Development of a Renewable Energy Assessment and Target Information for the Pembrokeshire Coast National Park: Draft Final Report

For Pembrokeshire Coast National Park Authority

Prepared by
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1. STUDY BACKGROUND AND BRIEF

AIMS AND OBJECTIVES OF THE STUDY

1.1. The Pembrokeshire Coast National Park Authority with partners wants to take a more pro-active role in identifying potential opportunities for renewable energy developments within the National Park, recognising their vital contribution to sustainability and in addressing the causes of climate change.

1.2. Specifically, the **aim** of this study has been to obtain a clear overview and information resource on the contribution that the National Park area can make to potential renewable energy provision to help meet the Welsh Assembly Government's targets, without compromising national park purposes, namely:

- to conserve and enhance the natural beauty, wildlife and cultural heritage [of the National Park]
- to promote opportunities for the understanding and enjoyment of the special qualities [of the National Park] by the public

While also potentially contributing to the National Park Authority's statutory duty:

- to seek to foster the economic and social well-being of local communities within the National Park by working closely with the agencies and Pembrokeshire County Council responsible for these matters.

1.3. The **objective** of this study has been to provide information on possible targets for renewable energy generation developments for the Local Development Plan (end date 2021). The study is also required to provide advice on energy conservation targets for commercial property (covered in **Appendix 1**).[1]

1.4. Overall, the study has:

- Mapped, using GIS, any available and potential renewable resources broken down by category e.g. solar, wind (land), hydro (available in a separate published map)
- Identified economic potential / feasibility of the potential resources
- Identified any potential for the renewable resources to be a community based scheme
- Identified the opportunities and limitations imposed by the capacity of the electricity distribution network to accommodate embedded or distributed renewable generation
- Identified how the potential renewable resources can be achieved without detriment to the National Park landscape.

BACKGROUND

1.5. The need for this study in part reflects the Ministerial Interim Planning Policy Statement 01/2005. *Planning for Renewable Energy* para. 12.9 refers to the need for local planning authorities to undertake an assessment of the potential of all renewable energy resources; renewable energy technologies; energy efficiency and

[1] Parallel to this study the Eco Centre is providing information on possible targets for the reduction in carbon emissions in individual domestic properties through energy conservation measures.

conservation measures and include appropriate policies in local development plans. In undertaking such assessments local planning authorities should:

- Take into account the contribution that can be made by their area towards carbon emission reductions and renewable energy targets; and

- Recognise that different approaches will be appropriate for the deployment of the different renewable technologies and energy efficiency and energy conservation measures.

1.6. The statement recognises that outside the Strategic Search Areas (for wind energy) identified by TAN 8 there can be limitations on the scale of onshore wind energy development up to 25MW on urban / industrial brownfield sites and less than 5MW elsewhere.

SCOPE OF THE STUDY

1.7. This study is therefore concerned with assessing the potential for:

- Low carbon and renewable land based technologies

- Energy saving within commercial properties

1.8. This study has specifically not been concerned with renewable energy development at sea, as this lies outside the planning controls of the National Park Authority. It has however, considered the implications of where energy generated at sea comes ashore.

1.9. Renewable energy is that generated from renewable resources such as wind, water, solar, ground heat, and biomass.

1.10. Some of these technologies produce no carbon in the generation of energy as in wind, hydro and solar. Others produce carbon but in significantly reduced amounts compared to conventional sources of power. These include the burning of biomass, anaerobic digestion and the use of small amounts of conventional energy to power the necessary circulation and heat exchange in technologies such as ground and air source heat pumps. These are described as low carbon technologies.

1.11. The full range of technologies considered through this study covers:

- Biomass
- Anaerobic digestion (generating methane or hydrogen)
- Waste to energy
- Micro hydro
- Stand alone wind energy including micro building mounted wind (typically no more than 3 kW per turbine, both horizontal and vertical axis)
- Photovoltaics (usually building integrated – roof mounted, including solar slates and tiles)
- Solar hot water
- Solar space heating
- Ground source heat pumps (via boreholes, trenches, aquifers and surface water)
- Air source heat pumps
- Micro district heating (e.g. involving ground source heat pumps or biomass boilers or CHP)
- Fuel cells for the storage of renewable energy.

APPROACH

1.12. The study has involved six main activities:

- Collection of national, regional and local datasets that identify both the renewable resources available (e.g. wind) and the constraints to energy generation such as nature conservation designations and protection of water resources, as well as grid connection issues.

- Review of relevant international, national and local policies and wider literature review on appropriate technologies.
- Discussions with key organisations and individuals on renewables potential including officers of the National Park Authority (NPA); Pembrokeshire County Council; PLANED[2]; the West Wales Eco Centre; Forestry Commission; Countryside Council for Wales; Coed Cymru; Pembrokeshire Bioenergy; Welsh Water; and Western Power Distribution.
- A landscape sensitivity study covering those aspects of renewable energy generation that are likely to have a landscape-wide effect, namely the planting of biomass crops and wind turbine developments.
- Identification of relevant funding sources.
- A workshop held in September 2008 to debate emerging findings from the study, as well as a series of Steering Group Meetings and presentation to the members of the National Park Authority.

The landscape sensitivity study

1.13. This has been a major piece of work within the overall study. It has used the Landscape Character Assessment of the National Park (2007) as its basis, as well as the relevant Aspect layers of LANDMAP, informed by subsequent site visits. It has looked in turn at the landscape impacts of large, medium and small-scale wind turbines and of biomass crops – both Short Rotation Coppice (SRC) and Miscanthus (Elephant Grass) that have the potential to have landscape-wide effects. In judging landscape effects, the sensitivity study has considered the effects of the individual technologies / plantings on:

- the attributes / characteristic of the landscape that are particularly sensitive to the renewables under consideration
- the special qualities of the landscape that underpin designation as a National Park, as described in the National Park Management Plan (draft) 2008.

1.14. Through the study the sensitivity of each of the 28 Landscape Character Areas to the different renewable technologies and plantings has been assessed and a 'score' allocated to each Landscape Character reflecting its sensitivity to each technology / type of planting. Because the National Park is recognised as a nationally important landscape, in reality none of the sensitivity assessment scores fall below 'moderate', with the majority of LCAs being judged as either 'moderate-high' or 'high' sensitivity to wind turbine developments and bioenergy crop planting. The assessment therefore recognises the national importance of this landscape and places it within the UK context – i.e. it uses a sensitivity score applicable to the whole of the UK, with national parks at the top end of this scale.

1.15. This methodology is described in full in the separate landscape sensitivity study report.

1.16. The specific outputs from this landscape sensitivity study have been:

- Maps that identify the landscape sensitivity of each of the 28 Landscape Character Areas to the individual technologies / plantings.

[2] Pembrokeshire Local Action Network for Enterprise and Development

- Landscape guidance for each Landscape Character Area setting out the specific circumstances that should guide the siting of individual technologies / plantings. This guidance is particularly important in that it gives precision to the more general sensitivity score, highlighting where renewables developments would and would not be appropriate.

- Generic landscape guidance for those technologies which are unlikely to have a landscape-scale effect but which may require the development of specific plant (as in anaerobic digestion, biomass plants and small hydro schemes).

1.17. The separate landscape sensitivity report contains a description of the methodology followed; sensitivity assessment and guidance for wind turbine developments and biomass crops for each Landscape Character Area; and generic landscape guidance for other renewable technologies that require built development.

The Stakeholder Workshop

1.18. The Stakeholder Workshop held in September 2008 was well attended and stimulated lively debate. It included members of the community with an interest in renewables and renewables suppliers and growers, as well as representatives of individual organisations:

- Campaign for the Protection of Rural Wales
- Countryside Council for Wales
- Eco Centre
- Environmental Network for Pembrokeshire
- Forestry Commission
- Friends of the National Park
- National Farmers' Union of Wales
- Pembroke 21st Century
- Pembrokeshire Organic Group
- PLANED
- Sustainable Development Commission

1.19. Discussions at the Workshop centred around the opportunities and constraints associated with individual renewable technologies; the general contribution that renewables could make to the National Park; and the potential policies that the NPA should develop in support of appropriate renewable technologies and carbon reduction strategies. As appropriate, views from the Workshop are provided through this report.

OUTPUTS

1.20. In summary, the main outputs from this study are:

- This main report which summarises the evidence and key findings

- A published ArcReader Map of the GIS layers developed in support of this study

- The separate Landscape Sensitivity Assessment for Renewables in the Pembrokeshire Coast National Park

STRUCTURE OF THIS REPORT

1.21. Having set out the policy context and potential policy emphasis (Chapter 2), the body of this report focuses on the main renewable / low carbon technologies considered through this study namely:

- Chapter 3: Biomass
- Chapter 4: Anaerobic Digestion (biogas and hydrogen)
- Chapter 5: Small / micro hydro
- Chapter 6: Ground / air source heat pumps
- Chapter 7: Solar

- Chapter 8: Wind
- Chapter 9: District heating and linked developments
- Chapter 10: Potential contribution of renewables to current energy use within the National Park
- Chapter 11: Funding Opportunities

Appendix 1: Energy saving within commercial properties

RENEWABLES AND THE NATIONAL PARK

1.22. Recognising the national park status of this area, this study has sought to identify the extent to which renewable and low carbon technologies can positively assist in supporting the environment and local economy whilst also maximising energy outputs. At a generic level renewable technologies can potentially be divided into the following three categories:

- Those technologies that operate in symbiosis with the landscape and help support the existing rural economy, as in anaerobic digestion and aspects of biomass linked to the management of existing woodland and the extension of semi-natural woodland within the National Park and the use of existing mills sites to generate hydro power.

- Those technologies that have no or limited impact on the environment and have the potential to make significant renewable energy contributions such as ground and air source heat pumps; solar technologies associated with individual premises; and micro-hydro.

- Those technologies that will have an impact on the environment but nonetheless can make a significant contribution to local energy generation – meeting local demand with local energy provision, as in larger scale biomass plantings and in the capture of wind energy.

1.23. In addition, in this coastal area in the future, off shore marine generation (tidal and wave) has the potential to make a very significant contribution to renewable energy generation. Much of this could potentially be achieved with minimal environmental impact. In the future therefore this area may be able to make a very much greater contribution to renewable energy generation than that suggested through this current study which focuses solely on onshore technologies.

1.24. Aside from environmental implications, all local renewable energy sources meeting local energy needs will help support the local economy in terms of broader skills, new jobs and services. In addition, revenue from energy production will be recycled locally rather than exported out of the area by national and multi-national energy companies. This is an important benefit to the local economy during the current economic climate.

The communities of the National Park

1.25. Potentially the greatest asset of Pembrokeshire Coast National Park in pursuing a low carbon economy, is the Park communities. Within the National Park there is a very high level of commitment to energy saving and the development of renewable energy resources, as indicated by the work of PLANED and the West Wales Eco Centre, as well as many local groups and individuals, that are very well informed on the renewable opportunities available.

2. POLICY CONTEXT

2.1. This chapter provides an overview of the Pembrokeshire Coast National Park; its demographic character and the main development areas where potential change is likely to occur over the next 10 years; existing sustainable energy approaches; and the policy context for sustainable energy – highlighting why energy issues need to be addressed.

OVERVIEW OF THE NATIONAL PARK

2.2. The Pembrokeshire Coast National Park was designated in 1952 and is one of three National Parks in Wales. It is Britain's only true coastal National Park, forming a discontinuous ribbon of land following the south west coast of Wales from east of Tenby in the south to Cardigan in the north, in total a length of some 416 km and covering 620 sq km. It offers a spectacular landscape of rugged cliffs, uninhabited offshore islands – a haven for sea birds and other marine life – immense sandy beaches, wooded estuaries, including Milford Haven, and the wild inland hilly landscapes of the Preseli Mountains. It contains many environmental designations **(Figure 2.2**)

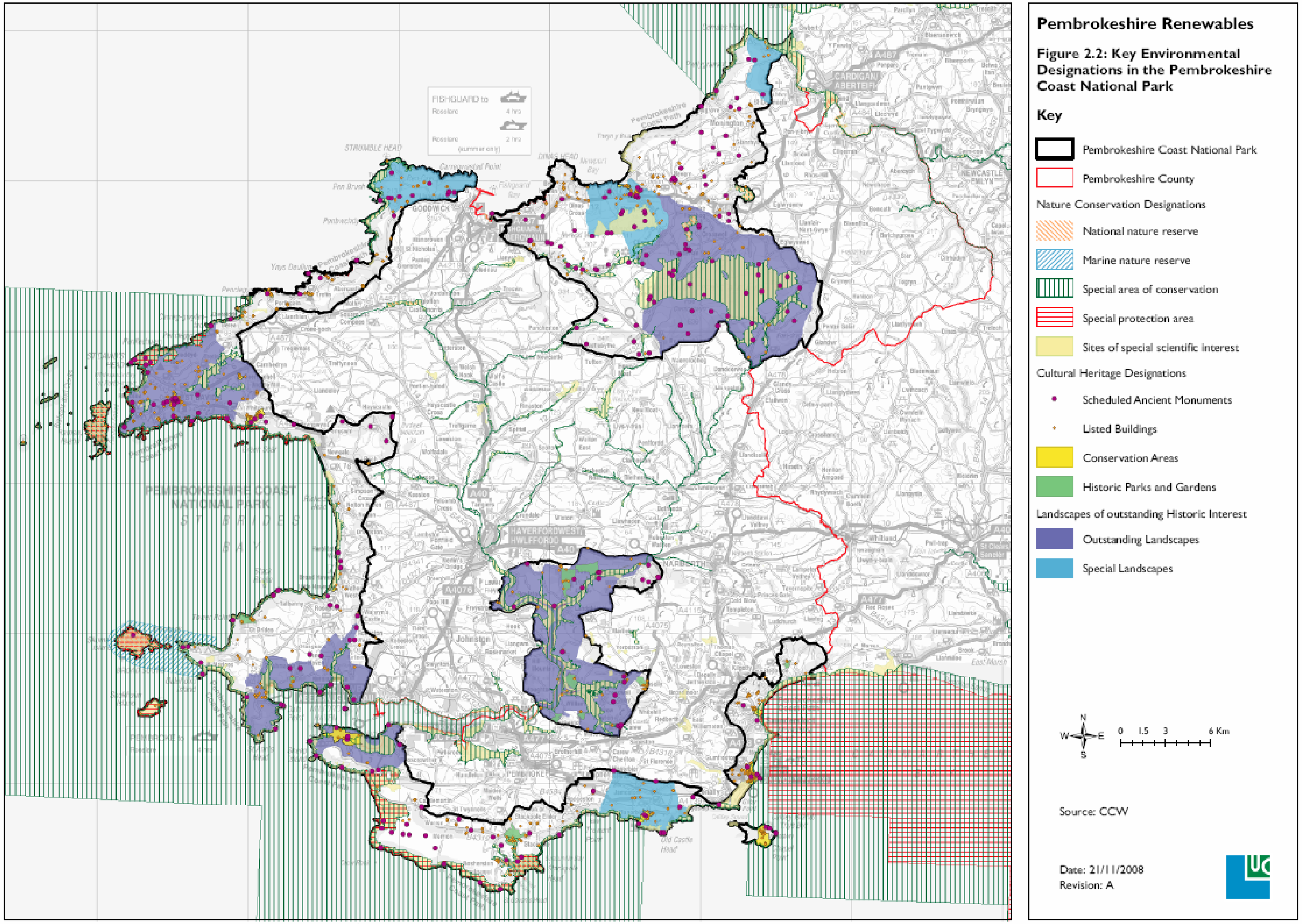
2.3. The Park has a resident population of 22,542 (2001 Census), with 9,862 households of which 70.6% are owner occupied. The economically active population is 8,817.

2.4. **Settlements:** The largest settlement within the Park is **Tenby**, a local service and tourism centre with a resident population of 4,850. It is also an attractive historic town designated as a Conservation Area.

2.5. The second largest centre is **Saundersfoot** with a population of 2,670. Tourism is the principal industry with a commercial area focused around the attractive harbour.

Figure 2.1: Pembrokeshire Coast National Park

Figure 2.2: Key Environmental Designations in the Pembrokeshire Coast National Park



File: S:\4300\4371 Pembrokeshire Renewables\GIS\Themes\ArcGIS9\4371-01_042_Env_Designations.mxd

2.6. **St David's** with a population of 1,309 is an historic settlement in an outstanding setting on the windswept coastal platform which forms St David's peninsula. The cathedral dates from the 12th – 16th centuries.

2.7. **Newport** is the forth largest settlement within the Park with an estimated population of 864 residents. It has a strong sense of community and a distinctive culture with two designated Conservation Areas.

2.8. The National Park also has a large number of smaller rural settlements many of which are important for tourism and have a strong sense of community. Nevertheless a third of all households are scattered within hamlets and as isolated dwellings and farms. The countryside of the National Park is dominated by pastoral faming (approximately 120 farms) and contributes greatly to the biodiversity and tourism value of the National Park.

Potential for change

2.9. The Wales Spatial Plan Pembrokeshire Haven Settlement Framework sets out the strategy for accommodating growth in the National Park. It identifies three strategic hubs, The Haven (Haverfordwest, Milford Haven/Neyland and Pembroke/Pembroke Dock); Carmarthen Town and Fishguard/Goodwick. These hubs will provide a regional role and will be a major focus for future investment. They are known as **Tier 1** Settlements (apart from Fishguard/Goodwick). These hubs lie outside the National Park.

2.10. Towns and villages in the National Park have lower order roles and are included as either Tier 2 or Tier 3 Centres:

- **Tier 2 Centres** i.e. Tenby have a service centre, employment and tourism function
- **Tier 3 Centres** i.e. Newport, Saundersfoot, St David's and Crymych are local centres with some also being significant tourism centres

2.11. To complement the Spatial Plan framework, which deals with the more strategic levels of the settlement hierarchy, two additional tiers are proposed by the National Park Authority within the Park:

- **Tier 4 'Rural Centres'** are identified for limited growth to help sustain rural communities and reduce the need to travel. These centres have a limited range of facilities largely meeting the day to day needs of residents
- **Tier 5 'Countryside'** where in accordance with national planning policy development is strictly controlled except for certain forms of development that would normally be found in a countryside location

2.12. Housing provision in the National Park to cater for locally generated needs and inward migration over the Plan period[3] (2008 – 2020) is as follows:

Tenby – 514
Newport – 55
Saundersfoot – 115
St David's – 134
Crymych – 15
Rural centres and countryside - 533

This totals some 31.80 hectares of new development. This is to cater for locally generated needs and inward migration.

[3] Pembrokeshire Coast National Park Local Development Plan Deposit (Working Draft) August 2008

2.13. Potential sites for employment and mixed use during the Plan period total some 4.09 hectares, a significantly smaller element of growth compared to housing.

EXISTING CONTEXT FOR SUSTAINABLE ENERGY WITHIN THE NATIONAL PARK

2.14. Support for renewable energy has been embedded in the vision for the National Park since 2003, with part of the 2050 vision for the National Park set out in its 2003 –2007 Management Plan being:

"2050…our skilled workforce continues to harness the area's huge potential for appropriate generation of renewable energy – a particular success story. Out migration of Pembrokeshire's young has been halted…… Pembrokeshire is a recognised specialist in renewables technologies on the world stage. By also increasing efficiency and conservation, we fast migrated to an economy of low net carbon emissions."

2.15. This sets an ambitious vision for this study, one that needs to be achieved within the context of the national park purposes, with the first purpose being to conserve and enhance the natural beauty, wildlife and cultural heritage [of the National Park].

Existing sustainable energy projects/initiatives within the National Park

2.16. Much is already being done to promote renewable energy and a low carbon economy in the National Park. The National Park Authority's (NPA) head office, several schools and leisure facilities use biomass fuels for space and water heating. There are a number of exemplar projects (such as Whitesands Bay café and shop) using PV, solar thermal and wind, and the use of PV panels for public toilets. Under the Sustainable Development Fund (SDF) the NPA has supported many initiatives and projects linked to energy awareness, energy efficiency and renewable energy. Equally there are many residents and businesses within the Park who have an interest in renewable energy, energy efficiency and climate change including established self-sufficiency experts.

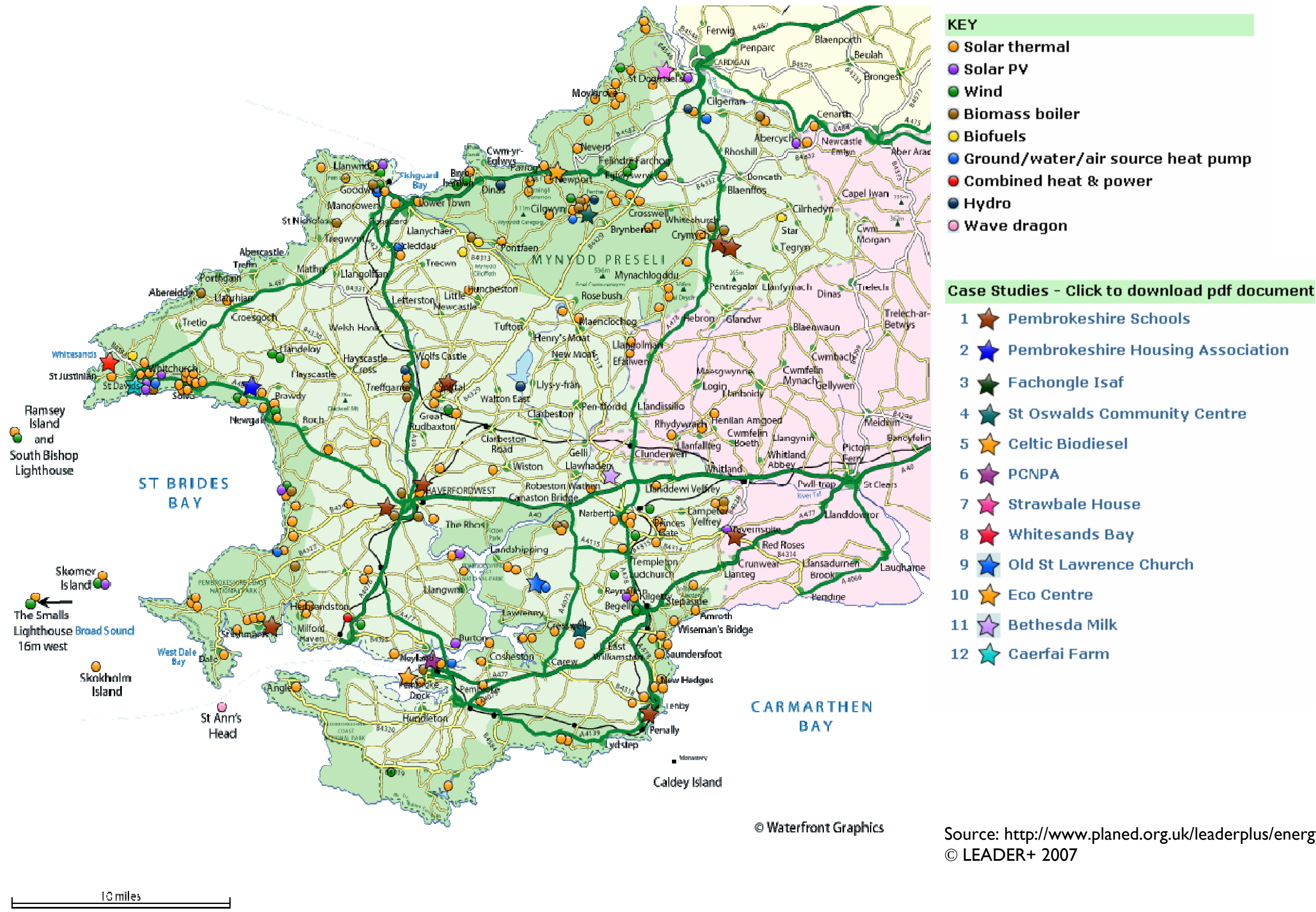
2.17. PLANED[4] and the West Wales ECO Centre have worked hard with local communities, individuals and businesses within the Park, encouraging a wide range of local initiatives such as Area Energy Groups, renewable energy trips / workshops, reports and studies aimed at carbon emissions reduction. The ECO Centre also provides energy efficiency and renewable energy advice services to householders and community groups within the Park.

2.18. Most recently, PLANED in conjunction with the Community Energy Network of Pembrokeshire, has compiled a Renewables Installation Map of the County (**Figure 2.3**). It highlights a large number of renewable / low carbon technologies installed within Pembrokeshire County and the National Park and highlights certain significant installation projects. The map can be viewed on the PLANED website www.planed.org.uk

2.19. As part of this study, the National Park Authority has provided information on the numbers and types of renewable technologies granted planning permission to date within the Park. This provides a baseline for monitoring future year on year progress in the growth in renewable technologies installed within the Park. Unfortunately there are gaps in data regarding size and output for some of the permitted installations. In this instance a proxy figure has been used to estimate likely out put. Analysis of the data shows that as of September 2008 existing permitted installations within the Park contribute 1.5GWh per annum of renewable electricity and 0.2GWh renewable heat energy.

[4] Pembrokeshire Local Action Network for Enterprise and Development

Figure 2.3: Existing renewables installations in Pembrokeshire National Park and Pembrokeshire County



Source: http://www.planed.org.uk/leaderplus/energy_map.htm
© LEADER+ 2007

Existing policy context

2.20. Climate change is arguably the greatest long-term challenge facing the world today. Addressing it is a key governmental concern. Sustainable energy provides a primary means of reducing the output of greenhouse gases.

International action

2.21. **EU Greenhouse gas reduction targets***:* The EU Climate and Energy package, published in January 2008, sets out proposals to achieve a reduction in EU greenhouse gas emissions of 20% by 2020, increasing to 30% in the event of an international agreement on climate change, compared to 1990 levels. In the longer term EU energy policy is for a reduction in greenhouse gas emissions of 80% by 2050, compared to 1990 levels.

2.22. **EU Renewable energy target:** The EU Renewable Energy target is to source 20% of the EU's total energy use – a combination of electricity, heat and transport – from renewable sources by 2020. Member State contributions to this target have yet to be determined, but the European Commission has proposed that in the UK 15% of total energy use should come from renewable sources by 2020.

2.23. **EU Energy Efficiency target:** The EU's Energy End-Use Efficiency and Energy Services Directive requires Member States to achieve a 9% energy saving target by 2016. In line with this, each national government have to produce energy efficiency action plans (EEAPs) in 2007, 2011 and 2014.

Climate Change in the UK and the role of renewable and low carbon energy technologies

2.24. **UK Greenhouse gas reduction targets:** The *Energy White Paper: Meeting the Energy Challenge* (2007) provides national standards and targets which set out that the UK's greenhouse gases must be cut by 60% by 2050 and that the uptake of renewables must be increased by 10% by 2010, rising to 20% by 2020. The Government has also introduced national targets to achieve at least 10,000MWe of installed CHP by 2010 and to save some 12 million tonnes of carbon through energy efficiency measures.

2.25. The **Climate Change Bill**, which is currently passing through Parliament, creates a new legal framework for the UK to reduce, through domestic and international action, its carbon dioxide emissions to at least **80% below** 1990 levels by 2050. The Government will be required to set five-year carbon budgets, which place binding limits on carbon dioxide emissions and set out the trajectory towards this target. Decisions on the carbon budgets for the first three five-year periods (2008-2012, 2013-2017, 2018-2022) will be informed by advice from the independent Committee on Climate Change (CCC) in December 2008.

2.26. Current UK performance shows that UK emissions of the basket of six greenhouse gases covered by the Kyoto Protocol were 20.7% lower in 2006 than in the base year 1990. UK net emissions of carbon dioxide were 12.1% lower in 2006 than in 1990.[5]

2.27. **UK Renewable energy targets:** In 2000 the UK set a target for 10% of electricity to come from renewable sources by 2010, with an announcement in 2006 to double that level by 2020. The key mechanism for delivering this growth has been the Renewables Obligation (RO), which requires electricity suppliers to source a prescribed and increasing proportion of their electricity from renewable sources.

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[5] 2006 UK Greenhouse Gas emissions, final figures, 31st January 2008 - Statistical Release

2.28. In March 2007 EU leaders, including the UK Government, agreed to adopt a binding target of sourcing 20% of the EU's energy from renewable sources by 2020. The UK's agreed contribution to the EU target is to increase the share of renewables in the UK energy mix from around 1.5% in 2006 to 15% by 2020. In June 2008 the Government launched its consultation draft UK Renewables Strategy, consulting on a range of possible measures to deliver the UK's share of the EU target.

2.29. The draft strategy puts forward a range of possible measures to deliver what is viewed as a very ambitious target for the UK. In 2006 only around 1.5% of the UK's final energy consumption came from renewable sources. To achieve the target of 15% will require a step change in a very short time frame to 2020. It has been estimated that it could require investment of at least £100 billion over the next decade.

2.30. Government funded analysis of the potential for renewable deployment in the UK, and results of independent studies of how much of this can be realised by 2020, suggests that reaching this level is achievable, although extremely challenging.

2.31. **UK Energy Efficiency targets:** Government produced the UK's *Energy Efficiency Action Plan* in 2007. This sets out a package of policies and measures to deliver improvements in energy efficiency in the UK in order to contribute to the achievement of the UK's climate and energy policy objectives and to meet the 9% energy saving target by 2016 under the European Union's Energy End-Use Efficiency and Energy Services Directive. It is expected that the measures will result in the target of 9% being exceeded, delivering 272.7 TWh in savings by the end of 2016, and equivalent to a saving of 18% over the target period.

Climate Change and the role of renewable and low carbon energy technology in Wales

2.32. **Wales's greenhouse gas reduction targets**: The Welsh Assembly Government (WAG) strongly believes that Wales should be at the global forefront of the transition to minimising carbon emissions and maximising low-carbon energy production. It is therefore committed to contributing to the UK's greenhouse gas reduction targets (One Wales[6]) and supports the UK Government's recent target to cut 80% of UK greenhouse gas emissions by 2050. In this document, WAG has outlined its plans to establish a Climate Change Commission for Wales, and its aim to achieve annual carbon reduction-equivalent emission reductions in Wales of 3% by 2011. Sustained reductions of 3% each year would enable Wales to achieve 80% reduction before 2050.

2.33. The Climate Change Commission is to develop the Wales Climate Change Strategy for consultation in 2009. It will set out how WAG will deliver the One Wales commitments; the targets for reduction in emissions; and will outline action needed to adapt to the impacts of climate change.

2.34. **Wales's renewable energy targets**: WAG is also committed to Wales exploiting its considerable renewable energy resources to the full. It has signed up to the 2020 EU target of 20% of energy requirements coming from renewable sources.

2.35. The current renewable electricity targets for Wales as set out in TAN 8[7] are:

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[6] One Wales – A progressive agenda for the government of Wales – June 2007
[7] Planning Policy Wales - Technical Advice Note 8: Planning for Renewable Energy July 2005 - WAG

- 4TWh by 2010
- 7TWh by 2020

2.36. These targets will be revised upwards following publication of the WAG Energy Strategy (para 2.43). Against the background of Wales's current annual electrical consumption of around 24TWh[8], in percentage terms these targets represent:

- 16.6% of electricity from renewable sources by 2010
- 29% by 2020

2.37. Renewable energy currently accounts for some 3% of Wales's electricity generation[9].

2.38. WAG published the *Renewable Energy Route Map for Wales* in February 2008, a consultation document setting out draft policies to guide Wales towards self-sufficiency in renewable energy generation. As part of the consultation WAG outlines its analysis[10] of possible electrical and heat generation from renewable energy in Wales, concluding that by 2025 Wales could be producing some:

- 33TWh per year of renewable electricity; and
- 3TWh of renewable heat.

2.39. With electricity, it is estimated that around half of this might come from marine sources, utilising waves and tides, a third from wind and the rest mainly from biomass resources, including waste, with smaller contributions from hydropower and micro-generation. Currently, Wales's annual electricity supply is 31.5TWh generated from gas, coal and nuclear power stations, with 1.5TWh generated from renewables. To achieve an increase in renewable electricity generation from 1.5TWh in 2007 to 33TWh in 2025 is a very ambitious and challenging target, particularly as this is more than the current annual electricity generation in Wales from fossil fuels and nuclear power. (Data source: Renewable Energy Route Map)

2.40. The Route Map also explains how Wales could maximise the use of its natural resources to generate renewable energy and explores the associated potential environmental, planning, and grid issues and community benefits. It considers how best to overcome barriers to each type of renewables development. It will be followed by more detailed action plans covering potential marine and biomass developments in Wales.

2.41. Prior to this in 2007, in its *Micro-generation Action Plan for Wales* (2007) WAG produced targets for micro-generation in Wales up to 2020. The action plan targets are:

- 20,000 micro heating systems installed by 2012, rising to 100,000 by 2020
- 10,000 micro-electricity systems installed by 2012 rising to 200,000 by 2020
- 50 combined heat and power (CHP) and/or district heating systems in place by 2020.

2.42. Through the Renewable Energy Route Map WAG proposes to issue planning guidance to make micro-generation easier to install.

2.43. **Wales's energy efficiency targets:** WAG's Renewable Energy Route Map also summarises its challenging ambitions for building energy efficiency and small-scale generation. This includes the aspiration that all new buildings in Wales should be constructed to zero carbon standards from 2011 onwards. These will be

[8] WAG – Renewable Energy Route Map for Wales – Feb 2008
[9] Planning Policy Wales
[10] WAG – Renewable Energy Route Map for Wales – Feb 2008

expanded further in a Wales National Energy Efficiency and Savings Plan, to be published for consultation later this year (2008), prior to the planned publication of an overarching Wales Energy Strategy in 2009.

NATIONAL PLANNING POLICY

Planning Policy Wales 2002 (Current guidance)

2.44. Planning policy guidance for local government in Wales is set out in Planning Policy Wales (PPW).[11] This includes promoting the generation and use of energy from renewable sources and energy efficiency, especially as a means of reducing the effects of climate change. Paragraph 12.8.6 states: "*The Assembly Government wishes to see the planning system play its part in contributing to the UK Climate Change Programme …….enabling Wales to work towards an agreed target of its electricity and heat requirements from renewable sources by 2010.*"

2.45. Relevant PPW guidance for sustainable energy is outlined as follows:

> Local Planning Authorities should make positive provision for sustainable energy by :
>
> - considering the contribution that their authority area can make towards developing and facilitating renewable energy and energy efficiency and conservation through their UDPs;
> - ensuring that development control decisions are consistent with national and international climate change obligations, including a contribution to renewable energy targets, having regard to emerging national and international policy on the levels of renewable energy required and on appropriate technologies; and
> - recognising the environmental, economic and social opportunities that the use of renewable energy resources can make to wider planning goals and objectives and the delivery of renewable energy targets [12.8.9]:.
> - Undertaking an assessment of potential of all renewable energy resources and the potential of renewable energy technologies and energy efficiency and conservation measures and include detailed polices in their UDPs
> - Taking into account the contribution that can be made by the area towards climate change and renewable energy targets;
> - Recognising that different approaches will be appropriate for the deployment of renewable energy technologies and energy efficiency and conservation measures [12.9.2].
> - Seeking opportunities to integrate energy efficiency and conservation objectives into the planning and design of new development in their areas [12.9.3].

2.46. The guidance also makes specific reference to wind energy technologies, stating:

> UDPs may, where possible and practicable, indicate broad locations or specific areas where wind energy developments are likely to be permitted. In defining such areas it will be appropriate to balance the scale and contribution of such developments to certain levels of renewable energy against the sensitivity of the receiving environment. Small scale or domestic scale schemes may be appropriate in most locations provided they are sensitively

[11] WAG Planning Policy Wales – March 2002

sited and designed. In nationally designated areas large scale deployment of renewable energy may not be appropriate [12.9.4]

2.47. In terms of development control and sustainable energy the guidance states:

12.10.1 Local planning authorities should consider the effects of any scheme and its associated infrastructure on the local environment.
Where a development is likely to cause demonstrable harm to a designated area by virtue of having a significant adverse impact on the qualities for which the site was designated, consideration should be given to refusing the development if such effects cannot be overcome by planning conditions or agreements.

12.10.2 Whilst having regard to the contribution of renewable energy use to wider planning goals such as the diversification of the rural economy, local planning authorities should ensure that any environmental effects on local communities are minimised, to safeguard quality of life for existing and future generations.

12.10.3 In determining applications for any form of development local planning authorities should encourage developers to integrate energy efficiency and conservation measures as part of the design of new development.

2.48. Among the relevant Technical Advice Notes that supplement the guidance, *TAN 8: Planning for Renewable Energy* (2005) outlines the major land use planning aspects of renewable energy technologies, with an emphasis on the strategic national planning issues raised by their development. It sets out seven Strategic Search Areas (SSAs) within Wales for onshore wind and provides indicative capacity targets for wind energy in these areas.

2.49. An amendment to PPW was subsequently made following publication of TAN 8 specifically to safeguard National Parks in Wales from wind farms or other large-scale renewable energy schemes. This is outlined below in summary.

Ministerial Interim Planning Policy statement – Planning for renewable energy – Jan 2005
The development of wind farms or other large-sale renewable energy schemes will not generally be appropriate in National Parks. Smaller (less than 5MW), domestic or community-based wind turbines may be suitable subject to material planning considerations. On urban/brown field industrial sites – small to medium (up to 25 MW generation) may be appropriate.

Emerging planning policy and guidance

2.50. **Planning and Energy Bill – England and Wales:** Currently passing through Parliament – this Bill creates a new legal framework for local planning authorities in England and Wales to set requirements for energy use and energy efficiency in local plans. This includes imposing reasonable requirements for:

a) a proportion of energy used in development in their area to be energy from renewable sources in the locality of the development;
b) a proportion of energy used in development in their area to be low carbon energy from sources in the locality of the development;
c) development in their area to comply with energy efficiency standards that exceed the energy requirements of building regulations

2.51. **Further Amendments to Planning Policy Wales – re: energy:** More recently, in line with its target to secure zero carbon development by 2011, WAG consulted in July 2008 on further amendments to PPW with the principal changes relating to providing guidance on energy efficiency and renewable energy targets for new development.[12] In summary the proposed targets are outlined as follows:

(1) From April 2008 social housing will be required to meet Code for Sustainable Home level 3 moving to levels 4 and 5 as soon as possible. Other public sector new build will be required to meet the BREEAM 'excellent' standard.
(2) After April 2009 Residential development (10 dwellings or more) will be required to meet Level 3 of the Code for Sustainable Homes; Non-residential with floor space of 1000m^2 or more will be required to meet BREEAM 'very good' (Both domestic and non-domestic development are to include decentralised or low-carbon energy equipment contributing to at least an additional 10% reduction in regulated CO_2 emissions)

(3) Local Planning Authorities should assess 'strategic' sites for bringing forward higher standards and targets together with a robust evidence base to back up the case for this.

2.52. It is anticipated that these amendments will come into force in April 2009.

2.53. It should be noted that there is currently no programme for enabling the WAG aspiration for zero carbon homes from 2011 to be met (para 2.43 above). However, the Assembly Government has commissioned the Sustainable Development Commission, in partnership with the Design Commission for Wales, to look at the key policy interventions and to provide a roadmap to enable all new buildings to become zero carbon. As a first step the SDC and the DCfW created a "coalition of the willing" i.e. key stakeholders from the private, public and voluntary sectors that will commit to taking a "can do" approach to tacking climate change through the built environment. This led to the launch of Wales's first green building charter (12 November 2008) where 40 leading organisations representing the construction sector in Wales have committed to support progress towards low or zero net carbon emissions as quickly as practically possible. With this commitment to accelerating progress towards zero carbon development it is likely that the *Proposed Further Amendments to Planning Policy Wales* highlighted above will be superseded within two years.

Permitted Development Rights re: micro-generation

2.54. The Town and Country Planning (General Permitted Development) Order 1995 (GPDO) gives a general permission for certain defined classes of development or uses of land, mainly of a minor character. The most commonly used class permits a wide range of small extensions or alterations to dwelling houses. These are restricted in their application in National Parks and other specified areas

Under Article 1(6) of the GPDO within National Parks, and within the areas of land specified in Article 1(5) of the GPDO - Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and conservation areas - the GPDO provides for the reduction of some permitted development rights while others are withdrawn.

2.55. In July 2007 WAG consulted on proposed changes to Permitted Development Rights[13], introducing relaxed restrictions on permitted development rights for domestic micro-generation within National Parks. The proposal is that micro-generation will not need permission unless it fronts a development i.e. 'principal

[12] WAG- Proposed further amendments to Planning Policy Wales – July 2008

[13] WAG Lifting the Planning Barriers to Domestic Energy Micro-generation – July 2007

elevation' or is visible from any highway in the area. At the time of writing, the changes have not been adopted by Government.

LOCAL PLANNING POLICY WITHIN PEMBROKESHIRE COAST NATIONAL PARK

Current planning policy

2.56. For the National Park, policies for renewable energy are contained in the current Development Plan - the Joint Unitary Development Plan for Pembrokeshire 2000 – 2016 adopted in 2006. The Plan was prepared by both Pembrokeshire County Council and the Pembrokeshire Coast National Park Authority. The relevant polices are:

Policy 62 Renewable Energy
Policy 63 Wind Energy Development

Emerging planning policy

2.57. The current Unitary Development Plan is being replaced by a Local Development Plan (LDP).[14] The National Park Authority commenced work on this through the preparation of a draft Preferred Strategy for the Park for consultation in 2007. Reflecting this consultation the Local Development Plan has been drafted and is due to be placed on deposit in December 2008.

2.58. The study refers to the Local Development Plan Deposit (Working Draft) August 2008 and the relevant policies contained within it.

[14] as required by the Town and Country Planning (Local Development Plans)(Wales) Regulations 2005

2.59. The strategy of the Local Development Plan is to support sustainable locations for development by locating housing adjacent to services. It seeks to minimise the contribution that new development makes to greenhouse gas emissions by constraining polluting or hazardous development in the Park; by promoting the use of renewable energy; and by encouraging sustainable design in development.

2.60. The Plan has a long term vision for sustainable energy whereby the Park is internationally recognised as a model of sustainable living. Sustainable design is inherent in all new buildings and community renewable energy generation schemes are popular. The Park has migrated to an economy of low net carbon emission by increasing energy efficiency and conservation. Development is low-impact, low energy and affordable.

2.61. The aim of the Plan is to ensure that at the end of the Plan period, new development (and existing development where extensions are proposed), will be more sustainable in design. The Park will have a series of community-based renewable energy projects, as well as individual proposals in operation.

2.62. The policies that seek to achieve this aim are outlined below:

Policy 9: Renewable and low carbon technologies in new development & extensions to existing buildings

2.63. The aim of Policy 9 is to secure appropriate energy efficiency standards and renewable or low carbon energy technologies to contribute towards lowering the regulated CO_2 emissions from the development (i.e. those emissions that can be controlled by design of the development as opposed to CO_2 emissions that can't be controlled by use of energy appliances by the occupant).

Policy 9 Sustainable Design

"All proposals for development will be expected to demonstrate an integrated approach to design and construction, and will be required to be well designed in terms of:

a) Place and local distinctiveness
b) Environment and biodiversity
c) Community cohesion and health
d) Accessibility
e) Energy use [67]
f) Energy generation [68]
g) Materials and resources
h) Water and drainage
i) Waste
j) Resilience to climate change

Where extensions to buildings are applied for energy, water and drainage efficiency improvements in the original building as well as in the extension will be sought where appropriate and practicable.

Within the Brynhir, Tenby, and Glasfryn, St. Davids strategic development sites new development should incorporate on-site and/or near-site decentralised and renewable or low-carbon energy technologies contributing at least an additional 20% in regulated CO2 emissions (20% reduction of the Target Emission Rate). Developers will be expected to demonstrate that they have explored all decentralised and renewable and low carbon energy options, and designed their developments to incorporate these requirements."

[67] Applicants will be expected to demonstrate a design approach which minimises energy use;
[68] Applicants will be expected to incorporate appropriate renewable or low carbon energy technologies including solar water systems, solar photovoltaic, wind, heat pumps and biomass

2.64. Policy 9 uses the emerging guidance outlined in *Further Amendments to Planning Policy Wales* (para 2.51 above) to justify setting higher standards of energy efficiency and renewable energy targets for new development on strategic sites.

2.65. All other development that is not of strategic scale is also required to demonstrate energy efficiency and incorporate renewable or low carbon technologies, but the policy does not prescribe a specific target to be achieved. The Policy can rely on the guidance in the draft Proposed Further Amendments to Planning Policy Wales when it is adopted in April 2009, as it will prescribe that sites for residential development (10 dwellings or more) will be required to meet Level 3 of the Code for Sustainable Homes; and non-residential with floor space of 1000m^2 or more will be required to meet BREEAM 'very good' (both domestic and non domestic will also be required to include decentralised or low-carbon energy equipment contributing to at least an additional 10% reduction in regulated CO_2 emissions).

2.66. Development sites within the National Park below these thresholds are still required by Policy 9 to incorporate appropriate renewable or low carbon technologies, but without stipulating a target developers will inevitably aim, on cost grounds, for the contribution from renewables to be less than a 10% reduction in CO_2 emissions. [15]

2.67. In this context there was very strong support at the Stakeholder Workshop held as part of this study (para 1.18) for Policy 9 to have more demanding targets, requiring at least 10% renewable energy contribution from all new housing, set at a sliding scale i.e.,

[15] At the County level Pembrokeshire County Council are currently committed to a reduction in CO_2 emissions of 2% below 1996 levels rising to 3% in line with WAG targets from 2011. The County does not as yet have targets for the provision of electricity or heat from renewable energy.

the larger the development, the higher the target. It has been reported that this policy stance has recently been taken by the Brecon Beacons National Park Authority.

2.68. Concern was also expressed about the current high costs of installing renewable technologies and recognition that this could conflict with priorities for the provision of affordable housing. The use of solar thermal technology was seen as key to overcoming this issue, as is the promotion of decentralised schemes for larger developments rather than single solutions for individual dwellings. Nevertheless, the stakeholders recognised that the savings in long term energy costs to the householder, particularly the fuel poor, should outweigh the short term development costs borne by developers for higher energy efficiency and installation of renewables.

2.69. Stakeholders also expressed concern that contributions from renewables would only be effective if the proposals put forward by developers are robust and viable. The need for close monitoring and scrutiny of energy statements accompanying planning applications by appropriately trained staff was considered paramount in achieving viable schemes in the long term.

2.70. **Potential changes to Policy 9:** In view of the imminent publication of the Further Proposed Amendments to Planning Policy Wales in April 2009, and the implementation of zero carbon homes by 2011, it is our view that Policy 9 strikes the right balance in that its priority is to achieve carbon reduction from higher standards in new development at both strategic and non strategic site levels. The policy wording is flexible enough to endure without change whilst national policy advances and sets the detailed requirements. This will avoid costly and time consuming appeals over individual planning applications once the national standards have been set.

Policy 10: Standalone renewable technologies

2.71. Policy 10 of the Draft Local Development Plan sets the requirements to be followed for standalone renewable energy schemes. Scale and location are important considerations to ensure that the special qualities of the National Park are not compromised.

Policy 10 Renewable energy

Small scale renewable energy schemes will be considered favourably, subject to there being no over-riding environmental and amenity considerations. Large scale renewable energy schemes which would compromise the special qualities of the National Park will not be supported. Where there are other renewable energy schemes in operation in the area, the cumulative effect of additional development will be an important factor to be taken into consideration.

Onshore connections to off shore renewable energy generators will also be permitted except where they conflict with other relevant policies or designations. Developers requiring an undeveloped coastal location for onshore connections to offshore renewable energy installations will need to clearly justify this need in relation to Policy 18i). Developments that would reduce the value of Natura 2000 sites will not be permitted.

2.72. Policy 10 reflects the outcome of this study in that in the majority of cases, small-scale renewable developments are the most appropriate for the Park in terms of the resources available. The main exception to this is wind energy, where the resource is abundant, but a variety of constraints limit opportunities for larger-scale schemes.

2.73. **Potential changes to Policy 10:** At the Stakeholder Workshop no specific comments were raised in respect of this policy and in the light of the above it is considered that it strikes the right balance between support for renewable technologies and protection of the special qualities of the National Park.

2.74. In the Chapters that follow the suitability of different renewable and low carbon technologies is considered in turn. Each Chapter is set out in roughly the same format to allow comparison between the different technologies.

3. BIOMASS

PRINCIPLES OF THE TECHNOLOGY

3.1. In all cases biomass plants are concerned with producing heat from the burning of plant materials. The final output will either be heat or electricity with the heat / steam used to turn a turbine.

3.2. There are currently three basic categories of biomass plant:

- **Plants designed primarily for the production of electricity**. These are generally the largest schemes, in the range 10 – 40 MW. Excess heat from the process is not utilised. These plants are major multi-million pound developments and are unlikely to be suitable within the National Park. They are therefore not considered further here.

- **Combined Heat and Power (CHP) plants** where the primary purpose is the generation of electricity but the excess heat is utilised, for instance as industrial process heat or in a district heating scheme. The typical size range for CHP is 5 to 30 MW thermal total energy output but smaller 'packaged' schemes of a few hundred kilowatts have been built in the UK. Most UK CHP systems are sized to have a thermal output of between 1.5 and 2.5 times the electrical output.

- **Plants designed for the production of heat.** These cover a wide range of applications from domestic wood burning stoves and biomass boilers to boilers of a scale suitable for district heating, commercial and community buildings and industrial process heat. Size can range from a few kilowatts to above 5 MW thermal.

TYPES OF PLANT

3.3. The size of **medium-scale plants**, such as CHP plants used in community schemes, schools and industrial units will depend on power output. A small heat plant for a school might consist of a boiler house some 4m x 4m with a fuel bunker of similar proportions and would cost in the range £20 - £30,000. The bunker may be semi-underground (bringing practical benefits for re-filling) with a lockable steel lid. The chimney will be 3m – 10m high, depending on plant design and surrounding buildings. Sufficient space to manoeuvre a large lorry or tractor and trailer safely is required for fuel delivery. Fuel will usually be either wood pellets or woodchip.

3.4. **Household** woodburning stoves are the size of a typical room heater and may be fitted with a back boiler to provide water heating as well as room heat. Costs range between £1,500 - £3,000. Where there is no existing chimney a separate internal stainless steel flue can be used, which can provide an additional source of heat. The standard fuel is wood logs.

Household biomass boilers connected to central heating and hot water systems are generally larger than 15 kW and utilise either wood pellets or woodchip. They typically cost between £5,000 and £10,000. The main space requirement is for the storage of the fuel, typically 7m³ of pellets or 21 – 35m³ of woodchip, and access to accommodate bulk deliveries of wood fuel by lorry or tanker.

Biomass plants in the National Park

3.5. Recently, the number of automated biomass installations in the National Park has increased rapidly from a low base (**Table 3.1**). In addition there are a large and unknown number of domestic installations, mainly wood burning stoves.

The PLANED Renewables Map reveals that there are 7 biomass boilers installed within the National Park. This equates to 1 boiler per 1000 home owners, and is much higher than the UK average of 1 biomass boiler per 30,000 home owners

Table 3.1: Pembrokeshire Biomass Installations Source: The Community Energy Network of Pembrokeshire renewable energy installation map

Location	Type	Cost	Summary
Pembrokeshire Coast NPA Headquarters Pembroke Dock	130kw Passat Boiler Pellets from Welsh Biofuels	Initial cost of installation c£30,000 £6,500 per year on fuel £22,000 obtained in grants from Clear Skies programme.	Installed in 2004 Used for space heating via radiators for the NP offices and adjoining CCW building Boiler lit in Autumn and run continuously throughout Winter
Crymych - Y Frennii	Passat Boiler Pellets from Welsh Biofuels	Initial cost of installation c£22,000 Funding obtained from Objective 1, SDF & New Opportunities Fund (NOF)	Space heating and hot water
Crymych – Ysgol Y Preselii	Passat Boiler Pellets from Welsh Biofuels	Initial cost of installation c£30,000 Funding obtained from Objective 1 and SDF	Space heating and hot water
Spittal New School	Passat Boiler Pellets from Welsh Biofuels	Initial cost of installation c£20,000 Funding obtained from SDF and Clear Skies programme.	Space heating and hot water
Slebech leisure complex	Woodchip boiler supplied from own estate.	N/a	N/a
Bluestone Holiday Village - Just outside the NP	Woodchip boiler supplied and run by Pembrokeshire Bio Energy (PBe/Pbesco) for heating swimming pool and buildings > 2MW	N/a	This 'Celtic Village' holiday park which includes a snow dome, waterworld and sports centre has a biomass energy centre as part of the development. It has helped create a market for Miscanthus within the Park.
St Oswalds Community Centre, on outskirts of National Park	Under floor heating system, powered by an Okofen pellet boiler which interacts with solar hot water	N/a	N/a
Bethesda Milk, diary	110kw Bio-Comfort boiler with pellet store and piping Pellets from Pembrokeshire Bio Energy	Biomass boiler cost £6000, plus £4000 for the pellet storage and installation. Biomass pellets cost £130 per tonne and approx. 1 tonne/ week used. Project received no grant funding.	The Biomass Boiler runs 24 hours a day, providing heat and hot water to the milk plant and farmhouse, and fuels the pasteurisation process. Bethesda Milk vans also use biodiesel for a proportion of their fuel supply

TYPES OF BIOMASS

3.6. The main types of biomass fuel used in medium and household technologies are sawn logs, woodchip and pellets.

Sawn logs

3.7. The main sources of sawn logs in the National Park and Pembrokeshire more generally are woodland thinnings and wood waste from commercial forestry management and wood products from conservation management. In addition to domestic use, some commercial users prefer log burning installations as bought in logs can be combined with the use of on-site waste materials (off-cuts) and are simpler to maintain. According to the Forestry Commission the revenue from logs is rising (from £20 / tonne in 2007 to £30 - £38 / tonne in 2008).

Woodchip

3.8. The best quality woodchip comes from dried roundwood, medium quality from Short Rotation Coppice (SRC) and Miscanthus (although there can be purity issues), and poorer quality chip from forestry residues. Materials can be mixed to improve calorific value. In Pembrokeshire the main current sources are forest residues (mostly supplied by local forest contractors) and waste from the wood processing industry. Woodchip is also produced from Miscanthus produced and marketed by the Pembrokeshire Bio Energy Co-Operative (Pbe) (para 3.24) which is also the largest processor of forest residues in Pembrokeshire, producing several thousand tonnes of woodchip from this source annually.

3.9. Experiments in Pembrokeshire have also looked at the use of hedge trimmings (especially if cut once every three years producing good size ash poles) and other sources to use in mixes, such as gorse (which has similar heat potential to that of charcoal) and heathland arisings (para. 3.16).

3.10. The market for woodchip is growing rapidly but in Pembrokeshire the woodfuel supply chain is still at an early stage of development. The potential for expanding this fuel source therefore depends on continuing improvements in the reliability and quality of supply, development of demand and effective marketing. Lack of markets is currently the biggest constraint. Other important considerations are the need for: drying/storage facilities, achieving the right mix of materials to attain the right calorific value, and the cost of woodchippers. These are typically beyond the means of most small woodland owners. All suggest the need for co-operative ventures between woodland owners and potentially between them and local communities, sharing the cost of the capital investment.

Pellets

3.11. Pellets are a refined, solid fuel biomass with a low moisture content, easy to transport and store. Although energy demanding in their production, pellets are easier to utilise in fully automated heating systems. They are manufactured from a range of products including Short Rotation Coppice (SRC), Miscanthus, straw, sawdust, woodchip, shavings, bark and wood residues. Pellets from the spent meal of processed oilseed are much cheaper to produce but have a lower calorific value.

3.12. In South Wales there have also been experiments into the use of bracken, rushes and garden prunings in pellet manufacture[16] but these may have high levels of sulphur and ash, and resinous residues, as well as varying calorific output. Nevertheless, pellettng of conservation materials does allow summer arisings to be stored in a stable state for winter use (para 3.16).

3.13. Pellet production is capital intensive with production of 30 – 40,000 tonnes a year necessary to be economic under present conditions. Current markets in the Pembrokeshire area are well below this. The main pellet supplier to the area is *Welsh Biofiels*

[16] Coed Cymru and Glasu (2008)

supplying from their Bridgend depot – over 70 miles from the National Park. Pembrokeshire Bio Energy cooperative (Pbe) also supplies roughly 4,000 tonnes of pellets, partly sourced from Welsh Biofuels and partly from further afield. These relatively long transport distances have implications for sustainability but are an important step in establishing a local market. (The distances are of course insignificant if compared to, say, the distance travelled by crude oil from the Gulf to Milford Haven, before entering the local heating oil distribution chain.) In the longer term a more local supply should have a competitive advantage as costs will be reduced.

THE RAW MATERIALS AVAILABLE WITHIN AND AROUND THE NATIONAL PARK

Existing woodland

3.14. The most important biomass resource within and around the National Park are the existing woodlands. Pembrokeshire (County) is one of the least wooded areas of Wales but still supports some 10,000 hectares of woodland, a large proportion of which is small unmanaged mixed and deciduous highly fragmented farm woodlands concentrated along river valleys, many on inaccessible or difficult terrain (see **Figure 3.1**). However, the population of the National Park is also dispersed meaning that local woods are well placed to provide sawn logs to local households. The incentive for the necessary woodland management may come from increased demand as the cost of conventional fuels increases.

3.15. There is a well-established local softwood supply chain in South West Wales. This is mostly sourced from fairly large commercial blocks of National Assembly woodland. The two main Forestry Commission plantations around the National Park are the Tracoon Estate just outside it and Slebech Estate within it. Slebech provides Oak, Beech, Larch and Douglas Fir. There are also a small number of large private forestry blocks at Preseli, Picton Castle and Drim Woods. These plantations are characterised by reasonably large production volumes, a high degree of mechanisation and proximity to major transport corridors. The main output from these estates are standing sales of hardwood logs and bars for sawmills, chipwood and pulpwood. The main opportunities for biomass here therefore are limited amounts of woodland thinnings and residues (suitable for woodchip and pellet production).[17]

Waste material from the wood processing industry

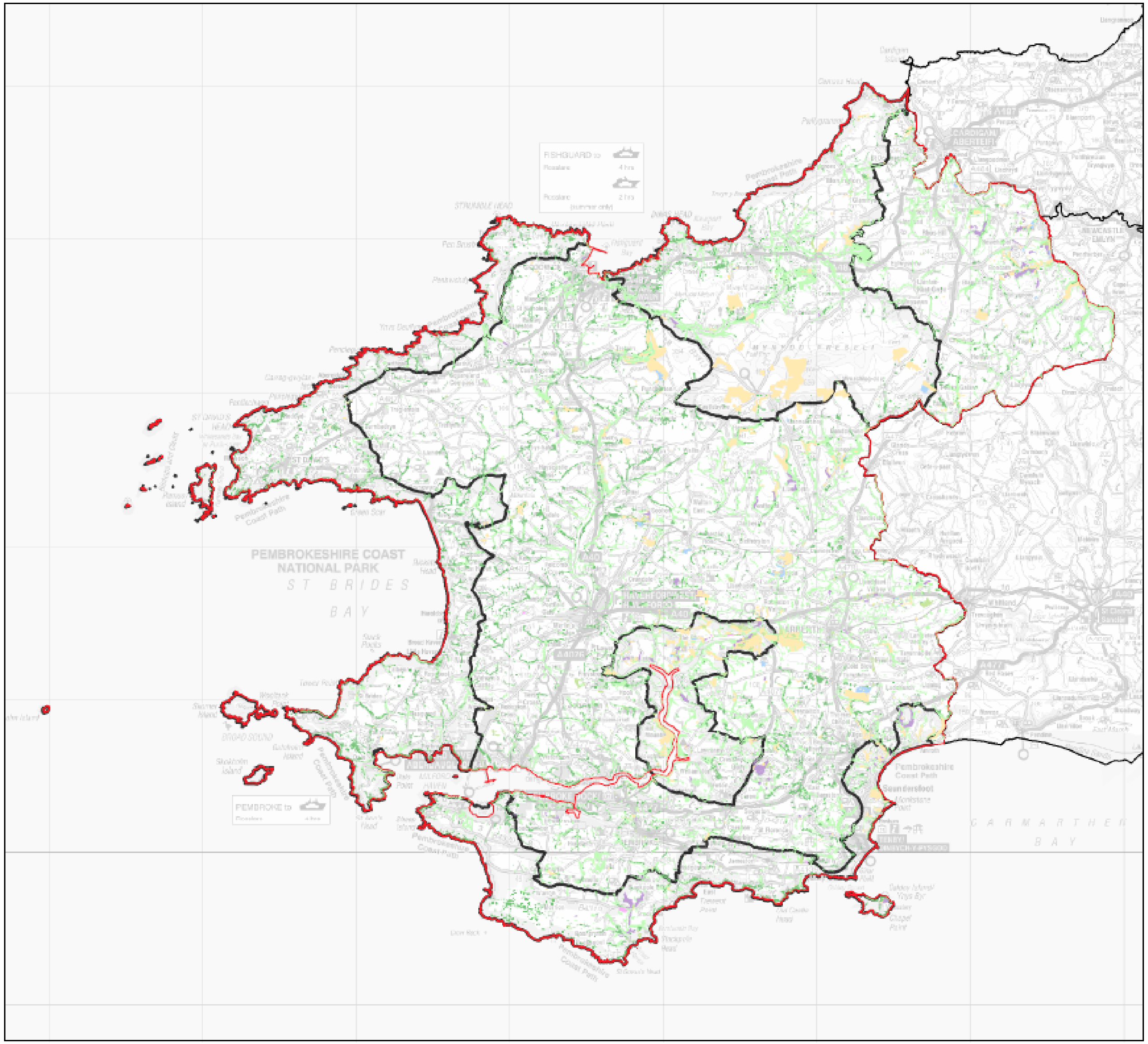
3.16. Another source of biomass in Pembrokeshire is waste material from the wood processing industry. This includes waste sawdust, shavings, chipwood and wood off-cuts from sawmills, furniture manufacturing, and joinery workshops. There is one major sawmill and a number of smaller mills around the National Park. Although some wood processing units in the area do currently utilise waste material for energy production, this is usually used internally as part of the production process and relatively little is sold. Established markets for products such as particleboard and chipboard are likely to continue to compete with energy production for wood processing waste.

Conservation arisings

3.17. The products of conservation management (coppice poles, bracken, reeds, heath etc) have the potential to be used as a biomass source for energy production, either for burning or in anaerobic digestion (Chapter 4). Such materials currently have no commercial use and go to waste. They do have variable calorific value but do not compete with established wood markets and agricultural commodities in their production. The main issue is finding a constant supply, especially as conservation sites tend to be small and fragmented and often on difficult terrain requiring bespoke machinery (para 3.8 and 3.11).

[17] Pers com Forestry Commission

Figure 3.1: Existing Woodland



Pembrokeshire Coast Renewable Energy Assessment

Figure 3.1: Existing Woodland

Key

- Pembrokeshire County
- Pembrokeshire Coast National Park
- Broadleaved Woodland (plantation)
- Broadleaved Woodland (semi-natural)
- Coniferous Woodland (plantation)
- Mixed Woodland (plantation)
- Mixed Woodland (semi-natural)
- Recently-felled woodland (broad-leaved)
- Recently-felled woodland (coniferous)
- Scrub (dense/continuous)

0 2 4 8 Km

Source: CCW

Date: 21/11/2008
Revision:

File: S:\4300\4371 Pembrokeshire Renewables\GIS\Themes\ArcGIS9\4371-01_006_Woodland.mxd

3.18. Despite these difficulties, utilisation of these resources, especially at the local level, could make a difference especially if community involvement is secured, as labour will be a key input.

Cilgerran Wildlife Trust in northern Pembrokeshire is investigating the feasibility of installing a biomass boiler at their headquarters utilising biomass gained from annual (mechanised) removal of dead growth from a wetland reed bed.

Short Rotation Coppice (SRC)

3.19. Both SRC and Miscanthus are purposefully planted energy crops, replacing other forms of agricultural production. SRC uses high yielding willows and poplars planted at some 15,000 cuttings per hectare. After one year these are cut back to base (i.e. coppiced) to encourage multiple shooting. These are then cropped on a 2 – 4 year cycle thereafter by cutting back to base. This cycle of harvest and re-growth can be repeated up to an expected lifespan of 15-25 years (corresponding to around six harvests). The shoots are usually harvested during the winter as chips, short billets or as whole stems.

3.20. Currently there is little SRC grown in or around the National Park although 12 hectares of willow are being trialled by two growers[18] in Pembrokeshire through the Willows for Wales project[19] and Pbe. Limited rainfall (compared to the rest of Wales), low soil water retention and high winds mean that the area is not ideal for SRC growth.

3.21. An alternative is **Short Rotation Forestry (FRC).** Here fast growing species such as willow and eucalyptus are grown on a rotation of 10 – 20 years. This has not been tried in the Pembrokeshire area and, within the National Park, it will be much more appropriate to plant native coppice woods as an extension to existing woodlands that have the potential to meet biodiversity targets as well as be a source of biomass.

Two year willow on short rotation coppice

[18] Hayscastle Farm, Haverfordwest and Newhouse Farm, Canaston Bridge

[19] Helyg i Gymru / Willow for Wales is a project that has been funded by the European Regional Development Fund (ERDF) Objective 1 through the Welsh European Funding Office to demonstrate the potential of SRC willow as a biomass crop in Wales

Miscanthus

3.22. Miscanthus or elephant grass is a perennial, rhizomatous grass originating from Asia that once established can be harvested every year for 15 years. It grows to about 3 metres in height and can produce very high yields with little pesticide or fertiliser use. By the third year harvestable yields are between 10-13 tonnes per hectare. Peak harvestable yields of 20 tonnes per hectare have been recorded. The West Wales Eco Centre has calculated that if one tenth of the arable area in Pembrokeshire were planted with Miscanthus, the energy produced would save the equivalent of 209,000 tonnes of carbon per year.

3.23. Currently the only grower-cum-supplier of Miscanthus in South Wales is the Pembrokeshire Bio Energy cooperative (Pbe).[20] Pbe is promoting Miscanthus production (and other bioenergy crops) to outgrowers, issuing five year contracts at guaranteed prices. Currently, there are 13 growers producing roughly 2,000 tonnes of biomass per year from 140 ha. of Miscanthus, used as a major feedstock (as woodchip) by the *Bluestone Holiday Village.* Under the terms of the contract, Pbe are responsible for producing the raw materials, while the related energy supply company *Pbesco*[21] then installs and maintains the boilers directly.

3.24. Switchgrass and reed canary grass have also been trialled by Pbe but are not considered to be well suited to West Wales and are unlikely to replace Miscanthus as the major biomass crop.

[20] Pbe started in 2005 with an initial grant under the SDF from Pembrokeshire Coast National Park Authority covering 50% of the costs of establishing 10 ha of miscanthus, They have secured a £175,000 Defra grant to develop and market carbon-neutral crops over three years.

[21] Pembrokeshire Energy Supply Company. The company sells the energy that they have generated from their installed boilers to the Holiday Village.

OPPORTUNITIES AND CONSTRAINTS FOR BIOMASS FEEDSTOCKS

3.25. Below consideration is given to the future opportunities and constraints for the different biomass feedstocks, within the National Park context. This is followed by consideration of the suitability of different scales of biomass plant. Clearly the two inter-relate.

3.26. In summary, the development of all biomass sources in the National Park is critically dependent on the availability of grant support and advice, and the development of markets and infrastructure. A significant spur was provided by the rising cost of conventional fuels in 2007-08. Without grant support, the majority of larger biomass energy schemes are still not viable. Within the context of the National Park the biomass sources with the greatest potential will be:

- The management of **the 80% of woodland that is currently unmanaged** and the extension of these woods. So long as sufficient dead wood is left to allow natural cycles, this will help meet community energy needs and biodiversity objectives and offers an additional income stream to farmers. This will be best suited to the production of sawn logs and wood chip. Grants for woodland management are available under the Forestry Commission's 'Better Woodland for Wales' scheme, with grant based on an approved long term management plan which meets the minimum standards under the UK Woodland Assurance Scheme.

- **Forest residues** from the management of commercial plantations sold as woodchip or pellets.

- **Wood waste** from the wood processing industry although much of this currently goes into the manufacture of chipboard.

- **Conservation arisings** (para 3.17) which would provide a commercial use for what is currently waste material, although the scattered nature of these materials suggests that they will be best suited to local / community biomass schemes rather than sold as a commercial energy source, at least in the foreseeable future.

Energy crops

3.27. Energy crops do not have the same level of environmental benefit as the management of existing woodlands but are important in developing a sufficient quantity of biomass to support local schemes, as demonstrated by the pioneering work of Pbe. Farmers within the National Park are examining the potential of energy crops and would consider switching from livestock production to energy cropping if this was clearly the more economically favourable. Energy crops have the advantage of not requiring major capital investment and having few environmental legislative restrictions compared to other types of farming and renewable energy production. They offer a good retirement crop. They may also be perceived to offer greater security against the high volatility of meat and milk prices, and the continuing concerns raised by bovine tuberculosis and bluetongue. These concerns may need to be balanced against the strengthening of food prices in the short to mid-term, with food security becoming an increasing issue in the face of climate change.

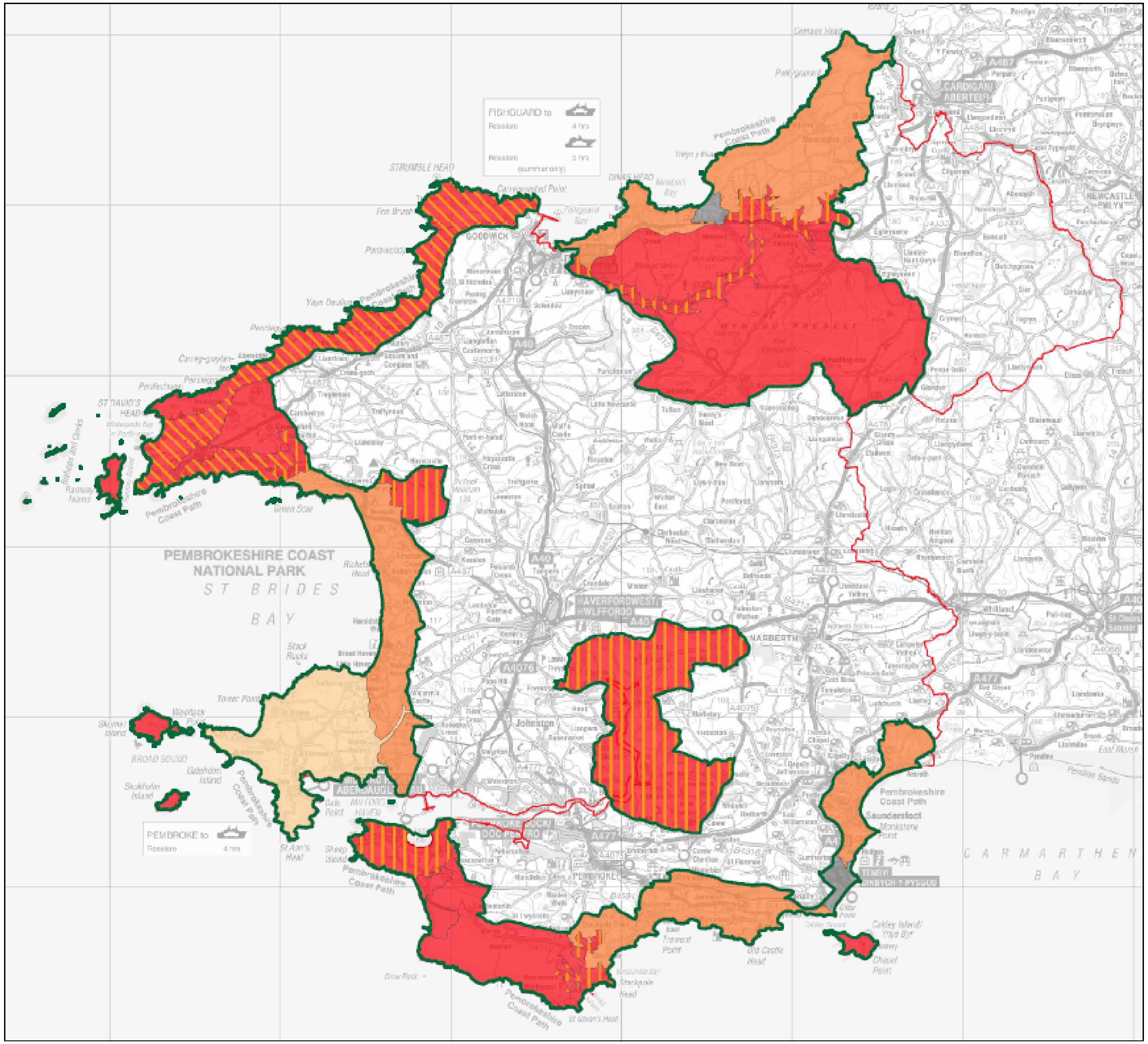
Pembrokeshire Sustainable Agricultural Network: Following an initial meeting in February 2008 between PLANED, CCW, NFU, FUW, and PCNPA the Pembrokeshire Sustainable Agriculture Network has been launched. This new network of farmers and farming / environmental organisations will be a forum and springboard for action for the development of sustainable agriculture in Pembrokeshire. It will look at renewable energy – biomass, biogas, (including biodiesel and timber) – as well as at recycling, novel crops and biodiversity.

3.28. Within the National Park **Miscanthus** (compared to SRC) is better adapted to local conditions and better suited to the Park's landscape.

3.29. **Landscape considerations:** Much of the National Park is characterised by an open, natural coastal edge backed by fields of predominantly pastoral farming. Areas of heathland and other semi-natural habitats also contribute to the landscape mosaic, including the rough moorland landscapes of the Preseli Mountains and Carn Llidi uplands. Where arable cultivation exists, it is located within a patchwork of pasture, rather than occupying large areas in its own right. The landscape is therefore sensitive to the introduction of new tall crops (see **Figure 3.2** based on the Landscape Sensitivity Study).

3.30. As such, the potential for the planting of monoculture bioenergy crops such as Miscanthus should be limited to those areas already under cultivation (arable cropping and short term leys), so maintaining semi-natural habitat and the overall patchwork of pastoral land cover. Landscape Character Areas judged as having capacity for Miscanthus are those which already contain areas of cultivation (see **Figure 3.3**). This figure is based on the accompanying Landscape Sensitivity Study which contains further guidance. As Miscanthus is taller than most conventional arable crops, care is needed in its location within the wider landscape. In all coastal areas planting should be at least one field back from the coastal edge to maintain its open character and often expansive views.

Figure 3.2: Landscape Sensitivity to Miscanthus Planting



Pembrokeshire Renewables

Figure 3.2: Landscape Sensitivity to Miscanthus Planting

Key

- Pembrokeshire Coast National Park
- Pembrokeshire County

Landscape Sensitivity

- High
- High but Moderate-high to Miscathus
- High but Moderate-high to SRC
- Moderate-high
- Moderate
- Urban

0 2 4 8 Km

Source: Land Use Consultants

Date: 21/11/2008
Revision: A

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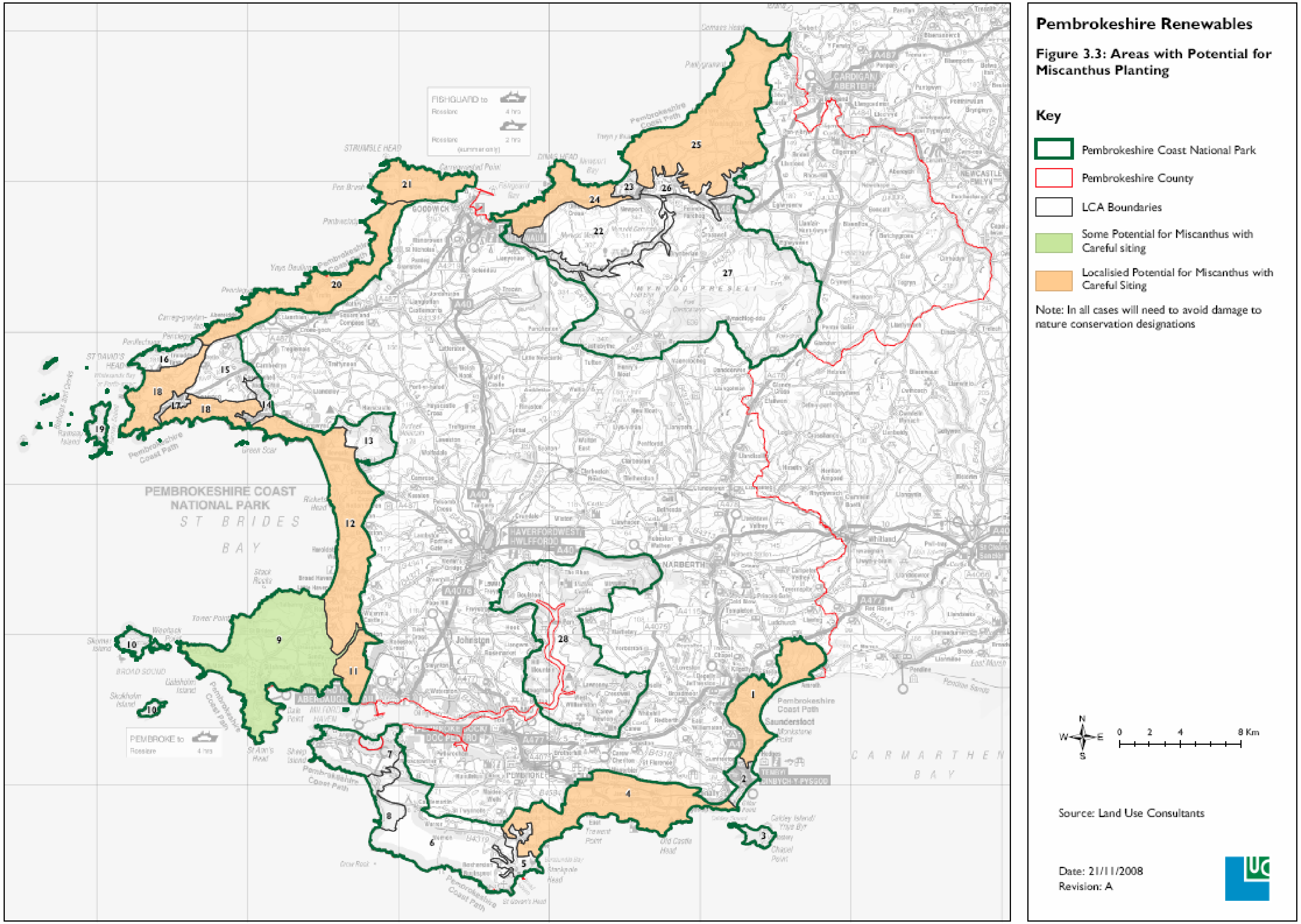
Figure 3.3: Areas with Potential for Miscanthus Planting



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3.31. Biodiversity22: Miscanthus can bring positive benefits for biodiversity during the establishment phase (up to three years) with the open conditions created supporting weed species attractive to a wide range of farmland birds including open-ground species such as skylark, meadow pipit and lapwing. Conversely once the canopy has closed the benefits for biodiversity will be reduced and may offer less diversity of habitat than traditional arable rotations, suggesting that different aged Miscanthus blocks should be maintained in proximity. The impact of Miscanthus on biodiversity will be more pronounced when planted on former set-aside or marginal farmland which are likely to support considerable biodiversity.

3.32. **Other considerations**: The use of heavy machinery at harvest means that Miscanthus should not be planted over archaeological sites. On the other hand, the low levels of fertiliser and pesticide use mean that Miscanthus brings positive benefits for natural resource protection. In particular, Miscanthus planted as a buffer between intensive production (e.g. where slurries are being spread) and water courses, can help reduce nutrient leaching into surface water.

3.33. **Funding:** Currently Wales is the only country in Europe not to offer grant support for biomass planting. This is being investigated as part of the agri-environment review being undertaken by WAG (Axis 2 review), with the possibility of funding being provided in the future.

3.34. The **overall suitability of Miscanthus** in individual locations, therefore, will be a balance between environmental constraints; the need to develop and sustain local biomass feedstocks; and the need to maintain the viability of individual farms through diversification activities, potentially assisted by the future availability of grant aid for biomass planting.

Types of fuel

3.35. The question still remains – are there woody biomass fuels that could be viably produced in the National Park? Overall, there appears to be strong potential for the production of sawn logs and woodchip but under current circumstances pellet production is unlikely within the National Park, because of the need for economies of scale. The advantages and disadvantages of the three fuels (sawn logs, woodchips and pellets) are summarised in **Table 3.2** following.

[22] Land Use Consultants (2006) Bioenergy: Environmental Impact and Best Practice. For Wildlife and Countryside Link

. Table 3.2: BIOMASS FUEL PRODUCTION IN THE NATIONAL PARK	
Opportunities	**Constraints**
Sawn logs	
Great potential through the management of currently unmanaged woodland and as a by-product of commercial forestry, brining strong environmental benefits	Likely to be labour intensive, potentially requiring community involvement (but this could be a benefit as we enter an economic downturn)
Scattered nature of existing woodlands suited to serving the needs of scattered local communities and individual farms	Limited capacity as requires mature (existing) woodland
Several sources of funding available (see Chapter 11)	
An additional income stream for farmers	
Little investment needed other than space for seasoning and storage	
Woodchip	
As for sawn logs, production suited to the scattered nature of woodland	As for sawn logs, may be labour intensive in the removal of wood and wood wastes from currently unmanaged woodlands
Local availability of wood processing waste and miscanthus (through the work of Pbe) as additional raw materials	Requires capital investment in woodchippers and drying facilities - suited to co-operative ventures
The work of Pbe and other local forestry contractors producing woodchip provides a base on which to build	Need to ensure reliability and quality of supply
Funding for woodfuel processing equipment potentially available through the FC Wood Energy Processing Scheme, although this is currently closed to applicants and is being updated	Woodfuel supply chains and markets still at an early stage of development
Pellets	
In the future smaller scale pelleting plants may become economic more suitable to the Pembrokeshire area	Large scale production plants are needed to benefit from economies of scale – producing 30,000 – 40,000 tonnes a year
	Large-scale production requires that processing is located close to very large quantities of raw materials – forestry that can be diverted into biomass production; wood processing waste; straw and other wastes from arable production; and large-scale energy crop planting. These are not a characteristic of the National Park.
	Plant requires a large industrial site and good road connections

OPPORTUNITIES AND CONSTRAINTS FOR BIOMASS PLANTS

3.36. In terms of biomass plants themselves, the opportunities and constraints are as follows.

Large-scale biomass plants

3.37. Overall, a large scale biomass plant generating heat and electricity is unlikely to be feasible or appropriate within the National Park.

3.38. A plant of this scale would either need to be developed on land designated for industrial development, or as part of a significant farm complex, avoiding visually prominent locations, well connected by road, and not adversely affecting settlement structure. A plant of this scale would have to be considered on its merits and could only be justified within the National Park if it resulted in drawing on local wood resources, yet the production of biomass in the Park and its hinterland is currently small scale and diverse in terms of feedstock types. Future production of wood and energy crops locally is much better suited to supplying local needs and is unlikely to achieve the scale required to provide sufficient feedstock for a large-scale plant.

Medium-scale biomass plants

3.39. There is considerable scope to expand the use of medium-scale biomass heating systems within the National Park across all sectors, including commercial premises, tourism facilities/accommodation complexes; community facilities (schools, leisure centres, public buildings) when existing heating systems are in need of replacement. The boilers and their associated storage facilities are small in scale and can easily be accommodated into the traditional settlement structure of the National Park. The number of opportunities in the Park is highlighted in **Table 3.3**.

3.40. Community biomass schemes that use local wood fuel bring significant reductions in CO_2 emissions (see **Table 3.4** which shows the CO_2 saved by replacing gas or oil fired heating with a biomass boiler). It will also provide a much needed stimulus to the existing local wood and energy crop supply chain and, in turn, will help diversify and strengthen the local land-based economy. Nevertheless, for all these benefits to be realised, such schemes must use local wood-based feedstocks rather than imported wood fuels.

3.41. Typical building types and boiler sizes are as follows:

Small Community Centre (500m²)	Boiler size 30kW
Small Hotel (1000m²)	Boiler size 60kW
Caravan site community centre (100m²)	Boiler size 15kW
Primary School (4000m²)	Boiler size 200kW
Swimming Pool Centre (1600m²)	Boiler size 300kW
Small office/commercial premises (1000m²)	Boiler size 50kW

Table 3.3: MEDIUM-SCALE BIOMASS PLANTS	
Opportunities	**Constraints**
Scope for use in tourism accommodation sites, visitor centres, community facilities, schools, and industrial units where there is a requirement for heat and potentially electricity. Nos of hotels = 76 Nos of community centres = 8 Nos of caravan sites = 37 Nos of swimming pools = 9 As local tourist facilities are moved up-market, there may be more, small pools or leisure facilities opened	Underdeveloped local market
Can be incorporated into existing settlement structure	Currently larger managed woodland resource used for timber production rather than biomass as timber more profitable – forest residues are therefore the main product available for biomass
Number of successful examples of biomass technology in use in the Park (**Table 3.1**).	Currently new planting used for amenity and environmental improvement rather than biomass – but there is potential for new planting to meet all these objectives
Suitable for district heating schemes	Swimming pools may also benefit from solar thermal but are unlikely to afford both measures
Significant carbon savings, particularly if used to produce heat or CHP, rather than electricity and if local (woodchip) feedstock used	Distance from pellet suppliers increases transport costs and significantly reduces CO_2 savings
Government policy support with potential for financial funding in future. Funding for biomass plants has been available under the FC Woodland Forestry Business Scheme which is currently being revised	
Existing local woodchip supplier (Pembrokeshire Bio Energy) looking to expand business in the local area	
Provides stimulus to bring local woodlands back under management, develop a local biomass production industry and, in so doing, will provide an additional income stream for local farmers	
Potential to develop strong local supply chains and boost local economy.	

Table 3.4:	Carbon savings achieved through the use of biomass boilers (compared to conventional fuels)				
Building Type	Typical floor area (m^2)	Fossil fuel typical practice Energy consumption figures ($kWh/m^2/yr$)*	Typical yearly consumption (kWh/yr)	CO_2 conversion factor ($kg/CO_2/kWh$)**	CO_2 Emission (kg/yr)
Small Community Centre	500	250	125,000	0.194 (gas)	24,250
				0.265 (oil)	33,125
				0.234 (lpg)	29,250
				0.025 (biomass)	**3,125**
Small Hotel	1000	360	360,000	0.194 (gas)	69,840
				0.265 (oil)	95,400
				0.234 (lpg)	84,240
				0.025 (biomass)	**9,000**
Caravan site Community Centre	100	250	25,000	0.194 (gas)	4,850
				0.265 (oil)	6,625
				0.234 (lpg)	5,850
				0.025 (biomass)	**625**
Primary School	4000	164	656,000	0.194 (gas)	127,264
				0.265 (oil)	173,840
				0.234 (lpg)	153,504
				0.025 (biomass)	**16,400**
Swimming Pool Centre	1600	1336	2,137,600	0.194 (gas)	414,694
				0.265 (oil)	566,464
				0.234 (lpg)	500,198
				0.025 (biomass)	**53,400**
Small Office/Commercial Premises	1000	151	151,000	0.194 (gas)	29,294
				0.265 (oil)	40,015
				0.234 (lpg)	35,334
				0.025 (biomass)	**3,775**

** Figures taken from CIBSE F Table 20.1 Fossil fuel and electric building benchmarks. Best practice is lower, and may apply where developers opt to improve energy efficiency first to minimise the amount of energy needed to be provided from relatively costly renewable resources.*

*** Figures taken from Building Regulations, Approved Document L2A Table 2 Carbon Emission Factors by Fuel Type.*

Household-scale biomass boilers

3.42. Household biomass boilers potentially offer considerable benefits for reduced CO_2 outputs, the environment and local economy. The issue therefore is the degree to which they are likely to be adopted.

3.43. Although domestic biomass heating systems (boilers) are a well established technology, uptake to date across the UK has been minimal primarily because of the market domination of gas condensing boilers, but also due to issues such as long payback periods, fuel availability, fuel storage, and reduced flexibility, compared to gas or oil systems The estimated number of installations across England, Wales and Scotland by 2007 was between 500-600 [23]. This is a very small number compared with other renewable heating systems, such as solar hot water with 90,000 installations.

3.44. Notwithstanding this, the potential for renewable systems in locations where the gas network is not yet available will be greater. Within the National Park 58% of households are not connected to the mains gas network, the majority of which will be using stored propane gas or oil for heating. For these, the rising cost of these fossil fuels may make biomass heating systems an attractive option. Other renewables such as solar hot water and heat pumps will also be realistic and competitive alternatives.

3.45. The opportunities and constraints relating to household biomass boilers is summarised in **Table 3.5.**

[23] The Growth Potential for Microgeneration in England, Wales and Scotland Element Energy- June 2008

Table 3.5:	BIOMASS (domestic) SMALL SCALE
Opportunities	**Constraints**
Scope to use in many detached properties in the National Park. Total households within the Park in 2001= 9862 Owner occupied = 6988 Local Authority /Housing Association = 1282 New dwellings by 2021 = 1141	Space required for storage of bulk deliveries of wood fuel– so larger and more expensive than fossil fuel equivalents
Potential for use by households not connected to the gas grid as an alternative to fuel oil	Flue needs to be above roof line, with potential planning, building and air quality regulatory issues
Can be incorporated into existing building structure with minimum impact so long as there is sufficient access for delivery of feedstocks	
Number of successful examples in the National Park	Costs of boiler and installation
Power can be supplier continuously so not dependent on weather	Require more frequent cleaning than conventional oil or gas boilers
Significant carbon savings if local (woodchip or sawn logs) feedstock used	More suited to supplying continuous heat loads rather than domestic evening requirements.
Existing local woodchip supplier (Pembrokeshire Bio Energy) looking to expand business in the local area	Reliant on road transport so availability can be affected
Provides stimulus to bring local woodlands back under management and develop a local biomass production industry and, in so doing, will provide an additional income stream for local farmers	The future take up of biomass systems is forecast to be low compared with competitors such as gas boilers and other emerging technologies such as micro CHP and fuel cells.
Potential to develop strong local supply chains and boost local economy.	

4. ANAEROBIC DIGESTION

PRINCIPLES OF THE TECHNOLOGY

4.1. Anaerobic digestion (AD) is a method of waste treatment that can either produce a biogas with a high methane content or following a similar process produces hydrogen, both from organic materials such as agricultural, household and industrial residues and sewage sludge (feedstocks). The methane or hydrogen can be used to produce heat, electricity, or a combination of the two. Alternatively hydrogen can be used for storage of energy in hydrogen cells or as a medium for transporting energy for use elsewhere. The demand for sustainably produced hydrogen for energy generation is expected to grow considerably in the next 10 – 20 years in the UK.

> The University of Glamorgan's Hydrogen Research Unit is leading Welsh research into hydrogen technologies. This includes running a successful hydrogen farm in Carmarthenshire as part of a joint European-funded project with a feedstock of grass and sugar beet.

TYPES OF AD PLANT

4.2. An AD plant typically consists of a digester tank, buildings to house ancillary equipment, a biogas storage tank and a flare stack (3 – 10m in height). The digester tank is usually cylindrical or egg shapes, its size being determined by the projected volume and nature of the waste and the temperature and retention time in the digester.

4.3. Broadly there are two scales of AD plant of relevance to Pembrokeshire Coast National Park.

4.4. **Small-scale plants** dealing with the waste from a single farm (generating in the region of 10kW) with the biogas potentially used to heat the farmhouse and other farm buildings in the winter when farm wastes are available. These are likely to be part of an integrated farm management system in which the feedstocks and products all play a part. Typically a plant using residues from 100 head of cattle will cost in the region of £60,000 - £70,000, and will be capable of producing electricity for approximately 13 homes, with running costs of £10,000 a year. Revenue from the sale of electricity is approximately £5-6,000 pa. rising as energy prices increase. Income also comes from the sale of Renewable Obligation Certificates (ROCs) (**Appendix 2**). Other financial offsets include using or selling the digestate as a fertiliser. Farming Futures www.farmingfutures.org has a number of case studies for further information on the advantages of biogas from AD.

> An example small-scale heat only plant is that at Caerfai Farm near St David's within the National Park which provides an on-site heat resource.

4.5. **A medium-sized centralised facility** (CADs) dealing with wastes from several farms supplemented by other feedstocks and potentially producing up to 2MW.

> An example is the Lawrenny EcoVillage, currently at the planning stage. Here the proposal is to use AD to heat 30 homes. The feedstock will be cattle slurry from 350 head of cattle on a local dairy farm.

4.6. The findings of a research study into the potential for AD in Pembrokeshire[24] concluded that three main centres might be established. This would potentially be better than a larger single unit due to the logistics of getting waste to the plant efficiently. All would need to be located in areas producing both agricultural and tourist wastes. The study also concluded that a local high value use for the heat generated[25] could be difficult to find and therefore the more likely market would be for electricity generation sold as Renewable Obligation Certificates (ROCs) (**Appendix 2**).

4.7. AD plants will be most cost effective if considered as part of waste management plans for farms, food processors and local authorities.

TYPES OF FEEDSTOCK WITHIN THE NATIONAL PARK

4.8. Within and close to the National Park the following feedstocks have the potential to be used in anaerobic digestion:

4.9. **Household / commercial waste residues[26]:** This includes biodegradable domestic waste, food and catering waste that might alternatively go to landfill or food wastes and food processing waste collected by local communities or from tourism providers.

4.10. The County Council is evaluating options for introducing AD within Pembrokeshire as it prepares to introduce food waste collections as part of its duty to separate municipal waste into distinct waste streams for appropriate treatment. A location has yet to be identified and approved. The project under investigation includes the treatment of slurries from the dairy industry – some of the contributing farms may be located within the National Park.

4.11. **Sewage sludge:** In the UK most water companies are now investigating the opportunities for AD at their sewage treatment works. Dwr Cymru Cyf (Welsh Water) is the Sewerage Agency for Wales and is responsible for Sewerage Services in the locality. In its Strategic Direction Statement (2007) it states: "*We will expand the use of advanced sludge digestion at key sites and use the methane gas produced to generate powe*r" (page 24).

4.12. There are no key sewage sites within the National Park. The nearest site to the National Park is at Narberth where Welsh Water runs an AD plant and Combined Heat and Power Unit. Given the low population density within the National Park (and potential difficulties in obtaining planning permission) it is unlikely that any "sludge centres" will be built in the Park by 2021.

4.13. **Farm wastes:** the National Park and Pembrokeshire more generally is a major livestock producing area with a large number of small dairy farms. There are currently 24 dairy farms within the National Park with the main concentration in the Presili area. **Table 4.1** shows the large amount of potentially collectible animal slurry in Pembrokeshire, primarily from cattle, particularly dairy.

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[24] ADAS Consulting 2005. Anaerobic digestion of domestic, industrial and agricultural wastes in Pembrokeshire

[25] Heat is difficult/expensive to transport and therefore requires a local market if its use is to be economic.

[26] A WAG funded scoping study into the use of energy from waste (EfW) technology (2007) for Pembrokeshire, Ceredigion and West Carmarthenshire has concluded that the disposal of residual waste (the material left over when all recycling and composting has taken place) is best treated through incineration, exporting energy as heat to local industry. This will therefore feature in the County's emerging Municipal Waste Management Strategy. Such a facility is not considered appropriate within the National Park, however, under the direction of the Regional Waste Management Plan (SW Wales Regional Waste Plan 1st Review Recommended Draft - March 2008).

4.14. This slurry comes from the indoor housing of animals in winter. Alternative feedstocks for digesters are required during the summer months - plant materials (see below), municipal and household wastes, and green wastes.

4.15. **Figure 4.1** identifies the farms within the National Park, all of which in one way or another could contribute to AD.

Table 4.1: Estimated livestock numbers for Pembrokeshire (2005)

	Approximate units	Potentially collectable waste (tonnes/year)
Dairy cows	62,000	745,490
Beef cattle	13,000	193,430
Sheep	140,000	24,420
Pigs	6,000	8,067
Laying hens	41,000	1,703
Poultry	270,000	3,554

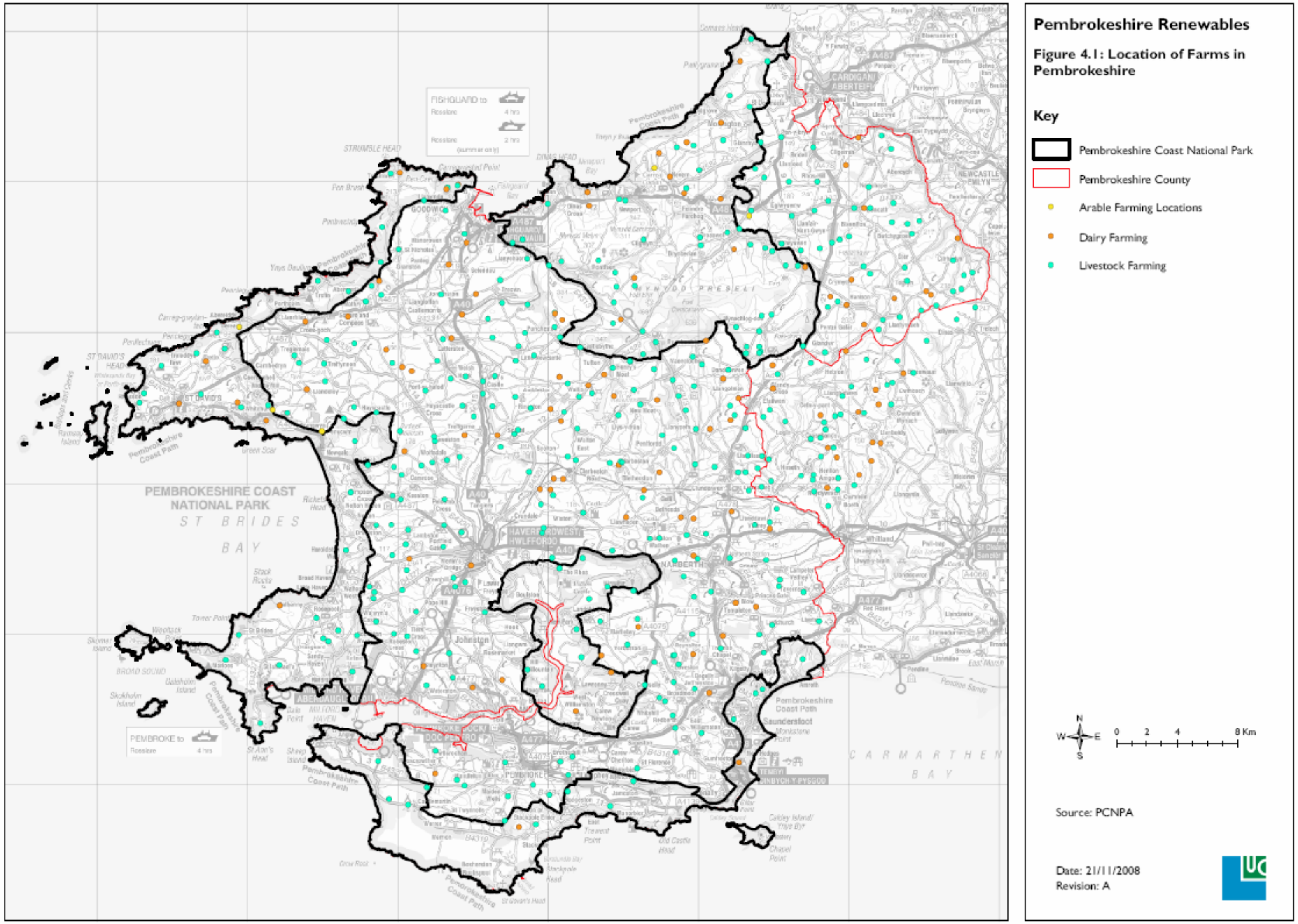
Source: ADAS (2005)[27]

4.16. The continuing availability of waste slurries is dependent on the future of farming in the area. Price volatility and the threat of animal diseases – e.g. bluetonge and bovine tuberculosis undermine the confidence of livestock farmers. Nevertheless, increasing concerns about national food security suggest a strengthening in the price of agricultural commodities in the short to mid-term. This may be accompanied by greater co-operation between farmers to capture more end value in the market place. It is also likely to be accompanied by continuing farm amalgamations, which may be beneficial for more centralised slurry production. On the other hand, the future may see a move to the New Zealand dairy farming system where cattle are kept outdoors the year round, removing the source of farm slurries.

4.17. **Agricultural crops:** Where farm wastes are used in AD these are often supplemented during the summer by farm crops grown for the purpose, such as whole-crop silage (maize), grass leys, and sugar beet. In many European countries grass/maize is grown specifically for anaerobic digesters under central government subsidy. In the National Park this is unlikely to be an option as these crops are needed in support of the livestock and dairy industry where crops for animal feed currently command a higher price than that grown for energy generation. There would therefore need to be a considerable rise in the value of energy crops for this change to occur and, if it did, it would suggest that livestock farming was no longer viable, thereby removing the availability of farm slurries.

[27] March 2005 Report: Anaerobic digestion of domestic, industrial and agricultural wastes in Pembrokeshire

Figure 4.1: Location of farms in Pembrokeshire



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4.18. **Alternative plant materials:** Other sources of vegetation waste that have also been considered as a feedstock for AD include (see also 3.17):

- Hedge arisings and weeds which have the potential to be used as top-up feedstock. Pbe are currently looking to maximise these wastes from their Miscanthus projects (see para 3.24)
- Algal blooms and blanket weed from the water bodies of Stackpole Estate, which are currently composted (100 tonnes annually)
- Harvested heathers and bracken from heathland, as an alternative to burning in-situ to rejuvenate the heathlands, although mechanised cutting is likely to be difficult given the often steep and rocky terrain
- Wild rushes and reeds from the annual mechanised removal of dead growth.

4.19. It is probable that these conservation arisings will be better suited to anaerobic digestion than use in biomass plants as no form of processing is required in the case of feedstocks for AD. The differential availability of different feedstocks at different times explains why most AD units rely on a range of feedstocks.

OPPORTUNITIES AND CONSTRAINTS FOR ANAEROBIC DIGESTION PLANTS

4.20. For AD plants the main opportunities and constraints are set out in **Table 4.2** and can be summarised as follows:

4.21. Overall AD offers significant potential for the generation of electricity and heat within the National Park. This particularly relates to small-scale plants servicing one or two farms (see paras 9.2 – 9.6).

4.22. Anaerobic digesters utilising farm and food wastes bring considerable benefits. They convert methane, a significant greenhouse gas and a major by-product of animal slurries from livestock farming and anaerobic decomposition of food waste, into energy (electricity and heat). They therefore make a significant contribution to reducing greenhouse gas emissions, both by reducing the quantities of methane released into the atmosphere, and by providing a carbon neutral energy source that substitutes for energy generated from fossil fuels. They also provide a form of farm diversification with the opportunity to sell energy in the form of electricity or heat.

4.23. So long as these digesters are integrated into the existing farm complex, or existing settlement area, and natural screening is provided where appropriate, small digesters can be incorporated into the wider landscape and should not conflict with the National Park management plan objectives. Larger digesters, shared between a number of farms will need to be considered on their merits with regards to impacts on landscape and the built environment.

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Table 4.2: ANAEROBIC DIGESTION	
Opportunities	**Constraints**
Provides a safe and productive use for a wide range of waste materials	Larger digesters shared between a number of farms will need to be considered on their merits with regard to impacts on landscape and the built environment
Can rely on consistently available local feedstocks, combining agricultural wastes in winter with tourism food wastes in summer – camp sites, caravan parks and hotels provide a significant seasonal increase in locally generated green waste	Odour, dust and air quality issues require regulatory control
Provides a cost effective alternative waste treatment method, reducing the amount of waste to landfill, increasingly important with rising land fill costs	Water produced during process can be contaminated with nitrates and other chemicals – needs to be processed before release to the environment
Significantly reduces the amount of agricultural methane released into the atmosphere. Methane is one of the most potent greenhouse gases (21 times stronger than CO_2)	An expensive technology requiring grant to encourage development under current circumstances
Helps meet the Nitrates Directive, with the resultant digestive being more stable and less likely to leach nitrates than raw sewage sludge	Lack of year-round availability of feedstock, especially if more cattle are housed outdoors in winter
Provides a carbon neutral form of energy production	
Could provide a future market for conservation wastes	
Allows energy production to be symbiotic with mainstream food production	
On farms, small digesters can be integrated into the existing farmstead thereby minimising impact on this sensitive landscape	
Scope for digesters to be located near existing settlements to maximise use of heat as a by-product	
At least one existing small-scale example within the National Park	
Brecon Beacons National Park Authority has promoted first AD plant within that National Park with WAG funding	
Support and funding for commercial AD development available from WAG Materials Action Programme – providing 30% of capital costs for any digestion facility set up to process commercial and industrial	

Table 4.2: ANAEROBIC DIGESTION	
Opportunities	**Constraints**
waste in Wales before March 31, 2009. Also WAG funding of AD centre of excellence at University of Glamorgan (for details see Chapter 11)	
If electricity is produced, can raise income from the sale of ROCs (**Appendix 2**)	
Development of an Environment Agency Quality Protocol (quality assurance guidelines) for AD to enable fully recovered waste products to be sold and used without the need for waste management controls	
Scope for development of hydrogen as a biogas learning from local expertise in South Wales (hydrogen Farm in Carmarthenshire and University of Glamorgan)	

5. MICRO-HYDRO

PRINCIPLES OF THE TECHNOLOGY

5.1. Water flowing from a higher to a lower point is used to drive a turbine which produces mechanical energy. This is usually turned into electrical energy by a generator.

5.2. Hydro power is well developed in Wales where most sites with a potential greater than 1 MW have been exploited. Within the Pembrokeshire Coast National Park the only realistic option will be micro-hydro with an installed capacity of less than 100kW or less. The majority of micro-hydro schemes are low head 'run of river' or tidal water schemes where water is taken from a river behind a low weir with no facility for water storage and then returned to the same water course having passed through the turbine. Typical examples are mills and weirs.

Low head water mill at Y Felin

Carew tidal mill

High head schemes however require a significant fall and a strong river flows. Development is therefore likely to take place in hilly or mountainous areas.

Glen Lyn Gorge high head hydro scheme – North Devon National Park

TYPES OF MICRO-HYDRO PLANT

5.3. New technology, less stringent regulation of grid-connected micro hydro generators and standardised turbine designs are now encouraging more widespread interest in micro-hydro in the UK. The key elements of a micro-hydro scheme are:

- a source of water that will provide a reasonably constant supply. Sufficient depth of water is required at the point at which water is taken from the watercourse – this is usually achieved by building a weir across the watercourse (of sufficient height to fill the penstock). This is called the ‘intake’.

- a pipeline, often known as a penstock, to connect the intake to the turbine. A short open ‘headrace’ channel may be required between the intake and the pipeline, but long headrace channels are rare due to environmental and economic constraints.

- a cover / small shed housing the turbine (converting hydro power into rotating mechanical power), generator (converting the mechanical power into electricity) and ancillary equipment – the ‘turbine house’.

- a ‘tailrace’ returning the water to the watercourse; and

- a link to the electricity network, or the user’s premises

5.4. The costs of micro-hydro are very site specific. For low head systems (not including the cost of the weir) low cost turbine-generator units have now been developed for a wide range of heads and flows. These are manufactured in the UK and available at prices of less than £2,000 per kW/hr. A typical 5kW domestic scheme might cost £20-£25,000 with unit costs dropping for larger schemes. Maintenance and running costs are low and systems have a life of over 25 years.

5.5. Overall total system costs can be high but for premises with no mains connection and access to a micro-hydro site, they can generate a steady more reliable electricity supply than other renewable technologies at a lower cost. Costs will often be less than the cost of a grid connection and with no electricity bills to follow. In off-grid applications the power is used for lighting and electrical appliances but space and water heating can be supplied when available power exceeds demand.

Micro-hydro in the National Park

5.6. There are no medium or large scale hydro schemes within the National Park as topography, rainfall levels and the network of relatively small rivers and streams do not provide sufficient resource.

5.7. The use of water power at the micro level however is long established in the National Park, with at least 10 traditional water mills. Most of these are either disused or converted to other uses. However, three working mills still remain as tourist attractions, namely:

- *Carew Mill* - an early 19^{th} century Tidal Corn Mill with two wheels and a vast 23 acre millpond, part of Carew Castle site;
- *Tregwynt* - Waterwheel turns but no longer powers the machinery at the Tregwynt woollen mill;
- *Solva Mill* is a 20^{th} century working Woollen Mill. The water wheel was restored for the Mill's Centenary in 2007.

5.8. Just outside the National Park located in the village of St Dogmaels is a working Corn Mill of 17^{th} century origin known as Y Felin. Current proposals are to use the mill to generate 10kW of energy. There is also at least one active micro-hydro scheme on a farm (south of Dinas Head), while many farmers within the Park are interested in investigating micro-hydro opportunities.

AVAILABILITY OF WATER

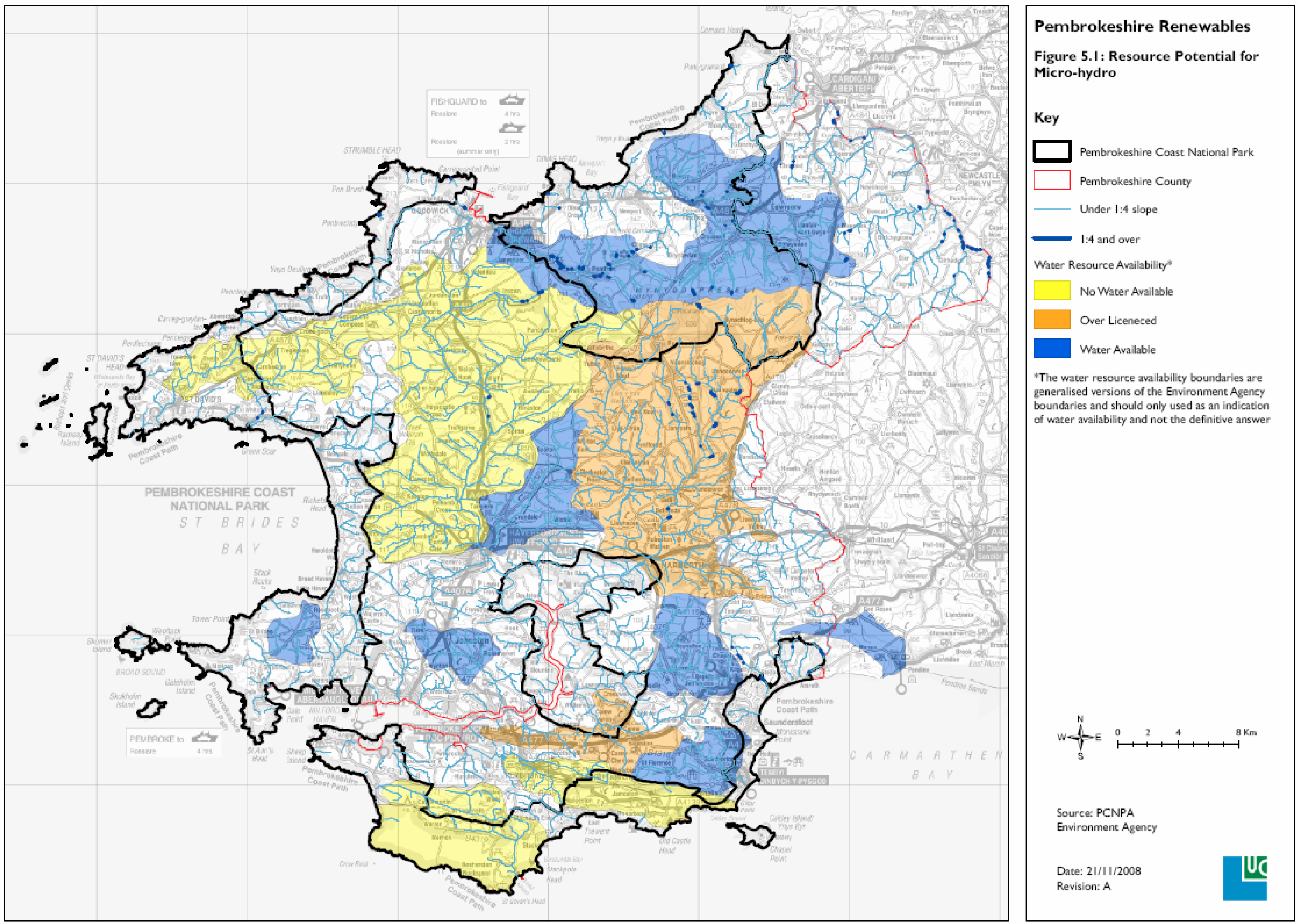
5.9. The rivers within the Park are all surface water-dominated with rapid changes in flows observed soon after rainfall events. The inland rivers include the Eastern and Western Cleddau, Creswell, Carew, Gwaun and Nevern. These are all typical Welsh rivers in that they are steep, fast flowing and shallow in their upper reaches, and become slower, deeper and more meandering towards their tidal limit. The smaller coastal streams vary from steeper shallower catchments, like the Solva and the Westfield Pill, to low lying sluggish catchments such as the Ritec and Castlemartin Corse.

5.10. Rainfall in the coastal areas of Wales is less than 1,000 mm year, considerably less than the mountainous areas of Snowdonia and the Brecon Beacons, where the yearly fall exceeds 3,000mm, comparable with that in the English Lake District or the western Highlands of Scotland. The months from October to January are significantly wetter than those between February and September. (Source: The Met Office), although with climate change rainfall events are becoming less predictable.

5.11. **Figure 5.1** highlights the sections of river and watercourse within the National Park with gradients of 1 in 4 or more, i.e. steep slopes which provide the potential of a high head (the vertical drop) required for generating hydro power. These are mainly concentrated in the Preseli Mountains. The map does not however indicate volume of water (flow) as this will vary between seasons and rainfall events and is site specific, requiring the collection of local data availability.

5.12. A further constraint is the availability of water. All hydro schemes require an abstraction licence from the Environment Agency. The Agency is less likely to grant a licence if the water course links to water habitats of international importance (see **Figure 2.2**). Abstraction licences may also be withheld in areas identified by the Agency as 'Over Abstracted' or 'No Water Available', also indicated in **Figure 5.1**. In the main these areas are found in the southern part of the Park and inland from St David's Head.

Figure 5.1: Resource Potential for Micro-hydro



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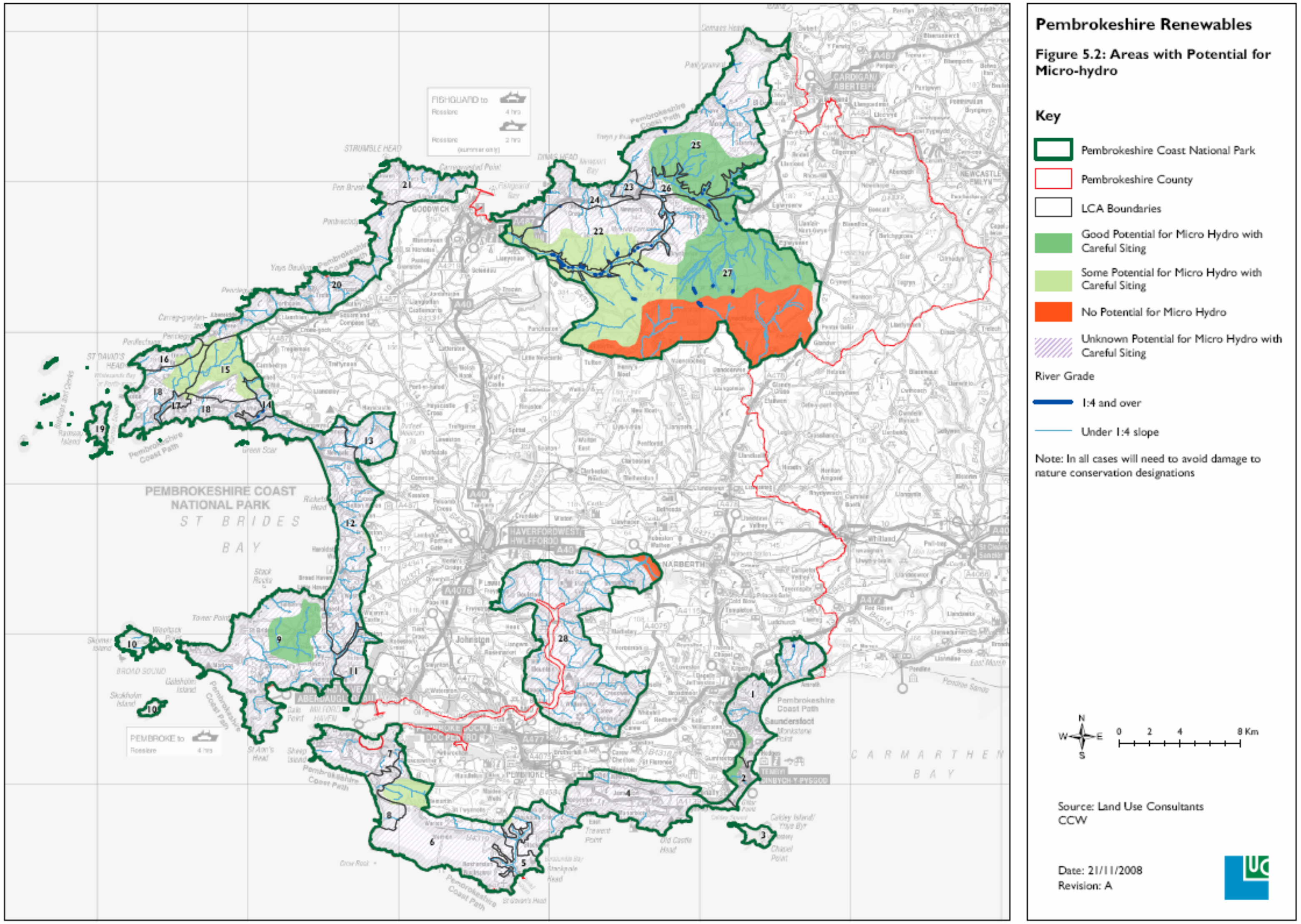
OPPORTUNITIES AND CONSTRAINTS FOR MICRO-HYDRO

5.13. For micro-hydro the main opportunities and constraints are set out in **Table 5.1,** with the main areas of potential for micro-hydro identified in **Figure 5.2.**

5.14. Although there is an abundance of rivers and streams, the lack of areas suitable for high head sites (> 1 in 4 slope steepness) and low head sites due in the main to environmental constraints, mean that there is no significant potential for generating electricity from hydro-electricity at the small scale. However, as feasibility is so site specific, there may be scope for harnessing support from WAG via the Convergence Fund to investigate potential for community-scale hydro schemes**.** The knowledge and skills of the local Energy Area Groups supported by PLANED, plus local Environment Agency representatives, and the mapped constraints and opportunities provided through this study should assist in defining more specific areas of potential. Future schemes could include further re-activation of old mills, and use of the technology by local farmers/landowners for non-grid connected power production**.**

Table 5.1: MICRO-HYDRO	
Opportunities	**Constraints**
Useful standalone power source for isolated commercial operations (farms etc) off the grid or where power supplies are unreliable	Environment Agency licence determination required re: water abstraction/quality/flow and environmental impact assessment required if important habitats may be affected
Good community projects with low maintenance costs and regular income and potential for re-activation of historic water mills within the Park	Limited areas of suitable topography (i.e. hilly areas with spring fed streams)
Good correlation with demand i.e. maximum output in winter and slow rate of change in output compared to wind energy	Variable water resource i.e. less in drier years, and times of high (tourist) demand (summer) – predicted that climate change will bring wetter winters and drier summers by the 2020s
Long lasting and robust technology requiring little maintenance	Costs – very site specific. Detailed feasibility study required on site by site basis i.e. head and flow rates, grid connection, works required, environmental impact assessment, planning permission
Environment Agency Water Resource Management Units (WMRU) cover large areas of the Park and define areas of water abstraction availability	
Highly carbon efficient	
Built elements are small and usually of a scale in keeping with natural environment in which they are sited	
Several funding sources including income from ROCs (See Chapter 11 and **Appendix 2**)	

Figure 5.2: Areas with Potential for Micro-hydro



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6. GROUND AND AIR SOURCE HEAT PUMPS

PRINCIPLES OF THE TECHNOLOGY

6.1. **Ground source heat pumps:** Ground source heat pump systems capture the energy stored in the ground surrounding (or even underneath) buildings or from water (rivers, canals, lakes or underground aquifers). Essentially they use low grade thermal energy from the ground and a refrigeration cycle to deliver heat energy at higher temperatures, (typically 40-45°C) or low temperatures, using a reverse cycle, for cooling (typically 6-12°C).

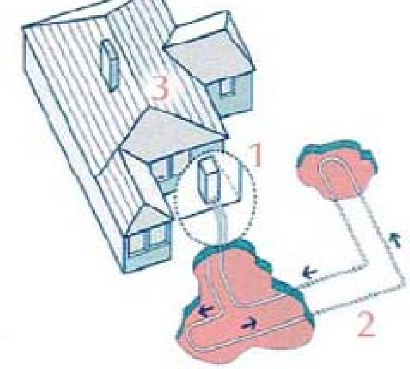
6.2. **Air source heat pumps:** An air source heat pump uses the air as a heat source for heating a building. Heat pumps tend to be much easier and cheaper to install than ground source heat pumps (as they lack any need for external heat collector loops), but are also usually less efficient, can be visually intrusive (as they tend to be mounted external to a property) and occasionally noisy.

TYPES OF PLANT

6.3. **Ground source heat pumps:** Many systems collect or deliver heat using ground collectors (typically coils or loops of pipe laid in trenches in the ground or vertical boreholes), in which a heat exchange fluid circulates in a closed loop and transfers heat via a heat exchanger to/ or from the heat pump. The heat pump itself is a similar size to a large fridge and is situated inside the building. A typical ground-source heat pump (GSHP) system has three major components: a heat pump, an earth collector loop (which may be laid in a trench or in boreholes) and an interior heating or cooling distribution system. Boreholes are drilled to a depth of between 15 - 150 metres and benefit from higher ground temperatures than trenches.

6.4. A typical 8kW system costs £6,400-£9,600 plus the price of connection to the distribution system. This can vary with property and location. Combining the installation with other building works can reduce costs. Currently GSHPs are most competitive in terms of running costs when compared to alternative conventional heating systems where mains gas is not available and where the building is well insulated.

Figure 6.0: Typical layout of a ground source heat pump



1. – Heat Pump
2. – Heat Collector Loop
3. – Internal Heating/cooling distribution system

Source: RetScreen International (2005). GSHP Project Analysis.

6.5. Currently there are four non domestic GSHP installations within the National Park and at least four residential installations in Pembrokeshire. Three of the latter are horizontal ground loops and one a pond loop located in Haverfordwest, Narberth and near Carew. Sizes range from 8 – 17kW.

Carfai Farm in the National Park near St David's has installed two 12kW GSHP horizontal trenched systems within a nearby field to provide space heating, cooling and domestic hot water to the farm complex. The field was chosen because it contains natural springs and has a higher water table. A better heat transfer from the soil occurs in wet rather than dry ground.

6.6. **Air source heat pumps:** An air source heat pump (ASHP) is similar to (and are in effect) an air-conditioning unit running in reverse. They can either be mounted directly on an external wall (sometimes under a window), or can feed a centralised ducted warm air central heating system. They can therefore be considered for retrofitting to previous gas systems installed in the 1960s/70s. Air source heat pumps generally have lower running costs and CO_2 emissions than electric storage heaters, but are likely to be more expensive to operate (with higher CO_2 emissions) than a well designed gas condensing boiler system. However they may be a sensible retrofit option where mains gas is unavailable.

6.7. Currently there are few air source heat pumps installed in the UK. Transco has supported some trials, and the largest known installation is a mixed renewables scheme serving 112 homes in Bishop Auckland, County Durham, where a community wind turbine is supported by Ground Source Heat Pumps, Air Source Heat Pumps (ASHPs) and storage heaters.

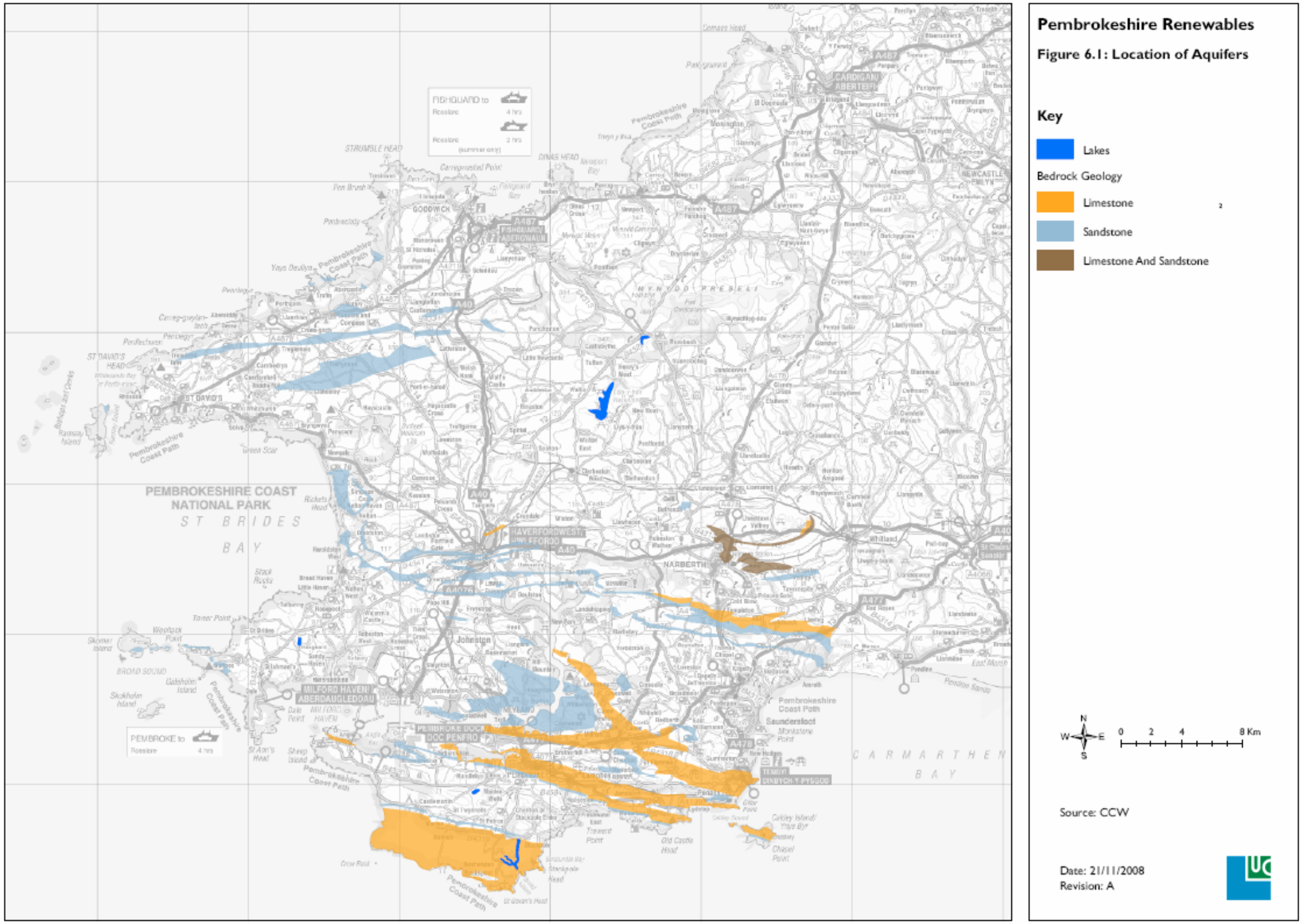
RESOURCE AVAILABILITY

6.8. Useful heat energy can be extracted from the ground (via loops placed in vertical boreholes or trenches or in the foundation piles of larger buildings) or from surface water (ponds, lakes, reservoirs, rivers or canals), or from the air. There are opportunities to exploit these resources throughout the Park.

6.9. Open loop systems use water from underlying aquifers, flowing from an abstract well to a reject well. Low grade thermal heat energy is effectively 'pumped' to deliver heat energy at a more useful temperature for heating (or cooling) buildings. **Figure 6.1** highlights the location of the bedrock geology for aquifers within the Park where open loop systems could be used.

6.10. Clearly there is no resource restriction on the location of air source heat pumps.

Figure 6.1: Location of Aquifers



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OPPORTUNITIES AND CONSTRAINTS FOR GROUND AND AIR SOURCE HEAT PUMPS

6.11. For ground and air source heat pumps the main opportunities and constraints are set out in **Table 6.1** and can be summarised as follows:

6.12. Overall, the availability of good ground conditions, aquifers and water bodies and the dispersed settlement pattern creates ideal opportunities for the development of all heat pump technologies.

6.13. Once operational **ground source heat pump** systems are unlikely to have any landscape or visual impacts. They also offer a considerable reduction in carbon emissions when compared with even the most efficient forms of traditional heating systems e.g. gas condensing boilers. Their use is therefore strongly supported within the National Park. Indeed they can be 100% renewable if solar PV (see Chapter 7) or some other form of renewable electricity generating system is installed to offset the use of grid electricity needed to provide continuous power for the operation of the compressor and pump.

6.14. **Air source heat pumps** raise issues of noise and visual impact so care is needed to minimize these issues. Specific advice should be sought from the National Park Authority Building Conservation Officer in the case of conservation areas and listed buildings/.

Table 6.1: HEAT PUMPS	
Opportunities	**Constraints**
Best suited to properties off mains gas supply where running costs are very competitive with conventional fuels	Excavation for GSHPs could impact on underground archaeology so advice would need to be sought
Opportunities for use on most farms and community buildings and within new development	Area of available open ground adjacent to the building may limit the use of trenching. Collector pipes in boreholes require much less open ground than trenching for the same size of heat pump; but drilling is more expensive than trenching
Deliver 3 - 4 units of heat for every unit of electricity supplied to the heat pumps	Expensive system compared to conventional heating
Easy to operate, low maintenance with long term reliability	Low take up rate to date in UK ie.750 – 2,000 GSHP by 2007 (annual sales 100); 160 ASHP by 2007 (annual sales 100). Forecast take up rate unlikely to improve as a result of other competing renewable heat technologies such as solar thermal, fuel cells and micro CHP (source: Element Energy report footnoted elsewhere)
Can be designed to provide summer cooling	
Have minimal visual impact once installed	
Popularity growing with technological and installation improvements	
Ground source heat pumps show reduced carbon emissions when compared to the most efficient forms of traditional heating (i.e. condensing boilers) - these savings can be increased further if electricity used to run the pumps is from a renewable source	
Existing examples of heat pumps within and close to the National Park	
In time air source heat pumps may overtake ground source pumps as cheaper	
Several funding sources (see Chapter 11)	

7. SOLAR TECHNOLOGIES

PRINCIPLES OF THE TECHNOLOGIES

7.1. All these technologies are concerned with capturing energy from the sun. The three technologies considered here are solar hot water (SHW); Photovoltaics (PV); and Active Solar Space Heating.

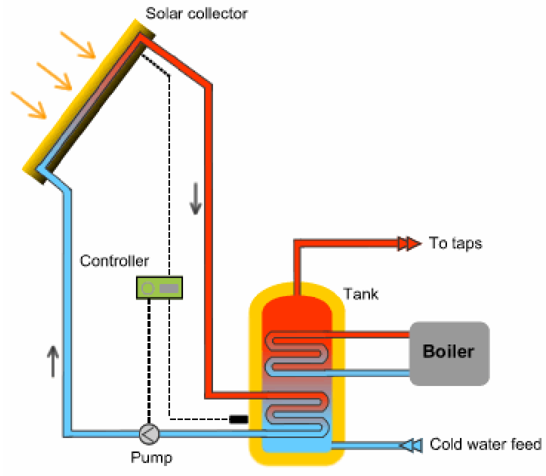
TYPES OF TECHNOLOGY

7.2. **Solar hot water:** Solar water heating is deployed primarily as a building mounted technology serving the needs of the building with which it is associated. It involves collecting heat from the sun via highly heat-absorbent collectors. Two main types are common in the UK: flat plate collectors and evacuated tube collectors, the latter being more effective throughout the year but more expensive. In both types, radiation from the sun is collected by an absorber plate in the collector, and is transferred as heat to a liquid, which may be either water, or a special fluid employed to convey the energy to the hot water system using a heat exchanger.

7.3. These systems are a long established renewable technology. They are generally easy to install and can heat water throughout the year. They work best alongside existing water heating systems which can help top up the heat required in winter months when solar energy is less.

7.4. System sizes vary in scale, so can be used for a variety of applications for the production of domestic or industrial hot water or the heating of swimming pools. The typical installation cost for a domestic system is £2,000 - £5,000 providing 50-70% of annual household hot water needs. They have a life of 20 – 30 years and little maintenance is needed.

Figure 7.1: Typical solar hot water system



Source: Solar Trade Association

7.5. **Photovoltaics (PV):** Solar Photovoltaics (PV) produce electricity from the light of the sun. PV can either be roof mounted or free-standing in modular form, or integrated into the roof or facades of buildings through the use of solar shingles, solar slates, solar glass laminates and other solar building design solutions. The most common form of device comprises a number of semiconductor cells which are interconnected and encapsulated to form a solar panel or module. There is considerable variation in appearance, but many solar panels are dark in colour, and have low reflective properties.

7.6. Solar panels are typically 0.5 to $1m^2$ having a peak output of 70 to 160 watts. A number of modules are usually connected together in an array to produce the required output, the area of which can vary from a few square metres to several hundred square metres. A typical array on a domestic dwelling would have an area of 9 to $18m^2$, and would produce 1 to 2 kW peak output. The electricity produced can either be stored in batteries or excess fed into the grid via the mains supply.

7.7. PV remains expensive even though prices are falling. Prices vary, depending on the size of the system, type of PV cell used and type of building that it serves. The size of the system is dictated by the amount of electricity required, with the average domestic system costing around £4,000- £9,000 per kW peak installed. Solar tiles cost more than conventional panels, and panels that are integrated into a roof are more expensive than those that are roof mounted. Maintenance requirements are low and PV cells can be expected to last for 30 – 40 years.

7.8. In the UK, PV systems are currently deployed in association with individual buildings. In continental Europe very large field-scale PV arrays are being used, replacing food production as a major farm diversification activity.

7.9. There are currently approximately 100 solar hot water units and nine PV units. The two largest arrays are located on Smalls and South Bishop lighthouses located on two islands off the coast but within the National Park area.

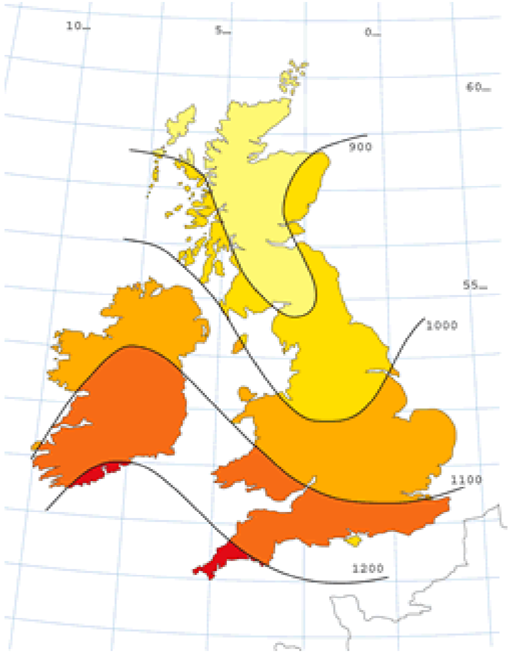
7.10. **Active solar space heating:** Active solar space-heating systems consist of collectors that collect and absorb solar radiation combined with electric fans or pumps to transfer and distribute that solar heat. Active systems also generally have an energy-storage system to provide heat when the sun is not shining. The two basic types of active solar space heating systems use either liquid or air as the heat-transfer medium in their solar energy collectors.

7.11. Liquid-based systems heat water or an antifreeze solution in a hydronic collector. Air-based systems heat air in an air collector. Both of these systems collect and absorb solar radiation, then transfer the solar heat directly to the interior space or to a storage system, from which the heat is distributed.

RESOURCE AVAILABILITY

7.12. The National Park receives average to good levels of solar radiation, compared to the rest of the UK (**Figure 7.2** below).

Figure 7.2: UK solar irradiation - Annual Total kWh/m^2 banding



Map showing average annual solar radiation on a 30° incline facing due south
Source: Solar Trade Association

7.13. The maximum amount of solar radiation energy falling on Milford Haven for example is around 111 GWh/year, in theory a substantial amount of energy. An average annual sum of global solar irradiation falling on horizontal surfaces in the area would be 1099 kWh/m^2/year; this is synonymous with the mid range band of irradiation in the UK.

7.14. **Figure 7.3** confirms the yearly total of global irradiation within the National Park area on an optimally-inclined surface, i.e. 35% - Source: http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php#

OPPORTUNITIES AND CONSTRAINTS FOR SOLAR TECHNOLOGIES

7.15. For SHW and PV the main opportunities and constraints are set out in **Table 7.1** and can be summarised as follows:

7.16. Overall, there is very significant technical potential for the further development of solar hot water – stakeholders see this as a key technology for meeting renewable energy targets in the National Park for private, commercial and community buildings, so long as care is taken to minimise the visibility of the units and /or it is integral to the building design (in the case of new builds and extensions). Specific advice should be sought from the National Park Authority Building Conservation Officer in the case of Conservation Areas and Listed Buildings.

7.17. PV has the same technical potential, but less overall potential because of cost and relatively low power generation, although power can be sold to the grid at times when generation exceeds use. Further, development of field-scale PV systems (as being developed in continental Europe) would not be appropriate given the national status of this landscape, with its characteristic open and natural character.

Figure 7.3: Yearly total of global irradiation on optimally inclined surface (35°) for Pembrokeshire

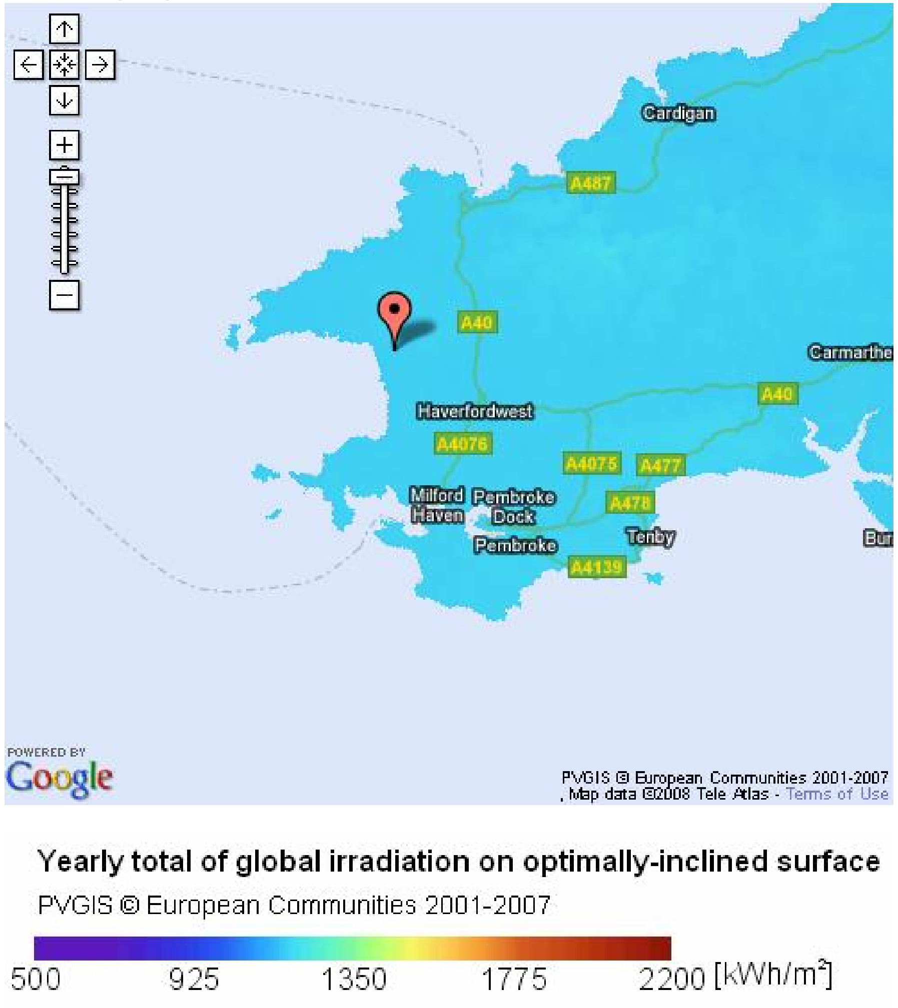


Table 7.1:	SOLAR TECHNOLOGIES
Opportunities	**Constraints**
Suitable for domestic, business and community use with scope to use both technologies, for example, in tourism developments e.g. caravan parks	Shading can severely reduce performance of solar technologies
Solar hot water is cost effective if correctly installed	PV produces relatively low power generation
Both have low maintenance requirements and longevity	PV is still an expensive technology for amount of energy generated
Both SHW and PV now fall under new General Permitted Development Order (GPDO) so do not require planning permission, reducing costs and time	Care needed in siting in Conservation Areas and on Listed Buildings; in these circumstances the advice of the National Park Authority Building Conservation Officer should be sought
Both SHW and PV deliver real carbon savings with short CO_2 payback period for energy used in manufacture and installation	Stakeholders gave anecdotal evidence of unregulated unaccredited installers working within the local community giving poor service, installing inefficient systems and giving technologies a bad reputation.
In new development there is scope to fit systems integral to the overall design.	
Retrofit systems should be located on a rear pitch roof (south facing), or on a flat roof, or roof of adjacent buildings or incorporated as a garden feature to minimise visual impact.	
PV can be standalone or grid connected with electricity sold to the grid when generation exceeds use (see **Appendix 2**)	
Pembrokeshire falls within the second highest irradiation zone in the UK	
Many SHW examples in the National Park, with some PV examples	
Several funding sources (see Chapter 11)	

8. WIND

PRINCIPLES OF THE TECHNOLOGY

8.1. Wind turbines are one of the best known and understood renewable technologies. Wind turbines use the wind's lift forces to rotate aerodynamic blades that turn a rotor that creates a mechanical force that creates electricity. The amount of energy derived from a wind turbine depends on wind speed and the swept area of the blade (the greater the swept area, the more power the turbine will generate).

8.2. Wind turbines can be deployed singly, in small clusters, (2 – 5 turbines) or in larger groups as wind farms (typically 5 or more turbines). In the Pembrokeshire Coast National Park the only potential will be as single turbines or, in very specific cases, small clusters, as set out in the separate landscape sensitivity study.

TYPES OF TECHNOLOGY

8.3. In all cases wind turbines consist of the tower, hub, blades, nacelle (which contains the generator and gear boxes) and a transformer that can be housed either inside the nacelle or at the base of the tower.

8.4. Wind energy developments are unique in relation to other tall structures, in that they introduce a source of movement into the landscape. In most current designs the turbine blades turn around a horizontal axis but in some designs (which have been deployed in and around the National Park) the blades turn around a vertical axis. These latter designs generate similar quantities to other turbines of equivalent size and are generally less visually intrusive as the turbine blades are less visible.

8.5. In the context of Pembrokeshire Coast National Park four sizes of wind turbine have been considered. The size of turbines is normally judged in terms of the amount of energy generated but given the sensitivity of this national landscape this study has also defined size of turbine according to height to blade tip. The four size classes (classified to reflect the landscape sensitivities of the National Park) that have been considered are:

Size	Height[1]	Energy output[2]	Cost of turbine[3]
Large	65m – 125m	330kW - 3MW	£800k - £1.3m
Medium	25m – 65m	50kW – 330kW	£130k - £800k
Small	<25m	10 kW - 50 kW	£10k - £139k
Micro	Building or mast mounted	< 10kW	£1.5k - £10k

1 Height to blade tip
2 Efficiency and energy output is increasing all the time and therefore these values are likely to increase over time
3 These are the installed cost. A 15kW Proven costs £45k and a 50kW Atlantic Orient costs in the region of £150k (costs could be reduced if an open lattice tower is used). A 200kW turbine might cost around £150k if obtained secondhand from Europe

8.6. **Large-scale turbines (65m – 125m producing 330kW – 3MW):** Turbines of this scale will normally be operated commercially with electricity sold to the grid. For the purposes of comparison a turbine of this scale could serve the electricity needs of the following number of households:

- 1 x 330kW turbine serving 219 households
- 1 x 800kW turbine serving 564 households
- 1 x1.3 MW turbine serving 796 households
- 1 x1.8 MW turbine serving over 1,000 households

8.7. The infrastructure requirements for large-scale turbines, in addition to the turbine itself, include:

- road access to the site
- on-site tracks
- turbine foundations
- temporary crane hardstanding areas
- one or more anemometer masts
- temporary construction compound
- electrical cabling and an electrical sub-station/control building plus connection to the grid.

8.8. The turbines can have a life of up to 25 years but will require daily/weekly maintenance checks.

8.9. Despite the high capital costs, on a site with good wind speeds, large-scale wind turbines are currently one of the most economically viable forms of renewable energy due the support given to wind through the Renewables Obligation (**Appendix 2**). Large-scale wind turbines are generally more efficient and deliver greater carbon savings than smaller turbines. Typical commercial scale turbines of 500kW – 2 MW can pay back the energy used in their manufacture and construction within approximately six months, depending on location.

8.10. **Medium-scale turbines (25m – 65m producing 50kW - 330kW):** Turbines of this scale may be developed for commercial production but, more often may be deployed singly in support of individual developments (with an 80kW turbine producing sufficient electricity to serve 58 households); as part of a community project or linked to a farm, production unit or school. In addition to the turbine, which may have a lattice base, the other elements of infrastructure needed are as for a large-scale turbine.

8.11. Although potentially focusing on serving local energy needs, nearly all turbines in this category will be connected to the grid, allowing the sale of unused electricity generated.

8.12. Medium sized turbines can be purchased new or, subject to availability, second-hand from Europe (where many are being replaced by larger turbines on the same site). Medium-scale wind turbines are generally less efficient and deliver lower carbon savings than larger turbines but can still pay back the energy used in their manufacture and construction within approximately 1.5 years, depending on location.

8.13. **Small-scale turbines (<25m producing 10kW – 50kW):** These turbines can be used by individual households (although the optimal size for an average sized household would be in the range 1.5kW – 3kW dependent on level of electricity use) or to provide power to a community hall or other public building. A 15kW turbine could provide enough electricity to serve the needs of 4 – 8 households.

8.14. A typical 6kW mast mounted turbine (such as a Proven WT 6000) has a height to blade tip of 19m. Small-scale turbines can either be connected to the grid or operated with battery storage systems.

8.15. **Micro-scale turbines:** These can be either building or mast mounted turbines. A typical turbine such as the Swift has a rated output of 1.5kW and a blade length of 1m. The present electricity generation of micro-turbines is relatively inefficient and does not appear to be delivering the power outputs advertised.

Nor do these turbines deliver carbon savings[28]. They are therefore not considered further here.

Wind turbines in the National Park

8.16. **Inside the National Park**: Since 1999, the Pembrokeshire Coast National Park Authority has granted planning permission for a total of 10 small scale/micro wind turbines in the National Park, either mast mounted or building mounted. Two applications for micro wind turbines have been refused.

8.17. Applications for large-scale wind turbines have also been submitted, but all these have been refused on the basis that their proposed locations would damage the environmental qualities of the National Park. At the present time no larger-scale community owned wind energy developments have been proposed/approved within the National Park.

8.18. **Adjacent to the National Park**: There have been a number of applications for large-scale wind farms adjacent to the National Park area varying from 2MW – 9.8MW in scale. These have been refused either on the basis of proximity and visual impact upon the National Park or proximity to Scheduled Ancient Monuments. However, two medium-scale standalone turbines of 490kW and 500kW respectively have been approved close to the National Park boundary, one at Lodge Farm north of Hubberston, the other at Castle Pill, east of Milford Haven.

[28] "Small-scale wind energy: Policy insights and practical guidance", Carbon Trust , August 2008; "Micro-wind Turbines in Urban Environments", Building Research Establishment, Dec 2007

RESOURCE AVAILABILITY

8.19. Wind speeds across the National Park have been estimated using the DBERR[29] wind speed database. Currently the BWEA[30] suggests that a large wind turbine requires average wind speed of more than 7m/s to be viable. Small turbines may be viable with average wind speeds as low as 5m/s.

8.20. **Figures 8.1 – 8.3** show the areas of the National Park that experience viable wind speeds at three prescribed heights above ground level provided by the DBERR wind speeds data base.

- **Figure 8.1** – Wind speeds at 45 metres height (over 7 metres per second)
- **Figure 8.2:** – Wind speeds at 25 metres height (over 7 metres per second
- **Figure 8.3** – Wind speeds at 10 metres height (over 5 metres per second)

8.21. The data are an estimate, generated by air flow modelling that estimates the effect of topography on wind speed. The model has been applied with a 1km square resolution and takes no account of small-scale topography or local surface roughness (such as tall crops, stone walls or trees), both of which may have a considerable effect on wind speed. Also no allowance is made for the effect of local thermally driven winds such as sea breezes or mountain/valley breezes. The data therefore only provides a rough guide and should be followed by on-site measurements to obtain an accurate assessment.

[29] Department for Business, Enterprise and Regulatory Reform
[30] British Wind Energy Association (BWEA) : Wind Power: A guide for farms and rural businesses (November 1994)

8.22. **Opportunities for large-scale wind generation (65m – 125m producing 330kW – 3MW) (Figure 8.1):** The data shows, not surprisingly, that the areas where the highest wind speeds are recorded in the National Park at 40m above ground level are in the uplands, i.e. the Preseli Mountains (were there are peaks between 400 - 500 metres above sea level); the hills east of Newport and Dinas Head; and the exposed coastal peninsulas of St David's, Marloes, St Brides, Dale, Angle, Castlemartin and Stackpole.

8.23. The more sheltered coastal area around Saundersfoot and Tenby plus the low lying inland estuarine hinterland of the Cleddau and Western Cleddau rivers experience the lowest wind speeds.

8.24. **Opportunities for medium-scale turbines (25m – 65m producing 50kW - 330kW) (Figure 8.2):** Here the results show that there are fewer locations within the National Park at a height of 25m that achieve the viable higher wind speed of > 7m/s for medium scale turbines. Again good locations predominate around the upland coastal areas and in the Preseli Mountains but, of course, at 40m above ground level the areas identified in **Figure 8.1** will apply.

8.25. **Opportunities for small-scale turbines (<25m producing 3kW – 50kW) (Figure 8.3):** The results show that with the exception of some of the lowland areas of the inland estuarine hinterland of the Cleddau and Western Cleddau rivers, the sheltered coastal area around Saundersfoot and the valleys or wind sheltered slopes of the Preseli Mountains, there is considerable opportunity for small scale wind generation within the National Park.

8.26. There will however be some locations where the prevailing wind cannot be exploited i.e. where buildings and other obstructions may have a detrimental effect on the quality and quantity of the wind resource. These would need to be assessed. The Energy Saving Trust Website provides the following advice:

Ideally, you should undertake a professional assessment of the local windspeed for a full year at the exact location where you plan to install a turbine before proceeding. In practice, this may be difficult, expensive and time consuming to undertake. Therefore we recommend that, if you are considering a domestic building mounted installation and electricity generation is your main motivation, then you only consider a wind turbine under the following circumstances:

- *The local annual average windspeed is 6 m/s or more. An approximate figure for your location can be checked on the BERR website*

- *There are no significant nearby obstacles such as buildings, trees or hills that are likely to reduce the windspeed or increase turbulence.* Source: Energy Saving Trust (September 2008*)http://www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/microwind*

Figure 8.1: Wind at 45m Height (over 7m per second)

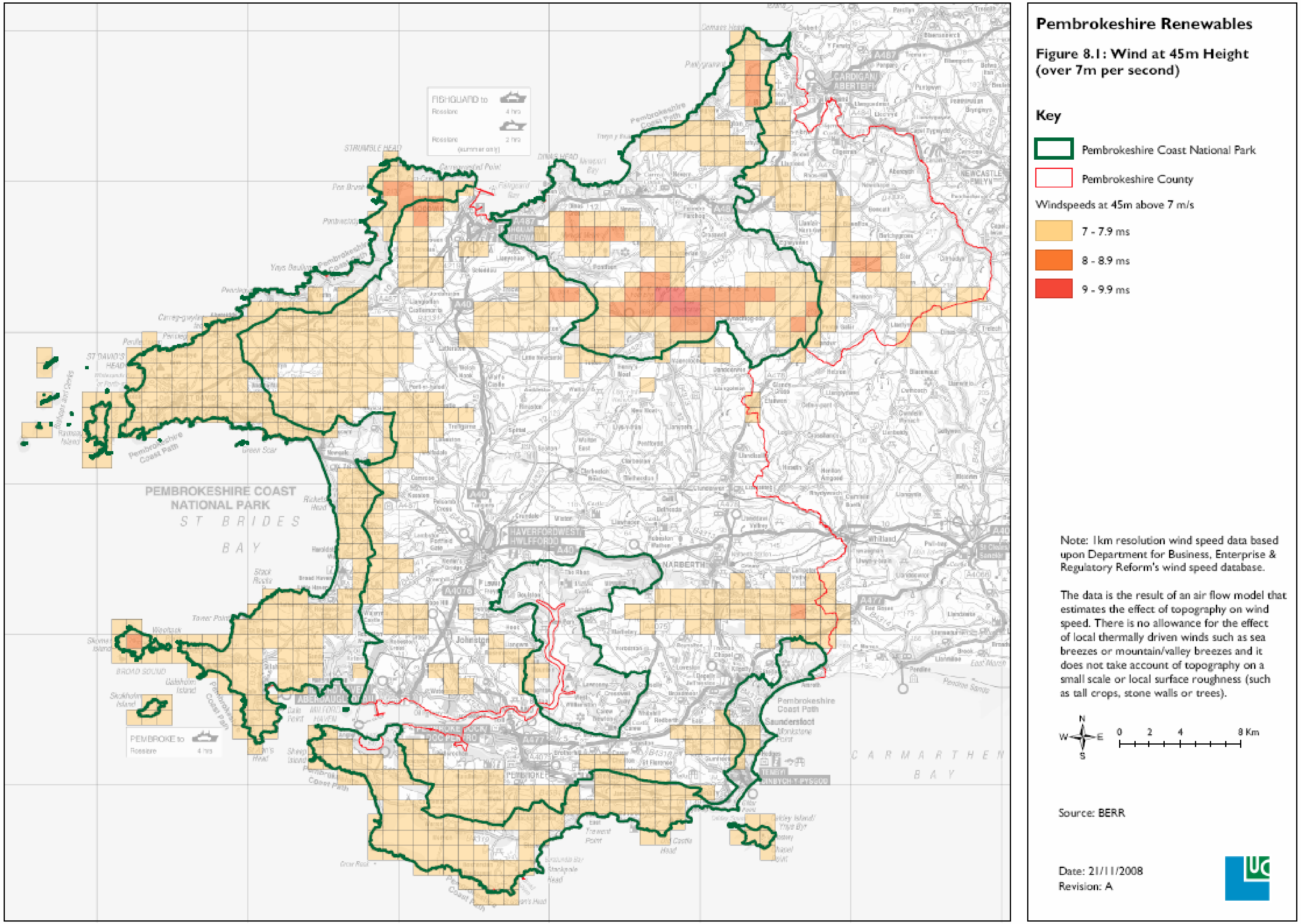


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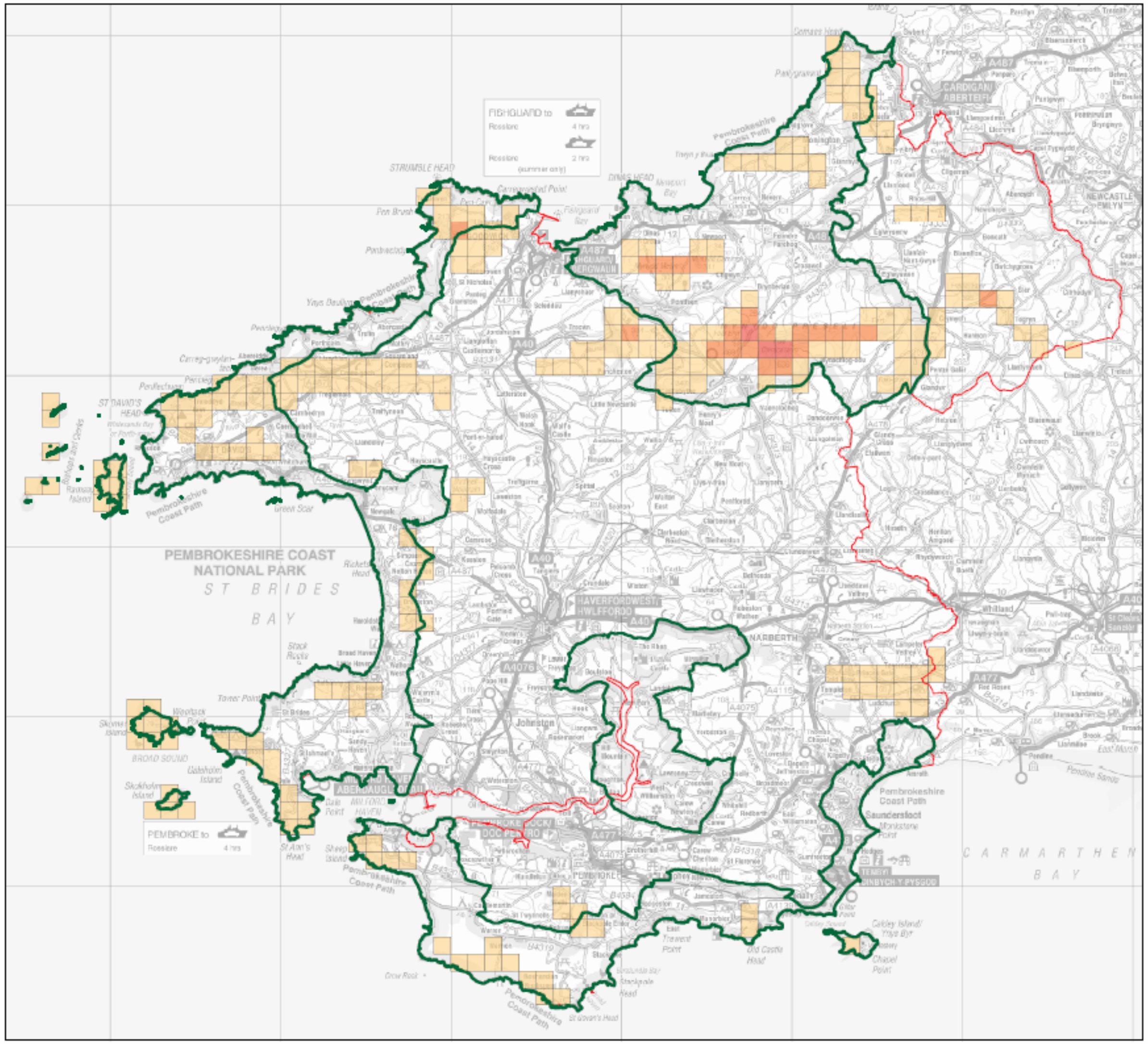
Figure 8.2: Wind at 25m Height (over 7m per second)



Pembrokeshire Renewables

Figure 8.2: Wind at 25m Height (over 7m per second)

Key

- Pembrokeshire Coast National Park
- Pembrokeshire County

Windspeeds at 25m above 7 m/s

- 7 - 7.9 ms
- 8 - 8.9 ms
- 9 - 9.9 ms

Note: 1km resolution wind speed data based upon Department for Business, Enterprise & Regulatory Reform's wind speed database.

The data is the result of an air flow model that estimates the effect of topography on wind speed. There is no allowance for the effect of local thermally driven winds such as sea breezes or mountain/valley breezes and it does not take account of topography on a small scale or local surface roughness (such as tall crops, stone walls or trees).

N W E S

0 2 4 8 Km

Source: BERR

Date: 21/11/2008
Revision: A

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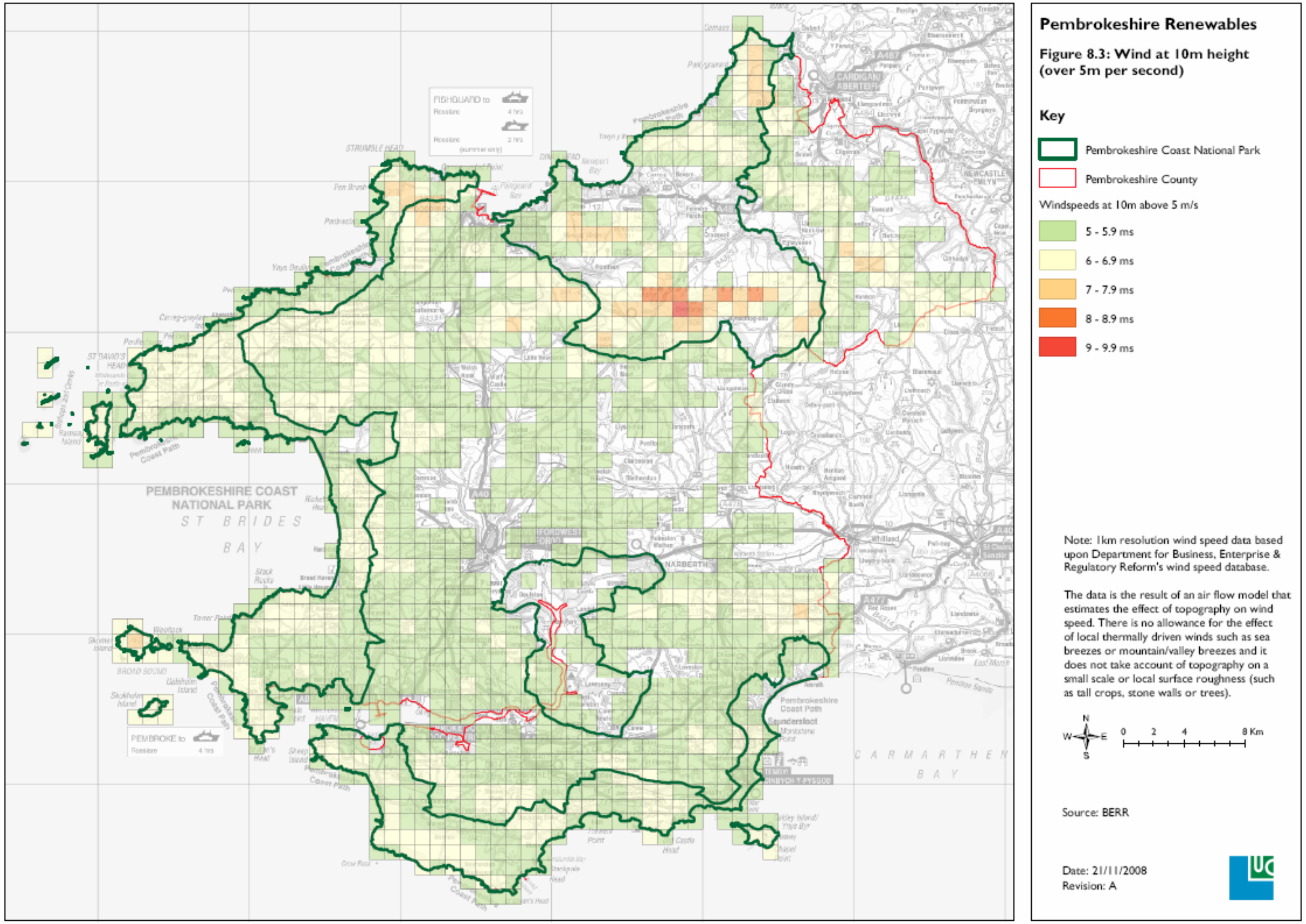
Figure 8.3: Wind at 10m height (over 5m per second)



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OPPORTUNITIES AND CONSTRAINTS FOR WIND TURBINES

8.27. Availability of wind is the main opportunity for the development of this technology in the National Park. On the other hand key constraints on these developments are both landscape sensitivity in this nationally important landscape and potential height constraints imposed by MOD and NERL.[31]

8.28. **Landscape sensitivity:** The National Park is defined by its open, undeveloped skylines along its gently undulating coastline, with long views across and between landscapes and out to sea. The area's spectacular coastline and maritime influences were the primary reason for the National Park's designation in 1952.

8.29. The development of vertical (moving) turbine structures, that could be visible from long distances across the National Park, needs to be considered carefully in terms of their impact on this sensitive and very special landscape. This has been the primary concern of the parallel Landscape Sensitivity Study – with the full results of this study set out in the Landscape Sensitivity Study report. The key conclusions of this study and the accompanying maps are set out below for the different size classes of turbine.

8.30. **MOD/ NERL restrictions:** NATS En Route Plc (NERL) is the air navigation service provider responsible for the safe movement in the en-route phase of flight for all aircraft operating in controlled airspace in the UK. To undertake this responsibility NERL has a comprehensive infrastructure of radar, communication systems and navigational aids throughout the UK. Theory and practical experience has shown that any of these could be compromised by the establishment of a windfarm or turbines in the wrong place. Maps illustrating where NERL would wish to be consulted on turbine developments are indicated in **Figures 8.6 and 8.9**.

[31] NATS En Route Plc (see paragraph 8.30)

Overall opportunities for large-scale wind turbines in the National Park

8.31. Large-scale wind turbines offer an economically viable form of commercial wind energy and can make a significant contribution to CO_2 reductions. The opportunities and constraints associated with this scale or turbine in the National Park are summarised in **Table 8.1** and outlined below.

8.32. The highly sensitive nature of the landscape within the National Park severely restricts the location in which these turbines can be considered. **Figure 8.4**, based on the Landscape Sensitivity Study, indicates that all Landscape Character Areas within the National Park with the exception of one are highly sensitive to turbines of this size.

8.33. The one Landscape Character Area with reduced sensitivity is Herbrandston (LCA 11). This lies on the edge of the prominent Milford Haven oil refinery where vertical chimneys and flares of over 60 metres in height are prominent in many views. One or more large-scale turbines located adjacent to this existing industry could potentially be incorporated into a skyline that is already dominated by large scale industrial structures. Along the same lines, LCAs 6 and 7 (Castlemartin/Merrion Ranges and Angle Peninsular), whilst overall having a 'high' sensitivity to large-scale turbines, partly abut the oil refineries on the southern shores of Milford Haven. Along these boundaries, with very careful siting, large-scale turbines might be used in specific locations to provide a renewable energy 'screen' to the highly visible petroleum industry on the edge of this part of the National Park. These areas with greatest potential for large-scale wind turbine development are indicated in **Figure 8.5.**

8.34. As indicated in **Figure 8.6** in parts of the areas indicated above there may be MOD restrictions on structures over 90 metres, requiring consultation to investigate effects on radar, air traffic control and low flying activity.

8.35. Wind speed is estimated to be between 6.1 and 8.0 m/s in these areas. This may be marginal for this size of turbine[32]. so a full wind speed assessment would be required for any turbine project to ensure viability – although as the size of these turbines will be significantly higher than the 40m height at which the above wind speed data is collected, it is quite possible that wind speed will not be an issue. All other environmental constraints would also need to be fully taken into consideration.

8.36. A 500kW wind turbine has been granted planning permission outside the Park boundary at Lodge Farm close to the Milford Haven oil refineries. This has yet to be constructed.

[32] The BWEA suggests that to be viable a large wind turbine requires average wind speeds in excess of 7m/s,

Table 8.1: LARGE-SCALE WIND	
Opportunities	**Constraints**
One of the most economically viable forms of renewable energy, able to provide significant levels of electricity to the grid and local communities	The landscape of the National Park is highly sensitive to these large structures. There are only two specific areas within the National Park where large-scale turbines might be considered with very careful siting – to the north and south of the Milford Haven refineries and industrial areas, providing a 'renewable screen' to these petrochemical industries (para 8.33)
Valuable diversification opportunity for agricultural land	Within these potential areas damage must be avoided to areas of ecological and archaeological/historical importance
Strong private sector investment potential	Buffer zones will need to be maintained around existing development
Community benefits – i.e. direct investment and return on exported energy including income from ROCs (see **Appendix 2**)	In most of the National Park new structures above 65m are deemed likely to interfere with overlapping areas of civil and military aviation and radar protection zones. Early investigations are required prior to a formal planning application
Wind speeds over 7 m/s at 45m cover large areas of the Park, with speeds above 9m/s on the highest points of the Preseli Hills and above 8 m/s on the coastal hilly area of Strumble Head	Technical and commercial grid connection feasibility is site specific. DNO[33] will need to assess the impact such connections would have on the transmission capacity of the network
	Public perception and community concerns relating to impact on house prices, visual impact, noise, interference with communication signals, and other environmental and ecological effects

[33] Distribution Network Operator

Figure 8.4: Landscape Sensitivity to Large-scale Wind Turbines (over 65m to blade tip)

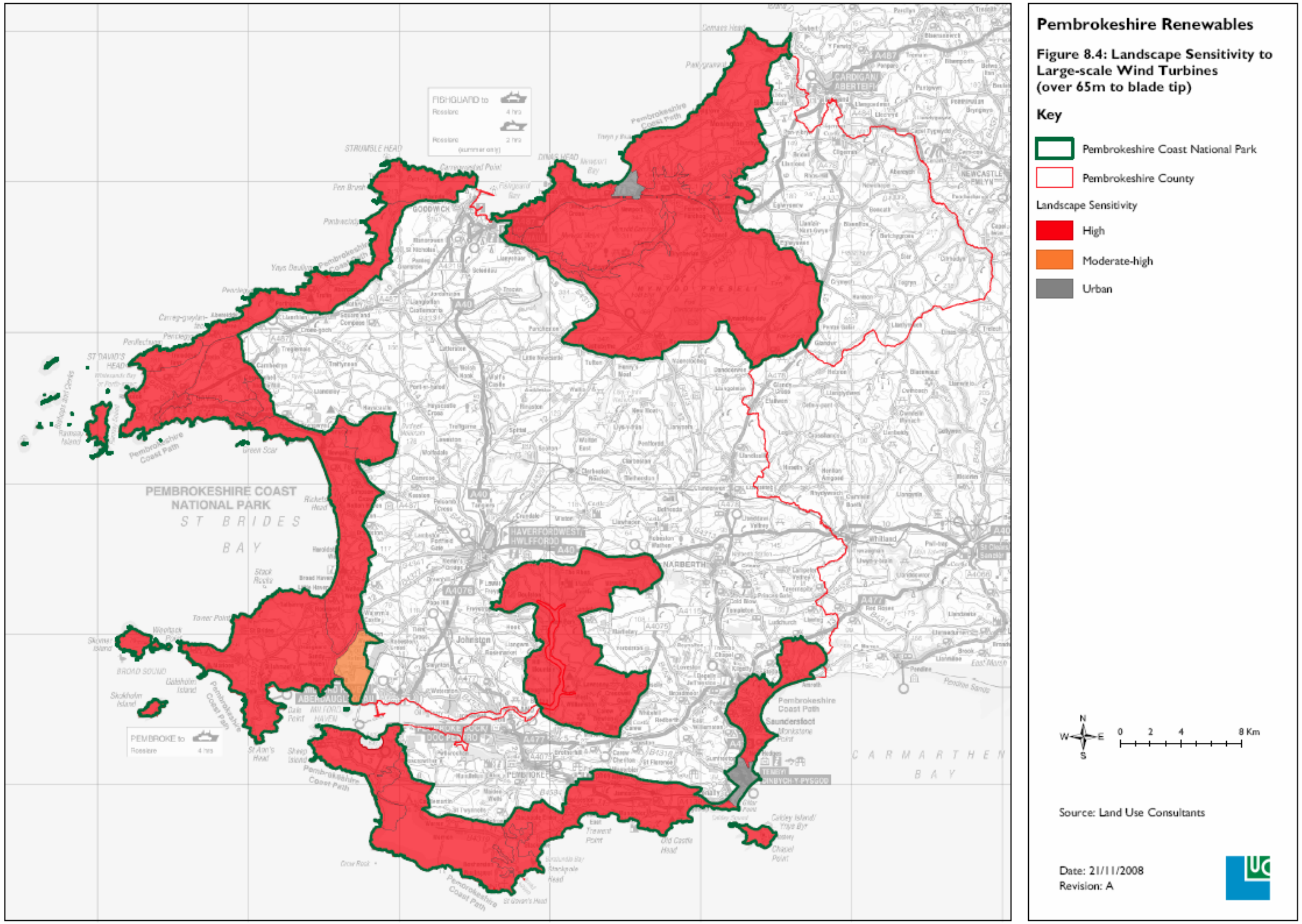

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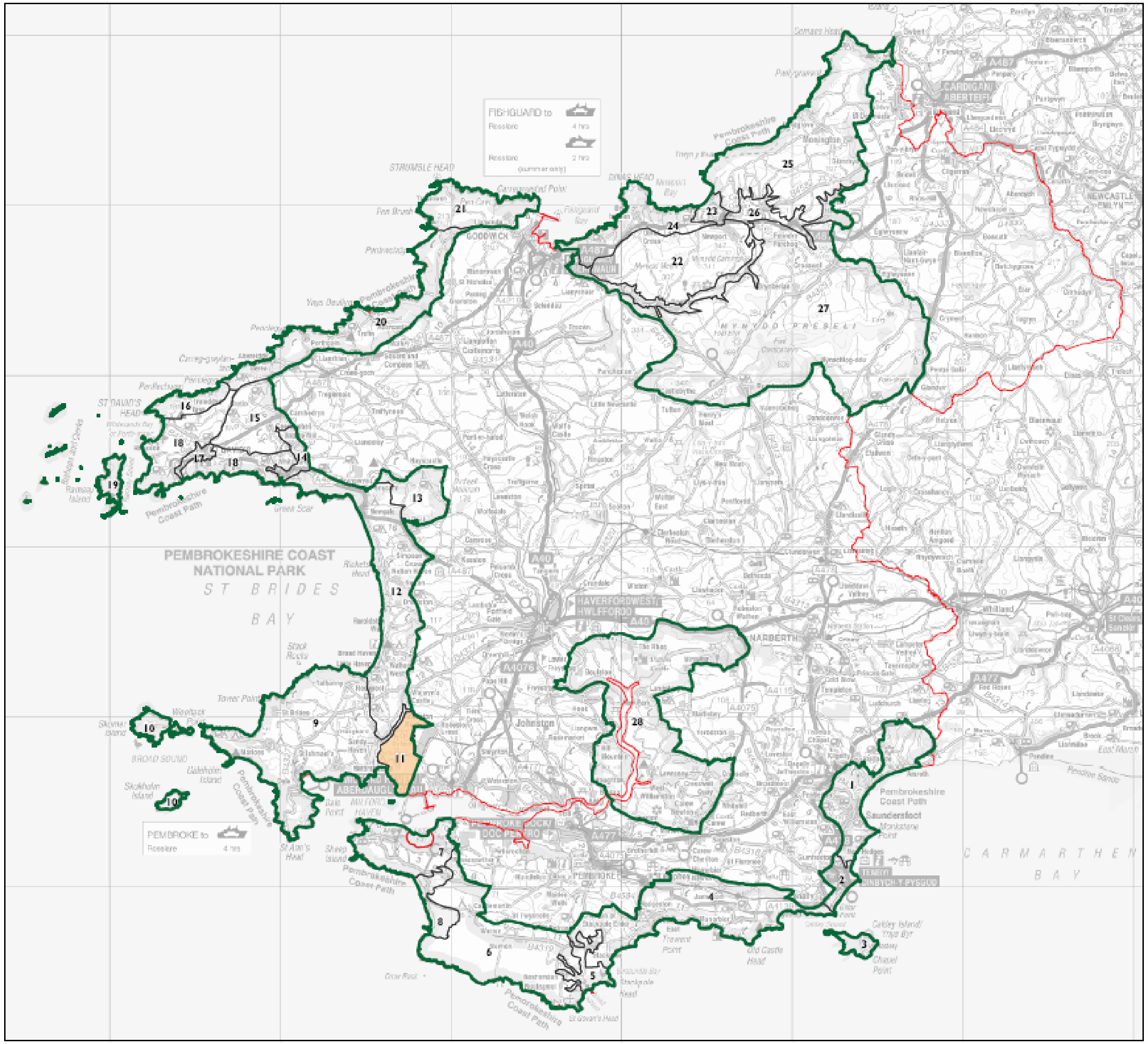
Figure 8.5: Potential for Large-scale Wind Turbines (over65m to blade tip)



Pembrokeshire Renewables

Figure 8.5: Potential for Large-scale Wind Turbines (over 65m to blade tip)

Key

- Pembrokeshire Coast National Park
- Pembrokeshire County
- LCA Boundaries
- Localised Potential for Large Scale Wind with Careful Siting

Note: In all cases will need to avoid damage to nature conservation designations and would be subject to consultation with MOD on height restriction)

N W E S 0 2 4 8 Km

Source: Land Use Consultants

Date: 21/11/2008
Revision: A

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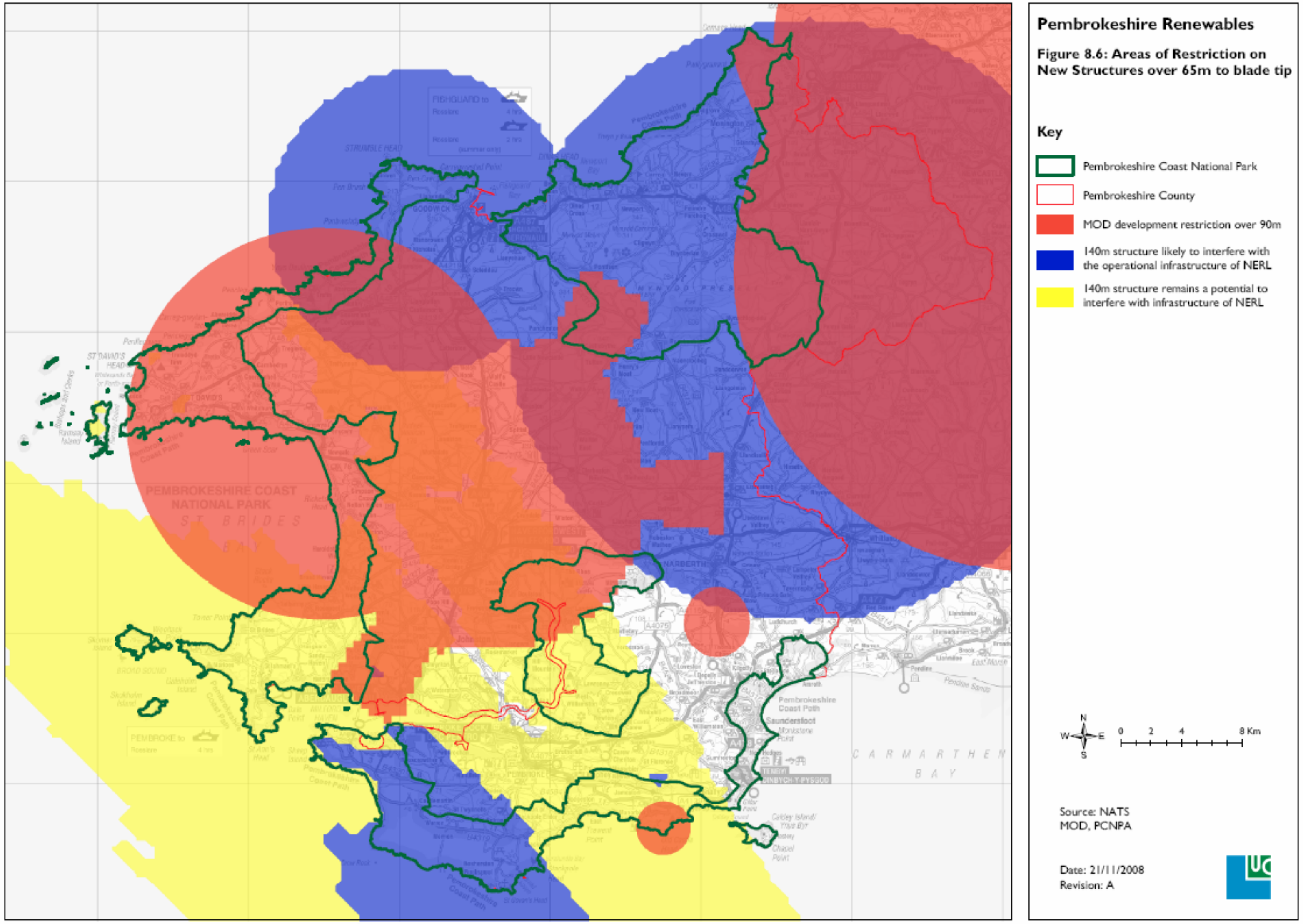
Figure 8.6: Areas of Restriction on New Structures over 65m to blade tip



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Overall opportunities for medium-scale wind turbines in the National Park

8.37. Medium-scale wind turbines also offer an economically viable form of commercial wind energy and over time can make a significant contribution to CO_2 reduction. The opportunities and constraints associated with this scale or turbine development in the National Park are summarised in **Table 8.2**.

8.38. Although these turbines are smaller in height than large-scale turbines, they are still likely to be damaging to the sensitive landscape of the National Park (see **Figure 8.7** based on the landscape sensitivity study). Consequently, there are limited areas where these sizes of turbine can be located within the Park. These areas are around Milford Haven, as in the large-scale turbine locations noted above, and areas of developed coastline in the south-east corner of the National Park, around Saundersfoot and Tenby, where there may be potential for the sensitive siting of single or small groups of 2 – 3 turbines providing they are clearly visually linked to the built up area and do not interrupt views along the coast. In such locations it will be vital that the landscape guidance set out in the accompany Landscape Sensitivity study is adhered to. These areas with greatest potential for medium-scale wind turbine development are indicated in **Figure 8.8.**

8.39. These coastal areas have wind speeds on the margins of viability for turbine developments of this scale, primarily due to the sheltered nature of these areas (from westerly and south westerly winds) and low lying topography. Full wind speed assessments would need to be carried out for any turbine project in this area to ensure viability. The Milford Haven area experiences higher wind speeds, so is more viable, but again an assessment would need to be carried out of wind speed potential.

8.40. All other environmental constraints would also need to be taken into consideration within these areas. These include scheduled ancient monuments, SSSIs and Conservation Areas. In addition, consultation would be required with aviation authorities and the MOD to investigate effects on radar, air traffic control and low flying activity.

Table 8.2: MEDIUM SCALE WIND	
Opportunities	**Constraints**
Suitable for community scale use, for schools, farms, industrial areas and new developments	The landscape of the National Park is highly sensitive to these structures.
Cheaper second hand turbines available from Europe	Within potential areas damage must be avoided to areas of ecological and archaeological/historical importance
Community benefits – i.e. direct investment and return on exported energy, including income from ROCs (see **Appendix 2**) and community energy funding opportunities (Chapter 11)	Buffer zones will need to be maintained around existing development
Valuable diversification opportunity for agricultural land	Technical and commercial grid connection feasibility is site specific. DNO will need to assess the impact such connections would have on the transmission capacity of the network
There are two specific areas within the National Park where these turbines might be considered with very careful siting – around Tenby and Saundersfoot (para 8.38).	Public perception and community concerns regarding the impact on house prices, visual impact, noise, interference with communication signals, and other environmental and ecological effects
In south and west areas of the Park there is less potential for structures between 25 – 60m height to interfere with overlapping areas of civil and military aviation and radar protection zones. Early consultation still required (see **Figure 8.9**)	Viable windspeed above 7m/s at 25m is less prolific across the Park, primarily in hilly areas around the coast and the Preselis
Viable windspeed above 7m/s is good for most of the Park area at a height of 45m, the height of which some medium scale turbines operate.	
A range of funding opportunities are available (see Chapter 11)	

Figure 8.7: Landscape Sensitivity to Medium-scale Wind Turbines (25m – 65m to blade tip)

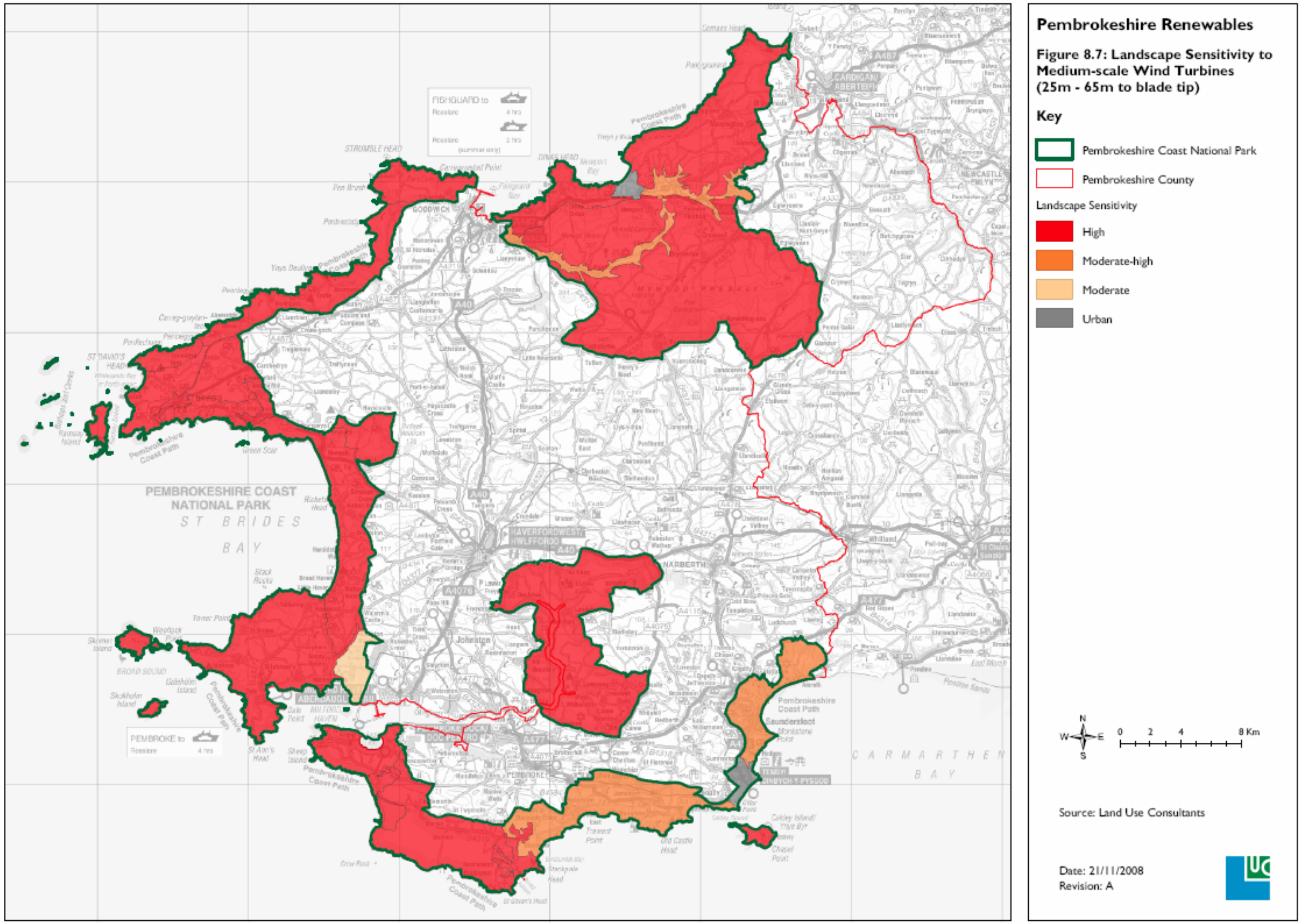

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Figure 8.8: Potential for Medium-scale Wind Turbine (25m – 65m to blade tip)

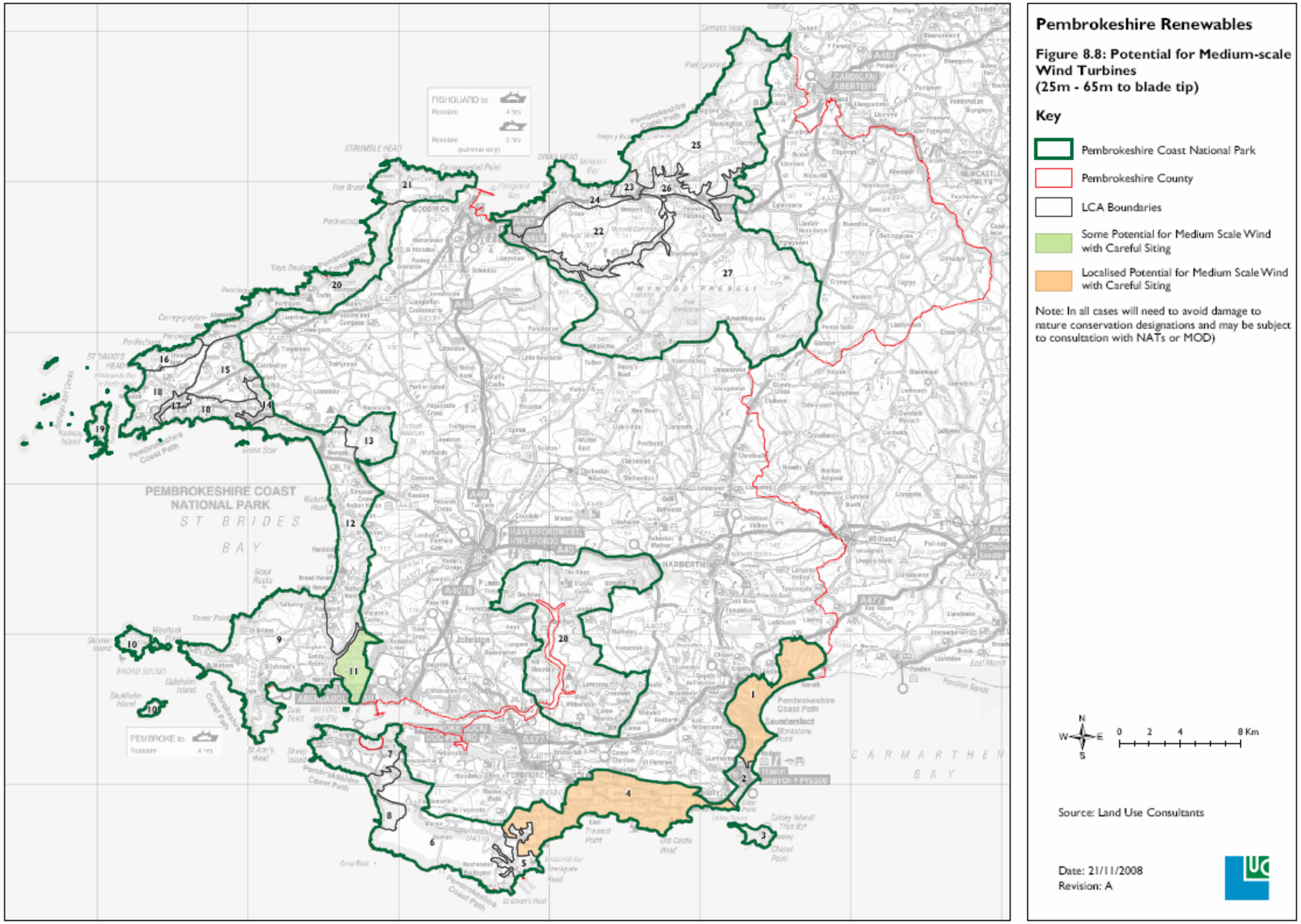

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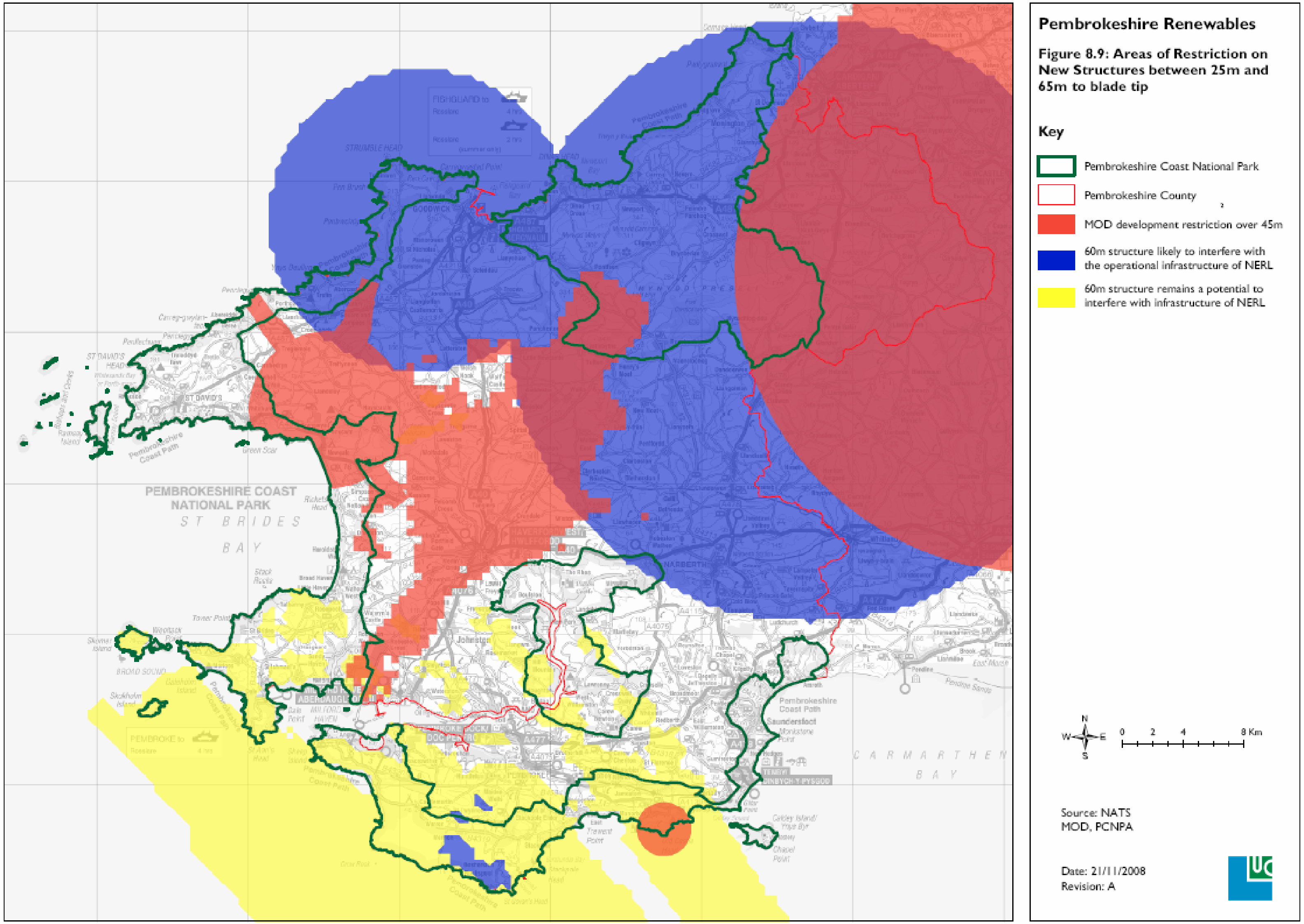
Figure 8.9: Areas of Restriction on New Structures between 25m and 65m to blade tip



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Overall opportunities for small-scale wind turbines in the National Park

8.41. Small-scale wind turbines offer considerable potential for renewable energy generation within the National Park providing their location and appearance, either individually or cumulatively, does not detract from the landscape and special qualities of the National Park. The opportunities and constraints associated with this scale or turbine development in the National Park are summarised in **Table 8.3**.

8.42. Single or small clusters of turbines (2 – 3) of less than 25 metres in height are more suited to the scale, character and scattered nature of settlement in the National Park than larger turbines. Overall they will have less impact on the landscape (see **Figure 8.10** taken from the Landscape Sensitivity Assessment). Small turbines reflect the working character of the landscape.

8.43. Broadly, most areas of the National Park with the exception of the Presli Mountains have localised potential for single turbines of this size with single turbines being able to be accommodated in some landscapes (**Figure 8.11**), providing the guidance set out in the Landscape Sensitivity Study is closely followed. In all cases, the location of small turbines will be most appropriate where linked to or incorporated within existing (or new) built development.

Cumulative effects
A key concern will be to ensure that the sequential development of small-scale turbines does not have a cumulative impact on the landscape of the National Park. This raises two particular issues:

- Farmers may be encouraged to become involved in wind crofting http://www.ruralgateway.org.uk/cgi-bin/item.cgi?id=1432 generating electricity from up to five-small-scale turbines on their farm for export to the grid. Such proposals will need to be carefully considered in the context of cumulative development, ensuring that the landscape guidelines are adhered to.
- It will be important to ensure that all approved developments are located where they can maximise output for their size. This is needed to avoid the situation where sub-optimal proposals are approved only to find that when optimal applications come forward they are refused on the grounds of cumulative impact.

8.44. Wind speeds are viable for this size of turbine across the majority of the National Park, with the exception of low lying land north of Saundersfoot and parts of the Cleddau estuaries.

8.45. All other environmental constraints would also need to be fully taken into consideration including scheduled ancient monuments, SSSIs and other nature conservation sites, and conservation areas.

Table 8.3: SMALL-SCALE WIND	
Opportunities	**Constraints**
Suitable for individual and groups of households and community building	Landscape guidelines will need to be adhered to
Valuable diversification opportunity for agricultural land, although wind crofting will only be suitable within the National Park if the number and siting of turbines reflect the landscape sensitivity guidance	Damage must be avoided to areas of ecological and archaeological/historical importance
Income available from ROCs (see **Appendix 2**)	Technical and commercial grid connection feasibility is site specific. DNO will need to assess the impact such connections would have on the transmission capacity of the network
Structures below 25m height should not interfere with overlapping areas of civil and military aviation and radar protection zones, although consultation will still be required.	Public perception and community concerns regarding the impact on house prices, visual impact, noise, interference with communication signals, and other environmental and ecological effects
Windspeeds above 5m/s at 10m height above ground are good across the National Park except for sheltered valleys, leeward slopes and forested areas	Will require careful siting relative to existing development to avoid noise and visual impact
Several funding sources available (see Chapter 11)	

Figure 8.10: Landscape Sensitivity to Small-scale Wind Turbines (under 25m to blade tip)

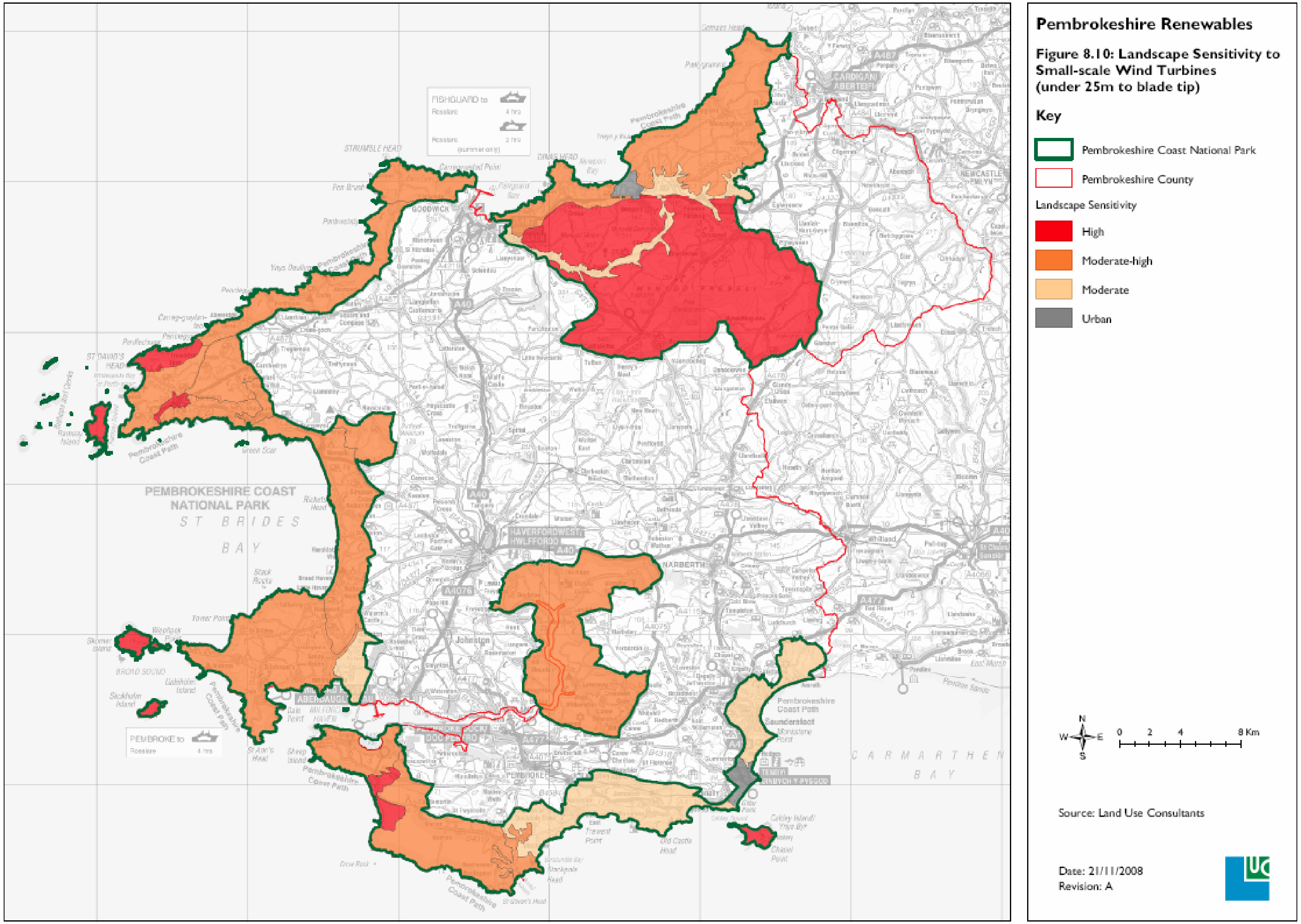

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Figure 8.11: Potential for Small-scale Wind Turbines (<25m to blade tip)

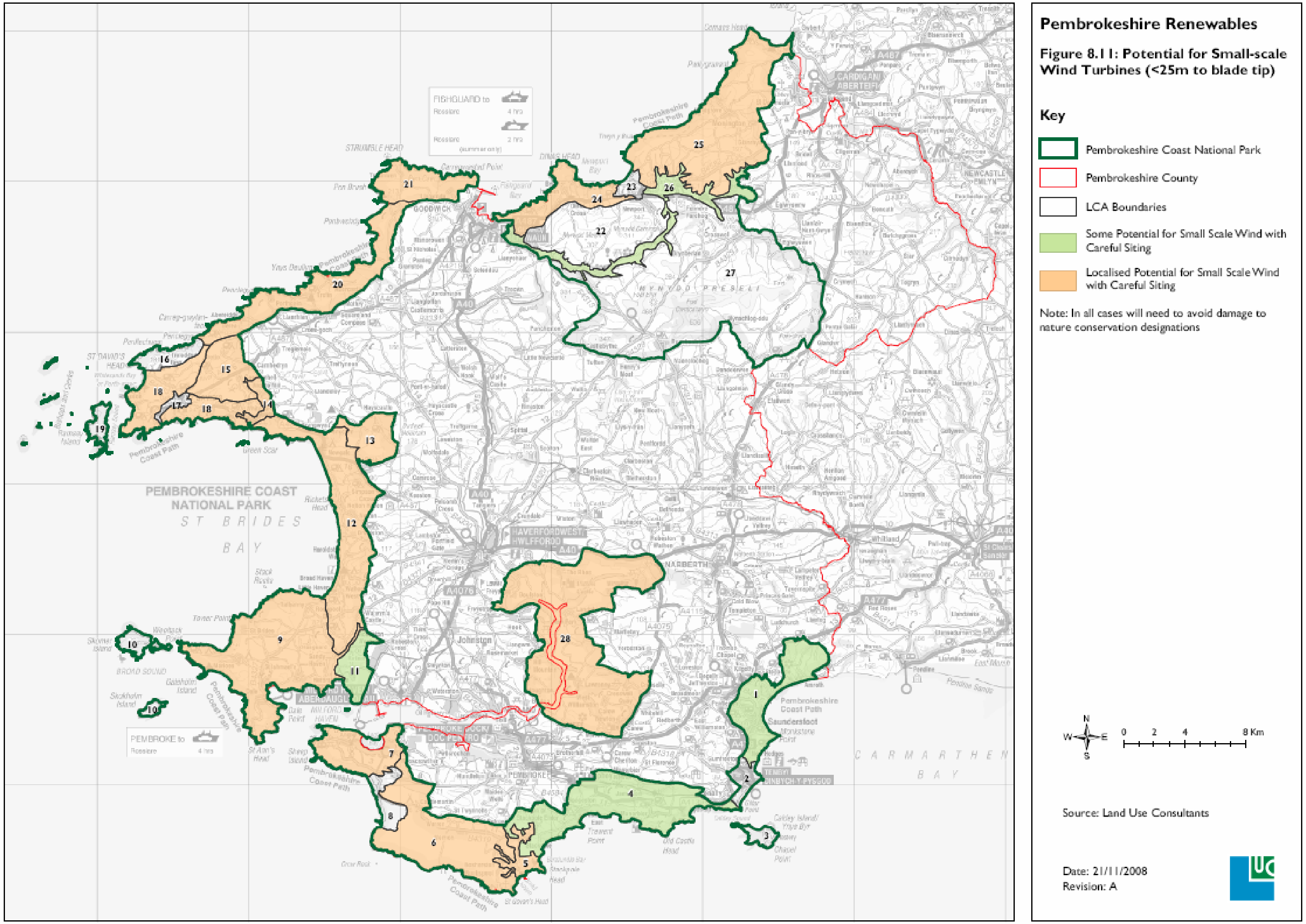

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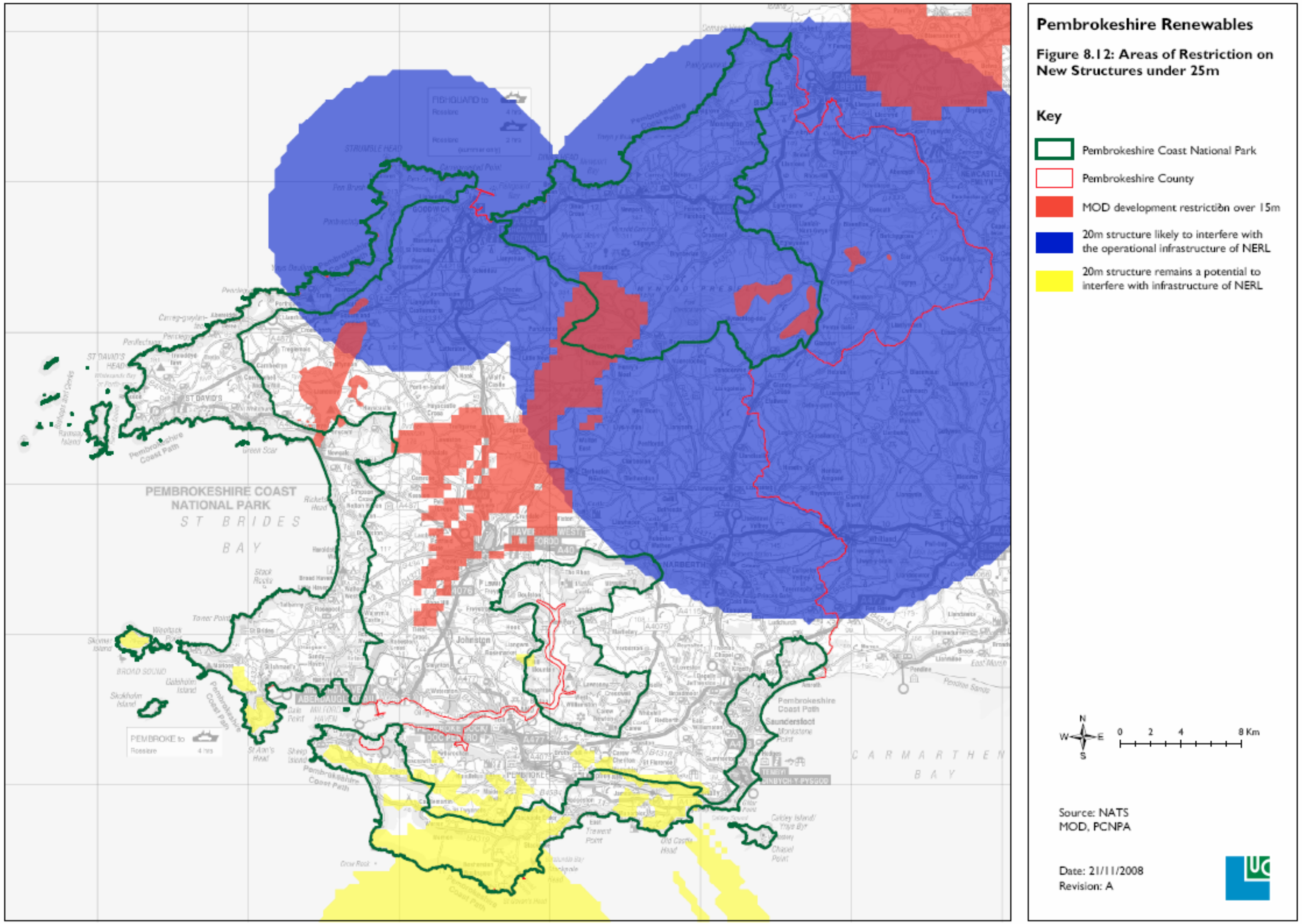
Figure 8.12: Areas of Restriction on New Structures under 25m



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9. DISTRICT HEATING AND LINKED DEVELOPMENTS

9.1. This final Chapter looking at the different technologies pulls together a number of loose ends. It considers the role of **district heating** and looks at the potential for **micro-generation** (based on the technologies already considered). It also considers the opportunities and constraints for **grid connection** and gives brief consideration to the potential for **marine renewable developments** and the implications for the landfall of these offshore energy sources.

DISTRICT HEATING

9.2. Renewable district heating schemes can make use of biomass boilers, anaerobic digestion and possibly ground source heat pumps. Currently the only district heating scheme within the National Park is the pellet biomass boiler serving the headquarters of the National Park Authority and the offices of CCW (**Table 3.1**). Another scheme is planned at Lawrenny Eco Village using anaerobic digestion (para 4.5). In addition, on the boundary of the National Park the biomass heating of the Bluestone Holiday Village provided by Pbe (based in St David's) and Pbesco (para 3.24) delivers 2.5 MW of biomass heat to the leisure facility and accommodation areas, with Pbesco currently being the largest Biomass Esco (Energy Supply Company) in the UK. These schemes provide valuable local expertise.

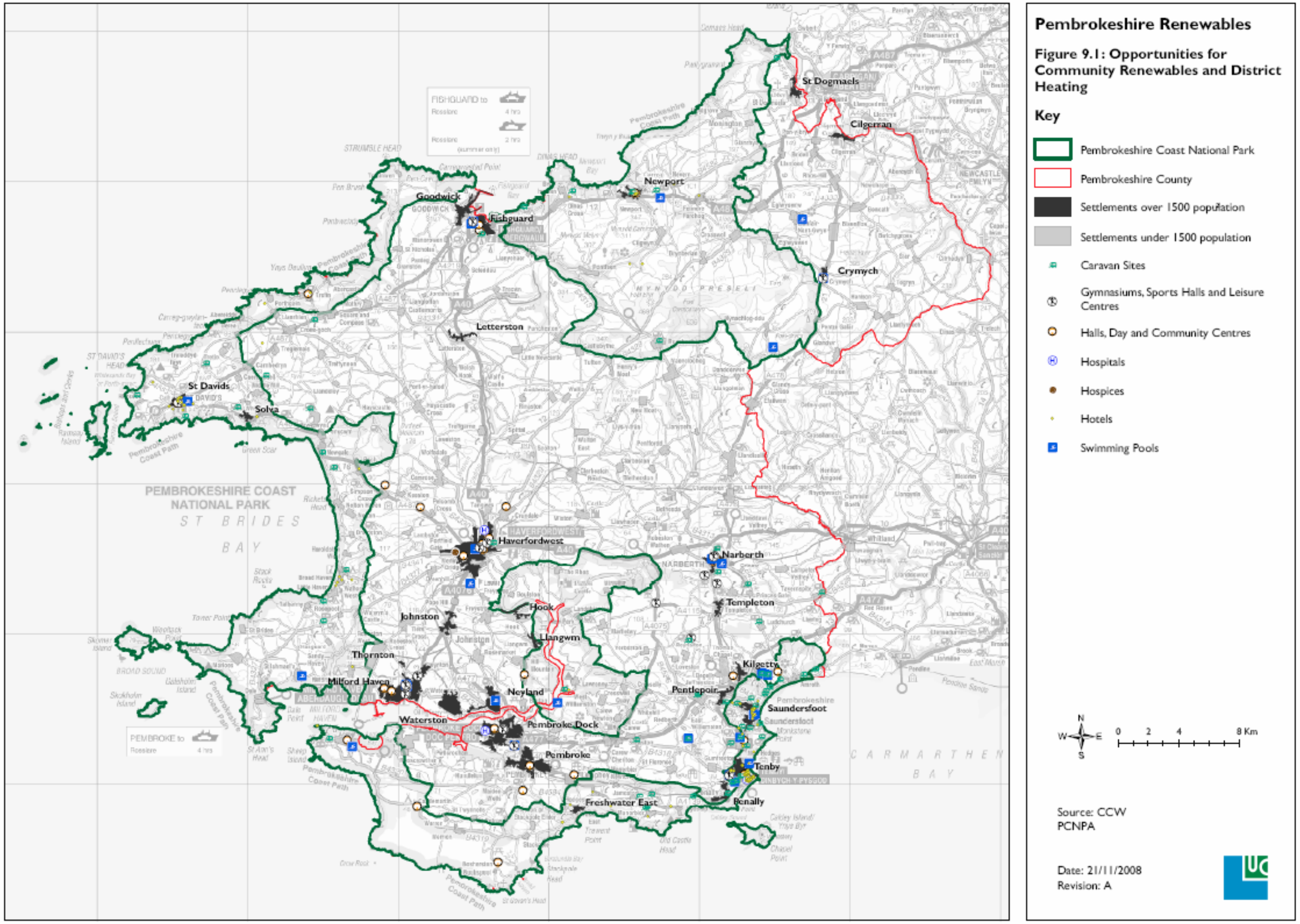
9.3. A study funded by LEADER+ has been carried out for PLANED to establish the feasibility of meeting the heating needs of the entire Old School site in Narbeth (outside the National Park) with a pellet-fuelled boiler. This could include heating the adjacent Pembrokeshire County Council-owned swimming pool. The boiler and district heating system is expected to cost £180,000 and would require external funding to help set up the scheme.

9.4. Clearly there is considerable scope for small-scale district heating systems associated with community facilities within the National Park such as swimming pools, leisure centres, sports halls, day and community centres, potentially combined with an adjacent new development. Other opportunities may include combining heating/cooling requirements for adjacent hotels, for example, in Tenby, Saundersfoot and St David's where there are a number of hotels in close proximity; or adjacent small business premises within the larger settlements of the Park, as highlighted by the planned scheme at Narberth. Clearly those facilities being heated need to be in close proximity to minimise the costs of distribution piping and to minimise thermal losses. Potential opportunity is highlighted in **Figure 9.1**.

9.5. So, in summary, the key opportunities are: small-scale district heating schemes associated with new development within the main settlements of the National Park either for the development alone, or if locationally feasible, linked to an existing facility within the settlement that has a large heat energy requirement. Alternatively they can be developed for a group of nearby facilities requiring heat such as those associated with the tourism industry. In all cases this shared use of heat offers the economical use of fuel with high carbon efficiency.

9.6. Nevertheless, district heating schemes have high investment costs that will take some time before the investment is paid off. Although, compared to other forms of heating, these could prove highly competitive in terms of fuel costs over time.

Figure 9.1: Opportunities for Community Renewables and District Heating



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MICRO-GENERATION

9.7. Many of the technologies considered through this study offer different forms of micro-generation, including household biomass boilers and wood-burning stoves; ground and air-source heat pumps; photovoltaics and solar hot water; and micro-wind. The majority of these will soon be able to be fitted under Permitted Development Rights within the National Park (para 2.54 – 2.53).

9.8. In recognition of the importance of micro-generation WAG has set a number of targets for 2012 and 2020 in the Wales Micro-energy Action Plan (para 2.41):

Technology	Numbers installed	
	2012	2020
Micro-heat systems: biomass, solar hot water, heat pumps	20,000	100,000
Micro electricity: PV, wind, hydro	10,000	200,000

9.9. Yet current levels of uptake are low. For example in the case of:

- Solar Hot Water 90,000 units were installed in the UK by 2007 with annual sales of 5,000 – 6,000. In the National Park currently 100 are installed
- PV 65 – 75 units were installed in the UK by 2007 with annual sales of 11 (mainly 4kW systems). In the National Park currently 9 installations are installed – a high percentage of the national total.

9.10. As a consequence, a UK Government funded research report by Element Energy[34] has concluded that the effectiveness of such targets is negligible in supporting and encouraging micro-technologies

"There is little industry demand for targets for micro-generation that are not legally binding, and micro-generation suppliers and investors claim they are unlikely to modify behavior as a result of a purely aspirational target."

9.11. Element Energy go on to conclude that if the currently announced policies to support micro-generation are rolled out as planned then micro-generation will have a very small share of the overall energy market even by 2050 in the UK. " *Annual sales are likely to be dominated by condensing gas boilers, with an increasing preference for electric over oil boilers, particularly for new build (due to low heating demand)"..*

9.12. Moderate fuel price rises would however lead to a large increase in micro-generation uptake by 2050, although overall numbers remain small compared with conventional technologies.

9.13. Therefore without significant and sustained government policy support combined with very significant increases in conventional fuel prices, micro-generation is forecast to be unlikely to achieve its potential relative to the size of the available market across the UK. Within the National Park, the enthusiasm of the local communities for achieving a low carbon future, means that the Park is likely to run well ahead of national trends in the use of micro-generation. Furthermore, rural homes without a gas

[34] Element Energy (June 2008) The Growth Potential for Microgeneration in England, Wales and Scotland

connection using oil receive greater subsidies than urban homes due to higher energy requirements and the higher CO_2 savings when displacing oil. The current subsidy offered for a wood pellet boiler, for example, is nearly £4,000 in a rural home, equivalent to a 50% capital subsidy. Notwithstanding this, the full potential for micro-generation is unlikely to be realised unless there is a significant increase in government support.

GRID CONNECTION

9.14. Western Power is the electricity grid provider for Pembrokeshire and the Pembrokeshire Coast National Park. So far the company has experienced very few failed applications for renewable technologies within the National Park due to connection issues. It is aware though that the key constraint to connection to the grid is cost, particularly where a project is small in scale and some distance from the existing grid network i.e. rural in location. Stakeholders have identified this as a key problem. This is the primary reason why some proposals in the National Park have not been taken forward. As a general rule Western Power does not foresee grid constraint issues precluding the development of medium to small-scale renewable electricity generating technologies as outlined in this study within the National Park The Park is very rural in nature but has an extensive low kilovolt (kV) network which can accommodate small to medium scale renewables. However, the exact location of proposals will ultimately determine suitability and viability.

MARINE RENEWABLE DEVELOPMENTS

9.15. These technologies have not been considered through this study as the marine environment lies beyond the jurisdiction of the National Park Authority (other than at the point where the energy comes ashore (considered separately below).

Marine technologies

9.16. Currently the main marine technology that is being considered is offshore wind – primarily large commercial wind farms being developed by multi-national energy companies and consortia. These are not considered further here.

9.17. But there are also an important range of emerging technologies that use tidal and wave power and offer huge potential for the generation of electricity for the communities of the Pembrokeshire Coast National Park – the only fully coastal National Park in the UK.

9.18. **Tidal:** Tidal energy can be harnessed in two ways. The first is to build a barrage which retains water behind, to create a difference in water level across the barrage as the tide goes out. The stored water can then be released through turbines to generate electricity. The historic tidal mill at Carew is a local example of this type of barrage at a small scale (see paragraph 5.2). Larger scale developments are very unlikely to be acceptable along the coast of the National Park as they could have a significant environmental impact on this internationally important coastline.

9.19. The second approach, which has significant potential off the coast of Pembrokeshire, is to harness marine tides or currents – with the Pembrokeshire coastline having very significant tidal rips. This technology is similar to a wind turbine except the blades are below the water surface and are turned by underwater currents as opposed to air. This technology is still in the research and development phase but holds great potential for the future. The UK government has piloted a scheme off the North Devon coast and is currently running another pilot scheme in the Irish Sea. In the National Park the SDF has been used to develop a prototype tidal stream generator.

The world's first deep-sea tidal-energy farm is to be built by E.ON and Lunar Energy off the Pembrokeshire Coast to provide electricity for 5,000 homes.

Eight underwater turbines, each 25 metres long and 15 metres high, are to be installed on the sea bed off St David's Head. Construction is due to start in 2009 and the tidal energy turbines, described as "a wind farm under the sea", should be operational by 2010.

9.20. **Wave power:** This harnesses the kinetic energy generated on the surface of waves as they move up and down. The energy is captured via wave energy collectors which come in three forms:

- Buoyant moored devices
- Hinged contour devices
- Oscillating water columns

These can be located at-shore, near shore or off shore. Wind resource is fundamental in generating waves, so the windiest areas are the best location (the south west and western coasts of the UK) and locations where waves have a long fetch. Again this technology is at the research and development stage and holds great potential especially in providing electricity for islands and coastal communities, such as the Pembrokeshire Coast.

The Wave Dragon www.wavedragon.co.uk
The Milford Haven Wave Dragon Pre-Commercial Demonstrator is a floating slack moored wave energy converter with a rated capacity of 4-7MW. The long term aim is to supply energy to 2,500 – 3,000 homes. Commissioned in 2007 it is currently the world's largest wave energy converter, some 300m long. It allows ocean waves to overtop a ramp which elevates water to a reservoir above sea level. This creates a 'head' of water which is subsequently released through a number of turbines and in this way transformed into electricity. Water is returned to the sea via vents in the base of the unit.

The current prototype is moored some 2 – 3 miles off St Ann's Head with this nearness to shore to allow monitoring of performance. Future units are likely to be placed further off-shore. This development has received funding from WAG through Objective One.

ONSHORE CONNECTIONS TO OFFSHORE GENERATION

General issues

9.21. Offshore renewable technologies are generally grid connected and require cabling from the offshore generator to a distribution transformer onshore. The number of cables will be determined by the peak load that will be generated (in MW or kW) and by the risk that is acceptable for redundancy in the cabling (to ensure that generated output can be exported).

9.22. The offshore cables are generally buried beneath the onshore material at a depth of around 1.5m deep. The cables will either take a route to the nearest road or a direct route to the nearest sub-station. A single cable would typically be of the order 22-100mm in diameter, depending on the continuous current rating.

9.23. If the coastline includes cliffs, a hole is drilled from the cliff top down to the base of the cliff. The cables will be connected within an inspection chamber (approx. 2m concrete cube, buried underground) at the cliff base; the cables pass through the rock and into a second chamber, placed at the top of the cliff, buried but with an inspection hatch exposed. The cable runs are buried in trenches at around 1.5m depth – width depends on the size and number of cables (e.g. a large offshore windfarm will require a trench width of over 2m).

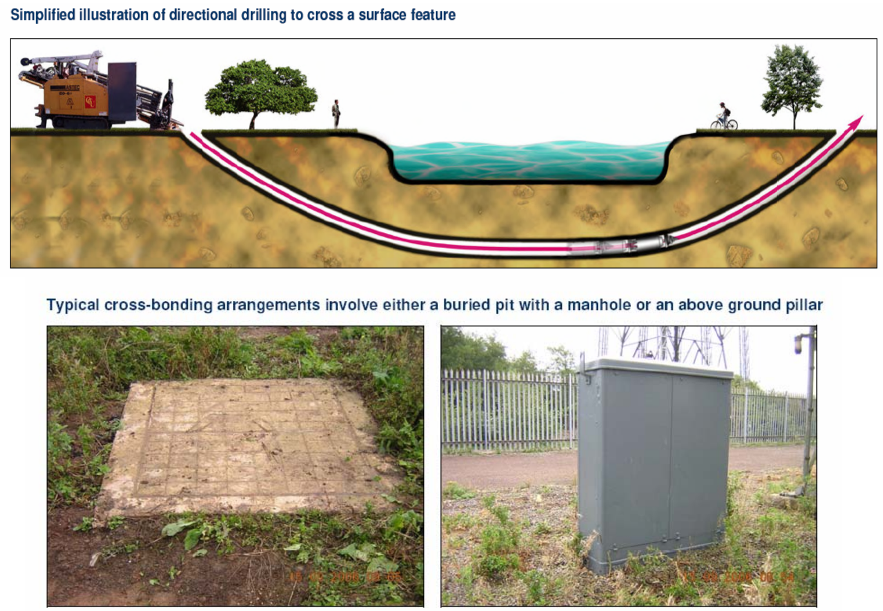

Illustration of hole boring for long distance cabling (top) and of below and above ground cable connection chambers (bottom)[35]

9.24. The location where the offshore cable comes on-shore is determined to a large extent by the Distribution Network Operator (DNO) (Western Power), although responsibility may soon pass to the National Grid. The location is determined by:

- surface features on the sea bed close to the foreshore
- geology of the cliffs (ease of drilling, stability, fissures, etc)
- impact on the existing grid infrastructure
- proximity of nearest distribution transformer
- cost and impact of cabling run to nearest transformer

National Grid's Offshore Project

9.25. The process by which offshore generation is linked to onshore infrastructure is currently the subject of a consultation being conducted by the National Grid on behalf of BERR and Ofgem (the 'Offshore Transmission Project', further details are available at: http://www.nationalgrid.com/uk/Electricity/offshoreProject/).

9.26. The current proposal is that the National Grid will undertake a feasibility study of various options for onshore connection and select the most appropriate and cost effective. National Grid will then contract a third party to create the onshore connection, recovering the cost from the developer. The onshore connection will clearly depend on the anticipated average and peak outputs from the offshore generator.

9.27. If National Grid receives multiple approaches from offshore developers, this will be factored into the design of the onshore connection (as in Mid Wales). However, this may not be predictable and ad hoc connections may have to be developed.

Specific policy considerations for onshore grid connection of marine technologies
Options for onshore connection points are determined by the Distribution Network Operator or the National Grid[36], taking

[35] 'Sheringham Shoal Offshore Wind Farm Onshore Grid Connection: Environmental Statement, Non-technical summary' Scira Offshore Energy Limited, prepared by Royal Haskoning. Available from: http://www.scira.co.uk/newsevents/documents/FINALNTS-220807.PDF [Accessed 21 July 2008]

[36] The responsibility depends on the capacity of the scheme and the associated voltage for the onshore connection to existing infrastructure. The National Grid

account of existing networks and infrastructure in relation to technical and economic considerations.

The Pembrokeshire Coast National Park Authority has a duty to consider the impacts related to the onshore connections – from the above-water shoreline, including the impacts of cabling, associated conditioning equipment and housing, connections into the existing networks and modifications to existing infrastructure.

Where onshore connection to offshore generation is in the local, regional or national interest[37], the National Park Authority has a duty to balance these needs against the potential impacts as established in Policy PS7 (National Park Purposes and Duty).

Applications for onshore connections will require an Environmental Impact Assessment and the NPA would expect proposals to include the assessment of more than one option for the point at which connections arise onshore.

Materials and activities associated with onshore connections (from the shoreline to point of connection to existing infrastructure) shall not cause pollution or introduction of hazardous substances. Policy PS8 Major Developments will provide the primary policy context in this respect.

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operates the transmission networks (275kV and above), the Distribution Network Operator operates the distribution networks (132kV and below)

[37] National in this context means the United Kingdom

10. POTENTIAL CONTRIBUTION OF RENEWABLES TO CURRENT ENERGY USE WITHIN THE NATIONAL PARK

10.1. The study has looked at a complex array of opportunities and constraints as a means of assessing the potential for a range of renewable/low carbon technologies within the Pembrokeshire Coast National Park, summarised in **Table 10.1.**

10.2. This chapter, using the evidence obtained, draws conclusions on the potential contribution that these technologies could make in the National Park towards Welsh targets for renewable energy use, taking account of all identified opportunities and constraints. Taking each technology in turn it:

- summarises the overall potential within the National Park with reference back to the relevant technology chapter
- provides an assessment of potential broad location(s),
- provides an assessment of potential quantities and potential timing up to 2021 and the possible electricity/ heat generation contribution this could make towards Welsh targets for renewable energy.

10.3. All calculations are based on realistic assessments of the quantity of energy that can be generated from individual technologies allowing for the realistic availability of the natural resource under consideration.

Table 10.1: Summary of energy production associated with identified renewable technologies

Scale	Power output	Application
Biomass:		
Medium	10MW - 40 MW	Commercial large-scale
Small	100kW – 300kW	Community small-scale
Household	6 – 15 kW	Individual
Anaerobic digestion (AD)		
Medium	2MW	Commercial/community
Small	10kW	Individual
Micro-hydro		
Micro	<100kW	Individual
Heat Pumps		
Ground/Air	Av. 5kW – 20kW	Community/Commercial/Individual
Air	N/A	Individual
Solar		
Solar hot water	N/A	Commercial/Individual
PV domestic	1.5 - 2kWp	Commercial/Individual
Solar space heating	N/A	Commercial/Individual
Wind energy		
Large	300kW – 3MW	Commercial/community
Medium	50kW - 330kW	Commercial/community
Small	10kW – 50kW	Community/Individual
Micro	< 10kW	Individual

BIOMASS

Large scale biomass

10.4. **Overall potential:** There are a number of factors which indicate that a large scale biomass plant is unlikely to be a feasible renewable energy technology within the National Park**.** Therefore the study concludes that **there is no potential electricity or heat generation arising from large-scale biomass plants within the National Park**.

Medium scale biomass

10.5. **Overall potential:** There is considerable scope to expand the use of medium scale biomass heating systems within the Park across all sectors, including commercial premises, tourism facilities/accommodation complexes; community facilities (schools, leisure centres, public buildings) when existing heating systems are in need of replacement. The boilers and their associated storage facilities are small in scale and can easily be accommodated into the traditional settlement structure of the National Park. They will also stimulate a stronger local wood-based business helping diversify and strengthen the local land-based economy. Nevertheless, for these carbon reduction benefits to be fully realised, it is important to ensure that such schemes use local wood-based feedstocks rather than imported wood fuels.

10.6. **Potential location:** Locations are most likely to be within existing urban areas and related to new sites identified for new housing and commercial development within existing settlements, particularly those not connected to the gas grid. They may also be associated with existing and new leisure / tourism facilities.

10.7. **Potential contribution:** An estimate of likely numbers/sizes and timescale is outlined below:

Table 10.2: Potential contribution from medium-scale biomass

Type of site	Nos/kw capacity	Annual GWh output per unit	Potential numbers & annual heat generation by 2016	Potential numbers & annual heat generation by 2021
Strategic sites	2 x 200kWe	0.9GWh	-	(2) 1.8GWh
Schools (new)	2 x 200kWe	0.9GWh	-	(2) 1.8GWh
Schools (existing)	5 x 200 kWe	0.9GWh	(2) 1.8GWh	(5) 4.5GWh
Leisure complex	9 x 300 kWe	1.3GWh	(3) 3.9GWh	(9) 11.7GWh
Large office (existing)	3 x 100 kWe	0.4GWh	(1) 0.4GWh	(3) 1.2GWh
Community centres	8 X 30kWe	0.13GWh	(3) 0.39GWh	(8) 1.04GWh
Caravan sites	12 x 15kWe	0.06GWh	(2) 0.12GWh	(12) 0.72GWh
Small office/hotel	24 x 50kWe	0.22GWh	(4) 0.88GWh	(24) 5.28GWh
Total			**7.49GWh**	**28.04GWh**

The potential generation of 28 GWh is equivalent to 0.028 TWh . **This equates to a theoretical potential contribution of heat energy generation in the National Park from medium scale biomass technology of 0.9% towards the Welsh target of 3TWh per yr by 2025.**

Small-scale biomass

10.8. **Overall potential:** Although domestic biomass heating systems are a well established technology, uptake to date within the National Park has been minimal primarily because of the market domination of conventional technologies combined with fuel availability, and reduced flexibility etc compared to gas or oil systems.

10.9. Recent UK Government funded research highlights that without significant and sustained government policy support domestic biomass micro-generation across the UK is unlikely to achieve its potential relative to the size of the available market. Therefore, a sustained limited uptake of heat based micro-generation technologies such as biomass boilers is forecast up to 2050[38], although there may be a significant uptake of wood burning stoves (see paras 3.43 – 3.46).

10.10. **Potential location**: Domestic biomass boilers can be used universally through out the National Park. This motivation will be highest in the 45% of households currently off the gas grid.

10.11. **Potential contribution:** Assuming approximately 3,500 owner occupier households within the Park unconnected to the gas grid, and that 10% [39] of these homes convert to biomass boilers by 2021, this would result in the installation of 350 domestic biomass boilers within the Park of between 6 – 15kW heat output. This could generate a total of between 3.5 – 9 GWh of heat energy per annum by 2021. This is a conservative estimate, especially as it does not take account of the contribution of wood-burning stoves. This is an area where concerted promotion and support from the NPA in partnership with others could bring significant renewable benefits.

[38] Element Energy – The growth potential of micro-generation in England, Wales and Scotland June 2008

[39] Using assumptions from Element Energy report on uptake of micro-generation over the next two decades in the UK.

The potential generation of between some 3.5 – 9GWh is equivalent to 0.0035 – 0.009 TWh . **This theoretical contribution of heat energy generation in the National Park from domestic biomass boilers offers between 0.1% and 0.3% towards the Welsh target for renewable heat of 3TWh per yr by 2025.**

ANAEROBIC DIGESTION (AD)

10.12. **Overall potential:** Anaerobic digesters utilising farm waste and food waste bring considerable benefits. They convert methane, a significant greenhouse gas, a major by-product of animal slurries from livestock farming and anaerobic decomposition of food waste, into energy. They therefore make a significant contribution to reducing greenhouse gas emissions, both by reducing the quantities of methane released into the atmosphere, and by providing a carbon neutral energy source that substitutes for energy generated from fossil fuels. They also potentially provide a form of farm diversification with the opportunity to sell energy in the form of electricity or heat and in the sale of fertiliser (the digestate).

10.13. Scope within the Park depends on the amount of animal slurry produced, and the amount of seasonal food and green waste from tourism in the summer season. Work is currently being undertaken to assess this potential by Pembrokeshire County Waste Department as part of the development of the Pembrokeshire Waste Strategy.

10.14. **Potential location:** So long as these digesters are integrated into the existing farm complex, or existing settlement area, and natural screening is provided where appropriate, small digesters can be incorporated into the wider landscape and should not conflict with the National Park management plan objectives. Larger digesters, shared between a number of farms will need to be considered on their merits with regards to impacts on landscape and the built environment.

10.15. **Potential contribution:** There are currently 24 dairy farms within the Park. The study has assumed the likelihood of five farms converting to AD and electricity generation between now and 2021; two commencing in 2010 and three commencing in 2016. We have assumed these are more likely to be small scale 10kW size.

The potential generation of some 0.35GWh of electrical energy by 2021 is equivalent to 0.00035TWh. **This theoretical contribution of renewable electrical energy generation in the National Park from anaerobic digestion offers approximately 0.001% towards the Welsh target for renewable electricity of 33TWh per yr by 2025.**

MICRO-HYDRO

10.16. **Overall-potential:** Overall there is a lack of suitable areas within the National Park for high-head micro-hydro (> 1 in 4 slope steepness) and low head sites due in the main to environmental constraints. Therefore, there is **no significant potential for economically generating electricity from hydro-electricity at the small to medium scale**. However, as feasibility is so site specific, there **may be scope to identify sites suitable for micro-hydro** although cost/viability may be a constraint, particularly in relation to grid connection in rural areas (para 5.14).

10.17. Collectively hydro schemes are unlikely to make a significant contribution to meeting the Park's energy demand over the Plan period

10.18. **Potential location:** Potential for micro hydro occurs where there is water resource availability, hilly areas or rivers/streams with good water flow. The study highlights this to be within the Presili area. There is also the potential to re-activate old mill sites.

10.19. **Potential contribution:** Assuming two micro hydro schemes of 10kW output are permissible and viable for development within the Park over a 10 year period (i.e. from 2011 to 2021) this would generate 0.04GWh of renewable electricity.

The potential generation of some 0.04GWh of electrical energy by 2021 is equivalent to 0.00004TWh. **This theoretical contribution of renewable electrical energy generation in the National Park offers approximately 0.0001% towards the Welsh target for renewable electricity of 33TWh per yr by 2025.**

HEAT PUMPS

10.20. **Overall potential:** Once operational ground and water source heat pump systems are unlikely to have any landscape or visual impacts. Their use is therefore very suitable within the National Park. They also offer a considerable reduction in carbon emissions when compared with even the most efficient forms of traditional heating systems e.g. condensing boilers, and can be 100% renewable if solar PV or some other form of renewable electricity generating system is used to power the compressor and pump. They are most competitive in terms of running costs when compared to alternative conventional heating systems where mains gas is not available.

10.21. **Potential location:** Heat pumps can be used universally throughout the Park, with the exception of air source heat pumps where there will be locational restrictions due to noise and visual impact. Opportunities arise for use on farms, in new commercial and domestic buildings and for retrofitting in existing buildings providing adequate space is available for the ground works (in the case of GSHPs).

10.22. **Potential contribution:** The study has assumed the likelihood that 10 commercial operations (particularly farming and tourism related) and 10 residential properties within the National Park could use GSHP technology, either as part of new development or retrofit. The systems are assumed to be rated at 20kW and 10kW respectively.

Table 10.3: Potential contribution from heat pumps

Type	Nos/kW capacity	Annual GWh output per unit	Potential numbers & annual heat generation by 2016	Potential numbers and annual heat generation by 2021
Commercial	10 x 20kWe	0.17GWh	(5) 0.85GWh	(10) 1.7GWh
Domestic	10 x 10kWe	0.087GWh	(5) 0.43GWh	(10) 0.86GWh
Total			**1.28GWh**	**2.56GWh**

The potential generation of some 2.5GWh is equivalent to 0.002 TWh . **This theoretical contribution of heat energy generation in the National Park from GSHP offers approximately 0.07% towards the Welsh target for renewable heat of 3TWh per yr by 2025.**

SOLAR TECHNOLOGIES

Solar hot water

10.23. **Overall potential:** There is very significant potential for the further development of solar hot water in the National Park. Local stakeholders see this as a key technology for meeting renewable energy targets in the National Park for private, commercial and community buildings.

10.24. **Potential location:** Solar thermal units can be used universally throughout the Park, principally within the built environment, offering a solution with low landscape impact so long as care is taken to minimise the visibility of the units within a development and /or it is integral to the building design (in the case of new builds and extensions). Domestic solar thermal micro-generation units will soon be able to be fitted under Permitted Development Rights within the National Park (para 2.54 – 2.55).

10.25. **Potential contribution:** The popularity and affordability of solar thermal is likely to result in increased levels of solar thermal installations throughout the Park over the Plan period to 2021. Assuming approximately 3,500 owner occupier households within the Park unconnected to the gas grid, and that 10% install a solar thermal unit in their homes by 2021, this would equate to an additional 350 solar thermal units. Similarly if solar thermal units are increasingly used by commercial premises – an estimate of additional 50 units by 2021, collectively this could generate about 1.2GWh of renewable heat energy.

The potential generation of some 1.2GWh is equivalent to 0.0012 TWh. **This theoretical contribution of heat energy generation in the National Park from solar thermal offers approximately 0.04% towards the Welsh target for renewable heat of 3TWh per yr by 2025.**

Photovoltaics (PV)

10.26. PV has less potential than solar thermal because of its cost and relatively low power generation, although it offers the potential to sell to the grid at times when generation exceeds use.

10.27. **Potential location:** Growth is likely to occur in the context of the domestic and small scale commercial buildings, but due to costs and competing cheaper renewable technologies this is unlikely to be on a useful scale. The development of field-scale PV systems (as being developed in continental Europe) would not be appropriate given the national status of the Park landscape.

10.28. **Potential contribution:** An estimate of likely contribution has therefore not been produced for this technology as it is considered unlikely to make a meaningful contribution to the Welsh renewable electricity target.

WIND TURBINES

Large-scale (330kW – 3MW)

10.29. **Overall potential:** Large-scale wind turbines offer an economically viable form of commercial wind energy and over time can make a significant contribution to CO_2 reduction. However, this nationally protected landscape severely constrains where these large-scale turbines can be located.

10.30. **Potential location:** An area of localised potential has been identified to the immediate vicinity of Milford Haven (para 8.33). Wind resource in terms of speed is estimated to be between 6.1 and 8.0 m/s in this area depending on height above ground level, the recommended wind speed is more than 7m/s, so a full wind speed assessment would be needed. .

10.31. **Potential contribution:** The study has assumed the potential for the development of two 330kW wind turbines becoming operational by 2021. This could be expected to generate approximately 1.72GWh of electrical energy per year.

> The potential generation of some 1.72GWh of electrical energy by 2021 is equivalent to 0.00172TWh. **This theoretical contribution of renewable electrical energy generation in the National Park offers approximately 0.005% towards the Welsh target for renewable electricity of 33TWh per yr by 2025.**

Medium-scale (50kW – 330kW)

10.32. **Overall potential:** As outlined for large wind turbines, medium scale wind turbines also offer an economically viable form of commercial wind energy and over time can make a significant contribution to CO_2 reduction.

10.33. **Potential location:** Although these turbines are smaller i.e. between 25 and 65 metres in height, they are still likely to be damaging to the sensitive landscape of the National Park. The only areas with the potential to accommodate this size of turbine are in limited locations along the south east coast and around Milford Haven (paras 8.38 – 8.40). The former have wind speeds on the margin of viability, as they are sheltered from the prevailing westerly and south westerly winds. Full wind speed assessments would need to be carried out to ensure viability. The Milford Haven area experiences higher wind speeds, so is more viable, but again an assessment would need to be carried out for any turbine project in this area to ensure viability

10.34. **Potential contribution:** The study has assumed the potential for the development of two wind turbines becoming operational in 2016. This could be expected to generate approximately 4GWh of electrical energy from 2016 – 2021.

Table 10.4: Potential contribution from medium scale wind turbines

Nos/kW capacity	Annual GWh output per unit	Potential annual electricity generation by 2021
1 X 80kW	0.2GWh	0.2GWh
1 X 250kW	0.6GWh	0.6GWh
Total		**0.8GWh**

The potential generation of some 0.8GWh of electrical energy by 2021 is equivalent to 0.0008TWh. **This theoretical contribution of renewable electrical energy generation in the National Park offers approximately 0.002% towards the Welsh target for renewable electricity of 33TWh per year by 2025.**

Small scale (10kW – 50kW)

10.35. **Overall potential:** Small-scale wind turbines offer considerable potential for renewable energy generation within the Park providing their location and appearance, either individually or cumulatively, does not detract from the landscape and special qualities of the National Park.

10.36. **Potential location:** The study findings highlight that most areas of the Park, with the exception of the Preseli Mountains, offer either some potential, or localised potential for small-scale wind turbines with careful siting. Wind speeds are viable for this size of turbine across the majority of the Park, with the exception of low lying land north of Saundersfoot and parts of the Cleddau estuaries (see para 8.43 – 8.45).

10.37. **Potential contribution:** The study has assumed the potential for the development of fifteen 50kW wind turbines, 5 becoming operational in 2010 and 10 from 2016. This could be expected to generate approximately 2GWh of electrical energy per annum by 2021.

The potential generation of some 2GWh of electrical energy by 2021 is equivalent to 0.002TWh. **This theoretical contribution of renewable electrical energy generation in the National Park from small-scale wind turbines offers approximately 0.006% towards the Welsh target for renewable electricity of 33TWh per year by 2025.**

Micro wind (<10kW)

10.38. **Overall potential:** The use of micro wind turbines in the Park and across the UK generally is gaining popularity, although the present generation of micro-scale wind turbines are relatively inefficient and not cost effective and as such initial trials indicate that they do not deliver any real carbon savings. Growth in the next 10 to 20 years is expected to continue to be negligible in comparison to other forms of renewable technologies.

10.39. **Potential locations:** Micro-wind turbines can be used universally throughout the Park, with low landscape impact so long as care is taken to minimise the visibility of the unit. Domestic micro-generation units will soon be able to be fitted under Permitted Development Rights within the National Park (para 2.54 – 2.55).

10.40. **Potential contribution:** An estimate of likely contribution has not been produced for this technology as it is considered unlikely to make a meaningful contribution to the Welsh renewable electricity target.

OVERALL ESTIMATES

10.41. Based on the above calculations of renewable energy contributions, Table 10.5 highlights that the potential future development of appropriately located renewable energy technologies would make a small contribution towards Welsh targets, primarily because these targets, particularly for renewable electricity generation, are very ambitious with the majority of energy expected to come from marine and wind sources.

10.42. Furthermore, the larger scale renewable electricity generating technologies (ie wind) are more visible in the landscape, which coupled with the National Park's special landscape qualities forms a significant constraint restricting potential contribution. Conversely, the development of heat energy from biomass and other low visibility impact technologies provides a better environmental fit within the Park, potentially making a more significant contribution to the Welsh renewable heat energy target and also contributing to wider conservation objectives and diversification of the rural and land-based economies. Installation of microgeneration technologies by home owners within the Park is currently well above the UK average. This highlights the suitability for renewables in the area, as well as good public awareness and positive perception of the technologies, all of which can be enhanced through future education and awareness raising initiatives within the Park

10.43. The potential for medium scale biomass, and also very limited numbers of large and medium scale wind turbines, provide the opportunity for local communities within the Park to take a direct stake in local projects. Communities must share common values in order for the project to succeed. There have been several attempts by members of local communities within the National Park over recent years to establish community renewable projects, but establishing consensus across whole communities has to date proven elusive. There are however many examples of successful community owned projects in the UK which can help build understanding in how to achieve community consensus in the future. See Energy4All www.energy4all.co.uk/energy_home.asp.

10.43 The Transition Towns initiative is also a way of educating and motivating a community towards addressing concerns of Peak Oil and climate change. Several local stakeholders within the National Park are helping their communities work towards Transition Town status. www.transitiontowns.org . Additionally, St David's has adopted EcoCity status whereby it has set itself an objective to be a carbon neutral city. This has resulted in recent installations of renewable technologies on local buildings such as solar water heating and solar PV. The project is also supporting Tidal Hydraulic Generator Ltd's efforts to attract grants to investigate the feasibility of installing a tidal turbine in Ramsey Sound that could provide St David's with 100% renewable electricity. www.eco-city.co.uk

Table 10.5: Potential contribution from renewable technologies within the Pembrokeshire Coast National Park to 2021

Renewable electricity		**Renewable heat**	
Technology type	**Potential generated (GWh) by 2021**	**Technology type**	**Potential generated (GWh) by 2021**
Anaerobic digestion	0.35GWh	Large-scale biomass	nil
Micro hydro	0.04GWh	Medium-scale biomass	28GWh
Photovoltaics	negligible	Small-scale biomass	3.5 -9GWh
Large-scale wind	1.72GWh	Heat pumps	2.5GWh
Medium-scale wind	0.8GWh	Solar thermal	1.2GWh
Small-scale wind	2GWh		
Micro- scale wind	negligible		
Total	**4.91GWh**	**Total**	**35.2 -**

			40.7GWh
Welsh target 2025	**33TWh**	**Welsh target 2025**	**3TWh**
% Contribution	**0.01%**	**% contribution**	**1.2 – 1.3%**

11. FUNDING OPPORTUNITIES

11.1. This Chapter provides a summary of the main funding sources available for the renewable and low carbon technologies identified in this report. It is divided into two parts:

a) Funding for **all types of renewable technologies**
b) Funding for **specific technologies**

FUNDING FOR ALL TYPES OF RENEWABLE TECHNOLOGIES

11.2. The funding sources identified below are those available to privately owned homes and businesses; they do not include funding streams that may be available to registered social landlords. The key funding programmes available include:

1. UK Low Carbon Buildings Programme
2. Carbon Emission Reduction Target
3. Green Energy Fund (by EDF Energy)
4. E.on SOURCE
5. Ashden Awards for Sustainable Energy
6. Salix (Carbon Trust)
7. Carbon Trust Enterprises Limited
8. Funding from Charitable Trusts
9. Environment Wales
10. Community Ownership / Community Energy Saving Programme
11. Sustainable Development Fund (SDF) / Sustainable Pembrokeshire Small Grants Scheme

1. UK Low Carbon Building Programme

11.3. The UK Government's Low Carbon Buildings Programme provides funding throughout the UK for community and public sector organisations via two grant phases.

11.4. Phase 1 is open for domestic schemes and grants are available towards the costs of: solar photovoltaics, solar thermal, wind turbines, ground source heat pumps, air source heat pumps, biomass boilers and CHP plant and micro CHP.

11.5. Phase 2 is open for public sector and charitable organisations. It offers larger grants to 'community' schemes which are owned and operated by a non-profit organisation for the benefit of the local community. Such organisations include councils, schools and housing associations. Grant of up to 50% of project costs can be obtained. An essential element of these schemes is their ability to raise awareness within the community and improve the national profile of renewable energy schemes.

- Both Phase 1 and 2 grants are awarded on a first come, first served basis (if they meet the pre-determined criteria).
- For more information on how the LCBP works see http://www.lowcarbonbuildings.org.uk/about/;

2. Carbon Emission Reduction Target (formerly known as Energy Efficiency Commitment 3)

11.6. This is the working name for the replacement grant scheme to the existing Energy Efficiency Commitment (EEC) placed upon UK domestic energy suppliers (with at least 50,000 UK customers). Under the current EEC, suppliers have to make a certain level of savings through approved measures which are usually based around domestic energy efficiency, including loft insulation, cavity wall insulation and the provision of subsidised compact fluorescent lamps (CFLs). Work is generally undertaken by approved contractors acting on behalf of the energy companies. Clients either receive a subsidy (if they are in an "able to pay" client group) or the work free of charge if they are in the priority group of low-income consumers. The current phase of the Energy Efficiency Commitment (EEC2) expires in 2008, and consultation is already underway about its replacement.

11.7. The Climate Change and Sustainable Energy Act (2006) allows the Government to expand the range of measures that can be used by energy suppliers to deliver their commitments under EEC. The UK Government launched a statutory consultation on the Carbon Emission Reduction Target (CERT) for energy suppliers for the period 2008–2011 in May 2007. As currently envisaged, the CERT will replace EEC but includes an expanded range of measures including micro-generation and behavioural measures, within the scheme. It also proposes an increased carbon target on energy suppliers, effectively requiring them to double their current effort, significantly increasing activity in well established markets like insulation, and encouraging new markets like micro-generation.

11.8. Although it is too early to be certain about the exact terms of the new CERT, the following measures are likely (domestic grants for owner occupiers and landlords other than RSLs):

- Cavity Wall Insulation.
- External Solid Wall Insulation.
- Loft insulation (including top-ups from under 100mm).
- Solar Water Heating.
- Air Source & Ground Source Heat Pumps.

11.9. It is likely that the domestic stream of the LCBP will end at the same time as the CERT is placed upon energy suppliers. Each energy supplier will, as at present, be able to set its own level of subsidy for approved measures, and to choose to include or exclude any particular measure.

3. Green Energy Fund (by EDF Energy)

11.10. This fund is open to local authorities, housing associations, public sector and community groups. It provides funding for the installation of small-scale renewable technology (up to £5K for feasibility studies, and £30K for installation).

4. E.on SOURCE

11.11. This fund is also open to local authorities, housing associations, public sector and community groups. It provides funding to assist the implementation of sustainable energy projects for buildings, including energy efficiency and micro-generation. The maximum award is £30K. www.eon-uk.com/source.aspx

5. Ashden Awards for Sustainable Energy (Renewable Energy Award)

11.12. This award is open to non-government organisations, not-for-profit organisations, schools and local authorities which have carried out projects or programmes to increase the supply of renewable electricity and/or heat at a local level. The maximum award is £30K. The annual round of awards opens in autumn of each year. www.ashdenawards.org

6. Salix (Carbon Trust)

11.13. Salix is an independent, publicly funded company that provides interest-free match funding to the public sector to invest in energy efficiency measures and technologies that will reduce carbon emissions. The next closing date for applications is 1st December 2008. http://www.salixfinance.co.uk/home.html

7. Carbon Trust Enterprises Limited

11.14. The Carbon Trust has also established a number of commercial organizations which collectively, under the Carbon Trust Enterprises Ltd banner, provide a variety of carbon reducing services. Connective Energy, a partnership between Doosan Babcock (energy services) and Tridos Renewables (ethical bank) provides the development, investment, financing, construction and operation of the infrastructure for sharing heat energy between neighbouring businesses. Insource Energy design, build and operate systems including anaerobic digestors, biogas and CHP for the food and drink sector. Partnerships for Renewables work with the public sector to develop community-based schemes using renewable energy technologies based on public sector land (including planning, design, construction and operation). Funding is provided for the development stages.

8. Funding from Charitable Trusts

11.15. There are a small number of charitable trusts within the UK that will occasionally support innovative or demonstration projects in the field of sustainable energy. These include Rowntree Foundation, the Eaga Charitable Trust, the Pilkington Energy Efficiency Trust (PEET) and the Gatsby Foundation. These Trusts provide support for innovative work rather than core funding.

9. Environment Wales

11.16. Environment Wales is funded by the WAG and aims to contribute to sustainable development. Environment Wales offers five grant streams for voluntary organisations and community groups. One of the streams is for providing practical sustainable improvement projects in the Welsh environment. There are various grant funds available ranging from £400 up to £10,000, depending on the stage of the project, www.environment-wales.org

10. Community Ownership Schemes

11.17. Community ownership provides an alternative means of financing medium to large scale renewable energy projects. There are a small number of community ownership specialists (most notably Energy4All, which developed out of the pioneering Baywind Community wind turbines in Cumbria) that specialise in setting up co-operatives. Traditionally these been around medium scale wind developments (of perhaps 1-10MW capacity), but the model could also be used for biomass or medium-sized hydro schemes. Community renewables schemes also often work on the demand side through promoting energy efficiency measures and an educational forum to promote changing current consumption habits. Communities may be strictly geographic or could also include those who share certain common values.

11.18. The benefits of community schemes for their members identified by Energy4All include:

- A direct stake in a local project
- Attractive financial return to members
- Extended economic benefits for the local area
- Delivery of local energy conservation projects
- Educational support on environmental issues
- Individual commitment to low carbon initiatives
- Membership of a nationwide network

11.19. They also note that for policymakers it helps the public feel more involved, consulted and supportive of the transition away from centralised fossil fuel or nuclear power. This helps local communities overcome some of the resultant evolution that occurs to the landscape.

Community Energy Saving Programme

11.20. This is a forthcoming initiative where Energy Companies are to be directed to put £350M into community based energy saving measures. It is to be implemented from October 2009 and is currently being drafted into the Climate Change Bill proceeding through Parliament. http://www.number10.gov.uk/Page16807

11. Sustainable Development Fund

11.21. All National Parks in Wales run a Sustainable Development Fund to encourage innovative sustainable development projects that help improve the quality of life for current and future generations within Welsh National Parks. It is administered in Pembrokeshire by the Pembrokeshire Coast National Park Authority.

11.22. Projects suitable for the fund include those involving the main sustainability themes:

- effective protection of the environment
- careful use of natural resources
- social progress recognising the needs of all people
- maintaining sustainable levels of economic growth

11.23. Projects can range from the locally-based to those applying across the National Park. Partnership working and community support is desirable.

Sustainable Pembrokeshire Small Grants Scheme

11.24. This is a local initiative that supports the development of sustainable projects. Funding has been made available by WAG to support the regeneration of local communities and the development of the environment.

11.25. The scheme is administered by the Pembrokeshire Association of Voluntary Services (PAVS), with '*the way we live*' strand of the Scheme financially supported by the Park Authority as part of the Sustainable Development Fund (SDF).

11.26. Projects should contribute to sustainable development and fall within any of the following themes:

- The place where we live - *Respecting our natural environment and heritage*
- The people we live with **-** *Creating a community where opportunities are accessible to all*
- The way we communicate **-** *Working to improve communication networks in communities*
- The way we live (funded by the SDF) **-** *Developing and testing ways of living in a more sustainable way*

11.27. Grants of up to £1,000 may be applied for by voluntary and community groups under any one of the themes of place, people and communication

11.28. Under the way we live grants of up to £1,000 may be applied for. This money can be used for research work, feasibility studies and actual project costs. At least 50% of project costs will be provided to successful schemes. Projects should either be based in the Pembrokeshire Coast National Park or at least have the support and involvement of community interests within the Park. The grant is open to organisations including community groups, as well as individuals and businesses. In the case of individuals and businesses, benefits to the wider community must be shown.

FUNDING FOR SPECIFIC TECHNOLOGIES

Biomass and energy crops

11.29. **Wood Energy Business:** This fund is set up by WAG and is managed by the Forestry Commission. It provides capital grants to businesses for the harvesting and processing of wood fuel, to assist with the capital costs of equipment purchase and plant installation including items such as wood chippers and drying sheds. The current phase of the Wood Energy Business Scheme (WEBS) ended in March this year, but it is hoped that a further scheme with funding will become available in the future. www.woodenergybusiness.co.uk

11.30. **Better Woodland for Wales** is the new Forestry Commission Wales (FCW) grant scheme. It places greater emphasis on good quality woodland management and offers grants specially designed for Welsh woodlands. The scheme currently offers the following incentives:

- **Management Plan Preparation Grant**
  Provides help towards the cost of using a Management Planner to prepare a foundation report and Management Plan as part of a BWW application.

- **Woodland Establishment Grants**
  Grants for creating new woodlands. Rates vary for new native woodlands, planting quality mixtures, simple mixtures and standard crops. Additional grants are available for creating new woodlands in habitat network areas. There are also additional grants for fencing, pest management and the cost of opening new woodlands to the public. New planting grants are part funded by the Rural Development Plan for Wales 2007-2013.

- **Replanting Grants**
  Available for the replanting of standard crops, mixtures and native woodlands. Higher rates are available for restocking as part of the maintenance of Plantations on Ancient Woodland Sites (PAWS).

- **Woodland Improvement Grant - Silvicultural / Environmental**
  Grants to help bringing woodland back into management and to enhance the conservation value of woodland. These grants are part funded by the Rural Development Plan for Wales 2007-2013.

- **Woodland Improvement Grant - Social**
  Grants available to provide beneficial recreational and educational facilities and to help with general amenity work.

Anaerobic digestion

11.31. **Materials Action Programme (Welsh Assembly Government):** The sustainable management of biowastes is a key policy and priority under *Wise About Waste*, the National Waste Strategy for Wales. WAG wishes to support the development of AD plants across Wales and has provided capital grant support under its Materials Action Programme (MAP).

11.32. The aim of the MAP capital support programme is to encourage a step change in the amount of biodegradable waste that is diverted from landfill in Wales – in particular from commercial and industrial sources such as food and drink manufacture and catering. This will help secure a reduction in greenhouse gas emissions from landfill in the form of methane.

11.33. The MAP AD Capital Support Programme is being managed and delivered by The Waste Resources Action Programme (WRAP) on behalf of the WAG. The capital competition (in line with state aid rules) is to provide funding towards strategic AD facilities across Wales. The funding provides 30% of capital costs for any digestion facility set up to process commercial and industrial waste in Wales before March 31, 2009.

11.34. The University of Glamorgan are setting up a Wales Centre of Excellence for anaerobic digestion to address the above needs. The Centre will also act as a point at which National and Local Government and Regulators can access this expertise to ensure that appropriate policies and guidance are developed and implemented in Wales.

APPENDIX 1:

ENERGY CONSERVATION IN COMMERCIAL PROPERTIES

ENERGY EFFICIENCY TARGETS FOR COMMERCIAL PROPERTY IN THE PEMBROKESHIRE COAST NATIONAL PARK

This study has included an investigation into the potential for adopting targets for improving energy efficiency within commercial properties in the National Park. Parallel to this study the West Wales Eco Centre is providing information on possible targets for the reduction of carbon emissions in individual domestic properties in the National Park through energy conservation measures.

Overview

There are currently no targets within the UK or Wales specifically directed at improving energy efficiency within the commercial sector. Current policy seeks to use encouragement, improved communication and information to improve the take up of energy efficiency amongst both organisations and individuals.

The following section outlines the current policy framework at the national level and in Wales to set the scene for how energy efficiency measures will be implemented in the future in this sector.

UK energy efficiency target

The European Union's Energy End-Use Efficiency and Energy Services Directive requires the UK to meet a 9% energy saving target by 2016.

Latest estimates [40] show that the UK is expected to exceed the 9% target, delivering 272.7 TWh in savings by the end of 2016, equivalent to a saving of 18% over the target period.

The UK Energy Efficiency Action Plan (2007) sets out the package of policies and measures that have been put in place across the UK to deliver improvements in energy efficiency in order to contribute to the achievement of UK climate and energy policy objectives and to meet the 9% energy saving target by 2016.

In the non-household sector the government has as number of schemes and incentives for energy intensive industrial sectors, as well as the large non-energy intensive sectors. At the smaller scale the government aims to communicate the importance of energy efficiency to industry and commerce via the following means:

- Encouraging the uptake of energy efficient goods and measures through the work of the *Carbon Trust*
- Provision of *enhanced capital allowances* for energy efficiency equipment
- Provision of information on the energy efficiency of commercial buildings when they are constructed, sold or rented out, through the *Energy Performance Certificate* scheme
- The extension of smart metering to all but the smallest businesses within the next five years.

[40] UK Energy Efficiency Action Plan 2007 - DEFRA

Energy Efficiency in Wales

A forthcoming National Energy Efficiency and Savings Plan is to look at how the Welsh Assembly Government can reduce energy use across Wales. It will look at how energy efficiency can contribute to climate change objectives, and also the important role energy efficiency in housing can play in tackling fuel poverty.

The results of the National Energy Efficiency and Savings Plan consultation will be brought together with those from the Renewable Energy Route Map (para 2.38) consultation to form Wales' Energy Strategy (para 2.43). This will be published in the summer of 2009. It will also form a major part of the Climate Change Strategy (para 2.33), which is due for consultation later this year.

The plan will contribute to greenhouse gas emission targets and fuel poverty objectives in Wales by reducing energy use. It will focus on areas the Assembly Government can influence, but will also consider other areas.

The plan will be action focused and look towards the vision for a low carbon Wales. The aim is to make the plan concise and accessible, and relevant to all sectors. The consultation document will include summaries for different audiences.

The plan will cover the whole breadth of the built environment and also energy use by appliances, consumer goods and machinery.

The plan will consider housing and business energy use, and the role of the Assembly Government, local government, the wider public sector and communities in achieving its objectives.

The plan will look at micro-generation, and will develop some aspects of the Micro-generation Action Plan that already exists (para 2.41). Micro-generation will be considered where it is the most appropriate option for reducing fossil fuel energy use (paras 9.7 – 9.13).

Timescales for the National Energy Efficiency and Savings Plan are:

Pre-consultation engagement July - October 2008
Consultation launch - December 2008
Consultation period and workshops - January/February 2009

Potential contribution: The study has assumed the likelihood that 10 commercial operations (particularly farming and tourism related) and 10 residential properties within the National Park could use GSHP technology, either as part of new development or retrofit. The systems are assumed to be rated at 20kW and 10kW respectively.

Local Tertiary Energy Demand

There is no separate data available for tertiary (industrial, commercial, public sector and agricultural) energy demand in the National Park area. However certain data is collated by AEA on behalf of Defra/WAG at a NUTS4 level – i.e. by County Council level, and this data is then reported in terms of equivalent carbon emissions. Estimated data for 2006 was released in September 2008:

Most of the emissions captured in the table will arise outside the National Park area, and the numbers have been adjusted to exclude energy used by the oil refineries. (These are regarded as primary energy users, and attributable energy is re-allocated to users of the resultant oil products.)

It is worth noting that Pembrokeshire as a whole is responsible for just 2.6% of non-domestic emissions, despite having 4.0% of the Welsh population. However it carries more than its share of electrical and agricultural emissions, the former potentially due to the low availability of mains gas in the county.

Table A1: CO_2 emissions and energy in tertiary sector

Source of CO2 emissions (Energy use)	Pembs. emissions $kTCO_2e$	Wales emissions $kTCO_2e$	%	Estimated energy equivalent GWh
Industrial &Commercial:				
- Electricity	427	6,438	6.6	993
- Gas (incl. large user/process)	23	7,191	0.3	121
- Oil	15	1,147	1.3	56
- Solid Fuels	23	1,746	1.3	72
Agricultural (mainly oil)	62	528	11.7	248
Non-Fuel	0	1,327	0.0	0
Other, incl. biomass/waste	4	709	0.6	40
Total	**534**	**20,799**	**2.6**	**1,530**

Source: NUTS4 data; NEF conversions

Next steps

One to one meetings will be held with key stakeholders to get their ideas, views and recommendations. This will lead on to engagement on key delivery areas with various forums and groups (September/October).

Existing groups will be consulted (e.g. Fuel Poverty Advisory Group, HECA (Home Energy Conservation Act) Forum, Welsh Local Government Association Strategic Environmental Directors group, Climate Change Commission Emissions Reduction Subgroup) as well as separate meetings with other stakeholders where necessary. During the consultation community workshops will be held and WAG representatives will attend meetings and forums early in 2009.

Flexible support for business

The Welsh Assembly Government also funds the work of the business support agency in Wales '*Flexible support for Business*'. This agency hosts the Wales Envirowise business advice service with the role of assisting businesses throughout Wales examine their environmental impact (including carbon footprint and energy use) and explore the cost savings available for reducing it.

PEMBROKESHIRE - EXISTING WORK ON COMMERCIAL SECTOR ENERGY EFFICIENCY

Under the EU Leader + Rural Development Programme, local Pembrokeshire agency PLANED supports a number of community initiatives within Pembrokeshire (including the National Park). Under the Energy and Recycling theme, PLANED have funded a recent evaluation of energy audit surveys carried out on a sample of small businesses in Pembrokeshire in 2006[41]. Twenty two of the forty seven businesses audited fall within the National Park area (see Annex A). The energy audit surveys recommended low cost measures for energy efficiency improvements. An evaluation survey conducted in 2007 observed that less than half the participants had gone on to take any kind of action to implement financial and CO_2 savings.

This recent outcome highlights the difficulty in ensuring the take up of energy efficiency within the commercial sector.

Conclusions

As a Planning Authority, the PCNPA does not have the financial resources or remit to fund specific work with the commercial sector to improve energy efficiency rates. It would therefore not be feasible to set targets for energy efficiency improvements within this sector in the National Park without sufficient resources. It may be that working in partnership with other organisations, PLANED, Pembrokeshire County Council, Flexible Support for Business, local business chambers and network groups could provide focus and resource to begin a local programme for energy efficiency in the commercial sector.

[41] An evaluation of the energy audits carried out for small businesses in Pembrokeshire under the PLANED Energy Savers Scheme – January 2008 – Arena Network

Annex A

An evaluation of the energy audits carried out for small businesses in Pembrokeshire under the PLANED Energy Savers Scheme – January 2008 – by Arena Network

Businesses surveyed within the National Park

	Organisation	Address	Business Type	Employees	Recommended Measures	Approx C02 Savings
1.	Town trails of Tenby, Chamber of Trade & Tourism	Highlands, Serpentine Road Tenby, SA70 8DD	Tourism	1 employee		
2.	Morris Bros	High Street, Tenby	Retail	5 employees	Lighting, replace T12s with T8 fluorescent tubes (@537kg) & timers on cooling cabinets (@1256kg)	1793kg
3.	T P Hughes	12 High Street, Tenby	Retail	34 employees	Lighting, replace 50w halogen lamps with 9w low energy lamps (@12316kg)	12,316kg
4.	Lydstep Park	Lydstep Park, Lydstep	Tourism	Not known		
5.	Kiln Park	Marsh Road, Tenby	Tourism	200 (peak season)		
6.	Woodlands Hotel	St Brides Hill, Saundersfoot	Tourism	Not known		
7.	Lowless & Lowless	Tenby	Solicitors	98 employees	Good housekeeping, switch off PCs When not in use (@3225kg) & Replace lights with low energy Bulbs (@1004kg)	4229kg
8.	Lydstep Nurseries	Manorbier, SA70 7SJ	Plant Nursery	7 employees		
9.	Vine Cottage Guest House	The Ridgeway Saundersfoot	Tourism	2 employees		
10.	Edgecombe House	The Ridgeway Saundersfoot	Tourism	2 employees	Good housekeeping, switch off standby power (@226kg) & replace lights with low energy bulbs (@193kg)	419kg
11.	Tything Barn Holidays	West Williamston, SA68 0TN	Tourism	Not known		
12.	The Grange Residential Home	Manorbier	Care Home	Not known		
13.	Swallow Tree Leisure Park	New Hedges, SA69 9DE	Tourism	Not known		
14.	Bramble Lodge Guest House	Tenby	Private dwelling	Not known		
15.	Ty Rhos Trees	Felindre Farchog, SA41 3XD	Tree nursery	4 employees	Draughtproofing of doors (@75kg)	75kg
16.	Havard Stores	East Street, Newport, SA42	Retail	3 employees		

	Organisation	Address	Business Type	Employees	Recommended Measures	Approx C02 Savings
17.	Tenby County Club	The Croft, Tenby	Private Club	1 employee		
18.	Broadlane Kennels	Lawrenny, SA68 0PS	Kennels	2 employees	Good housekeeping, switch off standby power(@226kg) & replace lights with low energy bulbs (@154kg)	380kg
19.	Lawrenny Community Shop	Kilketty, SA68	Retail	1 employee + volunteers		
20.	Lawrenny Hostel	Lawrenny, Kilketty, SA68 0PN	Tourism	1 employee		
21.	Court House and Curtis House	St Davids, SA62 6SE	Accommodation & Community centre	1 employee		
22.	Porthllisky Farm Cottages	St Davids, SA62 6RR	Farm	2 employees		

APPENDIX 2:

THE RENEWABLES OBLIGATION

The Renewable Obligation (RO) is a Government initiative to encourage more renewable electricity generation. A certificate, known as a **Renewable Obligation Certificate (ROC)**, is issued for each megawatt hour of renewable electricity generated. Electricity suppliers need these certificates as they have an obligation to source a specific and annually increasing percentage of the electricity they supply from renewable sources. The current level is 9.1% for 2008/09 rising to 15.4% by 2015/16.

ROCs can be issued on a monthly or yearly basis. The threshold for claiming 1 ROC is 0.5MWh. The renewables obligation is primarily aimed at large scale generation although micro-generators can participate. For example, a 1kW wind turbine may only generate enough electricity to claim 1 or 2 ROCs a year which could be valued as much as £40 or as little £15 per ROC depending on market price. The Government allows micro-generators to participate through an agent who can amalgamate the output of several micro-generators making it more worthwhile for micro-generators to get involved.

Renewable energy sources eligible under the Obligation are outlined below.

Eligibility of energy derived from waste

Electricity generating stations that use biomass, energy crops, agricultural waste and forestry material to generate electricity are eligible to claim ROCs. Source: Department for Business Enterprise & Regulatory Reform (BERR) 2008

Sources	Eligibility
Landfill gas	Yes
Sewage gas	Yes
Hydro exceeding 20 MW declared net capacity (dnc)	Only stations commissioned after 1 April 2002
Hydro 20 megawatts or less dnc	Yes
Onshore wind	Yes
Offshore wind	Yes
Co-firing of biomass	Yes. (There are no restrictions on the amount of co-firing a generator can undertake. However, suppliers can only meet 10% of their obligation from co-fired ROCs.)
Other biomass	Yes
Geothermal power	Yes
Tidal and tidal stream power	Yes
Wave power	Yes
Photovoltaics	Yes
Energy crops	Yes

http://www.berr.gov.uk/whatwedo/energy/sources/renewables/policy/renewables-obligation/what-is-renewables-obligation/page15633.html

APPENDIX 3:

CALCULATIONS OF ENERGY CONTRIBUTIONS

For the purposes of providing an estimate of the contribution the Pembrokeshire Coast National Park could make towards the Welsh renewable energy generation targets, the following assumptions and calculations have been used.

To calculate the annual electricity or heat generation in GWh, for each technology, the installed capacity (size of the unit i.e. 50kW) is multiplied by the number of hours in a year, and multiplied again by the 'capacity factor'. The capacity factor is the ratio of the actual output of the power unit over a period of time and its output if it had operated at full capacity over that time (e.g. Wind turbines will not always be operating at full capacity as wind speeds vary. With the exception of wind turbines and micro hydro the capacity factors have been taken from South East Energy Statistics, which is led by the Government Office for the South East and funded through the South East Development Agency and the south East England Regional Assembly. The capacity factor for wind turbines and micro hydro has been taken from the Companion Guide to PPS22.

Calculation:

Installed Capacity (GW) x Number of hours per year x Capacity Factor

(to convert from kW to GW multiply by 0.000001)	24 x 365 = 8760	e.g. 30% or 0.3

= Electricity (or heat) generated per year

Capacity Factors

Onshore wind: 0.3
Solar PV: 0.07
Micro hydro: 0.25
Business heating biomass plant: 0.5
Domestic biomass: 0.2
Anaerobic digestion: 0.8
GSHP: 1