Cairngorms National Park Energy Options Appraisal Study

Final Report

for

Cairngorms National Park Authority

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Contents

1 Introduction

1.1 Brief

SAC Consulting's Environment & Design Group (SAC) was commissioned by the Cairngorms National Park Authority (CNPA) in January 2011 to undertake a study of the options and potential for renewable energy deployment in the Cairngorms National Park (CNP). This report presents the findings of the energy options appraisal study, outlining:

- The principal renewable energy technologies and their application;
- The available energy resources in the National Park;
- Key physical and environmental constraints to energy deployment;
- Potential for development of each technology in the Park; and
- An overview of the potential renewables mix in the Park and its associated impacts and benefits.

The report concludes with a summary of the wider benefits and impacts of renewable energy development and the implications of the findings for the CNPA's opportunities for enabling sustainable renewable energy development in the Park. The findings of this report will also be used by CNPA to help guide the development of forthcoming Supplementary Planning Guidance (SPG) on renewable energy.

Readers should not infer from any part of the report that planning consent for specific energy developments will be more likely to be approved by the Cairngorms National Park Authority or the Local Authorities in the Park. Please refer to the relevant planning policies and guidance for information and speak to a planning officer when you start to consider any such development.

1.2 Policy Context

The National Park was designated in 2003 in recognition of the special qualities associated with its international importance for natural and cultural heritage, and the landscapes associated with its geology, climate, soils and habitats. It represents a unique landscape of over 4,500 square kilometres whose conservation is of paramount importance. However, the Park is also a place where people live, businesses prosper and which receives in excess of 1.4 million visitors annually[1]. A plan of the Park showing its boundaries is provided in Figure A.1 (Appendix A).

The CNPA was created by the National Parks (Scotland) Act 2000 to support four aims in the legislation:

- To conserve and enhance the natural and cultural heritage of the area;
- To promote sustainable use of the natural resources of the area;
- To promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public; and
- To promote sustainable economic and social development of the area's communities.

The CNPA is designed to be an enabling organisation, promoting partnership working and giving leadership to all those involved in the Cairngorms in order to meet the four aims. The CNPA also has statutory responsibilities to prepare a Park Plan and a Local Development Plan, and to undertake a range of planning and development management functions.

The Cairngorms National Park Plan (Cairngorms National Park Authority, 2007) provides a management framework for the CNPA and the agencies with which it works and partners. It identifies seven priorities for action between 2007 and 2012, and has strategic objectives for Sustainable Use of Resources and Energy which refer to the pursuit of renewable energy options at domestic, business and community scale in appropriate locations. The 2010 Local Plan (Cairngorms National Park Authority, 2010a) also includes a specific policy (Policy 15) stating:

"Developments for small scale renewable energy schemes ... will be favourably considered where they contribute positively to the minimisation of climate change, and where they complement the sustainability credentials of the development ..."

The policy context clearly establishes that windfarm developments will not be acceptable in the National Park. However they also create an environment in which smaller scale renewable energy development and progression of its supply chain will be encouraged where this does not have adverse environmental or other amenity impacts. The strategic objectives in the Park Plan confirm the CNPA's aspiration to contribute to national targets for renewable energy generation (see further discussion in Section 9.3), and to provide information to help communities and businesses to reduce energy demand and generate renewable energy. This report, and the anticipated SPG which will follow, are specifically aimed at meeting these objectives.

[1] This information and more details on the Park can be found from http://www.cairngorms.co.uk/thepark/keyfacts/

Climate change represents a significant threat to the habitats, landscapes and communities of the National Park. In addition to planning for adaptation to future changes in climate, the CNPA recognises its obligation (in the Park Plan and Local Plan) to contribute to reducing carbon emissions through its activities, and through the policy and development framework it sets. Renewable energy also represents an important sector where the carbon intensity of electricity and heat generation can be substantially reduced related to fossil fuel derived energy sources. The CNPA wishes to encourage or support appropriate forms and scales of renewable energy development which are sensitive to the special qualities of the Park, but which also help to reduce carbon emissions, promote energy self-sufficiency and provide economic and social benefits to its communities.

The development of woodfuel heating in the Park is already quite well advanced in terms of a fuel supply chain, and proposals for further deployment are being facilitated through a bespoke action plan (Cairngorms National Park Authority, 2010b). There are also a small number of renewable energy installations across the Park either operational or in the planning stages (see Chapters 3 to 8). However, the CNPA wishes to build on this by assessing energy feasibility more systematically, and using the findings to develop bespoke SPG for renewable energy. This will help to bring forward appropriate types and scales of renewable energy development, and underpin the CNPA's enabling role where renewables offer clear environmental and socio-economic benefits without detriment to the Park's special qualities.

1.3 Approach

A strategic desk-based approach to appraising the feasibility of renewable energy in the National Park[2] has been adopted. The following broad stages characterise the approach:

- Review of renewable energy technologies and applications to understand current best practice and identify applications in similar environments elsewhere;
- Identification of the energy resource and supply chains available in the Park for each type of renewable energy technology considered;
- Broad analysis of technical and physical constraints to developing renewable energy;
- Environmental constraints analysis, drawing on existing planning and environmental baseline data;

[2] The terms 'CNP' and 'the Park' are also used synonymously in this report to refer to the area within the Cairngorms National Park boundary. The Park Authority is referred to throughout as 'CNPA'.

- Appraisal of the potential for each renewable energy development type, taking account of the known constraints, energy resources, state of technology and other factors; and
- Commentary on the challenges for enabling appropriate development of the renewables sector.

The renewable energy study concentrated on seven types of renewables applications: woodfuel, wind, hydro-electric, anaerobic digestion (AD), solar thermal, solar photovoltaic (solar PV) and heat pumps. The implications of the study's findings are also briefly discussed in the context of wider issues, including carbon emissions, energy targets and benefits to communities and businesses in the Park from developing renewables.

The result of the analysis is a high level commentary on the types and scales of renewable energy developments which are technically robust, supported by available energy resources and supply chains, and which could be developed without having significant impacts on the special qualities of the Park. It identifies the broad level of potential for renewables technologies, setting out locations where renewable energy development may be appropriate and which could be encouraged through planning guidance and in terms of the CNPA's enabling role. The report also presents (in Chapter 9) a possible future renewable energy scenario for the Park commenting on how deployment of renewables may compare with national energy targets. The scenario analysis is necessarily very broad brush, is limited in projection to 2020 (to align with interim Scottish targets), and is presented as an indicative postulation of how renewable energy might develop in the Park rather than as any form of statement of strategy for energy development.

The study was not intended to form a detailed environmental assessment either of the baseline conditions in the Park or of the impacts of renewable energy development. As the study is a strategic review of renewable energy potential it would not be possible to provide location specific environmental assessments. Nevertheless, the appraisal of options for each technology has taken account of the generic impacts of renewables development and of the broad environmental and planning sensitivities inherent in the Park and its landscapes. The report also comments briefly on the potential for cumulative environmental issues, although the detailed assessment of such effects would need to be carried out with reference to specific development proposals or spatial plans.

1.4 Structure of this Report

The report is structured as follows:

- Chapter 2 presents the overall social, economic and environmental context of the Park.

- Chapters 3 to 8 take each key technology in turn, profiling the key features, considering the energy resources and environmental effects then discussing the energy potential and the cumulative issues associated with potential deployment.
- Chapter 9 considers the implications of deployment of all the technologies in terms of the wider and combined impacts and benefits.
- Chapter 10 summarises the key findings of the study and comments on their implications for enabling renewable energy and supply chain development in the Park.

A bibliography of citations used in the report is presented in Chapter 11 and Chapter 12 contains a glossary of technical terms associated with the renewable energy technologies. Supporting maps then follow in Appendix A and a summary of the UK Government's financial stimulus schemes for renewable energy is presented in Appendix B.

More detailed technology specific information notes are then presented in a series of technical annexes to the report as follows:

- Technical Annex 1: Woodfuel Information Note
- Technical Annex 2: Wind Information Note
- Technical Annex 3: Hydro Information Note
- Technical Annex 4: Anaerobic Digestion Information Note
- Technical Annex 5: Solar Information Note
- Technical Annex 6: Heat Pumps Information Note

Each technical annex presents an overview of the current state of the technology, best practice in design and installation, case studies and a list of references.

This report was drafted between June and November 2011. The statistics, references and information on tariffs were accurate as of November 2011. Readers should be aware however that some data are subject to regular change and the original data source should always be consulted to obtain the most recent information.

2 National Park Context

2.1 Introduction

This chapter presents an overview of the socio-economic, environmental and physical baseline context of the National Park. The following areas are addressed:

- Section 2.2 sets out a profile of the socio-economic conditions in the CNP with a particular focus on indices relevant to the consideration of fuel and energy;
- A summary of the key environmental designations, features and sensitivities of the Cairngorms are presented in Section 2.3;
- Physical constraints to energy development are briefly reviewed in Section 2.4 in particular considering transport access and energy networks; and
- Section 2.5 presents an overview of settlement, industry and energy demand in the Park.

The discussion is presented at a strategic level commensurate with the aims of this energy options appraisal study and is intended to provide a background to the consideration of each renewable energy technology in Chapters 3 to 8 and to inform the cross-technology appraisal in Chapter 9.

2.2 Socio Economic Profile

The CNP area faces many of the issues associated with the wider rural Scotland including an ageing population, economic migration of young people, a high proportion of second home ownership, and a narrow economic industrial base.

2.2.1 The Report on the Economic and Social Health of the Cairngorms National Park

Cairngorms National Park Authority, Highlands and Islands Enterprise and Scottish Enterprise jointly commissioned Cogent Strategies International Ltd to investigate the economic and social health of the Cairngorms National Park. The report entitled ‘The Economic and Social Health of the Cairngorms National Park’ (Cogent Strategies International Ltd, 2010) describes the economic and social baseline of communities in and around the Cairngorms National Park using the most up to date data available at the beginning of 2010. The report also identifies and analyses local economic trends, comparing these to the national picture and examines the impact that National Park status has had on the region’s economy, since its designation. Opportunities for economic strengthening are also identified. This report has been used as the primary source for the following discussion on socio economic conditions.

2.2.2 Population Profile of the Cairngorms National Park

The overall population of the CNP has increased by almost 5 per cent since its designation, and projections suggest it will reach 20,000 by 2040. The current population is 17,200 and there are 7,500 homes in the Park. The population is skewed towards older age groups compared with the Scottish average, fuelled by out-migration of young people and in-migration of older people. The mean ages of CNP population are 45 years (female) and 42.4 years (male); this is approximately 3.8 years older than the Scottish average. Statistically, the CNP area has a higher degree of age-dependency population (the ratio of older people to those of working age) than that of Scotland as a whole. This dependency is projected to rise at a slightly faster rate than the national figure, although lower than the rate of increase of at least one other comparable rural area (Dumfries and Galloway).

Like many parts of rural Scotland, the CNP area has also traditionally suffered from an out-migration of late teenagers and twenty-year-olds. The result is a population age profile with a very narrow 'waist' of people in their twenties. However, the CNP has a unique demographic situation in that since designation of the Park, the population of 20 to 30 year olds has improved and the CNP is projected to retain and in some cases increase the population of young people. The attraction of the area for younger persons is likely to be largely driven by the quality of place and the employment opportunities which exist in tourism-related industries. Continued ageing in the CNP area, however, will create both challenges and opportunities for providers of public and private services.

2.2.3 Economy and Industrial Structure

The structure of the Cairngorms economy is highly unusual, with a distinctive mix of industries contributing to the area's creation of wealth. Compared to elsewhere in the country, whisky production, forest products (specifically sawmilling, harvesting and forest stewardship) and agriculture (notably estates and conservation management) are particularly distinctive.

Cogent Strategies International Ltd have calculated the concentration and relative importance of the CNP's industrial structure using salience analysis; a technique which compares an indicator of economic activity in a specific region to a reference region (in this case the United Kingdom). The indicator most commonly used in this report is industrial gross value added (the value of sales less the cost of inputs). A positive salience for the Park means that the amount of activity in the Park is proportionately greater than in the reference region. Agriculture and forestry is the most distinctive sector in the area and with a salience value of 2.8, it is 17 times more important to the CNP economy than agriculture and forestry is to the UK economy as a whole. The wood sector is also highly distinctive, as is mining and quarrying and hotels and catering.

Land-based industries are an important generator of wealth for the Park, and an important employer of the Park's residents. Food and agriculture provide a living for 900 people, collectively generating £40 million of value added per annum. The importance of the whisky and drinks cluster is high but shrinking, now providing employment for around 100 people and value added of £20 million while the forestry and forest products cluster is growing in importance and diversity as the plantations mature. It now contributes £11 million (3 per cent) of the Park's total value added.

Most businesses operating in the Park are small; over two thirds of workplaces in the Park have fewer than five staff. However, the number of workplaces in the Park is now over 1,000 which is a rise of 13 per cent since CNP designation. The CNP area is also home to a small number of significant manufacturing operations. Together businesses in this production and manufacturing cluster account for £16 million of value added, and a part of this is due to the emergence of energy related business.

The industrial structure of the Park is relatively narrow compared with Scotland and is reliant on a narrow industrial base with greater potential therefore for asymmetric shocks to the local economy and possible lower growth in certain sectors.

2.2.4 Employment

There are a total of 11,500 people economically active in the Park. Of these, 9,000 are employed; around 2,000 are self employed; 200 (2% of economically active population) are unemployed compared to a peak of 1,000 during the late 1980s and 300 at Park designation in 2003; and the remainder are in full time further education. Most people who live in the Park also work within its administrative boundaries. Despite recent increases in unemployment levels in the CNP area, unemployment is generally much lower than the Scottish national average.

2.2.5 Income

Residents of the Park have a combined spending power of £435 million. 40 per cent of this is from employees working locally and up to 20 per cent from the capital gain on housing. Self-employment income accounts for an above-average 10 per cent of all spending power, with investment income providing over 10 per cent. There are no official data available for earnings in the CNP area, however, there is evidence that earnings are well below the Scottish and UK averages.

2.2.6 Housing

Housing supply in the Park differs from that of Scotland as a whole, being characterised by a higher level of large, detached properties, more vacant properties and a much higher level of second home and holiday accommodation. The overall supply of housing is affected by the significant proportion of the housing stock that is second or holiday homes (Cairngorms LEADER Local Action Group, 2007). There is a projected increase in the number of households containing just one adult; this increase is from 2,700 (35 per cent of all households) in 2008 to 4,360 (43 per cent) by 2033 (General Register Office for Scotland, 2010).

2.2.7 Impact of Socio-Economic Profile on Fuel Poverty

In the UK, fuel poverty is said to occur when, in order to heat its home to an adequate standard of warmth, a household needs to spend more than 10% of its income to maintain an adequate heating regime. Fuel Poverty is caused by a convergence of four factors:

- Low income, which is often linked to absolute poverty - while there are no official data available for earnings in the CNP area, combined spending power would indicate that earnings are well below the Scottish and UK averages;
- Poor energy efficiency of a home, e.g. through low levels of insulation and old or inefficient heating systems – there are no data available that would give an accurate indication of the energy efficiency of homes in the CNP area. However, statistics from a sample of household surveys undertaken by the Macaulay Land Use Research Institute (Macaulay Land Use Research Institute, 2008) revealed that average household related emissions (i.e. combustion and electricity consumption within the home only) was 4.59 tonnes, representing 7.9% of the CNP total, which is above the national average[3];
- Under-occupancy: according to UK government statistics, on average those in the most extreme fuel poverty live in larger than average homes - In the CNP, there is a high proportion of large detached properties, more vacant properties and a higher level of second home and holiday accommodation. This is compounded by a projected increase in single adult occupancy, which is expected to rise to 43% by 2033; and
- High (and rising) fuel prices, including the use of relatively expensive fuel sources (such as electricity in the UK which has been aggravated by higher tariffs for low-volume energy users) and in the CNP, oil and other fossil fuels.

[3] The National Atmospheric Emissions Inventory (NAEI) estimates that households typically contribute less than 5% of total CO_2 emissions but this relates to combustion from the home only and excludes electricity combustion. This leads to the assumption that households within the CNP area are more likely to suffer from poor energy efficiency.

Given all of the above factors compounded by lower wage increases generally and the corrosive effect of rising inflation, there is likely to be an increased risk of the occurrence of fuel poverty within the CNP over the coming years.

2.2.8 Impact of Renewable Energy Technology on Socio-economic Profile

The Park has the environmental basis for a good mix of renewable energy technologies, including biomass, wind and hydro and therefore has the potential to capitalise on everything that renewable energy technologies can offer. This may include increased local control of energy production and potential purchase for shares in the sale of energy; potential lump sums or regular payments into a fund for the benefit of local residents; land rental income; energy security and stable prices; clean energy that helps to improve local air quality and reduce environmental impacts on land, water and the climate. Renewable energy installations will help boost local economies through job creation during construction and operation and maintenance as well as through sustained employment in supply chain industries.

2.3 Overview of Environmental Constraints

The Cairngorms National Park is a landscape of international renown and a national designation in its own right. It is for this reason that the CNP is highly constrained from a development perspective by its landscape and natural heritage significance. SNH's strategic guidance on onshore wind farms (Scottish Natural Heritage, 2009b) for example, identifies the area as being a zone of high natural heritage sensitivity. The principal environmental constraints in the Park which are considered to be relevant to renewable energy development are detailed in this section. The discussion in Chapters 3 to 8 draws on these environmental constraints in presenting a broad appraisal of potential environmental impacts from each renewable energy technology. The potential for cumulation of environmental impacts is then considered in Chapter 9.

2.3.1 Landscapes

Within the CNP, there are two National Scenic Areas (NSAs); these are areas of outstanding scenic value centred on the highest mountain plateaux at the core of the Park, as shown in Figure A.2 (Appendix A). They cover a significant proportion of the National Park and span uplands, lower hills and areas of moorland, woodland and parts of the inhabited straths which characterise much of the Park (Scottish Natural Heritage, 2010).

CNPA has undertaken a Landscape Character Assessment (Cairngorms National Park Authority, 2009) of the Park, which identifies a total of 78 landscape character areas in a set of lowland areas and 12 landscape character areas in the set of upland areas. Significantly, the report also identifies the importance of the areas which overlap between lowland and upland, since these share characteristics of both groups and are therefore potentially sensitive to a wider range of landscape pressures and drivers. Landscape character and sensitivity assessment work has also been undertaken in neighbouring local authorities to the Park, notably by the Highland Council (Macaulay Land Use Research Institute, 2010). This work has included particular consideration of the sensitivity of landscape areas to wind turbine development including in the Monadhliath Mountains which form a large and sensitive landscape area bordering the Cairngorms National Park. Landscape character areas such as the Monadhliath are important to the overall landscape context of the CNP as they provide a 'buffer area' of generally high quality and high sensitivity landscape which is contiguous with the edge of the Park.

2.3.2 Natural Heritage Areas

The CNP State of the Park Report (Cairngorms National Park Authority, 2006), states that 39% of the Park is designated for nature conservation, as summarised in Table 2.1 and illustrated in Figure A.2 (Appendix A). The designated nature conservation sites are distributed throughout the Park, although the central upland areas of the Park, which include the sub-arctic zone of the Cairngorm plateau, are the most heavily designated area in terms of overlapping national and international designations for nature conservation.

Table 2.1: Designated Nature Conservation Sites within the Park

Designation	Number of Sites
Special Area of Conservation (SAC)	23
Special Protection Area (SPA)	16
Ramsar Sites	3
Sites of Special Scientific Interest (SSSI)	56
National Nature Reserve (NNR)	9
RSPB Reserves	2

The Park also has a diversity of geological resources, and there are 30 Geological Conservation Review (GCR) sites in the CNP. Ancient woodland is prevalent across the CNP focused in the straths of Spey, Don and Dee, and the Park is particularly important for its stands of remnant Caledonian pine forests.

The natural heritage importance of the Park is not solely limited to the interests represented by the designations and their associated protected species. There are a vast range of habitats and species whose existence and interactions combine with geological, soils and climatic variation to create a unique and highly biodiverse area. The Park is particularly important because it represents one of the largest assemblages of semi-natural and near-natural ecosystems in the UK and the presence of the arctic-alpine landforms, habitats and species supported are unique. The principal habitat types are presented in Table 2.2 along with an indication of the more important species associated with these habitats.

Table 2.2: Habitats and Species Characteristic of the Cairngorms

Habitats	Characteristics	Important Species
Woodland	• Extensive semi natural and ancient woodland stands • Caledonian pine forests • Upland broadleaved woodland • Estate policy woodlands • Fungus, bryophyte and lichen communities	• *Mammals*: Wildcat, Pine marten, Red squirrel • *Birds:* Black grouse, Capercaillie, Scottish crossbill • *Invertebrates*: Pine hoverfly, Aspen hoverfly • *Butterflies and moths*: Pearl bordered fritillary, Kentish glory, Dark-bordered beauty, Cousin German • *Plants:* Twinflower • *Lower Plants:* Blunt-leaved bristle moss • *Fungus:* Aspen bracket fungus
Farmland & Grassland	• Traditionally managed farmland • Unimproved grassland • Field margins, edge habitats and boundary features	• *Birds:* Twite, Black grouse, Redshank, Lapwing • *Invertebrates*: Mason bee • *Butterflies and moths*: Northern brown argus
Montane, Heath & Bog	• Arctic/alpine plant communities • Upland heath/heather moorland • Blanket and raised bogs and mires • Areas of deep peat	• *Birds:* Hen harrier, Black grouse • *Butterflies and moths*: Netted mountain moth • *Plants:* Woolly willow, Alpine sulphur tresses • *Lower Plants:* Baltic bog moss, Oblong woodsia
Wetland & Water	• High quality freshwater bodies • Rivers and burns • Standing waters including oligotrophic and mesotrophic lochs	• *Mammals*: Water vole • *Birds:* Goldeneye • *Fish*: Atlantic salmon • *Invertebrates*: Northern damselfly Freshwater pearl mussel • *Lower Plants:* River jelly lichen
Primary source: Cairngorms Local Biodiversity Action Plan web pages and Key Cairngorms Priority Species tables from CNPA website		

A detailed review of habitats and species in the Cairngorms is beyond the scope of this energy appraisal report but further information can be obtained from the CNPA website (including the Local Biodiversity Action Plan at http://www.cairngorms.co.uk/look-after/conservation-projects/biodiversity-action-plan/the-action-plan1/), from Scottish Natural Heritage and from other online resources such as www.cairngormslearningzone.co.uk.

The Park is noted for bird life due to the altitudinal range and diversity of good quality habitats, and there are a number of species within the Park of national and international importance (Cairngorms National Park Authority, 2006). This importance is reflected in the extensive areas designated as Special Protection Areas (SPAs) which have European significance for birds. In addition to the bird species listed in Table 2.2, the CNP has particular importance for Ospreys, Red grouse and raptors including Golden eagle, Peregrin falcon, Hen harrier and Merlin. The Raptor Track project (http://www.raptortrack.org) has recently been established by CNPA and other agencies to provide better information on raptor movements and to use this to benefit habitat conservation for raptors. The Park is also home to Britain's only endemic bird, the Scottish crossbill, which is closely associated with Deeside, Badenoch and Speyside and other important species include Grey partridge, Golden plover, Spotted flycatcher, Song thrush, Bullfinch and Siskin.

The Soprano pipistrelle bat and common pipistrelle bat are also present in the Park, both of which are priority UK and local species.

2.3.3 Wildness

The CNPA published Supplementary Planning Guidance (SPG) on wildness in July 2011 (Cairngorms National Park Authority, 2011b). It provides more detailed information about wildness and how it relates to planning applications. Wildness is considered to be a core special quality of the Park and it should be protected and enhanced throughout. Figure A.3 (Appendix A) illustrates the wildness zones as presented in the consultation: Band A has the strongest measure of wildness, Band B the next and Band C the lowest. In general, Band A is more sensitive to development than Band B or C and so any addition to this landscape may have a proportionately greater effect. It is also important to consider that a development may not only have an impact on one band of Wildness, e.g. a wind development within Band A, but may be visible from other locations or landscape character areas which may be nearby but have different levels of sensitivity.

2.3.4 Cultural and Built Heritage

There are 60 Scheduled Ancient Monuments recorded within the Park, covering six of the seven principal historic periods recorded (there are no Roman remains) (Cairngorms National Park Authority, 2006). These Monuments are scattered throughout the Park. Whilst the areas directly associated with the monuments are relatively small, it is important to consider the context and setting of monuments particularly those which are visible (above ground) and which relate to the landscape is some way, or have other cultural significance or tourism importance.

Gardens and designed landscapes form a relatively small part of the Park's landscape, and the majority of the designations are country house grounds and policies (Cairngorms National Park Authority, 2006). There are five Conservation Areas in the CNP, at Blair Atholl, Ballater, Braemar, Inverey and Grantown-on-Spey.

2.3.5 Rivers

The rivers within the Park are among the largest in Scotland; there are approximately 3,362 km of rivers within the Park. The rivers are of great importance locally, nationally and internationally, and have numerous national and international conservation designations for their biodiversity and high quality freshwater habitats.

Most of the area's flowing water is considered to be of excellent quality. Many of these freshwaters are internationally recognised for their important habitats and species, and are used as a benchmark against which others are judged (Cairngorms National Park Authority, 2006). The majority of the rivers and their tributaries in the CNP are designated as Special Areas of Conservation (SACs), typically based on qualifying interests of Atlantic salmon, lamprey, otter and freshwater pearl mussel. These designations reflect the contribution which watercourses make to the biodiversity of the Cairngorms and indicate their sensitivity to intervention from inappropriate new engineering works or from pollution.

2.3.6 Peat

The Park recently published Supplementary Planning Guidance on general development and carbon sinks and stores (Cairngorms National Park Authority, 2011a). Development within carbon sinks, e.g. peatland, may release carbon emissions where disturbance to soils results in dessication or changes in drainage. Blanket bogs (which are an extremely valuable active carbon sink) cover extensive areas of the Park where the climate is wet and drainage poor, and it is estimated that 13% of the soils in the Park are comprised of peat (Cairngorms National Park Authority, 2006) (see Figure A.4 in Apppendix A). Therefore, once damage or exploitation occurs it is a very slow and difficult process to restore. The importance of peat and other soil types and land cover as a carbon store is becoming increasingly important in the consideration of the life cycle carbon implications of new development.

Renewable energy developments, particularly those proposed for areas of peatland or related upland habitat such as wind turbines will increasingly need to estimate the carbon loss from site disturbance. This will typically form part of a 'carbon payback' calculation based on the CO_2

equivalent emissions offset from electricity generated by the installation when compared with generation for grid electricity.

2.4 Physical Constraints

2.4.1 Transport Network

The Cairngorm Mountains are a major geographical feature of the Park, and form a physical barrier to transport and physical communication within the Park's boundaries. The A9 trunk road is the main transport link north to south and lies to the west side of the Park. The only railway link in the Park (Highland Main Line) runs close to the route of the A9. Over half of the town/village based population of the Park live in settlements close to the A9 from Carrbridge in the north to Blair Atholl in the south. The road network is illustrated in Figure A.5 (Appendix A).

There are further connecting main roads running north east from Grantown-on-Spey to Ballater and the A93 runs south east from Ballater to Braemar and south outwith the Park boundaries. There are further minor roads and hill tracks but it is of note that there are no vehicle links across the central part of the Park east to west and no roads along the south west boundary due to the difficult terrain. These challenges with connectivity lead to some of the most remote communities in Scotland being found within the Park boundaries.

The limited road network in many parts of the Park may act as a constraint to the development of renewable energy projects in some instances. Road access is a key factor for determining the feasibility of many potential projects, across the range of technology types. The remote areas may be particularly well suited to renewable energy development, with good renewable energy resources, for instance wind or hydro, and with demand for off-grid electricity if grid connection is prohibitively expensive.

For projects which require large pieces of equipment to be taken to a generation site, better roads with higher weight bearing capacity and of sufficient surface standard and meeting the requirements for pitch and turning angles will be needed. Smaller scale projects (e.g. for wind turbines of less than 50 kW) will have less onerous requirements, but these may still be difficult to meet for some remote areas where access depends on steep and twisting tracks.

Many small scale wind turbines require access sufficient for the length of an articulated lorry, and will need an area where the components can be unloaded and transported by telehandler to the site for installation. Many smaller scale hydro projects use an Archimedes screw component, and access by crane will be needed for unloading and moving this into position.

2.4.2 Gas and Electrical Distribution Network

No mains gas is available within the boundaries of the National Park. The electricity transmission and distribution grid in the CNP is concentrated on the main communications corridors and principal areas of settlement, with a few remoter areas such as some of the glens connected where a source of demand or supply historically exists. The extent of the electricity grid in the Park is shown in Figure A.6 (Appendix A).

The north and west areas of the Park are supplied with electricity from the Boat of Garten Grid, the eastern area from the Tarland Grid and the southern area from Tummel Bridge. Discussions with Scottish and Southern Electricity (SSE), who operate the distribution network in the Park, indicate that these grid areas are all known constrained locations pending transmission updates. Indicative completion dates for the transmission upgrades are from 2014 to 2016. Further discussions with SSE (October 2011) indicate that it is not possible to be more specific about timings of transmission upgrades across the CNPA without selecting particular points and project scales for grid connection.

The existing primary substations tend to be near the periphery of the Park, so distribution system reinforcements are also likely to be needed. The extent of this will depend on detailed technical studies being formed for specific locations and capacities of renewable generation.

Consultation indicated that for energy projects below 50 kW, connection would be possible without transmission constraints or upgrades to the line being necessary. If the connection point to the grid was some distance away from the renewable project, costs will increase. The delay in completion date for transmission upgrades would delay the connection of medium to larger scale renewable projects connecting to the grid.

2.5 Energy Context

2.5.1 Main Areas of Population

The Park has a population of approximately 17,200 (Cogent Strategies International Ltd, 2010), with people living in the towns, villages and in the countryside. The main centres of population and numbers of residents are as follows (Cairngorms National Park Authority, 2011a):

Aviemore	2,624
Grantown-on-Spey	2,166
Ballater	1,646
Kingussie	1,410
Newtonmore	982
Boat of Garten	700
Carrbridge	700
Braemar (and Crathie)	600
Tomintoul	544
Blair Atholl	500
Kincraig (and Insch)	500
Strathdon	500

This accounts for the almost 13,000 living in towns and villages, with the remainder being distributed in the wider countryside. Clearly, a greater proportion of the population could be supplied with renewable energy if the centres of population are targeted; this may be especially relevant for district heating using woodfuel. Conversely, some isolated properties in remote rural areas may have difficulty accessing cost effective electricity grid connections and here a local source of electricity generated via wind or hydro may have a useful application. The lack of Feed-in Tariff (FIT) export tariff for these schemes would undoubtedly make them less financially attractive than if they could link to the grid, but they may provide a more economic means of electricity provision compared with paying for expensive grid connection in very remote areas. Although not representing an ideal solution, implementation of a renewable source of electricity in these off-grid situations may allow the occupier to limit the use of diesel powered generators, particularly if battery storage is available.

2.5.2 Industry and Employment in the Park

There are several features relating to industry and employment within the Park that are of relevance to the development of renewable energy:

- Tourism is more important in the Cairngorms area than in other parts of Scotland, and accounts for the largest proportion of economic activity (over 25%[1]) in the Park. The location of tourist activity and accommodation may influence where a renewable energy project is sited, and also the type of renewable energy technology to be developed;

- The Park has a relatively small public sector, with no large government offices or major health or college level education facilities. Development of renewable energy installations for public sector buildings, which are frequently targets for renewable energy implementation, are therefore limited in scale;
- Although the contribution of the whisky industry to industry within the Cairngorm area has declined in recent years, it is still important to the area and has a significant demand for energy, with the potential of a portion of this being provided by renewable sources. It is perhaps of note when considering the development of land based renewable energy that food and land based industries remain an important contributor to the economy;
- The economic contribution derived from forest products is growing as forest plantations mature. These land based sectors are frequently key to the development of many forms of renewable energy; and
- Businesses in the Park are mainly small, with over two thirds employing fewer than 5 staff. The number of workplaces in the Cairngorms National Park has increased since its designation, and there are now over 1000 workplaces.

The profile of business and industry in the Park and the generally small size of the business enterprises present suggests that investment in small to medium scale renewable projects (as identified in Chapters 3 to 8) would be feasible and appropriate for many of them.

2.5.3 Energy Demand

The CNP Woodfuel Action Plan (Cairngorms National Park Authority, 2010b) presents the results of a heat demand mapping exercise undertaken in 2009. This indicates that, for the estimated 9,100 heated buildings in the Park, there is an annual heat energy demand of 349 GWh. If, in theory, this demand was met entirely from woodfuel, it is estimated that annually around 100,000 tonnes of wood, around 47% of the readily available timber in the CNP, will be required. It is recognised, however, that much is already committed to industries with high value end products, and would not be available for woodfuel heating. A realistic target of converting 20% of the Park's heating capacity to woodfuel has been set. This would require 20,000 tonnes of fuel at 30% moisture content.

Domestic electricity demand can be estimated from national energy supply and consumption data provided on the Scottish Government's energy statistics database. Based on a population of 17,200 people in the CNP, the annual domestic electricity demand is estimated at approximately

38GWh. Electricity demand for industry and services is more difficult to assess, and an estimate has therefore not been attempted in this report.

3 Woodfuel

3.1 Introduction

This chapter reviews the potential for increased woodfuel deployment in the Park as a source of renewable heat. The appraisal draws on information about the technology presented in Technical Annex 1, estimates the scale of existing woodfuel heat capacity in the Cairngorms and assesses the extent of the local woodfuel resource. The energy potential of woodfuel heat is then discussed with reference to the environmental issues associated with its deployment.

In order to provide a consistent frame of reference for the scale of woodfuel installations, the following indicative categories have been adopted in this report which are considered to be appropriate in the context of renewable energy systems in the Cairngorms.

Table 3.1: Definitions of Scale of Technology – Woodfuel Installed Capacity

Micro	Small	Medium	Large
<45 kWth	45 kWth to 200 kWth	200 kWth to 1 MWth	>1 MWth
Sources: Small, medium and large categories defined from RHI Guidance for micro/small/medium/large scale commercial biomass (Ofgem, 2011)			

These do not necessarily represent specific industry wide agreed definitions but have been used to provide a context and reference point for the discussion of wood fuel systems in this report.

3.2 Technology Summary

Woodfuel is an excellent technology for the generation of renewable heat, and, as will be demonstrated in later sections of this report, there are very few situations where wood-fired heating will not be economically, technically and environmentally feasible within the CNP. It is fast emerging as the fuel of the future in many rural areas.

Although automated wood-fired heating is a relatively new technology in the UK, it is an established and mature market in a number of European countries. Although not yet widely deployed in the UK, the technology is very advanced and mainstream in these countries. Wood-fired heating is efficient and highly automated, and provides a realistic alternative to oil and LPG heating.

It would be highly unusual that a wood-fired heating installation would be constructed in a position that was not adjacent to an existing development. Unlike electricity generation, heat generation needs to occur close to the point of demand. Therefore, installations are very unlikely to take the form of an entirely new development in the landscape. A wood-fired system will consist of a boiler and a fuel store which may be within a building or housed in an external structure. The characteristics of a wood-fired heating installation that could be of concern in planning terms can be avoided to a great extent by best practice design of the installation. Every proposed installation will be unique in terms of its design and impact on its surroundings, therefore the case specific nature of this technology should be recognised.

3.3 Existing Level of Deployment[4]

There are several examples of woodfuel installations already being operated in the Park, ranging from domestic (micro scale) woodfuel boilers up to systems in large schools and district heating roles. Examples larger than domestic scale include the Albyn district heating scheme in North Aviemore, Ardverikie and Alvie Estates and the SNH office at Aviemore. A new report[5] recently commissioned by Forestry Commission Scotland has estimated that there are 2.7 MW of installed heat capacity across 19 woodfuel installations in the Park. Table 3.2 lists a number of installed woodfuel schemes within the CNP which are larger than domestic scale which have been identified during the course of this study.

Table 3.2: Existing Woodfuel Installations

Installation	Location	Capacity (kWth)
Grandview House	Newtonmore	200
Newtonmore Care Home	Newtonmore	200
Russwood Sawmill	Newtonmore	120
Alvie House	Alvie Estate, Aviemore	250
Neil McInness, Highland Wood Energy	Aviemore	20
Aviemore North	Aviemore	520
SNH Office	Aviemore	80
Dorback Estate (2 plants)	Abernethy	170
Tigh na Fraoch B&B	Nethy Bridge	32
Glenlivet Estate Office	Tomintoul	28
Bridge of Tilt	Calvine	150
Total Capacity		**1,770**
Source: Britain Renewable Heat Map, 1st Edition 2008, La Tene Maps and REA and Low Carbon Cairngorms website		

[4] As of November 2011.
[5] Grampian and Cairngorms National Park Biomass Production and Usage Report 2011, commissioned by Forestry Commission Scotland Grampian Conservancy. This report is not publicly available.

The figure identified by the FCS of 2,700 kW_{th} of installed heat capacity has been used later in this report (Section 9.3) as the most accurate and up to date estimate of woodfuel heat supply.

3.4 Energy Resource in the CNP

For woodfuel, the relationship between the nature of resource availability and the development of projects is slightly different from the other renewable technologies, in that the boiler can be located at a distance from the resource (but must be close to the source of demand). However, wood-fired heating has greatest environmental and local economic benefits when the source of the fuel is relatively close to the boiler.

Woodchip

The CNPA have undertaken a detailed ‘Supply Assessment and Resource Appraisal’ as part of their Woodfuel Action Plan (Cairngorms National Park Authority, 2010b). This work looked at the timber available from woodlands within the CNP, and its ability to provide the entire modelled heat demand in the Park. It considered various constraints on the availability of this timber (such as conservation designations, commitments to existing and high value markets and topography), as well as considering the availability or otherwise of other woodfuel resources such as additional forest increment, forest residues, sawmill co-products, waste/recycled wood and arboriculture arisings.

Overall, the report does not find that the resource availability is a barrier to the expansion of the woodfuel sector in the CNP, although it is likely that less readily available sources will need to be accessed, and that some careful management will be required in order to access this resource to market (particularly private sector). Guidance is required on “appropriate forest management techniques, which optimise woodfuel production whilst creating timber for other markets, and adding to local woodland landscape and biodiversity values” (Cairngorms National Park Authority, 2010b).

The Woodfuel Action Plan also highlights that the woodfuel resource is about more than just the availability of timber, but that robust supply chains are an essential part of connecting this resource with the growing market. If sufficient timber is not made available from within the CNP, this may result in sourcing from outside of the Park. In general, it is not economically viable to transport woodchip long distances. However, the money brought into the woodfuel supply chain through the Renewable Heat Incentive (RHI), as well as the existence of large timber merchants outside the CNP who have economies of scale and purchasing power, mean that woodchip can feasibly be imported. Therefore, the woodfuel resource available within the Park will not be a barrier to installations coming forward, at least in the short to medium term.

Wood Pellets

For a number of applications, wood pellets may be a more appropriate fuel than woodchip. At present there is no pellet mill within the CNP, since the high capital cost of the plants means that pellet mills tend to be on a large scale. As of 2010, there were only four plants in Scotland of any significant size, three of which are relatively close to the CNP: Invergordon, Kincardineshire and Boyndie.

Due to their higher energy density, transporting pellets is more economically efficient than transporting woodchips. Therefore, it is likely that pellets will be imported into the CNP in increasing volumes, alongside the increases in pellet production and distribution across the UK as a whole. The opportunity to increase the number of pellet boilers is not, therefore, limited by the availability of the resource within the Park.

Non-local Resource Availability

The demand for woodfuel across Scotland will continue to increase over the coming years as the RHI drives an increase in demand for wood-fired boilers. There is concern in some parts of the UK that the significant demand for timber from large biomass energy plants will constrain woodfuel availability for small and medium sized installations. However, in order for these large plants to secure finance they require contracts for hundreds of thousands of tonnes of timber which generally requires them to source from overseas. This is why these plants are usually in coastal locations.

The key reason why local heat users will be able to secure their supply in competition to remote markets is due to the fact that haulage costs are such a significant component of the delivered cost of woodchip. Therefore, if the market is prepared to pay a given price per tonne delivered, delivering to the local market will result in a greater profit margin for the woodfuel supplier. In addition, if there is potential competition from large scale electricity generating biomass plants, small to medium scale heat users are almost always able to pay more for their woodfuel per tonne, especially if subsidised by the RHI.

3.5 Environmental Effects

The potential environmental effects of wood-fired heating within the CNP are predominantly positive, such as reduction in CO_2 emissions and improved woodland management. Whilst there are some potential negative impacts of the technology, such as increase in volume of haulage, these can generally be avoided or mitigated.

Landscape and Visual Impacts

Wood-fired heating installations are generally constructed adjacent to existing development, as heat generation needs to occur close to the point of demand. Therefore, the landscape and visual impacts are unlikely to take the form of entirely new development in the landscape, rather as changes to existing developments, including the construction of new buildings and/or additions to existing structures.

The key elements of a wood-fired installation include a boiler house and fuel store, they may or may not be housed within the same structure, within an existing building or new structure, and the fuel store may be of a range of designs either above or below ground. Poor or unsympathetic design and location of buildings that house wood-fired systems may be considered as intrusive where they alter the landscape character or built environment, or they substantially change the views from nearby properties, open spaces, roads or paths.

The impact of an individual wood-fired installation varies on a site by site basis, as does the recommended best practice to address any potentially negative landscape or local amenity impacts. There are design solutions and guides available to minimise or remove the potential landscape impacts for the majority of wood-fired installations.

Air Quality

In rural areas, the latest reports and guidance suggest that the impact on air quality of wood-fired boilers is not significant. The principal local air quality issues associated with the combustion of woodfuel are related to emissions of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) (Defra, 2009). Air quality impacts from wood-fired boilers are generally only considered to be significant when levels of these pollutants are already near or above legal limits. As there are no Air Quality Management Areas or Smoke Control Zones in the CNP[6], significant impacts on air quality are unlikely. In fact, where wood-fired boilers displace oil the level of air pollutants will be

[6] http://smokecontrol.defra.gov.uk/locations.php?la_id=360

roughly equivalent to current levels, and where it replaces coal the emissions will be lower (Environmental Protection UK, 2010), therefore potentially creating an improvement in local air quality in some locations.

Emissions from wood-fired boiler systems can be kept to a minimum through correct specification of the system, use of abatement equipment and ensuring only good quality fuel is used. District heating schemes are also recommended, as it is easier to manage emissions from a smaller number of large boilers than many small ones. Given there are no existing air quality issues, and that in the vast majority of cases woodfuel would be replacing either oil or gas, there is no evidence to suggest that impacts on air quality are likely to be significant.

Land Use and Woodland Management

The major land use impact associated with wood-fired heating and CHP is the production and sourcing of woodfuel. The Woodfuel Action Plan sets out in detail how woodfuel should best be sourced and managed in order to fit within the CNPA's objectives and meet the modelled heat demand for the whole of the CNP. It notes that appropriate development and management of the woodfuel resource can make an important contribution to landscape and biodiversity values (Cairngorms National Park Authority, 2010b). The various management, biodiversity and sustainability issues surrounding the sourcing of woodfuel are dealt with in-depth in this document. If the Woodfuel Action Plan is implemented, then the CNP should not experience any negative impacts on land use or woodland management as a result of sourcing timber for wood-fired installations.

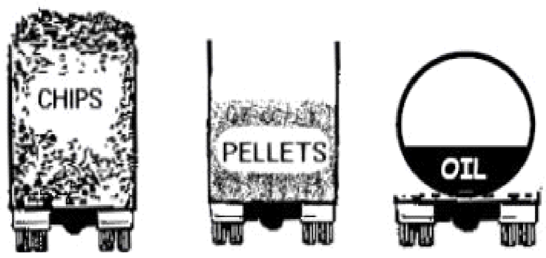
Haulage

As both pellets and woodchips are less energy dense than oil, replacing oil fired heating with woodfuel will have an impact on the frequency of fuel deliveries, and could therefore increase the volume of haulage within the CNP. For example, to replace one average 10,500 litres (i.e. one 16 tonne) oil delivery tanker would require:

- 30.4 tonnes (or 136.5 m^3) of woodchip; or
- 20.8 tonnes (or 33.6 m^3) of wood pellets.

Figure 3.1 illustrates the volume of each fuel needed to deliver the same quantity of energy.

Figure 3.1: Energy Density of Woodchips, Pellets and Oil



Therefore, to supply the same amount of energy, additional deliveries will be required. It is not straightforward to estimate the number of additional deliveries due to the site specific nature of fuel demand, fuel store design and vehicles available to local fuel suppliers. In order to minimise impacts it is critical that the fuel store size and design, as well as delivery method, are well designed and thought through during the early stages of a project. It is also important to consider that although there will be more haulage in terms of number of deliveries, the overall carbon footprint of each fuel delivery is likely to be lower because if the woodfuel is supplied from within the CNP each journey will be considerably shorter, meaning the total transport distance compared with oil is lower.

At present, it is understood that the volume of traffic in the CNP related to oil deliveries is not a significant environmental or amenity issue within the Park, nor do they form a significant proportion of traffic. There is no reason to suggest that a modest increase in additional local movements generated from woodfuel deliveries will significantly alter the volume of traffic within the CNP.

Summary

None of the potential environmental impacts identified in relation to wood-fired heating, either for individual installations or cumulative effects, has been identified as significant enough to restrict the deployment of the technology within the CNP, assuming best practice design and guidance are adhered to.

3.6 Energy Potential

Scale of Potential Deployment

In general, the development of wood-fired heating within the CNP is not constrained in the vast majority of locations, taking into account technical applicability, environmental considerations and resource availability.

The economics of woodfuel as an energy source are also attractive in many situations, due in part to the recent introduction of the RHI (see Appendix B). In order to illustrate the economic viability, Table 3.3 below sets out some theoretical examples of costs, fuel savings and payback periods.

Table 3.3: Theoretical Examples of Paybacks for a Range of Wood-Fired Boiler Installations

Example	Boiler Size	Capital Cost	Average Annual Fuel Bill Savings OR Income from Heat Sales Minus Fuel Costs	Average Annual RHI Payments	Simple Payback Period
Pellet Boiler for a cafe and gallery	27 kW	£8,000	£360	£1,640	4 years
Log boiler for a farm house	25 kW	£8,500	£2,000	£2,700	2 years
District Heating Scheme (100 houses)	620 kW	£1,000,000	£28,000 (based on charging 5 p/kWh)	£60,000	6.8 years

Mitigation Measures and Best Practice

High quality and sympathetic design can avoid many potential issues, and best practice design advice is available for all the different elements of the systems. The majority of impacts can be lessened (or even avoided altogether) through adhering to existing guidelines and planning policies, such as the CNPA Sustainable Design Guide and the statutory Development Plan.

There are a number of design solutions to minimise landscape impact, from cladding containerised fuel stores with local materials, to putting fuel stores underground. More detailed guidance is available from a number of sources as described in Technical Annex 1. It is very important, however, that the functionality of the boiler house and fuel store is not compromised, as this can significantly affect the viability of the installation in the long run. While many impacts can be effectively mitigated, they may result in a higher capital cost for the project

From a strategic planning point of view, cumulative impacts are unlikely if each system adheres to good practice and existing planning regulations. Cumulative impacts can also be minimised and controlled by promoting district heating. It is easier to manage the impacts of a single, large boiler house and fuel store which would go through planning, than of many individual installations.

Discussion

The financial incentive provided by the RHI will make woodfuel an attractive heating option, and the deployment of wood-fired heating will increase within the Park, irrespective of any proactive measures implemented by the CNPA.

The key question is not whether woodfuel is feasible, but what type of woodfuel sector and installations the CNPA wish to see develop within the Park. There is an opportunity for CNPA to enable woodfuel development which has a maximum positive and minimum negative impact.

As discussed in the section 3.3 there currently only around 19 substantial woodfuel installations in the CNP, meaning the anticipated increase in boilers will not happen overnight, as the installation industry simply does not have capacity at present. Therefore, the opportunity for the CNPA to influence how woodfuel is deployed is now. Two possible scenarios are presented in the following paragraphs, suggesting how the woodfuel market and renewable heat sector might develop in the Park, depending on the level of external stimulus from agencies such as the CNPA.

Scenario One: Minimal Intervention

Without intervention in the woodfuel sector by agencies in the CNP beyond existing powers such as development planning/management, and assuming the RHI is not substantially altered and oil prices remain high, then wood-fired boilers will continue to be installed widely across the CNP, leading to a displacement of oil and the attendant carbon savings. It is very difficult to predict the likely proportion of uptake in comparison to the overall heat demand, however it is considered unlikely that deployment would reach anywhere near the 100% of heat demand modelled for the Woodfuel Action Plan.

As small to medium scale wood-fired boilers are a permitted development (under Town and Country Planning (General Permitted Development) (Domestic Microgeneration) (Scotland) Amendment Order 2009), the majority of wood-fired boilers will be installed without contact with the planning authorities. Inevitably, there will be some projects which would fit very well with the CNPA’s objectives but which are not attractive business opportunities, for example barriers posed by access to capital for some businesses, communities and individuals. There will tend to be a larger number of smaller boilers serving individual buildings, rather than the development of heat clusters and district heating. Without assistance with their coordination and delivery, such larger schemes would require a great deal of skill and commitment from individuals to be successfully delivered.

If woodfuel is not easily available from within the Park, then it is likely that supplies will be imported from outside by large merchants. This would reduce the opportunity to retain the economic benefits within the Park, reduce the environmental benefits in the form of improved woodland management and increase the relative carbon footprint of each installation.

While this scenario will still be an improvement in terms of renewable energy generated and a reduction in carbon emissions, the scale of these benefits will not be near the full potential reductions possible. Additionally, the CNP will be missing out on some of the other benefits, such as retaining income from woodfuel sales in the local economy and improved woodland management.

Scenario Two: Enabling and Promoting

Since woodfuel is a mature renewable energy technology which could be rolled out at a large scale across the CNP, the CNPA may wish to actively support and steer the development of the sector. A coordinated development of the woodfuel sector would lead to the greatest carbon savings and environmental benefits, and minimise or control completely any possible negative impacts.

The Woodfuel Action Plan modelled the total demand for heat within the CNP. If this total heat demand was provided by wood-fired heating it would require in the region of 1,500 wood-fired installations, based on the heat clusters identified in the report. Active support from agencies in the CNP would be essential to achieve this level of uptake and coordination in terms of most effective clusters. This may seem ambitious given the current level of deployment and resources available to the CNPA and partners, but is possible.

Enabling activity could take a number of forms, as discussed below.

(i) Market Stimulation and Technical Support

The CNPA could take an active role in promoting the benefits of wood-fired heating, and in market stimulation. There are range of activities including marketing the benefits and facts about woodfuel and providing technical support services such as first pass feasibility studies and procurement support. This type of support could also assist in ensuring that systems are designed according to best practice and in line with objectives of the CNPA from a planning perspective.

(ii) Encouraging District Heating

District heating schemes represent a more cost effective and environmentally efficient alternative to multiple small scale installations, as emissions from one source are easier to control than emissions from multiple sources. A larger system can mean it is easier to justify the cost of additional abatement technology and automation, and will generally be more efficient. The boiler for a district heating scheme can also be strategically located in terms of emissions, for example taking into account prevailing winds and settlement patterns. Highland Birchwoods have already identified potential heat clusters in the CNP.

As woodfuel systems, particularly district heating networks, are more cost effective to install in new build situations, the CNPA could use their planning and enabling powers to raise the profile of woodfuel with developers. An Camas Mor presents a significant opportunity for CNPA to develop best practice wood-fired district heating in a major new settlement. Providing heating for the settlement would be highly feasible, cost effective and sustainable.

With regard to prioritising the type of woodfuel developments that will deliver maximum environmental benefits and minimise any potential environmental effects, then a focus on large heat users and district heating would be most effective. The fastest way to make significant carbon savings and increase renewable heat capacity in non domestic sectors will be to target the largest heat users such as the whisky industry, hotels, care homes, schools, swimming pools and public buildings.

The opportunity here is to actively encourage district heating schemes and clusters by enabling heat clusters and working with developers, installers, businesses and individuals. Additionally, access to finance can be a barrier for projects, and consideration should be given to establishing financial support mechanisms or providing advice on accessing external financial support.

(iii) Enabling Local Woodfuel Supply Chains

In order to realise the development of wood-fired boilers fuelled by timber from within the Park, it is recommended that early action is taken to address the issues outlined in the Woodfuel Action Plan, such as the guidance on the management of woodlands, particularly in sensitive areas.

Actions include training to raise skills levels and drive up the quality of woodfuel production. The provision of technical support services to advise potential woodfuel suppliers on the most effective business models, equipment choices etc is also important. A further option would be the coordination of local suppliers to help overcome inefficient supply chains, or even assist with the development of woodfuel supply cooperatives to combat barriers such as customer confidence in supply. These coordination or cooperation activities could also include promoting local suppliers (the benefits of local supply) to potential woodfuel customers.

3.7 Cumulative Issues

The key resources and receptors with potential to be cumulatively affected by wood-fired installations in the CNP and the potential for cumulative effects are set out below.

Sensitive Receptors/Resources	Key Issues and Potential Effects
• Views/viewers of architecturally important buildings or settlements • Native woodlands exploited for woodfuel • Local amenity and air quality	• Proliferation of new boiler and wood store facilities and flues • Woodlands need to be managed sensitively, opportunity for increased biodiversity • Increased local transport; potential air quality benefits from centralised district heating

It is anticipated that the potential for any significant cumulative effects in the CNP on building and settlement fabric from wide scale adoption of wood-fired heating systems can be mitigated through appropriate design and installation measures. Smaller schemes, which are permitted developments, generally require little alteration to buildings or only on a small scale for installation of new flues and boilers. Woodchip or pellet stores will come in a variety of forms and, where required, most will not be distinguishable from any other type of small building in the Park. In many cases, the new buildings would replace the existing ubiquitous green oil tanks, and significant cumulative landscape impacts are not predicted from wide scale adoption of woodfuel heating systems in rural areas or in larger settlements. On larger schemes subject to planning controls, these aspects can be managed by conditions of consent to ensure minimal impact on landscape and community amenity.

The indirect cumulative effects of woodfuel development will be associated with the response of the local woodfuel supply chain to growth in the woodfuel market, particularly if larger scale schemes become more common place. This will result in changes in forest and woodland management in the Park. Provided these are undertaken in a co-ordinated manner and following high standards of woodland management, it is predicted that increased local woodfuel production, processing and supply can benefit the ecological and landscape attributes of local woodlands. It is recommended that the CNPA promote and manage the woodfuel development process, using their strategic powers to ensure that the woodfuel opportunity is maximised economically and to the benefit of the area’s significant woodland biodiversity resource. A managed approach would also help to ensure that the logistics of woodfuel transport are efficiently operated, so that community amenity is not significantly affected by vehicle movements and deliveries.

It should also be noted that there is potential for significant cumulative positive socio-economic effects for the Park from the large scale development of the woodfuel sector in the Cairngorms. This aspect is considered later in this report in Section 9.2.

4 Wind

4.1 Introduction

This chapter reviews the potential for increased wind turbine deployment in the Park as a source of renewable electricity. The appraisal draws on information about the technology presented in Technical Annex 2, estimates the scale of existing installed wind capacity in the Cairngorms and assesses the extent of the energy resource. The energy potential of wind power is then discussed with reference to the environmental issues associated with its deployment and the key constraints discussed in Chapter 2.

In order to provide a consistent frame of reference for the scale of wind turbine installations, the following indicative categories have been adopted which are considered to be appropriate in the context of renewable energy systems in the Cairngorms.

Table 4.1: Definitions of Scale of Technology – Wind Turbine Height (to tip)

Micro/Domestic	Small	Medium	Large
<15 m	15 m to 30 m	30 m to 50 m	>50 m
Source: Scale agreed in discussion with CNPA officials.			

These do not necessarily represent specific industry wide agreed definitions but have been used to provide a context and reference point for the discussion of wind installations in this report.

4.2 Technology Summary

Onshore wind has been the world's fastest growing renewable energy source since 2003. This technology is now established as a mature source of energy, playing a vital role in energy production across Scotland. Within a context of European wind speed league tables, Scotland can lay claim to having the highest average wind speeds, however this resource has not been harnessed to the extent of some of its European neighbours. Wind energy, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation.

Over the years, the trend has been towards an increase in the size of turbines. Larger turbines are more efficient than small turbines, which is partly due to the fact that they are higher, and are therefore able to access higher wind speeds as wind speed increases with height above the ground. The higher up a turbine rotor, the less will be the effect of buildings, trees, hedgerows and other obstructions, and therefore the greater the yield. A single large turbine is likely to provide a greater annual yield, return on investment and carbon saving than a number of smaller turbines of similar cumulative installed capacity. Very large scale developers will normally only consider installing multiple smaller machines where a lesser visual impact is necessary or site access for installation limits machine size.

More recently, there has been a growing trend for medium to large scale wind project development, frequently owned by the landowner or other local business, and in some cases community groups, with the result that small clusters of one to three turbines have been erected. This type of wind energy development has tended to occur in areas where large wind farm developments would not be attractive or appropriate, and is a particular feature of the wind developments in Aberdeenshire (Booth, E & Bell, J, 2010). It has had the benefit of spreading ownership amongst different local businesses, rather than the large developers who are associated with the commercial energy generation projects, and a far greater share of financial return is retained by the local community. The Feed-in Tariff (FIT), introduced in 2010, has led to a marked improvement in the economics of small to medium scale turbines. This has increased the viability of a greater range of turbine sizes, and there has been a large increase in the numbers of planning applications for such turbines.

Turbine configuration should be selected based on site conditions. The turbine has to be able to withstand the maximum wind speeds encountered at a site while maximising the annual yield. On a lower wind speed site, a taller turbine with a larger rotor may be specified to drive the same size of generator that would driven by a smaller rotor on a lower tower at a high wind speed site.

Most turbines run at constant speed irrespective of the wind speed, and are directly connected to the local electricity grid and/or a local energy demand. Some designs however, are indirectly connected and can operate at varying speed. Variable speed turbines are designed for maximum efficiency at all wind speeds, and eliminate undesirable output peaks and high operating load. Modern turbines are generally of three bladed horizontal axis design, although several manufacturers offer two bladed horizontal axis designs. The only significant difference between these from a planning perspective is the visual impact. Three bladed machines appear to rotate more regularly, whereas due to optical illusion, two bladed machines can appear stilted in motion. There are also a number of vertical axis machines available, generally at the small scale.

Many turbine designs employ a gearbox between the rotor and the generator. Other designs, particularly small scale machines, have the rotor directly connected to the generator. Gearboxes can be the source of certain frequencies of noise. Gearboxes can also sometimes fail and require replacement during the life of a turbine. Some small scale turbines can be lowered to the ground for maintenance, negating the need for a crane should major component replacement be required.

All wind developments will require the necessary planning permissions to be in place before site works can commence. The requirement for formal EIA in support of planning applications will also need to be discussed with the local planning authority. In addition, further permits and licences may be required, for example, Controlled Activities Regulations (CAR) (SEPA, 2008) licences to bridge or culvert watercourses for the construction of access tracks. The local authority will also advise on the need for other controls, and all site construction needs to be undertaken in accordance with health and safety law, in particular the Construction Design and Management (CDM) Regulations.

4.3 Existing Level of Deployment[7]

There are a number of domestic scale, less than 15 m to tip, turbines in operation in the National Park; in the Laggan area and one near to Braemar. Two other single wind turbine applications have recently been approved by the CNPA. These are for a 27 m to tip (20 kW) turbine at Cromdale and a 43 m to tip (150 kW) machine at the Lecht Ski Centre. A number of small to medium scale wind projects are currently at the pre-planning stage, along with a project proposal for a 60 m to tip wind turbine at Glenbeg near Grantown-on-Spey.

4.4 Energy Resource in the CNP

For wind turbine viability the most important consideration is the wind resource available at the potential installation site. Power harnessed from the wind by a turbine is proportional to the cube of the wind speed. Therefore doubling the wind speed yields an eight fold increase in power: a 7 m/s wind is 60% more powerful than a 6 m/s wind. It is very important therefore that any wind turbine has a suitable exposure to the wind in terms of its generation potential, and its financial and environmental viability. The better an installation's exposure to the wind the more quickly it will be able to offset the carbon embedded in its manufacture and construction and the greater the contribution it will make to national annual targets for carbon reduction.

The average wind speed for Scotland is 6.4 m/s at 25 m above ground level. In general, attractive sites for wind turbines are those with average speeds above 7 m/s. Estimated mean wind speeds at three different heights above ground level have been calculated for each 1 km Ordnance Survey

[7] As of November 2011.

grid square in the UK. These estimated wind speeds can be accessed on the UK Government's DECC website (see Technical Annex 2 for further details).

From the DECC windspeed data, it is possible to comment on the wind resource within the Park at 25 m above ground level (see Figure A.7 in Appendix A for a plan of mean wind speed across the Park). Although the data are not detailed, it is possible to estimate that the windspeeds within the Park as a whole are generally greater than 4 m/s at 25 m above ground level. Exact windspeeds are not available at the Park-wide scale, and therefore it is not prudent to make a specific estimation of the average windspeed. The data identifies that lowland areas, such as Strathspey and other river valleys, exhibit lower wind speeds (in the range of 4 m/s to 7 m/s at 25 m above ground level), and the upland areas, such as the Cairngorms plateau and the Hills of Cromdale, exhibit higher wind speeds (up to 16.3 m/s at 25 m above ground level).

It should be noted that wind speed can vary greatly within a 1 km grid square, as identified in Figure A.7. In particular, in a mountainous landscape, 1 km may equate to the distance from the relative shelter at the bottom of a glen to an exposed site on top of a mountain. Therefore, a level of interpretation is required when using the data. Detailed feasibility studies normally use additional sources of wind speed data, such as those available from the Met Office, and many developers require accurate verification of wind data through on-site monitoring in advance of turbine installation.

The wind speed also increases the greater the height above ground level, and therefore using a taller tower will place the turbine in a region of higher wind speeds and remove it from turbulent air created by obstacles such as buildings and trees which can affect power generation. Overall, it is not considered that the wind resource within the Park is a particular constraint for wind energy given the generally substantial prevailing wind speeds. However, in order to achieve the highest possible wind speed at a specific location, the taller the tower, the higher will be the wind speed.

4.5 Environmental Effects

Scale Issues

When assessing the effects of wind turbine development on the environment within the Park, it is important to first discuss development size. The highest yielding sites in a locality tend to be the most prominent in respect of landscape and visual impact. A compromise has to be struck between the landscape and visual impacts and the environmental benefit of offsetting carbon emitted by the burning of fossil fuels to generate energy. Guidance published by SNH (Scottish Natural Heritage,

2008) (supplemented by (Scottish Natural Heritage, 2011)) details the level of visual impact assessment typically required for three differing scales of development as follows:

- 15 m and less to blade tip – formal visual impact assessment less likely to be required;
- 15 m to 50 m to blade tip – basic level of landscape and visual impact assessment likely to suffice; and
- Greater than 50 m to blade tip – more detailed landscape and visual impact assessment likely to be required.

The guidance also states the importance of the location of the turbines.

Whereas some planning authorities in Scotland may consider a 50 m tall structure to be small, this is not the case in the Park. From discussions with CNPA officials, the Authority would be more likely to adopt the following definitions of turbine size:

- 15 m and less to blade tip (domestic) – these turbines would be considered for household supply (typically a 6 kW turbine or less);
- 15 m to 30 m to blade tip (small) – turbines of this size would fit within a more urban or industrial landscape such as schools or small industrial developments (typically between a 6 kW turbine and a 50 kW turbine); and
- Greater than 30 m to blade tip (medium to large) – turbines of this size would be unlikely to be acceptable from an environmental perspective (typically greater than a 50 kW turbine).

The Local Plan states that the National Park is incompatible with the development of windfarms due to the National Park status and its numerous designated areas. The discussion in this report and assessment of potential for wind development is therefore primarily focused on single turbines, typically in the small to medium scale bands defined above and in Section 4.1.

Environmental Sensitivity

The National Park is a formal, national designation which recognises the outstanding natural and cultural heritage of the region. There are a number of natural heritage designations within the Park including a number of European nature conservation sites and two National Scenic Areas. The environmental sensitivity of the area has also been recognised by recent work undertaken by CNPA on landscape sensitivity and wildness.

CNPA have mapped Landscape Character Sensitivity to small wind turbines (15m to 30m) as part of the Landscape Framework for the National Park and the map is shown in Figure A.8

(Appendix A). What is shown on the map is relative sensitivity across the Park. The level of sensitivity shown for each landscape character area may change over time as effects are monitored and evaluated. The mapping does not include visual or wildness sensitivities, which would also be considered in decision making.

With regards to wildness, CNPA supplementary planning guidance (see Section 2.3) indicates that no turbine development will be considered within locations defined as 'Band A', as these are high quality wildness areas where the landscape is dominantly natural. Whilst turbines may be considered within areas of lower wildness (i.e. Bands B or C), those located in Band B or C which could be visible from Band A areas may also present planning difficulties due to inter-visibility issues.

Large areas of the Park are designated for their international importance for birds as Special Protection Areas (SPAs). Within these areas, and potentially at some distance from them, the development of wind turbines is likely to give rise to potentially significant impacts on the qualifying interests of the sites[8].

Strategic Locational Guidance for Onshore Wind Farms in respect of the Natural Heritage (Scottish Natural Heritage, 2009b) identifies zones of natural heritage sensitivity. The CNP in its entirety falls within Zone 3, and is therefore considered to be of high natural heritage sensitivity. In general in this Zone, wind farm proposals are unlikely to be acceptable in natural heritage terms. It should be recognised that this guidance relates to wind farms rather than smaller scale proposals. SNH is currently consulting on guidance for the siting and design of smaller wind developments (Scottish Natural Heritage, 2011) which indicate that the sensitivity of the receiving environment is affected by the following factors:

- Scale and extent of visibility across the landscape;
- Landscape patterns including settlements, field boundaries and roads;
- Landform including the presence of topographic or woodland features;
- Presence of built features (including existing turbines or large farm buildings); and
- Presence of landmark features.

The CNP is therefore sensitive to wind development from a landscape, visual and natural heritage perspective in particular. Wind turbine development is therefore unlikely to be permitted in the parts of the Park which have been shown to be sensitive in landscape or wildness terms, since it would be likely to lead to significant environmental impacts in each case. However, there are locations

[8] A recent European Court of Justice ruling in Italy confirms that windfarm development within SPAs is always likely to be unacceptable.

which are less sensitive to wind development, and from a landscape perspective, which are better able to accommodate some smaller scale wind development. The potential environmental effects of small to medium sized wind turbines in such locations are considered below.

Environmental Impacts and Mitigation

Wind turbines are generally large structures with the potential to have significant landscape and visual impacts, especially in areas where built development and vertical elements are not a key characteristic of the landscape. However, in some landscapes of the Park, micro turbines are more likely to have a localised rather than extensive impact. This is because they will usually be situated in lower lying areas where development is more common, or where they can be more easily screened by existing landform, cover (e.g. woodlands) or settlement. Provided the turbines are located sensitively with respect to local landform and land use patterns and potential receptors, significant landscape and visual effects are generally not predicted from micro turbines in these areas.

The potential for landscape and visual impacts from small turbines is dependent on the location of the installation, and the extent to which any ancillary infrastructure may be required (such as overhead lines). In more exposed locations, where wind speeds are typically greater, there is increased potential for impacts through effects such as those caused by skylining of turbines. Larger turbines are also visible for greater distances and have larger zones of theoretical visibility (ZTVs) than smaller installations. Nevertheless, with close attention to the siting and design of the turbines, it is considered that significant landscape and visual impacts can be avoided. Those areas where such development may be feasible are discussed later in this chapter.

The presence of medium sized wind turbines in important bird areas outwith SPAs could give rise to potential impacts, primarily from collisions and changes to bird foraging patterns. The significance of such effects would depend on the scale and number of installations and their proximity to bird nesting and foraging areas. With appropriate consideration of location, and sufficient distance from locations of known sensitivity, it is not predicted in general that small to medium sized turbines (either as single installations or small clusters) would have significant ornithological impacts. Clearly, such effects need to be considered on a site specific basis. For example SNH Guidance on micro renewables (Scottish Natural Heritage, 2009a) recommends that for turbines within 200 m of a SPA, the installer should consider whether there may be a detrimental effect on the species for which the SPA is designated.

Wind turbines also have the potential to affect bats, although the interactions involved are not yet fully understood. The installation of wind turbines on or near to buildings could increase the risk of collision. Relevant guidance (Scottish Natural Heritage, 2009a) recommends that until the impacts are better understood, a precautionary approach to the siting of wind turbines should be taken in sensitive locations. For example, turbines should not be installed within 50 m of a known bat roost or on known bat flyways.

Small and medium scale turbines need to be well designed and make use of natural cover and local topography to ensure their effects are mitigated as fully as possible. Experience to date suggests that this is not easy, but attention to the scale and context of the landscape and siting with regard to ecological sensitivities can help to ensure that these smaller installations do not have significant adverse environmental impacts in the CNP.

When considering the development of turbines within the Park, it is also important to consider any carbon emissions which may result from construction activities and associated disturbance of soils and superficial geology. Due to the sensitive nature of these areas, it is less likely that turbine development will be permitted within areas where foundation works for turbines, tracks and other infrastructure would require significant excavation of peat. In all locations where turbines (and other developments) are installed, there is an emphasis in current CNPA planning guidance[9] on appropriate restoration of sites and their vegetation to mitigate the long term change in land use.

4.6 Energy Potential

The wind resource within the CNP makes this area ideal to exploit wind as an energy source. However, the area is nationally and internationally important for its landscape and natural heritage, which is likely to limit the overall number and scale of wind developments due to the extensive areas which may be particularly environmentally sensitive. Whilst wind farms with large numbers of turbines and/or large scale individual turbines will not be permitted within the Park boundaries, the analysis suggests that small to medium scale turbines may be acceptable in less sensitive locations depending on the energy resource, the physical/technical constraints and the potential for environmental effects. Wind speed is not the only constraint to consider for wind turbine development; the acceptability and potential should also consider environmental issues based on sensitivity, grid connection, access and scale.

[9] For example in the recently published SPG on General Development and Carbon Sinks and Stores.

The Park itself is a national designation for outstanding natural and cultural heritage and therefore areas where small to medium scale turbines would be acceptable are limited by their potential environmental impacts. The key environmental constraints used in this analysis of potential are:

- European sites (in particular SPA/Ramsar Sites); and
- Wildness areas in Band A.

There are a number of areas within the Park which are subject to these high level environmental constraints, and these are identified along with other key constraints in the environmental baseline mapping in Figures A.2 and A.3 (Appendix A). Outwith these areas of environmental constraint are the locations which may be acceptable for wind turbine development at a small to medium scale. These broadly lie around the north and west edge of the Park, in parts of Strathspey and in the valleys of the Rivers Don and Dee.

Physical constraints should also be considered when assessing wind turbine developments: transport network, electrical distribution network, proximity to military and civil aviation/radar and communication links. The principal physical constraints considered to be significant within the Park are access and grid connection issues. Potential environmental impacts associated with installation of the grid connection cabling or access roads are also reduced if the access and grid connection is close to the turbine site.

Feasible sites for wind turbine development within the Park are likely to be in areas outwith the key environmental constraints outlined above, *and* which are close enough to the existing electricity distribution network for economic connection. The areas with technical potential for wind turbine development within the Park are highlighted in Figure A.9 (Appendix A). Table 4.2 provides commentary on the characteristics of the areas which have been identified as having some potential for wind turbine development.

Table 4.2: Characteristics of Areas with Potential for Wind Turbine Development

Turbine Scale	Justification
Micro/domestic	Potential for micro/domestic wind in edge of settlement and isolated farmsteads based on the following conditions: • The maximum turbine height to tip is 15 m; • It will not adversely affect the character of the landscape, settlements or buildings (individually or cumulatively); • It will not adversely affect the ecological, residential or recreational amenity of the surrounding area; and • The power produced is primarily used in adjacent properties.
Small	Potential for small scale wind based on the following conditions: • The maximum turbine height to tip is up to 30 m; • It will not adversely affect the character of the landscape, settlements or buildings (individually or cumulatively); • It will not adversely affect the ecological, residential or recreational amenity of the surrounding area; and • Within 0.3 km of the existing electricity distribution network.
Medium	Potential for medium scale wind based on the following conditions: • The maximum turbine height to tip is up to 50 m; • It will not adversely affect the character of the landscape, settlements or buildings (individually or cumulatively); • It will not adversely affect the ecological, residential or recreational amenity of the surrounding area; and • Within 0.3 km of the existing electricity distribution network.

The potential for wind development of the type suggested in the table is indicative, since conditions vary from site to site both in terms of wind speed and the environmental sensitivity. Each potential site must be considered independently, and demarcation of specific potential development areas would not be appropriate without more detailed site specific analysis. Grid connection is also important, and the potential locations for turbine development are often dependent on areas where electrical grid connection is likely to be feasible based on proximity (within a few hundred metres) to the existing electricity distribution network (see Figure A.6, Appendix A for grid extent).

A particularly good application for wind turbines is for the supply of electricity to isolated dwellings which do not have viable access to the electricity distribution grid. In these locations, there will generally need to be an immediate and clear source of electricity demand, such as a domestic property or farm in order to be viable. Since grid connection is not available, such installations are likely to be very small scale in nature. Figure 4.1 below shows a domestic wind turbine which would supply the needs of the household only. Such turbines need to be well designed and make use of any natural cover and local topography.

Figure 4.1: Micro Scale Wind Turbine in Laggan Area of the Park (Source: SAC)

Whilst domestic scale turbines within the Park may be more suitable for individual households, small turbines may be able to be utilised in more developed locations (e.g. adjacent to industrial sites) without significantly increasing the overall visual impact. This assessment has also indicated the potential acceptability of small (e.g. up to 20 to 30 kW installed capacity) wind turbines in less sensitive rural locations. These will most often be landscapes where human influence and land management are key characteristics and the scale relationship between landform and turbine is not dominated by the turbine.

4.7 Cumulative Issues

The key issues for cumulative effects associated with the harnessing of wind energy in the CNP are set out below.

Sensitive Receptors/Resources	Key Issues and Potential Effects
• Nationally important landscapes and natural heritage areas (including the National Park itself, and also NSAs and SPAs) • Sensitive landscape character areas/groups of areas and their landscape types and scale • Key/iconic views • Viewers who may experience 'combined visibility' or sequential effects • Locations which attract significant tourism • Areas of wildness value	• Recent European Court of Justice ruling on wind farms in Natura sites • Presence of overhead power lines in some locations and communications routes • Distance between application sites; overlap in Zones of Theoretical Visibility (ZTVs) • Scale of turbines, colour, positioning in landscape • Need for new access tracks or grid infrastructure • Potential to change character of an LCA

The potential for cumulative effects from wind installations in the Park is presently very low due to the absence of anything but the smallest domestic turbines in a few locations. Nevertheless, landscapes that contribute significantly to the special qualities of the CNP may have little or no potential to accept new wind turbines, or indeed for locations which can be viewed clearly from within the most sensitive landscape character areas. Despite the good wind resource present in these areas, the policy position of the CNPA with respect to the impacts of wind turbines has to be taken into account in this study, as discussed previously in Section 4.6.

Outwith these areas there may be greater scope for developing small wind turbines in appropriately sited locations. Where this is the case, the potential for cumulative effects will be heightened, and the impact which turbines may have on important views and landscape character. In such areas, it may become appropriate to define area-specific criteria to either guide the consideration of cumulative effects, or to avoid the possibility of such effects occurring at all (see Section 9.4).

The CNPA is currently preparing a Landscape Framework (which is due to go out to public consultation in March 2012). This is a strategic guide which provides a set of tools and information to use to look at landscape issues, but which does not provide a verdict on the appropriateness of any given development. By developing work already undertaken on LCAs (Cairngorms National Park Authority, 2009), the framework could be used to define particular sensitivities, and analysis of individual landscape character areas to help inform future wind turbine developments. This would be in line with guidance from SNH (Scottish Natural Heritage, 2005), which recommends that capacity studies are undertaken by authorities to help define the potential for renewable energy development and its cumulative effects.

As the pressure for wind turbine and wind farm development beyond the boundaries of the CNP also grows, so does the potential for indirect cumulative effects in the Park associated with new wind development. To date, no large scale wind developments have been approved within close proximity to the Park's boundary, although as recently as June 2011 the CNPA's planning committee objected to an application in the Monadhliath Mountains to the west of the CNP. These developments indicate that wind turbine applications in the CNP will need to take account of cumulative effects from wind developments further afield and from guidance produced nationally and by adjoining local authorities. A good example of this is the Highland Council's recent guidance on wind energy developments and the accompanying assessment of landscape sensitivity to wind turbine development.

5 Hydro-Electric

5.1 Introduction

This chapter reviews the potential for increased hydro-electric deployment in the Park as a source of renewable electricity. The appraisal draws on information about the technology presented in Technical Annex 3, estimates the scale of existing hydro electric capacity in the Cairngorms and assesses the extent of the energy resource. The energy potential of hydro installations is then discussed with reference to the environmental issues associated with their deployment and the key constraints identified in Chapter 2.

In order to provide a consistent frame of reference for the scale of hydro installations, the following indicative categories have been adopted which are considered to be appropriate in the context of renewable energy systems in the Cairngorms.

Table 5.1: Definitions of Scale of Technology – Hydro-Electric Installed Capacity

Micro/Domestic	Small	Medium	Large
<50 kW	50 kW to 100 kW	100 kW to 2 MW	>2 MW
Sources: MCS for Micro/Domestic scale; FIT bands for Small, Medium and Large scales			

These do not necessarily represent specific industry wide agreed definitions but have been used to provide a context and reference point for the discussion of hydro systems in this report.

5.2 Technology Summary

Hydropower is a mature technology having been utilised in the UK for many years, and Scotland's wet climate and mountainous terrain lends itself to application of the technology in many areas. The increase in the number of installations in recent years is due to the changing economics created by increasing energy prices and the incentive schemes introduced by the government to encourage the generation of renewable energy. Modern electronic control makes the operation of a hydro scheme a more automated process than was previously the case, and hydro electric schemes are one of the largest contributors of electricity from renewable resources worldwide.

Much of Scotland's existing hydro-power is generated from large impoundment schemes built in the period from the 1930s to the 1950s, such as the 2.5 MW Cuaich scheme near Dalwhinnie, which falls within the Park and was commissioned in 1959. Impoundment schemes employ a dam or weir to hold back the flow of a river in a reservoir, or by raising the level of a natural loch. SEPA consider schemes that impound more than 24 hours worth of water as impoundment schemes. These schemes, which allow electricity generation to be maintained over longer periods of time and to better match demand for power, will have by far the greatest environmental effect of any of the scheme types.

Because of the very different head/flow characteristics of each installation, hydro scheme designs tend to be very site specific. Within the Park there are a range of potential sites suitable for different technologies. Run-of-river schemes divert water from a watercourse via a pipe (penstock) or constructed channel (leat) to a turbine, and then return the water to the river further downstream. Minimal impoundment is necessary and therefore electricity can only be generated when there is a sufficient flow in the river. Run-of-river schemes are the most common form of modern hydro-electric installation type due to their lower environmental impact and capital cost compared to impoundment schemes. The feasibility assessment in this report therefore relates primarily to this type of installation.

5.3 Existing Level of Deployment[10]

The only existing large scale impoundment hydro installation within the Park is the Cuaich power station to the north east of Dalwhinnie, which is fed from Loch Cuaich and a number of other intakes on burns to the south and west of the power station. Water that would naturally flow to the Spey is diverted from here to the Tay catchment. The outfall from the Cuaich station is channelled by aqueduct to Loch Ericht, and contributes to the output from a total of five power stations before flowing to the sea via the river Tay. Further north, water is diverted back west to Loch Laggan from the Spey dam near Laggan and other intakes. From here it is fed to the hydro power station at the aluminium smelter at Fort William and outfalls to Loch Linnhe.

Three small and one medium scale hydro projects have been approved in recent years:

- A 70 kW Archimedes screw scheme at Semeil Farm, Strathdon which is already in operation, using existing infrastructure from a previous hydro scheme.
- A 180 kW plant at Clova Hotel in the Angus Glens which is now under construction, using two burns which previously powered a water mill in the village of Clova.
- An 11 kW micro hydro scheme at Allargue, Corgaff.

[10] As of November 2011.

- A 20 kW project at Kingussie which will restore a former low head hydro scheme on the River Gynack using an Archimedes screw.

Planning officers at the CNPA indicate that there are around 15 further hydro schemes at the pre-planning and scoping stages. There are also other historic hydro scheme sites in the Park with the potential for reinstatement. These tend to be low head sites located mainly along valley floors and near to towns and villages, farms and old mill sites. Data on numbers of these sites with potential for reinstatement are not readily available.

5.4 Energy Resource in the CNP

Rainfall Catchments

The Park includes parts of the following rainfall catchments: Spey, Don, Dee, North Esk, South Esk and Tay. "The Scottish Hydropower Resource Study" (Nick Forrest Associates; The Scottish Institute of Sustainable Technology; Black & Veatch, 2008) calculated the potential for financially viable hydropower within rainfall catchments across Scotland in kW and divided this potential by the area of each catchment to enable a power density map to be plotted based on appropriate parameters for financial viability at the time of the study. Although these parameters may no longer be valid, the relative viability between catchments remains. A map of the main catchments and the river systems in each catchment is provided in Figure A.10 (Appendix A) and a plan showing the main rivers and tributaries is shown in Figure A.11 (Appendix A).

The Spey, Don, Dee, North Esk and South Esk catchments all fell into the lowest power density classification (0 to 2 kW/km^2). Only the Tay catchment to the south west of the Park fell into the second highest classification (17 to 32 kW/km^2). It should be noted that the study was carried out prior to the introduction of the FIT scheme, which has greatly improved the viability of small scale installations.

Spey Catchment

The upper reaches of the Spey are fed from the Monadhliath Mountains to the North and the Cairngorm Mountains to the South. Annual rainfall over the higher tops of these ranges reaches 2,000 mm (Meteorological Office, 1977). This is the area of greatest hydropower resource within the Park, and much of it is diverted for use outwith the Park. Rainfall over the remainder of the Spey catchment to the east ranges from 800 mm annually along the river valley, to 1,000 to 1,200 mm on the Hills of Cromdale and 2,000 mm on the portion of the Cairngorm Mountains that drains to the north east. The shallow fall along the main river valley means that it is only suitable for low head hydro installations using the head created by a weir or natural waterfall. Small, high head schemes may be possible on the tributaries to the main river as they drop down from the mountains. River reaches that fall by 1 in 10 or steeper will be most suitable. These schemes will be restricted by the size of the catchment, which in most cases will be no more than a few square kilometres.

Don Catchment

The upper reaches of the Don fall within the Park in the area between Cock Bridge and Glenbuchat. Rainfall over this catchment ranges from 1,000 to 1,400 mm annually. As with the Spey, the main river is only suitable for low head hydro installations. There are many tributaries which fall steeply down to the Don which offer the potential for small high head schemes.

Dee Catchment

After the Spey, the Dee catchment covers the next largest area of the Park. The southern slopes of the Cairngorms drain via the Dee, through Braemar, Ballater and Aboyne on its route to Aberdeen. Annual rainfall reaches 2,000 mm at the North Western extreme of the catchment but ranges between 800 and 1,400 mm over much of the remainder. Again the greatest hydro potential will be for small high head schemes on suitable tributaries to the main river.

North and South Esk

Rainfall in the Angus Glens ranges from 1,000 to 1,600 mm annually. The steep sides of the glens offer the potential for small high head schemes although the catchment area of many of the closely spaced tributaries is very small.

Tay Catchment

A portion of the upper reaches of the River Isla falls within the Park boundary. Rainfall in this area is up to 1,600 mm annually and although remote the steep terrain does present a considerable hydro power resource.

All Sites

As detailed above there are many steeply sloping hill burns which will be potentially suitable for high head run-of-river hydro installations, subject to physical and environmental constraints. These sites are generally relatively inexpensive to develop, provided that access for construction and a grid connection can be easily achieved. Following the construction phase, they can be fairly unobtrusive and can be designed to blend in with their surroundings. Along valley floors, particularly around settlements or farm steadings where existing weirs or other infrastructure exists, there is some potential to develop low head sites. Hydro energy potential is assessed further in Section 5.6 of this report.

5.5 Environmental Effects

High Head Schemes

Weir/Abstraction Point

For high head schemes the abstraction point may be very unobtrusive in physical and visual terms, and in some cases a natural pool may be used, whilst in others a low weir may have to be constructed. The design of the abstraction point must maintain a suitable depth of water over the abstraction pipe to avoid air being drawn into the pipe. There will also have to be some means of ensuring that the bypass flow is allowed to pass through or over the weir at all times before any abstraction takes place. At sites where migrating fish have to be accommodated, some form of fish pass may be necessary. Once constructed, the visual impact of the abstraction point on a small scale high head scheme is not generally significant, but careful siting is needed to ensure the penstock/pipeline's form and intake fits with the landscape.

Construction of a hydro scheme will have a localised impact on the biodiversity of an area, and may affect the aquatic and terrestrial ecosystems, habitats and species. Issues that need to be considered include: water quality, flow and temperature, sediment transport and impacts on migratory fish and freshwater pearl mussels. The river Spey is designated as a Special Area of Conservation for Atlantic salmon, freshwater pearl mussel, otter and sea lamprey. The Dee is designated for Atlantic salmon, freshwater pearl mussel and otter, and the South Esk for Atlantic salmon and freshwater pearl mussel. Potential sites for high head schemes on tributaries to these rivers will be more appropriate where they are entirely located above an existing barrier to fish passage[11], and there is no existing presence of the species for which the sites are designated. The impact of hydro schemes on the aquatic environment will be influenced by the waterbody status of the watercourse affected. Waterbodies classed as 'high' or 'good' under SEPA's classification scheme are likely to be particularly sensitive to abstraction.

[11] Given the large number of watercourses in the CNP it has not been possible to identify barriers to fish in this report. Typically these are formed by steep waterfalls or man made interventions and a site specific investigation is required in each case.

Penstock

High head schemes have a penstock in the form of a pipe from the abstraction point to the turbine house. If the pipe can be buried, the visual impact after installation will be minimal provided vegetation, soils and hydrology are properly reinstated. In many areas of the Park, rock or areas of shallow soil cover may mean that it may not be possible to bury the pipe (or to achieve effective reinstatement of soils and vegetation). Potential sites on the Dee and parts of the Spey catchments fall within areas designated as NSAs or are considered areas with "wildness" value and therefore this form of construction is less appropriate. Construction of the pipeline may also require removal of vegetation or felling of trees.

In some cases a canal or leat may be used to move water around a contour, so that the length of the piped penstock can be minimised. This can often take the form of a ditch, but in some cases more engineered structures may be necessary. Hard engineered structures are likely to have a much greater visual impact particularly in an undeveloped upland setting and can add significantly to the capital cost.

Pipe materials, bedding material and construction and reinstatement techniques need careful consideration. Many of the potential impacts created by a run-of-river hydro power scheme are caused during the construction phase. Careful planning of this phase is important to avoid or minimise any negative impacts on sensitive or designated sites.

Turbine House

A turbine house is required to provide secure accommodation for the turbine, generator and associated electrical equipment. For small scale installations it may be possible for the equipment to be located in an existing building. Where a new building is required it can be designed to fit with its surroundings and a wide range of design approaches can be considered. Noise and vibration will be created by the turbine and generator, which may in turn affect nearby residential premises. Impacts can be minimised by careful design and layout of the installation, and by incorporating soundproofing into the turbine house. Figure 5.1 shows a turbine house for a 940 kW turbine in rural Perthshire.

Figure 5.1: A Turbine House for a 940 kW Turbine in Rural Perthshire (Source: SAC)

Cable Routes and Access

As with penstock pipes, cables can often be buried, in which case visual impact will be minimal following installation. Laying of the cable may require removal of vegetation or felling of trees. Where longer cable runs are necessary, overhead lines may be a more cost effective option, although these will have an attendant landscape and visual impact that must be considered.

Access to the site will be required for construction equipment during the construction phase. After installation, vehicular access to the turbine house will be required. Pedestrian and all terrain vehicle access to the abstraction point will often be sufficient for smaller installations.

Depleted Reach

The flow of water in the river between the abstraction and discharge point will be reduced from its natural level for substantial periods of time during the operation of the scheme although a minimum bypass flow will be maintained at all times as per the CAR licence for the site. This may have a detrimental effect on the ecology and amenity value of the location, particularly where existing walks and viewpoints exist. The effect on recreational users of the river needs to be evaluated. It should be noted that properly designed schemes can provide natural heritage benefits via habitat creation or enhancement, bank side planting and improved fish passage.

Low Head Schemes

For low head schemes, in the absence of any existing infrastructure such as an existing mill weir, the necessary civil works may be considerable and is likely to have a negative effect on the ecological status of the river. Where migratory fish are present especially on the Spey, Dee and South Esk, which are designated as SACs, any increased restriction on fish passage would be inappropriate and in fact an improvement to fish passage could be considered in the design of any potential scheme.

Access routes and cable tracks will be subject to the same issues as for high head schemes. Low head schemes are often situated close to existing buildings and infrastructure and may have less of a visual impact, although in this situation noise is more likely to be an issue.

5.6 Energy Potential

Maximising Site Potential

Abstraction of water at any site will be governed by the terms of the necessary CAR licence. Minimum bypass flows and maximum abstraction rates relating to the flow conditions of the river/burn will be agreed with SEPA and specified on the CAR licence. SEPA (SEPA, 2010a) and SNH (SNH, 2010) both provide guidance for developers of micro-hydro schemes which should be referred to throughout the design stage. It is important to distinguish between the consenting process required for planning permission (via the local planning authority) and the CAR licence application (via SEPA) (SEPA, 2010b). Developers will need to consider whether the dual applications should be progressed in parallel or in series, the decision being influenced by the complexities and issues associated with the development proposed.

Where a suitable hydro site is considered for development, there is good reason to maximise the amount of energy that can be produced in relation to any negative environmental impact. As well as making good financial sense, a more acceptable environmental return will be achieved where a scheme is sized properly in respect to the available resource. An undersized scheme may have a similar environmental impact as a scheme sized correctly under good environmental practice.

High Head Sites

Sites with the potential for high head run-of-river hydro schemes within the Park are likely to be on tributaries to the main rivers, on reaches that fall steeply and are upstream of an existing barrier to migratory fish, and which are close enough to the existing electricity distribution network for economic connection.

In the areas identified by CNPA as falling within the highest bands of wildness (see map in Figure A.3 (Appendix A)), the natural environment will be particularly sensitive to impacts from construction and permanent change in land use associated with access tracks, new buildings and any power lines needed for grid connection. These areas are generally co-incident with the remote uplands of the Cairngorm plateau including parts of the upper catchment areas of the rivers Tay, Spey and Dee. These areas will often have very shallow soil cover which limits the opportunity to bury pipes and reinstate cable runs. The acceptability of high head schemes in these areas is therefore predicted to be severely limited, although there may be some locations where it is possible to utilise existing access tracks and where pipes and cables can either be buried or screened by trees and where small schemes may be viable. Also, access tracks can be constructed of materials which will allow partial re-vegetation to minimise visual impact.

Outwith these most sensitive areas, where scheme outfalls are located upstream or immediately downstream of an existing barrier to fish migration, there is scope for high head run-of-river schemes, particularly where grid connection can be achieved at reasonable cost. Within the Park, electricity distribution networks predominantly run along the major valleys, and therefore sites closer to the major rivers are likely to achieve a more financially viable connection.

Table 5.2 identifies the river reaches outwith the areas of highest environmental sensitivity where there may be potential for high head schemes.

Table 5.2: River Reaches with Potential for Hydro Power Installations

Catchment	River/Reach/Area	Annual Rainfall (mm)
Upper Spey	Allt Cuaich (tributary of R Truim) above Dalwhinnie	1400-1800
Upper Spey	Tributaries of: R Calder above Newtonmore, R Gynack and Raitts Burn above Kingussie	900-1200
Upper Spey	Tributaries of River Tromie below Loch an t-Seilich	1400-1800
Upper Spey	Steeper tributaries of R Spey above Spey Dam	1000-1600
Mid Spey	Tributaries of R Feshie above Feshiebridge	1000-1600
Mid Spey	Tributaries of R Luineag and R Druie above Coylumbridge	900 – 1800
Mid Spey	Tributaries of R Dulnain above and below Carrbridge	800-1000
Deveron	Steeper tributaries of R Avon up and down stream of Tomintoul	1000-1200
Don	Upper parts of tributaries to R Don from Strathdon upstream	1000-1200
Dee	Upper part of R Muick above Linn of Muick	900-1300
Dee	Steeper tributaries of R Dee, Water of Tanar and Water of Feugh	1000-1200
North Esk	Water of Lee and Water of Mark	1200-1600
South Esk	Tributaries of R South Esk and Prosen Water	1200-1600
Tay	Tributaries to R Isla and Shee Water	1000-1600
Tay	Tributaries to R Tilt. Bruar Water	900-1400

Catchment	River/Reach/Area	Annual Rainfall (mm)
Tay	Tributaries to R Garry upstream of Blair Atholl	1000-1600
Potential sites are on tributaries with generally steeper topography, outwith areas of high wildness value and above reaches designated (usually as SACs) for salmonids (or above clear barriers to fish).		

The feasibility of sites in the table is indicative, since conditions vary locally within catchments and reaches both in terms of the resource and the environmental sensitivity. Each potential site must be considered independently, and demarcation of more detailed potential development areas would not be appropriate. The viability of a site for hydro power will, in particular, depend on the average rainfall at the site and the size of catchment above the intake point, as well as having suitable gradient to achieve the necessary head and ground conditions to establish infrastructure.

Grid connection is also important, and the locations in the table are based on areas where electric grid connection is likely to be feasible based on proximity (within a few hundred metres) to the existing electricity distribution network (see Figure A.6 for grid extent). Potential hydro schemes of a larger scale may be able to justify longer connections to secure grid access.

There may also be locations where small scale hydro schemes are viable without access to the grid. In these locations there will generally need to be an immediate and clear source of electricity demand such as a domestic property in order to be viable. Since grid connection is not available, such installations will be very small scale in nature.

Where individual schemes are judged to be environmentally acceptable, care should be taken to ensure that the cumulative effect of reduced surface water flows and habitats do not exceed the level of acceptability.

Low Head Sites

Where existing weirs or waterfalls are convenient for grid connection, hydro schemes may be possible without causing significant impacts on the water environment. In fact, fish passage can often be improved as part of such developments by introducing a fish channel where none currently exists. This type of scheme will be more appropriate where the site is adjacent to existing buildings or infrastructure, and will be less acceptable at natural waterfalls in scenic areas. The Park has a large number of visitors and residents who enjoy river based leisure activities such as canoeing, fishing and walking. Access to, and passage up and down rivers for them must be considered. Acceptable sites for low head schemes may exist where previous water power infrastructure remains around towns and villages, farms and old mill sites.

An inventory of existing weirs is beyond the scope of this study. Such sites are likely to be relatively small and have potential capacities in the tens of kilowatts. They are also likely to be within relatively easy reach of a viable grid connection. Similar to the high head sites each location needs to be considered on its own merits.

Overview

There is undoubtedly potential for the development of small to medium scale (up to 1MW installed capacity) hydro schemes within the Park. The main restrictions on high head schemes at this scale are the availability of grid connection at reasonable cost, the landscape and visual impact that that may result from the infrastructure, and from the depleted reach within designated areas. Mitigation of this impact will be possible for some sites, and each site must be individually assessed.

Sites for low head schemes are limited. Where existing weirs remain these could be developed and there may be the potential to improve fish passage and recreational river use. New weirs on the major rivers or the lower reaches of their tributaries will conflict with fishery and leisure interests, and are unlikely to be acceptable.

Site developers should be encouraged to maximise the yield from a site so that the maximum gain is obtained from any particular installation since, within reason, most of the environmental impacts will not change greatly with scale of the installation.

5.7 Cumulative Issues

The key resources and receptors likely to be affected by hydro schemes and the potential for cumulative effects are set out below.

Sensitive Receptors/Resources	Key Issues and Potential Effects
• Designated (SAC) river systems • Water quality issues • Presence of peat (if pipes are buried) • Areas of wildness value • Tourist areas/recreational river users	• Length of depleted reach in river systems • Cumulation of obstructions to fish passage in a watercourse • Impact of pipes, cables and buildings where these are difficult to screen/bury

This study has concentrated on run-of-river hydro schemes which typically have relatively low environmental impacts, at least as individual installations, in the hydrological regime of a watercourse or the surrounding ecology of the affected reach. Nevertheless, the potential for increases in the number of hydro schemes in the Park does raise the potential for cumulative environmental effects. These are unlikely to be significant for a watercourse as a whole, unless a number of schemes were to be installed within close proximity on a river or tributary, since SEPA will have close regard for the water quality and ecological objectives for watercourse in approving and setting conditions for the depleted reach flow, and for the effects on passage of (non-migratory[12]) fish.

There is potential for the infrastructure associated with hydro schemes to cause landscape and visual impacts, particularly where pipes and cables cannot be located underground, but also due to the groundworks associated with burying infrastructure. Such schemes would be likely to require significant environmental mitigation to be permitted and therefore it is unlikely that more than one such installation would be approved on any particular watercourse.

Reference should be made to guidance provided by SNH and SEPA where the cumulative effect of multiple hydro schemes has the potential to place undue pressure on local water resources, on the landscape of a glen or catchment area or cause undue disruption to the feeding areas of fish or mammal species.

[12] This study assumes that hydro schemes would not be permitted in any location where they would prevent a barrier to the migratory fish which form important interests for ecological designation, tourism and fishing.

6 Anaerobic Digestion

6.1 Introduction

This chapter reviews the potential for AD deployment in the Park as a source of renewable electricity and heat. The appraisal draws on information about the technology presented in Technical Annex 4 and assesses the extent of the energy resource available. The energy potential of AD installations is then discussed with reference to the environmental issues associated with their deployment and the key constraints identified in Chapter 2.

6.2 Technology Summary

Anaerobic digestion is the process of biological decomposition of organic material in the absence of oxygen. The lack of oxygen inhibits the range of bacteria that would normally populate under aerobic conditions and cause composting. In their place are bacteria that thrive without oxygen, and in doing so convert the sugars in the feedstock into carbon dioxide and methane. The methane can then be used to generate renewable electricity and heat in a Combined Heat and Power (CHP) engine; burned directly to produce heat; be cleaned and injected into the grid or used to produce vehicle fuel. The material left over after digestion, known as digestate, may, if it is sufficiently free of impurities, to be used as a fertiliser and soil improver which can help to reduce the need for artificial fertilisers, delivering further carbon emission savings.

There are three main types of AD plant that could come forward for the generation of renewable energy in the CNP, which are:

- On-farm, non-waste plant: The concept is that the plant runs on feedstocks from the farm, generally a base load of farm yard manure or slurry with energy crops, which in the CNP would most likely be grass silage or whole crop barley;
- On-farm waste treatment plant: This type of plant may also use manure to provide the anaerobic bacteria, but the bulk of the feedstock will be organic waste from food processers, slaughterhouses or possibly catering establishments;
- Centralised Anaerobic Digestion (CAD) plant: These are sizeable plants handling large quantities of organic municipal waste.

At the present time, the policy situation regarding AD in the UK is uncertain. There is enthusiasm from Government to see the expansion of AD plants and the Department of Energy and Climate Change (DECC) has stated a commitment to increasing energy from waste through anaerobic digestion. However, the present financial incentives available are generally insufficient to make plants economically viable at farm scale, and the regulations that apply to the plants taking in off-farm waste or exporting the digestate are onerous. DECC are currently consulting on the AD Framework and working groups with industry experts have been established to develop a strategy.

In addition to this uncertainty, the AD sector in the UK is very immature, with only 52 plants in operation (including municipal treatment facilities), and there “are so many variables in an AD supply chain; most importantly, what feedstock is used, where it is sourced and how it is treated or handled, what technology is used, and how and where are the outputs used (including biogas and digestate). Due to these numerous complex and often inter-related variables every AD plant is different, both in terms of costs, benefits and impacts” (AD Strategy Working Group 1, 2011).

6.3 Existing Level of Deployment[13]

The CNPA has received one initial enquiry for an AD facility at the time of writing of this report, however this has not progressed to a formal planning application. There are no other AD plants currently operating in the Park.

6.4 Energy Resource in the CNP

There are a wide variety of materials that can be used as a feedstock for an AD plant, they vary in the amount of methane they produce, how difficult they are to handle (due to regulations) and whether it is necessary to purchase them or be paid take them.

The information on resource availability in this section is based on desk-based research of existing information sources. It was beyond the scope of this report to undertake detailed, primary research into the actual volumes of feedstock available, and therefore the information in this section should be treated as indicative only.

It is important to note that while many feedstocks and combinations of feedstocks can be used in an AD plant, any one AD facility is designed to operate on a specific combination of feedstocks at relatively set ratios. There is some flexibility, depending on the set up, but in general it is not possible to simply use whatever feedstock is available at a given time. Therefore, it is important to consider not only if a feedstock is available, but also whether there are any seasonal fluctuations in its availability and over what time periods is it possible to guarantee supply. Common AD feedstocks are considered in the following paragraphs.

[13] As of November 2011.

Slurry and Farm Yard Manure

For many farm AD plants slurry and/or farm yard manure will form the basis of the feedstock. However, it has relatively low gas yields and in order to be economically viable a plant will generally require another higher yielding feedstock to be added.

Given the farming systems in the CNP, which tend to be extensive livestock farms, the volumes of manure and slurry are very unlikely to be a significant resource for AD plants. Any single livestock farm is not likely to produce sufficient slurry or farm yard manure to enable an economically viable AD plant. It may be possible for several adjoining farms to generate enough for one AD facility, but the low energy value to weight means that it is not economical to transport either feedstock very far.

Energy Crops

There are a number of energy crops that can be used either as the main feedstock or added to other feedstocks, such as slurry, to boost biogas production. Energy crops that are grown in the CNP include barley and grass silage, are currently grown for livestock feed. Market conditions and a reduction in cropping support has led to the area of arable crops cultivated in the CNP to halve over the last 25 years (Cogent Strategies International Ltd, 2010). Coupled with this, there is continuing financial pressure on livestock industries and a decline of beef cattle and sheep numbers, with the result that this sector is not in a position to compete for the land resource. In theory, there is potential for crops to be grown for the alternative energy market, however, given the soils, climate and yields achieved in the CNP, and the fragile economics of farm-scale AD, it is unlikely that crops can be produced at an economic price to justify an increase in the amount grown in order to feed AD plants.

Food Waste (Domestic and Commercial)

Food waste is a widely used feedstock for AD and has high biogas yields. It can be obtained from a range of sources, for example collection of separated domestic and commercial food waste, or from food processing factories.

The tonnage of food waste produced within the Park can be estimated in order to gauge the quantity of potential feedstock. In order to estimate this tonnage of domestic and commercial food waste a number of assumptions had to be made. It is estimated that approximately 8,000 tonnes per annum food waste is produced in the Park (4,500 tonnes domestic and 3,500 tonnes commercial). The tonnages used within this calculation are given in Table 6.1.

Table 6.1: Food Waste Estimation

Designation	Aberdeen	Angus	Highland	Moray	Average
Domestic Waste (2009/2010) (tonnes)[14]	148,499	76,780	158,451	64,531	-
Commercial Waste (2009) (tonnes)	185,054	77,520	252,128	72,271	-
Total Waste (tonnes)	333,552	154,300	410,579	136,801	-
Number of Households (2009)[15]	102,626	50,343	100,906	38,954	-
Domestic Waste per Household (tonnes)	1.45	1.53	1.57	1.66	1.55
Commercial Waste per Household (tonnes)	1.80	1.54	2.50	1.86	1.92

The average domestic and commercial waste tonnage as detailed in Table 6.1 was then used to estimate the food waste tonnage within the Park using the following information:

- Composition of food waste within domestic waste stream is 17.7%[16];
- Composition of food waste within commercial waste stream is 11.3%[17]; and
- Number of households within the Park is 16,595[18].

To put the 8,000 tonnes per annum food waste that is estimated to be produced in the Park in context, the Deerdykes CAD plant in Cumbernauld processes 30,000 tonnes of food waste per year, and Holsworthy Biogas Plant in West Devon processes around 140,000 tonnes per annum of organic commercial wastes a year, mainly waste from commercial food processers, but also from biodiesel manufacturers and local councils.

Whisky Industry

Both draff and pot ale, which are co-products of the whisky production process, are good feedstocks for AD. There are a number of whisky distilleries in and around the CNP, such as Dalwhinnie, Glenlivet, Macallan, Benromach, Royal Lochnagar in Ballater and Drumguish distillery in Kincraig. The Scotch Whisky Association are committed to reducing their carbon emissions, however, at present the volumes of these co-products available from any one distillery are not sufficient to run an economically viable AD plant[19]. However, this does not mean that there will not be opportunities in future for these products to be a component of AD feedstock and transported to a centralised AD system. The availability of this feedstock for AD projects within the Park will be affected by other markets outside of the Park. For example, the new bioenergy project at Rothes

[14] http://www.sepa.org.uk/waste/waste_data/waste_data_digest.aspx
[15] http://www.gro-scotland.gov.uk/statistics/theme/households/estimates/household-estimates-2009/list-of-tables.html
[16] http://www.wrap.org.uk/downloads/Scotland_MSW_report_final.96332e44.8938.pdf
[17] http://www.defra.gov.uk/statistics/environment/waste/wrfg03-indcom/
[18] http://www.gro-scotland.gov.uk/statistics/theme/population/projections/sdp-areas-national-parks/national-parks-2006-based/list-of-figures.html
[19] Based on communications with the Scotch Whisky Association.

will be taking whisky co-products from 16 distilleries within a 25 mile radius of Rothes which includes the Glenlivet distillery within the Park. Given the number of distilleries in the area and the industry's targets, further energy projects could come forward in future which could reduce feedstock availability for projects within the Park.

Sewage

AD based on sewage sludge has been practised by the water industry for around 100 years, however the biogas produced is not usually used for energy generation for various reasons. At present, the sewage sludge from the works in the Park is exported to Inverness, because the Inverness AD plant is of a scale that makes AD economically viable. It is possible to co-digest sewage sludge with other wastes such as food waste. If an AD processing facility was viable within the Park based predominantly on other feedstocks, the opportunities for accessing this sewage sludge as an additional feedstock could be explored with Scottish Water. It would be necessary to find out the economic and technical implications of its inclusion in a new project, and also the implications for the existing AD plant.

Other Sources

There are many other materials and wastes that can be used as feedstock for an AD plant, or used to boost the methane production, such as abattoir waste, glycerol and vegetable processing waste. No significant sources of these feedstocks have been identified within the CNP.

6.5 Environmental Effects

In general, best practice in design and housekeeping measures, as well as engineering solutions, exist to mitigate the majority of concerns that could arise in respect to AD plants, for example odour, noise and visual impact of structures (The AD Centre, 2011).

Landscape and Visual Issues

An AD plant typically comprises a digester tank, buildings to house ancillary equipment such as a generator, a biogas storage tank, possibly a flare stack and associated pipework (Office of the Deputy Prime Minister, 2004). The scale of the visual and landscape impact depends very much on the size of the plant and context. They may be considered as intrusive where they alter the landscape character or built environment, or where they substantially change the views from nearby properties, open spaces or paths.

A well designed and positioned farm-scale plant should have minimal effect on the landscape. A commercial scale plant would be larger and more industrial in aspect, therefore this type of plant would have to be carefully located and screened to avoid or reduce landscape and visual impacts.

There are micro AD plants coming to the market which have a much smaller visual impact than even a typical farm-scale AD plant, however their technical and financial viability are not yet demonstrated. Technical Annex 4 contains a number of photographs illustrating the typical form and layout of buildings and plant associated with digesters at different scales.

Where an AD plant is designed to export electricity to the grid, then this could have visual impacts where there is a need for new towers for overhead lines or other infrastructure such as transformers, depending on the location of the plant in relation to existing grid. If there is not a three phase connection point nearby then it may not be financially viable to connect, as installing cables underground is very expensive and the alternative in terms of new overhead power lines may create unacceptable landscape and visual impacts.

Ground and Water Courses

The digestion of farm waste could actually reduce the likelihood of a serious pollution incident caused by agricultural wastes by introducing modern and safe slurry containment systems. Emissions of effluents or other site run-off to watercourses can be minimised by following the Code of Good Practice on the Prevention of Environmental Pollution from Agricultural Activity - the standard publication used by SEPA and farmers in Scotland for preventing farm based water pollution.

Traffic Generation

Transport movements at on-farm digesters are not likely to add significantly to normal farm activities, but traffic generation on public roads could occur if the plant is taking in waste from off-site or exporting digestate. The impact this will cause will vary greatly depending on the size of the plant and amount of waste it is processing, and also the location of the plant and access routes.

CAD plants, because of their very nature as a centralised facility, will require feedstock to be brought in from outside the plant. The volume of traffic and resulting impact will vary greatly depending on the size, sources of the waste and location of the plant. The impact of this can be minimised by carefully considering logistics and reducing distances between feedstock sources, digester location and local markets for the digestate.

Odour

Generally, an AD plant does not create significant odour impacts. If the plant takes in food waste, some of the waste received will be in the process of decay so localised emissions of odour during delivery is possible. Using biofilters on the intake area is one possible solution, but these are expensive and need regular maintenance (The AD Community: An Independent Web Site, 2011). Odours may also arise where waste is mixed and sorted, when the digester itself is cleaned (it is sealed during use) and during digestate draw-off.

In Germany, AD plants are often sited within, or close by towns and villages. The odour is generally not considered to be any worse than that produced by conventional farming practices.

6.6 Energy Potential

The high capital costs and current levels of financial incentives generally mean that farm-scale plants are not economically attractive at the present time. Economies of scale are gained for large plants and viability increases. If the heat output (approximately half of the energy output from AD) can be effectively utilised, and a financial value accrued, this can also significantly improve economic viability. Due to the number of variables involved, such as variation in equipment required, costs/prices and biogas production of different feedstocks and the value to digestate, it is very difficult to give typical paybacks.

Mitigation and Best Practice

The landscape and visual impacts of an AD plant vary depending on scale, but the key consideration is to locate the plant in order to minimise visibility on a landscape scale, for example to make use of screening provided by natural land forms or woodlands.

In terms of haulage impacts, it may be possible to define prescribed routes for vehicle movements in order to avoid any sensitive areas (The AD Centre, 2011), or to manage delivery times to avoid unnecessary disturbance where there are concentrations of population close to the site and/or access routes.

Nuisance odours from waste movements will be minimised as wastes are usually delivered in closed vessels and vehicles and received in a closed reception area, while the digestion process takes place in a sealed tank. The digestion of slurry, for example, is significantly less odorous than the common farm practice of storing slurry in pits (Office of the Deputy Prime Minister, 2004).

Given the resource limitations in particular, it is unlikely that sufficient numbers of AD plants will come forward to create any cumulative effects.

Summary

At present, the major constraints on the deployment of AD in the CNP are resource availability, economic feasibility and regulation on handling wastes and digestate. These factors interact within the CNP to make AD a more challenging renewable energy option to deliver than some of the alternatives.

In general, the volumes of feedstock available on farms within the Park are relatively small - on the whole too small for the establishment of economically viable on-farm AD plants. This does not mean that some AD plants will not come forward, but that relatively low volumes of feedstocks within the CNP mean it is unlikely that there will be widespread deployment of farm based systems providing their own feedstock.

Based on resource availability alone, there is greater scope for on-farm waste treatments plants to be established which take in feedstocks from a variety of nearby sources. It does not appear from the information available at present that there is sufficient volume of food waste to warrant the establishment of a CAD facility within the CNP. However, it is possible that future changes in Government policy could alter this situation.

If CAD facilities are established outside of the CNP where there are greater densities of population and therefore more feedstock available, it is possible that if the economics are favourable, feedstocks from within the CNP will be transported to these plants outside of the Park. This situation could actually further reduce the availability of feedstock for AD plants within the CNP.

There is enthusiasm from Government to see a significant increase in the number of AD plants, and DECC has stated a commitment to increasing energy from waste through anaerobic digestion. It is important to note that if the Government decide to increase the financial incentives and take action to remove some of the regulatory barriers, the viability of AD plants could be greatly increased.

6.7 Cumulative Issues

The potential for AD as a source of renewable energy in the CNP is considered to be limited, at least in the medium term, for a range of technical and policy reasons. Whilst the potential environmental impacts of any new AD plant will need to be carefully evaluated with respect to its scale, location and surrounding receptors, it is considered unlikely that significant cumulative environmental effects will occur from multiple of AD installations.

7 Solar

7.1 Introduction

This chapter reviews the potential for increased solar energy deployment in the Park as a source of renewable electricity and heat. The appraisal draws on information on the technology presented in Technical Annex 5, estimates the scale of existing solar energy capacity in the Cairngorms and assesses the extent of the energy resource. The energy potential of solar installations is then discussed with reference to the environmental issues associated with their deployment.

In order to provide a consistent frame of reference for the scale of solar installations, the following indicative categories have been adopted which are considered to be appropriate in the context of renewable energy systems in the Cairngorms.

Table 7.1: Definitions of Scale of Technology – Solar Installed Capacity

Technology	Small	Medium	Large
Solar PV	<4 kW	4 kW to 10 kW	10 kW to 50 kW
Solar Thermal	<200 kW_{th}	<200 kW_{th}	N/A
Sources: FIT bands have been used to help define Small, Medium and Large scales for Solar PV (although all three scales are formally classed as microgeneration). RHI scheme has been used to define Small to Medium scale for Solar Thermal and no definition for Large has been presented as such schemes are not generally considered to be appropriate in the Cairngorms.			

These do not necessarily represent specific industry wide agreed definitions but have been used to provide a context and reference point for the discussion of solar systems in this report. Discussions in this chapter regarding permitted development relate only to microgeneration which is classified as solar PV under 50 kW and solar thermal under 45 kW_{th}.

7.2 Technology Summary

There are two types of solar technology: photovoltaics (PV) and solar thermal. Although they produce two different outputs; PV produces electricity and solar thermal produces hot water, they have many similarities, as they both commonly use roof-mounted equipment to collect radiation from the sun.

Solar PV can also take the form of large-scale commercial solar farms, however it is highly unlikely that proposals would come forward for the development of a solar farm in the National Park, as the relatively low levels of solar radiation in northern Scotland would not make an investment in a large-scale farm viable. In addition, the recent Government fast-track review of the FIT for PV has introduced much lower tariff payments for PV systems over 50 kW. This will still further reduce the likelihood of large scale solar farms coming forward in the CNP.

The Renewable Heat Incentive (RHI) has recently been announced and this will support solar thermal under 200 kW, however at present full details of how the RHI will support domestic properties is not yet available. Due to this uncertainty, it is difficult at this time to provide clear guidance on the likely patterns of uptake of solar thermal. Further information on the FIT and RHI is presented in Appendix B.

Solar thermal is a mature and recognised technology. It can be used to heat water for a variety of purposes, with the most common being domestic hot water, light industrial and agricultural use and the heating of swimming pools (Office of the Deputy Prime Minister, 2004).

Although the 2011 fast track review of the FIT scheme has reduced the tariff rates for some scales of PV, there is still uncertainty and speculation that they will be reduced still further. Solar PV technology is developing quickly however, and prices are coming down, driven by rapidly declining costs and prices due to economies of manufacturing scale, manufacturing technology improvements, and the increasing efficiency of solar cells. Despite this capital costs still remain high.

Planning permission is not normally required for domestic solar panels[20], however, there are circumstances when solar panels are not permitted development which are set out in detail in the accompanying technical annex. This includes on non-domestic properties in a National Park.

7.3 Existing Level of Deployment[21]

There are a number of photovoltaic panel installations already in use at the domestic scale on properties across the Park and anecdotal information from local residents suggests that the rate of installation of all types of solar panel has increased in the last year. In addition there is a proposed project in planning for a commercial scale PV application at Glenelg.

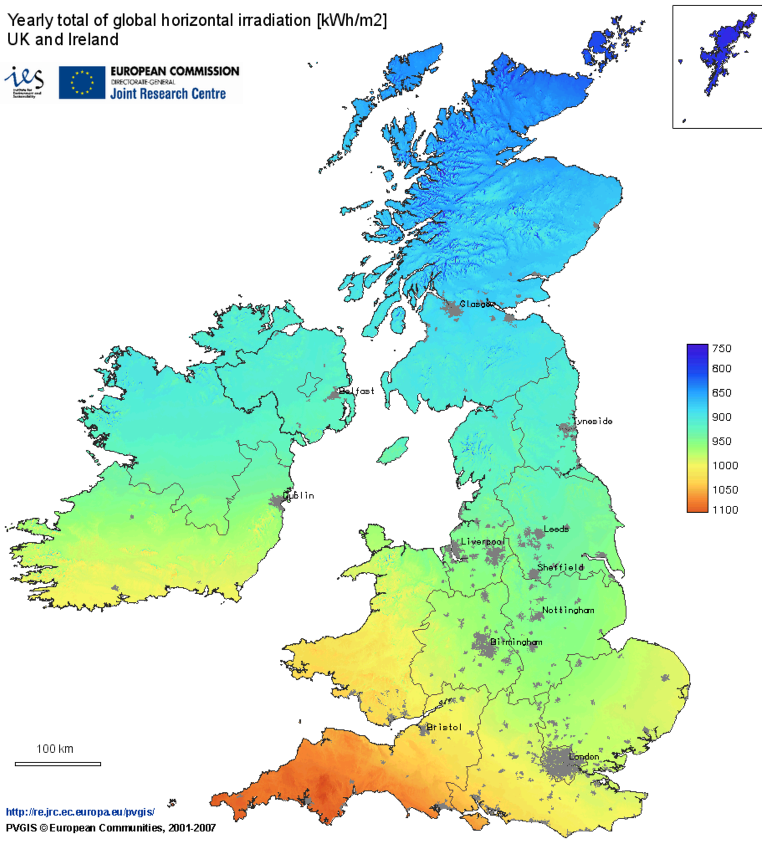
[20] Town and Country Planning (General Permitted Development) (Domestic Microgeneration) (Scotland) Amendment Orders of 2009 and 2010
[21] As of November 2011.

7.4 Energy Resource in the CNP

The solar insolation level an area receives is the amount of energy reaching the earth's surface per square metre (kW/m²). In the CNP each south-facing roof receives between 700 and 850 kWh/m^2 of solar radiation during the year as shown in Figure 7.1 (European Commission, 2008).

This figure clearly illustrates why commercial scale solar PV farms are significantly less likely to be viable in the CNP in comparison to even the south of Scotland. However, at a smaller scale, sufficient solar radiation may make PV or solar thermal attractive over larger payback periods. The heating season in the CNP is long, which makes the use of solar energy more cost effective in Scotland than in England in terms of reducing heating bills (Williams, 2000). Even on cloudy days approximately 30% of solar radiation can be usefully harnessed for lighting and energy use (Communities Scotland, 2000).

Figure 7.1: Yearly Total of Global Horizontal Irradiation (kWh/m^2)



In order to harness the maximum amount of solar radiation, it is essential that small scale solar installations are positioned to maximise the exposure to sunlight, and should be orientated facing from east to west (i.e. within 90 degrees of due south) (Office of the Deputy Prime Minister, 2004).

7.5 Environmental Effects

Solar energy systems are silent and clean in operation. The main environmental impact associated with solar technologies is their potential for impacting on visual amenity. PV and solar thermal panels are generally roof mounted, using a low support structure (a flat frame) and will therefore typically lie flush with the existing roof and not protrude above the roofline, as illustrated in Figure 7.2.

Figure 7.2: A New Build Dwelling in the CNP with Solar PV and Solar Thermal Panels (Source: SAC)

The significance of visual impact depends greatly on the design of the array, the scale, the context and architectural character of the area. Historic buildings, listed buildings and those located in Conservation Areas are likely to be particularly sensitive, and impacts in these areas will need to be mitigated through appropriate planning conditions. Listed building consent will be required for solar panels installed directly on a listed building, and planning permission will be required for solar panels installed on a detached building within the curtilage of a listed building. The local planning authority would need to be satisfied that the panels would not be detrimental to the character or appearance of the listed building or its setting, thereby controlling the visual impact.

In some locations, where the roofs of agricultural or industrial buildings are replaced with solar panels, this can result in an improvement to the visual appearance, particularly where existing structures are in a degraded condition or are visually unattractive.

Solar collectors can be integrated into the roof or facades of buildings through the use of solar slates, solar glass laminates and other solar building design solutions such as PV glazing. These technologies have very little visual impact as they are barely distinguishable from conventional building materials and can therefore be deployed to completely mitigate visual impacts or impacts on the setting of architecturally important buildings where the additional cost is justified.

Measures which can be employed to minimise the environmental impacts of solar technologies on buildings are considered further in Section 7.6 and more detailed guidance can be found in Technical Annex 5 to this report.

Domestic solar installations are permitted development in most situations subject to certain circumstances being met as defined by the Town and Country Planning (General Permitted Development) (Domestic Microgeneration) (Scotland) Amendment Orders of 2009 and 2010. Therefore, if the financial incentives (FITs and RHI) remain at attractive levels, solar installations have the potential to become more prevalent on residential and commercial buildings in the CNP. This creates the potential for cumulative visual impacts, and this issue is considered further in Section 7.7.

7.6 Energy Potential

Costs and Payback

In general, as the size of the solar installation increases, the cost per installed kW will reduce. However, the incentive payments from Government under the FIT and RHI reduce for installations over certain size thresholds (see Appendix B for further details). Therefore, the feasibility of installation will need to take account of capital costs, scale of installation, energy generation and level of payment under the relevant incentive scheme. This will allow for calculation of a payback period (in years) after which the installation will provide a net income for the building owner.

As an alternative to individuals or businesses purchasing solar panels themselves, there are a number of organisations offering to install solar PV panels to buildings without charge. The company installing the panels will benefit from the FIT payments and the building owner typically benefits from reduced energy bills and in some cases a rental income.

Solar Thermal

The Energy Saving Trust have calculated the following approximate savings based on the hot water heating requirements of a three bed semi-detached home with a 3.4 m^2 squared solar panel:

Costs for installation of a typical solar thermal system is around £4,800 (including VAT at 5%).

Savings are moderate - a solar thermal system can reduce the domestic water heating bill by between £50 and £85 per year. It will also save up to 570kg of CO_2 emissions, depending on what fuel is being replaced (Energy Saving Trust, 2011a).

Solar thermal systems under 200 kW are eligible for the RHI tariff payments of 8.5 p/kWh, thus reducing the payback period.

Solar PV

Costs for installing a solar electricity system have reduced significantly in recent years, with an average domestic system of 2.7 kilowatt peak production (kW) costing around £12,000 (including VAT at 5%). If the system is eligible to receive the FIT it could generate savings and income of around £1,170 per year (Energy Saving Trust, 2011a).

Mitigation Measures and Best Practice

Visual impacts can best be minimised by replacing conventional building materials with solar alternatives, such as glazing, slates or tiles where this is practicable. They have the aesthetic advantage of giving a roof a homogenous appearance, virtually indistinguishable from conventional roofing materials (Office of the Deputy Prime Minister, 2004). These options are usually more expensive than modules but can be very cost effective where they are used to replace other building materials.

For solar thermal, collectors are becoming available that can be incorporated into new or existing roofs in much the same way as proprietary roof windows, therefore reducing the visual impact. In all instances, solar panels should be sited so that they cause minimal harm to the character and appearance of the property and the wider locality. A solar panel sited at the rear, or side of the property is often the best approach, away from front elevations. However, the opportunities to move panels from south facing front elevations may be limited, as in order to function well they need to be orientated within 45 degrees of south.

Overall Feasibility

Solar energy installations are becoming more efficient and cheaper to install as technologies develop and the market expands. Despite the relatively low solar insolation levels in northern Scotland, both PV and solar thermal are viable in the Cairngorms, and a number of buildings have already installed these technologies. The advent of the Government incentive schemes for small scale renewables will reduce the financial payback periods for solar energy, thereby increasing the number of householders and businesses in the CNP who will respond to the opportunity to generate their own energy and a cash income from any excess.

Solar energy is therefore feasible for those with access to funds to purchase the technology, and relatively straightforward to deploy given the majority of installations will be permitted development.

7.7 Cumulative Issues

The primary sources of potential environmental impacts from solar installations on buildings are from the visual impact of panels on roofs or adjacent to buildings, and in some cases the impact of these on the fabric of surrounding architecturally or historically significant settlements. The potential for cumulative impacts arises from:

- A widespread increase in the number of isolated rural properties which incorporate or retrofit solar panels to roofs or other elevations, which might lead to an impression of rural visual/character change for some viewers travelling through the Park ; and

- Changes to the character and appearance of built up settlements of conservation significance, where multiple solar installations may lead to visual clutter and hence reduced amenity for residents and visitors.

It is predicted that the Government financial incentives will stimulate an increase in the retrofitting of solar PV and solar thermal panels and their incorporation into new buildings. However, the capital cost of panels for private householders in particular, and the length of their payback times (despite FITs/RHI) is likely to prevent widespread adoption of the technologies. Whilst there will undoubtedly continue to be growth in the retrofitting of panels, significant cumulative visual impacts from installation of solar panels to individual buildings in the countryside are not predicted. In settlements of particular architectural importance, designations such as conservation area status (and of course listed buildings in all areas) provide the local planning authorities and the CNPA with some control over the prevalence and potential environmental impacts of solar panels both individually and cumulatively. However, as solar PV installations under 50 kW are permitted development in many situations (see Technical Annex 5 for full details), the extent of control is more limited.

This study has not considered the potential for large solar arrays as a source of renewable energy at a commercial scale. Should any such applications come forward, there are likely to be significant landscape and visual impacts.

8 Heat Pumps

8.1 Introduction

This chapter reviews the potential for increased heat pump deployment in the Park as a source of renewable heat. The appraisal draws on information on the technology presented in Technical Annex 6 and assesses the extent of the energy resource. The energy potential of heat pump installations is then discussed with reference to the environmental issues associated with its deployment.

As this chapter will discuss, heat pumps are considered to have modest and generally domestic type applications in the Cairngorms. For this reason the discussion concentrates on domestic to small scale capacity systems which have been defined for the purposes of this report as being systems with an installed capacity of less than 100 kW_{th}. Discussions on permitted development for heat pumps in this chapter relate only to microgeneration scale which is for installations less than 45 kW_{th}.

8.2 Technology Summary

There are several types of heat pump. All use the same basic principle of extracting heat from a source and concentrating it to obtain a higher temperature, usually then applied to water for domestic heating and hot water (Energy Saving Trust, 2011d). There are two principal types of heat pumps that are in use in the UK: ground source heat pumps (GSHP) and air source heat pumps (ASHP).

Ground Source Heat Pumps: These take low-level heat which accumulates in the earth from solar warming, (the heat is collected through a series of underground pipes laid about 1.5m below the surface, or from a borehole system) and convert it to higher-grade heat by using an electrically-driven or gas-powered heat pump. Water is re-circulated in a closed loop underground and delivered to the heat pump, which is usually located inside the building (Carbon Trust, 2010).

Air Source Heat pumps: These use low-level heat, which occurs naturally in the air, and convert it to higher-grade heat by using an electrically driven or gas-powered pump (Carbon Trust, 2010).

Both ASHPs and GSHPs work most effectively with heating systems which are optimised to run at a lower water temperature than is commonly used in UK boiler and radiator systems. Therefore, they function best with under-floor heating and in well insulated buildings. As such, they are ideal for new build or conversion work where new highly insulated ground floors are installed with under-floor heating. The efficiency can vary significantly depending on the installation and customer behaviour and heat demand. Heat pump technology is relatively new to the UK market, and there has been little evidence on how well it performs over time (Energy Saving Trust, 2011b).

Technical Annex 6 also briefly comments on deep geothermal energy as a future potential source of renewable heat in the Cairngorms. As this technology is some way from full commercial application it has not been considered further in this report although early work suggests that it may have future applications in the area.

8.3 Existing Level of Deployment[22]

GSHPs and ASHPs are already in use in domestic situations, with many of these examples being found on new build houses. There are no figures available on the actual numbers installed within properties in the CNP.

8.4 Energy Resource in the CNP

Ground source heat pumps (GSHP) use ambient heat drawn from underground. A few metres underneath the surface of the earth, the temperature is constant (around 15^{o}C) all year round. Therefore, this resource is available across the CNP and poses no theoretical restriction to the deployment of such installations in areas adjacent to the heat demand (usually a building).

Air source heat pump (ASHP) systems work best in warmer climates. To function effectively ASHPs require an air temperature of above 7^{o}C, below this temperature ice may form on the evaporator as the air is cooled, restricting the air-flow which impairs performance. Consequently, the low average winter temperatures in the CNP mean that ASHPs may not function effectively during those months when they are most needed, therefore this is likely to limit their effective deployment across the Park.

8.5 Environmental Effects

In general heat pumps are unobtrusive, quiet and clean with minimal environmental effects in the majority of locations. In terms of carbon reduction, heat pumps do rely on electricity to function, and therefore they do have a carbon footprint during operation unless the electricity is from a renewable source.

[22] As of November 2011.

Heat pumps cover a wide range of capacities, from a few kW to many hundreds of kW, and can be used to heat or cool large, multi-storey buildings. For guidance, a 5 to 10 kW GSHP system would be large enough to heat a small office (Carbon Trust, 2010).

GSHPs, once installed, are unobtrusive (Energy Saving Trust, 2010a). This is because they use a buried ground loop which consists of lengths of pipe buried in the ground, or a very deep vertical hole, 50 or more metres deep (BRE, 2011). The installation of a GSHP therefore requires some civil engineering works, such as sinking bore holes or excavating 1-2 m deep trenches to house the collector pipe. The significance of the environmental impacts of these activities will vary depending on the type of technology, the scale of installation and the environmental sensitivity of the site. For example, a GSHP for a large building, with horizontal buried loops could involve soil stripping, pipe laying and reinstatement over a fairly large area of several thousand square meters. However, opportunities for laying lengths of pipe may arise if other work is being undertaken such as resurfacing a car park. The impact of this will depend on the nature of the ground being worked and whether it has any environmental designations, ecological sensitivities, drainage problems or a role in carbon sequestration. Ground restoration measures can be employed to mitigate against long term impacts, depending in particular on the depth and sensitivity of the soils. The surface of the land on which any works have been carried out must as soon as practicable after the development is completed be restored. If technologically possible, the installation of a bore hole GSHP will minimise these impacts but this method is more expensive and depends on suitability of the underlying geology.

All domestic (microgeneration) GSHPs are permitted development. Very sensitive sites will be protected through other designations or controls, for example trenching works for pipe installation would fall into Potentially Damaging Operations where a SSSI was affected.

ASHPs have very few environmental impacts from a planning perspective, and the technologies are very similar to air conditioning units in scale and appearance, meaning they can be sited either on the exterior wall of the building or close by. Domestic ASHPs are now generally permitted development (except for listed buildings) although prior consent must be obtained from the planning authority before the pump is installed. Most ASHPs are sited just outside the property, typically on/near to rear or side elevations where there will be minimal amenity or visual impact to surrounding properties or viewers. Figure 8.1 below shows a typical ASHP installation at a domestic property.

Figure 8.1: Example of a Domestic ASHP (Source: GrEnergy)

Overall, the environmental effects of installing heat pumps will be localised, and in most cases the long term impact of works to install GSHPs will be minimal provided reinstatement is effective. Given the small scale and site specific nature of the effects of heat pumps, it is not possible to identify areas of the Park which are more or less appropriate. The key here will be on ensuring adequate supervision of installation and post restoration checking.

8.6 Energy Potential

General Feasibility

The choice between a horizontally arranged GSHP pipe system or a borehole system depends on the area of land available to lay the pipes, the geology and the costs involved. If the site area is limited a borehole system would be required, but this is typically more expensive (SAC, 2009). Due to the expensive ground works required for their installation, payback times for GSHPs tend to be long (Energy Saving Trust, 2011b). However, GSHPs are eligible for the RHI, which will greatly reduce payback periods.

The air temperatures in the CNP during the winter months will limit how effectively ASHPs will function, consequently this could pose a barrier to their widespread deployment within the CNP. At present, ASHPs are also not eligible for support under the RHI although DECC are considering their inclusion in future.

There is a lack of data on heat pump performance in domestic properties and the Energy Saving Trust have recently undertaken the first large-scale heat pump field trial in the UK to determine how heat pumps perform in real-life conditions. For both types of heat pump, the study found that to be most efficient the heat pump must be selected to match the property and occupant's energy demand, and that the technology provider should take care to specify and install them properly (Energy Saving Trust, 2010a).

As both types of heat pump require electricity to function, their economic viability will also vary with the price of electricity. The extent to which this affects the costs of running the heat pump will depend on the coefficient of performance and system efficiency. Heat pumps of all types are typically only efficient and viable where they are installed in well insulated buildings with high thermal efficiencies.

Deployment in the CNP

As GSHPs (domestic and non-domestic) and ASHPs (domestic) are generally permitted development up to 45 kW, their deployment can go ahead without significant requirements for planning approvals and studies. This makes their installation more straightforward for developers with sufficient capital to invest in the required technology. Provided that pipes are installed underground in a sensitive manner, GSHPs should not present significant environmental impacts in the Park either singly or cumulatively. The CNPA may therefore wish to encourage the deployment of GSHPs in appropriate locations, particularly for new residential and commercial property developments, where high levels of insulation and under-floor heating makes the technology financially viable and effective as a lower carbon source of heat. Nevertheless, their use in any particular situation should be compared against other renewable heating alternatives to ensure the most appropriate system is installed, taking account of impacts, carbon emissions, payback periods and technological suitability.

As already discussed, there are potential problems with ice formation on ASHPs at low temperatures, and they are generally only suited to very well insulated houses with underfloor heating. This will act to limit the viability of ASHPs in the Park to new properties or those undergoing significant upgrading and therefore it is not predicted that the technology will be extensively deployed in the CNP in the next few years. Despite these limitations, a number of new buildings in the Park have already installed ASHPs, so it may be expected that a modest growth in the deployment of this technology will continue notwithstanding sub-optimal performance during winter months.

8.7 Cumulative Issues

In common with solar panels, domestic scale heat pumps are permitted development for most buildings which do not have architectural or historical significance. The potential for cumulative environmental impacts from heat pump installations is considered to be low. This is partly due to the limited and localised nature of the technologies and their possible effects and partly because a significant and widespread increase in their deployment is not anticipated in the CNP. Any localised and short term potential for environmental impacts from pumps (particularly GSHPs which require some earthworks and restoration of vegetation) can be addressed through best practice guidance and requirements in planning guidance, with larger scale applications likely to be controlled through the development management process.

9 Wider Benefits and Impacts

9.1 Introduction

From the information presented in Chapters 3 to 8 on existing renewables deployment in the Park it is estimated that current installed capacity of renewable energy in the CNP is in the order of 3 to 3.2 MW, excluding the large commercial hydro electric schemes. This comprises:

- Electricity generating capacity in the order of 250 to 500 kW; and
- Heat generating capacity in the order of 2,700 kW.

The figures are presented as a range to allow for small scale installations which have not been progressed through planning. These estimates demonstrate that renewable energy capacity in the Park in 2011 is still at a relatively low baseline level, particularly for electricity. In this chapter some of the wider and cumulative effects of increasing the number and scale of renewable energy installations in the CNP is explored. Section 9.2 considers the socio economic and financial benefits of increased renewables deployment in the Park. Section 9.3 then assesses the growth in renewables that might be achieved by 2020 and contrasts this with wider national energy targets. Finally Section 9.4 presents a discussion of the potential for cumulative environmental effects from the potential growth in energy capacity outlined in this chapter.

9.2 Wider Benefits

9.2.1 Economic and Community Benefits

There are a number of issues related to the development of renewable energy that are of relevance to communities. These can be considered in terms of local economic benefit and community involvement.

Local Economic Benefit

The development of renewable projects has potentially several means of realising socio-economic benefits to the community:

- Benefits for the local community can arise from construction and installation of renewable energy development schemes, with local businesses gaining work directly from supplying the project and indirectly from local spend by construction businesses, suppliers and personnel.

- If the project is owned by individuals or a group based in the local area, retaining the financial returns within the area will give important local benefits. Recent work by SAC (Booth, E & Bell, J, 2010) considered the financial benefits arising from the development of a medium scale wind energy project with a turbine of 0.8MW, comparing situations where the turbine was owned by a local developer with the project being owned by a company based outwith the area. The jobs created locally when the project was owned by a local developer were found to be around seven times the number compared with the outside developer.
- For medium to larger scale renewable energy projects, a community benefit payment is often made by the developer, so there is usually some direct financial community benefit from a development (Scottish Government, 2009a). Payments would typically be made to a local representative body to fund initiatives for benefit to the whole community. Sums paid will be less than if the project is owned and developed by the community, but for medium to large scale developments can be significant, and are associated with low risk for the community.
- Several local authorities, including Aberdeenshire, Moray and Aberdeen City, have a planning gain policy, whereby renewables developers contribute via Section 75 agreements to a fund specified by the Local Authority (*pers comm* Adam Syme, Aberdeenshire Council Legal Department, April 2011). This is applied to projects above 50 kW, but not where power is used solely by the developer e.g. on-farm. The finance raised will be used for such initiatives as addressing fuel poverty or improving energy efficiency within the local area.

The growth in renewable energy generation in future is likely to stimulate the setting up of businesses in and around the Park which are involved in the installation and maintenance of renewable energy systems. This will be small scale, particularly for renewable electricity installations, however it represents an opportunity for structural diversification of the economy in the Park.

A more significant economic growth prospect lies with the development of the woodfuel supply chain in the CNP, particularly as forest management and timber processing already accounts for a significant part of the local economy in terms of gross value added and employment[23]. As the size of the renewable heat market grows in the area, so will economic (and employment) opportunities for businesses involved in timber growing and harvesting, and in processing and the supply of fuels, as well as in the installation and maintenance of wood-fired boilers. In turn, this will generate spin offs in terms of associated professional services (including engineering/energy design consultants, energy service companies, forest management) and the growth in the sector will result in indirect and induced economic benefits for the wider community and its businesses. Finally, the

[23] The sector currently represents around 3% GVA and directly employs in the region of 200 people.

growth in renewable energy (electricity and heat) represents an opportunity for businesses, communities and land managers to reduce their long term energy costs, thereby improving their financial viability, and in cases where energy can be sold to the grid or as local heat, through a new income stream.

Community Involvement

Many consultees interviewed during the course of this study have stressed the importance of local consultation for renewable energy development in order to achieve community 'buy-in' to any project. This was perceived as being particularly important in the CNP, where landscape and environment are of especially high priority.

It may also be possible for the community to have an active involvement with the renewable energy project, and there are several models for direct community involvement. Wind projects have tended to be the most numerous community projects, but there are also examples for community involvement in hydro and woodfuel as discussed below.

At the larger scale, it may be possible for communities to invest in a share of the project through a public share offer. For example, at the Boyndie Wind Farm near Banff, a local co-op was set up to raise finance from individual investors in and around the local community. This has enabled the community to own the equivalent of one of the ten 2.3 MW wind turbines on the site. Creation of this type of community involvement opportunity requires a high level of financial due diligence and the publishing of a rights issue, which is costly. Given the scale, it is probably not a model that would be adopted widely in the CNP.

Another community involvement opportunity is where ownership of a single turbine within a group of turbines is assigned to the local community, for example at Fintry, Stirlingshire, where the local community group has secured the rights to one of fifteen 2 MW turbines.

Whilst the scale of renewable energy development described above seems unlikely to be deemed acceptable in the Park, the examples given do indicate that there are several routes whereby communities can gain an ownership stake.

A further model, where the community has complete ownership of a single turbine project, is exemplified by the Udny Community project in Aberdeenshire, where the community has gained lottery funding to provide the equity for a bank loan to fund an 800 kW turbine.

There are many other examples (over 130) of community groups being involved in wind projects at the pre-capital stage throughout Scotland[24]. These are not exclusive to large scale installations, with the size of projects being as small as 24 kW.

There are also a number of examples of community ownership of hydro schemes. These include hydro developments at a range of scales from 500 kW (New Lanark), 280 kW (Knoydart), 100 kW (Eigg) and 90 kW (Abernethy Trust at Ardgour). Some of these have gained funding from HIE and ERDF, along with other sources such as the National Lottery and LEADER, in addition to financial input from residents to enable community ownership. For both Knoydart and Eigg, the development of community owned renewable energy schemes has enabled the provision of electricity to remote areas where it would be uneconomic to connect to the National Grid.

Here We Are (HWA) Cairndow are a community enterprise established in 1998 to provide services to the local community and visitors. They were keen to explore opportunities that renewable energy could offer, and a feasibility study found that woodfuel was the most viable option. They developed a three way partnership between a large heat user (Lakeland Smolts), Mawera (the boiler manufacturer, installer and Energy Supply Company) and HWA. HWA have established a woodfuel supply business called Our Power, which supplies fuel to Mawera (the ESCo). They have ambitions to supply other boilers, and their aim is that within 5 years, this business venture will enable the HWA to become financially sustainable, thereby supporting the whole range of community services they offer.

Benefits for the Park

Community involvement will be an extremely important element to the successful development of renewable energy in the CNP, and one which adds value to the Park in the form of energy generation and carbon reduction together with financial benefits for proactive communities. At a minimum, consultation will be needed to achieve buy-in to any new renewable energy scheme, particularly one which may be associated with any disturbance, such as slow moving vehicles during construction, woodfuel delivery necessary for operation, visual disturbance caused by wind turbines or access roads to hydro plants. With greater co-ordination, the preceding discussion has identified that there are various options for the increase in uptake of appropriate scales of renewables by communities in their own right. It is considered important that support is provided to communities to realise these potential benefits through the development of guidance/advice on

[24] SAC and CES (2010). A community and landowner renewable energy loan fund. Report for Scottish Government.

appropriate development models, and potentially through more direct involvement, such as assisting with establishment and co-ordination of such models.

There are a number of ways in which the community can benefit from growth in renewable energy deployment and servicing. These include economic benefits for local businesses during construction and installation (and operation for woodfuel), community funds set up by the project developer, and planning gain. Far greater benefits for local jobs can be achieved if projects are locally owned, in order that the maximum financial benefit is retained in the area. The benefits gained will be greater from medium to large scale projects, so the impact may be limited in this respect for the CNP where most projects are likely to be smaller scale. Nevertheless, more direct community ownership and involvement in smaller scale schemes is possible which will give greater community benefit and examples already exist in Scotland for wind, hydro and woodfuel applications.

In Section 9.3 the potential structural and socio-economic benefits which will accrue from a step change in the woodfuel sector are discussed. In socio-economic terms, this represents the most significant area of opportunity for the Park from the growing renewables sector. These potential benefits have already been identified to some extent by the CNPA, for example in its Woodfuel Action Plan. The forest management, woodfuel supply and associated development industries will undoubtedly develop in the absence of local agency intervention, not least given the stimulus provided by the RHI. However, there is a clear opportunity for a co-ordinated approach by agencies and businesses in the Park which would contribute to the sustainability of the sector in all its community, economic and environmental respects. Options for such co-ordination are discussed further in Chapter 10 of this report.

9.2.2 Financial Incentives

The UK trails almost every other country in Europe in terms of the proportion of its renewable energy which is sourced from renewables, largely thanks to the cheap and abundant fossil energy supplies the UK has enjoyed in the form of coal, oil and latterly, natural gas. However, with dwindling supplies of these commodities, increased reliance on imports and legally-binding targets at the international level, this is set to change. The real-world implications of this are demonstrated by the numbers of renewable energy installations in the UK. Taking woodfuel for example, there are only around 2,600 non-domestic automatic wood-fired boiler installations in the whole of the UK, with Scotland accounting for around 203 in 2009 (Forestry Commission Scotland, 2010a), and an estimated 19 in the Cairngorms in 2011.

With this in mind, successive Governments have supported the renewable energy sector with a wide range of measures over the past decade. More recently, the advent of financial schemes for renewable electricity (the Feed-in Tariff) and heat (the Renewable Heat Incentive) represent a significant stimulus to renewable energy developments less than 5 MW installed capacity. Further details of these measures as well as more traditional routes to finance such as grants and loans are discussed in greater detail in Appendix B of this report.

9.3 Energy Future

9.3.1 Renewable Energy Targets

Scotland is committed to a target of 20% of total energy use coming from renewable energy sources by 2020 with sectoral targets as follows:

- Electricity: renewable generation to be equivalent of 80% of gross annual electricity consumption by 2020, with aspirations to achieve 100% of electricity demand equivalent as renewable energy by 2020; and
- Heat: 11% of heat demand to be met from renewable sources by 2020.

The policy context in the CNP clearly sets out the aspiration to contribute to national renewable energy targets (see Section 1.2). Attempting to translate these targets directly to the energy demand and supply situation in the CNP is somewhat arbitrary. As Section 9.1 identifies, the existing installed capacity of renewable energy in the Park is very low, particularly for electricity. Due to the physical constraints and high environmental sensitivity of the CNP, it may be unrealistic to expect that electricity generation capacity in the area should be sufficient to meet local demand. However, any new electricity generation capacity developed within the CNP would almost certainly have to come from renewable sources.

The analysis in Section 3.6 identifies that there are not any significant barriers to achieving a high level of renewable heat provision through woodfuel based schemes. 11% of the heat demand in the Park equates to around 38,000 MWh of heat per annum[25], which could be provided from an installed capacity of approximately 14 MW_{th}[26]. This equates to more than a five fold increase compared with the current estimated CNP renewable heat capacity of approximately 2.7 MW_{th}. The (Scottish Government, 2009b) indicates that on average, meeting the 2020 target for renewable heat will require a nine fold increase over the installed capacity at 2009. However more recent work by the Energy Saving Trust (Energy Saving Trust, 2010b) identifies that nationally Scotland

[25] The Woodfuel Action Plan identifies an annual energy demand of 348,360 MWh across 9097 heated buildings.
[26] Estimated from an average factor derived from the EST report to Scottish Government, Renewable Heat in Scotland, 2010.

stands at around 2.9% of the 11% target. The next sections consider whether 11% of heat demand is an achievable target for the CNP.

9.3.2 Renewable Energy Growth Scenarios

This section outlines possible scenarios for growth in the installed capacity of renewable electricity and heat in the CNP to 2020, with reference to the national targets set out above. The scenarios are based on a number of broad brush assumptions and do not represent formal energy modelling. Instead they present indicative but realistic pathways to meeting energy demand in the Park from more sustainable and locally installed renewables capacity. The projections are also drawn from data primarily relating to households (for electricity) and to buildings (for heat) therefore do not necessarily reflect all the energy demand in the Park. They are, however, intended to provide an indication of broad energy demand outwith specific and high energy users such as the whisky distilleries.

Electricity

Annual domestic electricity consumption in the Park is estimated at 37,400 MWh[27]. To provide 100% of this electricity from within the Park would require an installed capacity[28] in the region of 11.5 MW or around 9 MW to provide 80% of domestic electricity from renewable sources. It is of note that this could be achieved by the installation of two clusters of three 2.3 MW turbines. However, clearly this is not sustainable within the constraints identified in this study, and indicates that the national target does not easily 'transfer' to a regional context.

Scottish Government data (Scottish Government, 2010) predict a growth in national onshore renewable electricity generation between 2009 and 2020 from approximately 3.5 GW to 8.3 GW, or 137% growth over this period. The vast majority of this growth is predicted from onshore wind. The options assessments for the CNP in this report have shown the potential for growth in a number of types of renewable electricity technology, although uptake of each technology is likely to be modest, even taking account of the effect of the FIT. However since the baseline/current capacity for renewable electricity is very low (no more than 0.5 MW), a target in excess of a 150% increase from 2010 to 2020 should be achievable.

To match the national average growth in renewable electricity generation capacity to 2020, it is likely that capacity will need to be enhanced from a mix of new technology deployment. This mix

[27] Based on an average Scottish domestic consumption of 4.4 MWh per household (source: Energy in Scotland Statistical Report, December 2010).
[28] Based on national data on gross electricity consumption and installed capacity (source: Energy in Scotland Statistical Report, December 2010).

(which is broadly drawn from the energy potential findings presented in Chapters 3 to 8) could take the form of the following allocation of capacity:

- Wind energy: by allowing for some growth in micro to small scale wind turbines (estimate up to 20 No. single 10 kW domestic machines) and the establishment of a number of clusters of three small to medium sized turbines[29] (up to 5 No. clusters of three 50 kW machines). This could result in growth by 2020 of c. 1,000 kW;
- Hydro-electric energy: assuming development of a small number of high head schemes (estimate 5 No. schemes of up to 40 kW) and additional low head schemes in locations of former mill/hydro sites (estimate 3 No. schemes of up to 200 kW). This could result in growth by 2020 of c. 600 kW; and
- Micro-renewables on new and existing buildings: based on growth in installation of solar PV panels (estimate 200 buildings) it may be estimated that capacity could grow by the order of 500 to 750 kW.

Realising the above growth would equate to an increase in the order of 2.5 to 3.0 MW of installed renewable electricity capacity, representing a significantly larger increase than the national projected growth rate. Table 9.1 illustrates how this growth might be realised.

Table 9.1: Potential Growth in Installed Capacity for Renewable Electricity to 2020 in the CNP

	Wind	Hydro	Solar PV	Total Estimate
Existing capacity	<10 kW (est)	70 kW	<200 kW (est)	<300 kW
Approved installations[1]	170 kW	211 kW	N/A (permitted development)	380 kW
Current Pre application[2] and anticipated growth	1,000 kW (est)	500 kW (est)	750 kW (est)	2,250 kW
Total existing plus reasonably anticipated	1,200 kW	800 kW	<1,000 kW	2.5 – 3.0 MW

1. Data on approved developments provided by CNPA in October 2011
2. Data for wind and hydro are estimated based on information provided by CNPA regarding pre-application discussions for potential wind and hydro schemes. Data for PV is an estimate of likely growth

The table draws from information on estimated installed capacity in 2011 (presented in Chapters 3 to 8) and adds the capacity of installations which have received planning consent together with a projection of growth in renewable electricity across wind, hydro and solar PV to 2020.

[29] Assumed no larger than 30 m to tip, which equates to installed capacity for current machines of around 20kW.

Heat

Current renewable heat capacity in the Park is estimated at approximately 2.7 MW_{th} (see Section 3.3). This is a recent estimate in 2011 and is considered to have taken account of smaller scale installations since it has been derived from wood demand data.

It is complex to extrapolate the necessary installed capacity from this baseline to the predicted annual heat demand of 38,000 MWh which would be needed to meet the 11% target in the CNP. This is because different scales of boiler and the heat demands of their sites are not uniform. However, on the basis of an average factor taken from information in the EST's recent report to Scottish Government (Energy Saving Trust, 2010b), in the order of 14 MW_{th} installed capacity may be required. This represents a four to five fold increase on the current estimate of renewable heat capacity in the Park, which is ahead of the Government's figures on national progress towards the 11% target. It is therefore considered appropriate and achievable for the CNPA to aim to match this national renewable heat target.

Since a single growth factor does not provide a meaningful interpretation of how renewable heat may need to grow, considering alternative scenarios under which the 38,000 MWh of heat could be provided in the Park may be more useful. Drawing on information from the Woodfuel Action Plan for heat clusters, Table 9.2 presents two different and entirely illustrative scenarios (in terms of numbers and sizes of clusters) under which the 11% heat target could be met.

Table 9.2: Renewable Heat Scenarios to 2020

	Scenario 1		**Scenario 2**	
Settlement	**Clusters/Buildings**	**Energy (MWh)**	**Clusters/Buildings**	**Energy (MWh)**
Individual buildings	200	8,200	200	8,200
Small clusters (<20 buildings)	20 clusters/160 buildings	6,200	10 clusters/63 buildings	2,370
Medium clusters (20-100 buildings)	3 clusters/214 buildings	9,340	6 clusters/316 buildings	13,300
Large clusters	1 cluster/392 buildings	14,700	1 cluster/392 buildings	14,700
Total Energy		38,440		38,570

Note: For simplicity the data have been taken from figures used in the Woodfuel Action Plan for Sector 1 and the average heat demand figure used in that report for an individual building of 41 MWh per annum

The first scenario assumes a moderate take up of woodfuel heating in 200 individual properties, and a focus on small scale district heating schemes in around 20 different small to medium sized settlements (clusters) with one much larger settlement heating scheme. The second scenario is based on the same assumption about individual properties with the 'planned' element concentrating on a small number of micro grids in small settlements and a larger number of district heating schemes implemented in medium to large scale settlements. Both scenarios are entirely illustrative to show different mixes of woodfuel/heating scales which could be developed to achieve the 2020 renewable heat target in the CNP.

The scenarios are intended to provide a contrast in the way in which the target can be met. They assume that there will be a clear element of co-ordination across the Park to achieve the planning and investment necessary for micro-grids/district heating schemes for clusters of buildings. By way of comparison, if no co-ordination was undertaken and it is assumed that only individual properties respond to the RHI, it would be necessary for approximately 950 buildings (10% of the entire building stock) to have installed wood-fired boilers by 2020. Whilst this is not unfeasible theoretically, it would represent an extraordinary degree of take-up and would leave the more difficult work of planning and installing district heating still to be undertaken, possibly in a future financial environment in which less generous long term support will be available for investment.

The extent to which meeting the 11% renewable heat target in the Cairngorms is considered to be feasible is discussed in the next section, with reference to the scenarios presented above and other action which may be necessary.

9.3.3 Feasibility of Meeting the Scenarios

Electricity

The energy potential analysis presented in Chapters 3 to 8 of this report clearly indicates that whilst there is scope for growth in renewable electricity generation in the CNP, the level at which this is likely to be appropriate in environmental and planning terms is at the micro to small scale, with the possible exception of some limited expansion of small to medium scale wind and hydro in appropriate areas.

For these reasons, and those discussed in Section 9.3.2 above, it is not considered appropriate to set targets for renewable electricity in the CNP. Nevertheless, the CNPA is in favour of appropriately scaled renewables which are not environmentally damaging, and this policy is consistent with the national level Scottish Planning Policy on renewables. Therefore, it is appropriate to address ways in which growth in suitable renewables technologies may be realised in the Park over the next 10 years.

The scenario growth estimates presented in Section 9.3.2 above are very approximate. However they represent what might be possible and acceptable to develop in the Park provided that planning guidance allows for the increased wind energy development assumed, and on the basis that the FIT scheme will generally encourage the installation of all the renewables technologies profiled. Ultimately, the growth in wind and hydro power in particular is likely to be driven by site specific environmental and landscape sensitivities, therefore any projections for growth need to recognise that the material planning considerations of individual applications will always determine the development outcome, and hence the speed of achieving any growth target (if at all).

In Chapter 10 of this report we consider the extent and means by which the uptake of appropriate renewable electricity generation may be supported and co-ordinated.

Heat

A large number of renewable heat scenarios could be postulated which take account of varying cluster and settlement sizes and the suitability of the supply chain to meet the demand for woodfuel. In reality, it is likely that the demand for wood-fired heating systems will be patchy across the Park. Incentives such as the RHI will no doubt stimulate individuals to invest in domestic scale boilers, and this will provide some of the capacity needed to move towards the 11% target. However, given the step change in installed heat capacity needed to meet this target, it will almost certainly be necessary for larger clusters to develop renewable heat in the form of small to medium scale district heating schemes.

This finding is borne out by the hypothetical scenarios presented in Table 9.2, which illustrate two possible mixes of wood-fired heating scales, which could achieve the 38,000 MWh of heat in the Park by 2020. It is possible that more proactive communities, businesses or estates will respond to the opportunity presented by RHI to unilaterally plan and invest in heating schemes for small clusters of buildings. This process may also be accelerated by the emergence and entry of Energy Services Companies (ESCOs) in the area. As new housing, municipal and commercial property is developed there is also an opportunity for the CNPA to encourage installation of woodfuel based district heating systems for all new buildings as this is the norm in many parts of Europe. However, given the slow rate of change of land use over time and the barriers to retro-fitting of district heating to existing settlements, it is considered unlikely that the scale of response will be sufficient to move the Park to the 2020 target without some form of planned intervention.

The nature of such intervention, and the parties involved, could take several different forms and these are discussed in Chapter 10 of this report.

9.4 Cumulative Impacts

9.4.1 Assessing Impacts

The potential for cumulative environmental impacts from the growth in numbers of each individual renewable energy installation type has been considered previously at the conclusion of each of the technology specific chapters of this report. However cumulative impacts may arise from the growth in a mix of installations acting on one or more receptors as renewables become more widespread in the CNP, and as the pressure for development of different types of technologies increases. Cumulative impacts may also occur as a result of the in-combination effects from the development renewable energy projects and other developments such as new transport or energy utility infrastructure or new built development.

Since this study does not present a specific plan or spatial strategy for renewable energy development, it is not appropriate to attempt a bespoke assessment of cumulative environmental effects in the Park. Instead this section briefly addresses the potential for cumulative and in-combination environmental impacts based on the potential for growth in renewable energy generation outlined in this report.

9.4.2 Potential for Environmental Impacts

From the information presented in Chapters 3 to 8 on existing renewable energy deployment in the Park, and from site visits undertaken for this study, there is no evidence that renewable energy is currently contributing to any cumulative environmental impacts. Nevertheless, there is increasing development pressure for renewable energy of all forms in the CNP, and the potential for cumulative effects will need to be considered by CNPA as an increasing number of planning applications are received and consented. There are a number of particularly sensitive receptor types which have the potential to be affected by cumulative impacts, including:

- Sensitive landscapes including wild land;
- Important locations for European, UK and locally protected species;
- Special Protection Areas and other areas with ornithological significance;
- Rivers and their catchments;
- Settlements of architectural or conservation importance;
- Tourists (in numbers) at recognised visitor attractions; and
- Residents and visitors undertaking informal recreation near their homes or in more remote parts of the Park.

Depending on the scale, location and mix of renewable energy deployment in the coming years, there is potential for cumulative impacts on sensitive resources. Remoter and undeveloped areas are often co-indicent with the potential for wind and hydro energy in particular. Whilst applications for wind energy in the most sensitive landscape areas and Natura sites (particularly SPAs) are unlikely to be acceptable in policy terms, pressure for development on adjoining land or catchments could give rise to the incidence of a high head hydro scheme and a wind turbine (or cluster) in proximity to each other. Clearly, the potential for cumulative effects from such a case would be controlled through the planning process, however the example illustrates the *possibility* of such effects even if they are unlikely, at least in terms of development envisaged within the planning horizons in this report (to 2020).

In other locations, and for human receptors in the Park, previous sections have identified that many forms of energy installation will be classed as permitted development. Whilst significant cumulative impacts from these development types individually are not predicted, there is some potential for effects from changes to the character of buildings and settlements where a mix of woodfuel, heat pumps and solar panels are installed. Given many of these installations do not require planning consent it is recommended that the potential for cumulative impacts is reduced through specification of standards for high quality development in planning guidance. It may also be necessary to consider whether to establish planning arrangements, whereby certain types of permitted development may require prior notification, particularly if concerns arise over time regarding the capacity of particular areas or settlements to accommodate further micro renewables.

In locations where other significant developments have been consented locally or nationally, the potential for cumulative effects with renewables applications will need to be considered. For example part of the Beauly to Denny high voltage transmission line, now under construction, crosses the south western area of the Park and will reinforce the landscape and visual impact of existing communications infrastructure along the A9 corridor. It may be therefore that development of above micro scale energy installations in this area could lead to significant cumulative effects on the landscape or ornithological receptors. Reinforcements to other parts of the electricity transmission grid in the CNP are known to be planned in the coming years. Where this type of proposed development is known to involve a change in the existing environmental baseline (from an increase in the size of overhead line towers or new substations for example), then such information will be particularly important to the monitoring and assessment of potential cumulative effects. Similarly, proposals for non-energy infrastructure development which will be needed to accommodate predicted population growth in the CNP should be taken into account in the evaluation of the capacity of particular areas for new development, as well as in the assessment of impacts from new developments, whether singly or cumulatively.

The maintenance (and publishing) of a geographic record of development approvals and completed schemes may support monitoring of cumulative issues from development in relation to areas of known environmental constraint. This could be used to support a spatial strategy, as it would relate actual and consented development to locations of known sensitivity. It may be useful to planners and developers in providing unambiguous information about development pressure and environmental and resource capacity.

Finally, it should be recognised that renewable energy has the potential for positive cumulative environmental (and economic) impacts. Given the importance of climate change, the contribution which the collective mix of renewable energy in the CNP can make to reducing carbon emissions is important to the CNPA's policy objectives. The issue of potential emissions reductions from renewable energy is addressed in Section 9.4.3. Renewable heat, and in particular development of the woodfuel sector in the Park, has the potential not only to stimulate this important sector of the economy, but to provide opportunities for woodland management and creation which will benefit the natural environment. There is also a wider economic opportunity for individuals, estates, farms, businesses and the public sector to generate income from the FIT and RHI by investing in sustainable forms of renewable energy.

9.4.3 Carbon Emissions

On the assumption that all woodfuel facilities in the Park to 2020 will be supplied by locally sourced woodchip, the generation of 38,000 MWh of heat from woodfuel in 2020 would result in annual carbon emissions in that year of approximately 610 tonnes of carbon dioxide[30]. This compares with emissions of 9,900 tonnes CO_2 if the equivalent amount of heat was generated from burning oil. If the Park could generate all the heat required for its buildings from renewable (wood based) sources, then it could reduce its annual emission by the order of 90,000 tonnes CO_2 per annum compared with heat derived from fossil fuels. In reality, the savings will be less than this since some heat is already provided from renewable sources, a proportion of heat will be generated from fuels such as wood pellets which have higher emissions factors than wood chip and lifetime emissions of the fuel (i.e. including transport) have not been included.

[30] Defra 2010 emission factor for wood chip of 0.016 kg CO_2/kWh, for burning oil of 0.26 kg CO_2/kWh.

For electricity, it is estimated that the current Park domestic electricity demand is equivalent to annual emissions of over 20,000 tonnes[31] CO_2. If renewable energy is assumed to have zero carbon emissions, then a 2 MW increase in the installed capacity of renewables in the Park (as postulated in Section 9.3) could have the effect of reducing annual CO_2 emissions by approximately 3,500 tonnes per year by 2020 compared with the existing situation.

In combination, pursuing a sustainable path towards renewable energy as set out in this chapter could also return carbon emissions savings in the CNP area of up to around 10,000 tonnes CO_2 per annum by 2020.

[31] Defra 2010 emission factor for grid electricity of 0.545 kg CO_2/kWh.

10 Enabling Renewable Energy

10.1 Introduction

This chapter presents a summary of the principal findings from the renewable energy options study. Based on these findings, and from the preceding discussions on energy growth scenarios, recommendations are presented on how sustainable renewable energy growth can be enabled in the Cairngorms National Park. The chapter concludes with an overview for an energy vision for the Park by 2020.

10.2 Key Findings

10.2.1 Energy Resource Potential

This study has identified that each form of renewables technology considered, with the exception of anaerobic digestion, has potential for growth from the perspective of the energy resources available in the Park. The following broad conclusions can be drawn:

- The wind resource in the CNP is plentiful and large areas of the Park have a particularly favourable average wind speed. Existing deployment of micro scale wind turbines in lower lying areas indicates that useful energy can also be generated where average wind speeds are lower. However, wind energy development in the Cairngorms is controversial due to its potential impacts on landscape and natural heritage, and the special qualities of the Park must be balanced with the opportunity for low carbon energy.
- Hydro-electric generation potential is clear in all of the Park's river catchments, although potential is critically dependent upon the flow and head characteristic of each location. Low flow/high head schemes in upper reaches of the glens offer opportunities for isolated and off-grid properties to develop on-site electricity. Lower down the catchments the regeneration of former hydro power sites with higher flows and lower heads also have potential. As with wind power, environmental sensitivity is important given the protected nature of upland areas and the designations associated with nearly all the water catchments.
- Renewable heat generation from woodfuel schemes such as wood-fired boilers offers a clear opportunity for the Park's energy ambitions. The ready supply of local woodfuel and the relative ease of boiler installation, coupled with the RHI scheme is making wood energy an increasingly attractive investment proposition, as well as an environmentally benign means of heat

generation. The findings of this study support work already undertaken by CNPA in showing the clear potential of woodfuel as a renewable heat source for all types of building in the Park.

- Solar energy (PV and thermal) and heat pumps offer viable means of renewable heat and electricity generation on buildings throughout the Park, and the environmental impact is generally limited or very localised. Heat pumps should principally be considered for new, well insulated buildings and therefore will only offer only a modest contribution to renewable energy generation at a Park wide scale. Solar panels provide a contribution to buildings' heat or electricity requirements, and are therefore within reach of those with access to funds to purchase the technology, and are relatively straightforward to deploy given the majority of installations will be permitted development.
- Anaerobic digestion is not currently considered to be a viable technology for mainstream development in the CNP. This reflects limitations in available feedstock for AD plants (either on farms or from food waste collections), regulatory complexities of plants which handle food waste, national policy uncertainty in relation to growing feedstocks for digesters and the marginal economics of the technology.

The next section summarises the analysis of the extent to which energy resources can be deployed taking account of the relevant physical and environmental constraints in the CNP.

10.2.2 Impacts of Energy Deployment

The outstanding and internationally recognised environmental and natural heritage qualities of the CNP present a very significant constraint to certain types and scales of renewable energy development due to the potential for environmental effects, individually and cumulatively. The potential for significant environmental effects of each type of energy installation has been considered in this report, taking account of the nature of the developments and the varying sensitivity of the landscapes and protected areas of the Park. This has refined the assessment to take account of the types and scales of installations which are likely to be acceptable in environmental and amenity terms.

For the purposes of balance, it is also necessary to recognise the potential for positive environmental impacts from renewable energy. The scope for long term carbon emissions reduction is significant from the deployment of renewable heat, though arguably more modest for electricity given the scale of deployment discussed in Section 9.3 of this report. Increased woodfuel supply from local sources also has the potential to support improved woodland management in a manner which benefits landscapes and biodiversity, as well as helping to generate long term security of local woodfuel supply.

The report has also identified that there are clear economic benefits for people and communities in the Park from the development of the forest management and woodfuel supply sector. These will accrue in response to the projected increase in economic activity associated with woodfuel growing, processing, distribution and with boiler installation and related businesses, both 'green collar' and professional. The scale of this opportunity will depend on the speed at which woodfuel is taken up, and on the degree to which strategic enabling roles for renewable heat are pursued in the Park (see Section 10.3 below).

Communities can also directly benefit from all forms of renewable energy, particularly where they are closely involved in taking the development forward, for example by shared benefits of reduced energy costs. A range of partnering, co-operative and commercial models exist for investment in renewables, and for distribution of risks and returns. The advent of the FIT and RHI now presents real opportunities for communities, landowners and other developers to invest in low carbon energy generation at the smaller scale, and in some cases return a long term income which can support community development projects. These incentives, coupled with other loan schemes to reduce the costs and risk of the planning process, will increase the pressure for renewable energy development in the Park from applicants ranging from individual householders to ESCos.

The analysis has also taken account of physical constraints in the Park. Most of the area is not served by the gas supply network, which increases the importance and financial attractiveness of woodfuel as the primary long-term heat source. The electricity grid is more extensive and generally has capacity to accept small scale new generation developments, albeit upgrades will be required to the transmission network's capacity in the medium to longer term. Achieving grid connections in areas off, but close to, the distribution network will be a key economic factor in the feasibility of small to medium scale renewable energy installations such as wind and hydro schemes. There are also locations which are not served by the electricity grid, and here micro renewables present an important opportunity for properties to have independent energy supplies. Transport by road has not been identified as a particular constraint for either construction of new facilities or for supply of woodfuel, but there are many locations in the Park where access involves negotiation of narrow or steep and twisting minor roads, or where access may be via hill tracks. Finally, the thin and sensitive soils of many upland areas means that otherwise feasible development such as small scale hydro schemes become visually more prominent where infrastructure cannot be placed underground.

On the basis of the analysis of physical and environmental constraints, and taking account of the potential benefits and financial issues, it is recommended that sustainable renewable energy is either accepted or encouraged in the National Park in the following forms:

- Wind: in areas outwith the principal environmental constraints[32], micro scale turbines are feasible in most locations. Small to medium sized turbines (up to 30 m to blade tip) may have some potential for environmental impacts however with sensitive siting and design they are considered to have potential in a range of less sensitive locations.
- Hydro: high head sites outwith the highest wildness bands will be more environmentally acceptable and potential reaches have been identified on steeper tributaries to all of the main rivers above the normal range of migratory fish. Sites will generally only be viable where an economic connection to the electricity grid can be obtained except for very small schemes which could serve remoter off grid locations. Potential sites for low head schemes will exist where previous water power infrastructure remains around towns and villages, farms and old mill sites in the more developed straths.
- Woodfuel: there are few constraints to development of woodfuel supply and wide scale wood-fired boiler installation in the Park. It is recommended that the woodfuel and renewable heat sector is developed so that in the longer term it provides the primary form of heat in the CNP through co-ordination of new and retro-fitted district heating schemes with an effective and well managed local supply chain.
- Solar panels and heat pumps: as domestic and small building installations these have the potential to add to the renewable energy profile of the Park. Given the permitted development nature of most applications, their growth will generally go unchecked (except in some designated areas), however their effectiveness is most pronounced in new buildings and sensitively designed systems should be encouraged to reduce overall reliance on fossil fuels and to provide alternative sources of energy in off-grid locations.

This study has appraised the potential for the above forms of renewable energy and considered possible energy growth scenarios to 2020 in light of national Scottish targets for renewable heat and electricity. Whilst a significant growth in renewable electricity generation capacity can be sustained in the next 10 years, the constraints on larger scale developments identified in this report suggest that it will not be appropriate to try to match the national target of 80% (or 100%) of electricity provided by renewable sources within the Park. However the analysis does suggest that the national heat target (of 11% from renewable sources by 2020) is feasible in the Cairngorms

[32] These are primarily the SPAs and Wildness Band A areas although local circumstances in other areas may render sites equally sensitive in landscape and ecological terms.

and that in the longer term, with appropriate co-ordination, most of the Park's domestic and municipal building heat could be provided from the local woodfuel resource.

The cumulative environmental impacts of deploying renewable energy to the levels identified have also been examined at a broad scale. This appraisal has identified that whilst cumulative issues are not presently a concern, there is potential in the longer term for the following types of impacts:

- Impacts on sensitive receptors such as important landscapes or ecological sites from interaction within a defined area of one or more wind and/or hydro developments (including with other forms of new development such as electricity transmission infrastructure); and
- Gradual changes in the character of traditional buildings and settlements where a mix of woodfuel systems, heat pumps and solar panels are installed, largely as a result of cumulative permitted developments.

Clearly, the potential for cumulative effects from wind and hydro will be controlled through the planning process. It is suggested that active monitoring for potential cumulative effects is undertaken through analysis of consented energy development projects. The use of landscape frameworks and other planning tools, such as a spatial strategy for renewables, could also have an important role in avoiding cumulative impacts, whilst encouraging appropriate scales and forms of development and the benefits which they can bestow. It may also be appropriate to use planning guidance, or amend development management arrangements, to reduce the possibility of cumulative effects from 'creeping' permitted development from micro scale renewables on buildings and settlements of conservation importance.

Finally, the analysis has indicated that by pursuing a sustainable path towards renewable energy, carbon emissions savings in the CNP area of up to around 10,000 tonnes CO_2 per annum could be realised by 2020.

10.3 Recommendations for Enabling Renewable Energy

10.3.1 Enabling Options

The discussion in Section 3.6 identified that, particularly for renewable heat, there is a need to provide a measure of co-ordination and sector development if the opportunities and benefits associated with renewable energy are to be realised in the Park. This role is also important if the indicative growth scenarios set out in the previous chapter are considered to be appropriate objectives for the CNP.

The development management role of the CNPA, and its ability to guide and influence development through planning policy and advice is clearly important in realising sustainable energy generation in the Park. Planning can guide the form, scale and location of renewable energy just as with other forms of development. However, the CNPA also has a clear role in enabling renewable energy and this is where the greatest opportunity lies if the Park is to realise the full potential of renewable energy and to ensure that planning, development and investment is channelled into sustainable deployment which provides the best return on investment, whether public or privately funded.

There are a number of options or models for fulfilling a co-ordinating and enabling role beyond the provision of guidance and planning advice which the CNPA already undertakes. These vary in the degree of involvement that the various agencies may wish to play in the Park's renewable energy future, and in the extent to which they require funding and new institutional or establishment arrangements. A number of illustrative enabling options are presented in Table 10.1. The options are in no way exhaustive and are presented without detailed knowledge of the CNPA's current thinking in respect of renewable energy promotion.

Table 10.1: Options for Enabling Renewable Energy

Enabling Actions and Entities	Purpose and Activities
Establish a small scale or community renewables fund	• Encourage communities to take action and reduce the costs and risks of project planning stages • Ensure benefits from projects reach communities
Renewable energy advisors(s) and/or energy specialist(s) appointed to promote sustainable renewable energy among all sectors	• Advisory resource and technical support to stimulate projects and support communities with applications • Develop/promote a renewable energy strategy and plan • Provide a co-ordinating role with local authorities, business and stakeholders in particular for the woodfuel sector • Access or lead bids for projects eligible for EC and national funding
Establish a Cairngorms Renewable Energy Forum (or a more formally constituted partnership)	• Planning and development management co-ordination with the local authorities • Promoting and supporting smaller scale projects to increase local capacity, promote best practice and guidance (e.g. promoting Highland Council's community toolkit, establishing woodfuel co-operatives etc) • Partnership might have charitable status if fund raising was an important element of sustaining the initiative • Build on existing capacity such as Cairngorms Woodfuel Steering Group
Establish a renewable energy enabling agency	• Similar but more proactive role than for Forum which could include market stimulation & specific enabling 'powers' • Possibly with core public sector funding • Tasked in particular to develop district heating schemes and work with key industrial heat users/suppliers

Enabling Actions and Entities	Purpose and Activities
Establish a separate development company tasked with promoting and developing renewable energy projects	• Company could focus on public and municipal buildings and renewable heat schemes or be entirely free to invest and develop across energy opportunities • Separate board from CNPA but 'aligned' to ensure core sustainability principles and SPG are followed • A range of business models exist which could include, at the most ambitious, establishing an ESCo

Some of the options presented in the table may require the establishment of different commercial or public entities in order to pursue or deliver some activities, for example establishment of partnerships or joint ventures or development companies. It will be important to consider the range of options in relation to its anticipated resources, statutory functions and the degree to which the Authority wishes to engage directly with the various stakeholders. These groups will include communities, businesses, farms and estates, public sector/municipal, housing developers, infrastructure operators and energy suppliers.

A detailed assessment of the costs, legal and planning implications of such ventures is beyond the scope of this study. It may be appropriate to consider these options in discussion with networks and contacts from key stakeholders/potential partners, other agencies and other National Parks to identify what model(s) might be most appropriate for the Cairngorms.

The following sections discuss more specific issues arising from this study which could be addressed by an enabling entity for renewable electricity and heat. Whilst the issues have been presented separately, it is nevertheless recommended that any future enabling body or activity is integrated across all forms of energy to ensure that a fully co-ordinated approach is adopted. It may be, for example, that hybrid heat and energy schemes are appropriate in some circumstances and in any potential development it is always advisable to take a balanced appraisal of all energy options.

10.3.2 Enabling Renewable Electricity

This study has identified the potential for growth in renewable electricity generation in the CNP, albeit on a relatively modest scale and subject to very high standards of design and consideration for environmental sensitivities. It is not therefore appropriate to actively support the enabling of medium to large scale wind and hydro electric schemes. Instead it is suggested that the focus for co-ordination should be on securing maximum benefits to communities and businesses from the development of appropriately scaled installations which can support local objectives and enterprise without detriment to the environment. The Highland Council has already undertaken significant work on community renewables which can be promoted and deployed to good effect in the Cairngorms. The options for enabling renewable electricity generation are therefore likely to involve the following type of activity:

- Promotion and awareness raising among target stakeholders of the opportunities renewables can bring;
- Consulting with communities to more clearly identify barriers to wider scale adoption of renewable energy systems at the local community/partnership levels;
- Provision of information drawing on experience of previous developers (case studies, best practice) and on sources of finance available for the planning stages and for capital investment;
- Developing capacity of communities to take forward their own plans for renewables through talks, demonstrations, websites, advisory activity and targeted training;
- Providing targeted technical assistance for feasibility and assessment of schemes which meet defined criteria/objectives for returns to the community (as a 'benefit in kind' alternative to direct financial support from loan schemes for example);
- Further consideration of opportunities for renewables to provide reliable and low carbon energy supplies for sources of demand which are off electric grid in the Park; and
- Developing (and updating) strategy and action plans where appropriate to guide applicants on broad areas and technologies which are likely to be acceptable.

An additional possibility is the establishment of a small scale renewables grant or loan fund if the agencies in the Park wish to encourage a particular type or scale of installation. Other authorities have done this, for example the Yorkshire Dales National Park which has established a fund for small scale hydro schemes. It is suggested that such an option is discussed with organisations such as Scottish Government and CARES to obtain advice on the relevance and need for financial stimulus and the issues associated with its establishment and administration.

In relation to micro renewables for existing buildings, it is not proposed that a formal enabling role here is required. The issues associated with anticipated growth in the retro-fitting of solar panels and heat pumps to properties has been discussed in Chapters 7 and 8. It may be appropriate to raise awareness of the issues associated with such domestic scale renewables, perhaps through active promotion of future renewable energy SPG so that installations are encouraged where appropriate but also so that design, amenity and environmental considerations are fully taken into account.

10.3.3 Enabling Renewable Heat

There is a potentially substantial role to play in the development of renewable heat in the Park. This section briefly considers the key issues in the areas of supply (woodfuel) and demand (installations).

Woodfuel Supply

A number of potential enabling actions for woodfuel supply have been identified previously in Section 3.6 of this report. There are currently constraints to the development of a sustainable woodfuel resource and associated supply chain, many of which have already been reported in the Woodfuel Action Plan. Critically there is a lack of competition and choice in woodfuel supply which is acting as a constraint to local businesses and existing and potential woodfuel system operators. In summary, the key areas where enabling activity would be of benefit in addressing these constraints are in delivering:

- Guidance and training on sustainable woodland management, particularly in sensitive areas;
- Increased technical skills and capacity in the local woodfuel supply chain;
- Business development and marketing advice for existing and potential new entrants to the forest management and woodfuel processing/supply chain;
- Establishment or encouraging establishment of woodfuel co-operatives or similar collaborative forums; and
- Better promotion of the benefits and opportunities of woodfuel as a heat source to new end users (awareness raising).

There is clear role for co-ordination of the above activities, which could be fulfilled at a range of scales of ‘intervention’ and building on existing initiatives such as the low carbon Cairngorms web portal. Direct provision of the support identified may not necessarily be delivered by the agencies operating in the Park, however there does appear to be a requirement for an overseeing role in helping to effect the required support.

Energy Generation

A key aspect to growth of renewable heat installation, particularly at the more meaningful scale of district heating, appears to relate to addressing barriers to selecting and installing woodfuel systems. These often include one or more of the following:

- Awareness of renewable heat options and ease of installation;

- Access to professional and technical support and advice;
- Perceived planning complexity;
- Gaining community/neighbour support for larger schemes;
- Securing finance;
- Access to technical knowledge and advice for procurement;
- Identifying and selecting woodfuel supplies;
- Finding and engaging reputable installers; and
- Management of installation and operation.

As this report has already noted, for meaningful gains in renewable heat capacity to be realised in the CNP in the next few years, it will be necessary to target effort at larger scale schemes such as district heating. Implementing woodfuel district heating as part of new developments is an important first step to ensure that new development does not perpetuate reliance on fossil fuels. This can be achieved through appropriate planning standards or requirements. However the principal challenge for renewable heat in the domestic and municipal sectors in particular, will be the progressive retro-installation of community heating schemes. This is where the clearest need lies for co-ordination since it will require substantial organisational influence and capacity to bring about the necessary changes in attitude, planning support/funding, community consultation, capital investment, technical expertise and project management.

Whilst some new installations may come about from activity by private sector ESCos, it is recommended that the wide scale and co-ordinated action required needs to be steered by agencies working in partnership with other key public and private stakeholders. An initial area of focus could be for the enabling entity to develop and manage a programme for the retro-fitting of renewable heat to existing municipal/public buildings in the CNP, and wherever possible extending these to feasible nearby heat clusters. If the Park wishes to achieve the same penetration of renewable heat as the national targets for 2020 require, then (as Section 9.3.2 illustrates) co-ordinated action to bring about district heating across a number of moderate sized heat clusters will also be needed.

10.4 Energy Vision

This report has identified that there is significant potential for continued growth in renewable energy in the Cairngorms National Park. Renewable electricity generation is feasible for most technologies at all scales. Taking account of the special qualities of the Park means that there are constraints on deployment although it is proposed that small to medium scale wind and hydro schemes can be developed in less sensitive locations with careful planning and design. Renewable heat represents a major economic, environmental and energy resilience opportunity for the Park. An appropriately supported woodfuel supply sector can also bring significant socio-economic benefits to the area together with opportunities for sustainable woodland management which can contribute to biodiversity and landscape improvements in some areas.

By 2020 the report has identified that the Park can be generating a small but important contribution towards its electricity requirements from renewable sources, and it can at least match the national target to supply 11% of heat from low carbon sources. This scenario would result in significant annual reductions of greenhouse gas emissions across the Park compared with continued dependence on fossil fuels for domestic, municipal and business heat and power. The advent of Government incentives in the form of the FIT and the RHI schemes will help to stimulate the installation of renewable energy schemes and provide an opportunity for developers and community organisations to benefit from a longer term source of revenue.

Financial incentives and increased awareness alone are not predicted to effect the required structural changes in renewable energy supply. Achieving this future, and going beyond it as Scotland aims for total low carbon energy independence, will require co-ordination, guidance and enabling activity from agencies and businesses in the Park. Supplementary planning guidance on renewable energy will provide an important and consistent reference to ensure that energy is developed in the Park in a sustainable manner which contributes to local communities and protects the natural heritage and landscape. It will also help to avoid cumulative environmental impacts as the pressure for installation grows, particularly if the SPG is supported by new planning policies and potentially a spatial or development strategy for renewable energy. However, the CNPA's enabling role is critical to bringing about the step change in renewable energy (particularly heat) which a low carbon future demands, and in helping the Park realise the associated benefits which a co-ordinated low carbon energy sector can offer.

Renewable energy presents an exceptional opportunity for sustainable development in the Park. With sensitive developments in appropriate locations, supported by a well managed local woodfuel resource, the Authority has a key role in managing development whilst encouraging appropriate energy projects. With clear planning guidance, strategy and a formally defined co-ordinating role it will be possible for the Park to oversee sustainable energy development, to access support where required and to plan for this. The ambition for growth in renewable energy can therefore be aligned with the Authority's statutory duties to conserve and enhance the environment, while using resources more efficiently and promoting sustainable social and economic development.

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12 Glossary

Air source heat pumps	Air source heat pumps absorb heat from the outside air. This heat can then be used to heat radiators, underfloor heating systems, or warm air convectors and hot water in your home.
Anaerobic digestion	Anaerobic digestion is the process where plant and animal material is converted into useful products by micro-organisms in the absence of air.
Biogas	Biogas is a mixture of gases produced by AD. Its major constituents are methane (CH_4) at about 60% and carbon dioxide (CO_2) at around 40% with other gases in trace amounts (mostly hydrogen sulphide and ammonia). The composition of the biogas depends on the type of feedstock and the type of AD. Biogas can be 'upgraded' to pure methane, often called biomethane, by removing the other gases.
Combined heat and power	This technology generates heat and electricity simultaneously, from the same energy source, in individual homes or buildings.
Controlled Activity Regulations	A framework for the development of risk-based and proportionate measures to control impacts on the water environment and safeguard sustainable water use for now and future generations.
Environmental constraints	Environmental constraints data is made up of the locations and classifications of areas deemed to be of natural importance. These areas have restrictions that may limit the extent and type of development that can take place and knowing the type and location of these designated areas is important during the planning process.
Feed-in Tariff	The Feed-in Tariffs FITs scheme was introduced on 1 April 2010, under powers in the Energy Act 2008. Through the use of FITs, DECC hopes to encourage deployment of additional small-scale (less than 5MW) low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market.
Ground source heat pump	Ground source heat pumps use pipes which are buried in the garden to extract heat from the ground. This heat can then be used to heat radiators, underfloor or warm air heating systems and hot water in your home.
Heat pumps	A heat pump is a device that uses a small amount of energy to move heat from one location to another.
Hydro-electric/hydropower	Use running water to generate electricity, whether it's a small stream or a larger river.
Impoundment scheme	An impoundment is any dam, weir or other structure that can raise the water level of a water body above its natural level.

Pellets	Wood pellets are often manufactured from timber waste products produced through industrial processes. Material in the form of saw dust, wood shavings, timber offcuts etc may be ingredients of the finished pellet. Woodchips may be used as a woodfuel.
Permitted Development	A type of development that can be carried out without planning permission.
Photovoltaic	Capable of producing a voltage, usually through photoemission, when exposed to radiant energy, especially light.
Renewable Heat Incentive	On 10 March 2011, the Government announced the details of the Renewable Heat Incentive policy to revolutionise the way heat is generated and used. This is the first financial support scheme for renewable heat of its kind in the world.
Return of investment	Return of investment analysis compares the magnitude and timing of investment gains directly with the magnitude and timing of investment costs.
Run-of-river scheme	Run of river hydro projects use the natural downward flow of rivers and micro turbine generators to capture the kinetic energy carried by water.
Solar energy	The conversion of sunlight into electricity.
Solar thermal	The conversion of sunlight into thermal energy (heat).
Supplementary Planning Guidance	The SPG sets out detailed advice to help meet the requirements of the policies in the Cairngorms National Park Local Plan.
Wildness	The experience felt when in a wild landscape.
Woodchip	A medium-sized solid material made by cutting, or chipping, larger pieces of wood. Woodchips may be used as a woodfuel.
Woodfuel	Wood used as a fuel.
Yield	The amount of energy in kWh produced by a wind turbine.
Zone of theoretical visibility	The process of determining the visibility of an object in the surrounding landscape.

Appendix A: Cairngorms National Park Maps

List of Figures

Appendix B: Financial Support for Renewable Energy

Introduction

This appendix presents further information on the principal sources of financial support for the types of renewable energy project which have potential application in the Cairngorms National Park. The following is covered:

- Grant Aid
- Loans
- Renewables Obligations Certificates (ROCs)
- Feed-in Tariff (FIT) and Renewable Heat Incentive (RHI)

The information presented in this appendix was current as of November 2011.

Grant Aid

To date, renewable energy has been reasonably well supported through a series of UK-wide support programmes for renewable energy, with many of the funds available typically coming from community or rural development sources. The exception to this was the Low Carbon Buildings Programme, administered by DECC, which was targeted at achieving carbon dioxide emission reductions. This grant programme was highly competitive and continuously oversubscribed prior to its closure in May 2010 in the wake of Government cutbacks.

Other grant funding which has recently been available for renewable includes the CARES scheme, administered by Community Energy Scotland. This scheme was to have operated for 3 years from May 2009, but allocated all its available funds in 2010 and has not subsequently been topped-up by the Scottish Government. Similarly, the Scottish Biomass Heat Scheme, which had been active in one form or another since 2006, ended in March 2010, having supported several dozen boiler installations across Scotland, and a handful in the CNP. Again, the scaling back of Government funding has impacted on the availability of grant aid and the Scottish Biomass Heat Scheme has been permanently wound up.

For most rural businesses and community groups the sole remaining source of Government grant aid for projects is via the Cairngorms Local Action Group, the local LEADER body, the secretariat for which is provided by the CNPA. LEADER funding is currently fully committed and there is no indication of the availability of funding beyond 2011. However, the CNPA have made £60,000 of their own funds available via the Local Action Group, although this funding is limited to £5,000 per project, subject to a maximum contribution level of 50%.

For farming enterprises, there is the possibility of accessing Scottish Rural Development Programme funding for renewable energy equipment via two routes. The first, Axis 1 - “Renewable Energy Agriculture”, is intended to support the on-farm generation of renewable energy which is predominantly for a farm’s own consumption. This can support a range of renewable energy equipment up to a level of 60% subject to certain eligibility criteria being met, and on the condition that 51% or more of the energy produced would need to be used to carry out or directly support agricultural activities (Scottish Government, 2011a). The second route is via the Development of Rural Businesses strand, which is designed to help agricultural enterprises diversify away from core activities and to supplement the farm income. The measure can support renewable energy projects up to a maximum proportion of 50%.

As with all grants to businesses, the SRDP funding is capped as a result of state-aid regulations, this is currently €200,000 in a 3 fiscal year rolling period.

It is important to note that projects receiving grants from the public sector, including those from EU sources, will in most circumstances be ineligible to receive any tariff payments associated with the production of renewable electricity or heat. There are certain exemptions, although these are very limited, details of which are available on the Ofgem website[33].

Outside public sector channels, there are a number of other routes that charitable and many formally constituted community groups can explore for grant funding. There are few that are specifically targeted at renewable energy projects, but investing in renewable energy technology can often form part of a larger project, e.g. the refurbishment of a community centre or village hall. Funds sourced from non-governmental sources have the added benefit of being free of state-aid and double-funding regulations, meaning that renewable energy projects funded in this way are also likely to be eligible for tariff payments.

Funds of this type are many and varied, ranging from the Esmee Fairbairn Foundation, which in 2010 gave out grants totalling over £20m as part of its ongoing programme, through to schemes run by commercial companies as part of corporate social responsibility programmes. Tesco, for example, who have a store in Aviemore, gave £61.6m to good causes in 2010 as part of their CSR programme, and are expanding their programme of Community Champions - store employees who identify local needs and support local organisations (Tesco PLC, 2010).

[33] www.ofgem.gov.uk/Sustainability/Environment/fits/Grants/Pages/Grants.aspx

Loans

There are three principle sources of loan funding available for investment in renewable energy projects. The first is a straightforward bank loan which is secured on an existing asset such as a farm, house or other property - the type of loan which businesses, organisations and individuals might typically access for a holiday, new car purchase or investment in a new piece of equipment. The interest rates for these loans depend on the amount borrowed, the credit rating of the applicant and the duration of the loan agreement.

The second is a loan specifically created by an established lender for renewable energy projects. A number of the mainstream agricultural banks, such as Clydesdale and NatWest have recently launched products aimed specifically at the landowning and farming community. Other lenders, including the Co-op Bank and the ethical bank Triodos, have developed products specifically for renewables projects, with security being taken on the project, rather than other assets such as property. This offers a considerable benefit, and is particularly appropriate for medium scale projects, as it limits financial risk to the renewable project instead of other business assets such as farmland. Typical interest rates are 6-7% for renewable energy projects. There are not yet specific loans available from ordinary high street lenders, although this will no doubt change as the tariff schemes and technologies are better understood.

The third source of loan funding is Government or quasi-Government organisations which have a remit to support renewable energy uptake. Key among these is the Energy Saving Trust, whose Small Business Loans are available at 0% over up to 8 years for amounts of between £1,000 and £100,000 to support investment in a range of renewable and energy efficiency measures. The interaction of the interest foregone on the 0% loan and how this affects eligibility for FIT and RHI payments is not yet certain, but it may render applicants ineligible.

There is no such consideration when accessing loans via the Carbon Trust, whose partnership with Siemens Financial Services enables them to jointly offer loans on competitive terms for businesses on amounts ranging from £1,000 upwards (there is no stated upper limit). The financing is designed to pay for itself out of the running cost savings and tariff incomes, and the package will offer a good option for many businesses in the Park.

Finally, there is the option of the UK Green Investment Bank, which it has recently been announced, will begin operating in April 2012. Although early targets for the bank are anticipated to be offshore wind, energy from waste and non-domestic energy efficiency, a range of other technologies are also likely to be eligible. UK Government indicated that £3bn would be available initially, but that they would need to negotiate with the EU to establish the bank because of concerns over state-aid regulations. Realistically, the Green Investment Bank will not be operating until 2013, and will only achieve full borrowing capabilities in 2015 at the earliest.

Renewables Obligations Certificates (ROCs)

The Renewables Obligation and the Renewables Obligation Scotland are the main support schemes for larger scale renewable electricity generation in the UK and Scotland respectively and came into operation in 2003. The Feed-in Tariff is now available for renewable energy projects of less than 5 MW and projects of less than 50 kW will automatically be supported by the FIT scheme. Many projects of 50 kW to 5 MW have opted for FIT support, whilst it is the larger projects that are supported under the Renewables Obligation (RO). However, for some renewables projects with a capacity of less than 5 MW the RO may be preferable.

Under the RO, UK suppliers of electricity are obliged to source an increasing proportion of their electricity from renewable sources. Suppliers must meet their obligations by presenting sufficient Renewables Obligation Certificates (ROCs) and where suppliers do not have sufficient ROCs to meet their obligations, they must pay an equivalent amount into a fund. The proceeds from this fund are paid back to those suppliers meeting their obligations on a pro-rata basis.

The Government has indicated that suppliers will be subject to a renewable obligation until 31 March 2037. On 21 October 2111, the Scottish Government published the Renewables Obligation Banding Review, applicable to Scotland and effective between 2013 and 2017. The main proposed changes are as follows:

Table B.1: Proposed ROCS Changes

<table>
<tr><th>Technology</th><th>Current Support (ROCs/MWh)</th><th>Proposed Support (ROCs/MWh)</th></tr>
<tr><td rowspan="4">Anaerobic Digestion</td><td rowspan="4">2</td><td>2 in 2013/14</td></tr>
<tr><td>2 in 2014/15</td></tr>
<tr><td>1.9 in 2015/16</td></tr>
<tr><td>1.8 in 2016/17</td></tr>
<tr><td>Biomass (CHP)</td><td>1</td><td>0.5 from 2013</td></tr>
<tr><td rowspan="4">Biomass (Dedicated) - proposal to close this band in 2015, and to introduce capacity threshold</td><td rowspan="4">2</td><td>2 in 2013/14</td></tr>
<tr><td>2 in 2014/15</td></tr>
<tr><td>1.9 in 2015/16</td></tr>
<tr><td>1.8 in 2016/17</td></tr>
<tr><td>Hydro</td><td>1</td><td>0.5 from 2013</td></tr>
</table>

Technology	Current Support (ROCs/MWh)	Proposed Support (ROCs/MWh)
Wind	1	0.9 from 2013

Feed-in Tariff and Renewable Heat Incentive

The UK Government has introduced financial support for smaller scale renewable energy in the form of the Feed-in Tariff (FIT) and Renewable Heat Incentive (RHI). Under these schemes it is possible for renewable installations to generate revenue from the following sources:

- *Offset Energy Purchase* – By generation of energy for consumption on-site, the purchase of energy from the local network can be avoided or reduced. In this case the full purchase price of electricity or heat can be saved on each unit generated.
- *Export Sales – By exp*orting energy to the local network (or linked buildings in the case of heat) at times when production exceeds on-site demand an income can be received. For larger installations this may be via a contract with an energy supply company. Under the FIT scheme, this will be paid as an export tariff with a choice between a guaranteed minimum price for energy exported to the grid of 3.1 p/kWh, or electricity exported could be sold on the open market.
- *Incentive Payments* – Under the FIT scheme generation tariffs are dependent on technology and are payable on all energy produced, even where the energy is used on site.

FIT went ‘live’ in April 2010, and the RHI is expected to start for non-domestic properties in late 2011, and for domestic properties in 2012, and will support the production of heat from renewable sources. Details of current published payment rates for each technology under these schemes are provided later in this section.

The FIT and RHI schemes are intended to replace public grant programmes as the principal means of incentivising small scale, low-carbon energy generation, and will trigger a revolution in the deployment of renewable energy equipment through the payment of long-term tariffs for those adopting the technology.

The FIT

In order to encourage the adoption of renewable energy systems the UK Government introduced a new policy incentive scheme from 1 April 2010. The existing scheme of Renewable Obligations Certificates (ROCs) is being extended until 2027 however schemes under 50 kW will automatically go onto the FIT scheme.

Under the proposed FIT scheme, payments will are in two parts:

- Generation tariff – Dependent on technology and paid for all energy generated whether used internally or exported; and
- Export tariff – Choice between a guaranteed minimum price for energy exported to the grid of 3.1 p/kWh or electricity exported could be sold on the open market.

Table B.2 details the FIT payment rate for the range of technologies outlined in this report (payments will be increased in line with inflation). On 03 November 2011 the Department of Energy and Climate Change released the first phase of the Feed-in Tariff review consultation aimed specifically on solar PV. The proposals would introduce a new tariff for schemes up to 4 kW in size of 21 p/kWh – down from the current 43.3p/kWh. Reduced rates are also proposed for schemes between 4 kW and 250 kW, to ensure that those schemes receive a consistent rate of return. The proposed tariffs are detailed in Table B.2. The consultation is due to close on 23 December 2011.

The new proposed tariffs would apply to all new solar PV installations with an eligibility date on or after 12 December 2011. Such installations would receive the current tariff before moving to the lower tariffs on 1 April 2012. Consumers who already receive FITs will see their existing payments unchanged, and those with an eligibility date on or before 12 December will receive the current rates for 25 years.

The Government also intends to introduce new energy efficiency requirement for PV installations: From 1 April 2012, in order to achieve the full tariff, domestic installations must be accompanied by an Energy Performance Certificate at level C or above and have completed all 'Green Deal' measures.

Further restrictions are proposed for those with a portfolio of PV installations at different locations. It is anticipated that this will restrict the market for 'free solar' rooftop offerings.

Table B.2: FIT Tariffs

Technology	Scale	Tariff Received until 31 March 2012 (p/kWh)	Duration (years)
Micro-CHP	<2 kW	10.5	10
Wind	≤1.5 kW	36.2	20
	>1.5 – 15 kW	28.0	20
	>15 – 100 kW	25.3	20
	>100 – 500 kW	19.7	20
	>500 kW – 1.5 MW	9.9	20

Technology	Scale	Tariff Received until 31 March 2012 (p/kWh)	Duration (years)
	>1.5 – 5 MW	4.7	20
Hydro	≤15 kW	20.9	20
	>15 – 100 kW	18.7	20
	>100 kW – 2 MW	11.5	20
	>2 – 5 MW	4.7	20
Anaerobic Digestion	≤ 250 kW	14.0	20
	>250 kW – 500 kW	13.0	20
	>500 kW	9.4	20
Solar PV[34]	≤4 kW (retrofit)	21.0	25
	≤4 kW (new build)	21.0	25
	> 4 – 10 kW	16.8	25
	>10 – 50 kW	15.2	25
	>50 – 150 kW	12.9	25
	>150 – 250 KW	12.9	25
	>250 kW – 5 MW	8.5	25
	Stand alone system	8.5	25

The RHI

The RHI has yet to be officially launched, but is expected to open for non-domestic properties in November 2011. Non-domestic properties are effectively classed as any property which is not a single dwelling, i.e. a renewable heating device in a bungalow is not eligible for RHI until 2012 (exact date to be confirmed), but a pair of semi-detached properties sharing a heat source will be eligible from November 2011.

The RHI is a 20 year, index linked tariff payment for people who produce and use renewable heat. A range of technologies are covered, specifically ground source heat pumps (which are best suited to new, highly insulated buildings), solar thermal, biomethane and wood-fired boilers. This latter equipment is where the particular opportunity lies for farms and estates.

The RHI will pay out for each kWh of heat produced and used in a building or industrial process at a rate of 7.6 p/kWh for equipment below 200 kW, and at a range of lower values for larger equipment. The intention of this is to overcome the twin barriers to uptake – the significantly higher capital cost of renewable heating equipment, and the inertia of most individuals and businesses

[34] Proposed FIT rates as per November 2011 consultation.

when faced with a choice between business as usual and something ‘new’. The RHI payment rate is shown below in Table B.3.

Table B.3: RHI Payment Rate

Tariff Name	Eligible Technology	Eligible Sizes	Tariff Rate (p/kWh)	Tariff Duration	Support Calculation
Small Biomass	Solid biomass; Municipal Solid Waste (including CHP)	Less than 200 kWth	Tier 1: 7.6	20	Metering: Tier 1 applies annually up to the Tier Break, Tier 2 above the Tier Break. The Tier Break equals installed capacity x 1,314 peak load hours, i.e. kWth x 1,314
			Tier 2: 1.9		
Medium Biomass		200 kWth and above, less than 1,000 kWth	Tier 1: 4.7	20	
			Tier 2: 1.9		
Large Biomass		1,000 kWth and above	1		Metering
Small Ground Source	Ground-source heat pumps; water-source heat pumps; deep geothermal	Less than 100 kWth	4.3	20	Metering
Large Ground Source		100 kWth and above	3		
Solar Thermal	Solar thermal	Less than 200 kWth	8.5	20	Metering