Policy Statement

ENERGY AND THE NATURAL HERITAGE

SNH Policy Statement: 06/02

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1. Introduction

1. Energy is fundamental to modern life in Scotland. It provides the comfort of home central heating, the safety of lighting, the accessibility afforded by transport, and the power of machines and computers in the workplace. But energy use and generation also impact directly on the natural heritage, and on the environment of local communities, for example through the effects of open cast mines, hydroelectric dams, windfarms or motorways. SNH routinely provides advice on the natural heritage effects of energy and transport projects, with a view to minimising adverse effects on the natural heritage whilst ensuring that the benefits of energy availability can be achieved.

2. Energy use also gives rise to indirect effects on the natural heritage from the emissions of greenhouse gases, especially carbon dioxide from the burning of fossil fuels, which are predicted to have widespread and increasing effects on global climate, sea level and flooding. Reduction of greenhouse gas emissions has assumed a central importance in energy policy. Climate change has the potential to cause major changes in Scotland's biodiversity and ecosystems, and is viewed by SNH as the most serious threat to Scotland's natural heritage in the coming decades.

3. This statement explores the relationship between energy and the natural heritage. It provides an overview of energy trends and current government policies, and outlines how energy use and generation affect the natural heritage, across all the main sectors of transport, domestic, industry and services. Conclusions are drawn as to how energy policies should best be developed and implemented so as to minimise adverse effects on the natural heritage, including those caused by climate change. The statement addresses the difficult balances to be struck between limiting further impacts on the natural heritage, the need to switch to new sources of renewable energy which are free of carbon emissions, and the need for fundamental lifestyle changes in society to reduce energy demand.

4. These policy conclusions are of a general nature, but are nonetheless important, as they will provide the context for SNH's response to a wide range of energy-related developments, and the guiding framework for SNH's advice to Government on how energy policy should be developed to take the fullest account of natural heritage issues. More detailed policy statements are already available on SNH's approach towards renewable energy and the natural heritage, and on specific renewable technologies[1].

5. This statement on energy and the natural heritage also provides the context for SNH's own actions as a public sector organisation which uses energy, for offices

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1 SNH (2001) *Policy Statement: Renewable Energy*
SNH (2002) *Strategic Locational Guidance for Onshore Windfarms*
SNH (2003) *Marine Renewable Energy – an Overview and Policy Statement*
Work is in progress on *Biomass and the natural heritage.*

and transport. SNH's *Greening Strategy*[2] is founded upon this statement in respect of energy.

6. SNH has a remit to make sure that activities which affect the natural heritage are undertaken in a way which is sustainable. We consider that a sustainable energy policy should be guided by the five principles set out within the UK Sustainable Development Framework [3] and which form the foundation for Scotland's Sustainable Development Strategy[4]. All these principles are important, and the role of energy in underpinning a sustainable economy and in enabling a strong and healthy society are fully recognised. But, in the light of the widespread impacts of energy use and its role in climate change, it is of particular importance that energy policy should comply with the first of these - 'living within environmental limits'. It should embrace the need to:

- use resources wisely and efficiently, and within environmental limits;
- reduce emissions of greenhouse gases;
- minimise the more local impacts which are determined by the scale and location of developments associated with the supply, distribution and use of energy; and
- use best scientific knowledge, both in the technologies for energy use and generation and in assessing their impact on the natural heritage.

7. SNH has published a separate policy statement on *Sustainable Development and the Natural Heritage*[5]. A statement on *Climate Change and the Natural Heritage* is in preparation.

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[2] SNH (2005) *SNH's Greening Strategy*

[3] HM Government, Scottish Executive, Welsh Assembly, Northern Ireland Office (2005) *Our future – different paths: the UK's shared framework for sustainable development.* The five principles are:

- living within environmental limits
- achieving a sustainable economy
- ensuring a strong, healthy and just society
- promoting good governance
- using sound science responsibly

[4] Scottish Executive (2005) *Choosing our Future: Scotland's Sustainable Development Strategy*

[5] SNH(2002) *Sustainable Development and the Natural Heritage*

2. Energy Use, Economic Growth and Climate Change

8. Lifestyles in the modern developed world have increasingly revolved around an abundant supply of cheap energy for the bare necessities of heat, light and cooking, to manufactured goods and leisure services such as foreign air travel. Relatively cheap transport, especially private motoring and more recently air travel, has contributed to changes in our settlement patterns, influencing where we choose to live and work, shop and holiday.

9. Energy use is intimately linked to economic growth. Before the Industrial Revolution economies depended mainly on biomass through the use of wood, other vegetation and associated products such as peat. Simple renewable sources such as wind- and water-mills were important in the period before and in the early stages of the Industrial Revolution. The Industrial Revolution transformed this situation – and economies – through the mass exploitation of coal and, especially during the 20th Century to the present, oil and gas.

10. Over time the environmental impacts of energy use have tended to migrate from the local (such as the immediate impacts of felling timber, mining coal, smog, impoundments) to the national/continental (acid deposition, radiation) to the global (emissions of greenhouse gases). All are still relevant but in the last few years the focus has come to be on the last.

11. The world's climate has always changed due to a range of geological, biological, atmospheric, oceanographic and astronomic factors. But there is wide scientific consensus[6] that most of the warming in the last 50 years is likely to have been due to a human-induced increase in concentrations of 'greenhouse gases' which stop our planet from radiating the heat absorbed from the sun back into space, and that the warming is set to escalate unless greenhouse gas emissions are controlled. Globally, around 75% of emissions of greenhouse gases are carbon dioxide (CO_2) which is the product of the burning of fossil fuels; land use change such as forest clearance is responsible for most of the rest of the emissions.

12. Our climate is becoming more chaotic with more frequent and more extreme weather events. Such extreme events are difficult to predict beyond a few days away, especially storms. The severity of these problems in particular places will depend on a variety of local factors. Globally, the degree of effect will depend upon factors such as acidification of the oceans and the impact of temperature changes on ocean currents.

13. The impact of climate change on Scotland's biodiversity will be far-reaching. As temperatures rise further, the natural geographical limits for species will migrate northwards and upwards. Already we have seen the range of the mountain ringlet butterfly contract by 50%, and that of the scotch argus butterfly shift northwards. Some arctic-alpine species, like the snow bunting, will disappear from Scotland, as have some lichens and mosses already. Rates of change may exceed the capacity of natural dispersal processes to keep up. Springtime event

[6] For example, the International Panel on Climate Change (Third Assessment Report, 2001); Joint science academies' statement on climate change issued for the G8 summit in July 2005 and signed by Brazil, Canada, China, France, Germany, India, Italy, Japan, Russia, UK and USA.

will happen earlier, and autumn events later, and this may give rise to disruption in food chains. Plants in Scotland which flower in early spring are already appearing three weeks earlier than 25 years ago, and the growing season has lengthened by 29 days. Such changes may be responsible for the severe declines in coastal bird populations in north Scotland, as sand eels and zooplankton which form their food sources have retracted northwards.

14. Patterns of precipitation will change, with drier summers and wetter, windier winters and more frequent heavy rainfall and storm events. Sea level rise will affect low-lying coastal habitats like salt marsh and machair. Habitats will alter as their mix of species changes, responding to the more extreme climate. Already there is evidence of drier water courses, increased erosion of peatlands and an increased incidence of landslips. Droughts, floods and gales will cause physical damage to some ecosystems and may affect the productivity of soils. In 2004, storms and wave conditions of unusual ferocity caused a surge of the sea onto land in north-west Scotland, causing severe erosion of coastal habitats throughout the islands, damage to buildings, and loss of human life.

15. There will be a need for society to adapt to such changes, too, whether through increased flood protection or by measures such as deliberate coastal retreat or the restoration of unencumbered flood plains. There will be a need to ensure that species can bypass any barriers to dispersal like transport corridors and towns and cities. Habitats identified for their nature conservation value may change in species interest, and there may be a need for greater flexibility in such designations if habitats shift in location and distribution.

16. These effects of climate change on Scotland's natural heritage may become eclipsed by the scale of other impacts around the globe, which are expected to include substantial land losses in low-lying countries, desertification in Africa, increased damage from hurricanes and typhoons, and loss of polar ice cover. But nonetheless the above paragraphs indicate why SNH also considers climate change to be an issue of the highest level of concern for the natural heritage of Scotland.

17. These issues, and how SNH and others should respond, will be discussed in more detail in our forthcoming statement on 'Climate Change and the Natural Heritage'. For this paper on energy, the important point is that the prime cause of such effects is believed to be atmospheric carbon dioxide from the burning of fossil fuels for human use: for our heating, supply of electricity and transport. While the timescales involved in reducing levels of greenhouse gases on the atmosphere are very long, there is a need for urgent action by the developed world to achieve a major reduction in ongoing emissions in order to limit the scale of any further increases to present-day levels.

18. **SNH views climate change as the most serious threat over coming decades to Scotland's natural heritage. We therefore have a strong interest in the development of energy policy in a way which will limit the effects of climate change.**

3. Energy Use and Trends

Energy Use and Trends

19. In the UK, total energy use has increased by about 1% a year over the last 20 years (Figure 1)[7]. There is no sign of this growth slowing down, and current forecasts of electricity use for 2020 are usually based on a continued 1% growth assumption.

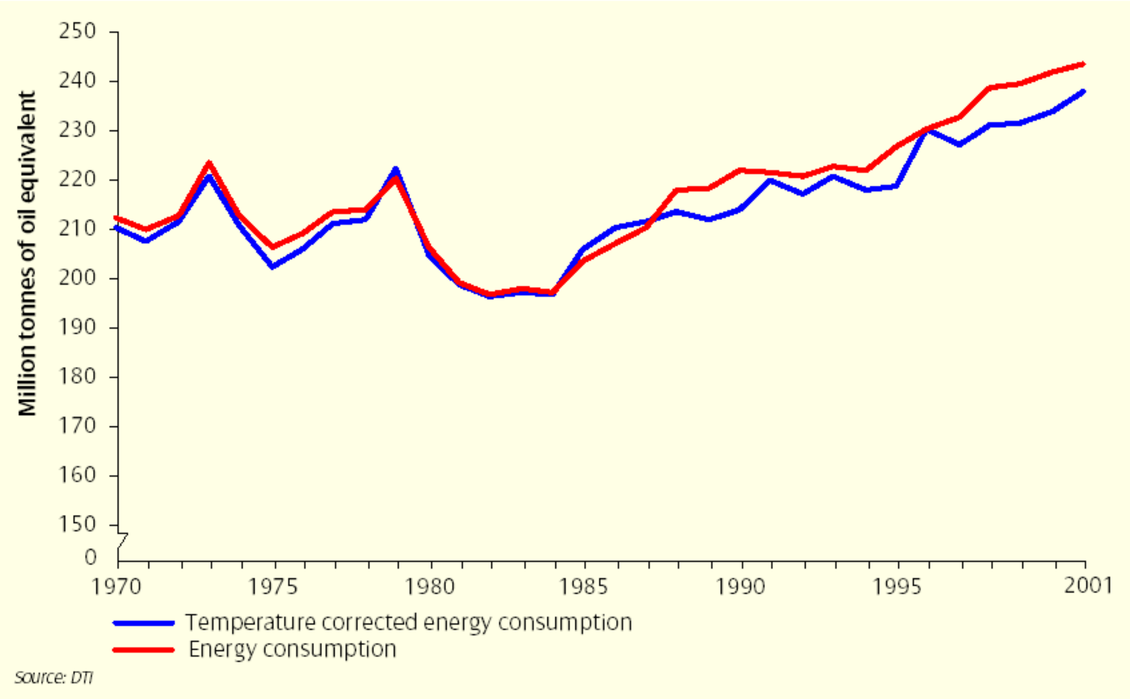

Figure 1. Total primary energy consumption, 1970 to 2001[4]

20. However, this rate of increase is much lower than the rate of growth of the UK economy. Energy use would have been much greater had it not been for action on energy efficiency and the structural changes in the economy which have taken place[8]. At a national scale the amount of energy used per unit of production is described, broadly, by the energy ratio – the ratio between energy use and Gross Domestic Product. If economic growth is to be enabled to continue, but to result in reduced energy use, then at the very least the energy ratio should decline over time, meaning that less energy is used per unit of activity. The energy ratio for the UK has declined markedly over the last 30 years, with an average decrease of nearly 2 per cent a year (the black line in Figure 2). This is due to at least five factors:

[7] DTI (2002, updated 2005) Energy Consumption in the UK
[8] DTI (2002, updated 2005) Energy Consumption in the United Kingdom, p.12

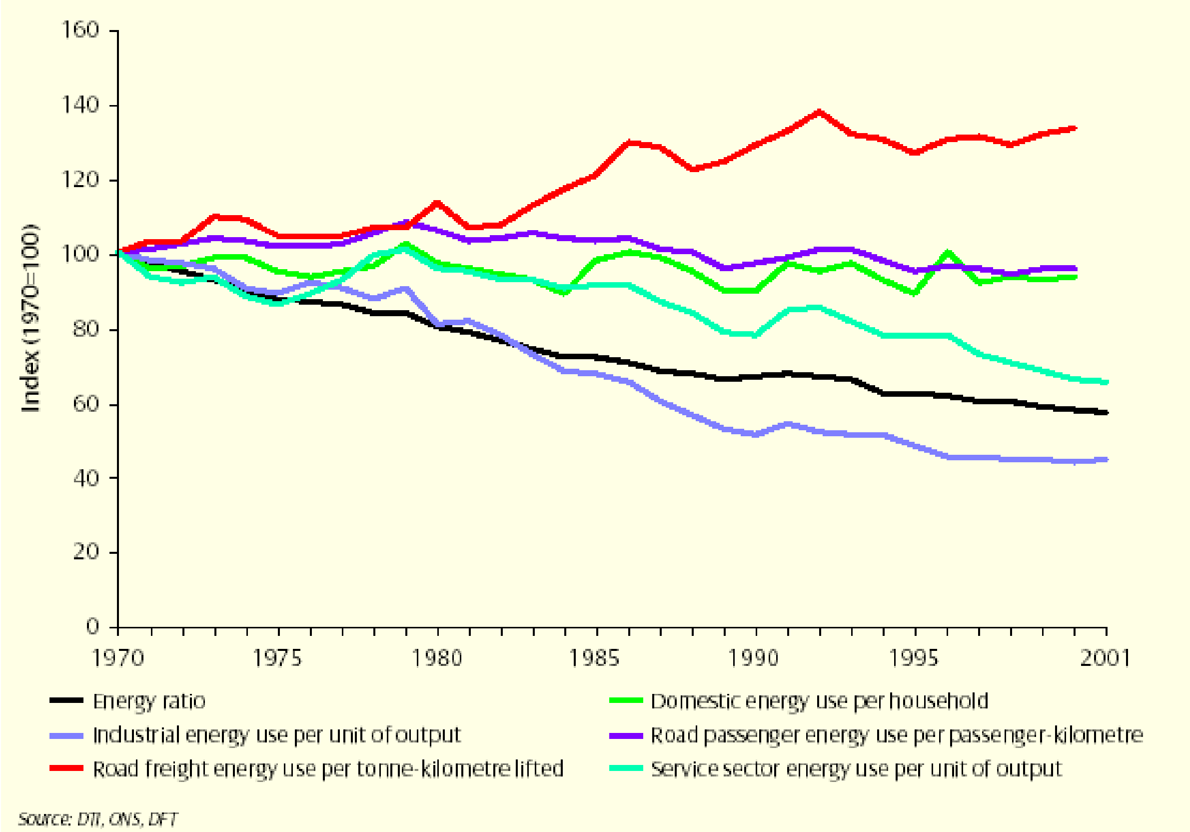

Figure 2. Sectoral energy intensity indicators, 1970 to 2001[4]

- improvements in energy efficiency – for example, domestic sector energy consumption increased by 30%, but would have been 59% higher than that had it not been for the increasing use of insulation[9];
- saturation in the ownership levels of the main domestic appliances;
- growth in some industries has not been linked to growth in energy demand, for example for space heating;
- fuel switching (from coal to gas for electricity generation); and,
- changes in the UK economy with a structural shift away from energy intensive activities (such as steel making) towards low energy industries (such as services) – between 1970 and 2001, energy consumption in the industry sector fell by 44%.

21. The last raises a caution. Reductions in energy use need to be 'real', reflecting the whole-life energy costs of the goods and services that we use, including the energy embodied in imported goods and services. While the manufacturing sector in the UK has declined substantially over the last 15 years, and with it the associated emissions of greenhouse gases, as a society we still use manufactured products, now imported from other countries. Ideally, the emissions associated with the manufacture of imported products should be included within the total which we seek to reduce.

[9] DTI (2002, updated 2005) Energy Consumption in the United Kingdom, p.29

22. Fossil fuels make up around 90% of the UK fuel mix for energy. Energy use and associated emissions of CO_2 are spread across all the major sectors. When the emissions from power stations are allocated to those who use the electricity then domestic users, industry and the transport sector each account for about 28% of emissions, and services about 14%[10].

23. The transport sector is responsible for 35% of all energy use, and is almost wholly dependent on petroleum (99%). Within the transport sector major increases in energy use are due to the increased use of private cars and air transport. Transport now consumes twice as much energy as in 1970. Despite substantial improvements since 1990 in vehicle efficiency, any savings in energy use have been outweighed by increases in the level of demand for transport, notably for air transport[12]. In 2000, 60% of all energy used in the transport sector was for personal transport.

24. Air transport now accounts for about 21% of energy used in the transport sector. This represents a five-fold increase since 1970, and air transport is projected to further double or treble by 2030[11]. What is more, figures based on energy use understate the influence of air travel on climate change, because emissions of CO_2 at altitude have a more potent greenhouse effect than the same quantity of emissions at ground level by a factor of 2.7 (RCEP[12]).

25. Transport aside, most energy in the UK is used for heating and lighting. Space heating accounts for 26% of overall energy use, and hot water a further 8% - in the domestic sector these uses alone account for four fifths of domestic energy requirements. Lighting and domestic appliances use a further 6% of all energy, though the proportion rises to 28% in the retail subsector[13].

Electricity

26. Electricity is particularly important because it accounts for almost 50% of energy use, the greater part of which at present is lost as waste heat during generation or during transmission and distribution. The current overall efficiency factor for power stations in the UK is 38.5% (UK Emissions Trading Scheme): for each unit of electricity used, 2.5 units of energy are lost. Electricity production accounts for around 30% of emissions of greenhouse gases in the UK.

27. Electricity is not a primary fuel - it is generated from coal, gas, nuclear, and renewable sources. Each of these primary fuels has its own environmental impacts (see paragraphs 85 et seq *Switching Sources*).

28. Most electricity in the UK is generated in large scale fossil fuel and nuclear installations. Each of these usually has more than 1000MW generating capacity. These power stations are located either close to fuel sources, such as coal fields,

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[10] DEFRA (2004) *Environment in Your Pocket*
[11] Air Transport White Paper, 2003
[12] Royal Commission on Environmental Pollution (2002) Special Report *The Environmental Effects of Civil Aircraft in Flight*
[13] DTI (2002) *Energy, its impact on the Environment and Society*

or with deep-water access to allow for fuel delivery by sea. Additionally, coastal locations give easy access to adequate cooling water for all types of power station, notably nuclear facilities.

29. There are five main thermal generating units in Scotland. The output from two nuclear stations (Torness and Hunterston B) and the gas-fired power station at Peterhead currently meet base-load demand. This leaves marginal output, to meet peak demand, to be met from the coal-fired power stations of Longannet and Cockenzie (most of the output from Cockenzie goes to meet demand in England), though the cost of their operation is likely to increase due to the combined effects of the EU Emission Trading Scheme and the EU Large Combustion Plant Directive.

30. Electricity cannot, at present, be stored on a large scale. Current technology and management of the grid requires that the rate of electricity production must balance the rate of consumption at all times to prevent blackouts. The electricity generated in power stations is fed into the country's transmission and distribution network, the National Grid, which is mainly made up of overhead lines carried on towers.

31. Just less than 50,000 GWh[14] of electricity was generated in Scotland in 2000 and 2001[15], of which customers in Scotland consumed around 70%, and 18% was transferred to England and Wales or Northern Ireland. The remaining 12% was accounted for by transmission and distribution losses, pumped storage[16] and own use, and major power producers' purchases from other generators.

[14] see Glossary for definition of GWh – gigawatt hours
[15] Key Scottish Environment Statistics (2003), page 6
[16] Most of the energy used for pumped storage is nuclear (using the night-time baseload).

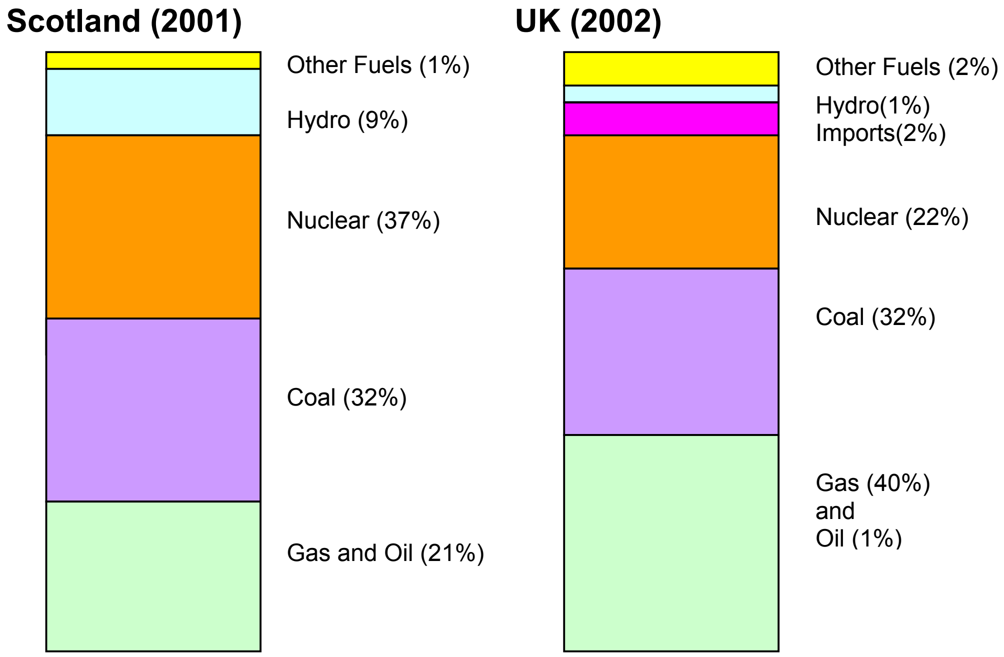

Figure 3. Fuel mix for electricity generation in Scotland and the UK. 'Other fuels' includes landfill gas and wind farms. Sources: Key Scottish Environmental Statistics (2003); Energy in Brief (2004)

32. Figure 3 shows that the fuel mix for electricity generation in Scotland differs significantly from the overall UK mix, with more reliance on nuclear fuels (usually around 40%), a greater proportion of hydro, and less use of gas. In Scotland, around 10% of electricity is generated by large-scale hydroelectric plant, developed during the mid 20th century, some of which has recently been refurbished.

33. In addition to the expected closure of coal-fired plant, all of Scotland's nuclear power stations are scheduled to close by around 2020. Even though Scotland currently has an electricity surplus, if nuclear generators are not replaced or their life extended these dates signal an impending need for alternative sources of supply unless energy use can be managed sharply downward.

4. The Policy Context

34. The European, wider international and national contexts provide important policy drivers that influence the amount of energy that Scotland uses, the source of energy, what it is used for, and Scotland's contribution to the UK programme to reduce emissions of greenhouse gases.

World

35. Energy is a commodity that is traded on the world market, and is therefore subject to the agreements on trade through the World Trade Organisation. Some energy sources, such as renewables, are geographically fixed (although the electricity generated from them can in principle be transmitted elsewhere). Other sources, such as coal and oil, can be traded or stored depending on world market situations.

36. The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol are the starting points for international efforts to cut emissions. The Protocol, which came into force on 16 February 2005, aims to reduce emissions of greenhouse gases by requiring developed countries to meet legally binding emission reduction targets for greenhouse gases. The UK's Kyoto Protocol target is to reduce emissions to 12.5% below 1990 levels by 2008-2012. Countries can use three mechanisms to meet their targets:

- reducing greenhouse gas emissions in their own country;
- funding projects to reduce emissions in other countries; and,
- trading in carbon. Countries that have achieved their Kyoto targets will be able to sell their excess carbon allowances to countries finding it more difficult or expensive to meet their targets.

37. The Kyoto Protocol is only a first step in tackling climate change. Achieving the targets will only reduce emissions from developed countries by 5.2% from 1990 levels. At the UN Conference on climate change in Montreal in 2005, further processes were agreed for considering future action on climate change.

Europe

38. At present energy policy falls under the sovereignty of EU Member States. European primary law does not provide for a European Community energy policy[17]. Nevertheless other sectoral policies have had a profound effect on Member States' energy policy. The EU regulates the internal market and competition and has created an internal market for electricity and natural gas. International obligations under the Kyoto Protocol have led to the promotion of energy efficiency, combined heat and power, renewable energy sources and most recently the EU Emissions Trading Scheme (see Glossary). Accordingly, European energy policy has three main aims: security of supply, competitiveness, and environmental protection.

[17] although this is one of the provisions of the proposed European Constitution, currently in abeyance

39. There is a broad similarity between energy issues at the EU (pre-enlargement), UK and Scottish levels. A European Environment Agency (2002)[18] report states that:

- emissions of greenhouse gases in the EU fell between 1990 and 2000. However, without additional measures they are unlikely to fall further by 2010 and beyond, because of increased energy-related emissions.
- energy consumption is increasing, mainly because of growth in transport but also in the household and services sectors.
- improvements in energy efficiency have been slow, but improvements in some Member States are showing potential benefits.
- the EU is switching from coal to the relatively cleaner natural gas, but after 2010 no further switching is expected. Furthermore, some nuclear installations will retire and, if these are replaced by fossil fuel plants, increases in carbon dioxide emissions are likely.
- the EU15[19] are unlikely to meet renewable energy targets.
- despite increases in energy taxation, most energy prices in the EU fell substantially between 1985 and 2001, as a result mainly of falling international fossil fuel prices but also of the liberalisation of energy markets. (Though it should be noted that since this report was issued in 2002, oil prices have risen substantially.)

40. The EU15 and most EU25 Member States are committed under the Kyoto Protocol to targets for reducing greenhouse gas emissions, against 1990 levels, by 2008-2012. The EU15 target is for an 8% reduction.

41. One of the measures to help deliver Kyoto targets adopted by the EU is a requirement for the EU to double its share of renewable energy from 6 per cent to 12 per cent by 2010 under the so-called Renewables Directive[20]. This target includes a specific requirement for the share of electricity from renewable sources to increase to 22% in the EU overall by 2010. Only four Member States are set to meet their national targets: Germany, Denmark, Finland and Spain. Other countries, including the UK, have introduced legislation which could enable them to reach their national objectives by 2010. The worst performing states are Greece and Portugal, which have fallen far behind meeting their targets. The EU recommends greater use of incentives such as green certificates, market-based mechanisms and tax exemptions, to achieve the overall target[21].

The United Kingdom

42. Under devolution in Scotland, energy policy remains one of the subjects reserved to Westminster. This includes regulating the generation, transmission, distribution and supply of electricity, and most aspects of oil and gas, coal and nuclear energy. The main exceptions are to do with planning consents including environmental issues, granting licenses for electricity generation and transmission, energy conservation, and mitigation of climate change: these

[18] EEA (2002) *Energy and environment in the European Union*, Environmental Issue Report No. 31
[19] this report was written in 2002: 'EU15' refers to the 15 EU Member States before enlargement to 25 Member states in May 2004.
[20] EU Directive on the Promotion of Electricity produced from Renewable Energy Sources, 2001
[21] www.euractiv.com - Renewable Energy in the EU, May 2005

matters are devolved to the Scottish Parliament. In addition, the promotion of and planning for renewables is devolved to the Scottish Executive by agreement with the UK Government.

43. The UK Energy White Paper *Our energy future - creating a low carbon economy* provides the policy context for the UK. The White Paper sets four goals for UK energy policy:

- "to put ourselves on a path to cut the UK's carbon dioxide emissions - the main contributor to global warming - by some 60% by about 2050 with real progress by 2020;
- to maintain the reliability of energy supplies;
- to promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and
- to ensure that every home is adequately and affordably heated."
- The 60% target relates to 1990 levels as a baseline and is supported by shorter term milestones which remain important because of the international obligations and implementation plans that lie behind them. They include:
- UK obligation to cut emissions of greenhouse gases by 12.5% against 1990 levels by 2012; and,
- a UK domestic goal to cut CO_2 emissions by 20% against 1990 levels by 2010.

44. On 23 January 2006, the UK Secretary of State for Trade and Industry and UK Minister for Energy launched the consultation document 'Our Energy Challenge: securing clean, affordable energy for the long term'. The consultation has a broad scope and considers all aspects of the energy system including both energy supply and demand. It sets out the energy challenges we are currently facing, and invites responses to the evidence presented and to what should be done to secure clean, affordable energy for the long term.

45. The latest projections[22] suggest that the UK will meet and surpass its obligations to the Kyoto Protocol, but that it will only make a 10% cut in CO_2 emissions against 1990 levels by 2010.

46. The UK Government views the EU Emissions Trading Scheme as a central plank of future emissions reduction policies in the UK. The Scheme creates a market for trading in carbon which provides an incentive for participants to reduce emissions of CO_2 (see Glossary for details). In 2005 the cost of carbon associated with the EU Emission Trading Scheme was around £54 per tonne carbon[23]. Current UK activity focuses on the level of allocations for Phase II (2008-2012) of the Scheme, increasing the use of auctioning to allocate carbon allowances and extending the scope to include a wider range of activities including intra-EU air services.

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[22] DTI (2006) *Our Energy Challenge: securing clean, affordable energy for the long term*
[23] see PointCarbon for market prices, noting that 3.66 tonnes CO_2 contain 1 tonne of C, so prices per tonne C are 3.66 times prices per tonne CO_2: http://www.pointcarbon.com/article.php?articleID=2574

47. Allied to the White Paper, targets have been set to increase the amount of electricity generated from renewable sources in the UK. Across the UK, a target of 10% renewable electricity by 2010 has been set, increasing the proportion from around 5% in 2000 (largely hydro electricity from Scotland and Wales). The target increases to 20% by 2020.

48. The Renewables Obligation is the UK Government's main mechanism for supporting renewable energy. It was introduced in April 2002 and provides a substantial market incentive for all eligible forms of renewable energy. The Obligation creates a new market in what are commonly known as tradable green certificates[24]. These Renewables Obligation Certificates must be produced by energy suppliers to prove that they have sourced the related amount of their electricity from renewables.

Scotland

49. The Scottish Executive's Sustainable Development Strategy sets out an overall aim of securing 'a profound change in the way we generate and use energy, and reducing greenhouse gas emissions'. Scottish Ministers have set enhanced targets for producing the electricity needed in Scotland from renewable sources. The targets are 18% by 2010 and 40% by 2020, including the contribution from large-scale hydro (paragraph 32). These targets reflect the abundance of renewable energy resources of various types in Scotland. The 2020 target has been translated into a target of generating 6GW from renewable sources.

50. The Renewables Obligation (Scotland) is designed to help Scotland meet its targets for production of electricity from renewable sources. The Renewables Obligations are being reviewed in 2005-2006. See Glossary for further details.

51. The Scottish Executive promotes energy efficiency through the Scottish Energy Efficiency Office which offers advice to businesses and individuals on ways to save energy and money. A number of other bodies inform and drive forward energy conservation efforts in all sectors. They include the Energy Saving Trust, which aims to improve domestic energy efficiency and develop markets for cleaner fuel vehicles, and the Carbon Trust, which supports the development of low carbon technologies. The Scottish Executive is developing an Energy Efficiency Strategy which will be a key tool in securing a coordinated approach towards reduced energy use.

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[24] tradable certificates in energy efficiency are called 'white certificates', and those that deal directly with greenhouse gases are 'black certificates'.

5. The Challenge

52. If at a global level we continue to burn fossil fuels at similar or greater rates to the last half-century, we will subject the world to even more catastrophic consequences of climate change for many centuries to come[25]. In line with the guidelines in our policy statement on *Sustainable Development and the Natural Heritage*, SNH believes that a sustainable energy policy should be characterised by 'living within environmental limits'[26], including the need to:

- reduce emissions of greenhouse gases; and
- minimise more local impacts which are determined by the scale and location of developments associated with the supply, distribution and use of energy.

53. Scotland's ecological footprint (see Glossary) is 5.35 hectares of productive land and sea per person[27], which is 2.8 times the figure required for 'one planet living', that is if each person in the world had an equal share of the planet's productive land and sea area. In Scotland, like other developed countries, the size of the ecological footprint is dominated by energy use. While the UK contributes over 2%[28] of global emissions it only has 1% of the world's population. As a developed country, the UK including Scotland has an important role to lead by example to reduce emissions of greenhouse gases.

54. In setting targets to reduce emissions, it should be recognised that emissions are unevenly distributed around the world and that as well as reducing them there is a need for countries to converge on an equitable level of emissions per person. Such a principle of 'contraction and convergence' is embodied in the United Nations Framework Convention on Climate Change. These considerations led the Royal Commission on Environmental Pollution[29] to recommend that the UK should reduce carbon emissions by 60% by mid-century, and aim for an 80% reduction by 2100. In 2002, the UK government adopted 60% reduction from 1990 levels by about 2050 as an over-arching objective of UK energy policy[30].

55. **SNH strongly supports the aim of seeking 60% carbon emission reductions by 2050, and expects that further reductions should be sought thereafter. We will do all that we can, within the scope of our duties to secure the conservation and enhancement of the natural heritage, and to foster its understanding and enjoyment, to support Government in achieving that aim. These targets should be kept under review and brought forward if needed in the light of further scientific information on the rate at which climate change is occurring.**

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[25] International Panel on Climate Change (2001) Third Assessment Report.
[26] HM Government, Scottish Executive, Welsh Assembly, Northern Ireland Office (2005) *Our future – different paths: the UK's shared framework for sustainable development*
[27] *Scotland's Footprint* (2004) Best Foot Forward - see www.scotlands-footprint.com
[28] DEFRA (2004) *Environment in Your Pocket* – but note this figure would be higher if it included the energy embodied in imported goods (paragraph 19)
[29] RCEP (2000) *Energy: the changing climate*
[30] UK Energy White Paper (2002) *Our energy future - creating a low carbon economy*

56. Driving down emissions of greenhouse gases by the amounts required will involve a mix of measures across all sectors of the economy, including:

- reducing demand for energy, including using it more efficiently, in both end-use and generation; and,
- switching sources of energy production, with much more emphasis on a diverse mix of renewable sources.

Both approaches are required because of the spread of emissions of greenhouse gases across all the main sectors (paragraph 22), the interactions between them, and because of the dependence on fossil fuels in the UK.

57. There is a need to change the long-term investment climate to encourage investment in low-carbon and carbon-neutral energy sources[31]. For greatest effect such incentives need to be accompanied by measures to discourage activities that result in emissions of greenhouse gases. Reductions need to be 'real' (paragraph 21).

58. **SNH considers that demand reduction measures should take the highest priority in any strategy to reduce emissions.** In general, reducing demand by measures such as energy efficiency, home insulation and encouraging more careful use of energy have little or no adverse effect on the natural heritage. They are also highly cost effective. Other measures, like the development of renewable energy are important, but may be associated with significant detrimental impacts on the natural heritage. To minimise adverse effects, they should be sensitively designed and located, and pursued in a planned and measured way.

59. The rest of this paper looks in greater detail at the options associated with both reducing demand and switching energy sources and at the associated natural heritage impacts.

[31] World Economic Forum, *Statement of G8 Climate Change Roundtable*, 9 June 2005

6. Reducing Demand

60. This is the most challenging aspect of energy policy because it raises fundamental questions about our lifestyles and assumptions about economic growth.

61. There are two main approaches to reducing demand:

- changing behaviour by increasing the price of energy, by raising awareness of the environmental implications of energy use, or by creating conditions in which people are able and willing to embrace lifestyles that involve lower energy use and especially lower carbon-use; and
- energy efficiency measures which make the most of the energy that is used, and which minimise waste.

Changing behaviour is led by sociology and psychology whereas energy efficiency is led by science and technology.

Changing Behaviour – Energy Prices

62. Price alone does not necessarily change behaviour, but it is an important factor. Even if consumers have perfect knowledge about the choices available and the consequences of their actions, they will not necessarily make choices that are environmentally or socially desirable, unless these options are competitive in cost.

63. Supplies of fossil fuels are finite, and oil and gas prices have already risen significantly in response to a decline in production from the North Sea. However market forces alone are unlikely to drive a sufficient slowdown in the rate of use of fossil fuels on the scale required to combat climate change. In particular, international coal reserves are sufficient to last well into the next century at current rates of use.

64. **It is therefore important that the price of energy at least reflects its associated environmental costs.** The energy sector does not as yet reflect the general principle that the costs of goods and services should include the environmental cost. Especially for the use of oil, gas and coal, neither producers nor consumers are required to pay for the full cost of their actions with regard to climate change. In effect the environmental cost of energy use in the UK will be paid for by future generations all over the world in coping with the effects of climate change, a transfer of costs which is contrary to the principles of sustainable development and which may be seen as a significant subsidy for the present-day industry and consumers.

65. The so-called 'social cost' of carbon is an attempt to quantify the cost of preventing or repairing damage caused by climate change – so it is actually a social and environmental cost. The UK Government[32] currently estimates the

[32] R Clarkson and K Deyes *Estimating the Social Cost of Carbon Emissions* Government Economic Service Working Paper 140 – see http://www.hm-

social cost of carbon emissions at about £85 per tonne C[33]. If the cost of reducing emissions is higher than £85, then it is argued that it would be better value to repair the damage caused by climate change, whereas if the cost is less than £85 per tonne, then reducing emissions is deemed to be better value. It is recognised that there are fundamental uncertainties associated with quantifying such a social cost (see Glossary).

66. If these costs were explicitly accounted for in the unit cost of fuels, then there would be substantial increases in electricity and gas prices. The required increases would range from 14% for domestic electricity to 57% for gas used by industry. In contrast, because of the relatively high level of taxes already applied to transport fuels, fuel price increases on this basis would be only around 1%. Despite such high taxes the transport sector has grown markedly (paragraph 23), indicating that while prices are important they need to act with other measures to change behaviour. Many of the current trends in the transport sector are entirely at odds with the aim of carbon reduction – for example rail costs remain high while the cost of flying, both within the UK and Europe, has been slashed, as a result of the emergence of highly-competitive budget airlines, to the point of making rail uncompetitive for medium or long journeys.

67. People are likely to respond if price structures are clear and fair in their objectives. Price systems should be geared to making the most sustainable options the most financially attractive ones, for example cheaper travel by train than air, lower VAT on energy efficient light bulbs and higher VAT on normal bulbs, or taxes to affect both the purchase price and licence costs of vehicles depending on their emissions of greenhouse gases.

68. Although significant rises in the price of energy could persuade people to use it more sparingly, care will always be required to ensure that price increases do not have an inequitable effect on people with low incomes or who are otherwise disadvantaged. For example there is a risk of increasing the number of people living in or close to fuel poverty, a situation typically arising from a combination of low income, high energy costs, and poor energy efficiency of the home (see Glossary). In 2002, there were 262,000 households in Scotland living in fuel poverty[34]. To ensure that rises in energy prices do not increases fuel poverty, a range of associated measures is likely to be required, for example, by using the revenue raised from fuel price increases to encourage the uptake of energy efficiency measures by those in or close to fuel poverty. Similarly any moves to discourage increasing use of private vehicles by increasing costs should be counterbalanced by measures which ensure that those on low incomes, or people in rural areas who are often highly dependent on private transport, are not disadvantaged. It will be of particular importance to ensure that increases in energy costs do not give rise to undue differentials in the cost of goods and services as between the remoter parts of Scotland and the central belt.

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treasury.gov.uk/Documents/Taxation_Work_and_Welfare/Taxation_and_the_Environment/tax_env_GESWP140.cfm - the figure of £70 per tonne carbon in 2000 is currently under review

[33] based on £70 per ton C in year 2000 range - £35-140 per ton - plus £1 increase in real terms for each year thereafter, plus around 13% total inflation 2000-2005.

[34] Scottish Executive (2002) *'Scottish House Condition Survey'*

69. It will be important that energy price increases, as they bear on the business and commercial sectors, are introduced in a measured way such as will enable a vibrant economy to be maintained. While increased prices of energy may make some products uncompetitive, they will also open new markets for new, more sustainable products in their place, products which may find an international marketplace opening up. A continued healthy economy will be an important factor in enabling the investment in new energy systems on the scale which is required over the next 20-50 years.

Changing Behaviour – Encouraging Lower Energy Lifestyles

70. Prices can help to curb excessive use, but there is also a need to act positively to encourage a cultural shift towards lower energy lifestyles, for example by:

- making people aware of the amount of energy they use and the consequences; for example, by encouraging calculation and awareness of personal ecological footprints;
- greater incentives to make more use of options that do not rely on fossil fuels such as renewable energy or solar heating;
- introducing an energy reward card in which people collect more points by choosing goods and services that use less energy or energy from renewable sources, and can trade the points in for a range of non-polluting benefits (see Glossary);
- promoting purchase of products from local sources where available; or,
- extending emission trading schemes into the domestic sector through the use of Domestic Tradable Quotas (see Glossary). This type of approach could help to establish an economic driver for further action to reduce the amount of energy used and to use it more efficiently, and could be extended into other major sectors of energy use such as private motoring and air travel.

71. In some cases, notably travel by private car, changing behaviour has proved to be very difficult indeed. Even though fuel taxes act to discourage car use, the attraction of using the car are strong and involve issues such as journey time and convenience, safety, reliability and the price of alternative modes. In rural areas, travel by private car may be the only practicable option.

72. Air transport is a key issue (paragraph 24). If air transport grows as predicted, then emissions of CO_2 from aircraft alone will jeopardise the UK's ability to meet carbon reduction targets. This is an area where rapid progress is needed at an international level, to secure agreement on fuel taxation or emissions quotas and common principles concerning limitation of growth. It would be helpful to show the way through policies for air transport within the UK and to negotiate agreement on EU-wide policies (see paragraph 46). **SNH supports the aim of including air transport-related emissions within the EU Emission Trading Scheme.**

73. Many air services in north and west Scotland can be seen as life-line services, socially and economically, but most of the increase in demand is for flights from Edinburgh and Glasgow to the rest of the UK and Europe. This presents a dilemma for Scotland in that peripherality has traditionally made transport,

including better air connections, a priority from an economic development standpoint. The challenge is to improve contacts and accessibility without the undesirable consequences in terms of fossil fuel consumption and emissions of greenhouse gases. Business should be encouraged to make greater use of alternatives such as rail transport or video-conferencing, and a high priority should be placed on good high speed rail connections from Scotland to major cities in the UK.

74. For surface transport, planning and public transport will play an important role. New business and housing developments should be designed so that transport requirements are based on the least polluting forms of transport, centred on walking, cycling and public transport.

75. But reducing the use of private transport presents a distinct set of problems for Scotland, which in turn may require a distinct set of policy solutions. The polarisation of the population into relatively dense urban centres (where public transport is viable) and highly dispersed rural communities (where conventional public transport is effectively not practical) means that great care is required to develop solutions that are not socially divisive.

76. Changes in business practices and behaviour in both the public and private sector can help to drive travel demand downward. Examples include allowing more people to work from home, sharing of office facilities including daily 'hot-desking' especially in the public sector, use of video-conferencing facilities, and car-sharing.

77. If peoples' behaviour is to change, there needs to be good information available on the energy consumption and greenhouse gas emissions associated with different products, practices and transport modes, as well as a widespread recognition of the role of these emissions in driving changes to our climate and environment. **SNH will ensure that in our work on education for sustainable development, energy issues will feature prominently.**

Energy Efficiency

78. In the domestic and service sectors, by far the main energy use is for space and water heating and lighting (paragraph 25). Though energy efficiency standards for new housing have been raised substantially, there is huge scope to further improve the energy efficiency of the country's housing stock (see Glossary under *Standard Assessment Procedure*). Measures are in place to improve the efficiency rating of new building stock[35] – though there is a need to ensure that regulations are enforced and to check the effectiveness of the work done. Also, new stock only accounts for about 1% of the building stock. Thus measures should also be brought forward to improve the energy performance of existing building stock. There is substantial scope for new 'green jobs' in improving the energy efficiency of the current housing stock, with costs repaid by energy savings.

[35] for example through the EU Directive on the Energy Performance of Buildings (Directive 2002/91/EC) which the UK must implement by January 2006

79. In the domestic sector there has been a tendency for people to keep homes warmer than in the past at least in part due the widespread uptake of central heating systems. Changing behaviour is important here, to enable adequate comfort and healthy living conditions without producing excessive waste heat or the need for air-conditioning. It is noteworthy that in Japan, in response to city-wide peak energy demands in hot weather, businesses have encouraged their workers to ‘dress-down’ in summer to reduce the need for air conditioning.

80. In the transport sector there have been notable improvements in engine and vehicle efficiency, though they have been countered by the overall growth in the transport sector (paragraph 23). Further efficiency gains are likely, and lighter and stronger materials will have a role to play. Given the force of demand, however, policy-led pricing for transport may also be needed, to make sure that emissions of greenhouse gases decline overall. Such a policy would aim to ensure that the least polluting forms of transport became a more attractive option for users than those with high greenhouse gas emissions.

Leadership by Business and Public Sector

81. Changing behaviour requires action from government, business and the public. There is a tendency for one group to pass responsibility to another which reflects the fact that all three are interdependent. For example, businesses often claim that they only supply what the customer wants, shifting the burden of change firmly onto consumers. But businesses also respond to other stakeholders, especially shareholders. And as well as driving demand, consumers also follow new trends and marketing which are at least in part driven by business.

82. For the public sector, taxpayers have to be confident that public funds are spent wisely and fairly, representing value for money. **Decisions on public spending should always reflect the full long-term cost associated with such decisions, including the social and environmental costs relating to energy use.** In some cases this may require a high initial spend to secure long-term savings, for example low-emission energy systems may have a higher initial cost but are often well justified over a full life cycle. Auditing of public bodies should be done in a way that encourages allocation of resources to make sure that the consequences of decisions taken by public bodies lead to sustainable energy use.

83. Making energy use and emissions of greenhouse gases a measure of effectiveness and efficiency in the public sector would help to drive down energy use, make sure it is used efficiently and help to raise the profile of non-fossil fuel sources.

84. **SNH will apply these principles where possible to our own activities. Our Greening Strategy sets out how our own practices will be developed to become more sustainable (see Figure 4)**

Figure 4: Energy commitments in SNH's Greening Strategy

- We will implement energy efficiency measures at all of our offices where appropriate (we have already set demanding energy efficiency standards for our new HQ in Inverness)
- We buy goods and equipment with high energy efficiency ratings
- We seek to ensure that our staff are aware of and use good practice at work, in terms of switching off equipment and heaters when not needed
- All the electricity we buy is sold as CO_2 free, as part of a large public sector contract with Scottish & Southern Energy
- We will install self-generated renewable energy at our offices where appropriate (we currently have a hydro scheme on Rum and a biomass heating plant at our Aviemore office)
- We will offset our emissions from energy use and travel, by re-investing the carbon costs in renewable energy plant for our offices
- We report our energy performance quarterly to our Management Team, and annually to our Board, and we publish this performance.

7. Switching Sources

85. Reducing demand is vital, but with 90% of energy use in the UK derived from fossil fuels, it is clear that we also need to switch to more sustainable sources. This section examines the impacts on the natural heritage of various alternatives.

Renewables

86. SNH strongly supports the development of a diverse range of renewable energy technologies to reduce the dependency on fossil fuels. However, while renewable energy is carbon free, there are a range of direct impacts on the natural heritage, ranging from the flooding of valleys to the risk of bird strikes. **We believe that renewable technologies can and should be developed in a way that minimises their impact on the natural heritage.**

87. Scotland is endowed with an abundant renewable energy resource, in the form of wind, wave, hydro, biomass and tidal energy. Given that abundance, it seems clear that Scotland can supply more than just its pro-rata share of renewable electricity within the UK. However, Scotland's natural heritage is of outstanding quality, and renewable energy development will not be without some significant impacts upon it. In making an equitable renewable energy contribution to the UK's climate change programme, it is important that environmental impacts, too, are shared equitably. Scotland should not become viewed as the prime supplier of the UK's renewable energy needs, unless technologies emerge which have little impact on the natural heritage; other parts of the UK, too, have a substantial renewable energy resource, including a greater potential to exploit solar energy in the south. It is important that there remains an incentive for people in all parts of the UK to take steps to cut energy consumption.

88. Some renewable technologies have more wide-ranging impacts than others, and the impacts most often depend crucially on the location and scale of development, the nature of the environmental interests, and how sensitively the scheme is sited and designed. Figure 5 offers a very generic ranking of technologies in terms of potential natural heritage impacts – assuming that sensible siting choices are made. This is necessarily a broad brush perspective, not only because of the differences between individual developments, but also because the environmental impacts of some new technologies are as yet only becoming apparent. It is vital that individual energy proposals, as they arise, are judged each on their merits and not according to this generic overview. Nonetheless, this overview provides some insight as to the most and least benign technologies. It illustrates the potential attractions of some marine technologies (wave and tidal stream), and of biomass. Specific technologies are discussed in more detail in our policy statements on *Renewable Energy* and on *Marine Renewable Energy*, and a further statement is in preparation on *Biomass Energy and the Natural Heritage*. Some technologies, like geothermal energy, are not as yet included in this overview, simply because as yet we lack any experience of proposals coming forward. Most forms of renewables should be judged better for the natural heritage than conventional fossil fuel generation, on the basis of carbon emissions.

Figure 5. Natural Heritage Impacts of Electricity Production

Least Natural Heritage Impact

Wave farms

Tidal stream generation

Biomass CHP[1] Energy from Waste

Offshore wind

Onshore wind

Fossil CHP[1] Nuclear[3]

Large-scale hydro Gas

Tidal barrage Coal (with CCS[2])

Coal

Most Natural Heritage Impact

[1] CHP = Combined heat and power

[2] CCS = carbon-capture and storage

[3] Range indicates uncertainty associated with safe /accepted long-term management of wastes

89. Over the last 50 years hydro-electricity has been the dominant form of renewable power, supplying around 10% of Scottish electricity from a network of dammed lochs, pipelines, and turbine stations. While these have had a major effect on Scotland's landscapes and river systems, some (eg Loch Tummel) have become part of our cherished scenery, and fish ladders and fish lifts have done much to protect the use of river systems by salmon. More recently, the Renewables Obligation (Scotland) (see Glossary) has played an important role in determining the way renewable energy has been taken forward in Scotland and how it has impacted on the natural heritage. The Obligation has successfully stimulated renewables development, but very largely of a single type, onshore wind, for which the technology is well advanced and the financial cost, per unit of electricity generated, lowest. It has not so far successfully fostered the development of wave and tidal energy which are at a developmental stage but which may, in terms of environmental impacts, be preferable to onshore wind. While capital grants are available from the DTI to support the research and development of new technologies, there is a need to ensure that the level of ongoing incentive available for each technology reflects the overall public benefit deriving from it, taking environmental and social impacts into account as well as economic costs.

90. The Renewables Obligation has been highly successful in stimulating interest and investment in renewable energy across Scotland, and in turn that is leading to new investment in the grid infrastructure which will enable further renewable energy resources to be tapped. However, it has triggered a market-led race to develop sites for windfarms, which has led to a large number of proposals whose

generating capacity considerably exceeds the amount needed to meet the 2020 target. While this target is not a ceiling, and it may be expected that further renewables will be required in the decades beyond, the present market-led process is proving wasteful of planning authority, Scottish Executive and developers' resources, in terms of the level of dispute over planning decisions and the number of Public Local Inquiries. Most developers are conscientious in assessing and seeking mitigation of environmental impacts, but nonetheless there is a need for a more strategically planned approach, guiding development towards those areas best able to accommodate it.

91. **During 2005 the Scottish Executive embarked upon a revision of the planning framework for renewable energy development in Scotland, in a process supported by Strategic Environmental Assessment. We welcome that move and recommend this should embrace all the main renewable technologies as well as related transmission and distribution requirements.**

92. The development of renewable energy is of considerable economic value to Scotland. The new employment in manufacturing and construction, and for some types of renewable, in operation, form a key component of the Scottish Executive's 'Green Jobs Strategy for Scotland'[36]. In rural areas, the financial returns to landowners and affected communities can also be of major benefit if invested in the sustainable development of the area. Many renewables developers have also invested in habitat management schemes that lead to natural heritage benefits which outweigh any adverse impacts of the projects themselves.

Energy from Waste

93. Generating energy from waste incineration makes use of the material which otherwise might biodegrade to form methane – a greenhouse gas over 20 times as damaging as carbon dioxide. Even though only a proportion of energy obtained from waste incineration is from renewable sources (many combustible wastes, like plastics, derive from oil or other fossil carbon sources), it helps the environment by securing energy benefit from a carbon output which would occur whichever waste disposal method is used. It also reduces demand for landfill disposal. Other energy from waste mechanisms, like incineration of sewage sludge or trapping and burning landfill gas, have similar benefits for the natural heritage. Provided that waste avoidance and recycling remain an overarching priority, harvesting the available energy from residual waste streams should be encouraged.

Microgeneration and Renewable Space Heating

94. Microgeneration refers to a range of technologies that produce heat and/or power primarily for local use, but often with the potential to export unused power to the national grid. These technologies include combined heat and power, run-of-river hydro, solar power, photovoltaics, small wind turbines, heat pumps and fuel cells (see Glossary for further details). Most forms of microgeneration,

[36] Scottish Executive (2005) *'Going for green growth: a green jobs strategy for Scotland'*

especially where they are fully integrated with buildings, have minimal adverse impacts on the natural heritage. Where the energy source is renewable, microgeneration can make an important contribution to emission reductions. Even where the energy source is non-renewable, use of combined heat and power generation can secure substantial efficiencies in overall energy consumption.

95. Overall, space heating accounts for over a quarter of overall energy consumption (see paragraph 25), and there is therefore a huge opportunity for energy from renewable sources to be utilised to heat houses, offices and commercial properties. The use of solar design and the integration of solar panels or solar tiles in the architecture of new buildings could supply a significant proportion of energy needed to heat the buildings. More widespread use of biomass for heating should also be encouraged[37], particularly to make use of woodfuel which could be widely available in rural Scotland. Systems are now available using chipped or pelletised wood which allow for automatic feeding and avoids the inconvenience associated with traditional log stoves[38]. Care will be required to ensure that adverse impacts do not arise through air pollution and an increase in airborne particulates. SNH is currently preparing a more detailed statement on *'Biomass Energy and the Natural Heritage'*.

Fossil Fuels

96. In terms of emissions of greenhouse gases, coal performs poorly among the fossil fuels used in the UK[39]: although it accounts for only 16% of the fuels used it results in 25% of emissions of CO_2 by fuel type.

97. There are also natural heritage impacts associated with extraction, for example in the legacy of spoil heaps and bings associated with deep mining in parts of the central belt. The high sulphur contents of deep-mined coal produce highly acidic leachates which can contaminate surface and ground waters. Open-cast extraction has major impacts over an extended period of years especially on landscapes, habitats, and amenity use. Some of the losses cannot be restored, such as where operations coincide with the sites of fragile habitats or rare species. In other cases satisfactory restoration and aftercare can help to mitigate impacts, especially where the proposed works respond to the needs of local communities and other interested parties. Where coal is imported, such impacts in other countries should be regarded as part of Scotland's global footprint, if the energy derived is used in Scotland. SNH has published guidance on good practice in the extraction of minerals, including coal, in relation to the natural heritage[40].

98. Oil and gas development around the coast of Scotland dates back to the 1970s, and in general there has been a serious effort to operate to high environmental

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[37] see Scottish Renewable Forum briefings '*Bioenergy in Scotland*' (November 2005) and '*Renewable heat for Scotland*' (March 2006)
[38] 'Woodfuel for warmth'. Sustainable Development Commission 2005.
[39] although UK coals tend to perform better in terms of CO2 emissions than poorer quality resources such as brown coals and lignite.
[40] ***Minerals and the Natural Heritage in Scotland's Midland Valley*** **(SNH, 2000)**

standards. Nevertheless, offshore oil and gas exploitation results in disturbance to the local environment. Exploration for oil and gas involves seismic surveys which may disturb whales and dolphins, and discharges of drill cuttings and hydrocarbons that can have impacts on the seabed in the vicinity of the installations. However, these potential impacts are carefully controlled and many have been reduced in recent years. The decommissioning of oil and gas platforms could also impact on the environment, though operations undertaken to date have not had adverse effects, despite the highly public controversy over the toxic substances alleged to be contained in the Brent Spar rig. Oil and gas terminals are major developments that can be difficult to locate sensitively within coastal landscapes and habitats. Extensive underground pipe-laying is required to connect oil and gas terminals to a refinery and consumers, though agricultural and other man-modified habitats can usually be satisfactorily restored. Transport of oil by road and ship can also result in discharges to the environment, including the risk of large spills through stricken tankers.

99. Large scale thermal plants for electricity generation can involve significant changes in land use: they are mainly large industrial complexes that inevitably have an impact on the land and surrounding landscapes. Careful siting and design, including the colour of the buildings, can help to mute the degree of visual impacts. The plants are often located near the coast, and coastal areas are more and more likely to be subject to extreme weather events and flooding associated with global warming: they can be protected, but hard coastal defences can lead to further problems along the coast. Direct-cooled power stations use billions of litres of water to condense the steam that turns the turbines, which is why they are located near the coast. The extraction of seawater needs to be carefully managed to avoid taking fish[41]. New technologies designed to eliminate these adverse effects are available and should be used.

100. Emissions of CO_2 from gas are about a third less per unit of energy than those for coal. However, the main gas resource in the UK – the offshore resources in the North Sea - is now strictly limited, and the UK is expected to be a major importer of gas by the end of this decade. The UK is set to have exploited to exhaustion the majority of a very valuable resource within a time span of only a few decades, which is hard to justify in terms of sustainability.

101. In addition to emissions of greenhouse gases, the burning of coal, oil and gas releases oxides of sulphur (SO_x) and nitrogen (NO_x)[42] into the atmosphere which when deposited increase the acidity of soil and freshwater. Most of the soils and freshwaters in Scotland are naturally acidic and are highly susceptible to the effects of acid deposition. Acidity builds up over a number of years, lowering the resistance of plants such as trees to disease, and may lead to loss of aquatic species depending on their sensitivity. Deposition of nitrogen can also lead to nutrient enrichment (eutrophication) of sensitive habitats. Peaty soils are particularly sensitive, as nutrient enrichment can cause changes in species

[41] P.A. Henderson (2004) Are coastal power stations affecting Northern European inshore fish populations? Pisces Conservation, available at http://www.irchouse.demon.co.uk/index2-paper001.html also reported in *BBC Wildlife*, March 2004, p.25.
[42] Nitrous oxide is also a greenhouse gas, with a warming potential 310 times greater than CO_2

composition, replacing heathland with grassland. In Scotland the effects have been of particular concern in parts of Dumfries and Galloway and in the area northeast of Glasgow, though there are now some indications of habitat recovery.

102. Emissions of oxides of nitrogen (NO_x) and sulphur dioxide (SO_2) from fossil fuel power stations can be reduced in a number of ways:

- installing flue gas desulphurisation (FGD) equipment to remove the sulphur at source, although care is required in selecting the sources of lime used in this technology (for example, avoiding protect landscapes and rare habitats such as limestone pavements);
- using coal with as low a sulphur content as possible;
- replacing old, inefficient stations with modern Combined Cycle Gas Turbine (CCGT) plant which release virtually no SO_2 (though noting the caveat about use of gas in the next paragraph); or
- retro-fitting coal fired stations with burners which reduce the amount of NO_x formed during combustion.
- Substantial progress in reducing NO_x and SO_2 has already been made: UK SO_2 emissions have fallen by 85% over the period 1970-2003 and NO_x by 48%.

103. **To address climate change, a clear objective should be to minimise the greenhouse gas emissions associated with use of fossil fuels, especially coal. Gas in particular should be used more sustainably, so that future generations can benefit from its continued availability.** There is currently a great deal of interest in techniques for capturing the carbon emitted from major fossil fuel plants and storing it in geological reservoirs. Such techniques need to be proven to be free of long-term risks that carbon will escape in significant quantities. A clear understanding is required of the risks of leakage which could lead to acidification of ocean waters or release of carbon dioxide back into the atmosphere. The risks might depend on the rates of leakage (e.g. sudden or gradual) which could in turn pose different threats to biodiversity or climate. Even if such ‘end-of-pipe’ technological methods are developed and adopted, they should not be allowed to delay the introduction of cleaner forms of energy supply and production. Additional measures may be required to provide alternative livelihoods for those communities that currently depend largely on the extraction of fossil fuels for their economic livelihood.

104. In general SNH supports the application of technologies that help to reduce the emissions of greenhouse gases, sulphur and nitrous oxides from heavy industry, power stations and vehicles. However, use of these technologies should not result in other environmental problems or impacts on the natural heritage. For example, in seeking to reduce acid depositions, care should be taken to minimise any associated increase in emissions of greenhouse gases, and the sources of lime used in flue gas desulphurisation should be sensitively selected.

Nuclear

105. Nuclear reactors do not emit greenhouse gases in their electricity generation process, so are highly attractive from a greenhouse gas point of view. There are

however problems and issues associated with unplanned discharges of radioactive material, through accidents in reactor operation or fuel transport, leakage during the long-term storage of radioactive wastes, or deliberate interference, for example by potential terrorists. While most of these discharges relate to human health, they could also affect the natural heritage in two main ways. Firstly, wastes might escape into the environment where they could affect species, habitats and ecosystems, either causing harm directly or thereby entering the human food chain and causing a risk to human health. Secondly, radioactive contamination might lead to risks to human health such as to require restrictions on the public in certain areas, preventing public enjoyment of the natural heritage, as has already occurred at Sandside beach near Dounreay. Such irradiation risks may be small but could be far-reaching in both physical extent and time because of the very long-term persistence of some radioactive elements.

106. The main fuel used in nuclear power plants is uranium. Because the UK has no commercially viable uranium deposits, nuclear power is dependent on mining activity which takes place overseas, such as in Canada, Australia and countries of the former Soviet Union. Even commercially viable uranium is present in very low quantities which means that very large volumes of material must be processed. The extraction of uranium ore, including site management, restoration and aftercare, are increasingly carried out to international environmental standards. But where this is not the case there is a risk that mine wastes can give rise to a range of natural heritage impacts from the scarring of landscapes to the contamination of local soil and groundwater systems. Although these activities and potential impacts take place in other countries, just as for fossil fuels, they should be considered as part of Scotland's global footprint if the energy derived is used in Scotland.

107. From a purely natural heritage perspective, nuclear power could provide part of the answer to the challenge that climate change places upon our use of energy. **But the acceptability of nuclear power from a natural heritage perspective will depend critically on the identification, through the current review[43], of techniques for the long-term management of radioactive wastes which are safe, secure and environmentally satisfactory.** It will be important to ensure that sites for storage and/or disposal are selected and designed with due regard to landscape and biodiversity interests and that unnecessary limitations on public access to the countryside are avoided.

108. If nuclear power is to be an increasingly important part of the energy mix in developed countries on climate change grounds, then the United Nations Framework Convention on Climate Change suggests that it should be an option for all countries. This raises issues about the international regulation of the industry in relation to the link between civil and military uses, issues about global security and terrorism, and management issues associated with the trans-boundary consequences of unplanned discharges, including long-term management of wastes.

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[43] The Committee on Radioactive Waste Management undertook a wide consultation during 2004-05 and is due to present its recommendations to Government in 2006.

Electricity Transmission and Distribution

109. On the National Grid, transmission losses are inevitable because of heating in the wires. These losses are usually less than 10% within the UK, but nonetheless they represent a significant additional generation requirement and hence contribute to greenhouse gas emissions. Transmission losses associated with renewable sources are not significant for emissions of greenhouse gases, but they do affect the overall scale of renewables development which is required to meet a given energy demand, and hence the overall extent of related natural heritage impacts.

110. Most high voltage networks use overhead lines that can have significant visual impacts. There are only a few examples of where high voltage lines have been buried in countryside settings. In such cases the visual amenity benefits have to be weighed against not only the additional costs and technical difficulties, but also the habitat disturbance. Cable burial can disrupt a corridor up to 40m wide along the length of the cable. Whether this is significant will depend on the type of habitat affected, including its conservation value and ease of restoration.

111. Given the variability in electricity demand, and the intermittency of most types of renewable generation, a high level of interconnection between Scotland and other parts of the UK will provide the best means for using renewable resources to maximum effect. This will enable any temporary shortfalls in generation in Scotland to be balanced by excess supply capacity elsewhere, and allow surpluses to be transmitted and used in the south. Interconnection will also minimise the need for supplementary generating plant to be built in Scotland for occasional stand-by use alone. The same principle applies in respect of interconnection of the UK with mainland Europe.

112. Within Scotland, many renewable energy resources – wind, wave and tidal, and forestry biomass – are most abundant in the north and west, areas which are not at present well connected by high-capacity transmission lines. In considering the impacts which new or upgraded transmission lines may cause, due recognition should be given to the climate change benefits of enabling such resources to be harnessed. Realising such benefits is likely to require significant upgrading and extension of the grid within Scotland and of the interconnection with England. SNH recognises the importance of upgrading network infrastructure to facilitate an increased contribution from a range of renewable sources. However, influential studies such as DTI's Renewable Energy Transmission Study did not include any environmental analysis; and investment decisions by Ofgem, while taking account of the objective of reducing carbon emissions, do not include consideration of other impacts on the environment. Consequently we are concerned that transmission proposals now coming forward in Scotland have been taken largely on the basis of technical and economic assessments, without as yet a full consideration, at a strategic level, of the natural heritage implications. We believe that a broad Strategic Environmental Assessment for renewable energy is needed which includes examination of renewable energy types and locations and associated transmission requirements.

113. Major technical advances in electricity storage seem possible in the longer-term, for example by deploying nano-technology to enhance power storage in batteries[44]. Such advances could play a major role in overcoming the fundamental constraint of a lack of large-scale storage on the national grid (paragraph 30), and in smoothing over intermittencies in the supply of energy from renewable sources. Pumped storage hydro-power schemes may have a role in balancing out the peaks and troughs of daily demand cycles. Electricity demand could also be evened out over time by use of equipment which constrains use when overall demand is high.

114. The increased use of microgeneration (see Glossary) may in the future be able to make a significant contribution to overall energy output, without a corresponding increase in adverse impacts on the natural heritage. The development of 'smart grids' which use computers to manage the complexity of variable power generation and usage patterns, and the development of enhanced storage may allow a much more distributed mix of electricity generation to contribute to energy needs from a multiplicity of small-scale devices.

Transport

115. The transport sector represents a particular challenge in efforts to reduce emissions of greenhouse gases for three main reasons:

- rapid growth in the sector (paragraph 23)
- continued dependence on oil for fuel; and,
- the dispersed nature of emissions from vehicles, which makes technologies such as large-scale carbon capture and storage impractical.

116. Fuel switching in the transport sector involves the development of biofuels, the use of fuel cells using hydrogen or other fuels produced renewably, and powering of transport directly from renewable electricity. Towards the end of 2005 the Department of Transport announced proposals for a Renewable Transport Fuel Obligation which could aim for around 5% of all transport fuel to be from renewable sources by 2010.

117. Some crops can be processed for use as substitutes for petrol and diesel. Fuels can be produced from annual crops such as cereals, oilseeds, sugar beet and fodder beet, and there is increasing interest in deriving ethanol from wood and straw, which could open new markets for Scottish timber products and land managers. Recycled vegetable oils and fats from the food chain can also be used to produce biodiesel – the UK's first commercial plant opened in Motherwell in 2005. Biodiesel can reduce CO_2 emissions by 70-85% compared with ultra-low sulphur diesel, and bioethanol can reduce CO_2 emissions by 60-70% compared with unleaded petrol, though as yet there is considerable uncertainty over the agricultural inputs required. Bioethanol derived from straw is particularly effective, resulting in reductions of nearly 100%[45].

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[44] joint report in 2004 by the Royal Society of London and Royal Academy of Engineers

[45] Elsayed MA, Matthews R, & Mortimer ND (2003) *Carbon and energy balances for a range of biofuels options*. Report for DTI report number B/B6/00784/REP, URN 03/836

118. Incentives for biomass energy or biofuels should reflect their potential for saving carbon. Emissions resulting from the farming methods used, crop processing, and from the transport of the crops or resulting fuel to the point of use or sale should all be taken into account.

119. Care will be needed to make sure that biofuel policies do not unpick the environmental and conservation objectives now built in to agricultural and forestry policies. For example, any moves to release previous set-aside land for biofuel production should be accompanied by measures to maintain the natural heritage benefits that have arisen (even incidentally) from the operation of set-aside policy. Biofuel crops should also be planned and managed to contribute to climate change adaptation objectives, for example to help reduce the risk of flooding. In general, incentives for biofuels should be well aligned with other policies for biodiversity, forestry and agriculture. It will also be important that environmental impacts are not in effect exported to other countries, through purchase of biofuels which are produced unsustainably elsewhere.

120. Hydrogen as a fuel has a high energy content and is clean - the only product of its combustion being water. It is manufactured by the electrolysis of water (the chemical decomposition of water triggered by an electric current). If this electrolysis is done using renewable electricity, then hydrogen is a renewable fuel. It is most likely to be of benefit as a transport fuel, and there are a number of small-scale pilots – for example in Unst – in which hydrogen is being generated renewably and used for local transport. The overall efficiency of the production cycle is, however, relatively low. It has also been suggested[46], based on losses currently experienced in handling gases, that if hydrogen were widely used, the loss of free hydrogen during storage and transport could lead to damage to the ozone layer.

121. The development of fuel cells (see Glossary[47]) may also aid fuel switching, enabling hydrogen or other fuels manufactured using renewable electricity to be used in vehicles. Successful trials running buses on hydrogen fuel cells have recently concluded in London, Amsterdam, Reykjavik and other cities. In the rail sector, the main emphasis on fuel switching is currently on the electrification of lines, which could reduce emissions if electricity is sourced increasingly from low-carbon or carbon-neutral sources. Electrification requires costly investment, however, and may not be a realistic option for many Scottish rail routes – for these, the greatest potential for carbon reduction may lie in developing trains powered by fuel cells.

122. For air transport there currently appears to be no practical alternative to kerosene as the main fuel, which means that emissions must be reduced through fuel efficiency or demand management.

123. Within the transport sector, the twin aims of energy efficiency and switching fuels merge into a common issue which is the need to invest in well-planned, low-

[46]Tromp *et al* (2003) Potential Environmental Impact of a Hydrogen Economy on the Stratosphere. *Science*, Vol 300, Issue 5626, 1740-1742 , 13 June 200
[47] under *micro-generation*

carbon public transport systems wherever there is an appropriate level of transport demand. If these are to be used as a first choice in transport they need to be priced competitively and to offer a level of service and convenience that can match, as far as possible, other more polluting ways of making the same journey. In rural areas where public transport systems are not warranted by levels of demand, vehicle efficiency and low-carbon fuels are the main tools for achieving emission reductions.

8. Conclusions

124. Continued reliance on fossil fuels for the bulk of energy needs in all sectors will preclude attainment of the UK's greenhouse gas emissions targets. If carbon emissions from coal- and gas-fired electricity generation plant were captured and stored in geological reservoirs, that would enable some reductions to be made. However, continued dependence on oil in the transport sector (including aviation), and on oil and gas for heating in the domestic sector, is likely to result in an insufficient reduction in Scottish and UK emissions of greenhouse gases to meet the aim of 60% emission reduction by 2050. These are stark conclusions which point to the need for fundamental changes in our approach to energy use, as outlined in the previous sections of this paper.

125. The rapid depletion of UK gas reserves is difficult to defend in terms of sustainability. Over the coming decades, gas might best be used primarily to make good the intermittency of renewables production, and not as a mainstream means of space heating as it is used at present. It is also particularly wasteful to take a fuel like gas, turn it into electricity and then use that electricity as a fuel for space and water heating, with all the inefficiencies associated with these transformation processes (paragraph 26).

126. The UK is already rapidly becoming dependent on imports for gas. The UK Government's energy policy places an emphasis on security of energy supplies (paragraph 43). Reducing our dependence on gas will further that aim and help to reduce emissions.

127. For all types of energy generation, it is important that in evaluating greenhouse gas emissions, full account is taken of all aspects of the generation process, including emissions associated with mining and transport of fuels, materials and machinery for construction, generation, decommissioning, and waste disposal or storage.

128. Current indications are that over the next 15 years, nuclear and coal-fired power stations coming to the end of their planned life-span will be replaced by gas generation and renewables[48]. If the end result is to replace nuclear by renewables, this would be in conflict with the stated goal of encouraging the growth of renewable technologies to reduce emissions of greenhouse gases. There are contentious issues in this debate. **To address climate change and ensure good stewardship of the natural heritage, SNH would prefer to see, in order of priority:**

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[48] HM Government (2004) *Review of the UK Climate Change Programme: consultation paper*.

(i) **measures to encourage reduction in the overall use of energy, aimed at securing reducing demand rather than continued growth;**

(ii) **continued expansion in the proportion of energy generated from renewable sources, but subject to a strategic approach which minimises adverse impacts on the natural heritage;**

(iii) **a commitment to reduce emissions and other environmental problems associated with non-renewable electricity generation, either through the application of carbon capture and storage technologies to fossil fuel generation, or through continued generation by nuclear power. Preferences should depend on the long-term security of carbon capture technology and on the success of the current review of options for the long-term management of radioactive wastes.**

129. An emphasis on demand management and fuel switching to a diverse range of renewables including microgeneration could lead to new employment opportunities in rural areas, as has been demonstrated both during the development of hydro power in the 1940/50s and more recently in the development of onshore wind energy. These benefits are much to be welcomed as long as the natural heritage impacts of such developments are at an acceptable level.

130. In turn, major changes in the way energy is supplied and distributed are likely to have significant impacts on our lifestyles, influencing where we work and live, shop and holiday. These changes are inevitable and should be guided by the relevant local, regional and global environmental limits.

131. It should be expected that in due course, in updating the energy strategy for the UK, and the UK and Scottish climate change programmes, there will be an opportunity to include a wider assessment of the environmental impacts of alternative means of reducing energy-related emissions at both Scottish and UK level covering:

- managing demand, including overall demand and making sure that energy is used effectively and efficiently (for example discouraging the use of gas to generate electricity which is then used for heating)
- the role of off-grid energy generation and heating
- fuel mix, including the role of biofuels for transport and domestic use
- dispersed or centralised transmission and distribution

Such an analysis will help determine the best mix of measures for Scotland and the UK and should allow environmental interests to be taken into account in a strategic way in relation to the supply, distribution and use of energy.

132. The combined needs to generate an increasing proportion of electricity from renewable sources, to replace major plant over the next 10-15 years, and to upgrade the transmission network could mean that we are at a major turning point in the way electricity is supplied and delivered in the UK. Similar major decisions over the same period will apply to transport to re-think the way people access goods and services, and switching fuels where transport is required. It is

important that decisions that are taken now do not preclude or delay shifts to more sustainable patterns of the supply, distribution and use of energy based on ‘living within our environmental limits’.

8. Summary

Climate Change

- SNH views climate change, which is thought largely due to the burning of fossil fuels, as the most serious threat over coming decades to Scotland's natural heritage.

Energy Use and Trends

- Fossil fuels currently provide 90% of the energy used in the UK.
- Overall consumption of energy has increased by about 1% per year over the last 20 years, despite energy efficiency measures and shifts from a manufacturing to a service economy.
- Energy use is spread across all the main sectors – transport, industry, services and domestic.
- Over 60% of the energy used to generate electricity is lost as waste heat.
- All of Scotland's nuclear power stations, providing 37% of Scotland's electricity, are scheduled to close by around 2020.

Policy Context

- An overarching aim of UK energy policy is to reduce carbon emissions by 60% by 2050.
- Meeting Kyoto obligations by 2008-2012 is only a first, preliminary step.
- The Emissions Trading Scheme, Renewables Obligations and energy efficiency strategies are key instruments in reducing emissions.

The Challenge

- SNH strongly supports the aim of a major reduction in carbon emissions.
- To meet this aim will require action both to
  - reduce energy demand, by changing behaviour and energy efficiency measures;
  - switch energy sources to use a diverse mix of renewable sources.

Reducing Demand

- Energy prices
  - the price of various forms of energy should at least include their associated environmental costs;
  - in some cases products should be deliberately priced so that people choose the most sustainable option.
- Creating the conditions
  - awareness of personal ecological footprints should be increased, through environmental education and better information;
  - incentives should be offered for practices which do not use fossil fuels, and taxes levied on those which do;
  - changes in business practices should be encouraged, such as home working and video conferencing, to help drive travel demands down;
  - energy issues should feature prominently in education for sustainable development.

- Energy efficiency
  - transport, especially air transport, should be included within emission trading schemes.
- Leadership by business and the public sector
  - public sector spending decisions should reflect the associated long-term costs, including the environmental costs of energy use.

Switching Sources

- Renewables
  - SNH supports renewable electricity generation, subject to adverse effects on the natural heritage being minimised;
  - different technologies have different impacts - in general marine technologies have the potential for a lesser impact than land-based ones;
  - the Renewables Obligation has successfully stimulated renewables development, but very largely of a single type, onshore wind;
  - microgeneration could make a significant contribution, with little impact on the natural heritage;
  - planning for renewable electricity should be based on an SEA of the impacts of the various technologies in various locations, including the effects of any transmission infrastructure required to connect them.
- Fossil fuels
  - further long-term use of coal should be minimised, unless techniques for carbon capture and sequestration are proven to be secure in the long-term;
  - gas should be used more sustainably, to enable future generations to benefit from its availability.
- Nuclear
  - nuclear power is almost free of greenhouse gas emissions, but from a natural heritage perspective its acceptability depends critically on the identification of environmentally satisfactory techniques for the management of radioactive wastes.
- Transport
  - the development of biofuels to substitute for petrol and diesel should be encouraged, provided that crops are grown in a way compatible with other land use objectives, and the development of fuel cells powered by hydrogen or other fuels generated from renewable electricity;
  - there are no currently feasible alternatives to fossil fuels to power aircraft;
  - investment is needed in well-planned, low carbon transport systems.

Conclusions

- SNH wishes to see, in order of priority:
  - measures to reduce the overall use of energy;
  - increases in the proportion of electricity and transport fuels derived from renewable sources, subject to minimising any adverse impacts on the natural heritage;
  - a commitment to reducing emissions and other environmental problems associated with continued use of non-renewable fuels.

10. Glossary

An Explanation of Technical Terms or Policy Tools

Combined Heat and Power plant consists of a conventional electricity generator powered by fossil fuels or biomass, but in which the waste heat is used to meet local heating needs, eg for space heating a factory or for a district heating scheme. Over 60% of the energy from conventional power plants is currently lost as waste heat. By contrast, combined heat and power (CHP) plants are around 85% efficient, which means that only 15% of potential energy is lost in the transformation process. Micro-CHP systems are also available which can operate at the small business or even household level. The widespread use of CHP systems could cut energy consumption for electric space heating and water heating by more than half compared with heating by electricity generated from primary fuels. The Energy White Paper emphasises the potential for combined heat and power (CHP) stations;

Domestic Tradeable Quotas. Under such a scheme the government would allocate citizens a number of carbon units on a per capita basis free of charge. The total number of carbon units would be linked to targets to reduce emissions of greenhouse gases from the domestic sector. When citizens buy fuel or electricity they would surrender an appropriate number of carbon units. When the initial entitlement runs out, consumers would have to purchase additional carbon units at prevailing prices. These are currently the subject of research by the Tyndall Centre for Climate Change Research, and under consideration by UK Government as part of the Climate Change Programme. See also **emission trading.**

Energy Reward Card. A reward card can help to change individual behaviour - consumers earn more points when they purchase products and services that rely less on fossil fuels, and the points can be traded in for things like leisure activities or towards the cost of public transport. The scheme has been under trial in Rotterdam, and proposed in Wales

Ecological Footprint is a measure of the mark which society has on the planet and its resources. The footprint measures the amount of resources we use compared with what is available in the world. It considers how much land and sea are needed to feed us and provide all the energy, water and materials we use in our everyday lives. It also calculates the emissions generated from the oil, coal and gas we use, and determines how much land is required to absorb our waste.

Emission Trading Scheme. This is a tradeable permit system wherein emissions targets for businesses are set, and those businesses which emit less than their target may sell their emission shortfall to those who exceed, thus establishing a market value for emissions.

In January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas emission trading scheme world-wide. The EU as the central authority sets a cap or limit on emissions of CO_2 for participants. Those who exceed the limit must buy additional quota from others who emit less than expected, for example as a result of improvements in efficiency or investing in new technology.

The scheme currently focuses on installations responsible for significant emissions of greenhouse gases. It covers a total of more than 12,000 installations in all 25 Member States (combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper). Together these account for nearly 50% of the EU emissions of CO_2, with about 46% of UK emissions covered by the approved UK National Allocation Plan. A tradable emissions quota has been set for each installation. The overall level of allowances in the EU is now fixed for 2005-2007 through the agreed National Allocation Plans. Current expectations are that the allowances are likely to be more scarce in Phase 2 (2008-2012) to enable the EU to meet its obligations under the Kyoto Protocol.

Economic instruments can provide significant incentives to enhance energy efficiency. In principle, tradable permits achieve the same result as environmental taxes, but they leave the market with complete flexibility to identify the best mechanisms. Whereas a tax sets a price (the tax) and leaves the polluter to adjust the quantity (the level of emissions), a tradable permit system sets a quantity (a quota of emission permits), and the price (the price of the permit) adjusts according to the resulting supply and demand for permits.

Fuel Cell. A fuel cell is an electrochemical device. It is similar to a battery, but fuel cells produce electricity from an external fuel supply as opposed to the limited internal energy storage capacity of a battery. Fuel cells are designed for continuous replenishment of the reactants consumed. Typical reactants include hydrogen and oxygen. There is considerable interest in the potential for fuel cells to power vehicles, fuelled by bottled hydrogen gas.

Fuel Poverty is defined under Section 95 of the Housing (Scotland) Act 2001 as *being a household living in a home which cannot be kept warm "at reasonable cost"*.

Gigawatt Hours and Megawatts. The numerical unit used to refer to energy is the watt. This is a measure of the rate at which energy is supplied or used. An electric kettle consumes electricity at a rate of about 1,000 watts, or a kilowatt (kW) as it heats water. A megawatt (MW) is a million watts, one gigawatt (GW) is a billion watts and a terawatt (TW) is a thousand GW. A million tones of oil burnt gradually over an entire year would produce heat at an average rate of 1.33GW.

Total installed generating capacity in Scotland, (including renewables but excluding pumped storage) is about 12,000 MW (or 12 GW). If this installed capacity were operating 100% of the time (8760 hours a year), then it would generate 105,120 Gigawatt hours (GWh). Actual output is less than this, at 48-49000 GWh, so the 'load factor' is about 50%. The load factor is relevant in considering how much new generating capacity is required in the future.

Heat Pumps move heat from one place to another, for example from the air outside to indoors, or from the ground to indoors (often called 'geothermal heat pumps'). They work like a refrigerator in reverse, but typically use over 70% less energy than conventional heating. They can be used in reverse to cool buildings in hot weather.

Micro-generation refers to a range of small-scale electricity generation technologies, which may be used at domestic or individual business scale. These include use of photovoltaic cells, micro CHP (combined heat and power) plant, small wind turbines, small-scale hydro plant, and fuel cells. Excess power may be supplied to the National Grid.

National Home Energy Rating (NHER) – see Standard Assessment Procedure SAP)

Renewables Obligation (Scotland). This obligation is matched by parallel obligations in England and Wales, and in Northern Ireland. It places an obligation on all electricity suppliers to supply a proportion of electricity from new renewable sources; the required proportion rises from year to year to 10.4% in 2010 and soon will be extended to 15.4% by 2015. (These requirements exclude the contribution to renewables from large-scale hydro and waste-to-energy schemes.) To comply with the Obligation electricity suppliers must either:

- produce Renewable Obligation Certificates (ROCs) to show that they have generated or bought electricity from recognised renewable energy generators; or,
- buy ROCs on the open market from other suppliers with a surplus; or,
- pay the 'buyout price' of 3p per kWh unit (£30/MWh) to make up the shortfall between their stock of ROCs and their statutory target.

The 'buy-out' price is payable to the Gas and Electricity Markets Authority, Ofgem. Buyout receipts are recycled back to suppliers in proportion to their production of ROCs.

The Renewables Obligation (Scotland) was introduced in April 2002 and has very successfully stimulated development interest in renewable energy projects: the market value of renewable electricity has risen to 6-7p per unit compared with the likely wholesale price of electricity in 2005 of 3 pence per unit[49].

Social Cost of Carbon. The social cost of carbon is more accurately described as the social and environmental cost of carbon, as the main contributory factor is the likely future cost to society of climate change, due to carbon emissions. Attempts to place a value on the social cost of carbon involve a number of key scientific uncertainties and uncertainties associated with economic valuation. The main scientific uncertainties include:

- measuring present, and predicting future emissions;
- translating levels of emissions to changes in the atmospheric concentration of carbon;
- estimating the climate impact associated with an increase in atmospheric concentration; and,
- identifying the physical impacts resulting from climatic change.

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[49] UK Sustainable Development Commission (2005) *Wind power in the UK*

The main economic valuation uncertainties include:

- estimating monetary values for non-market impacts (i.e. those impacts for which a market based price does not exist);
- predicting how the relative and absolute value of impacts will change into the future;
- determining the way in which damage estimates should be aggregated across regions with differing levels of national income; and
- determining the rate at which the value of future impacts should be discounted to today's prices.

In addition, some values cannot be expressed in monetary terms, and attempting to force them into such a framework may bring a high degree of artificiality to the resulting decisions. Other ways need to be found to make sure that non-market impacts (such as loss of biodiversity, change in ecological function, loss of landscape quality, impact on amenity value) are given due weight and regard to decisions about the amount and sources of energy that are used.

Standard Assessment Procedure (SAP). SAP ratings provide a measure of the energy efficiency of a dwelling and is based on estimates of space and water heating costs. A rating of 100 to 120 indicates an extremely efficient house. Based on this system, a house built to 1995 regulations would have a SAP rating of around 80, and a new house to 2002 regulations would have a SAP rating of about 100. The energy efficiency of the country housing stock has risen from a SAP rating of about 12 in 1970 to about 45 in 2000 (Energy Consumption in the UK, 2002).

In Scotland the preferred energy rating is the National Home Energy Rating (NHER). The two scales measure slightly different things: the SAP looks only at the fixed elements of the home and is the same wherever the property is located in the UK. All homes built to the same design should have exactly the same SAP. The NHER is a 10-point scale and includes various location-specific elements (including whether the home is south-facing or sheltered from wind by other buildings) and so reflects actual running costs. If two homes have the same floor area but different NHERs, then the home with the better (higher) NHER should cost less to run. This allows geographical variations such as Scotland's relatively cool climate to be taken into account when making comparisons across the UK. In Scotland the average housing stock has a rating of 4.1 to 4.5 (NHER) but 14% of the stock has a rating of 2 or less (Scottish House Condition Survey, 2002). An energy efficient home would have a rating of at least 7 on the NHER scale.

At present it is not possible to compare SAP/NHER ratings with measures used in other parts of the EU. Standardisation of various measures for building efficiency is one of the aims of the EU Directive on the Energy Performance of Buildings[50], which member States including the UK must implement by January 2006. The Directive is being given effect in UK law through changes to the Buildings Regulations, and will also apply to existing stock when changes of use are proposed.

[50] Directive 2002/91/EC

Whether measured by the Standard Assessment Procedure (SAP) or the National Home Energy Rating (NHER), the overall rating for homes remains well below the score associated with an energy efficient home.

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