capacity, Cardiff

Feature	Power Category (kW)	Maximum Potential (kW)	Sensitivity Category
LOCK	500 - 1500	1,500	High
WEIR	500 - 1500	1,500	High
WEIR	100 - 500	500	High
WEIR	100 - 500	500	High
LOCK	100 - 500	500	High
LOCK	100 - 500	500	High
WEIR	100 - 500	500	High
WEIR	100 - 500	500	High
WEIR	100 - 500	500	High
WEIR	50 - 100	100	High
WEIR	50 - 100	100	High
WEIR	20 - 50	50	High
WEIR	20 - 50	50	High
WEIR	20 - 50	50	High
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
WEIR	0 - 10	10	n/a
DAM	0 - 10	10	n/a
	TOTAL	6,970	
	TOTAL (MW)	**6.970**	

Figure 4.4 – Potential Hydropower Opportunities, Cardiff



Section G: Heat Opportunities Mapping

105. This section considers some of the issues associated with mapping opportunities for the utilisation of renewable and low carbon heat. The issues, research and questions associated with this element of the evidence base are as follows:

Background

- Why is it important to understand the nature of existing and future energy demand and infrastructure?

Identifying the location of strategic new development sites

- Where are the proposed strategic development sites in the Cardiff area?

Identifying anchor heat loads [AHLs]

- What and where are the key anchor 'heat' loads in Cardiff?

Identifying off gas areas [OGAs]

- Where are the areas not served by the gas mains network in the Cardiff local authority area?

Heat demand and density

- What is the residential heat demand and density for the Cardiff local authority area?

Areas of high fuel poverty

- Where are the areas of fuel poverty in the Cardiff local authority area?

Identifying existing DH & CHP schemes and sources of waste heat

- Where are the existing district heating and combined heat and power schemes and sources of waste heat in the Cardiff local authority area?

Developing an Energy Opportunities Plan for DHNs

- What is the nature of new development on proposed strategic sites in the Cardiff local authority area?
- What is the energy opportunities plan for an area / site in the Cardiff local authority area?

Background

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

- Identification of public sector buildings to act as 'anchor heat loads' (AHLs).
- To identify 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 data assists with the identification of sites with significant potential.

- The proportions of the relative demand for electricity and heat are also useful indicators as to what type of LZC technology might be appropriate in a particular area.
- Areas of high density energy demand may not always present the greatest opportunities. Energy density data needs to be combined with other data, such as the nature of energy demand, the composition of building types and uses, the accessible renewable energy resource, land and building ownership, existing infrastructure and any proposed development in order to isolate the greatest opportunity: These opportunities should also be reviewed against community priorities to align delivery to local requirements.
- Energy demand can be estimated from the types of proposed buildings, the quantity of development and the energy efficiency level. Energy efficiency can reduce the energy consumption, so it is important to estimate the future requirements in this regard.
- The locations of new development will be needed for assessments of strategic opportunities.

Identifying the Location of Strategic New Development Sites

107. This element of the evidence base involved establishing the location of strategic sites. The task was carried out as part of the LDP site sifting and candidate site selection process. By "strategic" we take to mean the largest sites, that Cardiff is considering allocating:

A. Cardiff Central Enterprise Zone and Regional Transport Hub
B. Former Gas Works, Ferry Road
C. North West Cardiff
D. North of Junction 33 on M4
E. South of Creigiau
F. North East Cardiff (west of Pontprennau)
G. North East Cardiff (east of Pontprennau)
H. South of St Mellons Business Park

108. Comprehensive GIS maps illustrating heat opportunities for each of the above strategic sites are given in the Appendix at the end of the report. A brief description of each site follows:

A. Cardiff Central Enterprise Zone and Regional Transport Hub – major employment-led initiative including a Regional Transport Hub together with other mixed uses in Cardiff city centre in order to fulfil Cardiff's role as economic driver of the city-region, provide major employment opportunities focused on financial and business services and maximise the advantages of its location adjacent to the Central Station and Cardiff Bus Station;
B. Former Gas Works, Ferry Road – housing based scheme of approximately 500 homes with associated community uses;
C. North west Cardiff – comprehensive development including approximately 7,500 homes, employment and other associated community uses;

D. North of Junction 33 on M4 – mixed use of approximately 2,000 homes, employment, other associated community uses and a strategic Park and Ride site;
E. South of Creigiau – housing based scheme of approximately 750 homes with associated community uses;
F. North east Cardiff (west of Pontprennau) – comprehensive development of approximately 6,000 homes, employment and other associated community uses;
G. North east Cardiff (east of Pontprennau) – housing-based scheme of approximately 2,000 homes with associated community uses;
H. South of St Mellons Business Park – a strategic employment site;

Identifying Anchor "Heat" Loads (AHLs)

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

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

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

111. The identification of PLs 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. CHP / DH schemes are most cost-effective when installed as part of new development rather than retro-fitting (this is covered under "energy demand from proposed development and infrastructure).
- Social housing schemes. These organisations are often tasked with achieving greater than the minimum environmental performance standards. The inclusion of such developments in DH/CHP schemes often enhance the energy profile to provide further evening, weekend and night time energy demands.

112. AHLs can help a CHP/DH schemes to become a realistic prospect and there are usually particular conditions that need to be in place, such as planned new development and/or a commercial building/group of buildings with a significant

demand for heat and/or with an energy profile suitable for the installation of a CHP unit.

113. Given the responsibilities placed upon LAs and the public sector in general for driving the climate change mitigation agenda, AHLs 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.

114. When it is proposed that private commercial buildings provide an 'AHL' the issue of 'ownership' is not as significant as when residential units are proposed for this role. The reason for this is that 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.

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

116. Table 4.12 below provides a non-exhaustive list of possible AHL at each strategic site.

Table 4.12: Possible AHLs at Strategic Sites

Opportunity		Potential Connection - heat load (MWh)
A. Cardiff Central Enterprise Zone and Regional Transport Hub		
New build employment and associated community development		
Anchor loads (within 0.5km)		
	Central Library	618
	St Mary the Virgin Primary School	165
	St Cuthbert's Primary School	104
	Grangetown Primary School	322
	St David's Hall	1,484
	Various social housing	
Anchor loads (within 1km)		
	Steel Works	-
	Trident Park EfW Proposal	-
	City Hall	3,000
	County Hall	2,006
	Cardiff Castle	499
	St David's Shopping Centres	-
	Adamsdown Primary School	141
	Mount Stuart Primary School	163
	St Paul's Primary School	107
	St Patrick's Primary School	120
	Ninian Park Primary School	32
	Splott Library	208
	Roath Library	197
	Tredegarville C.W Primary School	167

	St Peter's R.C Primary School	279
B. Former Gas Works, Ferry Road		
New Build Housing	500	
Existing Housing	500+units within 1km	
Social housing	Approx. 160 units within 1km	
Anchor loads (within 0.5km)		
	Various Employment uses along Penarth Rd and Hadfield Rd	
	Channel View Leisure Centre	502
	St Pauls Primary School	107
	Wilcox House	
Anchor loads (within 1km)		
	Grangetown Library	
	Grangetown Primary School	322
	Ninian Park Primary	32
	St Patrick's Primary	120
C. North West Cardiff		
New build housing	7,500	
Existing housing	1,500+ within 1km	
Social housing	Approx. 1,070 within 1km	
New build employment/retail		
Anchor loads (within 0.5km)		
	Holy Family Primary School	200
	Ysgol Gymraeg Coed Y Golf	
	Ysgol Gyfun Gymraeg Plasmawr	681
	Peter Lee Primary School	449
	Danescourt Primary School	209
	Radyr Comprehensive School	1,452

Anchor loads (within 1km)	Social Housing Radyr Police Station Radyr Library Radyr Weir Hydro Scheme Radyr Primary School Age Concern Community Centre	 121
D. North of Junction 33, M4		
New build housing Existing housing New build employment/retail Anchor loads (within 0.5km)	2,000 Creigiau Village Sewage Treatment Works	
E. South of Creigiau		
New build housing New build employment Existing housing Anchor loads (within 0.5km)	750 Creigiau Village Creigiau Primary School Sewage Treatment Works	 245
F. North East Cardiff (west of Pontprennau)		
New build housing Existing housing Social housing New build employment Anchor loads (within 0.5km)	6,000 1,500+ units within 1km Approx. 40 units with further potential (180 units) beyond 1 km	

	Cardiff Gate Business Park	
	Corpus Christi High School	941
	Llysfaen Primary School	104
Anchor loads (within 1km)		
	Avenue Industrial Park	
	Ty Enfys Care House	
	Bupa Hospital	
	Began Park Golf Centre	
	Christ the King Primary School	117
	Glyn Coed Primary School	146
	The Court Special School	205
G. North East Cardiff (East of Pontprennau)		
New build housing	2,000	
Existing housing	1,500+ units within 1km	
Social housing	Approx. 700 units.	
New build employment		
Anchor loads (within 0.5km)		
	St Cadoc's Primary School	177
	Glan Yr Afon Primary School	697
	Existing Retail & Commercial	
	Cardiff Gate Business Park	
Anchor loads (within 1km)		
	Avenue Industrial Park	
	St John's College	
	Pen Y Bryn Primary School	290
	St Mellons Primary School	85
	Bryn Celyn Primary School	222
	The Hollies Special School	498
	St Bernadette's Primary School	188

	Bupa/Spire Hospital	
H. South of St Mellons Business Park		
Existing housing	Approx. 1,000 units within 1km	
Social housing	Approx. 235 units	
New build employment		
Anchor loads (within 0.5km)		
	St Mellons Business Park	
	Willowbrook Primary School	327

Identifying Off Gas Areas

117. 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 DH schemes are often not developed in rural locations is often the same as the reason why the gas network has also not been extended – financial viability. It is the case however that rural housing can contribute to providing a useful energy demand profile to counterbalance the energy demands of commercial organisations [daytime requirement only] that may have installed CHP or plant large enough to supply DH scheme.
- CHP/DH fired by alternative fuels such as waste or biomass are often located in rural areas or on the urban fringe due to the space requirements necessitated by storage and vehicle access. They also tend to be located on industrial estates which offer opportunities to co-locate complementary businesses.

118. The maps within this Renewable Energy Assessment do not show off gas areas due to lack of access to data. Advice from Wales & West Utilities however indicates that the Cardiff area is well served by the gas network with gas in some of the more rural areas including Pentyrch and Creigiau on the west side. The main areas currently without gas are parts of Wentloog. As more information and data becomes available this element will be updated.

Residential Heat Demand and Density

119. A report for DECC suggests that DHNs are not feasible unless a heat demand is present of at least 3MW/km2 24. ‘Density’ of heat demand refers to kiloWatt hour [kWh] / square kilometre [km2] of heat energy consumed in dwellings.

120. 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.

121. 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 average. Above national average consumption may indicate lack of energy saving education or a higher proportion of poorly insulated buildings, etc.

122. When allocating energy consumptions to buildings utilising Valuation Office Agency (VOA) or Technical Memorandum (TM) 46 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 and add considerable value to functionality due to the age and type of buildings, particularly dwellings, being identified.

123. 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

Areas of High Fuel Poverty

124. Fuel poverty is a key concern of national governments and LAs alike. LAs produce reports relating to the number of people or households regarded as 'fuel poor'. Cardiff has developed an Affordable Warmth Strategy.

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

126. 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 CO2 reductions are proportionately better than when considered against natural gas.

Identifying Existing DH & CHP Schemes and Sources of Waste Heat

127. It is important to establish existing energy infrastructure as it may provide opportunities for expanded connectivity or increased efficiency / viability. Identification of current utilisation of renewable energy resources is covered by this Renewable Energy Assessment, including the current proportion of potential area wide targets being met.

128. The identification of existing CHP has been achieved through analysis of the Ofgem (Renewable Obligation Certificates) register and through discussion with relevant officers (energy & planning). The extensive nature of District Heating schemes, and industries which generate large amounts of waste heat, meant that LPA officers held the details of the installations in the local authority area. These are shown in Table 4.13 below.

129. The utilisation of current sources of waste heat can provide opportunities to improve fuel efficiency and secure CO2 emission reductions. Extending existing infrastructure to additional users can increase the viability of a particular scheme.

Table E3.3: Existing District Heat, CHP or sources of waste heat for Cardiff County Council

Name	LZC Energy Technology	Fuel Source	Capacity (MW)
Trident Park, Rumney, Cardiff	District Heating	EfW	20
Cardiff East Waste Water Treatment Works CHP	CHP		4.04
Steel Works, Seawall Rd	Waste heat?	Unknown	Unknown
Heath Hospital	Waste heat?	Unknown	Unknown

Developing an Energy Opportunities Plan for DHNs

130. The bringing together of the various data layers of heat opportunities described above, together with the location of strategic sites for new development, creates an ‘Energy Opportunities Plan’.

131. A District Heating Network (DHN) is the term given to a system providing multiple individual buildings with heat generated from a single source. The source is generally a building known as an energy centre in which heat can either be generated from traditional fossil fuels (from a boiler) or from a low carbon source such as biomass. The practical realisation is a centrally located energy centre building transmitting heat (as hot water) along buried pipes to a number of buildings in the local area. The pipes are known as heat mains. The scale can be anywhere from a few blocks of flats to a significant proportion of a city. A heat exchanger in each building is controlled and operated in the same way as the gas boiler it replaces, and buildings can retain a conventional distribution system, such as radiators.

132. Heat is sold to consumers in the same way that gas or electricity is sold traditionally, i.e. by metering of end use and regular billing. This is combined with a service charge to cover maintenance of the shared distribution system. Combined heat and power (CHP) is simply where the energy centre produces heat as a by-product of electricity generation. The heat is used to supply the DH network in the conventional way, whilst the electricity is either sold locally or onto the wholesale electricity market. The heat from CHP units can also be used to meet cooling demands via the use of absorption chillers. This can involve either a centralised chiller, distributing “coolth” via a chilled water network, or decentralised absorption chillers in individual buildings. This approach is sometimes referred to as “trigeneration” or CCHP (Combined Cooling Heat and Power).

133. The method used to develop the ‘Energy Opportunities Plan’ is as detailed in Renewable energy: A toolkit for planners’. Heat opportunity plans for each of the strategic sites can be found in the Appendix at the end of this report. These heat maps clearly show the strategic new development sites, and other opportunities, such as potential anchor heat loads, either within or in close proximity to each other.

Section 5: Building Integrated Renewables (BIR) Uptake Assessment

134. This section provides a summary assessment of the potential building integrated renewable (BIR) energy technology uptake in Cardiff by 2020. The assessment is based on the method detailed in 'Renewable energy: A toolkit for planners' and makes estimates by scaling the uptake results for the Pembrokeshire study on a pro-rata basis by varying the comparative level of existing and projected new build development.

135. The following indicates the issues, research and questions associated with this element of the evidence base:

Issues

- What is the role of microgeneration in the energy mix of Wales?
- How is 'microgeneration' defined in this REA?
- What is the difference between 'microgeneration' and 'building integrated renewables'?
- How much energy is generated from BIR currently installed in the local authority area?
- What is the potential energy generated by building integrated renewable energy technologies in the local authority area in 2020?

Introduction to BIR

136. The Welsh Government has set out its renewable energy route map which envisages a significant role for microgeneration in the energy mix of Wales. There is likely to be an increasing emphasis on the uptake of microgeneration technologies. It is considered that microgeneration technologies, for the most part, can be installed on a variety of buildings, but unlike the other renewable energy technology types highlighted in this report it is demand led, rather than supply led. Therefore predictions have been made on the take-up of microgeneration technologies in the Cardiff area.

137. The official definition of microgeneration 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 REA, and the uptake modelling, we are using the broader term Building Integrated Renewables (BIR). BIR can include systems that are larger than microgeneration, such as biomass boilers for schools, which can be up to 500kW of heat output or more. 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 that are covered elsewhere in this REA.

138. The term BIR also excludes those microgeneration 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.

139. BIR are 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

Modelling BIR uptake – Overview

140. Two key sectors have been considered in modelling the uptake of BIR technologies, and each, through necessity has been modelled differently owing to different factors influencing the level of uptake.

141. The first sector is that of future new buildings, both residential and non-residential. For this sector, uptake is likely to be predominantly driven by future Building Regulations and planning policies, requiring new buildings to reduce carbon dioxide emissions. In particular, this will be driven by the UK trajectory towards zero carbon dwellings by 2016 and for zero carbon non-domestic buildings by 2019. 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.

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

Table 5.1: Predicted Level of BIR Electricity Uptake by 2020

Row			Units
1	**Existing dwellings and non-residential buildings**		
2	No. of existing dwellings in Pembrokeshire	55,592	
3	No. of existing dwellings in Cardiff	150,002	
4	EDR	2.7	MWe
5	Predicted RE electricity capacity for Pembrokeshire by 2020	2.2	MWe
6	Predicted RE electricity capacity for Cardiff by 2020	5.94	MWe
7	**Future Dwellings**		
8	No. average net annual completions assumed for Pembrokeshire	585	
9	No. average net annual completions assumed for Cardiff	2,055	
10	NDR	3.51	
11	Predicted RE electricity capacity for Pembrokeshire by 2020	4.3	MWe
12	Predicted RE electricity capacity for Cardiff by 2020	15.11	MWe
13	**Future non-residential buildings**		
14	Future non-residential average annual new floor area assumed for Pembrokeshire by 2020	56,000	m2 GIFA
15	Future non-residential average annual new floor area assumed for Cardiff by 2020	80,574	m2 GIFA
16	FNR	1.44	
17	Predicted RE electricity capacity for Pembrokeshire by 2020	6.32	MWe
18	Predicted RE electricity capacity for Cardiff by 2020	9.09	MWe
	TOTALS		
19	**Total predicted new BIR RE electricity capacity for Cardiff by 2020 (sum of rows 6, 12,18)**	**30.13**	**MWe**
20	Existing BIR RE electricity capacity in Cardiff County Council area	4.7	MWe
21	**Total predicted new and existing BIR RE electricity capacity for Cardiff County Council area by 2020**	**34.82**	**MWe**

Table 5.2: Predicted Level of BIR Heat Uptake by 2020

Row			Units
1	**Existing dwellings and non-residential buildings**		
2	No. of existing dwellings in Pembrokeshire	55,592	
3	No. of existing dwellings in Cardiff	150,002	
4	EDR	2.7	MWt
5	Predicted RE heat capacity for Pembrokeshire by 2020	3.7	MWt
6	Predicted RE heat capacity for Cardiff by 2020	9.98	MWt
7	**Future Dwellings**		
8	No. average net annual completions assumed for Pembrokeshire	585	
9	No. average net annual completions assumed for Cardiff	2,055	
10	NDR	3.51	
11	Predicted RE heat capacity for Pembrokeshire by 2020	4.3	MWt
12	Predicted RE heat capacity for Cardiff by 2020	15.11	MWt
13	**Future non-residential buildings**		
14	Future non-residential average annual new floor area assumed for Pembrokeshire by 2020	56,000	m2 GIFA
15	Future non-residential average annual new floor area assumed for Cardiff by 2020	80,574	m2 GIFA
16	FNR	1.44	
17	Predicted RE heat capacity for Pembrokeshire by 2020	6.32	MWt
18	Predicted RE heat capacity for Cardiff by 2020	9.09	MWt
	TOTALS		
19	**Total predicted new BIR RE electricity capacity for Cardiff by 2020 (sum of rows 6, 12,18)**	**34.18**	**MWt**
20	Existing BIR RE electricity capacity in Cardiff County Council area	0.6	MWt
21	**Total predicted new and existing BIR RE heat capacity for Cardiff County Council area by 2020**	**34.75**	**MWt**

Section 6: Assessment Summary

143. In this section, two summary tables showing the potential renewable resource available by 2020 have been produced, one for renewable electricity and the other for renewable heat. For each technology, the extent to which the maximum accessible resource can be delivered is likely to be determined by a combination of the following:

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

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

145. With this in mind, each summary table sets out the maximum accessible resource, along with two lower scenarios, based on harnessing 75% and 50% of the accessible renewable energy resource

Table 6.1: Resource Summary for Renewable Electricity, Cardiff County Council Area

Energy Technology	Capacity Factor	Potential Accessible Resource		Current Installed Capacity		Target Scenarios for 2020					
						Maximum (100%)		High (75%)		Low (50%)	
		MWe	GWh/yr	MWe	GWh/yr	MWe	GWh/yr	MWe	GWh/yr	MWe	GWh/yr
Onshore Wind	0.27	0.00	0.00	2.30	5.44	2.30	5.44	1.73	4.08	1.15	2.72
Biomass (energy crops)	0.90	0.49	3.88	2.50	19.71	2.99	23.59	2.61	20.60	1.50	11.79
Energy from Waste	0.90	33.53	264.33	0.00	0.00	33.53	264.33	25.15	198.25	16.76	132.17
Landfill Gas	0.60	5.97	31.38	5.97	31.38	5.97	31.38	4.48	23.53	2.99	15.69
Anaerobic Digestion (animal and food)	0.90	2.67	21.07	0.00	0.00	2.67	21.07	2.00	15.81	1.34	10.54
Sewage	0.42	4.87	17.93	4.04	14.86	4.87	17.93	3.66	13.45	2.44	8.97
Hydropower	0.37	6.97	22.59	0.00	0.00	6.97	22.59	5.23	16.94	3.49	11.30
Building Integrated Renewables (BIR)	0.10	34.82	30.51	4.69	4.11	34.82	30.51	26.12	22.88	17.41	15.25
TOTAL		**89.3**	**391.7**	**19.5**	**75.5**	**94.1**	**416.8**	**71.0**	**315.5**	**47.1**	**208.4**
Local Authority projected electricity demand in 2020							1,717		1,717		1,717
Percentage electricity demand in 2020 potential met by renewable energy resources							**24.3%**		**18.4%**		**12.1%**

Clarifying notes

- Onshore wind figure above, excludes the potential area of wind recourse found in the assessment since proposals in the LDP may effectively constrain the resource which was identified.
- Energy from Waste figure includes the maximum capacity (30MW) of the treatment facility located at Trident Park plus Cardiff's predicted Commercial and Industrial Waste arisings.
- The accessible resource figures for landfill gas, sewage gas, hydropower and BIR should and do include the currently installed capacity.

Table 6.2: Resource Summary for Renewable Heat, Cardiff County Council Area

Energy Technology	Capacity Factor	Potential Accessible Resource		Current Installed Capacity		Target Scenarios for 2020					
						Maximum (100%)		High (75%)		Low (50%)	
		MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr	MWt	GWh/yr
Biomass CHP or Large scale heat only (energy crops/AD)	0.5	4.99	21.9	0.6	2.5	5.0	21.87	3.7	16.4	2.5	10.9
Heat from Energy from Waste (CHP or Heat Only)	0.5	27.06	118.5	0.0	0.0	27.1	118.50	20.3	88.9	13.5	59.3
Building Integrated (solar water heating, biomass, boilers, heat pumps)	0.2	34.75	60.9	0.6	1.0	34.8	60.89	26.1	45.7	17.4	30.4
TOTAL		**66.8**	**201.3**	**1.1**	**3.5**	**66.8**	**201.3**	**50.1**	**150.9**	**33.4**	**100.6**
Local Authority projected electricity demand in 2020							3,213		3,213		3,213
Percentage heat demand in 2020 potential met by renewable energy resources							**6.3%**		**4.7%**		**3.1%**

Clarifying Notes

- The heat from CHP will be informed by how much installed electricity capacity there is for each of the technologies given in the first table. Realistically, not all of this heat output could be used all of the time, and therefore a load factor of 0.5 (or 50%) has been assumed.
- Energy from Waste figure includes 20MW associated with the facility located at Trident Park, plus Cardiff's Commercial and Industrial Waste arisings.

- No heat generation has been assumed for the landfill gas recovery engine.
- No heat generation has been assumed for sewage as the resource is employed by the sewage plant and is therefore not a usable resource.
- The accessible resource for BIR should and does include the currently installed capacity.

146. A comparison between the energy generation potential identified in tables 6.1 and 6.2 above, against the figures set out in the lead scenario of the UK Renewable Energy Strategy which are suggested to meet the EU Renewable Energy Directive is contained below:

Table 6.3: Cardiff Renewable Energy Potential and UK Preferred Scenario

	Percentage energy demand in 2020 potential met by renewable energy resources	
	Cardiff	**UK Lead Scenario (RES)**
Electricity	24.27%	>30%
Heat	6.26%	12%

147. Cardiff's percentage of energy demand for both electricity and heat met by renewables falls short of the figures suggested in the UK RES lead scenario. Electricity demand potentially met by renewables is roughly 19% below the UK RES target. This gap may be partly attributed to Cardiff's relatively constrained strategic-scale onshore wind capacity. It should be noted however, that Cardiff has potentially large additional tidal power electricity generating resources opportunities such as the Cardiff Bay Barrage and the Severn Estuary, which were outside the scope of this study. More notably, Cardiff's future heat demand potentially met by renewables is substantially below the UK RES target of 12%.

148. Given the above findings, LDP policies could be formulated to encourage investigation and implementation of renewable and low carbon energy generation by prospective developers on future development sites. This will need to be balanced against the cost of implementing such schemes and the impact on development viability.

Appendix: Heat Opportunity Maps

Central Enterprise Zone

1000 metres

500 metres

Legend

Strategic Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

1000 metres

500 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

Gas Works, Ferry Road (77)

Land to the West of Cardiff (82)

1000 metres

500 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

Land to the North of Junction 33, M4 (46)

500 metres

1000 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

Land South of Creigiau (102)

1000 metres

500 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

North East Cardiff (112)

1000 metres

500 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

Church Road/Bridge Road, St. Mellons (72)

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

500 metres

1000 metres

Cardiff Parkway, East of Cypress Drive, St. Mellons (106)

500 metres

1000 metres

Legend

Candidate Site Area

Potential Anchor Heat Load (classified by BLPU class)

- Fire, Police and Ambulance stations
- Law courts
- Colleges
- Primary, Junior, Infants or Middle School
- Secondary School
- Libraries
- Museums
- Sporting activities
- Theatres/arenas/stadium
- Hospitals
- Offices and work studios
- Power stations/energy production
- Water/sewage treatment works
- Care homes

Council House

Additional Low and Zero Carbon point

Strategic Planning
City Development
Cardiff Council
County Hall
Atlantic Wharf
Cardiff
CF10 4UW

CARDIFF
CAERDYDD