Chapter 2 Climate Change and the Need for the Project

2.1 Introduction

1 The development of clean and reliable sources of energy is considered to be of great importance for society in mitigating the effects of climate change, in providing alternatives to falling reserves of fossil fuels and in delivering secure domestic supplies of energy.

2 These issues now form an important part of government policies, both at a national and international level, with targets having been introduced for the reduction of greenhouse gas (GHG) emissions and the promotion of renewable energy.

3 Offshore wind generation has been identified at European and national level as being capable of providing a significant contribution towards such targets. The Scottish territorial waters (STW) sites, including the Neart na Gaoithe project, are recognised as being important contributors to Scotland's and the UK's targets for reducing GHG emissions and generating electricity from renewable energy sources.

4 This section provides an explanation of climate change, summarises the implications at an international level and describes international and domestic efforts to mitigate the risks of a changing climate all set against a rapidly growing demand for secure energy. This provides the policy context for the project and the background to the need for the project at a national level. Further discussion of the regulatory and policy context of the project is set out in Chapter 3: Regulatory and Policy Context. Additional socioeconomic benefits of the project are discussed in Chapter 23: Socioeconomics.

2.2 Why do we need Renewable Energy?

5 Scotland, and the UK as a whole, require new, renewable, sources of energy to combat climate change and ensure that a secure supply of electricity is available to meet increased future demand. The provision of new renewable energy projects will help the government meet legally binding national and international targets on climate change.

2.2.1 Combating Climate Change

2.2.1.1 What is Climate Change?

6 Climate can be understood as the average weather conditions over a given time and in a given area. Climate change is a significant and lasting alteration in long term weather conditions. The earth is unique in this solar system in having a climate (among other favourable conditions) suited to sustaining life. The United Nations Framework Convention on Climate Change defines climate change as *"…a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."*

7 The temperature of the planet is maintained by the trapping of radiated heat by certain atmospheric gases - termed greenhouse gases. This containment of heat has been likened to the conditions within a greenhouse where the heat loss is minimised by the glass – the 'Greenhouse Effect'. Any factor which alters the ability of the atmosphere to trap or radiate heat will have an effect on climate (Leggett *et al*., 1992).

8 The Greenhouse Effect is a natural phenomenon whereby solar radiation from the sun passes through the atmosphere to warm the surface of the earth. Naturally occurring GHGs then trap some of the thermal energy radiating from the warm earth to maintain the temperature of the earth at around 30°C higher than it would otherwise be. Increasing amounts of GHGs in the atmosphere can amplify the insulating effect and accelerate the warming of the earth, contributing to climate change.

9 Human activities can accelerate the production of four of the major long-lived GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and carbon tetrachloride (CCl_4) (Leggett *et al*., 1992) and in doing so, magnify and accelerate the effects of climate change.

10 Changes in atmospheric concentrations of GHGs alter the energy balance of the earth's climate system and are believed to be responsible for increases in global temperature. The Intergovernmental Panel on Climate Change (IPCC) concluded that *"Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse-gas concentrations"* (IPCC, 2007).

11 The effects of climate change are becoming more apparent. Increases in global air and ocean temperatures and secondary effects such as decreases in the average annual cover of snow and ice are now accepted as a consequence of climate change (IPCC, 2007).

2.2.1.2 Implications of Climate Change

12 The IPCC estimates that if the global population continues to grow at the projected levels, with a corresponding continued reliance on fossil fuels, global temperatures could rise by 2.4-6.4°C on pre-industrial levels by 2099 (IPCC, 2007). Temperatures have risen by an average of 0.74°C across the globe from 1906 to 2005 and are predicted to rise further (IPCC, 2007).

13 The likely effects will be widespread and are predicted to include extensive flooding, displacement of populations, drought in some areas and global food shortages. Extremes of weather are also likely with intense storms, particularly hurricanes and typhoons, possibly becoming more common. In addition, a temperature rise of just 2°C could leave 15-40% of all species facing extinction (Stern *et al*., 2006).

14 According to the Stern Review (Stern *et al.,* 2006), the overall costs of adaptation to climate change could be equivalent to an ongoing loss into the future of at least 5% of global gross domestic product (GDP) each year with this estimate increasing to 20% of GDP if a wider range of risks and impacts are taken into account. These estimates have been subject to a level of academic criticism; however, they indicate a high possibility of economic loss arising from climate change. More recently the UK Government has undertaken a review of the risk associated with climate change for a number of business sectors, outlining possible impacts such as disruption to business supply chains and increases in energy requirements for some businesses (HM Government, 2012).

2.2.1.3 Reduction of Emissions through Adoption of Renewable Energy Technologies

15 Emissions of GHGs attributable to human activities increased by 70% between 1970 and 2004, and in 2006 levels of GHGs in the atmosphere were higher than at any point in the last 650,000 years (IPCC, 2007). Carbon dioxide is considered to be the most important anthropogenic GHG; between 1970 and 2004 annual global emissions of CO_2 increased by 80% (IPCC, 2007).

16 The combustion of fossil fuels such as oil, coal and natural gas accounts for over 80% of global energy generation (OECD/IEA, 2010b) and as a by-product of combustion, produces the majority of GHGs as emissions. In 2008, over 40% of global CO_2 emissions was produced by the generation of electricity and heat (OECD/IEA, 2010a). The generation of energy from renewable sources can be considered to offset energy which would otherwise have been generated using fossil fuels.

17 Emissions of CO_2 can be reduced through the displacement of conventional generation sources with low carbon technologies as well as careful management of energy supply and use, and through increased energy efficiency (Edenhofer *et al.*, 2011). Emphasis has been placed on the contribution of renewable energy technologies in meeting international emissions reductions targets with the G8[1] concluding in 2010 that *'Diversification of energy is crucial and the energy mix should include as many renewable sources of energy as possible'* (Fitzgerald and Demneri, 2010).

[1] The G8, also known as the Group of 8, is an assembly of world leaders who meet annually to discuss global issues (Understanding the G8, 2011).

2.2.2 Meeting Demand and Maintaining Energy Security

18 Diversification of energy sources is not intended solely to achieve a reduction in GHG emissions. Global energy demand is set to increase by 53% from 505 quadrillion British thermal units (BTU) in 2008 to 770 quadrillion BTU in 2035 (US Energy Information Administration, 2011). The OECD/IEA calculate that 81% of energy supply globally comes from a form of fossil fuel (OECD/IEA, 2010b). This reliance on finite supplies of fossil fuels, given an increasing demand and the risks this dependence brings, is now being recognised.

19 Saudi Arabia, Iraq, Iran and Venezuela now control the majority of the global oil reserves (Organisation of Petroleum Exporting Countries (OPEC), 2009). Regional volatility and consumer vulnerability to unilateral action from any or all of the main oil producers put global markets and national energy security at risk. This monopoly of control has led to accusations of price fixing and artificial inflation above the normal market value of crude oil through premeditated embargo of crude stocks from the market. Short term fall in supply as a result of conflict in the Middle East was common through the 1990s and into the 2000s. In conjunction with increasing concerns about the environmental impacts of exploitation of fossil fuels, this is also a major driver to shift to less vulnerable energy systems such as local renewable energy sources (Metz *et al*., 2007).

20 In the UK there are two main security of supply challenges: increasing reliance on imports of oil and gas in a world where energy demand is rising and energy is becoming more politicised; and the need for investment in new electricity generation capacity of around 30-35 GW over the next two decades to replace power station retirements and meet rising electricity demand as the economy grows (DTI, 2007).

21 Under the UK Renewable Energy Roadmap, energy from renewable sources, and from wind power in particular, is seen as an essential part of the energy generation mix required to meet demand (DECC, 2011). Although intermittent, wind power is not dependent upon potentially unreliable sources of oil or gas from overseas and therefore, as part of a mix of technologies, can increase energy security.

2.2.3 Climate Change and Renewable Energy Policies

2.2.3.1 Climate Change Policies

22 The European Commission (EC) has developed a number of mechanisms to reduce GHG emissions and to focus effort on strengthening and diversifying the generation and supply of energy. Alongside international agreements such as the Kyoto Protocol, these include policies on emissions trading (Directive 2009/29/EC), effort sharing on GHG emissions (Decision No. 406/2009/EC), taxation of energy products and electricity (Directive 2003/96/EC) and, importantly, Directive 2009/28/EC on the promotion of the use of energy from renewable sources ('the Renewable Energy Directive').

23 At the UK and Scottish level there is now considerable focus on addressing the causes of climate change.

> ***"The Government believes that climate change is one of the gravest threats we face, and that urgent action at home and abroad is required."***
>
> **HM Government, 2010**
>
> ***"Climate change is one of the most serious threats we face. Urgent action is needed to cut emissions which cause climate change."***
>
> **Alex Salmond, First Minister, Scottish Government, 2008**

24 The UK Government has set ambitious domestic targets to reduce GHG emissions. Under the Climate Change Act 2008 there is a commitment to reduce GHG emissions by at least 34% by 2020 and 80% by 2050, below the 1990 baseline. The Carbon Plan, a government-wide plan of action on climate change, reiterates these targets and sets carbon budgets for five year periods. In addition, drivers for renewable energy are strengthened in the Energy Acts (2004, 2008, 2010 and 2011). Chapter 3: Regulatory and Policy Context provides further information on the regulatory framework governing renewable energy and offshore wind development.

25 The Scottish Government's commitment to tackling climate change is laid out in the Climate Change (Scotland) Act 2009, which sets an interim target of a 42% reduction in GHG emissions by 2020, in addition to the UK target of an 80% reduction by 2050.

2.2.3.2 Renewable Energy Policies

26 The Renewable Energy Directive sets a target for the European Union to achieve a total renewable energy generation target of 20% by 2020, as well as specific targets for individual member states (European Commission, 2011).

> ***"European renewable energy policy has never been more important. Renewable energy plays a crucial role in reducing greenhouse gas emissions and other forms of pollution, diversifying and improving the security of our energy supply and maintaining our world-leading, clean energy technology industry."***
>
> **Gunther Oettinger, European Commissioner for Energy, 2011**

27 Under the Renewable Energy Directive, the UK has agreed to source 15% of its total energy needs (including electricity, heat and transport) from renewable sources by 2020. Due to of the relative inflexibility of other sectors, meeting this 15% target will require between 30%-40% of UK electricity consumption to come from renewable sources (DECC, 2009).

28 The UK's target under the Renewable Energy Directive is delivered by individual targets for England, Wales, Scotland and Northern Ireland. Scotland set a target in 2010 to source 80% of Scottish electricity consumption from renewable energy sources by 2020 (Scottish Government, 2010).

29 In 2011 the Scottish Government increased this target. The 2020 Routemap for Renewable Energy in Scotland set a target for renewable sources to generate the equivalent of 100% of Scotland's gross annual electricity consumption by 2020 (Scottish Government, 2011a).

> ***"Our new target of generating 100 per cent of Scotland's electricity needs from renewables by 2020 is one of the most demanding anywhere in the world. It is necessary if we are to become the green energy powerhouse of Europe. I also think it's achievable. A strong and vibrant offshore wind sector is at the heart of our vision to create new, low carbon jobs and industries."***
>
> **Fergus Ewing, Scottish Government, 2011b**

30 The Scottish Government considers that Scotland has approximately a quarter of Europe's tidal and offshore wind energy capacity (Scottish Government, 2009) and is therefore supporting the emerging technologies of offshore wind, wave power, tidal stream and biomass in a number of ways, including schemes such as the Saltire Prize for marine renewable energy research (Scottish Development International, 2011). Changes to the Renewables Obligation (Scotland) Order 2009 (as amended in 2010 and 2011) have also increased the financial support mechanisms for marine renewable energy, with the Scottish Government currently consulting on further changes to the support levels for projects (Scottish Government, 2011c).

31 In addition to the wider strategies for renewable energy development set out in the UK Renewable Energy Strategy, the Scottish Government has developed a Renewables Action Plan (RAP), which aims to drive development of renewable energy in Scotland.

32 Finally, the sector specific marine plan, 'Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters' (Marine Scotland, 2011) aims to maximise the energy contribution from Scotland's offshore wind resource, seeing this as both an environmental and economic imperative. The Plan highlights the links between an energy supply increasingly provided by renewable sources and a means of Scotland meeting its carbon reduction targets.

2.3 Why Offshore Wind Energy?

33 Offshore wind energy represents the most viable method of delivering the significant proportion of the UK and Scottish targets which can only be delivered by 2020 through the use of proven generation technologies (wind turbines). While onshore wind also has a significant contribution to make to targets there is concern that the onshore environment is less likely to be able to accommodate the scale of projects required under government policies.

34 The EC considers wind energy to be one of the most promising renewable energy technologies and an area which has made significant gains in the efficiency and effectiveness of energy generation (European Commission, 2011).

35 However, in the UK, suitable locations for the development of onshore wind farms are increasingly difficult to locate and consent. While offshore development is not without its challenges there is a general public perception that siting wind farms offshore may be more acceptable than in many locations onshore (e.g., Warren *et al.*, 2005).

36 Moving offshore allows deployment at a far greater scale than can realistically be achieved onshore. Additionally, moving offshore can take advantage of a higher wind resource; with both higher speeds and more consistent wind available in the marine environment.

37 Scotland has enormous potential for marine renewable energy development. Current estimates are that Scotland has up to 25% of Europe's offshore wind resource (Marine Scotland, 2011). The Carbon Trust believes that offshore wind can deliver up to 4.5% of the UK's 15% overall renewable energy strategy target (The Carbon Trust, 2008). Similarly, both the UK Renewable Energy Strategy (DECC, 2009) and the 2020 Routemap for Renewable Energy in Scotland (Scottish Government, 2011a) place considerable emphasis on the role of offshore wind in delivering targets. The Scottish Government is fully supportive of the offshore wind sector, recognising both the potential energy generation and economic development opportunities provided by the deployment of large scale wind turbines around Scotland's shores. This support is enunciated in the policy and guidance documents described in this chapter and Chapter 3: Regulatory and Policy Context.

2.4 The Need for the Project

38 The Neart Na Gaoithe project will offset GHG emissions and increase security of electricity supply, thereby assisting with the delivery of government policy and the meeting of renewable energy targets.

2.4.1 Emissions Reduction

39 As part of the renewable generation mix, Neart na Gaoithe will help to reduce emissions of CO_2, NO_X, and SO_2 during the operation phase equivalent to the annual emissions of CO_2, NO_X, and SO_2 from traditional thermal generation sources for the generation it replaces. A comparison of Neart na Gaoithe annual emissions with the equivalent annual emissions associated with traditional thermal generation sources are presented in Table 2.1.

Generation Source	Total annual emissions (t) for 1434.2 GWh		
	CO_2	NO_X	SO_2
Neart na Gaoithe	5460.4	131.7	91.4
Coal	1303687.8	2614.5	2046.6
Natural Gas	570811.6	1.0	N/A

Table 2.1: Annual emissions comparison

2.4.2 Carbon Emissions Offset

40 During the fabrication and construction of the development carbon emissions will be generated and released. Over the lifetime of the project these carbon emissions will be offset by the net reduction in emissions through the carbon neutral technology. A Lifecycle Carbon Analysis (LCA) is a method of measuring a product or process's effect on the environment in regard to GHGs throughout its life-time.

41 The carbon payback period is analogous to the financial payback period, and represents the period of time before a product or project has saved more CO_2 emissions than has been produced by its construction and operation.

42 In Chapter 5: Project Description two alternative installation, operation and maintenance and decommissioning scenarios are described; a high scenario where the maximum number of turbines, foundations and cables are required and are sourced from Europe and China and a low scenario where the smallest number of components are required and are sourced in the UK. The 'low scenario' is the best (realistic) case and the 'high scenario' is the worst (realistic) case.

43 Assuming a 25 year life of the turbines, the development will displace CO_2 emissions (CO_2e) from other energy sources by between 10.9 and 25.5 million tonnes in the low emissions case, and between 12.4 and 29.9 million tonnes in the high emissions case.

44 Although it might be expected that the high emissions scenario results in a lower nett displacement of CO_2e, the increased annual generation calculated for the high emissions scenario over time displaces more emissions, resulting in a greater nett displacement.

45 The payback range for Neart na Gaoithe has been calculated to be within 2 to 3 years from the start of installation. Additional information is presented in Appendix 10.3: Lifecycle Carbon Analysis.

2.4.3 Energy Provision

46 RenewableUK has developed the following equation (refer to Equation 1) which calculates the number of homes that can be supplied with energy generated by a wind farm project (RenewableUK, 2011).

$$\text{Homes Supplied} = B \times 0.3 \times 8760/4700$$

Equation 1: Homes supplied

47 In Equation 1, B is the installed capacity of the wind farm in kW, in this case taken to be 450,000 kW, 0.3 is the RenewableUK stated capacity factor (dimensionless) and 8,760 is the number of hours in one year. The average UK household annual energy consumption is taken to be 4,700 kWh/household (Renewable UK, 2012).

48 Applying this equation to Neart na Gaoithe, using a capacity a factor of 30%, is estimated to produce enough electricity each year to meet the needs of the equivalent of 251,617 households. Using what is contended to be a more representative capacity factor of 40%, the number of households increases to 335,489.

49 The City of Edinburgh has approximately 218,774 households (General Register Office for Scotland, 2010). In applying Equation 1, the Neart na Gaoithe wind farm would generate more locally produced electricity each year than the annual domestic demand of a city of this size.

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