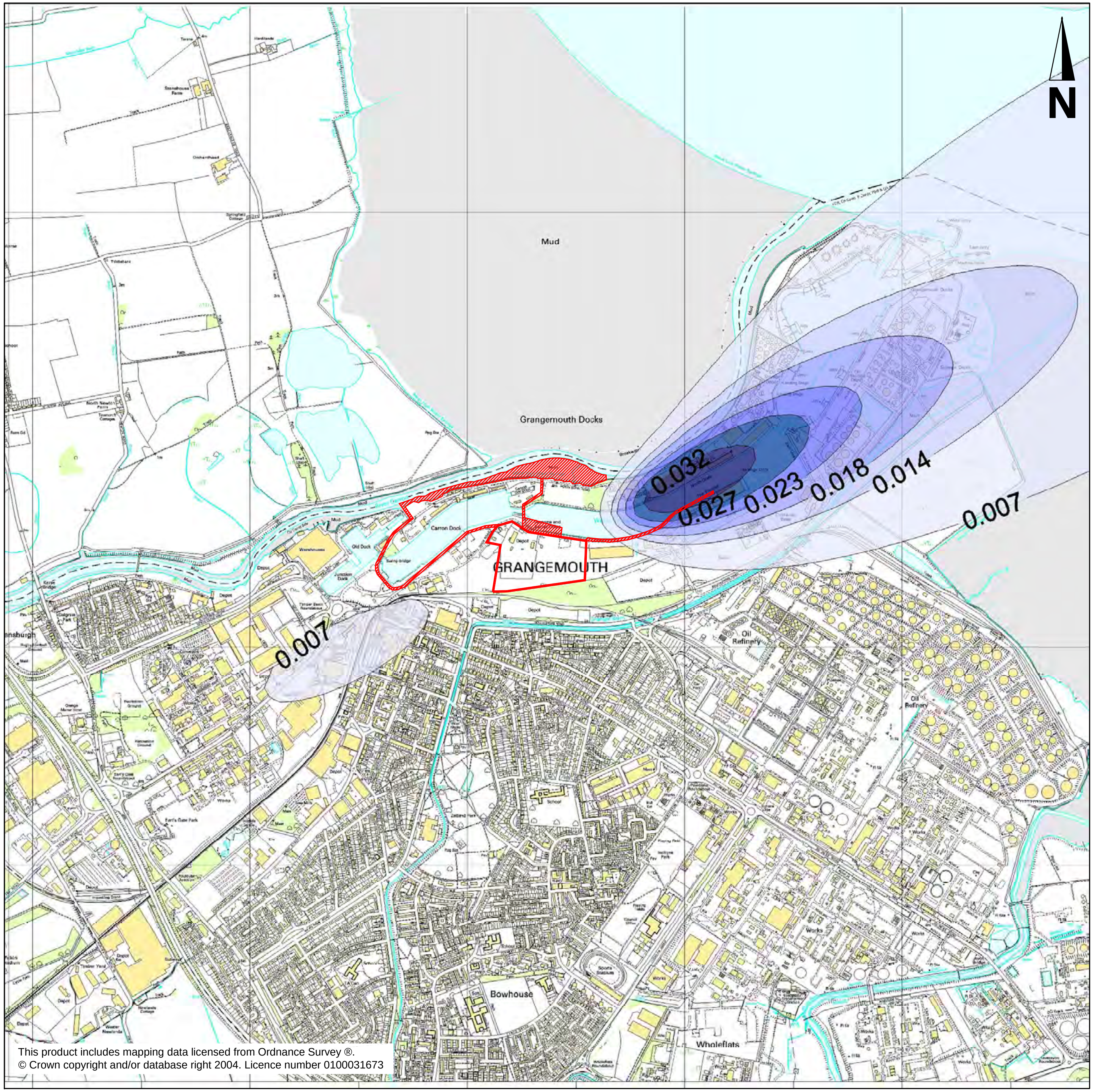

Forth Energy

Grangemouth Renewable Energy Plant

Figure 9.5

Annual Mean Chromium (VI) Process Contribution (2008)

Legend

- Application Boundary
- Area of Search for Cooling Water Infrastructure
- <0.007 ng/m³
- 0.007 - 0.014 ng/m³
- 0.014 - 0.018 ng/m³
- 0.018 - 0.023 ng/m³
- 0.023 - 0.027 ng/m³
- 0.027 - 0.032 ng/m³
- 0.032 - 0.037 ng/m³

EQS - 0.2 ng/m³

The process contributions when added to the baseline level of chromium (VI) do not exceed the relevant guideline.

0 500 1000
Metres

SINCLAIR KNIGHT MERZ SKM ENVIROS

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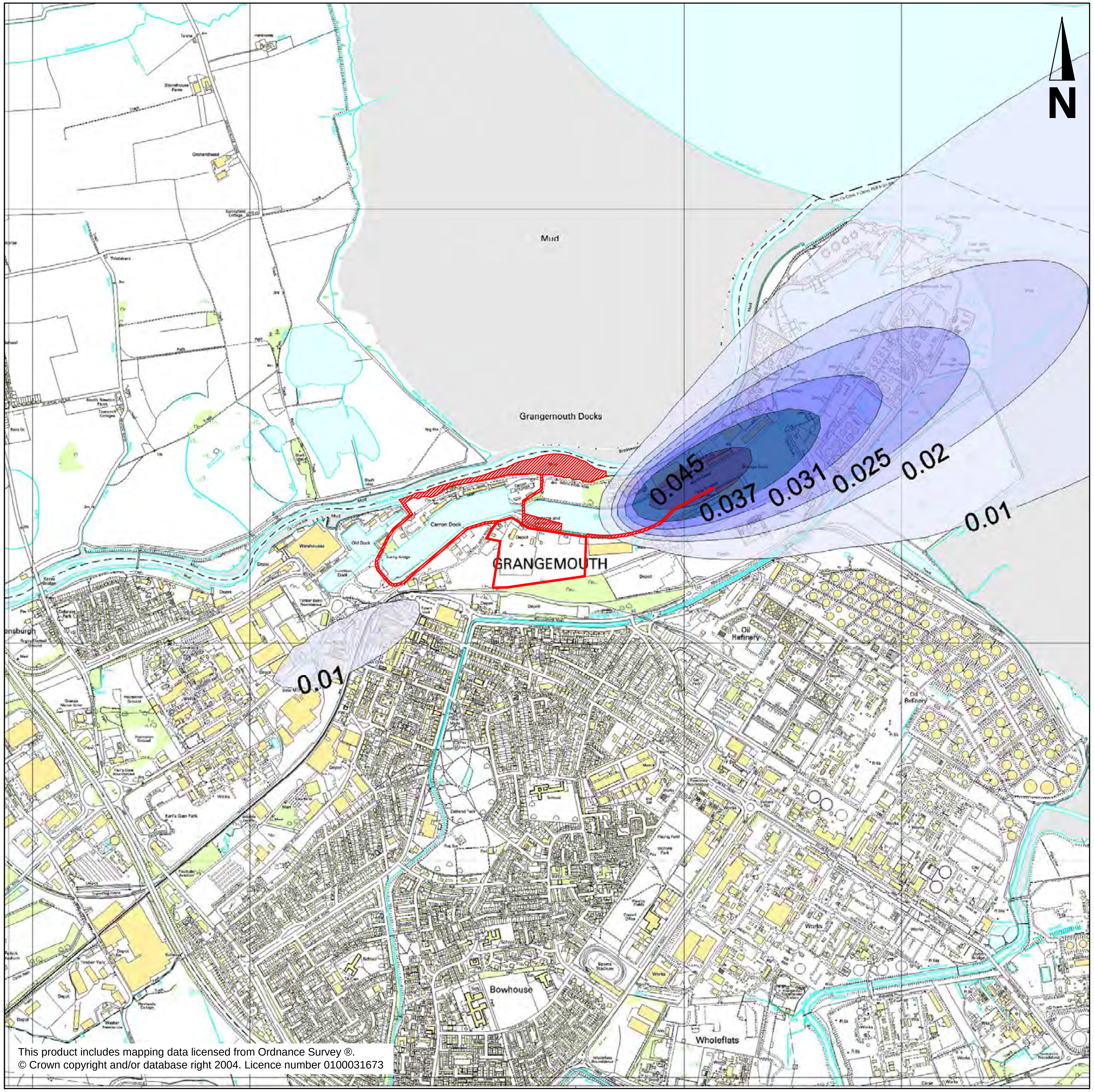

Forth Energy

Grangemouth Renewable Energy Plant

Figure 9.6

Annual Mean Benzo(a)pyrene Process Contribution (2008)

Legend

- Application Boundary
- Area of Search for Cooling Water Infrastructure
- <0.01 ng/m³
- 0.01 - 0.02 ng/m³
- 0.02 - 0.025 ng/m³
- 0.025 - 0.031 ng/m³
- 0.031 - 0.037 ng/m³
- 0.037 - 0.045 ng/m³
- 0.045 - 0.052 ng/m³

EQS - 1 ng/m³

The process contributions when added to the baseline level of benzo(a)pyrene do not exceed the relevant guideline.

0 500 1000
Metres

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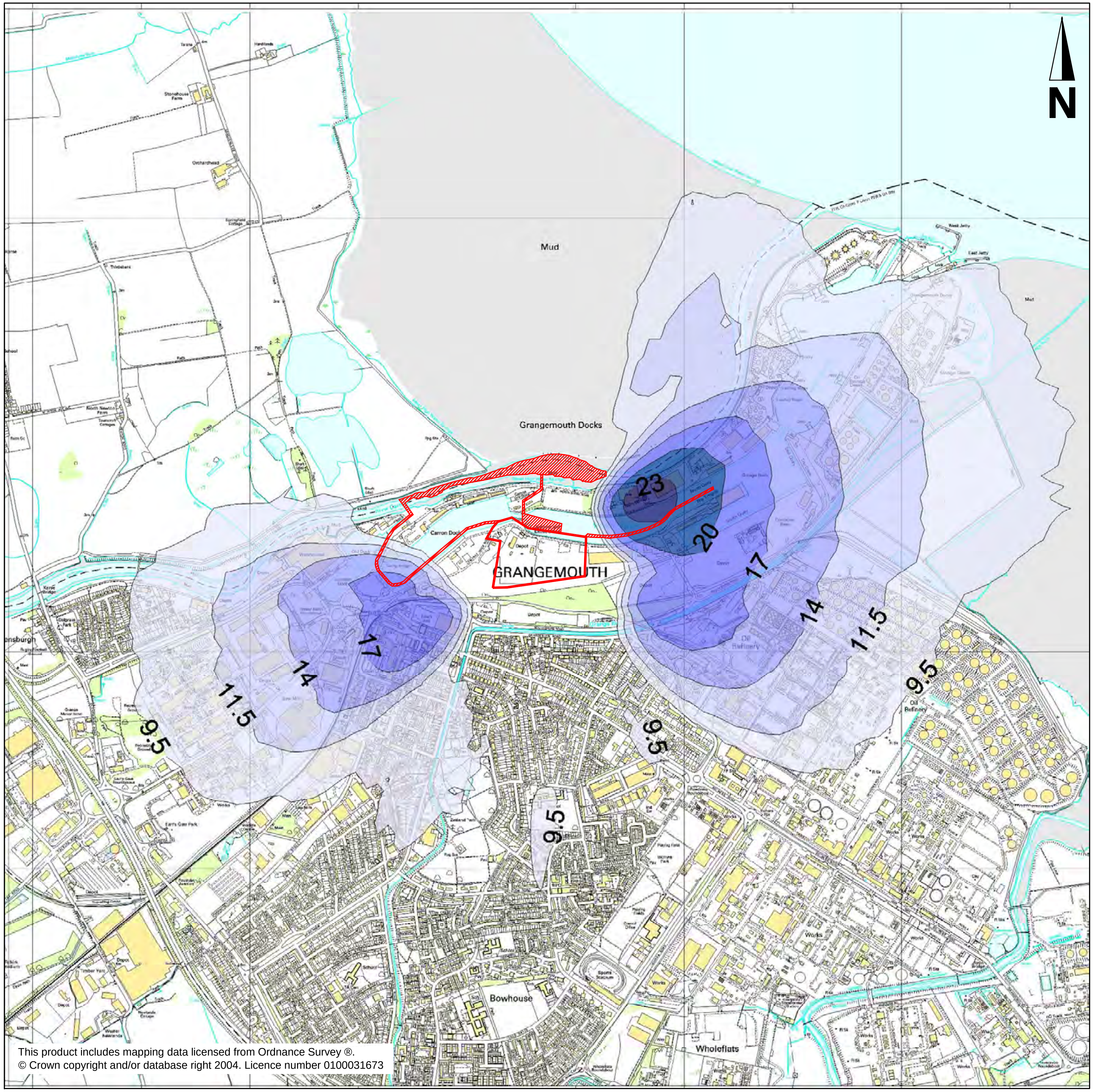

Forth Energy

Grangemouth Renewable Energy Plant

Figure 9.7

99.9th Percentile of 15 Minute Sulphur Dioxide (Method 2) Process Contribution (2007)

Legend

- Application Boundary
- Area of Search for Cooling Water Infrastructure
- <9.5 µg/m³
- 9.5 - 11.5 µg/m³
- 11.5 - 14.0 µg/m³
- 14.0 - 17.0 µg/m³
- 17.0 - 20.0 µg/m³
- 20.0 - 23.0 µg/m³
- 23.0 - 24.4 µg/m³

EQS - 266 µg/m³

The process contributions when added to the baseline level of sulphur dioxide do not exceed the relevant guideline.

0 500 1000
Metres

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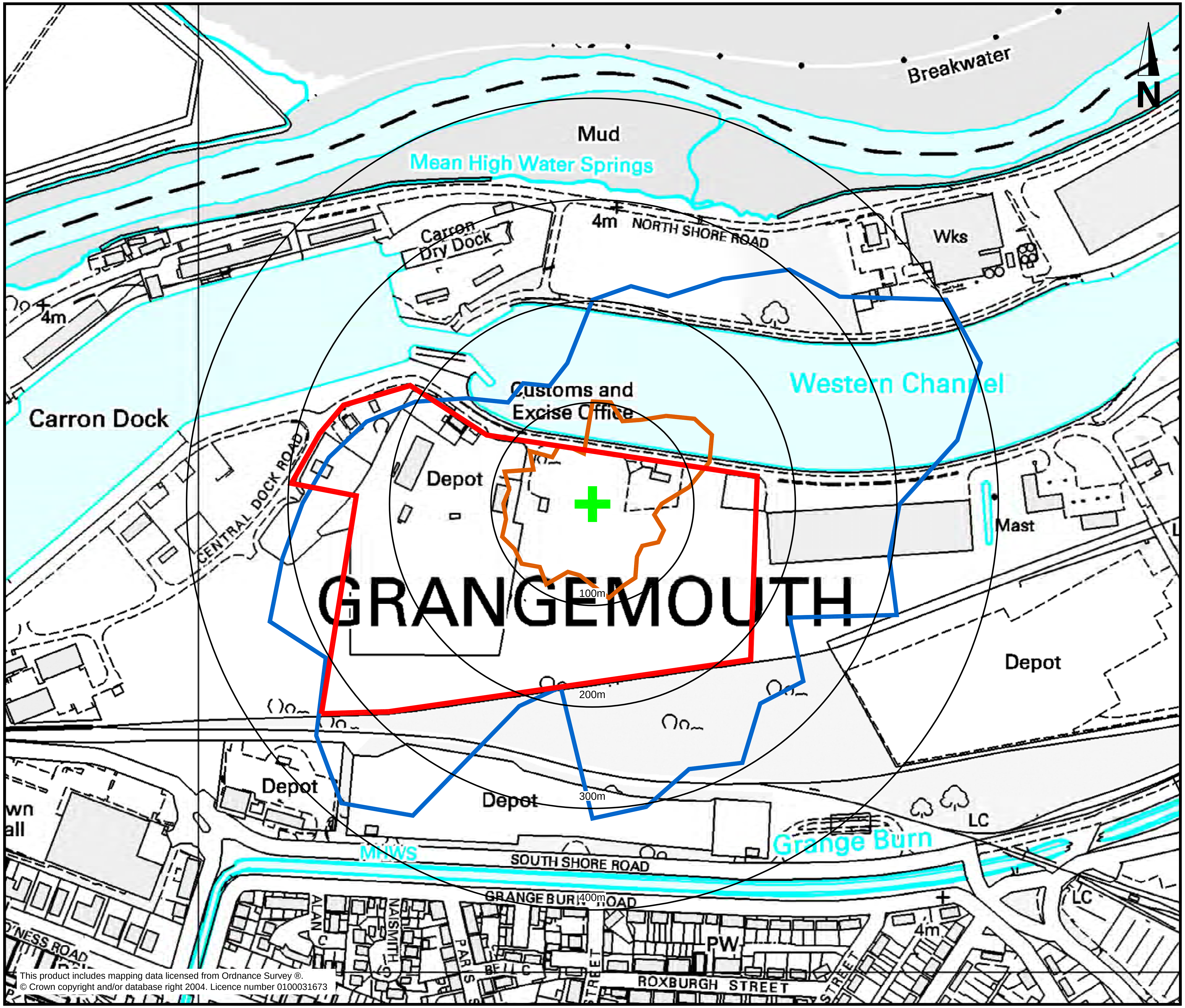

Forth Energy

Grangemouth Renewable Energy Plant

Figure 9.8

Visible Extent of Plume During Daylight Hours

Legend

- Application Boundary

Average / Maximum Plume Length

- Average Visible Plume
- Maximum Visible Plume
- Approximate Stack Location

0 100 200
Metres

SKM ENVIROS

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Forth Energy

Sustainability Statement for the Grangemouth Renewable Energy Plant

September 2010

SISTech scottish institute of sustainable technology

SINCLAIR KNIGHT MERZ SKM ENVIROS

Contents

Glossary

CAP - Common Agricultural Policy

CO_2e – Carbon dioxide equivalent

CSA - Canadian Standards Association

DECC – Department for Energy and Climate Change

Defra – Department for Environment, Food and Rural Affairs

EIA – Environmental Impact Assessment

EC - European Commission

FB - Fluidised Bed (FB

FSC - Forest Stewardship Council

GMO – Genetically modified organism

Ha – hectare

HGV – Heavy good vehicle

ITTO - International Tropical Timber Organisation

kV – Kilo Volt

LCA - Life Cycle Assessment

Mt – Mega tonnes

MW – Mega Watt

NPF2 – National Planning Framework for Scotland 2

Odt – oven dried tonnes

PEFC - Programme for the Endorsement of Forest Certification

PPC - Pollution Prevention and Control

RED – Renewable Energy Directive

RHI - Renewable Heat Incentive

RTFO - Renewable Transport Fuels Obligation

SAC - Special Area of Conservation

SEPA – Scottish Environment Protection Agency

SFI - Sustainable Forestry Initiative

SPA - Special Protection Area

SSSI - Site of Special Scientific Interest

UKWAS – UK woodland assurance standard

Executive Summary

This Statement describes Forth Energy's understanding of and commitment to the wider sustainability issues related to the Grangemouth Renewable Energy Plant.

The environmental and sustainability benefits of biomass generation have been recognised by international and national legislation and guidance. The electricity and heat generated from biomass fuels results in significantly less carbon emissions when compared with fossil fuel energy alternatives, and the use of these fuels has the potential to increase the security of Scottish energy supply and stimulate economic growth. Biomass energy applications also help Scotland meet its national and international renewable energy and climate change commitments.

The proposed Grangemouth Renewable Energy Plant would provide 100MW of electricity and around 200MW of heat. Its location at the Port of Grangemouth enables carbon efficient transport of biomass fuels to the plant site by ship. The proposed size of the plant takes into account the energy requirements of Falkirk and the plant will be large enough to supply almost all of the (industrial, commercial and domestic) electricity requirements of the district (around 92%) and a large proportion of its heat demand.

The development of biomass energy must go hand in hand with consideration of environmental protection and resource equity issues if it is to be considered sustainable. Destruction of fragile ecosystems and biodiversity, depletion of carbon stocks and increasing global inequity are among the main sustainability concerns that have been raised in relation to biomass fuels over the last decade.

The recent European Commission report (EC, 2010[1]) on sustainability of biomass energy applications addresses these issues by outlining a methodology for accounting for carbon emissions and reemphasising the sustainability criteria specified in the European Union Renewable Energy Directive (RED).

In order to meet the EC (2010) criteria, comply with relevant legislation and address the breadth of sustainability concerns regarding biomass fuel sources, Forth Energy will ensure that all forest-derived fuels used at the Grangemouth Renewable Energy Plant are certified by internationally accepted sustainability certification systems such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). Further, supplier performance will be regularly audited against the emerging national and international standards.

The plant will be capable of operating with a range of biomass fuels, and it is expected that the majority (70% – 90%) of these will comprise wood chip or wood pellets (virgin timber and forest residues), supplemented by other biomass fuels such as purpose grown energy crops (such as Short Rotation Forestry), agricultural residues and recovered biomass materials (e.g. wood, paper and cardboard).

It is Forth Energy's objective to procure as much of the fuel for the Grangemouth Renewable Energy Plant from indigenous suppliers as is practicable taking into account both economic and environmental concerns. It is recognised, however, that with the limited availability of UK sourced biomass, the majority of the fuel will be imported from overseas, at least initially. An assessment of UK and global fuel supplies has indicated that initially 10% of fuels will be sourced indigenously, with the remainder being imported from Scandinavia, Eastern Europe and North America.

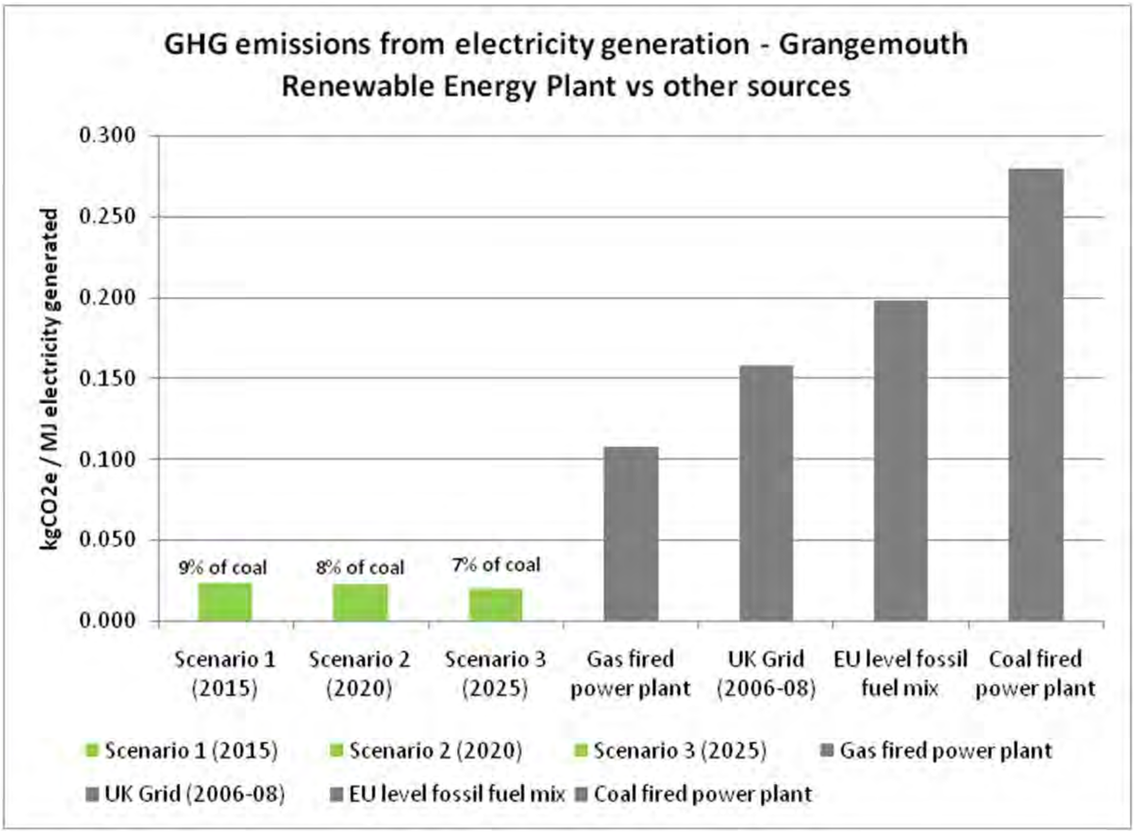
The diversification of energy supply - both by geographical location and by fuel type - can help to increase the resilience of energy supply and reduce the impacts of these challenges. Increasing the use of biomass fuel will improve the Scottish energy security position. Developing local supply capacity will reduce long-term energy dependence, whilst the

[1] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. European Commission, 2010.

use of fuel from Scandinavia and North America diversifies the number of source countries and fuel types used. The availability of biomass fuel from European Union countries and other allies of the UK also reduce the geopolitical risks.

Any concerns related to biomass competing with land for food crops will not be relevant to the supply of fuelstock for the Grangemouth Renewable Energy Plant, since the material will be almost entirely wood-based and agricultural residues will include only wastes or by-products from the agricultural sector (e.g. straw). Forth Energy will not support any moves to replace agricultural food crops with biomass energy crops.

A life-cycle carbon footprint of electricity generated at the Grangemouth Renewable Energy Plant for a range of fuel procurement scenarios shows that savings of 91% to 93% can be expected when compared to a coal fired power plant as shown in the figure below.



Carbon footprint of electricity generated at the Grangemouth Renewable Energy Plant (kgCO2e / MJ electricity generated)

The overall footprint also illustrates that electricity generated at the Grangemouth Renewable Energy Plant has the potential to deliver more than 3.5% of the overall Scottish electricity carbon reduction target for 2020[2] in the first 5 years of its operation. Lifetime savings from the plant, taking into account reductions in the carbon intensity of the UK grid, are estimated to be 3.2 MtCO_2e (mega tonnes carbon dioxide equivalent).

These estimates take account of all the carbon emitted during the production and transport of biomass fuels as well as the conversion to electricity at the Grangemouth Renewable Energy Plant. The footprint model used was developed in

[2] As described in the Scottish Climate Change Delivery Plan.

line with the methodology recommended in the recent European Commission report[3] on sustainability of biomass energy applications.

A top-down estimate of the carbon 'embodied' in the Grangemouth Renewable Energy Plant construction was found to be just under 0.02 $MtCO_2e$ which is equivalent to approximately 12% – 14% of the carbon emitted as result of the plant operations and fuels used in one year or around 1% of the carbon emitted over the life-time of the plant. This includes the materials used to construct the plant and the construction activity as well.

The environmental and socio-economic impacts of the operation of the plant have been assessed and appropriate mitigation measures proposed as part of the Environmental Impact Assessment process for this development. In order to manage environmental impacts of construction, Forth Energy will consider the issues covered by BREEAM in the detailed design of the proposed developments where applicable.

The main waste arisings from the Grangemouth Renewable Energy Plant will be the waste ash produced after woody materials are burnt to produce electricity and heat. Possible disposal routes for this ash include selling the ash as a useful by-product from the Grangemouth operations as an alternative liming material for agricultural soils, or in the production of construction materials.

In order to make use of the waste heat that will be generated as a result of the Grangemouth Renewable Energy electricity generation, a detailed Heat Mapping exercise has been commissioned to identify major energy users located close to the proposed plant. Preliminary estimates show potential renewable heat supply volumes ranging from between 1,052 GWh/annum to 1,500 GWh/annum, the latter being based on a thermal heat use of 201 MWth and giving an associated Quality Index (QI) of 116 for the Grangemouth Renewable Energy Plant. Discussions are ongoing with a number of these potential energy users and it is Forth Energy's intention that renewable heat/steam will be supplied to local users where there is demand and supply is commercially feasible.

An overall sustainability framework based on Scotland's Sustainable Development Strategy has been developed in order to understand the overall sustainability impacts of the plant. Using outcomes sought by this strategy, the assessment illustrates the range of sustainability benefits arising from the Grangemouth Renewable Energy Plant and outlines recommendations for any neutral or negative impacts.

Forth Energy intends to produce electricity at the Grangemouth Renewable Energy Plant which has significant carbon savings, without any damage to the wider environment, diversity of species and ecosystems and the rights of communities and indigenous people. Forth Energy's position in relation to sustainability has been clearly outlined and includes details of how Forth Energy will manage the sustainability of fuel supplies (by complying with legislation, addressing chain of custody issues, addressing fuel sourcing and transport issues, ensuring security of fuel supplies etc.), minimise the impacts of human induced climate change and manage the wider environmental impacts of the plant.

As there is no binding criteria to ensure sustainability of energy produced using biomass feedstocks at an EU or national level at the moment, Forth Energy intends to develop and implement its own biomass sustainability policy taking into account all national and EU regulatory drivers and guidelines.

[3] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. European Commission, 2010.

1 Introduction

1.1.1 Forth Energy plan to construct and operate four Renewable Energy Plants, at Dundee, Grangemouth, Rosyth and Leith. Forth Energy is a joint venture formed by Scottish and Southern Energy (SSE) and Forth Ports and has the potential to be Scotland's biggest developer of dedicated renewable power generation facilities. SSE is the UK's largest renewable energy generator; Forth Ports owns and operates seven commercial ports and manages 280 square miles of navigable waters in the UK. The projects proposed have a total electrical export capacity of 500MW and will also be capable of exporting renewable heat to users. This Sustainability Statement has been prepared to accompany the application for consent to Scottish Ministers under Section 36 of the Electricity Act, 1989 for the Grangemouth Renewable Energy Plant, to demonstrate that sustainability issues are addressed comprehensively and incorporated into subsequent decision making.

1.1.2 The use of biomass resources to produce energy has many benefits for Scotland. The electricity and heat generated from biomass fuels result in significantly less carbon emissions compared with fossil fuel energy alternatives and the use of these fuels has the potential to increase the security of Scottish energy supply and stimulate economic growth. Biomass energy applications also help Scotland meet its national and international renewable energy and climate change commitments.

1.1.3 The development of biomass energy must go hand in hand with consideration of environmental protection and resource equity issues if it is to be considered sustainable. Destruction of fragile ecosystems and biodiversity, depletion of carbon stocks and increasing global inequity are among the main sustainability concerns that have been raised in relation to biomass fuels over the last decade.

1.1.4 Forth Energy intends to produce electricity and heat at the Grangemouth Renewable Energy Plant in a sustainable way, without any damage to the wider environment, diversity of species and ecosystems and the rights of communities and indigenous people. This Sustainability Statement discusses some of these key sustainability issues and sets out Forth Energy's intentions in relation to each.

1.1.5 The structure of the statement is as follows:

- This first section introduces the Renewable Energy Plant and describes the site and plant proposed
- The main regulatory and legislative context for ensuring the sustainability of renewable fuels and biomass energy is given in Section 2
- Section 3 discusses the fuel supply for the Grangemouth Renewable Energy Plant and how Forth Energy plans to ensure its sustainability
- The significant carbon reduction potential of the plant, including both life-cycle emissions and 'embodied' emissions are presented in Section 4
- Section 5 describes how Forth Energy intends to manage any environmental impacts of the plant
- Section 6 outlines Forth Energy's plans to use waste heat from the plant
- Section 7 presents the results of an overall sustainability assessment of the plant
- A summary of Forth Energy's position with relation to the sustainability of the plant is given in Section 8

1.2 Description of Grangemouth Renewable Energy Plant and site

1.2.1 The proposed Grangemouth Renewable Energy Plant will export up to 100 MW of renewable electricity to the local electricity network from the use of up to 1.5 million tonnes per year of biomass fuel (this estimate is dependent upon the calorific value of fuels). Renewable heat supplies will also be made available to local users.

1.2.2 The plant is intended to operate as a 'base-load' plant, operating continuously except for periods of routine maintenance. The site will incorporate an enclosed fuel store, a power plant area, an electrical switchyard and a covered conveyor system for transferring fuel.

1.2.3 In terms of electricity generation, the Renewable Energy Plant has a strategic fit with the requirements of Falkirk, i.e. it will be large enough to supply almost all of the (industrial, commercial and domestic) electricity requirements of the district (around 92%) and a large proportion of its heat demand. It is difficult to assess the heat demand requirements for Grangemouth however the plant has the capacity to supply 23% of the target heat requirements set out by the Scottish Government as part of Scotland's 2020 Renewable Heat target and is equivalent to 2.6% of Scotland overall heat demand.

1.2.4 The development represents a substantial investment by Forth Energy and will lead to the generation of new opportunities for employment and the demand for locally sourced goods and services during the construction, operation and decommissioning phases of the Renewable Energy Plant.

1.2.5 Subject to the granting of all necessary planning and environmental consents and permits, construction of the Grangemouth Renewable Energy Plant could begin in 2012, with full operation anticipated by 2015.

<u>Location</u>

1.2.6 The Grangemouth Renewable Energy Plant is to be located within the Port of Grangemouth, the general location and boundaries of which are described in Chapter 6 (The Proposed Development) of the Environmental Statement accompanying this document. Figure 1 shows the location of the Grangemouth Renewable Energy Plant within the Grangemouth local area.

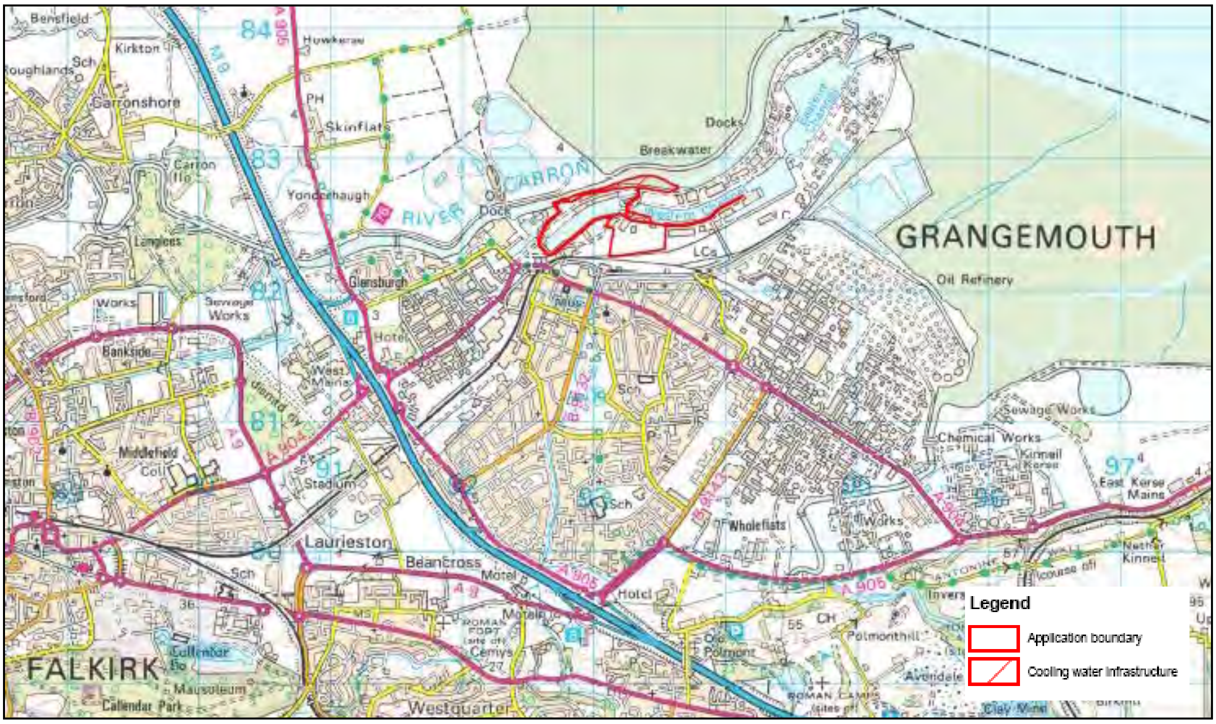


Figure 1: Location of the Grangemouth Renewable Energy Plant site

1.2.7 The Port of Grangemouth is a logical choice for biomass generation as it has the existing infrastructure for handling large quantities of materials. The port location means that the majority of biomass fuel can be delivered by ship, which is the most carbon efficient form of freight transportation. The Port of Grangemouth is also an industrial location, with urban hinterlands with a strong demand for electricity and potential heat.

Site layout

1.2.8 The total area within the proposed development site (within the onshore red line boundary as shown in Figure 1) is 18.05 ha with the main plant area covering 10.3 ha of this. The site will comprise the following elements:

- the main plant and fuel storage area;
- an area of search for the installation of the cooling water intake;
- two alternative infrastructure corridors for the installation of cooling water discharge pipes;
- an area of search for the installation of the cooling water outfall; and
- an infrastructure corridor for the fuel transfer conveyor.

1.2.9 Biomass from the fuel storage area will be transferred to the main boiler by means of a covered conveyor belt system. The main boiler will raise steam for a single steam turbine generator. Exhaust steam from this turbine will be condensed by an evaporative cooling system using hybrid low plume cooling towers. Condensed steam will then be re-circulated back to the boiler. Electricity will be exported from the Renewable Energy Plant via a 132 kV underground electrical connection to the local 132 kV network at Bainsford substation where it will enter the main national transmission network. Chapter 6 (The Proposed Development) of the Environmental Statement has more details of the site layout.

1.2.10 The flue gases will exit the boiler and pass through flue gas abatement equipment, including a high efficiency dust collection system (i.e. fabric-bag filters) for particulate removal. The flue gases will then discharge to atmosphere via a stack (110 m), ensuring the appropriate dispersion into the environment. Flue gas emissions are considered in detail in Chapter 9 (Air Quality) of the Environmental Statement.

Biomass fuels and waste ash

1.2.11 It is intended that the plant will operate with a range of biomass fuels, however the majority of biomass will comprise wood chip or wood pellets (virgin timber and forest residues). A more detailed discussion of the availability, types and sustainability of fuels is described in Section 3 of this statement.

1.2.12 Although all biomass fuels used will fit within the above categories, the precise fuels to be used will be finalised and agreed with the Scottish Environment Protection Agency (SEPA) as part of the Pollution Prevention and Control (PPC) Permit application. The amount of recovered timber, paper and cardboard in the final fuel portfolio will be determined by a combination of commercial and technical factors including availability, price and boiler design.

1.2.13 Biomass fuels will mainly be delivered to the plant via ship, offloaded at the existing operational quay and transferred to the fuel storage area via a covered conveyor system. The plant will also be capable of accepting fuel by road.

1.2.14 The main waste arising from the Grangemouth Renewable Energy Plant will be the waste ash produced after woody materials are burnt to produce electricity and heat. Details of the amount and disposal routes for this ash are given in Section 5.3 of this Statement.

2 Review of relevant regulatory and legislative drivers

Summary of this section

This section of the Sustainability Statement presents a brief summary of some of the main regulatory and legislative drivers for biomass and sustainability at a local, national and EU context.

In the UK, the policy and vision for sustainable development is set by the UK Framework – *One Future – different paths*, 2005. This has been translated into commitments and plans in Scotland in *Choosing Our Future: Scotland's Sustainable Development Strategy*, launched by Scottish Ministers in December 2005.

At a national level there are a number of different legislative drivers for biomass energy applications and sustainability.

- The Renewables Obligation (Scotland) Order 2009 require that suppliers report on the type, form and country of origin of the purchase of all biomass used, and whether any 'environmental quality assurance schemes' apply.
- The UK Renewable Transport Fuels Obligation (RTFO) encourages sustainability reporting to take account of different sustainability principles including biodiversity conservation, carbon conservation and land rights.
- The Biomass Action Plan for Scotland sets out a coordinated programme for the development of the biomass sector in Scotland.
- The recently published draft consultation for the Renewable Heat Incentive identifies the significance of a new diverse infrastructure to support current and future heat demands.

As part of the requirements for the Renewable Energy Directive, the European Commission has recently published a report on requirements for a sustainability scheme for solid and gaseous biomass fuels. Though it does not propose binding criteria at European Union level, the report does give recommendations to member states on their development of sustainability schemes, and recommends a carbon accounting methodology that should be used across Europe. This methodology has been used in the carbon assessment in this statement.

The need for biomass energy applications and sustainable energy is also recognised by the regional and national planning system. The Grangemouth local and regional plans demonstrate Falkirk Council's support for renewable energy applications. The National Planning Framework for Scotland 2 describes the Scottish Government's commitment to the greater use of biomass for generating renewable energy in Scotland.

2.1.1 There is a range of European and UK Government policies that establish a strategic need for renewable energy provision in the UK to assist in tackling climate change. This section of the Sustainability Statement presents a brief summary of some of the main regulatory and legislative drivers for biomass and sustainability at a local, national and EU context. A detailed description of all policy documents that are relevant to this proposal can be found in Chapter 4 (The need for the proposed development) of the Environmental Statement.

2.2 National strategies that promote sustainable development

2.2.1 In the UK, the policy and vision for sustainable development is set by the UK Framework – *One Future – different paths*, 2005[4]; and *Choosing Our Future: Scotland's Sustainable Development Strategy*[5], launched by Scottish Ministers in December 2005. The UK framework sets out a common goal for sustainable development across the UK:

> *"to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations"*

2.2.2 In *Choosing Our Future: Scotland's Sustainable Development Strategy*, the Scottish Ministers set out a number of ways in which it will measure progress in meeting the commitments made in the strategy and more generally progress on sustainable development. This included measuring progress against a wide set of indicators that reflect social and environmental as well as economic goals, to capture the different dimensions of sustainable development. There are four main outcomes sought by this strategy:

- The well-being of Scotland's people;
- Supporting thriving communities;
- Protecting Scotland's natural heritage and resources; and
- Increasing Scotland's global contribution.

The aims and principles incorporated in both of these documents have been taken into account in the preparation of this Statement and are reflected in the sustainability assessment matrix presented in Section 7.

2.3 National legislation that promotes and regulates biomass

<u>Renewables Obligation Regulations</u>

2.3.1 The Renewables Obligation (Scotland) Order 2009, designed to incentivise renewable generation into the electricity generation market, is the main support scheme for renewable electricity projects in Scotland. It obliges suppliers of electricity to source an increasing proportion of their electricity from renewable sources.

2.3.2 Suppliers meet their obligations by presenting sufficient Renewables Obligation Certificates (ROCs) to the regulator, or by paying into a fund, the proceeds of which are paid back on a pro-rated basis to those suppliers that have presented ROCs. Dedicated regular biomass plants can earn 1.5 ROCs per MWh of output; the use of energy crops[6] or combined heat and power (CHP) qualifies the plant to earn 2.0 ROCs per MWh.

2.3.3 The Renewables Obligation regulations require that suppliers report on the type, form and country of origin or purchase of all biomass used, and whether any 'environmental quality assurance schemes' apply, but no scheme compliance is required and no restrictions are put on the origins of the fuel for reasons of sustainability[7]. Suppliers must also, for biomass of plant origin (such as forest products or energy crops), report the use to which the land on which the plant matter was grown has been put to since 30th November 2005.

<u>Renewable Transport Fuels Obligation</u>

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[4] One future, different paths - the UK's shared framework for sustainable development. HM Government, Scottish Executive, Welsh Assemble Government and Northern Ireland Office, 2005.

[5] Choosing our future: Scotland's sustainable development strategy. Scottish Government, 2005.

[6] Note: The term 'energy crops' is defined in Renewables Obligation Scotland as 'a plant crop planted after 31 December 1989 which is grown primarily for the purpose of being used as fuel or which is one of the following (a) miscanthus giganteus; (b) salix (also known as short rotation coppice willow); or (c) populus (also known as short rotation coppice poplar).'

[7] Renewables Obligation: Fuel measurement and sampling guidance. Ofgem, 2009.

2.3.4 At a national level the UK Renewable Transport Fuels Obligation (RTFO) sets out indicative carbon and sustainability standards for the performance of biofuels used by transport fuel suppliers[8]. The RTFO encourages sustainability reporting to take account of different sustainability principles including biodiversity conservation, carbon conservation and land rights.

Biomass Action Plan for Scotland

2.3.5 The aim of the Biomass Action Plan is to set out a coordinated programme for the development of the biomass sector in Scotland. There is a need to evaluate the contribution biomass makes to the wider aims of the Scottish Ministers, in terms of, for example, sustainable economic development, rural diversification and tackling climate change. However the diverse range of interests covered in this Action Plan does not easily lend itself to setting useful or manageable targets. The report suggests using key targets from Scottish Government policy documents that can be summarised as:

- to generate 18% of Scotland's electricity from renewable sources by 2010, rising to 40% by 2020;
- to exceed the Scottish share of UK carbon savings by 1 million tonnes of carbon in 2010, totalling 2.7 MtC annually;
- to increase the percentage of transport fuel from renewable sources to 5% by 2010;
- a commitment to include targets for production of renewable heat for the period up until 2020 as part of the Renewable Heat Strategy.

Renewable Heat Incentive

2.3.6 The UK Government has recently published a draft consultation paper for the Renewable Heat Incentive. The RHI identifies the significance of a new diverse infrastructure to support current and future heat demands. Together with the Renewable Heat Action Plan for Scotland, the RHI identifies strategies and programs to help achieve an 11% renewable heat target.

2.3.7 The current level of installed renewable heat capacity and output in Scotland is about 1.4% (of the projected 2020 demand), with around 70% of this used in the industrial sector. The RHI is planned to be implemented from April 2011. The Renewable Heat Action Plan notes that "Renewable heat ... will play a key role in helping to address both climate change and renewable energy ambitions".

2.4 European Commission guidance on the sustainability of biomass fuels

2.4.1 In Europe, sustainability of agricultural production is regulated through the environmental requirements of the Common Agricultural Policy (CAP). Forest management is regulated at national level, with policy guidance through the European Union (EU) Forestry Strategy and international processes such as the Ministerial Conference for the Protection of Forests in Europe.

2.4.2 The Renewable Energy Directive (RED)[9] includes a sustainability scheme for liquid biofuels, and a requirement for the European Commission (EC) to report on requirements for a sustainability scheme for solid and gaseous biomass fuels in electricity, heating and cooling. The resulting report (EC, 2010[10]) on sustainability requirements for electricity and heating from biomass does not propose binding criteria at European Union level, but it does give recommendations to member states on their development of sustainability schemes, and also undertakes to

[8] Year One of the RTFO - Renewable Fuels Agency report on the Renewable Transport Fuel Obligation 2008/09. Renewable Fuels Agency, 2010.

[9] Directive 2009/28/EC.

[10] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. European Commission, 2010.

closely monitor progress of national schemes and of international climate change negotiations, and to reassess the situation by 31 December 2011.

2.4.3 The report states that within the EU, where most biomass comes from forest residues and processing residues, and as forest management governance structures are strong, 'the current sustainability risks are considered to be low', but cautions that an increase of demand for EU and non-EU biomass feedstock should be accompanied by vigilance regarding the impact on carbon stocks in forests and agricultural land and soils. It sets out a Life Cycle Assessment (LCA) methodology by which the carbon impacts of biomass proposals should be assessed. This methodology has been used by Forth Energy to quantify the likely carbon savings associated with the Grangemouth Renewable Energy Plant and the results are described in detail in Section 4. Member states are also encouraged to 'differentiate in favour of installations that achieve high energy conversion efficiencies'.

2.4.4 The recommended sustainability criteria described in EC (2010) on the sustainability of biomass are broadly in line with those laid down in the RED. They can be summarised as

- The use of biomass fuel should result in minimum greenhouse gas saving values of 35%, rising to 50% on 1 January 2017 and to 60% from 1 January 2018 for plants in which production started on or after 1 January 2017.
- Raw material should not come from high biodiversity value areas, from the conversion of high-carbon stock areas, or from undrained peatland.
- Agricultural raw materials cultivated in the Community should be obtained in accordance with specific agricultural regulations of the EU.
- Economic operators show compliance with the criteria using the 'mass balance' method for verifying the chain of custody.
- These criteria need not be applied to biomass feedstocks classified as wastes.

2.5 Regional and national planning frameworks that promote biomass and sustainability

Statutory Development Plan

2.5.1 The regional and local plans for Grangemouth have been reviewed in terms of relevance to sustainability of biomass plants. The statutory Development Plan covering the application site for the proposed Grangemouth Renewable Energy Plant is as follows:-

- The approved Falkirk Council Structure Plan (2007), and
- The adopted Grangemouth Local Plan (1985, 2nd Alteration 1990).

2.5.2 The Finalised Falkirk Council Local Plan is currently a material consideration in the determination of any planning application in the Plan area and is given considerable weight by the Council in contrast to the current adopted Local Plan which is very dated. Chapter 3 of the Environmental Statement describes the planning policy framework in some detail. However, the key policy of relevance to biomass sustainability in the Structure Plan is Policy ENV.13 'General Principles for Renewable Energy', which is supportive of renewable energy developments and states:

> *"Proposals for the generation of energy from renewable sources will generally be supported subject to an assessment of individual proposals in relation to Structure Plan Policies ENV.1-ENV.7. The council will work in partnership with other agencies to set out, in the local plan, the criteria for the location and design of renewable energy developments."* (page 54)

2.5.3 In 2003, Falkirk Council carried out a study on the renewable energy potential in the Council area and focused on wind, hydro, biomass and geothermal. Their findings suggested that wind and biomass may have some potential on a commercial scale. Within the Finalised Local Plan, Policy ST20 'Renewable Energy Development' indicates that the Council will operate a presumption in favour of renewable energy development. Policy ST20 states:

"The Council will support development required for the generation of energy from renewable sources, and the utilisation of renewable energy sources as part of new development, subject to assessment of proposals against other Local Plan policies. Renewable energy development will be viewed as an appropriate use in the countryside where there is an operational requirement for a countryside location." (page 79)

2.5.4 In terms of sustainability, Policy EQ1 'Sustainable Design Principles' of the Finalised Local Plan states that::

"New development will be required to achieve a high standard of design quality and compliance with principles of sustainable development." It adds that proposals should accord with a number of principles, the following of which are relevant:

(1) Natural and Built Heritage. Existing natural built or cultural heritage features should be identified, conserved, enhanced and integrated sensitively into development;

(2) Urban and Landscape Design. The scale, siting and design of new development should respond positively and sympathetically to the site's surroundings, and create buildings and spaces that are attractive, safe and easy to use;

(3) Accessibility. Development should be designed to encourage the use of sustainable, integrated transport and to provide safe access for all users;

(4) Resource Use. Development should promote the efficient use of natural resources, and take account of life cycle costs, in terms of energy efficient design, choice and sourcing of materials, reduction of waste, recycling of materials and exploitation of renewable energy;

(5) Infrastructure. Infrastructure needs and their impacts should be identified and addressed by sustainable mitigation techniques, with regular regard to drainage, surface water management, flooding, traffic, road safety and noise."

<u>The National Planning Framework for Scotland 2</u>

2.5.5 The National Planning Framework for Scotland 2 (NPF2)[11] articulates the spatial consequences of policies for economic development, climate change, transport, energy, housing and regeneration, waste management, water and drainage, catchment management and the protection of the environment. It provides the high-level commitments that Scottish Government has and identifies key strategic infrastructure projects as national developments and reflects the ambitious emissions targets that will see Scotland move towards a low carbon economy.

2.5.6 Planning Authorities are required to take this framework into account when preparing development plans and it is a material consideration in determining planning applications. Within the key challenges listed in the NPF2 energy issues (paragraphs 25 and 26) the following is highlighted:

"....Growing demand in the expanding Asian economies is raising concerns about the implications for future energy prices and long-term security of supply. Addressing these challenges will demand profound changes in the way we produce, distribute and use energy over the coming decades......The European Union has responded by committing to deriving 20% of the energy it uses from renewable sources by 2020. The Scottish Government supports this objective and has in place its own, higher target for electricity generated from renewable sources. It also wants to see continued improvements in energy efficiency; the development of technologies which derive clean energy from fossil fuels; the harnessing of renewable sources of heat; and decentralised energy production, including local heat and power schemes and micro-generation."

2.5.7 Within Paragraph 65 of the NPF2 it is stated that:

[11] National Planning Framework for Scotland 2. Scottish Government, July 2009.

"The Government is committed to realising the power generating potential of all renewable sources of energy. Development of onshore windfarms has been proceeding apace, but much of the longer-term potential is likely to lie with new technologies such as wave and tidal power, biomass and offshore wind." [Emphasis added].

2.5.8 In addition, Paragraph 135 states:

"Waste, biomass and timber movements are of increasing significance. The closure of landfill sites can result in waste having to be moved further. Timber harvesting is set to increase to 2020 as our commercial forests mature. The Government will work with local authorities and the forestry industry to improve access to plantations to ensure that maturing timber can be harvested. Increased levels of harvesting means that movements of timber and other forest products will grow significantly. With improvements to infrastructure, more of this material could be transported by rail or water."

2.5.9 Paragraph 145 states:

"The Government is committed to establishing Scotland as a leading location for the development of renewable energy technology and an energy exporter over the long term. It is encouraging a mix of renewable energy technologies, with growing contributions from offshore wind, wave, and tidal energy, along with greater use of biomass. The aim of national planning policy is to develop Scotland's renewable energy potential whilst safeguarding the environment and communities." [Emphasis added].

2.5.10 The document identifies that biomass is likely to make a large contribution to Scotland's energy generation over the following decade (paragraph 146). It also notes (paragraph 148) that biomass plants should be sited where they can make best use of locally available resources.

2.6 Other relevant legislation

2.6.1 Other nationally important strategy and policy documents have been described in Chapter 4 (The Need for the Proposed Development) of the Environmental Statement. The key points arising from these have been incorporated into the sustainability assessment.

The drivers, requirements and safeguards in the relevant legislative and regulatory documents reviewed here have been taken into account by Forth Energy. Section 8 of this statement provides a summary of Forth Energy's position with regard to the sustainability of the Grangemouth Renewable Energy Plant.

3 Sustainability of fuel supplies

Summary of this section

This section outlines sustainability certification systems for biomass fuels, sources and availability of biomass fuels, and Forth Energy's commitments in relation to the sustainability of these.

The main certification systems internationally include the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). These systems address a range of sustainability concerns including the verification of the chain of custody of a fuel source.

The impact of forestry certification systems has been varied worldwide, and some systems are considered stricter than others. Forth Energy is confident that complying with these sustainability standards when sourcing fuels will address the key concerns related to biomass fuel supply.

In terms of the fuel sources for the Grangemouth Renewable Energy Plant, a wide range of biomass fuels will be used, which would be sourced both indigenously (within the UK) and abroad. The main types will include virgin wood chips or pellets including forestry derived energy crops (e.g. short rotation forestry) supplemented by agricultural residues and wood reclaimed from commercial / industrial waste streams.

The balance of indigenously sourced fuel to imported fuel used in the Grangemouth Renewable Energy Plant will vary in accordance to availability of biomass material in Scotland and the UK and prevailing global market conditions. Initially, this balance is expected to be approximately 80% - 90% imports due to the projected lack of indigenous wood for biomass energy from 2012 onwards. Forth Energy will make all efforts to minimise the impacts of long distance transport of fuels, and the port location of the Grangemouth Renewable Energy Plant means that fuels can be transported directly to the site by ship with minimal extra road transport.

In order to promote an increased proportion of material sourced from Scotland and the UK during the lifetime of the plant, Forth Energy will seek to develop indigenous supply chains, and work with the Scottish Government and Forestry Commission (amongst others).

3.1.1 The significant climate related advantages of biomass energy applications would be negated by the use of biomass fuels which have been produced unsustainably. The key to ensuring sustainability in the supply of forest-based material is to make sure all suppliers are accredited under an internationally acceptable forest certification scheme with a clear chain of custody. This section outlines the main certification systems already in place in the European Union and North America, fuel sources and availability, and Forth Energy's commitments in relation to sustainability of biomass fuels.

3.1.2 The majority of fuels to be used in the Grangemouth Renewable Energy Plant will be forest-based fuels, both imported and from indigenous sources. The remaining (agricultural residues and reclaimed wood) will be sourced from within the UK where current EU and UK agricultural and waste legislation ensure that 'chain of custody' issues are monitored by regulatory agencies.

3.2 Sustainability Certification systems

3.2.1 In order to meet the EC criteria for biomass sustainability[12] (see Section 2.4), comply with relevant legislation and address the breadth of sustainability concerns regarding biomass fuel sources, Forth Energy will ensure that all

[12] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. European Commission, 2010.

forest-derived fuels used at the Grangemouth Renewable Energy Plant are certified by internationally accepted sustainability certification systems such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). The nature of these schemes and the sustainability concerns they address are discussed in more detail in this section.

3.2.2 The FSC and the PEFC are the two main umbrella certification systems internationally. They came into operation in 1993 and 1999 respectively. They both use independent third party assessment of on-ground forestry practices against established standards which cover economic, social and environmental issues. Appendix A outlines the main principles under each system.

3.2.3 The FSC is the dominant certification system on a worldwide basis, with over 800 organisations involved, and is recognised in some 90 countries. The FSC sets the benchmark for certification, incorporating chain of custody certification and restrictions on land conversion as well as ensuring overall good forest management practice (see Appendix A).

3.2.4 The PEFC is not a competitor to FSC, but rather developed on similar principles with a view to supporting the development of nationally owned systems. The need for PEFC arose from the fact that individual countries were putting forward their own schemes (often after failing to reach agreement with FSC) and so it was clearly necessary to assess and police these schemes to ensure that they achieve and maintain the standards of sustainable forest management that timber retailers and consumers demand in the post-Rio[13] world.

3.2.5 The main difference between the two is the established standards each use to assess sustainability of a forestry project. Where the FSC ensures that all forest certification standards should comply with international forestry principles developed by the FSC, the PEFC relies on inter-governmental principles developed and adapted for different regional forest areas. Overall, the FSC is generally regarded as having stricter environmental standards than the PEFC[14].

3.2.6 In North America, certification standards include the Sustainable Forestry Initiative (SFI) and the Canadian Standards Association (CSA). With geographical bases limited to the USA and Canada, the SFI and CSA both promote sustainable forest management through a range of sustainability principles including measures to protect water quality, biodiversity, wildlife habitat and species at risk.

3.2.7 Both are endorsed by the PEFC, and in total both initiatives cover approximately 125 million ha of forest. There have, however, been concerns raised regarding both these schemes internationally[15]. The SFI did not initially require third party certification, and both schemes allow individual forestry companies to customise the standards against which it will be verified, meaning that the standard for each of these schemes varies on a case by case basis.

3.2.8 One important aspect of certification of forestry schemes is the verification of the chain of custody. It is crucial that any certification system tracks the biomass product through the supply chain from suppliers at each stage (primary production through conversion, processing, and trade to end use). Both FSC and PEFC enable biomass products to use internationally registered trademarks to illustrate certification and conformity with their systems. Assessment of the chain of custody is done by third parties in accordance with ISO guidelines for accreditation

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[13] The Rio Declaration was produced as a result of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. It defined a number of principles to guide countries towards sustainable development. See Chapter 4 (The Need for the Proposed Development) of the Environmental Statement.

[14] Sustainability Criteria and Certification Systems for Biomass Production. Biomass Technology Group, 2008. Report prepared for Directorate General of the Environment, European Commission (DG TREN).

[15] Sustainable Biomass for green power. Ryckmans, Y, 2010. Paper presented at Eurelectric workshop 'Biomass for power production: Sustainability and availability' held on the 26th of March, 2010.

and certification bodies, and requires that any wood that is mixed is labelled clearly as certified and non-certified material.

3.2.9 The impact of forestry certification systems has been varied. Whereas in North America and Western Europe 28% and 55% of forest land had been certified in 2005, this figure is less than 5% for countries in Asia, South America and Central and Eastern Europe[16]. However, international reports have emphasised that the biggest impact of these certification schemes could be in these latter countries if supported by supply chain demand and institutional structures.

3.2.10 Apart from obligatory compliance with RED, it is Forth Energy's intention to ensure that all the forest-derived fuels used in the Grangemouth Renewable Energy Plant are certified by an internationally accepted sustainability certification system such as FSC or PEFC, with the aim of sourcing all such fuel from certified forests.

3.2.11 Forth Energy is confident that complying with these standards will address the key sustainability concerns related to biomass fuel supply. The main concerns that will be addressed by Forth Energy can be demonstrated in Figure 2 (adapted from Ryckmans, 2010[17]).

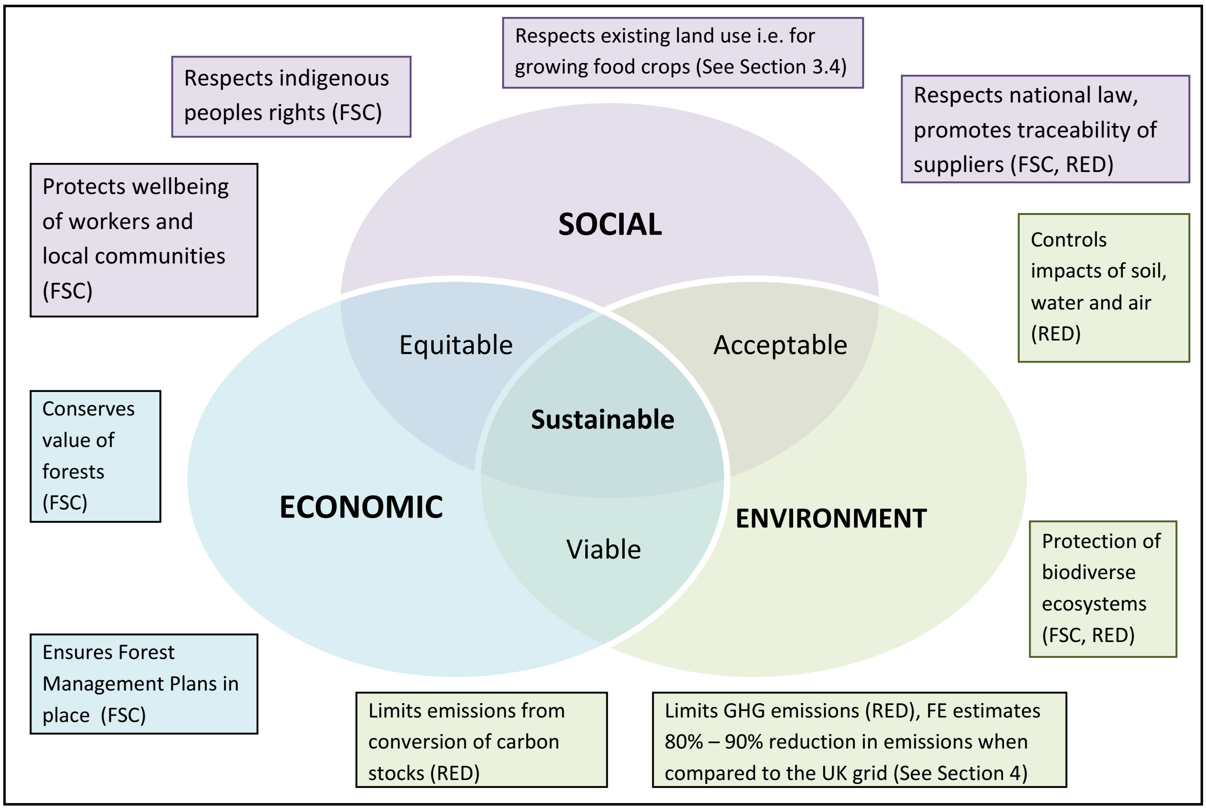

Figure 2: How Forth Energy will ensure the Grangemouth Renewable Energy Plant fuels are sustainably sourced - compliance with RED and FSC, and Forth Energy's commitments

3.2.12 Forth Energy also intends to develop and implement its own biomass sustainability policy taking into account all national and EU regulatory drivers and guidelines (see Section 8.2). The types and sources of fuels to be used in the plant are also crucial to the sustainability of the plant. These are discussed further in following sections.

[16] Confronting Sustainability: Forest Certification in Developing and Transitioning Countries. Yale School of Forestry and Environmental Studies, 2006. Editors: Benjamin Cashore, Fred Gale, Errol Meidinger, Deanna Newsom.

[17] Sustainable Biomass for green power. Ryckmans, Y, 2010. Paper presented at Eurelectric workshop 'Biomass for power production: Sustainability and availability' held on the 26th of March, 2010.

3.3 Types and forms of biomass fuels

3.3.1 The Grangemouth Renewable Energy Plant will be designed to operate using a wide range of biomass fuels, which would be sourced both indigenously (within the UK) and imported from abroad. The types of fuels to be used in the Grangemouth Renewable Energy Plant and current and projected global availability for these is discussed in more detail in the following sections.

Types of fuels

3.3.2 The fuel stock will include a mix of virgin wood chips or pellets including forestry derived energy crops (e.g. short rotation coppice) supplemented by agricultural residues and wood reclaimed from commercial / industrial waste streams. A short description of different fuel types is as follows:

3.3.3 Forestry products and by-products: Also known as 'virgin wood', this type of biomass fuel includes products from traditionally managed timber plantations and woodlands, as well as residues from management of forests (e.g. bark, sawdust and wood sticks from the pruning of trees). Virgin wood can also include by-products from the wood processing industries in the form of sawdust and off-cuts.

3.3.4 Energy crops: These are plants that are grown specifically for use in biofuel production and biomass plants and typically include densely planted, high yielding crop species. Energy crops include short rotation forestry (e.g. eucalyptus), short rotation coppice (e.g. willow) and grasses (e.g. miscanthus). For the Grangemouth Renewable Energy Plant, it is likely that the main energy crops will include eucalyptus and miscanthus. In addition to improved yields, these fuels have the potential to be established and then regenerate within significantly shorter time frames than traditional fuel resources. Eucalyptus for example could be harvested on an eight years cycle compared to 20+ years for traditional forestry.

3.3.5 It is acknowledged that the indigenous supply chain for material including short rotation forestry such as eucalyptus is currently immature however Forth Energy will work with the Scottish Government and the U.K. supply chain to develop these potentially significant sources of fuel supply.

3.3.6 Agricultural residues: Agriculture generates significant residues and co-products that can be used to generate energy. Sources of this biomass fuel type include arable crop residues such as straw or grain husks and olive, sunflower or rape seed expeller. Using agricultural residues as biomass fuels provides additional income to farmers while producing a low environment impact fuel for biomass energy applications.

3.3.7 Reclaimed wood: A considerable amount of wood material applicable to biomass applications exists in the form of waste wood generated from the wood processing industries as well as construction, demolition and remodelling activities, and from manufacturing of packaging, furniture, joinery and fencing. Using this wood has important environmental benefits as its diversion from landfill reduces significant methane emissions from the decomposition of organic material. This fuel type could also include paper and cardboard reclaimed from the waste stream.

Forms of fuel

3.3.8 A further distinction within fuel types that needs to be discussed is the form of the fuels i.e. wood chip or wood pellets. Wood is dried and chipped to a uniform size to produce wood chip whereas wood pellets are usually manufactured from compressed sawdust or waste material derived from sawmills and other industrial products. Wood chips generally have a lower energy density by mass compared to wood pellets (typically 12.5 GJ/tonne compared to 17-18 GJ/tonne for wood pellets) and the chipping process is less energy intensive than pelletisation. Pelletised fuels are denser but have a higher calorific value.

3.3.9 Even though the pelletisation process is relatively energy intensive compared to the chipping process, due to the decrease in the amount of fuel required the carbon impacts of transporting pellets over longer distances are less than those related to wood chips. In terms of locations from where the imported fuel for the Grangemouth Renewable Energy Plant will sourced (see Section 4), the carbon impacts of wood chips and wood pellets are broadly comparable.

3.3.10 Forth Energy will ensure that all wood chips and wood pellets used in the Grangemouth Renewable Energy Plant will be technically specified in accordance with British Standards[18]. The proposed plant will be fully compliant with the EC Waste Incineration Directive (WID) of 2000. The operation of the Grangemouth Renewable Energy Plant will conform to current guidelines from Scottish Environment Protection Agency (SEPA) i.e. the Thermal Treatment of Waste (current version 2009).

3.4 Availability of biomass fuels

3.4.1 The balance of indigenously sourced material to imports used for the Grangemouth Renewable Energy Plant will vary in accordance with the availability of biomass material in Scotland and the UK and prevailing global market conditions. Initially, this balance is expected to be approximately 80% - 90% imports due to the projected lack of indigenous wood for biomass energy from 2012 onwards[19].

Forth Energy is progressing the wider evaluation of potential supply chains and will be publishing its initial findings as they are concluded.

Indigenous supply of biomass fuels

3.4.2 Forth Energy believes that the development of the Renewable Energy Plants provides an opportunity to develop further additional indigenous supply chains to supplement material imported from abroad.The UK currently has a total forest area of some 2.84 million ha[20] of which 47% are located within Scotland[21]. UK production of wood fibre is expected to reach 20 million tonnes by 2019, of which a significant amount would be from Scotland. A large proportion of this wood fibre is currently used to supply the traditional wood based industries (e.g. the pulp and panel board industries) in the UK.

3.4.3 The volume of Scottish wood fibre that can be expected to be available for use as fuel was estimated to be 1.8 million green tonnes per annum in 2005[22] (roughly equivalent to 950,000 oven dried tonnes). Currently, the overall forest increment is more than sufficient for present levels of wood energy use. However, the projected increase in large scale heating and CHP projects (including the Forth Energy proposals) could increase demand by a further 3GW by the year 2016 indicating an annual biomass requirement of some 25 million green tonnes of biomass.[23] It is likely that not all of these plans will be developed. If they were however, it would put strain on internal supply markets and therefore future planning of supply capacity has to be seen in a global context. It is currently understood that theThe volume of fuel required for the Renewable Energy Plants represents a very small percentage of the available global resource. It is considered possible that an increasing volume of material could be supplied from indigenous sources without impacting on existing markets.

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[18] British Standard EN 14961-1:2010 Solid biofuels. Fuel specifications and classes. General requirements.

[19] Wood fibre availability and demand in Britain 2007 to 2025. John Clegg Consulting, 2010.

[20] This includes woodland areas under Forestry Commission ownership and woodland areas owned by other bodies.

[21] Forestry Statistics 2009. Forestry Commission, 2010.

[22] Woodfuel for Warmth. A report on the issues surrounding the use of wood fuel for heat in Scotland. Sustainable Development Commission, 2005.

[23] Current status and challenges in the global availability of biomass. H.Roder 2010. Paper presented at Eurelectric workshop 'Biomass for power production: Sustainability and availability' held on the 26th of March, 2010.

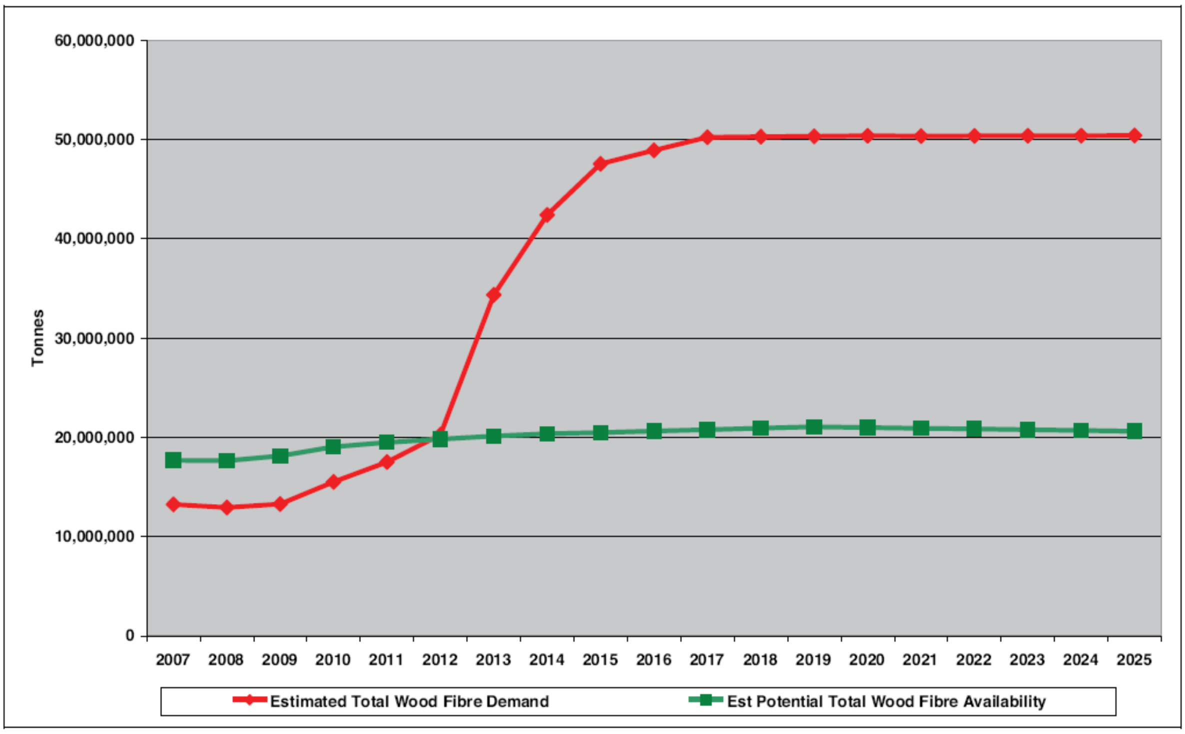

Figure 3: Forecast total potential availability and total demand for wood fibre in Britain from 2007 to 2025 (Source: John Clegg Consulting, 2010).

3.4.4 This situation has been echoed by a recent report by John Clegg Consulting[24] for UK wood processing industries which has found that the demand for wood fibre in Britain will exceed supply after 2012 (see Figure 3). Based on production data from the Forestry Commission, data collected from individual wood processing companies and information on proposed and operational biomass facilities in the UK over the next 15 years, the study takes into account virgin wood fibre of different types, reclaimed wood from the waste stream and energy crops. The main conclusion of the study is that the UK will have to significantly increase wood imports after 2012 in order to reduce the impacts of supply chain pressure and price increases on both energy companies and the wood processing industry. This report, however, does not consider any developments in the fuel supply chain that may take place to realise further indigenous potential.

European supplies of biomass fuels

3.4.5 The situation in Europe is similar to that in the UK, as reflected by reports on the availability of biomass fuels across Europe. Current growing stock in Europe (EU27) has been estimated at 23 billion m^3 and the current growth rate exceeds the rate that trees are cut by around 35%[25]. Within Europe, the Nordic and Baltic countries are recognised as having significant forestry resources[26]. Other countries with significant forest resources include France, Germany and Austria[27].

[24] Wood fibre availability and demand in Britain 2007 to 2025. John Clegg Consulting, 2010.

[25] Forest Biomass availability in EU. J.Hynynen and A.Asikainen 2010. Paper presented at Eurelectric workshop 'Biomass for power production: Sustainability and availability' held on the 26th of March, 2010.

[26] Sustainable Use of Forest Biomass for Energy: A Synthesis with Focus on the Baltic and Nordic Region. Röser, D., Asikainen, A., Raulund-Rasmussen, K., Stupak, I. (Eds.), 2008. Springer: The Netherlands.

[27] Mobilisation and efficient use of wood and wood residues for energy generation. Report to the Standing Forestry Committee by the Standing Forestry Committee ad hoc Working Group II on mobilisation and efficient use of wood and wood residues for energy generation, July 2008

3.4.6 However, if the proposed EU targets on the expansion of renewable energy are to be achieved (20% by 2020) and assuming current proportion of renewable energy to be derived from wood biomass energy is retained, the current favourable wood supply situation would be reversed and the total demand from industry and energy use combined would grow to 1,200 million m^3 in 2020[28]. This is a conservative estimate as in reality the proportion of renewable energy from biomass within the overall renewable energy targets is likely to increase, overtaking other sources such as wind and solar power. This means that there are likely to be insufficient biomass fuels available from EU sources on a sustainable basis and European biomass energy applications will also become dependent on imports.

Global supplies of biomass fuels

3.4.7 The main regions in the northern hemisphere projected to become major biomass suppliers in the coming years are North America and Russia (see Figure 4). Both countries show the largest potential harvests of roundwood that are currently unutilised. In Canada and North America east coast and west coast supplies of virgin wood look very promising for the immediate future due to maturing softwood plantations, though their potential is expected to decline marginally in the longer term.

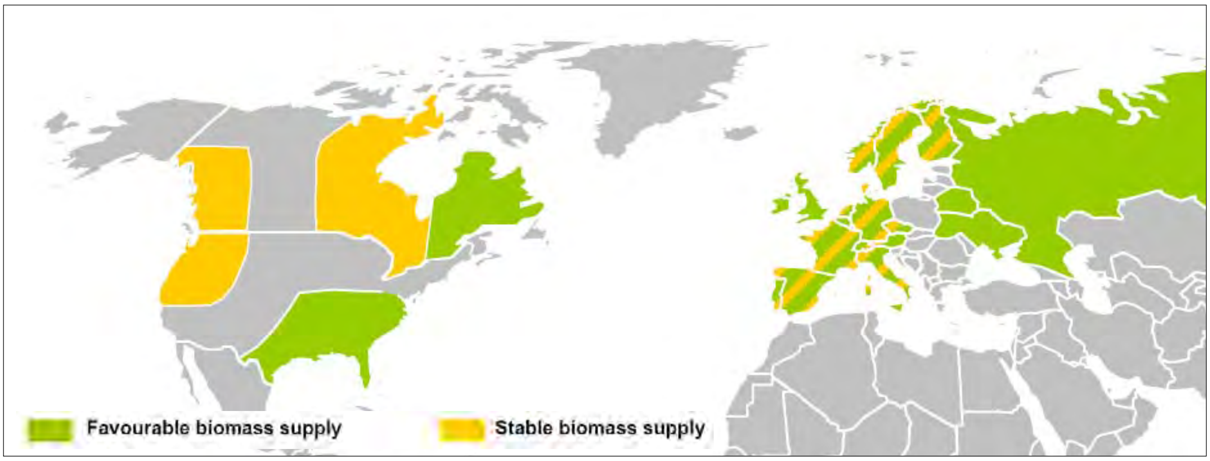

Figure 4: Global biomass supply showing North America and Russia as major potential biomass supply regions (Source: Roder, 2010)

3.5 Fuel sources for the Grangemouth Renewable Energy Plant

3.5.1 The key factor in the sustainability and security of Forth Energy's fuel supply is the design capability of the Grangemouth Renewable Energy Plant which enables the use of a wide range of fuels at the plant and allows a continuing review of the mix of both materials as well as the country of supply. In the short and medium term, it will not be possible to meet the fuel requirement from within the UK and Europe. Consequently, Forth Energy proposes to import (at least initially) 80% - 90% of its supplies from Scandinavian countries, Eastern Europe, North America and Canada, with 10% - 20% being supplied from within Scotland and the rest of the UK.

3.5.2 This situation is anticipated to improve through the lifetime of the plant with Forth Energy aiming to increase indigenous wood supplies to 30% of the fuel requirement for the Grangemouth Renewable Energy Plant, by working closely with local suppliers to support the local supply chain and with Scottish Government to encourage more indigenous forestry resource.

[28] Current status and challenges in the global availability of biomass. H.Roder 2010. Paper presented at Eurelectric workshop 'Biomass for power production: Sustainability and availability' held on the 26th of March, 2010.

3.5.3 Forth Energy will also work with both the Forestry Commission and private forestry estates to promote good and innovative forestry practice and ensure maximum yield and utilisation of forest products to develop a core of national biomass-supply chains.

3.5.4 Forth Energy recognises that the indigenous supply of biomass fuel in Scotland must not be increased at the expense of other wood use industries and agricultural land use. Forth Energy will support the Scottish Government in dealing with these inevitable concerns that will arise in parallel with increased biomass production in Scotland.

Transport of fuels

3.5.5 As described in previous sections, though all efforts will be made to include as much indigenous wood as is economically and sustainably feasible for the Grangemouth Renewable Energy Plant, Forth Energy understands that the realistic global fuel availability situation means that a significant proportion of the fuel mix will be imported. Forth Energy will make all efforts to minimise the impacts of long distance transport of fuels, and the port location of the Grangemouth Renewable Energy Plant means that fuels can be transported directly to the site by ship with minimal extra road transport.

3.5.6 As a mode of freight transport, shipping has been shown to be significantly less carbon intensive than road transport, with the tonne-kilometre footprint of road freight almost an order of magnitude higher than freight transported by sea[29]. As demonstrated in the carbon footprint of the Grangemouth Renewable Energy Plant (see section 4), even after taking into account the transport of fuels to site, the carbon footprint of electricity generated at the Renewable Energy Plant results in considerable savings: it is 91%-93% less than that of electricity generated at a coal-fired power plant.

3.6 Security of fuel supplies

3.6.1 The term 'energy security' is used to describe a range of concerns: the pressures on supply due to increasing global energy demand; concerns about the geopolitics of fuel supplies; fear of natural disaster or terrorist attacks on supply infrastructure; and the fundamental issue that reserves of gas, oil and coal are finite.

3.6.2 A number of 'energy crises' over the last 40 years have resulted in dramatic price increases or energy shortages, and the uneven global distribution of fuel resources makes some countries more vulnerable than others. North Sea reserves are in decline and Scotland will be increasingly dependent upon imported oil and gas; at the same time there are currently no plans to replace Scottish nuclear power stations as they reach the end of their lives. (The UK is currently a net importer of energy: net imports accounted for 26.5 per cent of total UK primary energy consumption in 2008[30].)

3.6.3 The diversification of energy supply - both by geographical location and by fuel type - can help to increase the resilience of energy supply and reduce the impacts of these challenges. Increasing use of biomass fuel will improve the Scottish energy security position. Developing local supply capacity will reduce long-term energy dependence, whilst the use of fuel from Scandinavia or North America diversifies the number of countries and fuel types being imported to Scotland. The availability of biomass fuel from European Union countries and other allies of the UK reduces the geopolitical risks.

3.6.4 Recent analysis for the UK government's Renewable Energy Strategy concluded that increased UK consumption of biomass-based energy "*is likely to have positive security of supply implications by increasing fuel diversity and reducing reliance on imported oil and gas*" and that while imported biomass will be subject to some supply risks, these will typically be lesser risks than those associated with imported fossil fuels.

[29] 2009 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting – 2nd Issue. Department of Energy and Climate Change (DECC) and Department of Environment, Food and Rural Affairs (Defra), 2009.

[30] Energy Security: A national challenge in a changing world. Department of Energy and Climate Change (DECC), 2009.

3.7 Land use issues related to future supply

3.7.1 Concerns have arisen in recent years with respect to the diversion of agricultural crops from food use to the manufacture of bio-fuel. These concerns have been particularly related to the growing use of food crops for the production of bio-ethanol or biodiesel. In the UK, including Scotland, there has been interest in the production of oilseed rape for biodiesel manufacture. Whatever the validity of these concerns, they will not be relevant to the supply of fuel stock for the Grangemouth Renewable Energy Plant, since the material will be almost entirely wood-based and agricultural residues will include only wastes or by-products from the agricultural sector (e.g. straw or rape seed expeller). Forth Energy will not support any moves to replace agricultural food crops with biomass energy crops.

3.7.2 Forth Energy will also seek to encourage and promote forestry activities on land where agriculture is not viable and where there are no concerns with respect to carbon emissions from land use change (i.e. use of peat land for forestry) or where conversion would lead to the loss of areas of high biodiversity.

3.7.3 As part of the FSC certification system, the conversion of large areas from within the forestry estate is not permitted[31]. However, the FSC and other certification systems do not normally consider the conversion of high-value land (i.e. high value in terms of biodiversity or the ability to sequester carbon) when it is being incorporated into the forestry estate.

3.7.4 Under the Renewable Obligations Order (Scotland) 2009 section 54 sub paragraph (k) there is a requirement to provide such information that "where the biomass was plant matter or derived from plant matter, the use to which the land on which the plant matter was grown has been put since 30th November 2005". As indicated in Section 8.5 of this document, Forth Energy will develop a comprehensive biomass sustainability policy that will cover all pertinent environmental, social and forest management aspects of biomass production including land use and land use change.

3.7.5 In order to fulfil this promise and to meet the requirements of the Renewable Obligations Order, Forth Energy will require documentation from every biomass supplier providing details of the country and location of production, proof of management in accordance with an approved forest certification system and details of the land use history (from 2005) for the production area. Information on land use will be checked through the auspices of the relevant third party forest certification agent as far as possible. Land use will be described in accordance with the main parameters of perennial/annual cropland, grassland, forest land – plantation and natural forest, together with the intensity of management as defined in the Guideline for the Calculation of Land Carbon Stocks for the purpose of Annex V to Directive 2009/28/EC[32]. Where there has been a change in land use, the carbon stock values will be calculated using the agreed formula defined in the EC guidelines as part of the standard reporting process.

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[31] Principle 6.10 Forest conversion to plantations or non-forest land uses shall not occur, except in circumstances where conversion: a) entails a very limited portion of the forest management unit; and b) does not occur on high conservation value forest areas; and c) will enable clear, substantial, additional, secure, long term conservation benefits across the forest management unit.

[32] Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C(2010) 3751) (2010/335/EU)

4 Carbon footprint of the Grangemouth Renewable Energy Plant

Summary of this section

This section presents the results of two carbon accounting exercises: the first quantifies the carbon emissions and savings related to electricity generated at the Grangemouth Renewable Energy Plant; the second discusses the carbon impacts of constructing the plant.

The carbon emissions associated with electricity generated at the Grangemouth Renewable Energy Plant include those from the harvesting and production of biomass fuels as well as the transport of the biomass fuels to the plant. In order to quantify these emissions a life-cycle assessment (LCA) approach was used in which secondary data was used to populate the fuel cultivation, harvesting and processing stages, with project specific information being used for the transport and fuel conversion stages. Fuel sourcing scenarios were developed by assessing the market for sustainable biomass fuels, current prices and availability of fuels, supply routes and global and indigenous markets for biomass fuel.

The results of this LCA show that carbon savings of 91% to 93% can be expected from electricity generated at the Grangemouth Renewable Energy Plant when compared to a coal fired power plant. Within the different stages of the life-cycle, the transport from country of origin to the plant site is the biggest contributor to the life-cycle emissions related to the plant.

Lifetime savings from the plant, taking into account the expected reductions in the carbon intensity of the UK grid, are estimated to be 3.2 $MtCO_2e$. Also, the plant has the potential to deliver more than 3.5% of the overall Scottish electricity target for 2020 as described in the Scottish Climate Change Delivery Plan.

Data from comparable Government funded research work on other biomass plants has been used to develop an estimate of the carbon embodied in the Grangemouth Renewable Energy Plant construction. This was found to be just under 0.02 $MtCO_2e$ which is equivalent to approximately 12% – 14% of the carbon emitted as a result of the plant operations and fuels used in one year or around 1% of the carbon emitted across the life-time of the plant.

4.1.1 As described in Sections 2 and 3, the basic requirement for carbon footprinting with respect to biomass plants in national and EU level guidelines is to assess the life-cycle impacts of the final energy product, in this case the electricity generated at the Grangemouth Renewable Energy Plant. However, the carbon embodied in the Renewable Energy Plant itself, i.e. the construction footprint of the plant, could also have a significant carbon impact and Forth Energy is keen to understand the magnitude of these carbon emissions.

4.1.2 This section presents the results of two carbon accounting exercises: the first quantifies the carbon emissions and savings related to electricity generated at the Grangemouth Renewable Energy Plant; the second discusses the carbon impacts of constructing the plant.

4.2 Carbon footprint of electricity generation and related carbon savings

4.2.1 The carbon emissions associated with electricity generated at the Grangemouth Renewable Energy Plant include those from the harvesting and production of biomass fuels as well as the transport of the biomass fuels to the plant. These emissions can be expressed as 'carbon savings' when compared to standard fossil fuel comparators. In this Statement four comparators have been used: the UK grid electricity average, the EU average fuel mix, a gas fired power plant and a coal fired power plant.

Methodology

4.2.2 Life cycle analysis (LCA) is particularly useful in understanding the relative impacts of using fossil fuels and renewable fuels to generate energy because they compare not only the 'end-of-pipe' emissions related to combustion of fuels on site, but include all the energy associated with extracting, processing and transporting the fuels. In order to conduct an LCA, the main steps in the development and use of a product or service need to be identified and the main inputs (i.e. energy, materials) and outputs (i.e. emissions to air, land and water) measured. A life-cycle carbon footprint, similarly, includes all energy used as inputs and greenhouse gases (GHG) emitted as outputs. The main drawback to the LCA methodology is the need for robust, supply chain specific data which is not always available. PAS 2050[33] recommends that in the event that primary data collection is not possible for a carbon LCA, robust secondary sources of data (preferably from an established national source, or academic literature) can be used to build up the LCA process chain.

4.2.3 For the carbon footprint of electricity produced at the Grangemouth Renewable Energy Plant presented here, primary data collection was not feasible for all steps in the life-cycle. This is due to the lack of an established fuel supply chain as the plant is not yet operational. As a result, a hybrid approach was used in which secondary data was used to populate the fuel cultivation, harvesting and processing stages, with project specific information being used for the transport and fuel conversion stages. See Appendix B for details of the main inclusions and assumption in this study. All the secondary data was sourced from robust, government funded research and international agencies where possible (see Appendix B).

4.2.4 The latest European Commission report (EC, 2010[34]) on sustainability criteria for biomass plants includes an outline methodology, units and boundaries for developing the life cycle carbon footprint for electricity and heat produced using biomass fuels. The Scottish Government's generic scoping advice for biomass plants[35] (published before the release of the EC report) states the Scottish Government's intentions to take a case-by-case approach to deciding whether further sustainability appraisal is required for Section 36 applications, until the EC framework is established.

4.2.5 EC (2010) recommends that the LCA methodology outlined in their report is used for assessing GHG savings. Forth Energy considers it appropriate to align the LCA for the Grangemouth Renewable Energy Plant with the EC recommendations to produce a robust and comparable assessment, and therefore this carbon footprint follows the EC methodology recommendations.

System Boundaries

4.2.6 The system boundaries for the analysis include the following:

- Greenhouse gases emitted as a result of direct and indirect energy inputs into each stage of the life cycle including fuels for transport, diesel and fuel oil for crop harvesting and drying machinery, electricity usage for chipping and pelletisation etc.
- Greenhouse gases associated with production of materials used including fertilizers, herbicides, manganese etc. used in crop husbandry and forestry
- Greenhouse gases associated with the production of diesel and electricity used during the life cycle of the biomass fuels

[33] The Publicly Available Standard (PAS) 2050 was published by the Carbon Trust in October 2008 and outlines a UK standard methodology for assessing the carbon impacts of a product.

[34] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. European Commission, 2010.

[35] Generic Scoping Advice for Biomass Plants in Scotland. Scottish Government, 2010.

4.2.7 Most academic and government funded work in this area includes details of carbon embodied in machinery and infrastructure associated with the life cycle of biomass energy, such as fencing and machinery used in crop husbandry, and the materials and construction of the Renewable Energy Plant itself (Mortimer and Elsayed, 2001[36]; Elsayed et al., 2001[37]; 2003[38]). EC (2010), however, recommends the exclusion of emissions from the manufacture of machinery and equipment, and the comparable Defra / Environment Agency figures for grid electricity do not include those emissions either. Therefore, in order to quantify the magnitude of carbon savings associated with the Renewable Energy Plant in line with EC (2010), the carbon embodied in machinery and infrastructure was excluded from this analysis.

4.2.8 The assessment in the LCA follows the energy chain from source to final energy, i.e. from the production of fuels through to the electricity produced from it. It therefore includes the conversion of the biomass fuels to electricity within the Grangemouth Renewable Energy Plant.

Functional Unit

4.2.9 The functional unit for the analysis is kilograms of carbon dioxide equivalent ($kgCO_2e$) emitted per mega joule (MJ) of electricity generated at the Grangemouth Renewable Energy Plant as specified by EC (2010). This can be expressed as $kgCO_2e$ / kWh by multiplying the $kgCO_2e$ / MJ figure by 3.6.

Reference Systems or avoided emissions

4.2.10 Reference systems are used to determine the effects of alternative activities that are avoided or displaced by the steps within an LCA. For example, in the case of clean wood recovered from the waste stream, such as chipboard, it is necessary to account for the emissions that have been avoided due to this waste not going to landfill, or to be used in other industry. In the case of other biomass fuels, reference systems are needed to account for the fact that the land used to grow the biomass could have been used for growing another crop or may have been lying fallow.

4.2.11 In the UK, Defra and the Environment Agency (Defra / EA, 2010[39]) and the Department for Trade and Industry funded research (Elsayed, 2001; 2003) has investigated the main issues and approaches to dealing with reference systems. The Defra / EA (2010) guide suggests that the inputs and outputs for a reference system form credits, which are subtracted from the relevant inputs and outputs of the main process chain under consideration. The guide also recommends methodologies and optimum reference systems for various biomass energy feedstocks in the Biomass Environmental Assessment Tool[40]. These systems were used in the analysis presented in this report.

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[36] Carbon and Energy Modelling of Biomass Systems: Conversion Plant and Data Updates, Mortimer, N. D., and Elsayed, M. A., 2001. Department of Trade and Industry Report B/U1/00644/00/00REP, Energy Technology Support Unit, Harwell, United Kingdom.

[37] Estimating the Energy Requirements and CO2 Emissions from Production of the Perennial Grasses Miscanthus, Switchgrass and Reed Canary Grass, Elsayed Bullard, M., and Metcalfe, P., 2001. Department of Trade and Industry Report B/U1/00654/REP, Energy Technology Support Unit, Harwell, United Kingdom.

[38] Carbon and Energy Balances for a Range of Biofuels Options, Elsayed, M. A., Matthews, R., and Mortimer, N. D., 2003. Report B/B6/00784/REP, Resources Research Unit, Sheffield Hallam University for the Department of Trade and Industry, London, United Kingdom.

[39] Biomass Environmental Assessment Tool v2.1- User Guide (Issue Number 4). Defra / Environment Agency, 2010. Prepared by AEA Technology and North Energy for Associates for DEFRA and the Environment Agency.

[40] Biomass Environmental Assessment Tool v2.1- User Guide (Issue Number 4). Defra / Environment Agency, 2010. Prepared by AEA Technology and North Energy for Associates for DEFRA and the Environment Agency.

Scenarios

4.2.12 At this time, the exact details of the fuel supply chain to be used in the proposed Renewable Energy Plant are not known and would vary year on year. As a result, it has been necessary to develop a number of different possible scenarios for the fuel types and sources as shown in Table 1. These scenarios were developed by assessing the market for sustainable biomass fuels, current prices and availability of fuels, supply routes and global and indigenous markets for biomass fuel.

4.2.13 The scenarios given in Table 1 illustrate realistic combinations of fuel type, fuel origin, form and timescale and thereby effectively 'frame' the basis for the calculation of carbon savings associated with the electricity generated at the Grangemouth Renewable Energy Plant.

4.2.14 The main variables used to draw up the three scenarios included:

- Different fuel types – energy crops from short rotation forestry / coppice (willow / eucalyptus), forestry products and forestry by-products (pine / spruce), clean wood recovered from the waste stream (chipboard, medium density fibreboard, waste from the wood processing industry) and agricultural products (straw)
- Different forms of fuels (chips, pellets)
- Different countries of origin for fuel sources (Scotland, Sweden, Estonia, USA)

4.2.15 The following scenarios have been used in this assessment:

Table 1: Scenarios used to understand potential carbon impacts of electricity generated at the Grangemouth Renewable Energy Plant

	Fuel origin	Fuel type	Form of predominant fuel?
Scenario 1 (considered feasible by 2015)	90% sourced from overseas	Overseas Fuel Supplies: Forestry products (50%), forestry based energy crops (50%)	78% woodchip, 22% pellets
	10% sourced from Scotland / UK	Indigenous Fuel Supplies: Forestry products (40%), recovered wood waste (20%), agricultural by-products (40%)	
Scenario 2 (considered feasible by 2020)	80% sourced from overseas	Overseas Fuel Supplies: Forestry products (50%), forestry based energy crops (50%)	80% woodchip, 20% pellets
	20% sourced from Scotland / UK	Indigenous Fuel Supplies: Forestry products (70%), recovered wood waste (10%), agricultural by-products (20%)	
Scenario 3 (considered feasible by 2025)	70% sourced from overseas	Overseas Fuel Supplies: Forestry products (50%), forestry based energy crops (50%)	82.5% woodchip, 17.5% pellets
	30% sourced from Scotland / UK	Indigenous Fuel Supplies: Forestry products (80%), recovered wood waste (7%), agricultural by-products (13%)	

4.2.16 In each of the scenarios shown in Table 1, the overseas fuels are sourced from Sweden, Estonia and the south-eastern USA (Florida), with 12.5%, 12.5% and 75% of the overseas fuel being sourced from these locations, respectively. Indigenous fuels are assumed to have been sourced from within Scotland and transported 50 miles by road (agricultural residues and waste wood), and 400 miles by sea (forestry products).

4.2.17 The ship dimensions included in this study have taken into account the capacity of the Port of Grangemouth as supplied by Forth Ports.

<u>Carbon emissions from electricity generation</u>

4.2.18 The carbon footprint of the electricity generated at the Grangemouth Renewable Energy Plant under each of these scenarios is shown in Figure 5 below.

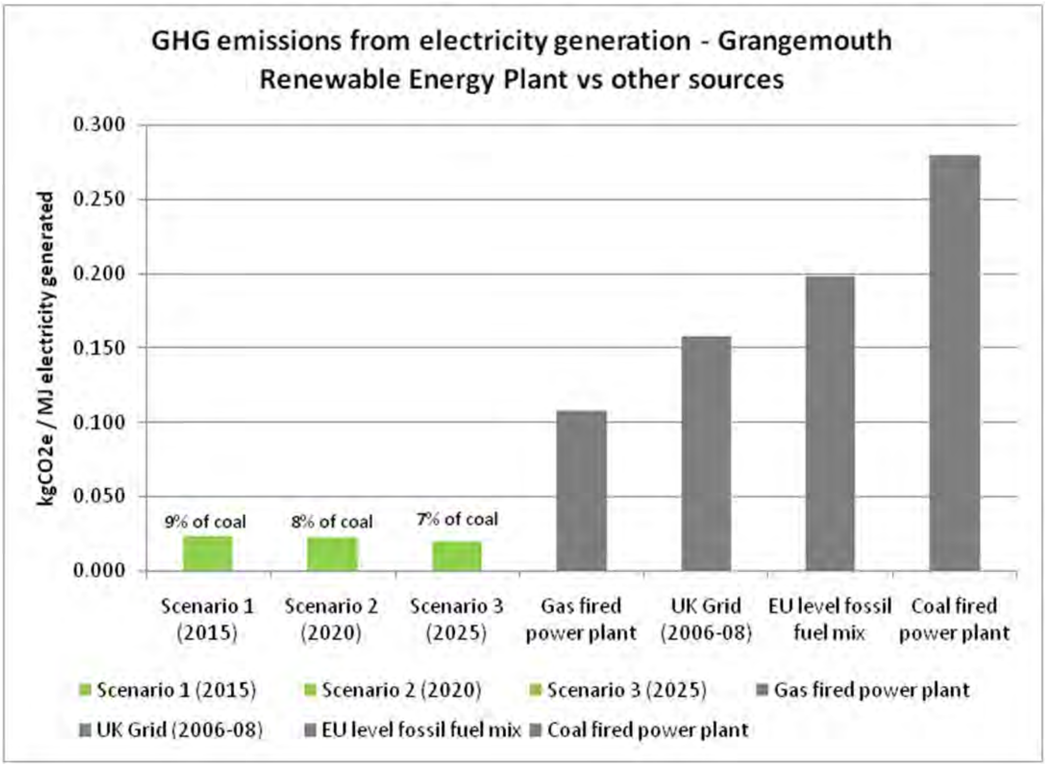

Figure 5: Grangemouth Renewable Energy Plant electricity emissions (kgCO_2e / MJ electricity generated) compared to fossil fuel comparators

4.2.19 The life cycle carbon emissions associated with scenarios 1, 2 and 3 are 0.024, 0.022 and 0.020 kgCO_2e / MJ (0.087, 0.080 and 0.072 kgCO_2e / kWh) respectively[41]. The overall savings are summarised in Table 2, which

[41] The four comparable life-cycle carbon footprints in Figure 5 are:

- the recommended fossil fuel comparator recommended in EC (2010), which includes emissions from electricity generated using a mix of different fossil fuels
- emissions from UK grid electricity, using the three year average for 2006 to 2008
- emissions from electricity generated in a coal fired power plant
- emissions from electricity generated in a gas fired power plant

These comparator data were sourced from EC (2010) and Defra / EA (2010). They each include emissions from the extraction (e.g. mining), processing and transport of the fuels, as well as emissions from the generation stage, and so provide comparable life-cycle carbon footprints to the results presented here for the Grangemouth Renewable Energy Plant.

shows the savings in carbon emissions for each of the three scenarios, compared to each comparator life-cycle carbon footprint.

Table 2: Carbon savings for Grangemouth Renewable Energy Plant Scenario 1, 2 and 3 when compared with the EU grid, the UK grid, a coal fired power plant and a gas fired power plant

	% carbon emissions saved when comparing the Grangemouth Renewable Energy plant to:			
	EU level fossil fuel mix	UK Grid (2006-08)	Coal fired power plant	Gas fired power plant
Scenario 1 (2015) (10% indigenous fuel)	88%	85%	91%	78%
Scenario 2 (2020) (20% indigenous fuel)	89%	86%	92%	79%
Scenario 3 (2025) (30% indigenous fuel)	90%	87%	93%	81%

4.2.20 A comparative assessment of these scenarios illustrates annual savings in carbon emissions of between 78% – 91% in 2015 depending on whether the comparator chosen is a gas fired power plant, UK grid electricity, the generic EU fossil fuel mix or a coal fired power plant (see Table 2).

4.2.21 These savings can be expected to increase to 92% and 93% when compared to coal power plants in 2020 and 2025 (Scenarios 2 and 3) due to increased proportions of indigenously sourced wood becoming available (see Table 2).

4.2.22 The Grangemouth Renewable Energy Plant is to be a base load plant, and electricity from the plant would be expected to replace electricity generated in a coal fired power plant. The UK grid comparator used in this study also includes 5% – 6% electricity generated using renewable sources which would not be displaced by electricity from the Grangemouth Renewable Energy Plant. Consequently, a comparison with the non-renewable part of the UK grid would show higher savings.

4.2.23 It is important to note that the overall savings presented in this Section are conservative due to the fuel types used in the scenarios presented here. The use of wood pellets rather than chips results in higher processing carbon emissions, due to the extra energy required to produce the pellets. This increase in energy use, however, will be offset by a decrease in the number of transport trips made, as the density and calorific value of pelletised fuels are higher. As allocation between fuel types has been on an availability and tonnage basis this offset has not been taken into account in the results presented here, and in reality slightly higher savings could be expected from electricity generated using pellets at the Grangemouth Renewable Energy Plant.

4.2.24 The Climate Change (Scotland) Act 2009 requires Scottish Ministers report on annual and lifetime greenhouse gas emissions of any electricity generation applications greater than 50 MW approved in Scotland. Estimates of these figures for the Grangemouth Renewable Energy Plant have been drawn up based on the fuel sourcing scenarios discussed in this chapter. These are as follows:

- The average greenhouse gas emissions per megawatt hour (taking into account different fuel sourcing scenarios throughout the life of the plant) is estimated to be 78 kg CO_2e / MWh.
- The estimated lifetime cumulative emissions from the plant are estimated to be 2.64 mega tonnes CO_2e.

4.2.25 In its Climate Change Delivery Plan[42] the Scottish Government states that the electricity sector needs to deliver emissions reductions of 9 $MtCO_2e$ against 2006 levels in order for Scotland to meet is 42% emission reduction target by 2020. Electricity generated at the Grangemouth Renewable Energy Plant has the potential to deliver over 3.5% of this overall Scottish target in the first 5 years of its operation, with an estimated 3.2 $MtCO_2e$ saved over the lifetime of the plant[43]. In reality, this is a conservative estimate, as Scotland's carbon accounting boundaries would not include the carbon emitted as a result of the production and processing of the fuel which would occur outside Scotland, and the contribution of the Grangemouth Renewable Energy Plant to meetings Scotland targets would be bigger.

Carbon emissions from different stages of the life-cycle

4.2.26 Figure 6 presents the emissions attributable to the different stages in the life-cycle of the electricity produced at the Grangemouth Renewable Energy Plant. For each of the scenarios, the production stage includes an overall carbon 'credit' due to Forth Energy's intention to include wood waste in the fuel mix for the Renewable Energy Plant. The overall credit in each case is due to avoided methane emissions from the decomposition of wood waste that would have occurred if the wood was disposed of to landfill rather than being used in the Grangemouth Renewable Energy Plant. Methane emissions have a global warming potential of 23, i.e. the impact of 1 kg of methane emissions on climate change is 23 times more than the impact of 1 kg of carbon dioxide. Even though the overall percentage of wood waste to be included in the fuel mix is very small (<2%), the avoided methane emissions are significant[44].

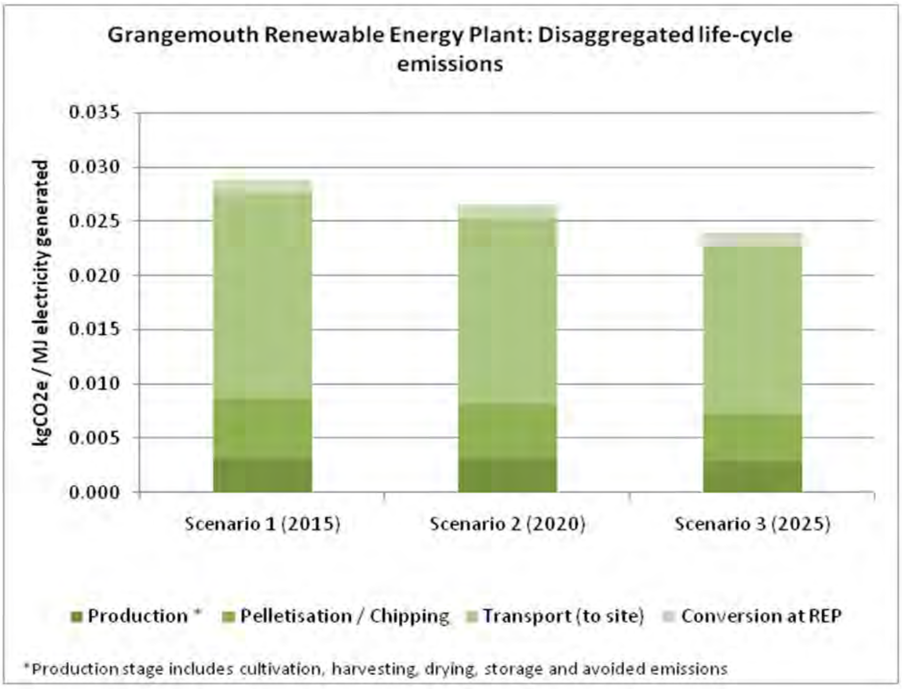

Figure 6: Life-cycle carbon emissions from electricity generated at Grangemouth Renewable Energy Plant

[42] Scottish Government, 2009. Climate Change Delivery Plan: Meeting Scotland's Statutory Climate Change Targets.

[43] This estimate has been quantified taking into account the reduction in carbon intensity of the UK grid as projected by the Committee on Climate Change, based on AEA (2008) MARKAL-MED model runs of long-term carbon reduction targets in the UK. Available at http://www.theccc.org.uk/sectors/power/ .

[44] The reference system used in this study is adapted from the Biomass Environmental Assessment Tool (BEAT) v2.1 (EA / Defra, 2010) and includes disposal of wood waste to landfill with energy recovery.

4.2.27 For all three scenarios, the largest components of the carbon footprints shown in Figure 6 are from the transport stage of the life-cycle. This is due to shipping the fuel from country of origin to Grangemouth, and from transporting the fuel within each country to the port or within Scotland by bulk road transport. The carbon intensity of transport by sea (6 gCO_2e/tonne.km) is much lower than the carbon intensity of road transport (86 gCO_2e/tonne.km)[45]. As a result, even though the marine transport distances in this study are much larger than the road transport distances, road transport is responsible for approximately 40% of the overall transport footprint in the Grangemouth Renewable Energy Plant scenarios.

4.2.28 The results presented in this Section take into account an initial assessment that the Grangemouth Renewable Energy Plant will also be producing around 200MWth of heat which will be utilised (see Section 6 for details on heat utilisation).

Assumptions

4.2.29 The main assumptions associated with this work are as follows:

- Energy use associated with growing, crop husbandry and harvesting associated with the biomass are assumed to be the same as those in the UK and elsewhere in the EU (data sources are EU / UK specific).
- Changes from land use have been assumed to be negligible due to the lack of data on country specific information.
- Simplest transport routes between two places (i.e. without stopovers) are assumed for the transport of biomass to the Renewable Energy Plant. Freight transport emission factors chosen have been based on the sizes of ships applicable to the Port of Grangemouth.

4.3 'Embodied' carbon footprint of construction of the plant

4.3.1 In general the carbon embodied in the manufacture of capital infrastructure is not included in life-cycle carbon assessments due to the uncertainty associated with quantifying these carbon emissions. As EC (2010) specifically excludes capital infrastructure in its recommended methodology for carbon accounting in biomass energy generation, the embodied carbon in the Grangemouth Renewable Energy Plant construction has been excluded from the overall savings given in Section 4.2.

4.3.2 Forth Energy is keen to understand the magnitude of this embodied carbon in order to reduce the carbon emissions associated with the materials they use. Table 3 presents the carbon embodied in the main materials that are expected to be used to construct the Grangemouth Renewable Energy Plant. These figures have been developed using databases included in SimaPro life cycle assessment software.

[45] These carbon intensities average factors for each mode of transport taken from Defra / DECC (2009).

Table 3: Carbon Footprint of Building Materials

Category type	Description	SimaPro Database	Footprint (per kg)
Binders	Cement	Ecoinvent System Process	0.774 $kgCO_2e$
Bricks		EcoInvent System Process	0.22 $kgCO_2e$
Concrete		EcoInvent System Process (Concrete block analysed)	0.115 $kgCO_2e$
Steel		ETH-ESU System Process (Steel I analysed)	1.83 $kgCO_2e$
Glass		EcoInvent System Process (Flat glass, coated analysed)	0.669 $kgCO_2e$
Wood		EcoInvent System Process (Glued, laminated timber for indoor use)	-612 $kgCO_2e$
Coverings	Ceramic tiles	EcoInvent System Process (Ceramic tile analysed)	0.818 $kgCO_2e$
	Roof tile	EcoInvent System Process (concrete roof tile analysed)	0.212 $kgCO_2e$
	Plaster	EcoInvent System Process (base plaster analysed)	0.218 $kgCO_2e$
Insulation	Foam glass	EcoInvent System Process (foam glass, at plant analysed)	1.58 $kgCO_2e$
	Polystyrene foam slab	EcoInvent System Process	4.2 $kgCO_2e$
	Cellulose fibre	EcoInvent System Process (cellulose fibre inclusive of blowing in)	0.281 $kgCO_2e$
	Mineral wool	EcoInvent System Process	1.48 $kgCO_2e$

4.3.3 Table 3 lists guideline footprints that will be used both as a basis to ensure materials used within construction are appropriate and also as a guide to minimise any materials that are particularly high in global warming potential in order to minimise the impact of the building as a whole.

4.3.4 As the exact quantities of different materials to be used will not be available till the detailed design phase, a bottom up footprint of construction using detailed estimates for each material was not practicable. Consequently, data from comparable Government funded research work on biomass plants[46] has been used to develop a top down estimate of the carbon embodied in the Grangemouth Renewable Energy Plant construction. This was found to be just under 0.02 $MtCO_2e$ which is equivalent to approximately 12% – 14% of the carbon emitted as result of the plant operations and fuels used in one year or around 1% of the carbon emitted over the life-time of the plant. These embodied carbon estimates include both the materials used to construct the plant and all the related construction activity.

[46] Carbon and Energy Modelling of Biomass Systems: Conversion Plant and Data Updates, Mortimer, N. D., and Elsayed, M. A., 2001. Department of Trade and Industry Report B/U1/00644/00/00REP, Energy Technology Support Unit, Harwell, United Kingdom.

4.3.5 It is important to note that the estimates presented here are based on studies of a variety of different plant sizes and therefore the actual embodied carbon in the Grangemouth Renewable Energy Plant would need to be developed from figures given in Table 3. Nonetheless, the estimates given here serve as an indication of the magnitude of carbon emissions resulting from the plant's construction.

5 Environmental and socio-economic impacts of the plant

Summary of this section

The main environmental and socio-economic impacts of Grangemouth Renewable Energy Plant have been assessed and described in detail in the Environmental Statement accompanying this proposal. The main issues have been summarised in this section.

In order to manage environmental impacts of construction, Forth Energy will consider the issues covered by BREEAM in the detailed design of the proposed Renewable Energy Plant where applicable.

The waste arisings from the Grangemouth Renewable Energy Plant will be the waste ash produced after woody materials are burnt to produce electricity and heat. Possible disposal routes include selling the ash, a useful by-product from the Grangemouth operations, as an alternative liming material for agricultural soils, or in the production of construction materials.

5.1 Managing environmental impacts of operation

5.1.1 The main environmental and socio-economic impacts of the Grangemouth Renewable Energy Plant and appropriate mitigation measures are described in the Environmental Statement for the development. Some of the main issues highlighted in the Environmental Statement are given below.

Air Quality and Climate Change

5.1.2 The Environmental Statement assesses the potential impacts on air quality during the construction, operational and decommissioning phases of the proposed Renewable Energy Plant using a variety of emission dispersion modelling techniques. Dust emissions during all phases will be controlled through implementation of a range of mitigation measures including those incorporated into the plant design. The health risks associated with the residual emissions from the proposed facility were evaluated and it is concluded that there will be no significant adverse effect on human health. The assessment found that the maximum process contribution to acid deposition at the nearest point of the designated habitat site would be more than 1% of the relevant criteria at the Bo'ness area of the Firth of Forth SPA which triggers the need for a Habitat Regulations Appropriate Assessment. Levels of acid and nitrogen deposition also exceeded 1% of the relevant critical loads at Slamannan Plateau SPA. When including the Rosyth and Leith Renewable Energy Plants, modelled levels of acid deposition at Blawthorn Moss SAC and Black Loch Moss SAC exceeded 1% of the critical load. The process contribution at these sites is a small fraction of existing background levels of deposition, and any effects from the Renewable Energy Plant are unlikely to be significant. The residual impact was assessed as not significant for the various pollutant considered.

Landscape and Visual

5.1.3 The assessment has shown that the proposed Renewable Energy Plant will result in no significant landscape impacts at the application site, Grangemouth or the wider landscape context considered within the study area. The proposed plant will create visual impacts throughout the study area but these are generally not significant. Four of the nineteen views will potentially experience significant visual impacts, the majority of which are restricted to within 2 km of the site. No significant cumulative landscape or visual impacts were identified by the assessment. No significant issues are identified in relation to landscape designations, landscapes or views from noted viewing locations. Although sometimes visible from a considerable distance, the proposed Renewable Energy Plant is always seen in the context of a landscape which is characterised by the presence of existing large scale industrial structures and complexes. Generally, although not contained within the landscape, the proposed plant will be entirely in keeping with the established landscape and visual characteristics of the Forth

Estuary corridor. Secondary mitigation in the form of architectural styling of the proposed Renewable Energy Plant has the potential to introduce a distinctive modern building to the urban landscape surrounding Grangemouth.

Noise

5.1.4 The Environmental Statement assesses the potential noise and vibration impacts of the construction, commissioning, operational and decommissioning (demolition) phases of the proposed Renewable Energy Plant and has included ambient noise measurements at the nearest residential receptors and computerised noise modelling of the proposed Renewable Energy Plant. Construction, commissioning and decommissioning noise will not result in any significant impact at the nearest receptors. Potential vibration generated during the construction and decommissioning phases is unlikely to be significant, although monitoring of piling vibration levels in Grangeburn Road is recommended. Noise from increased road traffic during construction, decommissioning and operational activities will also be insignificant. A number of measures have also been incorporated into the current design to minimise the noise impact of the Renewable Energy Plant during the operational phase. Noise from the construction, operation and decommissioning of the proposed Renewable Energy Plant will be considered further at the detailed design stage and appropriate measures incorporated into the design and layout of the site to ensure that noise emissions from the site are minimised. No significant residual effects are anticipated.

Terrestrial Ecology

5.1.5 The Environmental Statement assesses the potential impacts on terrestrial ecology receptors of the construction, operational and decommissioning phases of the proposed plant and shows that the proposed Renewable Energy Plant is unlikely to result in significant impacts on the majority of the identified sensitive terrestrial receptors during the construction operation and decommissioning phases, following the implementation of suitable mitigation measures. A significant residual impact on the Firth of Forth SSSI is possible at Preston Island due to acid deposition resulting from airborne emissions, although the actual extent of any effect is uncertain owing to limited information on the responses of vegetation to increases in deposition on sites, such as the Firth of Forth, where the critical load is already greatly exceeded. With the implementation of mitigation measures, no residual impacts are expected to occur on mudflat habitat, otters or breeding birds as well as qualifying interests in the Firth of Forth SPA. In line with good practice, mitigation measures will be carried out to ensure that even non-significant impacts are minimised.

Aquatic Ecology

5.1.6 The Environmental Statement assesses the potential impact on the aquatic ecology due to the use of cooling water which will be abstracted from the Western Channel and discharged to the River Carron. It is proposed to use a closed-cycle cooling water system with hybrid cooling towers to minimise the volume of water extracted. The heated effluent will be up to 12C warmer and will only be discharged during a falling tide to ensure its efficient dispersal. The assessment has predicted that no significant impacts on aquatic life will occur.

Hydrology, Hydrogeology, Geology and Soils

5.1.7 The Environmental Statement assesses the potential impacts of the construction, operation and decommissioning phases of the proposed Renewable Energy Plant on surface water, groundwater and soil, and provides an assessment of flood risk and likely changes to existing flood risk patterns. The flood risk assessment has determined the need to raise sensitive equipment above a design datum of 5.5 m AOD and provide areas of safe refuge above this datum for personnel within the site. It is likely that the Renewable Energy Plant will require a piled foundation solution and a Foundation Works Risk Assessment will be undertaken prior to construction. Appropriate working methods based on good practice will be incorporated into an Environmental Management Plan. No significant environmental effects have been identified in terms of impacts to the hydrological or hydrogeological environment. Overall this development will not result in any predicted negative residual effects of significance on the water or soil environments.

Cultural Heritage

5.1.8 Potential impacts of the proposed Renewable Energy Plant upon cultural heritage features resulting from its construction, operation and decommissioning have been considered in the Environmental Statement. Construction impacts have been assessed as being of negligible significance. Potential operational impacts upon the setting of cultural heritage features have been considered and assessed for the Historic Docks and the Antonine Wall and the impact is considered to be of negligible significance. No significant cumulative impacts are predicted.

Socioeconomic impacts

5.1.9 The development of the Renewable Energy Plant will bring a number of positive benefits to the local economy, assessed as being of moderate positive impact. These positive benefits over the total project period would comprise the equivalent of 206 direct jobs, 157 indirect jobs and £26.45 million of Gross Value Added per annum into the local economy. The operating and maintenance expenditure would provide an injection into the economy of £15.6 million over each year of operational life of the Plant. The project would also create wider qualitative socio-economic benefits including a wide range of potential job and skills opportunities for both the local business community and for members of the local labour force. Other positive impacts would include overall renewable industry supply chain benefits, biomass / wood-fuel resource supply chain benefits, and enhancement in sustainable biomass / woodfuel supply in Scotland.

Aviation and Telecommunication Systems

5.1.10 The Environmental Statement assesses the potential impact of the proposed Renewable Energy Plant upon existing communication systems, in the vicinity of the site. It has been assessed that there will be no potential impact on aviation and telecommunication systems. The proposed development may impact on TV reception in Grangemouth by "shadowing" the TV signals provided, primarily the relay transmission from the Craigkelly transmitter. Modelling has estimated that the Zone of Theoretical Shadowing caused by the proposed development would cover an area encompassing approximately 50 residential properties. Forth Energy will put in place mitigation measures to address deterioration identified with respect to TV reception, where this is the result of the proposed development. Adoption of the proposed mitigation measures will ensure that no impact will occur on any aviation or communication during construction, operation or decommissioning of the Plant.

Traffic

5.1.11 The proposed transport routes, access arrangements, estimated traffic volumes and potential environmental effects of traffic during construction, operation and decommissioning of the proposed Renewable Energy Plant are addressed within the Environmental Statement and also within a detailed Transport Statement (Volume 4 of the Environmental Statement). With the exception of localised pedestrian severance impacts, no significant impacts are predicted during the construction phase. Operational traffic numbers will be significantly less than those during construction. Up to 212,000 tonnes per annum of locally sourced fuel will be delivered by road. The Transport Statement (TS) provides details of the HGV movements this volume of material will generate, but the numbers equate to no more than 2 HGV movements each way every hour. The TS concludes that there is capacity on the local road network to take this increase plus other maintenance vehicles and deliveries. Due to the low levels of total vehicle movements during the operational phase of the plant, (including those of the 40 staff) the Environmental Statement does not predict any significant effects. No cumulative environmental effects of the proposed development are predicted due to the Earlsgate 2 proposal. All effects associated with decommissioning traffic are also considered to be insignificant.

5.2 Managing environmental impacts of construction

5.2.1 The Building Research Establishment Environmental Assessment Method (BREEAM) process allows an assessment of the environmental performance of both new and existing buildings. It is regarded by the UK's construction and property sectors as the measure of best practice in environmental design and management.

5.2.2 BREEAM areas cover the lifecycle of the buildings and look at their environmental and sustainability performance throughout the construction and operational phases. Forth Energy will consider the issues covered by BREEAM in the detailed design of the proposed developments where applicable to ensure sustainability of the development is maximised.

5.3 Waste material from the Grangemouth Renewable Energy Plant

5.3.1 The main waste arisings from the Grangemouth Renewable Energy Plant will be the waste ash produced after woody materials are burnt to produce electricity and heat. It is estimated that each year the Grangemouth Renewable Energy Plant will produce 19,500 tonnes of ash. Details of the amount and disposal routes for this ash are given in Figure 7.

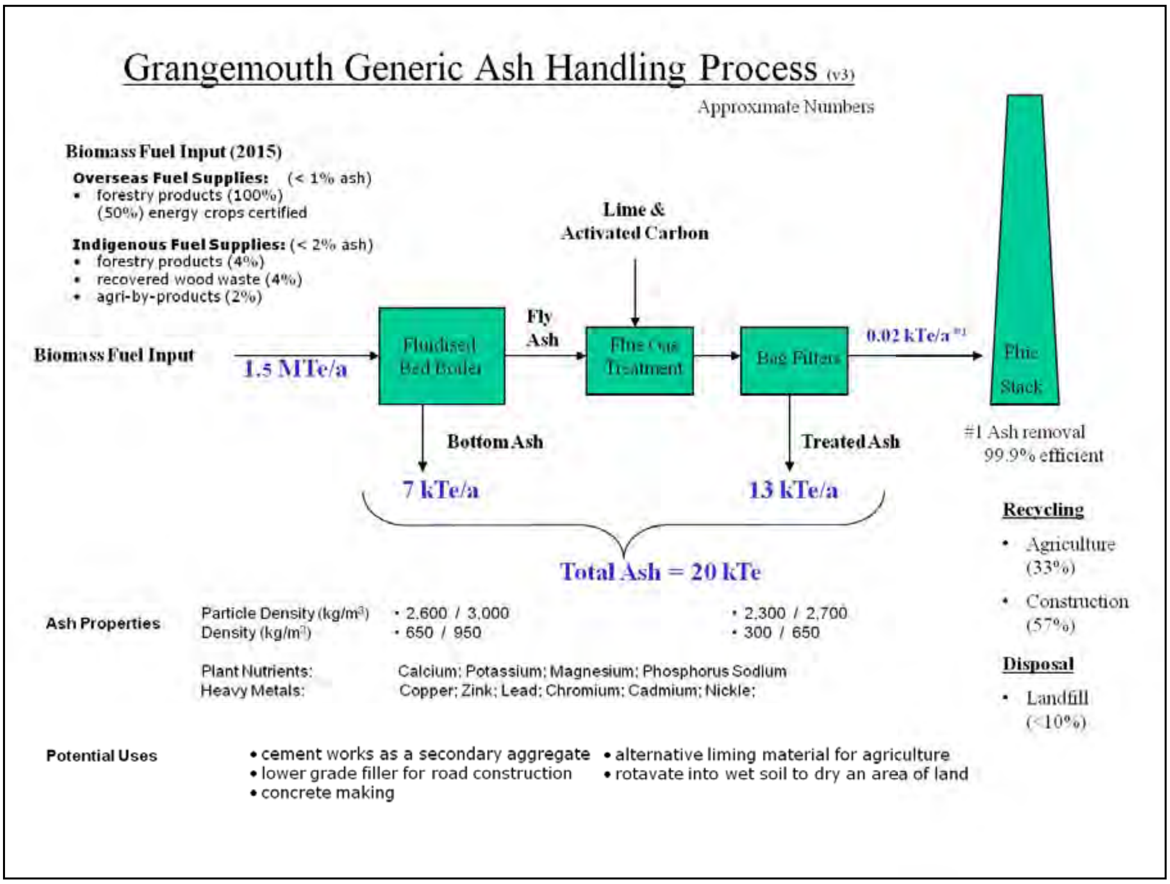

Figure 7: Generic ash handling flow diagram

5.3.2 Forth Energy is exploring ways in which this ash can be sold as a useful by-product from the Grangemouth operations, rather than being disposed to landfill. One of the main diversion routes for wood ash is as an alternative liming material for agricultural soils. The advantages of using wood ash for the purpose of neutralising acidic soils rather than lime (calcium carbonate) is that wood ash contains many of the nutrients originally absorbed from the soils by tree growth and it improves crop growth through improved nutrition. Other benefits of using wood ash in this way include weed control and an increase in soil fertility[47].

[47] Lickacz, J., 2002. Wood ash – an alternative liming material for agricultural soils. Agri-Facts published by Alberta Agriculture, Food and Rural Development, Canada.

5.3.3 Other possible uses for wood ash include production of cement, use as inert filling material and as a substitute for low-quality, fine grained aggregate material used in road and concrete construction. In the UK, many of these uses have been evaluated over the last 10 years including brick making, concrete making, and tests for use as secondary aggregates, block making and use in cement kilns[48].

[48] Dhir, R. K., Paine, K. A., Caliskan, S., 2004. Repackaging of previous research on use of recycled materials to facilitate sustainable urban development. Final Report to Department of Trade and Industry, CTU/3605. Technical Report.

6 Utilisation of heat generated at Grangemouth Renewable Energy Plant

Summary of this section

The main Grangemouth Renewable Energy Plant will be designed to supply heat to both process heat users as well as district heating users. A detailed heat mapping exercise has been commissioned to identify major energy users located within approximately 5 km of the proposed plant.

Preliminary estimates show potential renewable heat supply volumes ranging from between 1,052 GWh/annum to 1,492 GWh/annum, the latter being based on a thermal heat use of 200 MWth and giving an associated Quality Index (QI) of 116.35 for the Grangemouth Renewable Energy Plant. Discussions are ongoing with a number of these potential energy users and it is Forth Energy's intention that renewable heat/steam will be supplied to local users where there is demand and supply is commercially feasible

6.1 Heat mapping exercise

6.1.1 In order to make use of the heat that will be generated as a result of the Grangemouth Renewable Energy electricity generation, the potential for the plant to increase its efficiency through the supply of steam and/ or hot water to nearby activities have been investigated.

6.1.2 A detailed heat mapping exercise has been commissioned to identify major energy users located within approximately 5 km of the proposed Renewable Energy Plant. This exercise has made use of spatial analysis techniques to produce Heat Density maps and to locate potential heat users. The analysis does not distinguish between energy used for space heating and energy used to provide domestic hot water.

6.1.3 The exercise identified a number of large process steam users who could potentially consume more energy than would be produced at the Renewable Energy Plant. Initial discussions with the steam users have centred on providing the steam users with a substantial proportion of their steam requirements while allowing them to retain their existing steam production facilities.

6.1.4 The heat mapping exercise also identified limited demand for district heating. The location and dispersion of the potential heat users will make delivering a viable district heating system difficult to achieve. It is therefore Forth Energy's intention that these energy consumers will be connected after the process heat users so that further investigations can be carried out with the intention of trying to secure additional heat users.

6.2 Heat demand and consumption

6.2.1 The identified heat users are proposed to be connected in five phases over an 8 year period from 2015 to 2023. The first three phases will include only the process steam users and the last two phases is proposed to include both the process steam users and hot water users. The total potential heat demand for each phase is predicted based on the individual potential heat consumptions for the identified heat users as shown in Table 4. It is proposed that the steam supplied to process heat users will be extracted from the turbine, whereas heat required for the district heating users will be recovered from the flue gas.

Table 4: Heat demand and consumption

Heat Demand					
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Heat available from **turbine extraction** (MW)	200	200	200	200	200
Heat available from **turbine extraction** (MWh/annum) **	1,492,107	1,492,107	1,492,107	1,492,107	1,492,107
Potential heat consumption for **process heat users** only (MWh/annum)	1,052,096	1,302,109	1,492,107	1,492,107	1,492,107
Potential heat consumption for **process heat users** only (GJ/annum)	3,787,546	4,687,592	5,371,584	5,384,829	5,371,584
Energy use percentage of total annual energy production (%)[1]	**70%**	**87%**	**99%**	**100%**	**100%**
Heat available from **flue gas extraction** (MW)	19	19	19	19	19
Heat available from **flue gas extraction** (MWh/annum) **	141,474	141,474	141,474	141,474	141,474
Potential heat consumption of **district heating network** only (MWh/annum)	-	-	-	3,679	8,130
Potential heat consumption of **district heating network** only (GJ/annum)	-	-	-	13,245	29,267
Energy use percentage of total annual energy production (%)[2]	**0%**	**0%**	**0%**	**3%**	**6%**
Total heat consumption (MWh/annum)	1,052,096	1,302,109	1,492,107	1,495,786	1,500,236
Total Heat Consumption (GJ/annum)	3,787,546	4,687,592	5,371,584	5,384,829	5,400,850
Energy use percentage of total annual energy production (%)[3]	**70%**	**86%**	**99%**	**99%**	**100%**

[1]: the plant export capacity is based on 200.4 MW from the turbine extraction
[2]: the plant export capacity is based on 1.1 MW from the recovery of the flue gas
[3]: the plant export capacity is based on 201.5 MW from the recovery of the flue gas and the turbine extraction
**: Assumed plant availability is 85 %

6.2.2 The estimated average annual heat load for the scheme for each phase within 8 years following the commissioning of the Renewable Energy Plant is illustrated in Figure 8.

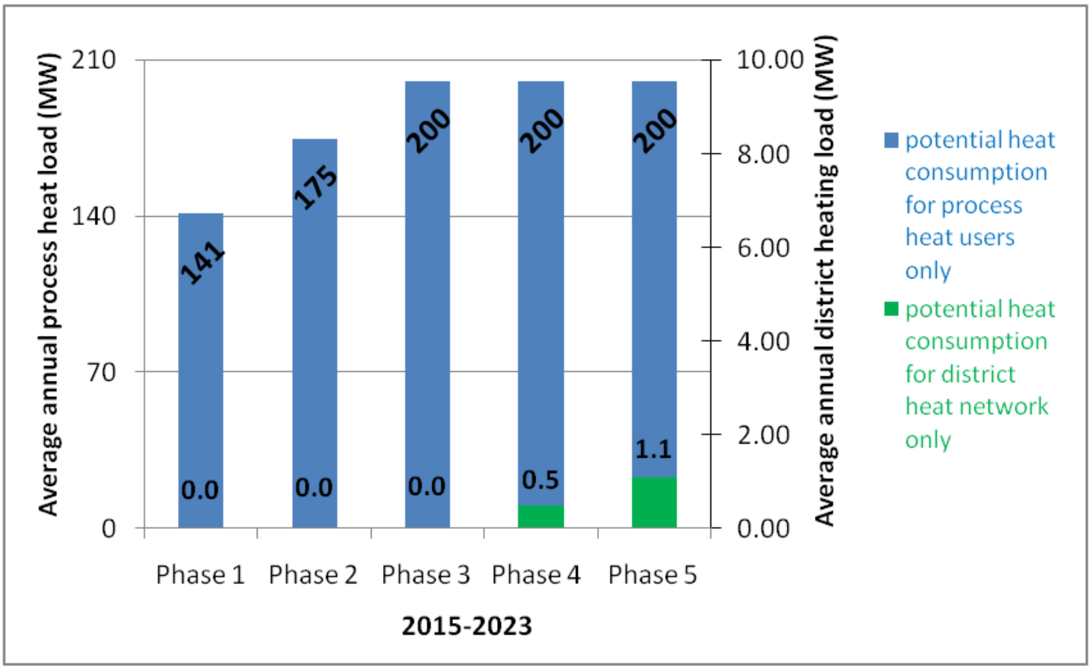

Figure 8: Illustrative heat loads for the Grangemouth Renewable Energy Plant

6.2.3 The start of the construction of the heat system is dependent upon the viability of the system and the location of the heat users. For example, planning and gaining consent for installation of the pipework off the site would take a significant amount of time due to the potential impact on local traffic management. Site restraints at the receiver end, would also play an important role in the project programme. These generally include the site health and safety rules depending on the nature of their processes and the access to the steam connections points within the site. It has been assumed that the first phase of the heat network will be online in 2015 following the commissioning of the Renewable Energy Plant.

6.3 CHPQA Quality Index

6.3.1 The table below shows expected annual Quality Index (QI) values and power and heat efficiencies and total potential heat demand for each phase of the heat and power plan.

Table 5: Quality Index values and efficiencies for heat plan phases

QI and Efficiency Table					
	Phase 1 (2015)	Phase 2 (2017)	Phase 3 (2019)	Phase 4 (2021)	Phase 5 (2023)
QI	111	114	116	116	116
Power Efficiency (%)	24%	23%	22%	22%	22%
Heat Efficiency (%)	29%	35%	38%	38%	38%
Total Efficiency (%)	53%	58%	61%	61%	61%

7 Sustainability Assessment of Grangemouth Renewable Energy Plant

7.1.1 In *Choosing Our Future: Scotland's Sustainable Development Strategy*[49], Scottish Ministers set out a number of ways in which they will measure progress in meeting the commitments made in the strategy and more generally progress on sustainable development. This included measuring progress against a wide set of indicators that reflect social and environmental as well as economic goals, to capture the different dimensions of sustainable development. There are four main outcomes sought by this strategy:

- The well-being of Scotland's people;
- Supporting thriving communities;
- Protecting Scotland's natural heritage and resources; and
- Increasing Scotland's global contribution.
- These outcomes have been embedded in the sustainability assessment methodology used in this Section.

7.2 Methodology

7.2.1 A sustainability framework has been developed to assist with testing the sustainability of the various aspects of the project. This comprises a matrix of sustainability objectives that sits within the project objectives and which has been derived from the review of policy and strategy guidance given in Section 2 – together with associated targets and indicators where available. The proposed development has been appraised on the basis of whether it moves towards or away from achieving each sustainability objective. As far as possible, at this stage of the development process, there are appropriate recommendations for reducing potential adverse effects and maximising beneficial effects that could be achieved in taking the proposals forward. Each of the objectives has been assessed as to whether the project's impact is positive or negative using the following denotation:

Symbol	Criteria
++	Significant beneficial / desirable effect
+	Marginal beneficial / desirable effect
-	Marginal negative / undesirable effect
--	Significant negative / undesirable effect
⇔	Could go either way / uncertainty
0	No impact anticipated

7.2.2 The assessment has been completed on the basis that the mitigation measures described in the associated Environmental Statement for the project has been implemented.

[49] Choosing our future: Scotland's sustainable development strategy. Scottish Government, 2005.

7.3 Sustainability Assessment Matrix

Table 6: Sustainability Assessment of Grangemouth Renewable Energy Plant

Aim	Sustainability objectives	Targets & indicators	Likely impact of the proposals on the current baseline		Recommendations
Well being	Increased economic opportunities for all	Employment Workless households	++	New jobs will be created during the construction and operation phases of the developments. These will include direct and indirect job opportunities. (See Chapter 16 of the Environmental Statement)	Encourage local employment
	An environment that provides the conditions for health and well-being	Health inequality	⇔	A detailed air quality assessment has been undertaken for each project which demonstrates that there will be no significant impact on local air quality. (See Chapter 9 of the Environmental Statement)	Monitoring of stack emissions and local air quality to be undertaken as required under the permitting regulations and conditions of the Section 36 Consent.
	A focus on the promotion of good mental health and well-being	Well being Crime	0	No impact anticipated.	Ensure security at site perimeters is maintained.
Supporting thriving communities	Well connected places	Mobility	0	No impact anticipated	-
	The regeneration of local environments	Environmental equality	⇔	Full exploration of the associated environmental and human impacts of the proposed developments has been undertaken and presented within the associated Environmental Statements. Appropriate mitigation measures will be implemented; however, the introduction of a Renewable Energy Plant in any location is likely to have some negative impact that need to be weighed against the social, environmental and economic benefits associated with the proposals.	Implement mitigation measures detailed within the Environmental Statements and ensure monitoring is undertaken as necessary. Supplier performance will be regularly audited against the emerging national and international standards. Any impacts on global environmental equity that may arise as a result of biomass fuels will be mitigated by Forth Energy's commitment to ensuring a clear chain of custody is established with relation to fuel suppliers.

Aim	Sustainability objectives	Targets & indicators	Likely impact of the proposals on the current baseline		Recommendations
	People at the heart of change	Active community participation	+	Community engagement has been undertaken for the proposals to ensure that sufficient knowledge and awareness has been given to surrounding communities and to understand any concerns.	Forth Energy will make efforts to inform and involve the local community in the vicinity of the development by reporting to the local community and liaising with consultees including the Forth Estuary Forum.
Protecting Scotland's natural heritage and resources	Biodiversity loss halted	UK and Local Biodiversity Action Plan Habitats and Species	0	A detailed assessment of the ecological impact of the Grangemouth Renewable Energy Plant has been prepared and demonstrates no significant impact on biodiversity. Forth Energy's intention to procure all forest based fuels from suppliers accredited by internationally recognised certification systems will ensure that no biodiverse habitats will be threatened by the demand for forest based fuels generated by the Grangemouth Renewable Energy Plant.	Supplier performance will be regularly audited against the emerging national and international standards.

Aim	Sustainability objectives	Targets & indicators	Likely impact of the proposals on the current baseline		Recommendations
	Natural resources are managed in a sustainable manner	Resource use Waste	+	It is intended that the plant will operate with a range of biomass fuels, which will comply with the requirements and definitions of biomass as defined in the Renewables Obligation Order[50]. The Renewable Energy Plant will only use biomass from sustainable sources (See Section 3). It is Forth Energy's objective to procure as much of the fuel from indigenous suppliers as practicable both economically and environmentally. However, it is recognised that, with the limited availability of UK sourced biomass, the majority of the fuel will be procured from overseas. Ash will be recycled, as far as possible, to for example, the construction industry or for soil improver.	Supplier performance will be regularly audited against the emerging national and international standards.
	The environment is protected effectively	Air quality Noise levels Water quality Habitats and species Landscape and visual Cultural Heritage	0	No adverse impacts on fish stocks or river quality will result from the proposed development (see Chapter 13 Aquatic Ecology of the Environmental Statement). Forth Energy is committed to protecting the environment at every stage of its operation.	Forth Energy will monitor the treatment process for any discharges to the aquatic environment.

[50] The Renewables Obligation Order 2009

Aim	Sustainability objectives	Targets & indicators	Likely impact of the proposals on the current baseline		Recommendations
Scotland's global contribution	Reduced greenhouse gas emissions	Greenhouse gas emissions	+	Sustainably sourced biomass is a recognised source of renewable energy[51] as emissions of CO_2 during combustion are largely offset during the growth of the biomass fuel. A full life cycle CO_2 evaluation of the project results in overall annual carbon savings of 91% to 93% when compared to a coal fired power plant (see Section 4 of this statement).	-
	Reducing the ecological impact	Habitats Species	0	A detailed ecological assessment has been completed for the Grangemouth Renewable Energy Plant with associated mitigation measures identified. The outcome of the assessment notes that in ecological terms the developments do not have a significant impact.	-
	Are contributing to the Millennium Development Goals	Childhood poverty Pensioner poverty Social justice	+	Direct and indirect job creation benefits associated with the development will have positive impact.	-

The positive and neutral impacts of the Grangemouth Renewable Energy Plant shown here have been addressed by Forth Energy. Forth energy's position and commitments related to sustainability of the plant are given in Section 8.

[51] The UK Renewable Energy Strategy (UKRES), Department of Energy and Climate Change (DECC), July 2009.

8 Managing sustainability: Summary of Forth Energy's position

8.1.1 Forth Energy intends to produce electricity and heat at the Grangemouth Renewable Energy Plant resulting in significant carbon savings, without any damage to the wider environment, diversity of species and ecosystems and the rights of communities and indigenous people.

8.2 Sustainability of fuel supplies

8.2.1 Forth Energy's position with relation to maintaining the sustainability of fuel supplies is as follows:

Compliance with relevant legislation

8.2.2 Forth Energy will comply with all relevant legislation pertaining to the sustainability of biomass fuels including the RED, and with the recommended sustainability criteria developed by the European Commission in February 2010.

Addressing chain of custody issues

8.2.3 In order to account for chain of custody related issues like threats to biodiversity and indigenous people, Forth Energy will likewise ensure that all forest-derived biomass material used at the Grangemouth Renewable Energy Plant is from sustainably managed forests or plantations both in terms of forestry operations and in terms of land use and land procurement. All forest-derived fuels used will be certified by internationally accepted sustainability certification systems. Where possible FSC certified fuels will be given preference over other comparable schemes.

Fuel sourcing and transport

8.2.4 Fuel types will include a mix of virgin wood, energy crops, reclaimed wood waste and agricultural residues. Initially 10% to 20% of fuels will be sourced indigenously with the remainder coming from Scandinavia, Eastern Europe, North America and Canada. The balance of indigenous material to imports used will vary in accordance to availability of biomass material across the UK, Europe and globally. Forth Energy will seek to increase the proportion of indigenous material over the life of the plant by supporting local supply chains and the Scottish Government; initial estimates suggest that 30% indigenously sourced material may be feasible by 2025.

Ensuring security of fuel supplies

8.2.5 Forth Energy's proposed plant will help improve the Scottish energy security position by developing local supply capacity which will reduce long-term energy dependence. The use of fuel from Scandinavia and North America will also diversify the number of source countries and fuel types brought into Scotland.

Avoiding displacement of food crops

8.2.6 Forth Energy will not support any moves to replace agricultural food crops with biomass energy crops in the UK or elsewhere. Forth Energy will seek to encourage and promote forestry activities on land where agriculture is not viable and where there are no concerns with respect to carbon emissions from land use change (i.e. use of peat land for forestry).

Biomass fuels sustainability policy

8.2.7 Forth Energy intends to develop it's own biomass fuels sustainability policy to manage the wider sustainability issues of fuel sourcing.

8.3 Minimising the impacts of climate change

8.3.1 With relation to minimising the impacts of human induced climate change through the significant carbon savings expected from electricity generated at the Grangemouth Renewable Energy Plant, Forth Energy's position is as follows:

Significant carbon savings

8.3.2 Forth Energy expects an 91% – 93% reduction in carbon emissions from electricity generated against equivalent electricity produced at a coal fired power plant. As the Grangemouth Renewable Energy Plant is a base-load plant it is anticipated that electricity generated at the Grangemouth plant will replace electricity generated using coal.

Contributing to Scotland's targets

8.3.3 Within the first five years of its operation the Grangemouth Renewable Energy Plant is expected to contribute 3.5% of the target reduction in Scottish carbon emissions from the electricity sector which is a crucial part of Scotland' overall 42% reduction target for 2020.

Minimising embodied carbon

8.3.4 The carbon embodied in the construction of the Grangemouth Renewable Energy Plant is expected to amount to 12% - 14% of the carbon emitted by the plant in its first year or around 1% of the lifetime emissions from the plant.

8.4 Overall sustainability

8.4.1 Forth Energy's position with relation to the overall sustainability of the construction and day to day operations of the Grangemouth Renewable Energy Plant are as follows:

Minimising environmental impacts

8.4.2 Any environmental impacts of the operation and construction of the plant identified through the Environmental Impact Assessment process will be mitigated and managed as described in the Environmental Statement.

8.4.3 Forth Energy will consider the issues covered by BREEAM in the detailed design of the proposed developments where applicable to ensure sustainability of the development is maximised.

Creating employment opportunities

8.4.4 Forth Energy's proposed plant will create employment opportunities both directly and indirectly. These positive benefits over the total project period would comprise the equivalent of 206 direct jobs, 157 indirect jobs and £26.45 million of Gross Value Added per annum into the local economy

Reducing waste ash

8.4.5 Forth Energy will seek to divert as much of the waste ash produced at the Grangemouth Renewable Energy Plant from landfill as is possible through innovative means (selling to local farmers, or to construction industry for using in a range of supplementary processes).

8.5 Developing a biomass sustainability policy

8.5.1 The planned production of electricity at four Renewable Energy Plants across Scotland makes it likely that Forth Energy will be purchasing and using a significant amount of biomass in coming year and will have the opportunity of playing a major role in future biomass supply chain development. As there is no binding criteria to ensure sustainability of energy produced using biomass feedstocks at an EU or national level at the moment, Forth Energy intends to develop and implement its own biomass sustainability policy taking into account all national and EU regulatory drivers and guidelines. This policy will:

- Address minimum GHG savings on a lifecycle basis including direct and indirect land use impacts;
- Address wider environmental and social impacts, e.g. biodiversity, impact on food prices and impacts on soil and water quality;
- Be independently audited and verified.

8.5.2 Forth Energy intends to develop this policy with input from and engagement with relevant stakeholders including the Scottish Government, Local Authorities and third sector organisations.

8.6 Conclusion

8.6.1 This Statement describes Forth Energy's understanding of and commitment to the wider sustainability issues related to the Grangemouth Renewable Energy Plant.

Forth Energy has undertaken a detailed appraisal and evaluation of the all relevant sustainability issues and is confident that this plant will make a positive contribution to the health, wealth, safety and environment of Scotland.

APPENDIX A: Forest Certification Systems

Forest Stewardship Council (FSC)

The Forest Stewardship Council (FSC) is the dominant certification system on a worldwide basis, with over 800 organisations involved, and is recognised in some 90 countries. The FSC sets the benchmark for certification, incorporating chain of custody certification and restrictions on land conversion as well as ensuring overall good forest management practice. The ten FSC principles and what they require are shown in Table 7.

Table 7: FSC Principles of Forest Stewardship

FSC Principles		Main aspects / requirements
Principle	**Description**	
Principle 1: Compliance with laws and FSC Principles	Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is a signatory, and comply with all FSC Principles and Criteria	In signatory countries, the provisions of all binding international agreements such as the Convention on Biological Diversity shall be respected. Forest management areas to be protected from illegal harvesting, settlement and other unauthorized activities.
Principle 2: Tenure and use rights and responsibilities	Long-term tenure and use rights to the land and forest resources shall be clearly defined, documented and legally established.	Tenure agreements to be defined. Mechanisms for disputes over tenure and rights to be established.
Principle 3: Indigenous peoples' rights	The legal and customary rights of indigenous peoples to own, use and manage their lands, territories, and resources shall be recognized and respected.	Customary rights shall be respected. Cultural areas will be recognized and given due protection.
Principle 4: Community relations and worker's rights	Forest management operations shall maintain or enhance the long-term social and economic well-being of forest workers and local communities.	Employment opportunities will be identified for local communities. Management planning will incorporate social impact assessment. Process will be defined for dealing with grievances.
Principle 5: Benefits from the forest	Forest management operations shall encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits.	Production should be aimed at avoiding concentration on a single product. Harvesting to be kept to a level that promises sustainability.
Principle 6: Environmental impact	Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.	Environmental assessment to be conducted at a level appropriate to the scale of operations. Protection strategies to be enacted for defined conservation areas/species. Minimal use of chemicals and banning of those considered highly toxic.
Principle 7: Management plan	A management plan -- appropriate to the scale and intensity of the operations – shall be written, implemented, and kept up to date. The long term objectives of	The Management Plan must define objectives of management, details of the forest resource and the estimated yield and its method of calculation.

	management, and the means of achieving them, shall be clearly stated.	
Principle 8: Monitoring and assessment	Monitoring shall be conducted -- appropriate to the scale and intensity of forest management -- to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.	Documentation to be provided by the forest manager to enable monitoring and certifying organizations to trace each forest product from its origin, a process known as the "chain of custody." The results of monitoring shall be incorporated into the implementation and revision of the management plan.
Principle 9: Maintenance of high conservation value forests	Management activities in high conservation value forests shall maintain or enhance the attributes which define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach.	An assessment of the forest that can be defined as High Conservation Value Forests to be completed, at an appropriate extent to the scale and intensity of forest management. The consultative portion of the certification process must place emphasis on the identified conservation attributes, and the various options for their maintenance.
Principle 10: Plantations	Plantations shall be planned and managed in accordance with Principles and Criteria 1 - 9, and Principle 10 and its Criteria. While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's needs for forest products, they should complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests.	Diversity in the composition of plantations is to be preferred, in order to enhance economic, ecological and social stability. Such diversity may include the size and spatial distribution of management units within the landscape, number and genetic composition of species, age classes and structures. Species selection to be based on their overall suitability for the site and their appropriateness to the management objectives. Ideally, preference to be given to native species over exotic species though exotics can be used if their performance is clearly better than that of native species.

The PEFC Certification System

The Programme for the Endorsement of Forest Certification (PEFC) works throughout the forest supply chain to promote good practice in the forest and to ensure that timber and non-timber forest products are produced with respect for the highest ecological, social and ethical standards.

PEFC is an umbrella organization. It works by endorsing national forest certification systems developed through multi-stakeholder processes and tailored to local priorities and conditions. In this respect it is more adaptable than FSC but still adheres to the same principles. Each national forest certification system undergoes rigorous third-party assessment against PEFC's unique Sustainability Benchmarks to ensure consistency with international requirements. Unlike FSC, therefore there are not a defined set of PEFC criteria, but rather forest managers are required to work to benchmarks that have already been developed by internationally-recognized bodies. These benchmark criteria are regularly revised through multi-stakeholder processes involving participants drawn globally from civil society, business, governments, and labour and research institutions to take account of new scientific knowledge, societal change, evolving expectations and to incorporate latest best practice.

Today, PEFC currently includes 34 national certification systems including the UK Forestry Commission supported system: the UK Woodland Assurance Standard (UKWAS).

PEFC in the UK

The UK Woodland Assurance Standard (UKWAS) is an independent certification standard for verifying sustainable woodland management in the United Kingdom, and has been certified by the PEFC. The main features of UKWAS are given in Table 8.

Table 8: Main features and requirements of UKWAS

UKWAS Section	Main Requirements
Management Planning	Records of forest inventory and mapping and clear links to protected areas Growth and yield estimates defined Harvesting Records Clear monitoring procedures
Woodland Design	Environmental and ecological assessment prior to forest operations Impact of woodland to be considered at the level of landscape Emphasis on diversity of species, age structure, provenances Extensive clear felling to be avoided Conversion to non-forested land to be restricted to roads etc
Operations	Control of contractors and proof of close supervision Harvesting to be carried out in accordance with principles of minimal site damage Restriction on the burning of forest waste
Planning	Planting plans designed to ensure diversity of species and age structure Management of wild mammals Existence of a fire plan Use of pesticides and fertiliser kept to a minimum. Highly hazardous chemicals (defined by FSC) not allowed. Use of GMOs not allowed
Protection of rare species and natural resources	Identification of SACs, SPAs, SSSIs etc; all such areas to be managed in accordance with plans by conservation bodies. Semi-natural woodland to be identified and further change minimised 15% of woodland area to be managed for conservation Deadwood habitats to be promoted Game management in accordance with licence conditions
Community	Proof of good consultation practices. Access promoted and sites of interest advertised Integration of forest business into the local economy
Health and Safety	Adherence to all codes Training support for work force Full insurance cover

PEFC in Europe

The certification criteria to be used in PEFC endorsed and mutually recognised national or sub-national schemes in Europe are based on the current Pan-European Criteria for Sustainable Forest Management. These are as follows:

Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles;

Maintenance of forest ecosystems' health and vitality;

Maintenance and encouragement of productive functions of forests (wood and non-wood);

Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems;

Maintenance, conservation and appropriate enhancement of protective functions in forest management (notably soil and water); and

Maintenance of other socio-economic functions and conditions.

PEFC in the tropics

The forest certification criteria for forest management of natural tropical forests is linked to the International Tropical Timber Organisation (ITTO) guidelines on the sustainable management of natural tropical forests (1992) and the ITTO guidelines on the conservation of biological diversity in tropical production forests (1993). Further, the forest certification criteria for forest management of planted tropical forests shall be compatible with ITTO guidelines for the establishment and sustainable management of tropical forests (1993).

APPENDIX B: Life-cycle carbon accounting model inclusions and data sources

This appendix describes some of the technical details related to the carbon accounting model developed for the Grangemouth Renewable Energy Plant.

Generic process map

The generic stages in the life cycles of the fuels considered in this study and inputs included in each stage can be seen in the following diagram.

Establishment / planting*	Energy and fuel use associated with crop husbandry
Fertilisation*	Energy embodied in fertilisers
Harvesting **Transport**	Energy and fuel use associated with crop husbandry; assumed distances
Storage / drying **Transport** **Chipping / pelletisation**	Energy and fuel use associated with drying and processing; assumed distances
Transport	Mapped distances to port locations
REP: Conversion to electricity	Quantities of biomass, other fossil fuel use on site, expected electricity / heat output

* For forestry residues these stages have been replaced by one stage 'Regeneration / Seeding'.

Detailed descriptions of the inputs included in the study and sources of data for each fuel type are described in the following sections.

Virgin wood: forestry residues and products

Regeneration (Elsayed et al. 2003)

Included in the calculations for regeneration are the carbon requirements for fuel consumption for mounding and spreading herbicide, application of a mixture of herbicides and consumption of tree seedlings in stand establishment and regeneration.

It was assumed that the forest residues are procured from a pre-standing forest, and that half of the trees will originate from natural regeneration and half from enrichment planting.

Reference system figures considering the energy savings for allowing land to return to wilderness with no energy inputs were either non-existent or insignificant, so no reference system was used.

Stage: Harvesting (Elsayed et al. 2003)

Including in calculations for tree felling and harvesting are the carbon requirements for diesel fuel consumption.

Stage: Extraction (Elsayed et al. 2003)

Including in calculations for collection, baling and extraction are the carbon requirements for diesel fuel consumption.

Stage: Transport to storage / drying facility (Elsayed et al. 2003)

Included in calculations are direct carbon requirements for transport by bulk road carrier. There is an assumed round trip distance of 90 +/- 18 km.

Stage: Chipping (residues) (Defra / EA, 2010)

Included in calculations is diesel fuel consumption used by machinery in conversion of dried wood fuel to chips.

Stage: Pellitisation (Defra / EA, 2010; Defra / DECC, 2009)

Included in calculation is energy input for pelletisation.

Virgin wood: short rotation forestry / coppice

Stage: Cultivation (Elsayed et al. 2003)

Included in the calculations for cultivation are the carbon requirements for fuel consumption for sub-soiling, ploughing, harrowing, rotavating and spreading herbicides.

Reference system figures assume fallow set aside with diesel fuel consumption for mowing.

Stage: Harvesting and baling (Elsayed et al. 2003)

Including in calculations for harvesting, baling and collecting are the carbon requirements for diesel fuel consumption.

Stage: Transport (Elsayed et al. 2003)

Included in calculations are direct carbon requirements for transport by bulk road carrier. There is an assumed round trip distance of 64.37 +/- 12.878 km.

Stage: Chipping (Defra / EA, 2010)

Included in calculations is diesel fuel consumption used by machinery in conversion of dried wood fuel to chips.

Stage: Pellitisation (Defra / EA, 2010; Defra / DECC, 2009)

Included in calculation is energy input for pelletisation.

Energy crops: miscanthus

Stage: Establishment / fertilisation (Elsayed et al. 2003)

Included in the calculations for cultivation are the carbon requirements for the application of ammonium nitrate fertiliser, phosphate fertiliser, potash fertiliser, lime application, manganese application, mixture of herbicides application, and fuel consumption for land preparation, planting, and fertiliser and herbicide application.

Stage: Harvesting (Elsayed et al. 2003)

Included in calculations is diesel fuel consumption for cutting, swathing, baling, loading, carting and transferring.

Stage: Storage (Elsayed et al. 2003)

Included in calculations is diesel fuel consumption for handling fuel feed.

Stage: Chipping (Defra / EA, 2010)

Included in calculations is diesel fuel consumption used by machinery in conversion of dried wood fuel to chips.

Stage: Pellitisation (Defra / EA, 2010; Defra / DECC, 2009)

Included in calculation is energy input for pelletisation.

Agricultural products: wheat straw

Stage: Fertilisation / Baling (Elsayed et al. 2003)

Included in the calculations for cultivation are the carbon requirements for the application of ammonium nitrate fertiliser, phosphate fertiliser, potash fertiliser, and diesel fuel consumption for baling and loading.

Also included in the calculations is a reference system reflecting savings of diesel fuel consumption from straw chopping and extra.

Energy for planting is not counted because it is assumed that straw is sourced as an agricultural by-product.

Stage: Transport to storage / drying facility (Elsayed et al. 2003)

Included in calculations are direct carbon requirements for transport by bulk road carrier. There is an assumed round trip distance of 80 km (Elsayed et al. 2003).

Stage: Storage (Elsayed et al. 2003)

Included in calculations is diesel fuel consumption used for baled straw handling in storage.

Wood processing waste

Stage: Transport to chipping plant (Defra / DECC 2009).

Included in calculation is operational fuel consumption, assuming an average distance of 100 km between waste wood source and chipping plant.

Stage: Chipping (Defra / EA, 2010)

Included in calculations is diesel fuel consumption used by machinery in conversion of dried wood fuel to chips.

Reference: displaced emissions from disposal to landfill with energy recovery (Defra / EA, 2010)

Reference system calculations include greenhouse gas inputs from processes of on-site vehicles, operational materials, construction materials and decommissioning materials. This input is offset with the carbon requirement of displaced grid electricity.

Data sources

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