Final Report V 1.1 Project UKPIR11

MINIMISING GREENHOUSE GAS EMISSIONS ACROSS ENVIRONMENTALLY REGULATED INDUSTRY IN SCOTLAND AND NORTHERN IRELAND

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EXECUTIVE SUMMARY

UKPIR11: Minimising Greenhouse Gas Emissions across Environmentally Regulated Industry in Scotland and Northern Ireland (January, 2008).

Project funders/ partners: SNIFFER, SEPA, EHS, SG, DOENI

SNIFFER commissioned the project 'Minimising greenhouse gas emissions across environmentally regulated industry in Scotland and Northern Ireland' under its UK Research Programme (UKPIR11).

Objectives of research
This project focuses on environmental regulations in Scotland and Northern Ireland. It aims to identify those areas of regulation that have a material impact on greenhouse gas (GHG) emissions which is not currently considered, particularly in cases where regulatory decisions actually cause an increase in greenhouse gas emissions. The research also considers how the impact on GHG emissions could be minimised through the use of guidance. In addition to this report, a key output of the work is a Climate Change Mitigation Toolbox which provides information and advice to regulators of various environmental media.

Approach
These objectives were addressed as follows. First we analysed quantitative data to identify which of the sectors that Scottish Environment Protection Agency (SEPA) and Environment and Heritage Service (EHS) regulate are responsible for material GHG emissions. We combined a review of the literature and interviews with regulators to explore the extent to which GHG emissions are already considered in the regulatory decision making framework. Through this research and in discussion with the project Steering Group, we identified examples of instances where regulations, such as the requirement for abatement of emissions, can cause an increase in GHG emissions. We then established whether the GHG emissions impact of the environmental regulations could be reduced and the extent to which this could be influenced by the provision of guidance. The final step was the production of a Climate Change Mitigation Toolbox for use by regulators and regulated industry.

GHG emitting sectors regulated by SEPA and EHS
The combustion of fossil fuels is the largest source of greenhouse gas emissions in Scotland and Northern Ireland. SEPA and EHS regulators influence a proportion of these emissions through their role in implementing EC directives addressing the industrial and power generation sectors. However, the regulatory bodies have no influence over two large emitting sectors: domestic and transport energy use. Domestic emissions from fossil fuel combustion and from electricity use in the home are not directly influenced by the regulator[1].

[1] Although the efficiency of electricity generation is covered by regulations, its use in the home is not.

Based on our estimates, sectors which are environmentally regulated account for around 55% of Scotland's greenhouse gas emissions and around 45% of Northern Ireland's emissions, though the extent and influence of regulation varies widely between sectors and there are caveats around this analysis[2]. The main sources from environmentally regulated industry were identified as:

- power generation, industrial combustion and refineries which are all regulated via Pollution Prevention and Control (PPC), plus agricultural soils which are regulated indirectly in certain areas through the Nitrates Directive, are responsible for the largest volume of GHG emissions of the sectors that SEPA regulates; and

- power generation, agricultural soils, industrial combustion and cement are responsible for the largest volume of GHG emissions of all the sectors that EHS regulates (via PPC and the Nitrates Directive).

Extent to which GHG emissions already accounted for in the regulatory framework

SEPA and EHS regulate three main areas of legislation, stemming from the overarching EC directives in the areas of: PPC, water regulations and waste management.

In terms of the **PPC** Part A regulatory framework, greenhouse gas reduction is factored in to permit requirements to some extent through the consideration of BAT and energy efficiency. However, this only focuses on carbon dioxide emissions and regulators can only enforce basic energy efficiency requirements at sites with a Climate Change Agreement. This approach for sites with CCAs is in line with Defra's light touch regulation position. For EU ETS/PPC sites, there are restrictions on the application of BAT to CO_2 emissions from site activities falling under the scope of the EU ETS. PPC Part B permits focus on air quality pollutants and do not address energy or greenhouse gas reduction.

Based on feedback from the **water** regulators, licensing and risk assessment when granting water consents does not take GHG minimisation into account. Regulators can only recommend "the most sustainable option" to operators when reviewing waste water treatment upgrade proposals. Although this involves some consideration of energy use, regulators cannot insist on low energy alternatives, particularly given that the compliance options are limited and because there is no explicit regulatory requirement to do so, as water quality is the driving force.

Larger **waste** management sites are caught by PPC Part A and so their energy usage is reviewed under the permit assessment (described above). Energy use is not part of the permit conditions for smaller, non-PPC sites (e.g. council civic amenities) which are only covered by Waste Management Licenses (WML). In addition to carbon dioxide emissions from energy, this sector is also responsible for emissions of methane (a more potent GHG). The choice of approach to address methane emissions (through energy generation, flaring or venting) is primarily driven by cost and practicality issues rather than GHG impacts.

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2 The extent to which the regulators can help to avoid increases in GHG emissions depends on (i) the scale of GHG emissions in a particular sector, (ii) the extent to which they are regulated and (iii) the range of options available to ensure compliance with those regulations. The analysis here considers the first of these factors combined with an estimate of the impact of the second. As such it provides an idea of the potential impact that regulators could have but does not allow us to categorically state where the greatest impact could be made.

Extent to which the regulations cause an increase in GHG emissions[3]

Given that the regulators influence the activities of a wide range of sectors in a variety of ways, there is considerable potential for regulatory decisions to impact on GHG emissions. In some cases the impact is negative (i.e. causes an increase in GHG emissions) in others it is positive (i.e. environmental compliance mitigates the climate change impact). The table below summarises some key examples.

The research for this project highlighted that the **Large Combustion Plant Direct** (LCPD) and the water regulations have the strongest link to increasing greenhouse gas emissions. Under the LCPD coal-fired power stations must install flue gas desulphurisation (FGD) equipment if they are to continue to operate in the long term. This is energy intensive and leads directly to a 3% increase in carbon dioxide emissions from power generation, but with a reduction in emissions of SO_2 to atmosphere and an improvement in local air quality. A second key area is where sites upgrade waste water treatment plants from basic treatment to secondary and tertiary treatment in response to the **Urban Waste Water Treatment Directive** (UWWTD) and **Water Framework Directive** (WFD). This can lead to a significant increase in electricity use on site in order to provide the benefit of increased water environment quality.

SEPA and EHS activity also leads to a reduction in greenhouse gas emissions. For instance, the **Nitrates Directive** encourages efficient fertiliser application in nitrate vulnerable zones and so lower emissions of nitrous oxide. In the waste sector, the **Landfill Directive** is directly aimed at reducing the volume of biodegradable waste sent to landfill and so reducing the methane emissions from landfill. On the other hand, the **Waste Incineration Directive** (WID) can have both a positive and negative impact (it encourages a reduction in the total amount of waste and the recovery of waste heat, but it can also increase GHGs as the additional transport and treatment of materials like waste oils may have a limited upward impact on GHG emissions[4].)

Table A: Greenhouse gas emissions and their link to environmental regulations

Regulation	Emissions source	Emission Northern Ireland (kt CO_2e PA)	% total GHG emission Northern Ireland	Emission Scotland (kt CO_2e PA)	% total GHG emission Scotland	Strength of link between regulation and GHG emissions*	*Emissions: Year (source)*
PPC/ Land fill/ WML	Landfill & disposal to land	292	1.4%	1204	2.2%	Strong (+ve)	*2005(GHG Inventory) 2006(SPRI)*
LCPD	FGD on coal power stations	81	0.4%	379	0.7%	Direct (-ve)	*2003 (EUETS)3%*
UWWTD WFD	Water company energy use	143	0.7%	250	0.5%	Strong (-ve)	*2005/06 (Company)*
UWWTD WFD	Sewage sludge decomposition	58	0.3%	170	0.3%	Strong (-ve)	*2005 (GHG Inventory)*
PPC/ WID/ WML	Incineration of waste	10	0.05%	116	0.2%	Medium (+/-)	*2005(GHG Inventory) 2006(SPRI)*
Nitrates directive	Leaching N fertiliser & manure	631	3.1%	1090	2.0%	Weak (+ve)	*2005(GHG Inventory)*

*Strong negative (-ve) link means regulation causes an increase in GHG emissions
Strong positive (+ve) link means regulation helps reduce GHG emissions

[3] This report considers the Kyoto basket of six GHGs: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6).

[4] The WID imposes air emission limits that are not economically viable for small waste oil burners (SWOBs) to comply with and this can lead to a small increase in indirect GHG emissions from the transportation of the waste oil to a waste oil cleaning centre.

Can the GHG emissions impact of the environmental regulation be reduced?
We have identified a number of ways that, in principle, the impact of regulation on GHGs *could* be reduced. However, in most cases there is either a cost implication, or an impact on the quality improvement achieved. There is a balance to strike between addressing the global environmental impact of climate change and necessary local improvements in e.g. air or water quality.

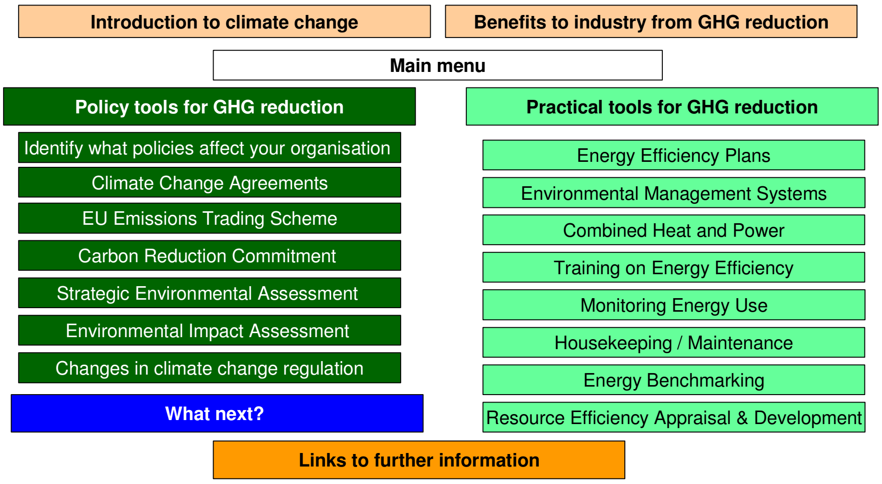
For instance, both Longannet and Kilroot power stations are in the process of installing FGD systems and there is no alternative way for these plant to continue operating long term and comply with the LCPD to ensure the necessary improvements in air quality. Therefore it is important for regulators to maximise their influence on system energy efficiency at the design stage when the regulator will be involved through PPC and pre application discussions and thence application determination[5].

Another area of regulator influence is around waste water treatment through capital investment decisions, regulatory drivers (WFD, CAR, PPC) and the water industry regulations. Sites where either limited land is available, or where land is very costly, may find that there is no feasible alternative to installing energy intensive treatment technologies to meet UWWTD, Shellfish Directive and Bathing Water Directive discharge limits. Although some waste water treatment technologies have a lower energy intensity than others, there is typically a trade off with the land area required and the quality improvement they deliver. Whereas investment decisions for LCPD compliance have already been taken, this is a crucial time to influence the decision of water companies. For instance, the WFD requirements are currently being rolled out and the Carbon Reduction Commitment (CRC) which will capture these companies will be introduced in 2010. In addition, ongoing investment plans concentrating on water quality post 2012, such as Quality and Standards III and IV in Scotland, are likely to increase energy use in the waste water treatment industry.

Climate Change Mitigation Toolbox
Feedback from the SNIFFER Steering Group, the desk review and regulator interviews indicated that guidance in the form of a Climate Change Mitigation Toolbox could help Government policy makers, regulators and industry incorporate greenhouse gas emission reductions into the regulatory process. It was agreed by the project Steering Group that generic guidance that could be accessible to a wide audience from both industry and environmental regulators would initially be most useful. The set of tools developed as part of this project address general awareness raising of the contributing factors to climate change and provide both practical and policy measures for its mitigation. The tool's structure is illustrated below.

5 These installations' inclusion in the EU ETS means that they already have a direct incentive to take the carbon impact of any additional energy use into account for investment decisions like this.

Figure A: Structure of the Climate Change Mitigation Toolbox



Recommendations/ opportunities for strengthening the regulator's role

A recurrent theme throughout this research has been the potential tension between addressing local environmental priorities and the global issue of climate change. Feedback from regulators indicates that, other than where the focus of the regulation is climate change, local issues tend to take priority, sometimes with a negative impact on GHG emissions. There was some enthusiasm amongst the regulators interviewed to be able to take a stronger stance on climate change and energy matters where the rules allow.

This could require changes to the rules and guidance to which regulatory bodies work. As things stand, regulators consider that they do not always have sufficient grounds to push energy and GHG issues or to give them equal priority to other environmental goals. This could involve ensuring that the cost of carbon is incorporated into operator investment decisions particularly for those activities that are not captured by an emissions trading scheme.

There are also steps that regulators could take to raise awareness of climate change issues internally, to be able to maximise the scope for influence that is already available. For instance, each SEPA and EHS office could nominate a 'carbon champion' to field industry and regulator questions on energy and climate change and promote awareness of the issues. This could extend to encouraging the consideration of energy savings and GHG impacts on site visits and in communication with operators. SEPA already has a central carbon champion in place and EHS has a climate change expert, but there is still significant scope for the election of champions at a sub regional level and to ensure sufficient attention is paid to climate change mitigation (as well as adaptation).

There may also be scope for policy makers to work with regulators to help bridge the gap between the national Government focus on greenhouse gas mitigation and the local priorities of the regulations that regulators work with day to day. There is a need to ensure that policy makers are aware of (and take consideration of) the tensions discussed in this report and also to ensure that regulators are made aware of the national priorities and the recommended way to take them into account.

Key words: Greenhouse Gas Emissions, Climate Change, Toolbox, Guidance Environmental Regulations, PPC

Glossary

AQEG	Air Quality Expert Group
BAT	Best Available Techniques
BREF	BAT Reference documents
CH_4	Methane
CHP	Combined Heat and Power
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEFRA	Department for Environment, Food and Rural Affairs
DOENI	Department of the Environment Northern Ireland
EA	Environment Agency
EC	European Commission
EHS	Environment and Heritage Service
EIA	Environmental Impact Assessment
GHG	Greenhouse gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
IPRI	Industrial Pollution and Radiochemical Inspectorate
kt	Kilotonnes
LA	Local Authority
LCPD	Large Combustion Plant Directive
MBR	Membrane Bio-reactor
MSW	Municipal Solid Waste
Mt	Megatonnes
MWh	Megawatt hour
N_2O	Nitrous oxide
NAEI	National Atmospheric Emissions Inventory
NI	Northern Ireland
NIW	Northern Ireland Water
NOx	Nitrogen oxides NO, NO_2
PAH	Polycyclic aromatic hydrocarbons
PFCs	Perfluorocarbons
PM	Particulate matter
PPC	Pollution Prevention and Control
RDF	Refuse Derived Fuel
READ	Resource Efficiency Appraisal and Development
RIA	Regulatory Impact Assessment
SBR	Sequential Batch Reactor

SEA	Strategic Environmental Impact Assessment
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SF_6	Sulphur hexafluoride
SME	Small to medium sized enterprise
SOC	Soil organic carbon
SOx	Sulphur oxides SO, SO_2
SPRI	Scottish Pollutant Release Inventory
SWOB	Small Waste Oil Burner
WFD	Water Framework Directive
WID	Waste Incineration Directive
WML	Waste Management License
WMU	Water Management Unit

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APPENDICES

1 INTRODUCTION

1.1 Objectives

The Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) commissioned the project 'Minimising greenhouse gas emissions across environmentally regulated industry in Scotland and Northern Ireland' under their UK Research Programme (UKPIR11). This project forms part of the UK Programme of Research that SNIFFER manages on behalf of the Scottish Environment Protection Agency (SEPA) and the Environment Heritage Service (EHS).

The project focuses on regulations in Scotland and Northern Ireland. It aims to identify those areas of environmental regulation that have a material impact on greenhouse gas (GHG) emissions which is not currently considered, particularly in cases where regulatory decisions (be it EC directive, UK or devolved government regulation) may actually cause an increase or decrease in greenhouse gas emissions. It also considers how the impact on GHG emissions could be minimised (either avoided completely or at least reduced) through the use of guidance. Regulators will be able to draw on these findings when deciding on the most appropriate approach to the environmental management of the areas identified. The findings of the research will also be more widely disseminated to stakeholders in the various regulatory areas.

The key objectives for this project, addressed in this report, are as follows:

- Identify which of the sectors that SEPA and EHS regulate are responsible for material GHG emissions.
- Identify the extent to which GHG emissions are already considered in the regulatory decision making framework, when issuing permits or consents for these sectors.
- Identify examples of instances where regulations, such as the requirement for additional abatement of emissions, cause an increase in GHG emissions.
- Establish whether the GHG emissions impact of the environmental management options chosen could be reduced (either through technological or management change). Assess the impact of those alternative options in terms of additional costs or cost savings to industry.
- Identify cases for consideration by government, including devolved government, where changes may be needed to regulations or to policies to ensure GHG emissions are taken into account in situations where they are not currently.

1.2 Approach

Through a quantitative literature review of the sectors that SEPA and EHS regulate, we have established which sectors have the largest impact on GHG emissions. We reviewed published sectoral GHG emissions data for each of the two regions. The National Atmospheric Emissions Inventory (NAEI) was the main source of greenhouse gas emissions data. This allowed us to identify 'priority' sectors i.e. those where the regulators can have the most impact on GHG emissions for further research. The raw data used for this part of the project is presented in Appendix I to this document.

To complement the quantitative review, we also conducted a review of published documents that highlight the interplay between pollution regulation, abatement measures and greenhouse gas mitigation. This review identified examples of where research has already indicated that regulation is at odds with GHG reduction, to support our assessment of the priority sectors.

We also undertook a review of existing practice which comprised two aspects.

- A desk review of environmental regulation documents, with a view to outlining current practice in addressing GHG reductions, gaps and areas that actually increase greenhouse gas emissions.
- Interviews with SEPA and EHS regulators plus input from industry on the existing practice of regulating sectors. We have explored how energy and greenhouse gases are considered while ensuring compliance with air, land and water emission limit values.

We have also conducted face-to-face interviews with regulators in each region. The points that they have raised have informed our view of the most appropriate areas of focus for the remainder of the project.

1.2.1 Overview of the criteria used to establish priority sectors

In this report we have focused on a shortlist of sectors where Enviros and the Steering Group agreed additional research would be beneficial. In order to establish these priority sectors for research in this study, the following key questions were addressed for each regulatory area:

- Is the sector SEPA & DOENI regulated?
- Are there significant greenhouse gas emissions from the sector?
- Are GHG emissions in the sector increasing, even before regulatory intervention?
- Is environmental regulation at odds with achieving GHG savings?
- Is a more joined up approach in regulatory objectives needed?
- Is there an information gap (i.e. is it that regulators are not aware of the possible GHG impact)?

The sectors chosen are core regulatory areas for both SEPA and EHS, which, based on our research, have a potential for conflicting goals between GHG reductions and compliance with other environmental emission limits. This conflict stems from the need to implement a number of EC directives, each of which target different environmental receptors or sectors of industry.

1.2.2 Development of a toolbox

Once we had identified and agreed the priority sectors with SNIFFER we researched a number of case study examples in more detail (both through literature review and also discussions with key stakeholders).

We also drew on the feedback received from regulators during the interviews to develop a guidance ‘toolbox’ which sets out how regulations impact on climate change and different options to reduce those impacts. The Toolbox is presented in Microsoft PowerPoint which was considered user friendly and straightforward to upload onto a website at a later date if necessary.

1.3 Structure of this report

The remainder of this report is divided into three parts.

Part I: how do environmental regulations affect greenhouse gas emissions and why is it important?

- In section 2 we introduce the key regulations in the UK and highlight some of the ways that environmental regulations can impact on climate change.

- In sections 3 to 7 we introduce each of the five priority sectors chosen for this report, power generation, agriculture[6], water industry, waste disposal and solvents. The sections provide a summary of the nature of GHG emissions in each of these sectors and the way that regulators influence them.

Part II: to what extent do regulations already take these impacts into account?

- In sections 8 to 12, we review the key environmental regulations and consider: (a) how the regulations currently account for minimising greenhouse gas emissions (b) the scope for improvement in addressing GHG reduction (c) the potential for adverse climate change impacts when the regulations are implemented.

- Conclusions and recommendations from our research findings are summarised in section 13.

Part III: taking GHG into account in regulatory decisions: a toolbox

- Lastly, in section 14, we summarise the feedback that we received from the regulator about the need for additional guidance and describe the toolbox that we have developed as part of this project.

[6] Note that here and throughout this document, agriculture refers to growing crops and rearing animals rather than to land use change or forestry.

PART I: HOW DO ENVIRONMENTAL REGULATIONS AFFECT GREENHOUSE GAS EMISSIONS AND WHY IS IT IMPORTANT?

2 INTRODUCTION TO THE IMPACT OF REGULATORS ON CLIMATE CHANGE

2.1 Key environmental regulations in the UK: PPC

The Integrated Pollution Prevention and Control Directive controls pollution from certain industrial activities. It is the basis for the majority of EHS and SEPA environmental regulation and so a brief overview is provided in the text below. IPPC Directive is implemented by requiring eligible sites to hold a pollution prevention and control (PPC) permit that specifies how they are complying with the regulations.

By taking an integrated approach, the regulations consider environmental impacts on all media i.e. emissions to air, water, land and other environmental effects. For each controlled activity, the best available technique (BAT) that takes into account all the requirements specified by the regulations must be used to prevent pollution. The EC publishes sector-specific BAT Reference documents (BREF notes) (Defra IPPC 2005).

Other regulations on industrial activity, such as the Waste Incineration Directive and the Large Combustion Plant Directive (LCPD), are implemented through the PPC permitting process, so that an industrial site will only have to apply for one permit that covers all its polluting activities.

2.1.1 Scotland and NI specific aspects

In Scotland, SEPA implements the IPPC Directive through The Pollution Prevention and Control (Scotland) Regulations 2000. The Regulations specify the types of activities covered and the procedures that must be applied when regulating these activities. Around 200 of Scotland's larger industrial sites are regulated via Integrated Pollution Prevention and Control (SEPA PPC web 2007).

Installations covered by the regulations are divided into two regimes: Part A and Part B. The distinction depends on thresholds and sector types. Part A activities are considered the most polluting industrial activities and are regulated on emissions to all media (air, water and land), while Part B activities are only regulated on their emissions to air (as they have limited impact on land and water) (SEPA PPC Regulations 2000).

The Pollution Prevention and Control Regulations (Northern Ireland) 2003 bring in the PPC legislation in Northern Ireland (NI PPC Regulations 2003). The Environment and Heritage Service (EHS) is the designated regulator and is responsible for issuing PPC permits to NI sites.

2.1.2 Role of SEPA and EHS

The figure below provides an overview of the regulatory responsibility for implementing PPC in Scotland and Northern Ireland. SEPA regulates both Part A and all Part B sites, whereas EHS splits Part B sites into Part B and Part C, with the Part C sites being regulated by Local Authorities (LA). PPC Part A covers emissions to air, land and water and also covers energy use, whereas PPC Part B and Part C only cover emissions to air.

Figure 1 PPC regulation for Scotland, Northern Ireland and England and Wales

	Scotland		Northern Ireland		England and Wales	
Issues Covered	**Schedule 1 definition**	**Regulator**	**Schedule 1 definition**	**Regulator**	**Schedule 1 definition**	**Regulator**
All PPC	Part A	SEPA	Part A	EHS	Part A(1)	EA
All PPC			Part B		Part A(2)	LA
Principally Air	Part B		Part C	LA	Part B	LA

2.2 What are the greenhouse gases?

The greenhouse gases (GHGs) considered in this report are those covered by the national emissions inventories and the legally binding commitments that the UK has made to mitigate climate change. Known as the 'basket' of six greenhouse gases, they are:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs); and
- sulphur hexafluoride (SF_6).

2.3 How are they measured?

The extent to which each gas is thought to contribute to global warming is classified through its Global Warming Potential (GWP). The standard methodology assumes that carbon dioxide (CO_2) has a GWP of 1 and expresses the GWP of all other gases relative to this. GWP can be determined on a number of time horizons; national emissions inventories use a 100 year time horizon.

They are taken from the Intergovernmental Panel on Climate Change (IPCC) 2nd Assessment Report (AR) which was published in 1995. However, the IPCC has recently published revised GWP figures in its 4th AR in 2007. These reflect recent advances in scientific understanding of climate change and are presented alongside the older figures, below[7].

[7] There are numerous HFCs and PFCs. Here the GWPs for the simplest compound of each are provided.

Table 1 Global Warming Potentials (GWP) relative to CO_2

GHG	Notation	100yr GWP (IPCC 2nd AR)	100yr GWP (IPCC 4th AR)
Carbon dioxide	CO_2	1	1
Methane	CH_4	21	25
Nitrous oxide	N_2O	310	298
HFC-23	CHF_3	11,700	14,800
PFC-14	CF_4	6,500	7,390
Sulphur hexafluoride	SF_6	23,900	22,800

Source: IPCC, 2007

The relevant global warming potentials can be used in order to compare volumes of different gases on a like-for-like basis. A quantity of a GHG is multiplied by its GWP to convert it into a volume of carbon dioxide equivalent (CO_2e), which is the standard unit that emissions are reported in. Reporting emissions of different gases in the same units makes it easier to compare the impacts of different volumes of gases on the environment. It also allows a single total volume of GHG emissions to be calculated.

The GHGs included in this report are all considered to have a direct impact on global warming. Other pollutants to air also feature in this study in a non-GHG context, such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs). It is possible that these other emissions may have an indirect radiative effect on global warming. However, the science around this remains very uncertain and the impacts may be limited because, for example, of their short lifetimes in the atmosphere. Therefore for the purposes of this study they are considered as local air pollutants rather than also as GHGs.

2.4 Climate change: a high profile, global challenge

The UK has agreed to challenging legally binding targets for sustained long term reductions in greenhouse gas emissions, with a target of 60% reduction in carbon dioxide by 2050, under the Draft Climate Change Bill (Defra, March 2007). The Scottish Government is consulting on a Climate Change Bill including proposals for an emissions reduction target of by 80 per cent by 2050 (Scottish Government September 2007). Every sector and region of the economy needs to play its part if these targets are to be met. Tackling climate change is a stated priority for both Central Government and the Devolved Administrations and a range of policies have been put in place to address GHG emissions.

Beyond directly incentivising changes in the way that organisations conduct their business to reduce GHG emissions, it is also important that policy makers and regulators consider the impact that their decisions have on progress to the targets. Joined up thinking in Government and regulatory bodies is required in order to deliver the fast action necessary to mitigate climate change.

A regulatory decision that is considered best practice to deliver one environmental objective may simultaneously cause an increase in one or more of the basket of six GHG emissions. It is therefore essential that environmental regulation on industry avoids increases in greenhouse gas emissions wherever possible, whilst meeting the other goals of environmental regulation.

The purpose of this project is to help establish where these impacts may occur and to provide Regulators with an understanding of alternative approaches that may avoid an increase in GHG emissions.

2.5 The impact of regulators on climate change

Through the implementation of regulations like PPC, regulators impact on climate change when limits are set on emissions to air, land and water. A common impact is where industry uses energy-consuming abatement technologies to meet the emission limits. However, the impacts are not limited to regulations focussing on air quality or to requirements for abatement technologies. In fact, a broad range of potential climate change impacts exists; the table below summarises some examples. It is important to note that the alternatives that mitigate GHG impacts are not necessarily the 'better' option; a holistic approach which takes into account both the impact on greenhouse gas emissions and also the impact on other environmental receptors is required. This will typically involve the consideration of site specific characteristics and so a case by case appraisal is needed when applying each regulation.

Table 2 The interaction between environmental regulations and climate change

Area of regulation	Example of potential impact on GHG	Possible way to mitigate GHG impact
Integrated Pollution Prevention and Control (PPC)	Permit restrictions on odour can require additional thermal oxidation to combust chemicals in the exhaust gases which leads to additional CO_2 emissions	Installing a filtration technique using carbon to capture odours would be a low energy alternative, but this is weighed against the embodied energy in filter regeneration and landfill disposal of organic material
Air quality strategy permitting	Large wet scrubbing systems to remove particulates can require higher energy consumption and water use, so have a negative GHG impact	Consider on an case by case basis whether other options (such as bag filters or cyclones) may reduce GHG emissions
Air Quality Daughter Directives Implementation		
Waste Incineration Directive (WID)	The monitoring costs resulting from compliance with WID affect wood panel and rendering sites (through tallow-monitoring costs). WID compliance and costs force sites to stop burning renewable by-products and burn gas instead	Review the definition of waste as defined by the WID to investigate if monitoring requirements would apply to only certain plants using tallow as a fuel in Europe
Solvent Emissions Directive	A PPC permit may be required for plants using solvents e.g. in the manufacture of paint and a thermal oxidiser, requiring gas as a fuel, may be needed	Look for alternative approaches to reduce VOC emissions e.g. through the solvent management plan at the site, improve the handling and storage of solvents, look at options for a low VOC product

Area of regulation	Example of potential impact on GHG	Possible way to mitigate GHG impact
Large Combustion Plant Directive (LCPD)	The installation of FGD reduces SO_2 and NO_X emissions but requires greater energy use (around 2% of power station emissions plus 1% GHG increase for lime production) and also CO_2 emissions from the use of limestone	Main energy demand is from the fans which blow flue gases through the FGD system, so efficiencies in fan motors would save carbon. Alternatives to limestone may also be considered
Water Framework Directive	Water industry regulations make the effluent treatment process more energy intensive	Advice and incentives (such as the option to move to metered water) for customers to reduce water use and use rainwater etc are already in action to some extent.
Agriculture and land use	Inorganic fertiliser application to land leads to increased nitrous oxide emissions	Increased use of organic matter on land as a fertiliser as an alternative to inorganic fertiliser will reduce GHG emissions (though it will have air quality impacts as ammonia emissions to air may increase)

To illustrate how the actions of regulators impact on greenhouse gas emissions, the example below shows the way that air quality regulations impact on climate change.

2.5.1 An example: air quality and climate change interplay

The Air Quality Expert group (AQEG) was asked by DEFRA and the Devolved Administrations to find synergies between air quality pollutants and climate change. The report[8] highlights the following points relating to the relationship between air quality pollutants and climate change impacts:

(1) There is a relationship between air quality pollutants and climate change. Pollutants such as nitrogen oxides and sulphur dioxide are reflective and cause a negative (cooling) radiative forcing of climate. Black carbon from diesel vehicles absorbs solar radiation and other aerosols creating positive (warming) radiative forcing.

(2) Changes in climate have a correlation to chemicals in the air. Changes to air quality are governed by changes in pollutant emissions and the weather. Climate Change could result in changes to the ozone layer, increasing summer pollution episodes.

As a result, regulations that drive an improvement in air quality can have both a positive and negative impact on climate change. Of all the environmentally regulated industries covered by the AQEG report, the clearest trade-offs are: flue gas desulphurisation (FGD), fertiliser applications and waste disposal (each of which is discussed later in this report).

Equally, reductions in greenhouse gases can have a positive impact on other environmental receptors too. Not only are these interactions now known, and increasingly

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[8] The purpose was to identify areas where measures can be adopted to improve air quality (AQ) which will also help to ameliorate climate change (CC). The group's report "Air Quality and Climate Change, A UK Perspective, Air Quality Expert Group 2007" also examined trade-offs between these two areas where policy measures act in opposition.

understood, the magnitude of their impact can also be measured in monetary terms. Carbon reductions not only reduce the aggregate social costs of carbon, but they can also lead to an increase in ancillary benefits (i.e. they can avoid other environmental costs).

It is more straightforward to monetise the ancillary benefits (which are locally tangible) than the reduced carbon costs (the benefits of which are global). For example, the installation of FGD at a coal fired power station would lead to a measurable improvement in air quality and a reduction in the recorded number of local respiratory episodes within in fairly short timeframe. This is more straightforward to evaluate than the long term benefits that carbon reductions could deliver by mitigating climate change.

It is possible to provide a framework to monetise the ancillary benefits of improved air quality resulting from reducing energy use. The following steps are proposed to quantify the ancillary benefits, such as air quality benefits, from carbon emission reduction measures.

(1) Projected energy savings from reduced electricity and gas use resulting are quantified.

(2) The avoided damage costs resulting from reduced gas use are then calculated by multiplying emission factors (e.g. tonnes NO_x per MWh gas) by estimates of the damage cost per tonne pollutant (e.g. £/tonne NO_x emitted).

(3) The aggregate ancillary benefits are then calculated by multiplying the per unit damage costs by the total volume of energy saved at each site.

(4) This process is repeated to give the damage costs for each pollutant.

(5) Figures can be discounted at 3.5% social discount rate to give the present value of the ancillary benefit of the improved air quality.

2.5.2 Weighing up climate change impacts against other environmental goals

Throughout this report, the focus is on the climate change impacts of activities covered by one or more environmental regulation It assesses whether the actions needed to meet the release limits set by environmental regulations can be made less GHG intensive, or whether alternative approaches could deliver GHG benefits.

This emphasis on climate change should not detract from the vital benefits that environmental regulations provide for the UK population. For example, FGD provides substantial benefits for air quality at both a local and wider level. Waste water treatment enables ecosystems and coastal tourism to flourish. Experience to date has shown that air, land and water pollution often has a pressing localised impact that regulators are well placed to address through regulations like PPC. This interplay is illustrated in the table below which highlights where regulations in different sectors can result in both positive and negative environmental impacts.

The implication is therefore not that climate change should be prioritised over and above other environmental impacts, but rather that it should be considered alongside other environmental goals.

Table 3 Impacts of environmental regulation across climate change, air, land and water

	Upgrading waste water treatment	**FGD at power stations**	**High WID compliance costs make small waste oil burners unviable**	**Fertiliser application to agricultural soils**	**Thermal oxidisers to address solvents/odour**
Significant greenhouse gas emissions?	High electricity use ✗✗	High electricity use ✗✗	Only a small GHG increase from the transport of waste oils to processing -	Major source of N_2O emissions ✗✗	Very common, gas (or liquid fossil fuel) powered ✗
Significant impact on air quality?	Smaller enclosed systems reduce odour. Electricity generation AQ impacts. ✓✗	Major AQ benefit from SOx removal. Electricity generation AQ impacts. ✗	Local AQ benefit from avoided dioxins, particulates etc. ✓✓	Can lead to ammonia emissions to air. ✗	Major benefit from reduced odour nuisance and less VOCs reduce smog episodes ✓✓
Significant impact on land quality?	Sewage sludge disposal to land ✗	Contaminated solid waste outputs e.g. sludge\fly ash ✗	No impact -	Returns nutrients to soil ✓	No impact -
Significant impact on water quality?	Vital for improved water quality ✓✓	FGD aqueous discharge may contain trace metals ✗	No impact -	Eutrophi-cation leads to ecosystem damage ✗✗	No impact -

Environmentally detrimental impact ✗✗
Environmentally beneficial impact ✓✓

3 POWER GENERATION

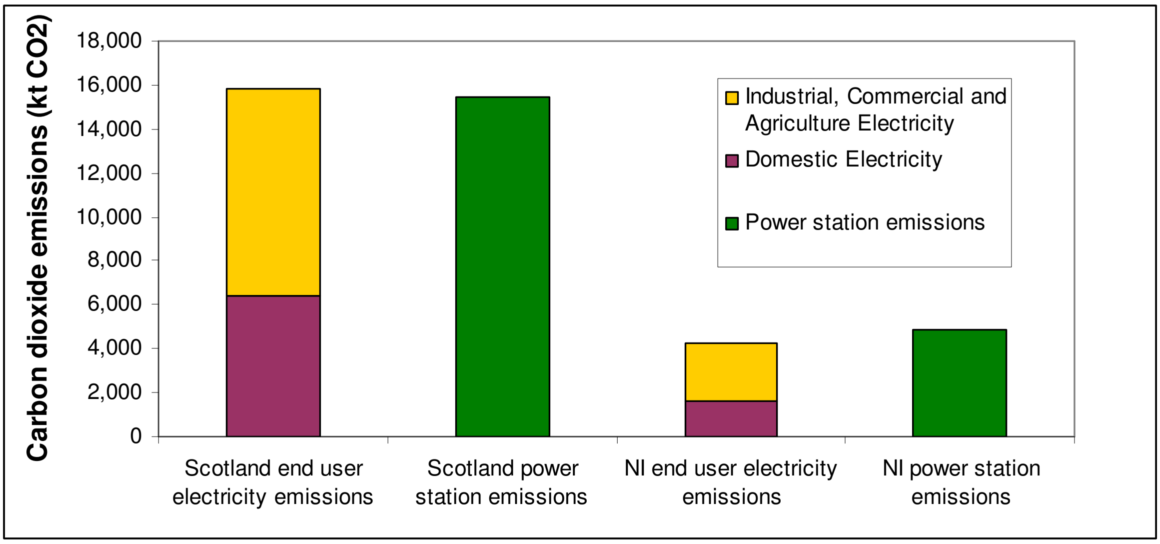
3.1 Power generation: type and volume of greenhouse gas emissions

The dominant source of greenhouse gas emissions in both regions is fuel combustion (accounting for 87% of all GHG emissions in Scotland in 2005 and 74% of emissions in Northern Ireland (National Air Emissions Inventory). The main greenhouse gas that results is carbon dioxide.

Power stations, road transport and residential combustion are the top three GHG emitting combustion activities in both Scotland (58% of GHG emissions) and Northern Ireland (60% of GHG emissions). Of these, power stations in Scotland account for 26% of greenhouse gas emissions and in Northern Ireland this sector emits 25% of all greenhouse gases[9]. The absolute level of emissions is illustrated in Figure 2 below, which also highlights the split between electricity end use (splitting the emissions from electricity use by industry and/or agriculture and that used by domestic end users).

Emissions from power station generation in Scotland and Northern Ireland (green bars) are similar to emissions from total electricity end use in these areas (gold/purple bars). The difference relates to the volume and type of power that is imported to, or exported from, the region. In some regions, for example London, demand greatly exceeds the region's supply and so the allocated end user emissions would greatly exceed power station emissions to reflect a large volume of imports.

Figure 2 Carbon dioxide emissions at power stations and emissions from national grid electricity use allocated to end user[10]



Source: Local and Regional CO_2 Emissions Estimates for 2004, Defra Experimental Statistics, AEA, Nov 2006

9 Source: 2005 Greenhouse Gas Inventory

10 The end user totals based on the Defra Experimental Statistic are different to the totals reported in the national inventory reports because some national emissions cannot be assigned to local areas.

3.2 Power generation: influence of the environmental regulator over greenhouse gas emissions

Regulation of power generation itself

SEPA and EHS regulate the power generation sector under PPC Part A and B and the Controlled Activities regulations and they also regulate the industry and agricultural sectors that consume part of the generated electricity. As a result, this is a sector over which SEPA and DOENI (EHS) has considerable influence (shown by the presence of two ticks in the right hand column of the tables in Appendix I). As a result, their regulation could have a considerable impact on GHG emissions.

Regulation of electricity consumption

In addition to affecting GHG emissions at source (i.e. at the power station) the regulators can also affect the amount of electricity that is used by industrial end users (and so, therefore, the volume of electricity generated and the emissions from the power stations). When power station emissions are allocated to end users (as illustrated in the chart above) it is clear that the environmental regulators have no jurisdiction over the 40% or so of electricity that is used in the domestic sector in Scotland and Northern Ireland.

This leaves around 60% where the Regulators may be able to influence end users (although the Regulators do not affect all of the industrial, commercial and agricultural sectors). Reductions in electricity end use in Scotland and Northern Ireland may reduce generation emissions but, due the interlinked nature of the national grid, this reduction may be seen in the reduced use of a power station in England and Wales rather than in the region in which demand is located.

3.3 Power generation: impact of regulations on greenhouse gas emissions

Flue gas desulphurisation: SO_2 and CO_2 emissions

The Large Combustion Plant Directive (LCPD) has led to the need for reduced sulphur emissions from large power stations and to the phased introduction of flue gas desulphurisation systems (FGD) in Scotland and Northern Ireland. In Scotland, this relates solely to coal fired generating capacity. Sulphur content in oil is restricted to a maximum of 1% for heavy fuel oil and 0.1% for gas oil by the Sulphur in Liquid Fuels Regulations. Installing an FGD system on a power station can lead to approximately a 3% increase in its CO_2 emissions (AQEG, 2007). This results from two sources, noted below.

(1) Using FGD for SO_2 abatement requires around 2% of the electrical power output of the power stations to drive the abatement system (e.g. powering large fans to blow flue gases through the FGD system) which leads to an increase in CO_2 (EHMS, 2004).

(2) The second impact is the CO_2 released through wet scrubbing with limestone[11] which leads to a further 1% increase in CO_2 emissions, giving an overall increase of 3%.

There are two coal fired power stations requiring FGD under the LCPD:

- Scotland, Scottish Power – Cockenzie (not planned) and Longannet (under construction); and

[11] through the reaction $CaCO_3 + SO_2 = CaSO_3 + CO_2$

- Northern Ireland, AES – Kilroot[12].

Adding FGD systems to Longannet and Cockenzie coal fired power stations in Scotland could increase CO_2 emissions by ~380ktCO_2 per annum[13]. If FGD was added to Kilroot power station, CO_2 emissions would increase by ~80ktCO_2 per annum[14]. The impact of these regulations is summarised in the table below.

Table 4 Power generation regulations in Scotland and Northern Ireland

Area	Regulatory group	Regulation	2005 GHG emissions (ktCO_2e)	FGD
Scotland	Part A - Power generation	Large Combustion Plant Directive. PPC Part A under the Pollution Prevention and Control (Scotland) Regulations 2000.	14,158 kt CO_2e from all power station combustion (GHG Inventory). 12,649 kt CO_2e from Longannet and Cockenzie[15] in 2003. Adding FGD adds **~380 kt CO_2**.	Using FGD for SO_2 abatement consumes 2% of electrical power output of the power station. An additional ~1% CO_2 is released through wet scrubbing with limestone (AQEG 2007). Overall FGD adds a ~3% CO_2e increase.
Northern Ireland	Part A - Power generation	Large Combustion Plant Directive. PPC Part A under the Pollution Prevention and Control Regulations (Northern Ireland) 2003	5,287kt CO_2e from power station combustion (GHG Inventory). 2,711kt CO_2e emitted from Kilroot in 2003 (NAP Phase 1). Adding FGD adds **~80 kt CO_2**.	

3.4 Power generation: overview

The qualitative and quantitative reviews that we have conducted for this report indicate that:

- ➔ Greenhouse gas emissions (CO_2) increase by ~3% when FGD is installed.
- ➔ Greenhouse gas emissions from the sector are significant and are regulated.
- ➔ However, two plants are already installing FGD to meet LCPD requirements; it is a high profile issue with little room to manoeuvre so there may be little benefit in a more joined up approach or more information.

[12] In December 2005 Kilroot power station was granted consent to install FGD equipment, to enable it to meet its obligations under the LCPD from January 2008 onwards. The Department of Enterprise, Trade and Investment will assess the application under the Electricity (Northern Ireland) Order 1992 (NICS News Release 2005). Scottish Power will invest over £170M over the next three years to install FGD at Longannet to allow it to operate beyond 2020 (Scottish Power CSR website). Currently the high level of SOx emissions from Longannet is a local air quality issue. The installation of FGD would improve air quality and also create scope for Longannet to use the higher sulphur regionally produced coal.

[13] Cockenzie has had a recent extension (operational not physical), but no plans for FGD were included as part of this.

[14] Based on Northern Ireland energy data available through the Phase 1 EU ETS National Allocation Plan

[15] EU ETS Phase 1 National Allocation Plan (NAP)

LCPD requires power station FGD systems	
SEPA & DOENI regulated?	Y
Significant greenhouse gas emissions?	Y
Increasing GHG emissions?	Y
Environmental regulation at odds with GHG savings?	Y
More joined up approach needed?	N
Information gap?	N

4 AGRICULTURE

4.1 Agriculture: type and volume of greenhouse gas emissions

The agricultural sector[16] is a significant source of N_2O and CH_4 both of which have high global warming potentials (21 and 310 respectively). Nitrous oxide is the main greenhouse gas for agricultural soils while methane emissions are the main impact from agricultural livestock.

The application of fertiliser to agricultural land has a significant impact on nitrous oxide emissions. It is estimated that approximately 30% of N_2O emissions from agriculture are from the denitrification of leached nitrate in estuaries and other slow-moving waters (AQEG 2007).

4.2 Agriculture: influence of the environmental regulator over greenhouse gas emissions

The regulations considered for this project relate to the impact of different agricultural practices on water, summarised in the table below.

Table 5 Agriculture regulations in Scotland and Northern Ireland

Area	Regulatory group	Regulation	2005 GHG emissions ($ktCO_2e$) Source: Greenhouse Gas Inventory	Impact on GHGs
Scotland	SEPA Water Regulation	Sewage sludge in agriculture regulation Nitrates regulation Groundwater regulations	3,894 kt CO_2e N_2O from agricultural soils.	ADAS results suggest that the greatest savings in CO_2-C (on a per hectare basis) can be achieved from the application of digested biosolids cake, green waste compost and paper crumble in the range 1430-1640 kg/ha/yr (ADAS 2008).
Northern Ireland	EHS Water Manageme nt Unit (WMU)	Sewage sludge in agriculture regulation Nitrates regulation Groundwater regulations Birds and habitats regulations	2,104 kt CO_2e N_2O from agricultural soils.	

Nitrates regulation

The nitrates regulation is covered by EHS and SEPA and this focuses on reducing nitrate leachate, for example, through more efficient application of nitrogen fertiliser. Reducing nitrogen application under the Nitrates Directive works indirectly to reduce GHG emissions (nitrous oxide).

The Nitrates directive only applies to areas within a designated nitrate vulnerable zone (NVZ). In Scotland, 14% of the land area lies within NVZs, while the whole of Northern Ireland is designated a NVZ. There is already clear guidance available to farms on the regulations affecting them. Guidance focuses on water and there is much less information on greenhouse gases.

16 Note that here and throughout this document, agriculture refers to growing crops and rearing animals rather than to land use change or forestry.

4.3 Agriculture: impact of regulations on greenhouse gas emissions

A reduction in nitrate leaching should reduce indirect N_2O emissions and therefore measures taken as a result of the Nitrates Directive, which is regulated by SEPA and EHS water units, should help reduce emissions of N_2O.

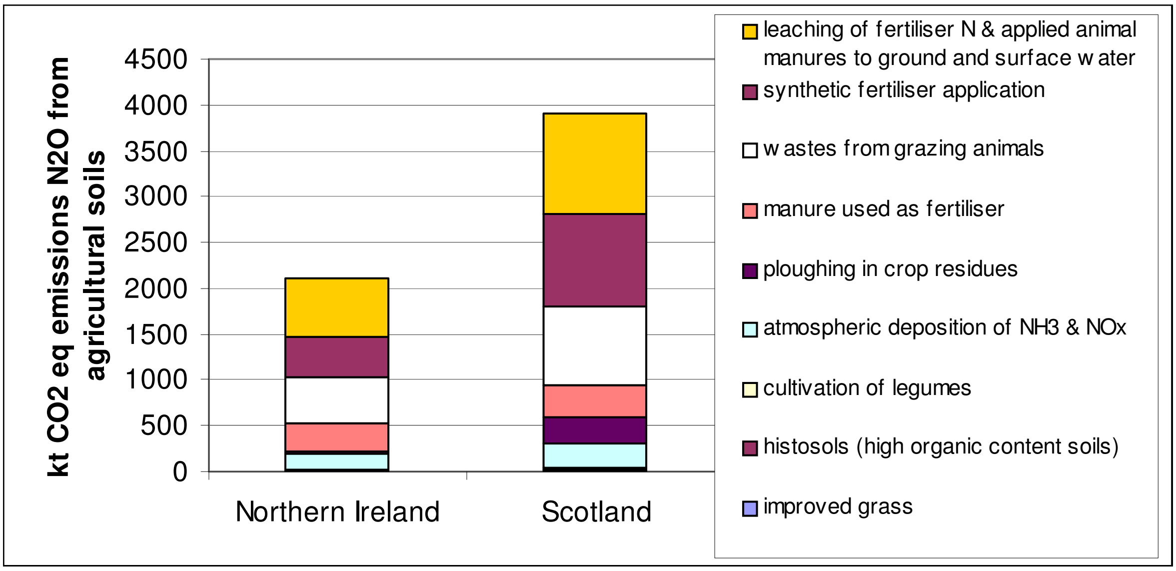
Fertiliser application: N_2O and ammonia emissions

The use of inorganic fertiliser is expected to decline by 5-10% between 2003 and 2020, meaning N_2O emissions will also reduce (Entec, 2004). In contrast, common agricultural policy (CAP) reform is expected to lead to a small (approximately 5%) increase in nitrogen fertiliser use as set-aside become less attractive and the land reverts to cropping (AQEG 2007). The increase is expected to be more than offset by the overall decrease in inorganic fertiliser use and therefore the net effect could still be a reduction. However, measures to reduce the potent greenhouse gas nitrous oxide can lead to an increase in the air pollutant ammonia.

Increased use of urea fertiliser (instead of inorganic fertiliser) could decrease N_2O emissions by up to 21% (Entec, 2004) but it would increase ammonia emissions at the same time[17]. Slurry management measures to reduce ammonia emissions such as land-spreading slurry to increase the amount of nitrogen in the soil, increase nitrous oxide emissions.

Leaching of nitrogen fertiliser and animal manure to water courses accounts for about 30% of N_2O emissions from soils, as shown in the chart below. The nitrates directive addresses fertiliser application and more information is provided in section 10.5.

Figure 3 2005 nitrous oxide emissions from soils (kt CO_2e) broken down by N_2O source for Scotland and Northern Ireland



Source: GHG Inventory Report for 2005

17 Chemical inhibitors used for reducing the rate of nitrification in the soil, is likely to reduce N_2O emissions by a further 12%, in addition to switching to urea (AQEG, 2007)

Organic fertiliser options to reduce greenhouse gases

Fertilising land through inorganic fertilisers or through the application of a variety of organic material to land has a major impact on nitrous oxide release. One of the publications that we reviewed[18] assessed the best organic fertiliser options in terms of reduced greenhouse gas emissions; its findings are summarised below.

Although organic material additions reduce the need for inorganic nitrogen fertiliser additions they do result in nitrous oxide emissions themselves; their main benefit in terms of GHG mitigation is increasing soil carbon storage. One of the drivers for the addition of bio-solids/ paper crumble/ compost to land are regulations to deflect these materials from landfill and so to avoid the associated methane emissions.

Research has been conducted into the impact on N_2O emissions and soil organic carbon content (SOC) when manure, slurry, sewage waste and sludge cake are spread on land. It suggests that the greatest savings in CO_2-C[19] (on a per hectare basis) can be achieved from the application of digested bio-solids cake, green waste compost and paper crumble in the range 1430-1640 kg/ha/yr, assuming typical annual application rates (ADAS 2008).

Nitrous oxide emissions increased when dairy slurry and broiler litter were spread on land, but the increase in soil organic carbon from their application led to an overall saving in carbon emissions[20] compared to inorganic manufactured fertiliser. Digested sludge cake and green waste compost have less readily available nitrogen and so release less N_2O after spreading than other materials such as dairy slurry. In addition, cake and compost application also increased soil organic carbon (SOC) compared to inorganic fertiliser application, leading to a high overall carbon saving for these two organic materials, as shown in the table below.

Table 6 Net greenhouse gas savings (in CO_2-C) following application of selected organic materials at a rate of 250kg/ha of total N

Manure type	Application rate (t or m^3/ha ds)	SOC increase (kg/ha)	Fertiliser manufacture change (kg/ha CO_2-C)	Net N_20-N change (kg/ha CO_2-C)	Net CO_2-C saving (kg/ha)
Cattle (Fresh Farmyard Manure)	10.5	630	49	30	709
Dairy slurry	5.0	300	83	-50	333
Broiler litter	4.8	290	73	-50	313
Digested sewage sludge cake	8.3	1500	34	15	1549
Green waste compost	23	1400	15	15	1430
Paper crumble	30	1800	-59	-100	1641

Source: ADAS 2008

[18] ADAS (2008) The effects of reduced tillage practices and organic material additions on the carbon content of arable top soils, ADAS 2008.

[19] 1 kg of CO_2-C is equivalent to ~3.67 kg of CO_2 (CO_2-C reports mass of carbon)

[20] It is questionable whether increases in SOC or CO_2-C savings following farm manure additions can be counted as genuine carbon sequestration (ADAS 2008). Powlson *et al.* (2007a,b in press) stressed that increases in SOC at a given site due to the addition of organic materials could not necessarily be regarded as genuine carbon sequestration and that it was essential to consider the alternative fate of the materials if not applied to soils.

4.4 Agriculture: overview

- Nitrates regulation focuses on release to water but as an indirect benefit of this, it also helps reduce GHG emissions of nitrous oxide.
- N_2O emissions from agricultural soils have a major climate change impact.
- Emerging research indicates spreading certain organic materials on land can reduce GHG emissions.

Fertiliser application to agricultural soils (in NVZs)	
SEPA & DOENI regulated (through nitrates dir etc)?	Y
Significant greenhouse gas emissions?	Y
Increasing GHG emissions?	N
Environmental regulation at odds with GHG savings?	N
More joined up approach needed?	N
Information gap?	Y

5 WATER INDUSTRY

5.1 Water industry: type and volume of greenhouse gas emissions

The water sector contributes around 1% of total UK carbon emissions. The volume of GHG emissions as a result of energy use in the water industry in Scotland in the year 2005/06 (~250ktCO_2e) was larger than the nitrous oxide and methane emissions emitted during sludge treatment and decomposition (170ktCO_2e). The full energy intensity and associated greenhouse gas emissions of the waste water treatment industry is not apparent from the greenhouse gas inventory, as it assigns power station emissions to the power plant rather than the end user.

Not only is the sector relatively energy intensive, but also energy use (and so carbon dioxide emissions) have been increasing in recent years[21]. We understand that in Scotland this increase is a consequence of the company's asset development programme and to meet tightening water regulations (ENDS Report No 385 September 2007). In Northern Ireland this reflects a period of capital investment and energy use is expected to continue growing to 2008/09 as large private finance contract works come on line[22]. There is a move from local discharges (with basic or no treatment) to more centralised treatment facilities (collection schemes) and associated pumping schemes. This will entail GHG increases at coastal locations in particular.

Table 7 Energy related carbon emissions in Scotland and Northern Ireland for 2005/06 (ktCO_2e)

Water company	Category	Energy Use	Electricity Use	Gas use	Renewable generation	Grid electricity use
Scottish Water*	Energy use (GWh)	500	480	20	25	455
	Carbon emissions, energy use (ktCO_2e)	250	246	4	0	246
Northern Ireland Water**	Energy use (GWh)	289	252	37	-	252
	Carbon emissions, energy use (ktCO_2e)	143	136	7	-	136

*Source: Scottish Water submitted energy data directly to ENDs, published in ENDS Report (No. 385 Feb 2007)

**Source: Telephone interview, Northern Ireland Water, 17th Dec 2007

Scottish Water's carbon emissions from electricity imported from the grid which constituted around 95% of its total electricity use were approximately 250ktCO_2e in 2005/06. If the upward trend in electricity use has continued to 2006/07, we would expect carbon emissions to have risen by another 6ktCO_2e (i.e. to 256ktCO_2e) in total.

Even in the face of increasing energy use, the companies do have an opportunity to reduce their greenhouse gas emissions. 5% of electricity use is generated by Scottish Water itself through their small hydro schemes. Typically waste water companies are able to make use of efficient combined heat and power (CHP) generation and renewable generation (in the form of sewage sludge). As a result, their on-site carbon emissions

21 Energy use for Scottish Water has increased by around 8% over the four-year period shown in the table (an average rate of increase relative to other companies) (ENDS 2007). Northern Ireland Water's electricity use has increased by 17% over the four year period (NIW Dec 2007).

22 NIW estimates that electricity use is split in the ratio 40%:40%:20%, for water treatment: waste water treatment: network pumping (NIW Dec 2007).

from electricity generation are relatively low (see zero emissions figure attributed to renewables in the table above). Northern Ireland Water relies entirely on grid imported electricity, reflected in the higher level of carbon emissions per unit electricity consumed.

5.2 Water industry: influence of the environmental regulator over greenhouse gas emissions

This sector's activities are also widely regulated, as set out in the table below.

Table 8 Water industry regulations in Scotland and Northern Ireland

Area	Regulatory group	Regulation	2005 GHG emissions ($ktCO_2e$) Source: Greenhouse Gas Inventory	Electricity
Scotland	Water	Water regulation through CAR (Controlled Activity regulations)	N_2O and CH_4 emissions from sewage sludge decomposition were 170kt CO_2e	Scottish Water's energy related carbon emissions were ~250kt CO_2e for 2005/06. Energy increased by ~2.5% per year.
Northern Ireland	Water	The Water Order, from 1989	N_2O and CH_4 emissions from sewage sludge decomposition were 58kt CO_2e	Northern Ireland Water's energy related carbon emissions were ~143kt CO_2e for 2005/06. Energy increased by ~5% per year on average.

However, the Water Regulations give the regulators very little influence over the type of treatment technology the water industry uses, as the regulations focus only on aquatic discharges. The water regulations do not directly regulate the efficient use of energy at these sites.

5.3 Water industry; impact of regulations on greenhouse gas emissions

The tightening of discharge limits under the Water Framework Directive is expected to lead to further increases in energy use by the industry to 2015. Reportedly, higher effluent standards are pushing water companies to energy-intensive processes including aeration, membrane treatment, for coastal discharges and UV disinfection. This has consequently pushed the low-energy alternatives to be considered as non-preferential options. There is a trend of 2.5% increase energy usage per year. We understand that the Environment Agency is currently looking at energy use and what is required of companies to meet water discharge consents.

5.4 Water industry: overview

- ➔ Greenhouse gas reductions are often at odds with tightening environmental regulations on discharge limits to water.
- ➔ Greenhouse gas emissions from the sector are significant.
- ➔ The energy use of (and so CO_2 emissions from) the sector is growing.

Water industry	
SEPA & DOENI regulated?	Y
Significant greenhouse gas emissions?	Y
Increasing GHG emissions?	Y
Environmental regulation at odds with GHG savings?	Y
More joined up approach needed?	Y
Information gap?	Y

6 WASTE DISPOSAL

6.1 Waste Disposal: type and volume of greenhouse gas emissions

Emissions from both landfill and waste incineration are a significant source of greenhouse gases. Nitrous oxide is the primary GHG from sewage sludge decomposition, while methane emissions are the main impact from landfill. The table below quantifies emissions from landfill and incineration in Scotland based on the Scottish Pollutant Release Inventory (SPRI) database, which provides a greater level of detail than the GHG Inventory[23].

All sites covered by the Waste Incineration Directive must have energy recovery where possible. At two of the Scottish incineration sites, greenhouse gas emissions are offset by the recovery of energy from waste. The Dundee Energy Recovery Ltd (DERL) incinerator generates electricity from combustion heat and which is then sold to the national grid. An energy recovery facility in Lerwick provides district heating for about 1,000 homes around the plant (SEPA 2003).

Table 9 GHG emissions in Scotland (ktCO_2e)

Industry sector (PPC activity)	2004	2005	2006
5.1 Incineration and co-incineration of waste (ktCO_2e)	56	180	116
Number of incineration & co-incineration installations[24]	3	2	4
5.2 Landfill and disposal to land (ktCO_2e)	1,593	1,567	1,204
Number of landfill and disposal to land installations	31	40	43

Source: SPRI, 2007

The waste incinerated/co-incinerated at the four incineration installations above the reporting threshold includes: municipal waste, animal waste (non-hazardous), biomass and hazardous waste. GHG emissions from these sites rose sharply between 2004 and 2005, which is thought to be due to an increased use of existing incineration capacity (SEPA Summer 2007). The drop off in incineration emissions between 2005 and 2006 is likely to be due to reduced capacity use, but could also be influenced by an increased fraction of biomass which is assumed to have a zero GHG emissions factor.

There are a much greater number of landfill installations in Scotland and the number has increased steadily over the past three years (from 31 to 43). However, greenhouse gas emissions have decreased as a result of a reduction in methane emissions driven by the Landfill Directive. The directive has encouraged a reduction in the volume of waste sent to landfill and also an increase in both methane flaring and the capture and combustion of methane to generate electricity using methane recovery systems.

Although, as Table 10 shows, total GHG emissions from incineration and landfill combined fell between 2004 and 2006, it is worth noting that the data presented here only include methane emissions from active landfills. There are also a relatively large number of

[23] Northern Ireland does not yet have a web accessible database equivalent to SPRI to provide this breakdown.

[24] The Waste Incineration Directive defines a co-incineration plant as any stationary or mobile plant whose main purpose is the generation of energy or production of material products, and: (1) which uses waste as a regular or additional fuel, or (2) in which waste is thermally treated for the purpose of disposal.

closed landfills, including those that could not get PPC permits, which are still venting methane (work is under way in the UK to quantify the number and emissions from closed landfills). Therefore the figures above are likely to be underestimates of landfill methane and the overall trend in GHG emission may not be as clear cut. Other specific examples where we understand that GHG emissions may have increased as a result of regulatory exemptions (based on interview feedback for this project) are also set out below.

- Closed landfills may still be venting methane – closed landfills are not covered by PPC; they are captured under the waste management licensing regime, and they continue to vent methane to the atmosphere.
- Waste oil treatment requirements of the Waste Incineration Directive (WID) which mean that oil may no longer be burnt for energy generation (see section 6.3).
- Farmers and clean wood off-cuts (e.g. forestry) are exempt from having to install energy recovery for burning. Although these are small point sources, there many of them. Virgin timbers are not classified as waste and are not subject to waste regulatory controls when used as a fuel.
- Some landfills are exempt from methane capture and usage because if it is not cost effective to install it (e.g. in the case of old landfills with an inadequate cap)

6.2 Waste Disposal: influence of the environmental regulator over greenhouse gas emissions

SEPA and EHS regulate waste disposal, as shown in the table below.

Table 10 Waste sector regulations in Scotland and Northern Ireland

Area	Regulat-ory group	Regulation	2005 GHG emissions ($ktCO_2e$) Source: Greenhouse Gas Inventory	WID impact on waste oil burners
Scotland	Part A (small sites Part B- no WML)	Waste incineration directive	Sludge incineration: 9kt CO_2e of N_2O. Clinical waste incineration: 18kt of CO_2. Incineration and co-incineration of waste 116kt in 2006 (SPRI) Landfill and disposal to land 1,204kt in 2006(SPRI)	144 waste oil burners in Scotland were in operation in 2003 (now closed down). 90% were garages burning waste oil to emit ~ 0.8 kt CO_2 during 2003. The (small) GHG impact of the WID is the transport of the waste oil for cleaning, as the oil is still used once cleaned. 22 Scottish sites used waste oil as a fuel for road stone coating.
Northern Ireland	Part A (small sites Part B- no WML)	Waste incineration directive, Waste Incineration Regulations (Northern Ireland) 2003	Sludge incineration: 3kt CO_2e of N_2O. Clinical waste incineration: 6kt of CO_2 Incineration of waste 10kt Landfill and disposal to land 292kt	Only ~5 small waste oil burners in NI. Thus ~0.03kt CO_2 emitted per year (still in operation). Some road stone coating sites were forced to stop burning waste oil as costs to meet WID were too high.

6.3 Waste Disposal: impact of regulations on greenhouse gas emissions

Waste disposal: incineration and air quality

Waste disposal in landfill sites accounts for roughly 20% of UK methane production (AQEG 2007). Incineration with energy recovery (especially CHP) is found to provide a net saving in GHG emissions from bulk Municipal Solid Waste (MSW) incineration. However, the effectiveness of the policy depends on the energy source replaced (AQEG, 2007). General waste, tyres, waste oil and sludges are incinerated in the UK and lead to emissions of air quality pollutants, oxides of nitrogen (NO_X), carbon monoxide (CO), particulate matter (PM) and polycyclic aromatic hydrocarbons (PAHs). Combustion of these wastes is subject to very strict limits set by WID.

In order to reduce methane (CH_4) emissions from MSW (which is historically sent to landfill), energy from waste and incineration plants are used instead which can result in some emission of the above mentioned air quality pollutants. SEPA and EHS waste teams regulate on the Landfill Directive which is aimed at reduced landfill CH_4 emissions, and incineration is captured by the Waste Incineration Directive through PPC, enforced by SEPA and EHS.

Municipal solid waste incineration reduces GHG emissions compared with landfilling (AQEG 2007). However, waste incineration leads to the emissions of several important air quality pollutants such as NO_X, PM, CO, PAHs and dioxins in addition to creating toxic solid waste. EU emissions legislation, implemented by the environmental regulators, is in place to limit these emissions to an appropriate level. Energy from waste therefore, can be seen as an example where there is a trade-off between negative air quality impacts and a reduced climate change impact compared to landfill.

Classification of wastes

(1) **Waste oils.** The Waste Framework Directive categorises waste oils[25], refuse derived fuel (RDF) and tallow as wastes and so this can restrict the flexibility with which these energy sources can be used as fuel at the point of production. The regulations implementing EC Directives allow operators to use these energy sources but may impose stringent requirements which make it unattractive to the operator. Consequently, these materials are transported to larger facilities which are permitted to process the oils for reuse or to use the oils for combustion. This can have an upward impact on GHG associated with transportation of the waste oils to centralised processing sites.

Categorisation of waste oil was addressed in the Court of Appeal judgement in *OSS Group Ltd v Environment Agency* where the Court was asked "whether a lubricating oil, thus not originally used as a fuel, which becomes waste can thereafter be burnt other than as waste…" The Court said that "it should be enough that the holder has converted the waste material into a distinct, marketable product, which can be used in exactly the same way as an ordinary fuel, and with no worse environmental effects." This decision is thus

[25] The Scottish Executive has undertaken a regulatory impact assessment (RIA) of the implementation of the WID in 2003 (Scottish Executive 2003). This states that there were around 144 waste oil burners in Scotland, of which it is estimated that 90% were at garages - burning approximately 2 tonnes of waste mineral oil per annum. No Scottish garages should now be burning waste oil, so that if these oil burners are still in use they will be burning virgin oil instead. Around five Northern Ireland small waste oil burners are still in use as they avoid WID conditions because NI chose to regulate the burners under PPC Part C.

mainly restricted to waste oils and not wastes in general. The Court also suggested that Defra and the Environment Agency should provide practical guidance for those affected on what it referred to as “the end of waste test” (Defra 2007). As a result, the Environment Agency has set up a Technical Advisory Group drawn from industry to advise on the development of a specification such that a waste oil processed to this specification will cease to be waste. The specification will then be sent for consultation.

Concerning other waste streams, the European Commission has issued guidance on when process by-products or residues are waste. Defra plans to issue a consultation paper on the definition of waste in the near future, although from the information available at present, it is unlikely that waste solvents, tyres or RDF will cease to be waste before they are burned (Personal Communication, EA, 2008). SEPA has published guidance on determining what is classified as waste[26] which applies in Scotland. Waste oil guidance for Northern Ireland is available through NetRegs[27].

(2) **RDF for co-firing in power stations.** Scottish and Southern are investigating with the EA the usage of RDF as a co-firing agent. Waste diverted from landfill to be used as a fuel provides a net overall greenhouse gas saving. Co-firing RDF would mean refurbishment costs for the power stations to meet emission requirements and they will need to obtain a PPC permit for their co-boilers. However, this could still be cost-effective.

(3) **Disposal of sewage sludge.** In 2006, it was claimed that the shortage of disposal routes for sewage sludge meant that Scottish Power had to continue burning the sludge, even though Longannet was reportedly in breach of the carbon monoxide limits set under the Waste Incineration Directive (WID).

6.4 Waste disposal: overview

- ➔ Based on approximate estimates, garages in Scotland emitted 0.8ktCO_2 from waste oil combustion in 2003.
- ➔ Thus, the greenhouse gas emissions from replacing waste oil with virgin oil and transporting waste oil for processing are relatively small on a national scale.
- ➔ Information is available on waste oils through the Scottish Oil Care Campaign (SEPA and Scottish Water) and Oil Care in Northern Ireland, which have an oil bank helpline to find the nearest oil recycling bank.
- ➔ The environmental regulations affecting waste oils and their interpretation are under review.

26 http://sepa.org.uk/pdf/guidance/waste/is_it_waste_v2.pdf
27 http://www.netregs.gov.uk/netregs/sectors/1842950/1843542/1865867/?version=1&lang=_e

Waste oil burning under WID	
SEPA & DOENI regulated?	Y
Significant greenhouse gas emissions (waste oil)?	N
Increasing GHG emissions?	N
Environmental regulation* at odds with GHG savings?	N
More joined up approach needed?	Y
Information gap?	N

7 SOLVENT EMISSIONS

7.1 Solvent emissions: type and volume of greenhouse gas emissions

Solvent emissions consist of volatile organic carbons which do not themselves have a significant impact on global warming because of their short atmospheric half life. VOCs do absorb infra red radiation, however their concentrations in the upper troposphere are too low to class VOCs as a true greenhouse gas.

Solvent abatement is important as they cause an odour nuisance and VOCs play a key part in ozone formation, which is detrimental to air quality. Therefore, regulators need to ensure that solvents are abated before they are released to air. The most common approach is to use a thermal oxidiser, powered by natural gas. Thermal oxidiser gas combustion is the main climate change impact of solvent abatement.

7.2 Solvent emissions: influence of the environmental regulator over greenhouse gas emissions

The Solvent Emissions Directive is implemented by regulators using permits under PPC Part B.

Table 11 Solvent emissions regulations in Scotland and Northern Ireland

Area	Regulatory group	Regulation	2005 GHG emissions ($ktCO_2e$) Source: Greenhouse Gas Inventory	Impact on energy use
Scotland	Part B	Solvent emissions directive implemented through Part B permits	No direct GHG emissions from solvent use.	There is very little impact on energy use from the tightened VOC standards under the solvent emissions directive as most plants can meet limits by good housekeeping and using lower solvent products.
Northern Ireland	Part B	Solvent emissions directive	No direct GHG emissions from solvent use.	

Note – there are some Part A installations that fall under the SED – e.g. print works. The use of >200 tonnes per year of solvent is the cut-off between Part A and B.

7.3 Solvent emissions: impact of regulations on greenhouse gas emissions

Although thermal oxidisers are sometimes needed to reduce solvent emissions to limits required under the Solvent Emissions Directive, in most cases experienced by SEPA[28], particularly at the Part B sites, no additional abatement equipment is required. Sites such as dry cleaners can meet tightened volatile organic compound (VOC) limits through good housekeeping and closely measuring solvent usage. Larger sites considering a thermal oxidiser will have to increase their energy use through the gas used to power the system. However, a regenerative thermal oxidiser will help to recycle heat and could be a more efficient technique.

[28] Personal communication from Part B regulator, SEPA Aberdeen, Nov 2007

7.4 Solvent emissions: overview

➔ The review for this project has indicated that solvent abatement is not an area of regulation-GHG conflict and the greenhouse gas emissions linked to this sector are not significant.

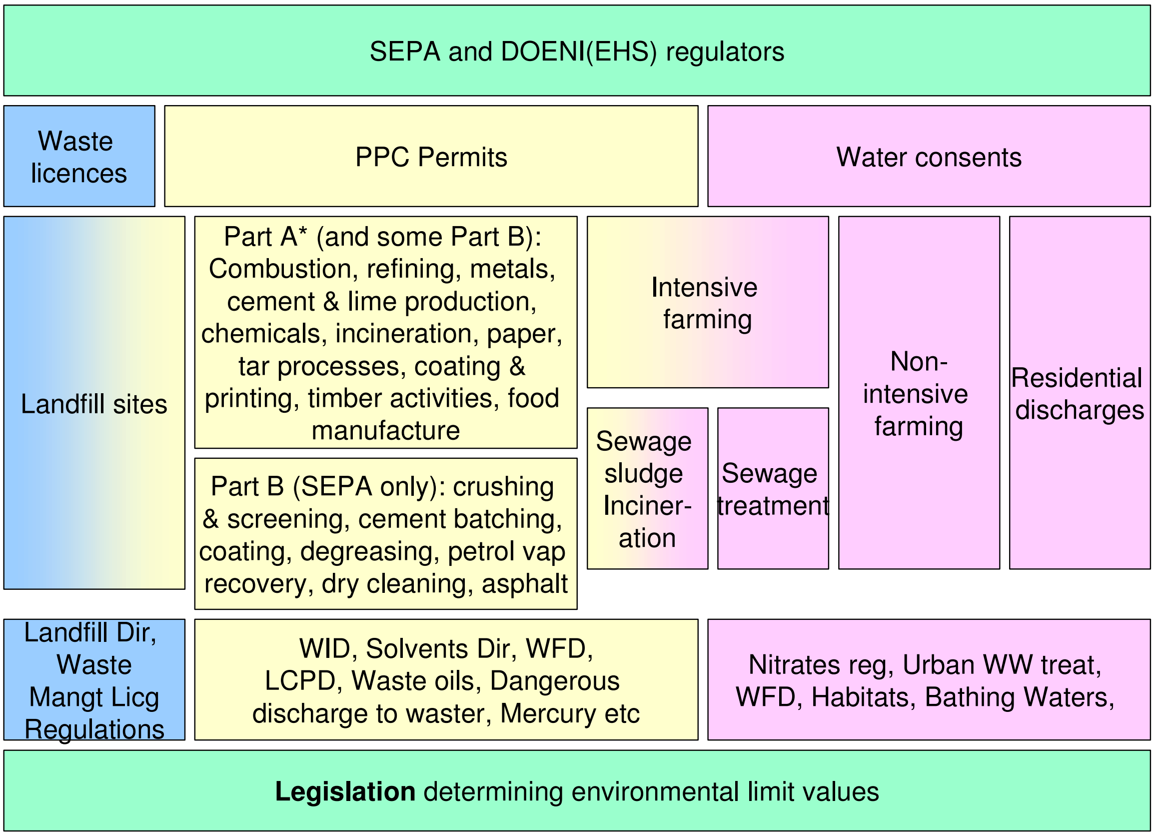
Solvent emissions directive through Part B permits	
SEPA & DOENI regulated?	Y
Significant greenhouse gas emissions?	N
Increasing GHG emissions?	N
Environmental regulation at odds with GHG savings?	N
More joined up approach needed?	N
Information gap?	N

PART II: TO WHAT EXTENT DO ENVIRONMENTAL REGULATIONS ALREADY TAKE THESE IMPACTS INTO ACCOUNT?

8 OVERVIEW

The regulators in Scotland and Northern Ireland are responsible for regulating over a wide range of environmental receptors. As a result, they influence the investment and operational decisions of operators in a wide range of sectors, from industry to agriculture. The extent of their influence varies from activity to activity, depending on the scope of the regulations to be implemented and the options available for compliance. The diagram below illustrates how each of the areas that SEPA and EHS regulate fit together for different sectors. It shows that waste licensing predominantly affects landfill sites, while PPC permitting affects a wide range of industrial sectors and some agricultural practices. In parallel, water consents affect some of the same activities, plus, for instance, the residential sector.

Figure 4 Map of relationship between the regulatory units, sectors under environmental regulation and legislation



Key for sector coverage by legislation: blue = covered by waste licensing, yellow = covered by PPC, pink = covered by water consents

The assessment of existing regulatory practice that follows focuses on the three areas of activity illustrated in the diagram: (1) PPC; (2) Water regulations; and (3) Waste plus (4) Strategic Approach. It focuses on two questions:

(1) Are greenhouse gases accounted for under the existing framework of environmental regulation?

(2) Are industries emitting more greenhouse gases as they introduce additional abatement techniques to comply with environmental legislation?

In order to provide examples of where industry has found climate change objectives and environmental emissions limits to be at odds, we have provided case studies for:

- waste water treatment technology (an area of particular interest for regulators and operators given the interplay between waste water treatment emissions standards and the energy use of treatment technologies); and
- thermal oxidiser technology (which is widely used across a number of different industry sectors to meet permit conditions under PPC).

Together these provide real examples of competing environmental goals.

9 POLLUTION, PREVENTION AND CONTROL (PPC)

9.1 What is PPC?

The principles of PPC are introduced in section 2.1 of this report. The sectors regulated by EHS and SEPA under PPC permits include energy industries, production and processing of metals, mineral industries (e.g. cement manufacture), waste management, food and drink production and others. Other regulations on industrial activity affecting these sectors are often integrated into the PPC permitting process so that an industrial site only has to apply for one permit that covers all polluting activities.

For instance, Industrial activities covered by the Waste Incineration Directive (WID) are regulated by PPC permit conditions. Activities such as the incineration of sewage sludge are often covered by Part A PPC permits and waste oil issues are also captured by PPC. As a result, this section of the report also covers the WID.

9.2 Are greenhouse gases accounted for under PPC?

In summary carbon emissions are accounted for under PPC Part A existing practice through energy efficiency and BAT requirements covering energy. However, regulators consider that the approach to and guidance about energy use could be improved.

9.2.1 Consideration of greenhouse gases in PPC to date

Requirements on energy efficiency are described in PPC Horizontal Guidance Document H2 (Environment Agency 2002). This provides "cross-cutting information relevant to all sectors to provide supplementary information to assist applicants in responding to the energy efficiency requirements…" Box 1 below summarises the specific guidance on energy use and carbon emissions outlined in Document H2.

Box 1 Greenhouse gas consideration under the PPC permitting process

The permitting process aims to take a holistic approach considering economics, energy use, raw material consumption and emissions to air, land and water. PPC document H2 summarises how energy efficiency should be taken into account in the permitting process:

- "All installations under the scope of PPC shall meet a set of basic energy requirements for energy efficiency as defined in sections 2.7.1 – 2.7.2 of Sector Guidance Notes. These include:

  - provision of information on energy consumed or generated by the activities within the permit and the associated direct and indirect carbon dioxide emissions

  - energy management provisions

  - a description of the proposed measures for the improvement of energy efficiency in operating and maintenance procedures, control of excessive heating and cooling losses and building services

  - provision of an energy efficiency plan that identifies energy efficiency techniques that are applicable to the operation of the activities.

- All installations under the scope of PPC must also meet additional energy efficiency requirements either:

  - through participation in a Climate Change Agreement or Direct Participant Agreement in the ETS or

- through compliance with further permit-specific requirements as determined with the regulator.

- The regulators will not enforce any part of a Climate Change Agreement or Direct Participant Agreement of the Emissions Trading Scheme.
- Where participating, the operator must provide evidence that the activities within the permit are covered by a Climate Change Agreement or Direct Participant Agreement in the Emissions Trading Scheme.
- The operator must notify the Regulator within 14 days in the case of any failure to obtain recertification of a Climate Change Agreement or the termination of or withdrawal from an Emissions Trading Scheme Direct Participant Agreement, or if the permitted activities leave such an agreement.
- Many energy efficiency techniques result in a net cost-saving over the life of the technique. The Regulators consider such techniques to be Best Available Techniques (BAT).
- The Regulators intend to review the setting of an appropriate cost benchmark (e.g. £/tonne CO_2) in future, in the light of information arising from the Climate Change Agreements and Emissions Trading mechanisms.

When asked to comment on how energy and GHGs are included in the current licensing process, regulators made the comments summarised in the table below. The majority of comments focussed on energy i.e. carbon dioxide, rather than other gases (e.g. refrigerants). While there is restriction of some GHGs within the emissions to air category (e.g. oxides of nitrogen; fluorine and its compounds) other significant GHGs (including CO_2 and CH_4) are not regulated directly.

Table 12 Feedback from interviews: existing practice for dealing with greenhouse gases under PPC

Interviewee	Describe how your existing licensing process or risk assessment deals with energy and greenhouse gases?
SEPA Part A	SEPA's risk assessment process is formalised so ~4 site inspections per year tend to be made, if energy intensity big problem this will be a focus on the site inspection.
SEPA Part B	Part B does not directly cover energy and Environmental Management Systems. One option would be to encourage EMS more for Part B sites.
SEPA Part B	Part B doesn't look at GHGs. Does not cover really big energy users.
EHS IPRI[29] Past A Part B	Energy is dealt with under the H2 guidance and in the PPC application section on energy. The H1 guidance covers a broad environmental assessment of which climate change could be a part but this is typically low priority.
EHS Strategy Unit	The PPC permit process requires sites to have an EMS. The focus of the permit application process is weak on energy. Help and audits on saving energy are typically in the domain of the Carbon Trust, but that does not mean that energy cannot be covered by other bodies. Under the SEA process, high level climatic factors are considered as part of the risk assessment.

[29] Industrial Pollution and Radiochemical Inspectorate

9.2.2 Scope for improvement

Some of ideas to ensure that energy issues are more full taken into account are summarised below.

- **Part A** already deals with energy: on site inspections, under H2 guidance, in the PPC application section on energy and under H1 guidance. However, the H1 guidance covers a broad environmental assessment and climate change is typically given a low priority. The general consensus amongst interviewees for this project was that the energy aspects of PPC Part A could be implemented in a stronger fashion (although it was noted that energy and carbon savings are typically the domain of CCAs (usually at sites covered by trade association memberships) and the Carbon Trust).
- **Part B** regulators do not currently cover energy directly. It was suggested that the introduction of Environmental Management Systems (EMS) for Part B sites could help to include energy objectives.

Parts of the permitting process that environmental regulators could emphasise in order to help reduce GHG emissions include those listed below (the majority of these relate to energy):

- energy benchmarking against other UK/ EU sites (compulsory in some sectors);
- incorporation of energy objectives into the EMS;
- monitoring energy consumption;
- housekeeping;
- energy efficiency plan commitment; or
- Climate Change Agreement (CCA) for the site.

A key point raised was that where sites are covered by a climate change agreement (CCA), they can use this to partly meet PPC requirements, but PPC requirements still apply. Feedback from the regulators has highlighted that CCAs inhibit regulators from challenging energy use at a site as thoroughly as they would like to do so (once a CCA already is in place, there is limited scope for further investigation)[30].

The extent to which these changes can be affected depends on the number of sites where the regulations are yet to be applied; although the majority of UK sites have now been permitted under PPC and all have been permitted by SEPA in Scotland, there is still a need to permit new plants and variations to existing plants. Not all PPC-eligible sites in Northern Ireland have been permitted yet.

9.3 PPC: potential for adverse impacts on greenhouse gases

Permitting under PPC is one example of where a regulatory process specifies that energy use should be taken into account, but where implementation of the permit conditions may lead to an increase in energy use (due to end of pipe treatment needs). Feedback from regulators highlighted that there is a bias towards managing individual local impact

[30] This issue is covered in more detail in Section 9.3.4

pollutants rather than GHGs in PPC as the PPC regime is site specific. Examples of these impacts are summarised below; the first two areas are discussed in more detail in the text that follows while LCPD and solvents have been discussed above (in sections 3.3 and 7.3 respectively).

(1) **Waste Incineration Directive** – This covers waste oils and tallow. It makes these energy sources more difficult to use for fuel due to their classification as waste. Where waste oils are substituted with other fuels, and/ or need to be transported long distances for disposal/ reuse, this may result in an increase in GHG emissions.

(2) **Odour control** – For example, permit restrictions on odour can require additional thermal oxidation to combust chemicals in the exhaust gases. The increased energy requirement to use the thermal oxidiser leads to additional carbon dioxide emissions.

(3) **Solvents Directive** – A solvents permit may require a thermal oxidizer to be applied to flue gases, leading to increased carbon dioxide emissions from gas combustion.

(4) **LCPD** – compliance with the Large Combustion Plan Directive may require the introduction of flue gas desulphurisation (FGD) to a coal-fired power plant in order to control SOx emissions. This results in increased GHG emissions for two reasons (i) the energy used to power the FGD; and (ii) the reaction with limestone in the FGD wet scrubbing process[31].

Other specific examples include: VOC treatment, sludge treatment, wet electrostatic precipitator scrubbing particulates from chipboard production and broiler house fans for ammonia dispersal (see table below).

Table 13 Feedback from interviews: the adverse impact that PPC permit conditions could have on greenhouse gas emissions

Interviewee	Which aspects of the regulations you implement do you feel aggravate greenhouse gas emissions directly or indirectly?
SEPA Part A	BAT is likely to have a negative impact on GHGs e.g. as **VOCs** win in most cases v. energy efficiency unless the energy burden is excessive – there is a bias in PPC towards managing individual pollutants rather than GHGs. GHGs very difficult to assess on a local level. Definition of waste is big problem, see example in 2.3 below.
SEPA Part A/B	For example, **Sludge Treatment** Centre big energy use (but this is Part A), but technologies tend to be driven by trends rather than regulation
SEPA Part B	Part B permit conditions are for specific smaller scale processes and do not generally result in energy intensive end of pipe equipment being installed.

31 See Section 3.3 for further details.

Interviewee	Which aspects of the regulations you implement do you feel aggravate greenhouse gas emissions directly or indirectly?
EHS Part A Part B	In general, as environmental restrictions and pollution thresholds tighten, industry will need to consume more energy in abatement in order to meet permit conditions, e.g. for **particulate abatement**, a wet electrostatic precipitator (WESP) is appropriate abatement for chipboard manufacture, costing £1M and having a significant energy consumption. IPRI regulators assume that the author of the sector guidance note has reviewed the full impact of the WESP in terms of benefits of abatement vs. electricity demand. IPRI are not in a position to review the GHG impacts of the WESP. For **odour abatement**, thermal oxidizers are seen as BAT, and the only reliable option for high intensity odours, as outlined in the PPC guidance. This means that in some cases odour control will lead to increased GHG emissions which unavoidable. Similarly for thermal oxidizers used in solvent abatement in district council controlled operations. (Under PPC district councils have no direct role in ensuring efficient energy usage). **FGD** fitted to coal-fired power station. Electric fans fitted to broiler houses to improve dispersion of **ammonia** emissions, increases the energy consumption on the site.
EHS Strategy Unit	The regulation and guidance on EMS does not aggravate GHG emissions Companies not implementing EMS may choose not to do so because of a number of barriers such as the shortage of resources in SMEs to set up the EMS and instigate continual improvement. For applications for renewable energy sites, environmental impact is looked at on a local level and may cause a barrier to the development – which in fact reduces the environmental impact on climate change.

9.3.1 PPC: greenhouse gas emissions and waste incineration

Why does implementation of the WID affect GHGs?

The Directive[32] aims to prevent pollution and the resulting risks to human health caused by the incineration of waste. The WID regulations cover waste oils (although final judgement on what is considered waste in a particular case lies with the courts). Prior to the implementation of the WID, industries were able to burn waste oils for power generation, either on industrial scale or in small waste oil burners (SWOBs). However, the Directive means that waste oils can now only be dealt with by permitted plants (ENDS Feb 2005)[33]. Combustible liquid wastes can still be burnt as long as they meet emissions limits where: the mass content of polychlorinated aromatic hydrocarbons amounts to concentrations not higher than those set out in EC legislation; they do not contain other hazardous constituents in quantities inconsistent with the achievement of the objectives set out in the legislation; and have a net calorific value of at least 30MJ/kg (Scottish Executive Environment Group, 2003). Where waste oils are substituted with other fuels, and/ or need to be transported long distances for disposal/ reuse, this may result in an increase in GHG emissions.

How great an impact does it have on GHG?

The Scottish Executive has undertaken a regulatory impact assessment (RIA) of the implementation of the WID (Scottish Executive 2003). It states that there were around

[32] The WID was introduced in 2000 and since 2002 it has been applied to all new waste incineration and co-incineration plants. From 2006 onwards it has also applied to all existing plants (EC 2003). The Waste Incineration (Scotland) Regulations 2003 transpose the requirements of the Directive for Scotland while the Waste Incineration Regulations (Northern Ireland) 2003 provides for implementation of the WID in Northern Ireland.

[33] 'Permitted plants' include cement kilns (which can burn the waste oils for energy); they now have a monopoly over the market as few other plants have a license. SWOBs are now illegal in Scotland as there was a broader application of the WID than in the rest of the UK.

144 waste oil burners in Scotland, of which it was estimated that 90% were at garages. These were burning approximately 2 tonnes of waste mineral oil per annum. Based on the RIA, compliance with the WID is expected to have cost around £800 for a typical business. If a business decided that it was not worth the investment, they will have needed to find an alternative source of energy. It is likely that this will require virgin fuel oil being brought onto the site, while the waste oil has to be transported off-site. The RIA also highlights that there are 30 road stone coating waste oil burners that need to comply at a cost of around £20,000 each. Opting to avoid these costs would again mean finding an alternative fuel for the road stone sector.

Northern Ireland implemented the WID for waste oils using the same approach as England and Wales. In Northern Ireland a small number waste oil burners are allowed to continue operating upper PPC Part C conditions where the waste oil is clean enough to be construed as a fuel and not as waste. These are regulated by Local Councils (EHS Personal Communication March 2008). Northern Ireland's Industrial Pollution and Radiochemical Inspectorate (IPRI) regulators estimate that there are around 5 small waste oil burners in Northern Ireland still in operation. As Scotland took a broader approach, all Scottish waste oil burners were required to meet the WID requirements, and as a consequence, they no longer continue to operate.

Could its impact be reduced?
Since WID permits are allocated as part of PPC permit conditions, any plant with a WID permit must also comply with the IPPC Directive. This is a holistic approach which should mean that the energy cost implications and energy savings (and so therefore the carbon dioxide impact) is taken into account. However, as noted in section 9.2.2 above, although energy must be covered by the permit application (if only by reference to the CCA) in some cases, there could be a stronger focus on energy management and reduction in the application.

Given the impacts of the Directive's implementation, there have been a number of court cases arguing over the status of waste oil since its implementation. An Appeal Court has recently ruled that "A lubricating oil, thus not originally used as a fuel, which becomes waste can thereafter be burnt other than as a waste".[34] This appeal was lodged by the Environment Agency for England and Wales (Defra July 2007). This could open the way for such oils to be used as fuels without having to comply with the Waste Incineration Directive. In response, the Environment Agency has set up a consultative committee to draw up guidance of when used oils cease to be waste and. guidance in this area has also been published in Scotland.

However, there is a negative impact on GHGs caused by the transportation of the waste oil. The box below summarises a case study in Aberdeen where implementing the WID meant that high quality oil extracted from waste drill cuttings could not be used in on-site boilers. This was because it was classed as waste oil and needed to be driven from Aberdeen to Middlesbrough where the nearest WID compliant burner (i.e. a burner permitted to burn that type of waste) was operating.

[34] http://www.bifca.org.uk/news.php British Industrial Furnace Constructors Association, Oct 200718

Box 1 Case study: High quality waste oil transported from Aberdeen to Middlesbrough to nearest WID compliant burner for use a fuel.

Drill cuttings from oil rigs are a mixture of mud, diesel and water that come onshore as waste. If disposed of as they are they would have to be treated as 'special waste' and probably end up in landfill. Instead, the site heats cuttings to 300°C so that water and oil evaporate off and distillation means oil separated out. The result is a very clean product, cleaner than diesel even.

In the past this product was used to fire boilers on site covered by the PPC permit. But now the WID requires very expensive continuous monitoring etc. It would cost ~£0.5million to continue burning it on-site in compliance with the WID.

Therefore waste oil is now put into a tanker to drive to Middlesbrough from Aberdeen where the nearest WID compliant burner is located (at Corus). The drill cutting site now has to buy virgin diesel as a substitute to fire the plant. Not only is this costly (at around £30,000/quarter), the GHG impact of transporting all waste oil off site to Middlesbrough is considerable.

Source: SEPA Part A interviews, November 2007

9.3.2 PPC: greenhouse gas emissions and odour controls

Why does odour control affect GHGs?

Feedback from regulators revealed that thermal oxidizers are regarded as BAT, and are the only reliable option for high intensity odours, based on recommendations contained in the PPC guidance[35]. This means that in some cases odour control will lead to increased GHG emissions which are arguably unavoidable.

Could its impact be reduced?

Lower GHG impact options for odour abatement do exist (shown in the table below). For example, the installation of bio-scrubbers, using microbes to capture odours, can have a smaller climate change impact. These are similar to the kind of technology options for solvents and/or volatile organic compound (VOC) removal.

Table 14 Technology options for capturing odour

Reduced carbon impact ↓

Technology	Description	Carbon reduction	Disadvantages
Thermal oxidisers	Fuelled through natural gas, combusts flue gases.	Energy intensive – natural gas consumption	Fuel costs to run (gas)
Auto thermal oxidisers	As above but waste heat is recycled.	Recycles waste heat so reduces natural gas needed	Fuel costs to run (gas)
Carbon filters	Very absorbent filters to which odour particles stick	Zero energy for process but energy intensive to manufacture filters	Water vapour in vent stream damage filter; filters need replacing but energy intensive to manufacture
Bio-scrubbers	Layer of microbes that digest odour particles	Zero energy	Require very large surface area

Source: Enviros

Note: The table ranks technologies on their GHG impact based on the amount of energy input to the system; however, a full life cycle assessment approach (i.e. one that takes account of embodied energy and carbon e.g. in the carbon filters) may affect this order.

35 Odour control is addressed in the Horizontal Guidance note H4, which focuses on assessing an odour source.

An alternative approach to end of pipe treatment is capturing odours in a sealed gas recycling system during sewage treatment, for instance. The use of thermal oxidisers are more energy intensive; they use 24.4kWh of biogas per total dry solids, compared to the 6.24kWh (primary) of electricity per total dry solids used by the sealed gas system. However, the biogas fuelling the thermal oxidisers is short cycle CO2 and is classed as a renewable energy source. This is illustrated by the case study below.

Box 3 Case study: Replacement of thermal oxidisers used for odour control with a sealed gas recycling system at a local sewage sludge treatment centre

This case study illustrates that although thermal oxidisers can be an energy intensive odour abatement technique as they are often gas powered, in some cases they can be powered by renewable biogas generated on site. In this case, the oxidisers are replaced by a sealed gas recycling system that is less energy intensive, but uses electricity, and so leads to higher greenhouse gas emissions.

A sewage sludge treatment centre operator has submitted a draft application to SEPA to vary their existing permit to allow a change from thermal oxidisers for odour control to a sealed gas recycling system. The thermal oxidisers, fuelled by biogas, are currently used to incinerate the odorous gases from the headspace of the sludge pulping tanks. The proposed gas recycling system prevents these odorous gases from being released and diverts them back into the anaerobic digesters for capture as biogas for subsequent energy generation usage. As the thermal oxidisers are removed, the biogas is no longer needed to power them.

The thermal oxidisers burn biogas as a fuel and currently use approximately $4m^3$, equivalent to 24.4kWh, of biogas per total dry solids (tds) of sludge produced (biogas energy = $6.11kW/m^3$ biogas). No electricity is used.

The replacement gas recycling system is not fuelled by biogas but operates on electricity, using 2.4kWh/tds sludge (equivalent to 6.24kWh/tds using a conversion factor of 2.6 for public supply.) Average sludge production is 48 tds/day. Operation of the old system of thermal oxidisers running on biogas emitted 222kg CO2 per day, but as this is short cycle CO2, biogas can be classed as a renewable energy source. The new sealed gas system will operate using electricity and will indirectly emit approximately 56kg CO2 per day.

The operator states that the excess biogas resulting from the removal of the thermal oxidisers will be used to generate power in the CHP, which will help offset the carbon emissions of the plant.

Source: SEPA PPC Part A/ Part B interviews, November 2007

9.3.3 PPC: greenhouse gas emissions and EU ETS

Some of the organisations covered by PPC are also covered by the EU Emissions Trading Scheme (EU ETS).

Why does the EU ETS affect GHGs?
The EU ETS is an emissions trading scheme that requires participants to measure and monitor the direct carbon dioxide emissions from the combustion of fossil fuels on site. By requiring organisations to buy carbon credits (‘allowances’) to cover their emissions. By gradually reducing the number of allowances available, the EU ETS aims to encourage CO_2 emissions reductions.

A key element is the fact that organisations are able to buy and sell allowances with each other. An organisation can decide whether it is cheaper to undertake carbon savings itself or to buy allowances from someone else that has made emissions savings. Although this means that an individual installation’s emissions may actually increase (if it chooses to buy allowances rather than abate) total emissions from participants as a whole should reduce over time.

Could its impact be strengthened?
In order to avoid damaging the competitiveness of UK industry through high administrative burdens, climate change policies like the EU ETS and regulatory enforcement must work together in a joined up way. Government continues to review the implementation of the overall package of policy measures to ensure the best fit of emissions coverage to administrative requirements. In a recent consultation[36] Government acknowledged the overlap between the energy efficiency requirements in the IPPC Directive and various climate change policies, including the EU ETS.

Following adoption of the EU ETS Directive, an amendment was made to the IPPC Directive which effectively dis-applied the application of BAT to CO_2 on EU ETS/PPC sites.

Box 4 Amendment of PPC Regulations to avoid overlap with the EU ETS

Regulator influence over CO2 emissions from activities falling under both PPC and the EU ETS is limited due to an amendment of the IPPC Directive resulting from the adoption of the EU ETS Directive:

> “where emissions of a greenhouse gas from an installation are specified in Annex 1 to [the ETS Directive] in relation to an activity carried out in that installation, the permit shall not include an emission limit value for direct emissions of that gas unless it is necessary to ensure that no significant local pollution is caused”.

This has been implemented by amendment of the PPC Regulations, adding new paragraphs 8A and B to regulation 12:

> “where emissions of a pollutant from an installation are the subject of conditions imposed pursuant to reg 10(2) and (3) of the [ETS Regs], the permit shall not include an [ELV], equivalent parameter or technical measure in respect of those emissions unless the regulator considers that the value, parameter or technical measure concerned is necessary to ensure that no significant local pollution is caused.”

Source: Statutory Instrument 2003 No. 3311, The Greenhouse Gas Emissions Trading Scheme Regulations 2003 http://www.legislation.gov.uk/si/si2003/20033311.htm

In effect the amendment shown in the box above dis-applies the application of BAT to CO_2 emissions from activities falling under the scope of the EU ETS[37]. However, the relationship of this duty with BAT is not clear i.e. when the BAT requirement for carbon dioxide is dis-applied there still remains a statutory requirement to use energy efficiently. The Environment Agency has lobbied Defra on the broad definition of combustion, small emitters and the concept of “whole installation” (Defra has recognised this issue in the Climate Change Simplification Consultation) (Personal Communication, EA, 2008). The outcome of the Commission review of the EU ETS Directive was announced early in January 2008.

In January 2008, the Commission announced that Member States could remove small installations from the EU ETS under certain conditions, as it is not cost effective for them to remain in the EU ETS. The installations concerned are those with a rated thermal input below 25MW whose reported emissions were lower than 10 000 tonnes of CO_2 equivalent in each of the 3 years preceding the year of application (EC 2008). The EC estimate that, Europe wide, 4,200 installations, accounting collectively for around 0.7% of total ETS emissions, could be opted out of the system under these provisions.

[36] Defra, 2007, Consultation on the Recommendations of the Climate Change Simplification Project: Climate Change Instruments. Areas of overlap and options for simplification.
[37] See section 9.2 which explains the energy efficiency requirements under PPC.

The Commission proposes that installations can be excluded from the ETS only if measures are in place that will achieve an equivalent contribution to emission reductions. As the site would be captured under PPC when it falls out of the EU ETS, permit conditions will be key to ensuring sites meet their equivalent contribution to emission reductions.

Combined Heat and Power, Pollution Prevention and Control & the EU ETS
Based on feedback from the Steering Group of this report, regulators feel that CHP is important to GHG mitigation, and they would like more back up to encourage the installation of CHP at sites where it is a viable option. The Environment Agency has recently reviewed what it can do in its regulatory role to encourage the uptake of Combined Heat and Power (CHP) at more PPC sites. It found that most major carbon dioxide point sources are covered by EU ETS. If sites were to report on waste heat through the Resource Efficiency Appraisal and Development (READ) tool, it would give a much improved overview of PPC sites which could reduce waste heat through CHP systems. Or alternatively, for sites with fuel combustion over a certain threshold one option is to require them to report waste heat produced at the site in their permit. SEPA already does this to some extent as it requests heat use and energy use at site. More data allows regulators to focus on large heat losses and potentially to encourage CHP heat output to be shared between neighbouring sites. Incentives are needed to encourage site to take waste heat reduction and energy efficiency more seriously.

9.3.4 PPC: greenhouse gas emissions and CCAs

Why do CCAs affect GHGs?
Climate Change Agreements (CCAs) are a voluntary scheme that allows any PPC covered installation that is eligible to pay the Climate Change Levy (CCL) a substantial discount on that levy if it complies with energy or carbon emissions reduction targets. As a result, the primary aim of CCAs is to reduce greenhouse gas emissions.

Under a CCA, participants are required to monitor and report their energy and production data once every two years (known as a 'milestone'). This requirement applies to fuels like gas plus non-Levy fuels such as oil. The same information can be submitted to meet PPC energy reporting requirements. Although basic energy efficiency requirements under PPC still have to be met by CCA-covered companies, their CCA is allowed to constitute the additional energy efficiency requirements.

Could their impact be strengthened?
Feedback from regulators for this project indicates that this site exemption from the PPC additional energy requirements restricts the impact that the PPC permit can have on energy saving at the site. As a result it restricts the regulator's influence over greenhouse gas emissions from site activities.

The exemption is given on the premise that these sites are already actively making energy savings to meet their CCA target. However, based on the regulators' experience, this is often not the case. Sites failing their CCA target can make up the shortfall by buying carbon allowances from the UK Emissions Trading Scheme. This is a particular issue for this UK scheme because there has been a glut of allowances for several years. Not only is it consequently very cheap for companies to buy up carbon allowances (and so to avoid abating themselves), but also the allowances arguably do not represent additional emissions savings (and so there is no positive impact on GHG emissions).

It is acknowledged that where a site has a CCA a regulator's options for reducing energy use are more limited (it does not, for instance, need to impose energy efficiency targets). However, the regulator can still:

- emphasise the use of CCAs for meeting PPC; and
- use the basic energy requirements under PPC to help ensure CCAs are being complied with through in-house measures (rather than purely through buying carbon allowances).

The current CCAs expire in 2010; Government has announced that they will continue to 2017 but has yet to decide on the form that they should take. The current Climate Change Simplification Project consultation[38] puts forward the view that the current 'light touch' approach to CCA covered organisations under PPC should continue. Response to this consultation could provide an opportunity for regulators to establish how they can do more for energy at sites which already have a CCA.

9.3.5 PPC: EC review of PPC directive

In December 2007, the Commission adopted new legislation to strengthen industrial regulation (EC 2007). Proposals are based on merging the current IPPC Directive and six sectoral directives into a single new industrial emissions directive. The aim of the new directive is to tackle the shortcomings of current legislation on industrial emissions. The new directive aims to increase the use of "best available techniques" (BATs), ensuring that industrial operators use the most cost-effective techniques to achieve a high level of environmental protection. Emission limits are tightened across a number of areas under the proposals, particularly for large combustion plants.

These proposals by the EC to simplify legislation are reported to lead to a decrease in administrative costs faced by operators and industry. Consultation on the proposals is on-going in 2008. With more stringent emissions limits, greenhouse gas emissions from abatement technology will increase if, for example, more extensive use of FGD is needed for large combustion plants.

9.3.6 The Scottish Climate Change Bill

Under recent proposals for the Scottish Climate Change Bill (SG 2008), the Scottish Government's preference is to reduce emissions by 80% by 2050. Opting for an ambitious target recognises that Scotland has a relatively affluent economy and great potential for generating energy from renewable sources. Other environmental legislation such as the EU ETS will interact and help achieve these goals and the Scottish Government is consulting on the role the EU ETS can play. A watching brief should also be kept on tightening industrial environmental regulations such as in the water and large combustion plant areas, where the energy increases needed to run abatement equipment will make it harder to reach 80% GHG reductions in these areas.

[38] Defra, 2007, Consultation on the Recommendations of the Climate Change Simplification Project: Climate Change Instruments Areas of overlap and options for simplification.

10 WATER REGULATIONS

10.1 What is the Water Framework Directive?

Water regulations in the UK are based on the rolling out of the Water Framework Directive (WFD)[39] which requires all inland and coastal waters to reach at least 'good status' by 2015. It uses a river basin management approach and requires that for each river basin district, a 'river basin management plan' is established and updated every 6 years.

The WFD is complemented and partially implemented by some other Directives, including:

- **Nitrates Directive** – This aims to reduce water pollution by nitrates from agricultural sources by controlling the application of nitrates (e.g. fertilizer) to the ground. The Directive only applies to certain areas, designated as 'nitrate vulnerable zones' (NVZs).

- **Urban Waste Water Treatment Directive** – This Directive imposed treatment requirements for sewage from urban waste water and biodegradable waste water from the food-processing industry. As a result, by the end of 1998 the UK had stopped all water basin/ sea-bound disposal of sewage sludge left over from treatment processes.

- **Dangerous Substances Directive** – This controls the release of dangerous substances to water and introduces measures to eliminate (List I) or reduce (List II) pollution of the aquatic environment[40].

A chronological list of key regulations in the waste water treatment industry is provided in the table below:

Table 15 Chronology of waste water treatment regulations

Year	Regulation/Directive
1991	Urban Waste Water Treatment Directive (UWWTD)[1]
2000	Water Framework Directive entered into force (WFD)[1]
2000	Integrated Pollution Prevention and Control (IPPC)[1-3]
2002	The New Water and Sewerage Authorities Dissolution (Scotland)[2]
2003	Transposition in national legislation[1-3]
2006	Shellfish Waters Directive adopted (SWD)[1]
2006	Establishment of monitoring network[1-2]
2007	Water Resources Management Plans[2]

Source: 1. Defra water issues 2. SEPA Waste Water Treatment 3. Environment & Heritage Service (Northern Ireland) Water

[39] The WFD had a deadline for transposition into national legislation by 2003 and presentation of draft river basin management plans by 2008 (EU WISE 2007). In the UK the devolved administrations are implementing the regulations independently. However, they are seeking advice from the UK Technical Advisory Group on the WFD (UKTAG) on the environmental standards that should be introduced and this work covers all of the UK administrations (Defra WFD 2007).

[40] The Priority Substances Daughter Directive (which will eventually replace the Dangerous Substance Directive) is soon to go through a second reading in the European Parliament.

Scotland and Northern Ireland specific aspects

In Northern Ireland the Department of the Environment (DOE) is implementing the WFD and EHS is the relevant regulator. It has been transposed into national legislation and some river basin management plans have been published. However, the DOE has taken a fairly high level approach, leaving flexibility for the individual plans. In NI there are some 100 major industries currently licensed to discharge to waters, 770 small-scale commercial and industrial activities discharge to sewer systems and a further 900 discharge direct to waters (NI DOE booklet 2007). Up to April 2007 Northern Ireland Water Service was the main water utility provider in NI and it resided within Government. However, in April 2007 it became a Government Owned Company (GoCo), providing water and sewerage services in NI.

In Scotland the Scottish Executive has been responsible for transposing the Directive into Scottish law. The Water Environment and Water Services (WEWS) Act implements the Directive[41]. Under this the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) (SEPA 2005, 2007) establishes a framework to protect and manage Scottish water resources based on an assessment of the risk posed to the water environment. It brings a requirement for any controlled activity to be authorised so that under CAR. SEPA regulates the requirements brought in under this Act and has taken a fairly comprehensive approach[42].

10.2 Are greenhouse gases accounted for under the WFD?

In summary feedback from regulators suggests that licensing and risk assessment when granting water consents does not deal with GHGs as things stand.

10.2.1 Consideration of greenhouse gases in the WFD to date

There is a preference for sites implementing the most ‘sustainable’ treatment option available which should help encourage compliance with a lower impact on energy use. Although sites can be encouraged to choose “the most sustainable option”, we understand that the interpretation of this by companies has been rather subjective and the regulator cannot insist on one technology over another. These points are highlighted in the table below.

Table 16 Feedback from interviews: existing practice on dealing with energy and greenhouse gases in the water consents process

	Describe how your existing licensing process deals with energy and greenhouse gases?	**As a regulator, where do you feel you can make greatest impact in reducing greenhouse gas emissions?**
EHS Water Utilities	The licensing and risk assessment does not deal with GHGs. However, the regulator prefers sites to implement the most sustainable treatment option available which would provide consistent compliance but with a lower impact on energy use if possible. The regulator cannot insist on one technology over another.	Energy and greenhouse gases are not considered in the water regulators risk assessment of applications. There is a debate to be had on trading off one part of the environment (Climate change) off against another (water quality).

41 SEPA water environment directives website: http://www.scotland.gov.uk/Topics/Environment/Water/15561/2437#a6

42 SEPA website: http://www.sepa.org.uk/wfd/

	Describe how your existing licensing process deals with energy and greenhouse gases?	As a regulator, where do you feel you can make greatest impact in reducing greenhouse gas emissions?
EHS Water Agriculture	Regulations do not cover energy and GHGs directly.	GHGs are "another item on the agenda" for the environment and the Water Management Unit (WMU) cannot deal with them directly.
EHS Water Discharge Consents	The only opportunity to think of GHG impacts is in the recommendation to choose "the most sustainable option" however, this has subjective interpretation by companies. WMU cannot recommend specific technologies as they may not meet the consent limits and WMU would then be exposed. WMU recommend that companies seek advice from consultants.	
SEPA Water	Site inspections are to check that the works are performing to standard. Energy use is not covered on visits and would only come up if they were increasing the capacity of the treatment.	SEPA are keen to encourage energy efficiency and green energy where they can, though they cannot force operators down that road. SEPA encourage new residential developments to choose more sustainable treatment options e.g. choose a reed bed for sewage treatment over a sequential batch reactor.
SEPA Water	Current set up does not deal with GHGs – only focus on water environment. Does not mean to say it cannot be factored in now.	In the course of negotiation, there may be some room to influence energy use decisions.

Water Framework Directive: cross-over with other regulations

Although the water licensing process does not specifically account for energy use and greenhouse gas emissions, cross-over with PPC permitting for larger industries discharging effluent mean that those sites at least need to take account of energy use. Cross-regulation under the EU Emissions Trading Scheme (EU ETS) and the Carbon Reduction Commitment (CRC) also indirectly results in GHG emissions being considered by these organisations for other regulatory reasons[43].

- **PPC:** although the majority of the UK waste water industry is not covered by PPC, some specific treatment activities are permitted under it. This includes biogas generation from sludge treatment. Other non-water industries that discharge to river basins or coastal areas are also covered by both sets of regulations. This means that these sites need to take account of their energy use under the PPC requirements and regulators will set site specific energy requirements under the PPC permits, with the aim of reducing energy wastage on site.

- **EU ETS:** there is limited cross-over with the EU ETS which captures all installations with combustion equipment >20MWth. This has resulted in some sludge drying facilities in the water industry being included, but it is estimated that only a small proportion (less than 5%) is captured[44]. Installations captured by the EU ETS must measure and monitor their CO_2 emissions from direct energy consumption and buy carbon credits ('allowances') for those emissions. This acts as an incentive to reduce energy use (and so carbon emissions).

[43] Section 9.3 provides further detail on climate change policies.
[44] This could decrease further as the new EU ETS de minimis threshold for smaller sites, announced by the EC in December 2007, comes into effect.

- **Carbon Reduction Commitment:** although the water industry initially lobbied for an opt-out, it is now likely to be covered by this UK-wide scheme. Organisation would be required to measure and monitor their emissions from both direct and indirect (electricity) energy use. Like the EU ETS, the CRC is an emissions trading scheme and organisations will be required to buy emissions allowances to cover their emissions to encourage them to reduce those emissions.

10.2.2 Scope for improvement

Increased energy consumption and thus greenhouse gas emissions are linked to tightening effluent thresholds. As things stand, greenhouse gases are not accounted for in the consent approval process; a more joined up approach to the environment could be taken to encourage industry to use less energy intensive techniques.

PPC introduces the concept of BAT for different industries. If this concept were brought into the effluent treatment processes (which are not covered by PPC) it could include a requirement that BAT considers the impact on GHG emissions.

An alternative approach could be to ensure that any increase in energy use is accommodated for by renewable energy supply. More guidance on the energy and greenhouse gas impacts of treatment technologies may help industry choose more sustainable options.

10.3 Water Framework Directive: potential adverse impacts on GHGs

The most direct impact on the waste water treatment industry and GHG emissions seems to be the tightening of the standards for effluent being pumped into inland and coastal waters. More stringent discharge limits on phosphates require more extensive water treatment with ferric oxide to precipitate the phosphate and there is a high embodied energy in the production of ferric oxide. Regulator feedback indicated that the goals of the Directive, e.g. diverting sewage sludge from sea disposal, were necessary but that the alternative options for compliance all have climate change impacts e.g. pelleting sewage sludge to be used as a fertiliser.

The higher standards are pushing water companies towards energy-intensive processes for waste water treatment in order to reach the effluent standard. The techniques include aeration, membrane treatment for coastal discharges and ultra-violet (UV) disinfection. Low-energy alternatives do not typically produce adequate effluent quality and therefore other, more GHG intensive, options are preferred. Impacts will also extend beyond the water industry; any industry discharging effluent directly into a river basin or coastal area will need to meet the tighter thresholds.

However, there are mixed views on whether the WFD will lead to additional sewage treatment requirements in order to meet the revised local water quality standards. One interviewee considered that many of the tightened measures that will be needed to reach “good status” under the WFD had already been implemented or were in the pipeline already (see responses in the table below).

Table 17 Feedback from interviews: aspects of the water regulations that may aggravate greenhouse gas emissions

Interviewee	Which aspects of the regulations you implement do you feel aggravate greenhouse gas emissions directly or indirectly?
SEPA Water	Water regulators do not directly aggravate GHG emissions. Aquatic environment is the main driver, though socio economic factors are incorporated into everything that SEPA do. It is up to the discharger how they go about meeting the conditions on BOD, nutrient levels and pH. Lower energy use treatments such as reed beds are supported by SEPA.
SEPA Water	The fact that the water regulations (CAR) does not account for energy consumption of treatment technologies could lead to increased energy use and carbon emissions. **Sewage sludge disposal** is a challenge and leads to greenhouse gas emissions. Dumping of sludge to sea was banned and this meant that a new solution was needed, with potentially higher greenhouse gas emissions. New means of disposal is **pelleting for fertilizer**. Pellets displace fertilizers and promote growth. Aberdeen area pellets sludge at a communal plant and uses for fertilizer. This is done at the NIGG waste water treatment plant, which has sludge processing facilities. Energy costs come from transporting sludge to single site and from drying the sludge. Sludge must be pelleted centrally as it is not cost effective to have low utilisation pelleters at smaller sites.
EHS Water Utilities	Under the GHG inventory, 1-2% of methane comes from waste water and 0.5% of nitrous oxide comes from activated sludge plants (mostly where denitrification is not operated optimally). Monitoring of nitrous oxide is a possibility for the future Methane emissions depend on the quality of the sewage sludge – they are greater if the sludge has already started breaking down anaerobically. The **WFD** will not have such a major impact on additional sewage treatment requirements in order to meet the local water quality standards. Many of the tightened measures had already been implemented or were in the pipeline already.

The WFD does have a requirement that each Member State carries out an economic analysis of water uses in order to identify the most cost-effective programme of measures for achieving the Directive's aims. In fulfilling this, there should be some consideration of the costs of energy used by the water industry. However, the energy consumption in this sector has increased sharply since 1989, at a rate of 2.5% per year (ENDS Report No. 385 2007).

10.3.1 Options to reduce energy use for waste water treatment

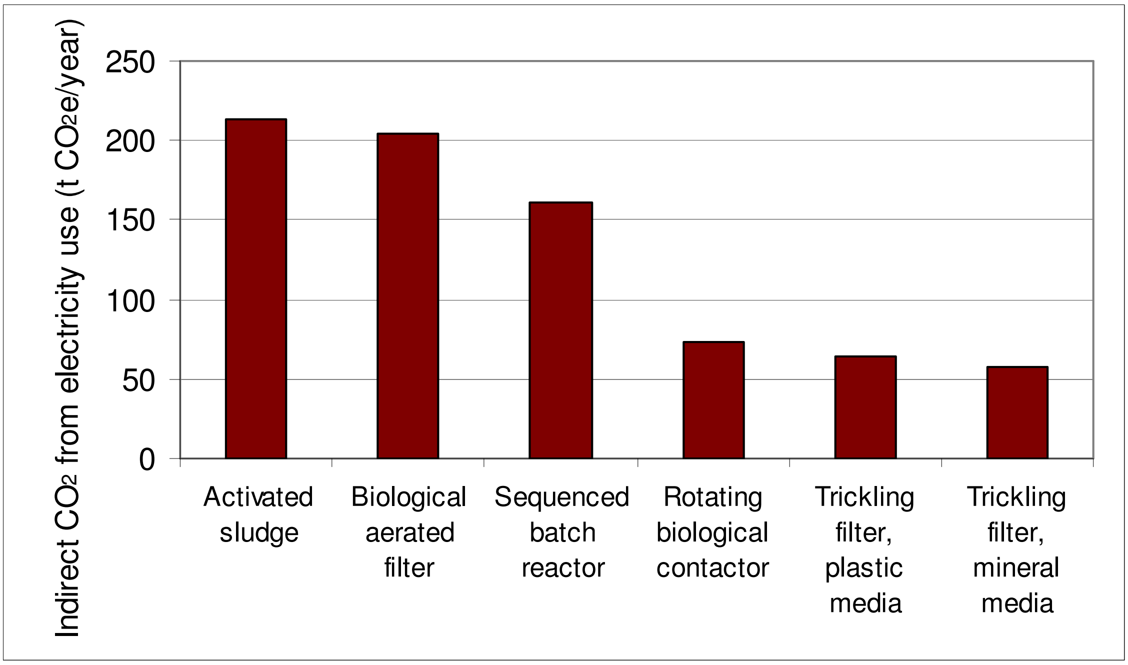
Waste water treatment measures fall in three stages:

- primary treatment (removes the large particles in the sewage);
- secondary treatment (degrades the biological content in the sewage); and
- tertiary treatment (additional "effluent polishing" to raise the released water's quality).

- Secondary treatment is the most energy intensive stage of the process (Entec 2002)[45].

There are various options available to the waste water treatment industry to meet the consent release conditions set by SEPA and EHS. The electricity consumption of each is compared in the chart below. It shows that the electricity use of activated sludge treatment requires around three times the electricity consumption of a trickling filter plant with mineral media process. The stringency of the water consent will determine whether activated sludge treatment is needed.

Figure 5 Carbon dioxide equivalent emissions from the electricity used to power secondary waste water treatment technologies



Source: Entec 2002

In addition to the GHG impact caused through direct and indirect energy use for these technologies, chemical use (such as the dosing of ferric chloride used to remove phosphorus from the effluent) also has significant embodied carbon. It is estimated that, for each technology listed above, the manufacture of the treatment chemicals used can add another 150 tCO_2e/year to greenhouse gas emissions (Entec, 2002).

Even in the face of rising electricity prices, energy intensive treatment technologies are often chosen because of two key drivers:

- the stringency of the water consent means that only energy intensive processes are guaranteed to meet the standard every day of the year; and
- land availability is often limited or expensive, and less energy intensive technologies (such as trickling filter) would require a massive land take to cope with the volumes and standards for treatment.

This is illustrated in the case studies below.

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45 Electricity use is based on a conceptual plant servicing 12,700 population equivalent and with a constant for BOD, COD etc for comparison.

Box 5 CASE STUDY: Scottish Water; energy impacts of plant upgrades

Scottish Water provided data on the electricity use of waste water treatment plants before and after upgrading technology in order to meet tighter discharge limits under new legislation (Personal Communication, Scottish Water, 2008). These upgrades were completed between 2002 and 2007 and were selected by Scottish Water to illustrate where tighter limits have led to more energy intensive plant being installed. The information (summarised in the table below) represents a spread of plant sizes with different volumes of waste water throughput.

The main legislation driving the upgrades was the introduction of the Urban Wastewater Treatment Directive which requires all discharges from agglomerations of greater than 10,000 population equivalent to have secondary treatment. The UWWTD actually states that: Member States shall ensure that urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment as follows:

- at the latest by 31 December 2000 for all discharges from agglomerations of more than 15000 p.e.,
- at the latest by 31 December 2005 for all discharges from agglomerations of between 10000 and 15000 p.e.,
- at the latest by 31 December 2005 for discharges to fresh-water and estuaries from agglomerations of between 2000 and 10000 p.e" (Directive 91/271/EEC). As well of a long list of other categorise."

This meant that many Scottish Water plants needed to be upgraded from preliminary or primary treatment only, to secondary treatments such as activated sludge and sequenced batch reactors. In addition to secondary treatment, tertiary treatment (UV and sand filters) is needed to meet the water quality standards laid out under the Bathing Waters Directive and Shellfish Directives. Restrictions on the availability of land and the need to meet the discharge limit 100% of the time has resulted in the more energy intensive waste water treatment technologies being installed.

Electricity use and the associated greenhouse gas emissions increases resulting from the upgrades range from a growth of between 150% to 2400% in the cases cited. However, this reflects a complete overhaul of the plant moving from purely a sieving or settling function to a full activated sludge process, sludge treatment centre and tertiary treatment in the examples given.

Scottish Water plant upgrades and the increase electricity use CO2 resulting from the upgrade

Plant	Legislation driving upgrade	Treatment technology		Indirect electricity use CO2 per population equivalent (tCO2ePA/population equivalent)		Upgrade impact: % increase in indirect electricity use CO2 per population equivalent
		Pre upgrade	Post upgrade	Pre upgrade	Post upgrade	
Plant A	UWWTD, Bathing Waters, Shellfish Directive	Primary treatment	Tertiary treatment (activated sludge, extended aeration, sand filters,UV)	0.0157	0.0428	172%
Plant B	UWWTD	Primary treatment	Secondary treatment (activated sludge) & sludge treatment	0.0042	0.0106	150%
Plant C	UWWTD	No treatment	Secondary treatment (sequenced batch reactor & drum thickener)	0.0017	0.0432	2441%

Source: Scottish Water (Personal Communication, Scottish Water, 2008)

Box 5 CASE STUDY continued: Scottish Water; energy impacts of plant upgrades

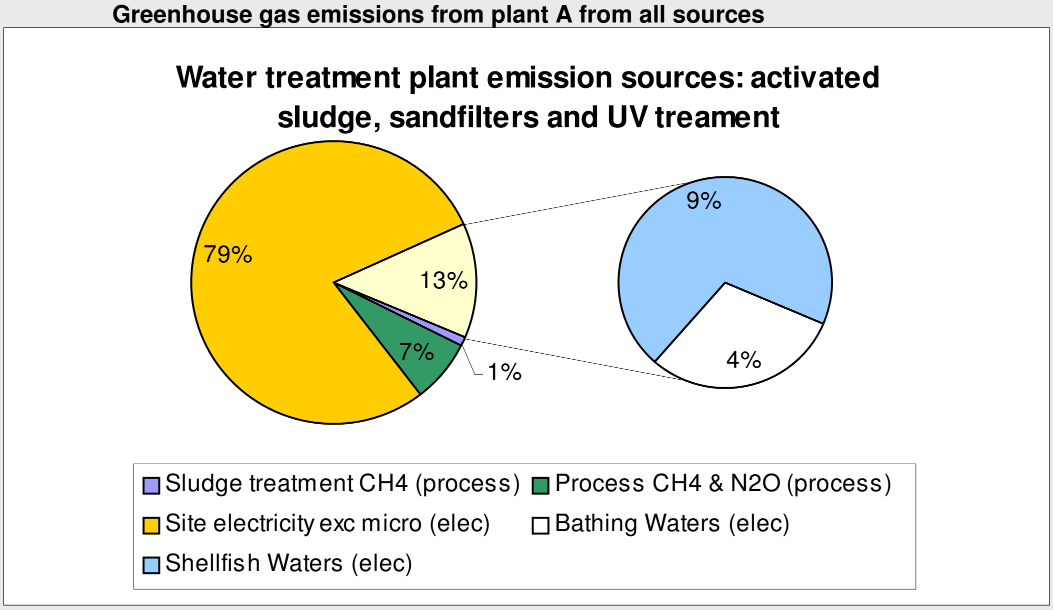
Plant upgrades are often necessary to meet specific consent requirements set due to the type of discharge waters, be it shellfish farming or bathing areas.

In the case of the plant A, Scottish Water allocated all greenhouse gas emissions sources to demonstrate the climate change impact of meeting the legislation requirements. As the plant discharged into a coastal bay there were tight discharge limits set under the Bathing Waters Directive and Shellfish Directives. This meant that tertiary (microbiological) treatment was required; UV and sand filters accounted for 13% of site electricity use in this case.

Secondly part of the electricity in the “other activities” section was used to provide dissolved oxygen and is also attributable to the bathing and shellfish water directives. Nitrification/denitrification treatment is not a requirement to achieve the UWWTD however this level of treatment was necessary to allow effective microbiological treatment to follow.

As the UWWTD applies across Europe, these case study insights for Scottish Water are also of relevance to the issues faced by Northern Ireland Water in addressing waste water treatment requirements.

Greenhouse gas emissions from plant A from all sources



Source: Scottish Water (Personal Communication, Scottish Water, 2008)

Box 6 CASE STUDY: Northern Ireland Water installation of a membrane bio-reactor

Northern Ireland Water provided a case study on energy intensive treatment technology installation (Personal Communication, Northern Ireland Water, 2008).

Ammonia standards: EHS sets the waste water treatment works ammonia standards on the basis of the mandatory standards of the regulations. It allows a 28% instantaneous reduction in quality at the point of discharge, as does the Environment Agency.

Suppliers will only guarantee compliance with the ammonia standards by using membrane bio-reactor (MBR) technology. Northern Ireland Water has found that activated sludge plants can achieve similarly low ammonia levels, comparable with that achieved with MBR, but the lack of a compliance guarantee prevents the company from installing the lower-energy activated sludge plant.

Environmental drivers for the plant upgrade: The Water Order discharge standards set for Ballyclare works are 10 mg/l BOD, 15SS mg/l and 1.5 mg/l ammonia with an upper tier of 5 mg/l. The reason for the ammonia standard was compliance with the requirements of the Fresh Water Fish Directive. In addition to the need to comply with a tight ammonia standard the works was old, overloaded and required replacement

Technology introduced to meet tightened consent: The only plant which suppliers would guarantee to meet the ammonia standard was an MBR. Since its installation, the MBR has consistently complied with the ammonia standard.

Energy use and costs of technology: The cost of the MBR plant at Ballyclare (Pop 18000) was approximately £10.7m and an estimated cost of a conventional plant £8.5m

Technology annual energy use (MBR vs. SBR):

- The running costs of the MBR plant is about £260k pa of which about £120k is for electricity.
- The running costs of an equivalent Sequential Batch Reactor (SBR) is about £217k of which about £110k is electricity.

10.3.2 Water regulations: greenhouse gases emissions and the Nitrates Directive

Why does implementation of the WID affect GHGs?

The Nitrates Directive has the objective of reducing water pollution caused or induced by nitrates from agricultural sources and is intended both to safeguard groundwater and to prevent wider eutrophication of waters (Nitrates Directive (91/67/EEC)[46]. One interviewee for this project commented that:

> "The Nitrates Regulation has a positive impact on GHG emissions. Nitrogen is applied more efficiently to reduce water pollution and an indirect benefit is reduced nitrous oxide emissions".

Emissions of the potent greenhouse gas nitrous oxide decrease as the amount of nitrogen fertiliser applied to land decreases. The nitrates regulations therefore indirectly help to reduce nitrous oxide emissions as they encourages reduced nitrogen application through:

- restricted slurry spreading periods;
- chemical nitrogen fertiliser limits;
- requiring adequate slurry storage capacity; and
- record keeping.

46 The SEPA and EHS water units are responsible for implementing the Directive.

Could its impact be increased?

Given the positive impact of the Nitrates Directive on GHG emissions, there could be some merit in increasing this impact. One interviewee commented:

> "The most success in this area (communicating greenhouse gas saving techniques) has been road shows promoting efficient techniques for slurry injection, which helps address nitrates regulation requirements and also leads to less nitrous oxide release as injected slurry is absorbed more effectively into the crops and so less is needed."(EHS Water Management Unit (WMU) Agriculture interviews)

This points towards awareness raising as being a useful way to have a positive impact on GHG emissions.

As the Nitrates Directive is only applicable to nitrate vulnerable zones, it has a limited impact in Scotland and Northern Ireland. There are many influencing factors in determining the zone coverage, but if the zones are reviewed and expanded, the Directive would have a larger impact in reducing nitrogen fertiliser in run off. Wider coverage would indirectly help to reduce nitrous oxide emissions.

11 WASTE MANAGEMENT LICENSING

Under the EU Waste Framework, all regions of the UK are required to ensure that waste is recovered or disposed of without causing pollution or health impacts. They must also apply a waste hierarchy, to try and reduce the absolute levels of waste produced, and also to recover waste. This not only has a positive impact on GHG emissions through the reduced use of various resources, but also encourages the use of any residual waste as a source of energy.

There are a range of other Directives that apply to specific waste streams; e.g. the Landfill Directive introduces stringent technical requirements for waste and landfills and sets targets to reduce the volume of biodegradable municipal waste that is sent to landfill. Measures such as the combustion of methane (a particularly potent GHG that is otherwise often flared) are encouraged and are expected to deliver significant benefits in terms of climate change.

11.1 What is Waste Management Licensing?

SEPA and EHS deal with the implementation of these policies, including all permits that relate to waste management, spanning landfill, scrap heaps, transfer stations, pollution complaints and general queries. A waste management licence (WML) is a legal document issued by the Regulator that helps to ensure that activities do not cause pollution of the environment, harm to human health or serious detriment to local amenities (Defra website). Some waste recovery or disposal activities are exempt from waste management licensing, if the risk is judged low enough that compliance with the permitting regime would be disproportionate.

11.2 Are greenhouse gases accounted for under Waste Management Licensing?

11.2.1 Consideration of greenhouse gases in Waste Management Licensing to date

The SEPA Waste Team interviewed implemented the Waste Management Licensing conditions in their region of Scotland (their feedback is summarised in the table below). Larger waste management sites are also caught by Part A PPC and so would have their energy and greenhouse gases reviewed under the permit assessment. Smaller non-PPC sites e.g. council civic amenities, that are only covered by Waste Management Licenses and not by PPC do not have energy use as part of the permit conditions.

Site decisions to deal with methane through energy generation, flaring or venting, often fall down to cost and practicality issues (a clause in the Landfill Directive allows this). While energy generation is the most preferable option in terms of climate change, flaring is often more cost-effective and still reduces the GHG impact. However, even flaring may not to be cost-effective or practical e.g. for smaller sites.

Table 18 Feedback from interviews: existing waste licensing practice and GHGs

Interviewee	Describe how your existing licensing process or risk assessment deals with energy and greenhouse gases?
SEPA Waste Management	Risk based audit approach used, number of site inspections made will be based on site's risk to environment. Energy use/GHGs not a part of risk assessment
SEPA Waste Management	Conditions do say that they have to abate to some extent but (site) decisions based on cost.

11.2.2 Scope for improvement

The Environmental Permitting Programme (EPP) is a joint Environment Agency, Defra and Welsh Assembly Government development that aims to streamline the waste management licensing and pollution prevention control (PPC) regimes. It will apply in England and Wales from April 2008 and, through the simplification of requirements on operators, *may* help to ensure that GHG emissions increases are avoided. Similar measures in Scotland and Northern Ireland could serve to have a positive impact on climate change.

11.3 Waste Management Licensing: potential for adverse impacts on greenhouse gases?

We have not identified a specific conflict in the waste sector that leads to regulatory limits accelerating greenhouse gas release. This reflects the fact that the legislation is built around minimising resource use and environmental impacts, and so also therefore climate change impacts.

However, the extent to which the Landfill Directive is implemented at sites does influence methane emissions at a site level and this is considered in section. There are also a number of reasons why emissions from some waste sites might be increasing (e.g. if they are closed but still emitting, or exempt on some other ground)[47].

Table 19 Feedback from interviews: greenhouse gas emissions increase due to regulatory exemptions

Interviewee	Which aspects of the regulations you implement do you feel aggravate greenhouse gas emissions directly or indirectly?
SEPA Waste Management	Landfill gas emissions – can be greater than 30% methane. Closed WML landfills have passive gas venting. PPC landfills require remediation although this might not necessarily be in the form of gas engines. Waste oils, small garages used to have small waste oil burners, but this was phased out under WID despite usage of waste oil, virgin fuel oil used instead at increased cost to garages. Waste oils in the Aberdeen area have to go to the Bridge of Don site where they are bulked up. From there it is taken to their waste management site at Coatbridge where they refine it to make cleaner, significant transport impacts.
SEPA Waste Management	Exemption to farmers means no energy recovery from waste burning on farms. Only other exemption for Waste Management Licenses is for clean wood/ clean plant material e.g. waste from developers or forestry sector clearing felled forest/ clean wood from demolishing constructions etc. Exemptions are due to costs and interests of sectors, but means that there is no energy generation (yet clean wood could be good for wood pellet supply) All farms should have a waste management plan, but they may still burn plastic/ fertilizer drums etc, even though SEPA encourages take-off. Also, exemption to Landfill Directive regulations for methane capture as not cost effective in some cases.

[47] Refer to section 6.1. Similar points have been made elsewhere in this document in relation to the Waste Incineration Directive and the treatment of Waste Oils.

12 STRATEGIC APPROACH TO MINIMISING GREENHOUSE GASES

A number of tools for integrating climate change considerations into regulations at a strategic level are used by government and industry. This section looks at how Environmental Management Systems (EMS), Resource Efficiency Appraisal and Development (READ), Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) deal with greenhouse gas reduction objectives.

12.1.1 Benefits of using an EMS to address energy use

How can an Environmental Management System help to reduce GHG emissions?
An Environmental Management System (EMS) is a set of processes and practices that enables an organisation to reduce its environmental impacts and increase its operating efficiency (US EPA website). EMS is a helpful tool to implement energy objectives and with which to measure energy efficiency performance on an ongoing basis. By providing a framework in which to identify, measure, monitor and reduce environmental impacts, an EMS can provide a useful for tool to reduce GHG emissions for many different kinds of organisations. Amongst interviewees for this study, the EHS Strategy Unit in Northern Ireland in particular, advocates the use of EMS, based on the benefits shown in pilot implementation projects to date.

How can that benefit be achieved?
For PPC **Part B** regulated industry, the regulator only focuses on air quality emissions and not on other impacts such as energy use. There is no requirement for Part B sites to have an EMS. However, this group of organisations could benefit from it; a NetRegs survey of small and medium sized enterprises (SMEs) in Northern Ireland reported that around two thirds of SMEs agree good environmental practice can reduce operating costs, while just over half consider that it improves competitiveness (NetRegs 2007).

In light of this, the EHS Strategy Unit considers that, in the medium term, it would be worthwhile to encourage SMEs to adopt an EMS. This could be achieved alongside an increase in site inspections or inspections of smaller companies.

It is worth noting that an EMS is only one of six tools listed under Better Regulations and should be considered alongside those other options. However, regulators in Northern Ireland interviewed for this project, consider that there could be some merit in testing the roll-out of EMS to small to medium sized firms in particular, to demonstrate the potential benefits that an EMS could bring. They were of the view that such **testing** should be completed before any wholesale changes to existing practice are made.

During the interviews, it was suggested that EMS could be given more weight in the PPC **Part A** regulated sites. Some interviewees were of the view that, at present, sites are not given sufficient credit for having an EMS, particularly in Northern Ireland. We understand that SEPA already gives credit to sites with good monitoring and management systems in place, through the risk assessment process i.e. less site inspections are needed. One approach suggested for PPC sites was to change the legislation so that the inspection frequency is reduced if the site has a good EMS in place with clear energy objectives and demonstrable improvements. This would act as an incentive for sites to commit to EMS.

12.1.2 Resource Efficiency Appraisal and Development

How can READ help to reduce GHG emissions?
This benchmarking tool is called 'READ' which stands for Resource Efficiency Appraisal and Development and is being developed by the Environment Agency. It is designed to

help any type of organisation improve its reporting and the way that it uses resources, including energy. The project is developing tools that will enable participants to benchmark and compare their performance against that of their peers.

Benefits of READ tool for the operator include (EA Briefing note 2007):

- It is quick and easy to use and is suitable for small as well as large organisations.
- The tool can help to improve the organisation's physical resource performance.
- The tool can help organisations with their target-setting.
- Some organisations will be able use the tool as a comparator against others' performance.

How can that benefit be achieved?
Following implementation of the READ tool in 2008, it will be a mandatory requirement for PPC operators in England and Wales to use the tool and, through discussion with the EA, there may be potential for its use in the Devolved Administrations and Local Authorities. It may also be possible to cover the assessment and reporting of waste heat under READ for certain operators, using screening criteria such as combustion capacity and emissions threshold (see section 9.3.3).

12.1.3 Strategic Environmental Assessments (SEA)

Where a Strategic Environmental Assessment is needed, EHS are required to account for the SEA aspects such as climate, land and social aspects. SEAs are mostly conducted on government infrastructure projects and the process is currently under judicial review in Northern Ireland and the UK. In Northern Ireland and England SEA is only carried out on plans and programmes – not on policy (Scotland has SEA in policy as well).

Strategic Environmental Assessments take climate change impacts of proposed plans and policies into account. SEA Objectives are used to test the environmental effects of the plan or to compare alternatives, and they can be expressed so that they are measurable e.g. an objective to 'reduce greenhouse gas emissions', could be expressed as "reduce CO_2 emissions by, for example, 5% by 2010".

Examples of some SEA objectives and indicators (ODPM, SE, DOENI, WAG 2005) include the following climate factors:

- reduce greenhouse gas emissions
- reduce vulnerability to the effects of climate change e.g. flooding etc.
- electricity and gas use
- electricity generated from renewable energy sources and CHP located in the area
- energy consumption per building and per occupant
- carbon dioxide (CO_2) emissions

SEA reviews use a standard matrix to assess how different environmental objectives interact. This is used to factor climate change in to the decision making process, and the matrix may be useful for the toolbox stage of this study reviewing the varying environmental impacts of a measure.

Table 20 SEA matrix assessment for reviewing one environmental impact against another (fictional case)

	Option 1: multi-function waste treatment facilities (management, storage and processing) in population centre with >25,000 inhabitants			Option 2: limited function waste treatment (management, recycling and some treatment) dotted around the county, one facility per 10,000 inhabitants		
	Short term	Med term	Long term	Short term	Med term	Long term
Limit air pollution to safe levels	+/-	+/-	+/-	+	++	+++
Minimise greenhouse gas emissions	-	+/-	+/-	-	+	+
Reduce the need for travel	+/-	+/-	-	+	++	+++
Key: + positive – negative 0 neutral ?uncertain +/– minor ++/– – major						

12.1.4 Environmental Impact Assessments (EIA)

Environmental Impact Assessment (EIA) is a technique for ensuring that the likely effects of new development on the environment are fully understood and taken into account before it is allowed to go ahead. It is part of the planning application process and stems from a European Community Directive which was introduced into UK planning procedures in 1988.

Historically, under the EIA process greenhouse gases were not given priority, though this is starting to change. GHG emissions from a proposed development are considered in some cases under the EIA process. Part of the justification of a new development could be made through the EIA process to show that it could help reduce carbon emissions or has at least addressed them e.g. public transport link or a more centrally placed store so people can access it easier. Climate change impacts are typically covered in the sustainability appraisal of the Environmental Statement for the proposed development, however, they may not be sufficient emphasis, one example of this is in the box below.

During an EIA, carbon emissions of buildings may be overlooked as it is assumed that they will be handled under BREEAM and the EBPD directive.

As the focus of this research is on environmentally regulated industry in Scotland and NI, EIA is not covered in detail as it should only be a key factor if a large new plant was being built.

Box 7 Balancing EIA recommendations against the carbon saving potential of renewable energy development proposals

DETI NI promotes renewables and energy from waste and sometimes there are barriers to these types of developments posed by issues raised in the environmental impact assessments. NI needs more renewable energy but wants to avoid adding other environmental problems. Only around 3% of NI fuel comes from indigenous sources of oil, coal and gas, so there is pressure to find alternative but sustainable sources of energy.

To encourage the joined up approach "DETI provides regular input to other Northern Ireland departments on energy related issues – for example, the Department of Environment's draft PPS18 on Renewable Energy." (Northern Ireland Assembly 15 June 2007).

Environmental impacts can prevent renewable developments going through. For example, a hydroelectric power station is proposed on a site of special scientific interest, which is sensitive under the Water Framework Directive. This is a major barrier to the development approval process.

Source: EHS interviews, October 2005

12.1.5 Cost of Carbon interaction across all government policies

A new "shadow price of carbon" is to be used for appraising government policies which will strengthen the weighting of climate change impacts in the policy decision making process. This replaces the 'social cost of carbon', a lower price that was previously recommended for use in policy appraisal. Defra's Economic Group have based the revised figure - £26.50 per tonne of CO_2e equivalent in 2008 prices - on Stern's review of the economics of climate change. Defra outlined that the price will rise to £60.80 in 2008 prices by 2050 as global warming impacts grow in significance and cost to the earth.

When appraising new policies and measures, all government departments must factor in the cost of carbon, particularly for crucial developments such as new energy infrastructure. The Shadow Price of Carbon will need to be used consistently and universally across all government decisions and so this will have a direct impact on future legislation falling on environmentally regulated industries.

13 SUMMARY AND CONCLUSIONS

13.1 Summary

13.1.1 How great an influence do the regulators have on GHG emissions?

Fuel combustion (for power, industry, transport etc), liming and agricultural soils are the IPCC sectors responsible for the largest amount of GHG emissions in Scotland, while fuel combustion (power, industry, transport etc), agricultural livestock and agricultural soils have the greatest impact in Northern Ireland. These impacts are primarily driven by emissions of CO_2, N_2O and CH_4 (i.e. three out of the basket of six greenhouse gases).

SEPA and EHS are responsible for regulating a large proportion of the industrial and generation sectors, but have no influence over domestic and transport energy use. If fuel combustion is split out into subsectors, it is the power generation sector that has the greatest impact in both regions (although road transport and residential combustion are both significant). SEPA and EHS regulate large-scale power generation but not necessarily the end use of energy (e.g. in the domestic sector).

Appendix I provides an analysis of the GHG inventories to establish the influence of the regulators over greenhouse gas emissions from each sector. Based on our estimates, sectors which are environmentally regulated account for around 55% of Scotland's greenhouse gas emissions and around 45% of Northern Ireland's emissions, though the extent and influence of regulation varies widely between sectors and there are caveats around this analysis[48]. The main sources from environmentally regulated industry were identified as:

- power generation, industrial combustion and refineries, which are all regulated via PPC, and agricultural soils which are regulated indirectly in certain areas through the nitrates directive – these sectors are responsible for the largest volume of GHG emissions of the sectors that SEPA regulates; and
- power generation, agricultural soils, industrial combustion and cement are responsible for the largest volume of GHG emissions of all the sectors that EHS regulates (via PPC and the nitrates directive).

13.1.2 Where do regulations already affect GHG emissions?

Regulations often have the potential to influence greenhouse gas emissions where they affect (either directly or indirectly) energy use, refrigerant use or leakage, emissions of methane or emission of nitrous oxides. For instance, regulations that impact on emissions of nitrous oxides and sulphur dioxide impact on climate change. In particular SEPA/ EHS influence these climate change impacts via regulations that require:

- the installation of FGD (increased electricity CO_2 emissions) under the LCPD;
- the efficient application of fertilisers (reduced N_2O emissions) under the Nitrates Directive, in nitrate vulnerable zones;

[48] The extent to which the regulators can help to avoid increases in GHG emissions depends on (i) the scale of GHG emissions in a particular sector, (ii) the extent to which they are regulated and (iii) the range of options available to ensure compliance with those regulations. The analysis here considers the first of these factors combined with an estimate of the impact of the second. As such it provides an idea of the potential impact that regulators could have but does not allow us to categorically state where the greatest impact could be made.

- the upgrade of waste water treatment plants (increased electricity CO_2 emissions) under the UWWTD and WFD;
- the enforcement of energy saving permit requirements under PPC Part A (reduced gas and electricity CO_2 emissions); and
- the route for waste disposal (CO_2 vs CH_4 emission) via implementation of the Waste Incineration Directive and Landfill Directive.

In addition, the following regulatory activities may impact on GHG emissions:

- enforcement of odour controls, requiring gas powered thermal oxidiser installation (GHG increase);
- the classification of waste oils, requiring long distance transport to treatment sites (small GHG increase);
- approval of the use of refuse derived fuel (RDF) for co-firing in power stations (GHG saving); and
- routes for the disposal of sewage sludge (incineration vs land spreading).

In summary, the abatement technologies needed to meet permit and consent conditions under PPC, LCPD, odour controls, UWWTD and WFD are all powered by electricity or gas and lead to an increase in greenhouse gas emissions.

13.1.3 Areas to consider to reduce regulatory impacts on GHG emissions

Potential areas of focus are summarised in the table below. Other areas where our research indicated that GHGs are dealt with fully or where the regulation does not lead to GHG increase were not considered further for this study, but could form useful ways to deliver GHG reductions in future.

- **Nitrates Directive:** this aims to manage fertiliser application in nitrate vulnerable zones to reduce nitrate release to water which results in a concurrent reduction in nitrous oxide. This already has a positive impact on climate change.
- **Waste Management Licensing:** reducing biodegradable waste to landfill already leads to significant methane emission reductions. However, gaps in the application of methane capture have led to venting of methane from existing landfills in both Scotland and Northern Ireland. Exemptions for the burning of waste (e.g. for farms and wood industries) can have a negative GHG impact. Closed landfill sites are mostly covered by WML and are a significant unchecked source of methane emissions.
- **Strategic Environmental Assessments:** climate change mitigation is a key objective of SEAs in Scotland and Northern Ireland. It is also incorporated into policy appraisals through the use of a shadow price of carbon. SEAs have the potential to be a good way to help integrate GHG considerations into policy making and to foster a joined up approach.
- **Environmental Impact Assessments:** climate change is dealt with under the sustainability appraisal, although this part of the process could arguably be prioritised. It is important that global concerns like climate change are given

appropriate weighting alongside local issues. For instance, there is the potential for local considerations to block the development of renewables like wind farms.

Table 21 Summary of research findings

	Water industry	FGD at power stations as result of LCPD	Waste oil burning under WID*	Fertiliser applied to agricultur-al soils**	Solvent Emiss-ions Directive (Part B permits)
SEPA & DOENI regulated?	Y	Y	Y	Y	Y
Significant greenhouse gas emissions?	Y	Y	N	Y	N
Increasing GHG emissions?	Y	Y	N	N	N
Environmental regulation at odds with GHG savings?	Y	Y	N	N	N
More joined up approach needed?	Y	N	Y	N	N
Information gap?	Y	N	N	Y	N

*Legislation under review **In NVZs.

13.2 Conclusions

We have drawn together the findings from this research in the conclusions listed below. We first highlight a shortlist of areas where regulatory decisions have a particular impact on carbon emissions from combustion (i.e. energy use). We then consider some other impacts that regulatory decisions have on other GHG impacts e.g. on methane and nitrous oxide. Based on feedback from the interviews and the other research conducted, we have also looked to see where there may be potential to strengthen the regulators' role.
(1) Cross regulation.

(1) Regulatory impact on energy use and carbon dioxide emissions

Power generation

- FGD installation is the only technology available to comply with LCPD SOx limits, but this results in a 3% increase in greenhouse gas emissions from coal fired power stations in Scotland and Northern Ireland. Given that coal fired power stations are large point sources of emissions, although the relative increase is quite small, the absolute increase in emissions is considerable.

- Further tightening of large combustion plant operation under the EC's proposed merger of the IPPC directive with other industrial regulations, will mean that SOx abatement limits tighten further. As decisions on LCPD compliance have largely already been made, there would be limited potential for regulators to influence this sector in future.

Waste water treatment

- Waste water treatment sites with limited (cost effective) land availability can find that the feasible technology treatment option to meet UWWTD, Shellfish Directive and Bathing Water Directive discharge limits is relatively energy intensive. Other, lower energy treatment technologies can cover a large land area and so are not suitable in many cases where the water company cannot afford to purchase extra land to site the treatment facility.

- The UK government has recently completed river basin characterisation under the WFD and, as River Basin Management Plans are drawn up over the next 5 to 7 years, it is a good time to consider the implications for increased energy use at treatment works. This is a crucial time for water companies who will also start to be captured by the Carbon Reduction Commitment from 2010 onwards.

PPC Part A

- Some regulators consider that they cannot have meaningful influence over energy use at PPC Part A sites that also have a CCA or an EU ETS permit. Defra's Climate Change Simplification project would further extend this 'light touch' approach to Carbon Reduction Commitment (CRC) participants in future providing it can be done on a sound legal basis.

- Arguably the incorporation of energy/ carbon targets through the CCA and of the cost of carbon via trading schemes should be sufficient incentive to mitigate GHG emissions in itself. However, regulators have raised a concern that only basic (not additional) PPC Part A energy requirements can be enforced on CCA sites, resulting in some opportunities for energy savings being missed. One way around this could be helping to enforce Defra's Qualitative Requirements for CCA sites, which states that participants should have a structured energy management system in place, though CCA information in deemed confidential.

PPC Part B, Water and Waste Regulations

- While PPC Part A sites must address energy use under their permits, environmental regulation requirements across all other industrial sites (PPC Part B, Water, Waste Management Licensing) have no explicit requirement to address energy use.

- To some extent, cross-sector climate change policies and measures (like the CCAs, EU ETS, and the CRC) can fill this gap. However, these are typically 'hands-off' market driven approaches. There is a balance to strike between avoiding double regulation and meeting the principles of Better Regulation, while making use of the informed and influential position that environmental regulators can offer, particularly given that they have access to many sites across Scotland and Northern Ireland.

(2) Other regulatory impacts

Minimising non-energy related GHG emissions

- The main (non-energy related) process greenhouse gases emitted from environmentally regulated sectors in Scotland and Northern Ireland are nitrous oxide and methane[49]. These primarily originate from agriculture, landfill and waste water treatment. With the exception of emissions captured by the Landfill Directive and Nitrates Directive, these sources are not currently well covered by environmental regulation. Even with the extension of climate change policies to new organisations and emissions sources there is a risk that these could continue to slip through the net. For example, the forthcoming CRC does not cover process emissions, so there will continue to be no incentive to capture waste water treatment process emissions to air.

- We have not considered emissions from refrigeration as part of this report. This is partly because although these gases are potent, the total volume emitted is smaller than some from some of the activities captured here. It is also because F-gases emitted from leaks in refrigeration systems are now specifically addressed and targeted by the F-gas regulation which became active across the UK in 2007.

- Emissions of methane and nitrous oxide are most commonly addressed through the adoption of thermal oxidiser technology. Although energy use increases as a result in order to power the equipment, this a necessary compromise (the CO_2 emitted from combustion has a lower global warming potential than either nitrous oxide or methane). However, where possible, methane should be captured and used for energy generation.

Life cycle GHG emissions to be considered

- When industry is faced with the choice of replacing abatement technology with a lower energy using alternative, ideally, life cycle emissions should be considered, accounting for the embodied energy in the new equipment. For example, using carbon filtration systems to capture odour requires energy to make and replace the carbon filters. Research has found that very little information is available that clearly states the life cycle carbon impacts of different abatement options.

(3) Strengthening the regulator's role

- Feedback from regulators and the Steering Group highlighted the need for generic guidance on climate change policies and tools for greenhouse gas reduction. The Climate Change Mitigation Toolbox developed as part of this project will help to strengthen the regulators role by providing quick access to information on the subject.

- There is a gap between the government focus on greenhouse gas mitigation and the regulations that the regulators work with every day. Policy makers at a national and EU level could consider a more joined up approach between climate change policy goals and environmental regulations.

- Government climate change policies could be raised to a higher profile at regulator level.

- Time pressures, a lack of legislative back-up and the job descriptions of regulators can limit the opportunity to build global climate change considerations into regulatory practice, which typically focuses on local impacts. Because industry permits, licences or consents do not explicitly specify energy or greenhouse gas mitigation

[49] Process emissions of CO2 from cement production are also a significant source of greenhouse gas emissions.

requirements, regulators often do not feel able to challenge operators in these areas.

- Regulators have a strong regional presence across Scotland and Northern Ireland and this broad network could be a good infrastructure to build on in order to raise awareness on minimising greenhouse gas emissions. Some areas are already active, such the EHS road shows on efficient use of nitrogen fertiliser.

(4) Cross regulation

- It is current practice to assess proposed government policies using strategic environmental assessment and this is an important route to considering climate change in setting future industrial environmental regulation. All government departments have been instructed to use Defra's recently revised shadow price for carbon to factor in the cost to the economy of the climate change impacts, when monetising environmental impacts.

13.3 Recommendations

Our recommendations from the research focus on the two areas where there is the strongest link between greenhouse gas emissions increasing as a result of meeting regulatory limits – FGD and waste water treatment technologies. Although there are no immediate low carbon alternatives to these technologies, industry, government and regulators can work together to consider climate change in their decision making processes.

Recommendations for reducing regulatory impacts on greenhouse gas emissions

- In Northern Ireland, both Longannet and Kilroot power stations are in the process of installing FGD systems, so regulator/government input at an early stage could help maximise the energy efficiency of the system.

- Waste water treatment policy is laid out at European level through the Urban Waste Water Treatment Directive and the more recent Water Framework Directive. As the WFD is rolled out across Scotland and Northern Ireland, lessons should be learnt from the energy intensive upgrades of waste water treatment plants reportedly required under UWWTD. It may be possible to investigate whether water quality discharge limits are proportional and balanced against the climate change impacts of meeting the tighter standards.

- Waste water treatment operators will be covered by the Carbon Reduction Commitment and will be pushed towards lower carbon options as the CRC cap and trade scheme is introduced in 2010. This pressure on operators should be considered where possible when setting stringent discharge limits requiring additional water treatment.

- Future policy will also be informed by the ongoing Environment Agency two-year science project identifying opportunities for improving energy efficiency and carbon reduction in the water and wastewater sectors through initiatives such as the increased use of renewable energy, pollution control, sustainable drainage, the Carbon Reduction Commitment and sharing best practice.

Recommendations/opportunities for strengthening the regulator's role

- Based on regulator feedback, EHS and SEPA have a strong awareness and commitment to climate change at all levels. However, many regulators feel that their hands are tied as they must regulate according to the rules laid down and will be exposed if energy saving is prioritised, as if they are challenged or sued by an operator, the regulations will not back them up.

- This could require changes to the rules and guidance to which regulatory bodies work. For instance, ensuring that the cost of carbon is incorporated into operator investment decisions particularly for those activities that are not captured by an emissions trading scheme. Each SEPA and EHS office could nominate a carbon champion to raise awareness internally and to field industry questions on energy and climate change.

- On site visits and communication with sites, regulators could give more priority to climate change and always recommend energy saving advice / provide information sources to increase energy saving. Encouraging BAT up take in Water and Part B sites could strengthen energy use consideration.

- Regulator's approach to NI Part B sites will be informed by the EHS Strategy Unit's ongoing review of the effectiveness of promoting EMS to SMEs.

- Plants dropping out of the EU ETS under the new de minimis threshold will be captured by PPC Part A and regulators will have an opportunity to ensure the H2 additional energy requirements are implemented in full, and potentially help the plants achieve greater energy savings than previously under the EU ETS. Some small emitters could be covered by the CRC providing the parent organisation exceeds the qualification threshold.

Recommendations for further work

- Although available evidence indicates that tightening water regulations requires more energy intensive waste water treatment technologies installed at plants, more in-depth research, through questionnaires and sites visits could benefit industry and regulators to clearly set out the technology options.

- Nitrous oxide emissions from fertiliser leached to water continue to be an important issue in Scotland and Northern Ireland and routes to address this emission source should be investigated further as this is a policy gap.

- As the EC puts forward proposals to overall industrial environmental regulation, including PPC, a review of the effect that this will have on Scotland and Northern Ireland's greenhouse gas emissions would be informative.

Table 22 Summary by regulation of existing practice for GHGs and whether GHG emissions are increased

Area of regulation	More joined up regulatory approach needed?	GHGs dealt with under existing practice?			Regulation actually increases greenhouse gas emissions?	
PPC						
Part A	Yes, in some areas.		+++	CCAs, EMS, EE plans, Energy cost assessment	- -	Pollutant abatement e.g. VOCs take prioritised over climate change
Part B	Yes, in some areas.		o	Not addressed. Small sites. Only deals with AQ	-	Smaller sites so less need end of pipe treatment.
Implemented via PPC						
LCPD (FGD)	No, no FGD alternative.		+++	See Part A and B	- - -	3% CO_2 increase in power station emissions.
Odour controls	Potential/No	Part A Part B	+++ o	See Part A and B	- -?	Thermal oxidiser gas consumption
WID	Potential/No	Part A Part B	+++ o	See Part A and B	-	Transportation and treatment of waste oils
Water regulations						
WFD	Yes, in most areas.		o/+	Most sustainable technology encouraged. Not a focus.	- - -	Water industry energy demands rise as limits tighten
Nitrates Dir	No		+++	Reducing nitrates help reduce nitrous oxide emissions	o	Does not increase GHG emissions
Waste Management Licensing						
Waste Manageme nt Licensing	No		+++	Landfill Dir. Targets will lead to CH_4 cuts.	-	Exemptions when methane capture not cost effective
Strategic tools						
EMS	Yes, in reaching smaller sites.		+++	Under energy objectives and continual improvement	o	Does not increase GHG emissions
SEA	No		+++	GHG reduction core objective when reviewing policies	o	Does not increase GHG emissions
EIA	No		++	Climate change gaining importance in Env Statements	-	Can prioritise local env impacts above climate change benefits (e.g. RE)
Key						
	Yes *Potential* *No*		*+++*	*Comprehensively deals with GHG reductions*	*- - -*	*Regulation significantly increases GHG emissions*
			o	*GHGs are not addressed*	*o*	*No effect on GHG emissions*

PART III: TAKING GHG INTO ACCOUNT IN REGULATORY DECISIONS: A TOOLBOX

14 CLIMATE CHANGE TOOLBOX

14.1 Stakeholder requirements for a Climate Change Mitigation Toolbox

In order to increase the regulator and industry consideration of climate change, a Climate Change Mitigation Toolbox was required as a key output of this SNIFFER research project. The content, format and audience of the toolbox were informed by the following:

- Requirements of the SNIFFER Steering Group;
- The desk review summarised in sections 3 to 7; and
- Feedback from interviews with SEPA and EHS regulators.

The SNIFFER Steering Group wanted the Toolbox to be accessible to a wide audience from both industry and environmental regulators, and so a generic set of tools were most appropriate. Focussing on one specific sector would have reduced the usage and impact of the Toolbox.

Insights from the desk review highlighted the need to make clear the important role that regulators and industry could play in integrating climate change into their priorities when reviewing abatement technology options. Sectors as the waste water treatment industry could make a large impact on increasing greenhouse gas emissions when upgrading treatment plant. Greenhouse gas emissions from abatement technology was an issue in the majority of sectors, therefore a generic toolbox was preferential to a sector specific toolbox.

Detailed feedback from the regulators interviews gave a number of differing needs from a Climate Change Mitigation Toolbox with interest ranging from a technology specific review of GHG emissions and energy costs through to general awareness raising, pulling together practical and policy measures to address climate change.

When asked what form of energy and GHG guidance the regulators would find helpful and were given the following responses:

- Strategy – General awareness raising and an overview of climate change legislation such as the CRC.
- Part A – formal training on applying energy efficiency to industrial processes e.g. through IChemE.
- Part B – details of BAT giving technology options for different industries with energy costs to use as a driver for operators to use low energy options.
- Part B – guidance on effectiveness vs. GHG and cost assessments. Possible information gaps e.g. on particulates and on solvents.
- Water – Regulators would be interested in more information on GHG emissions and water technologies, covering their annual energy consumption etc.
- Waste – help on preparing energy plans. Provided ranked list of technologies by energy use based on comparisons by energy use.

Their detailed responses are provided in the table below.

Table 23 Feedback from interviews: views on what form of GHG guidance would be useful

Regulator	What form of guidance around energy and GHGs would be most useful for regulators and industry? *e.g. factsheets, toolbox, regulation clarifications*	Interested in extra guidance?
SEPA Part A	H1 / H2 / BREF already useful; benchmarks provided for industry sector are useful but can be too generic. **Formal training on applying energy efficiency** across different process options for SEPA officers could be useful with training by IChemE or similar body.	✔ ✔
SEPA Part B	Document to refer to in terms of BAT could be more useful if it included various options for different industries. Include some energy costs – CAPEX, payback etc **as driver for operators to use cost effective low energy options.**	✔
SEPA Part B	Simple guidance should be encouraged – there may be some demand from the operators for **guidance on energy and GHGs.**	✔
EHS IPRI – Part A and Part B	Envirowise publications are helpful on benchmarking - something similar for energy usage could be useful. Not much information is available at present on effectiveness vs. GHG and cost assessments. Possible information gaps e.g. on particulates and on solvents.	✔
SEPA Water	The regulator is policy driven – if you want to change behaviour, change the policy. There is already information overload. Water regulator's key document is the standard policy and guidance, it is used to defend decisions when they are challenged.	✕
SEPA Water	Regulators would be interested in more information on GHG emissions and water technologies, covering their annual energy consumption etc. Regulators are often not aware of the energy use of different treatment technologies.	✔
EHS Water Management Unit (WMU) - Utilities	Some clarification on the options, costs and energy used to run technologies may help the water industry.	✔
EHS WMU - Agriculture	There is already clear guidance available to farms on the regulations affecting them. Guidance focuses on water and does not cover greenhouse gases.	✕
EHS WMU – Discharge Consents	A factsheet on greenhouse gases, costs and technologies could be helpful. Normally regulators use information on NetRegs and the quarterly update on CEDREC.	✔
SEPA Waste	**Provided ranked list of technologies:** PPC sites supposed to use BAT, but no lists of technology comparisons by energy use etc. Ranked list to see if sites have put reasonable technology forward.	✔
SEPA Waste	**Help on preparing energy plans**	✔
EHS Strategy Unit	Awareness raising is particularly an issue with SMEs; the 2007 NetRegs SME survey found that "only 10% businesses in Northern Ireland thought that they undertook activities that could cause harm to the environment"[50]. Raising awareness of forthcoming legislation such as the CRC would help NI business.	✔

[50] SME-nvironment 2007: Northern Ireland, NetRegs Survey http://www.netregs.gov.uk/commondata/acrobat/smenvironment_2007ni_1856973.pdf

14.2 Climate Change Mitigation Toolbox overview

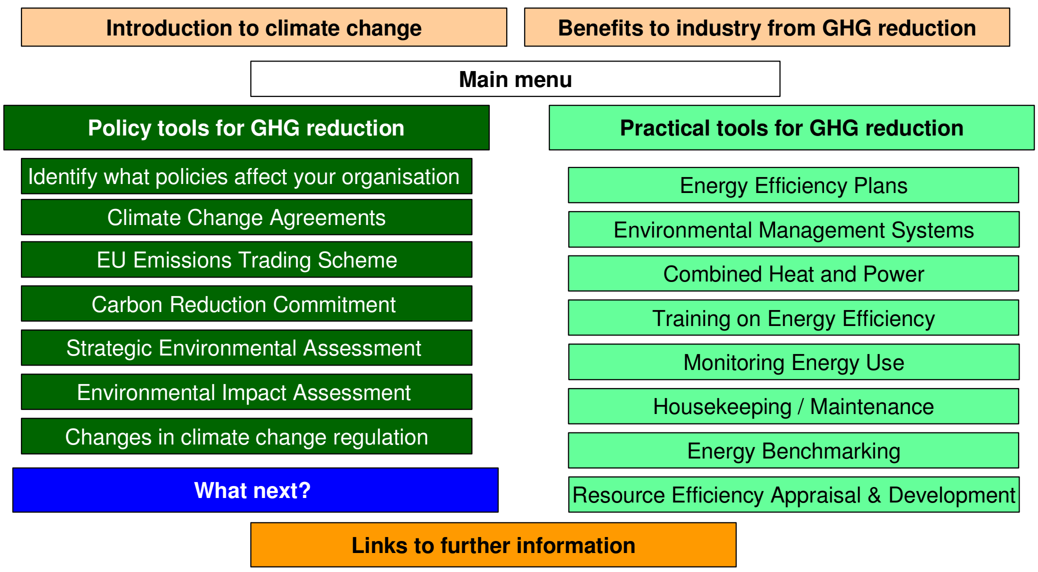
The aim of the Climate Change Mitigation Toolbox is to provide:

- Generic help and advice on the consideration of climate change in environmentally regulated industry in Scotland and Northern Ireland
- An overview of the main climate change policies affecting environmentally regulated industry
- Practical tools for climate change mitigation for both industry and regulators to use
- A hub for links to additional guidance, further information sources, relevant legislation and contacts on climate change and industry

As the Climate Change Mitigation Toolbox needs to be easily accessible with rapid access to the specific area of interest for the user, it was set up in a Power Point form, with hyperlinks between slides. Users will be able to download this web-based tool in the form of a PowerPoint presentation from the web.

The structure of the Toolbox is summarised in the figure below and is split into two main areas (1) policy tools for greenhouse gas reduction and (2) practical tools for greenhouse gas reduction. Policies covered in the Toolbox were chosen to be relevant to the industries covered by environmental regulations, and the overlap and relevance to PPC was highlighted for each climate change policy. SEA is included as this was flagged as a helpful climate change tool in regulator interviews and by the Steering Group, but it is more relevant to policy makers and regulators than for industry. EIA was included for the same reasons, but is of most relevance to new developments.

Figure 6 Climate Change Mitigation Toolbox Structure



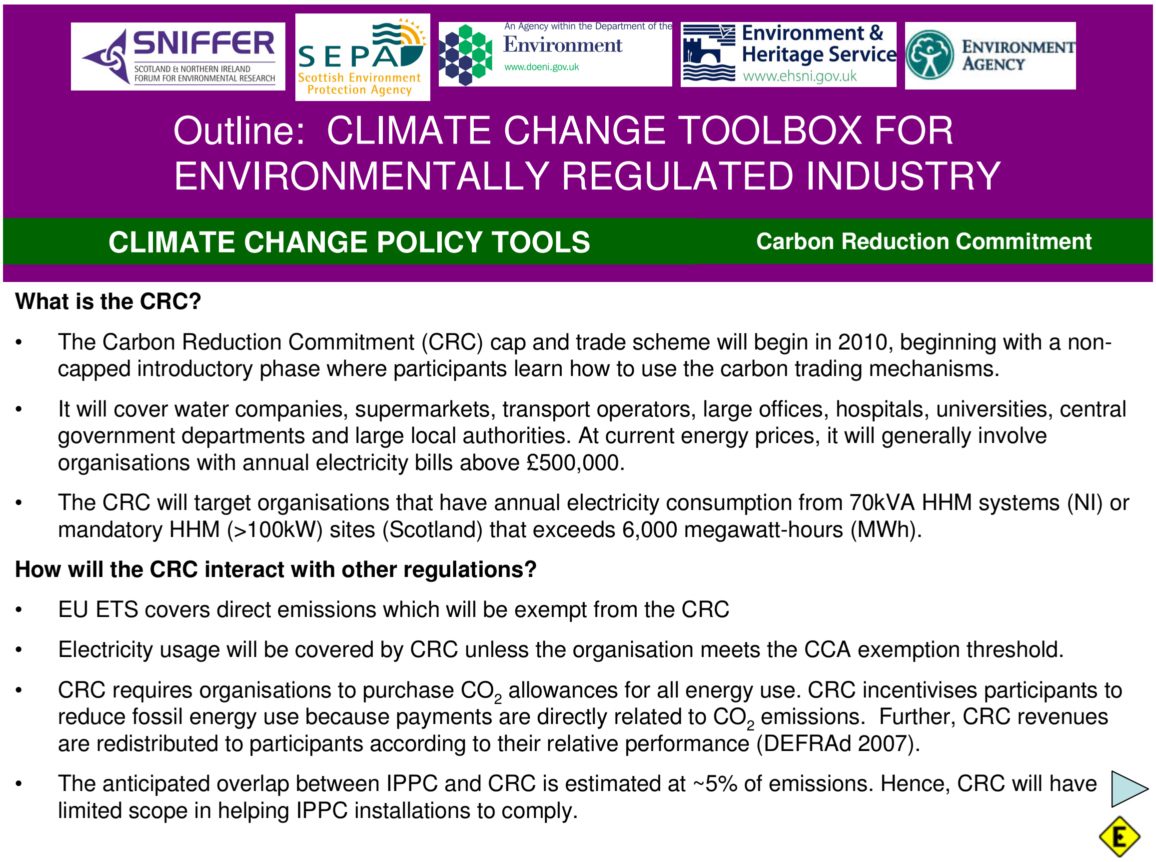
Practical tools included cover energy saving methods that enable sites to reduce greenhouse gas emissions on the ground and to help them comply with the energy aspects of PPC permits. The toolbox is very useful to regulated sites outside PPC as these companies would have less experience of options available for reducing energy use.

The summary presented for each tool covered is structured along these headings:

- How will the measure (e.g. CCAs) interact with PPC?
- What are the implications for industry
- What are the implications for regulators
- Targets under the measure
- Options to meet targets
- Energy saving benefits

Screen shots from the Toolbox are included below for the Carbon Reduction Commitment as an example of the information provided on each of the climate change policy tools. The introduction to the Toolbox aims to provide motivational factors on the benefits to industry that come directly from measures to reduce energy use/greenhouse gas emissions. An introduction to climate change is provided to put the challenge in perspective with UK greenhouse gas reduction targets and global warming potentials for the major greenhouse gases are provided.

Figure 7 Screen shot from Climate Change Mitigation Toolbox



Outline: CLIMATE CHANGE TOOLBOX FOR ENVIRONMENTALLY REGULATED INDUSTRY

CLIMATE CHANGE POLICY TOOLS — **Carbon Reduction Commitment**

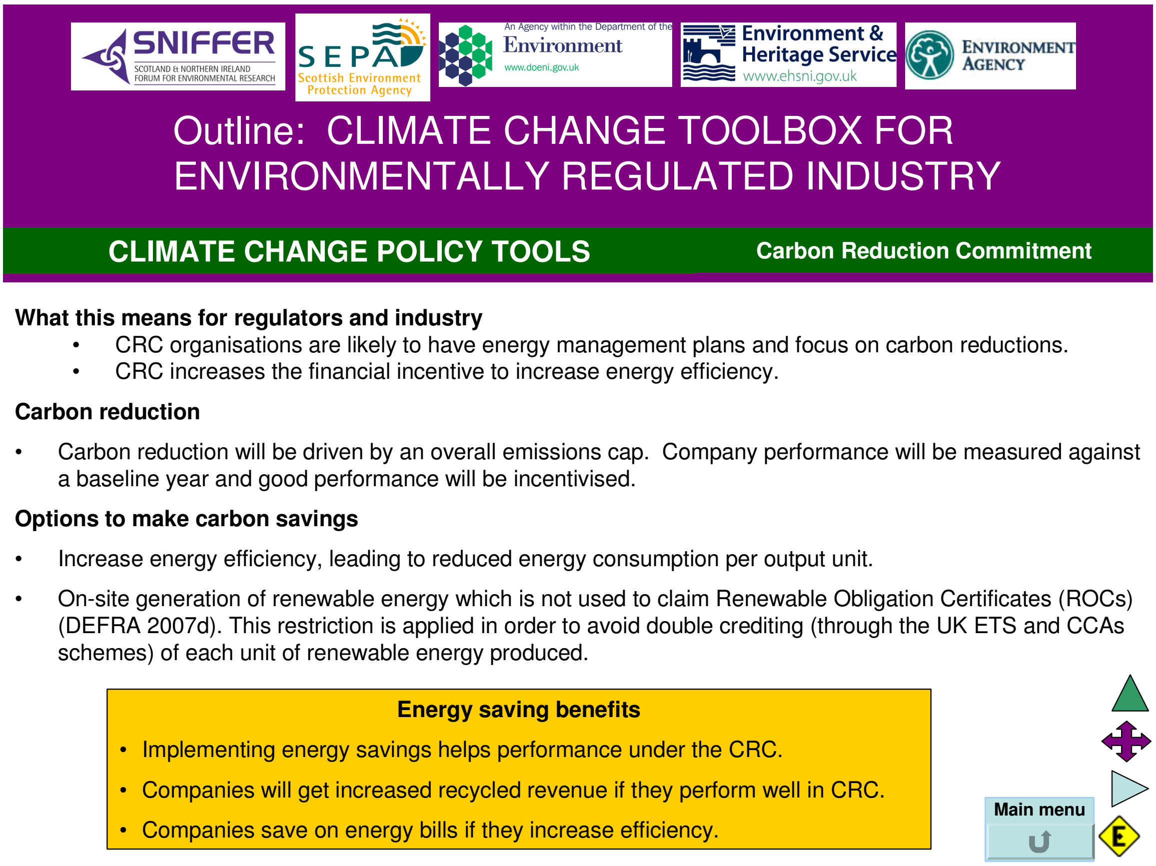
What is the CRC?

- The Carbon Reduction Commitment (CRC) cap and trade scheme will begin in 2010, beginning with a non-capped introductory phase where participants learn how to use the carbon trading mechanisms.
- It will cover water companies, supermarkets, transport operators, large offices, hospitals, universities, central government departments and large local authorities. At current energy prices, it will generally involve organisations with annual electricity bills above £500,000.
- The CRC will target organisations that have annual electricity consumption from 70kVA HHM systems (NI) or mandatory HHM (>100kW) sites (Scotland) that exceeds 6,000 megawatt-hours (MWh).

How will the CRC interact with other regulations?

- EU ETS covers direct emissions which will be exempt from the CRC
- Electricity usage will be covered by CRC unless the organisation meets the CCA exemption threshold.
- CRC requires organisations to purchase CO_2 allowances for all energy use. CRC incentivises participants to reduce fossil energy use because payments are directly related to CO_2 emissions. Further, CRC revenues are redistributed to participants according to their relative performance (DEFRAd 2007).
- The anticipated overlap between IPPC and CRC is estimated at ~5% of emissions. Hence, CRC will have limited scope in helping IPPC installations to comply.

Figure 8 Screen shot from Climate Change Mitigation Toolbox



15 REFERENCES

ADAS (2008) The effects of reduced tillage practices and organic material additions on the carbon content of arable soils, ADAS 2008

AEA (2007) Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007

AEA (2006) Local and Regional CO_2 Emissions Estimates for 2004, Defra Experimental Statistics, AEA, November 2006

AEA (January 2006) Scotland Energy Study, AEA, January 2006

AQEG (2007) Air Quality and Climate Change, A UK Perspective, Defra, Air Quality Expert Group, 2007

Carbon Trust (2002) Northern Ireland Energy Study, Carbon Trust and AEA, 2002

Defra (2007) AQ17(07) Additional Guidance from Defra and the Welsh Assembly Government, Regulation of Waste Oil, Defra, July 2007, revised August 2007: http://www.defra.gov.uk/environment/ppc/localauth/pubs/guidance/notes/aqnotes/pdf/aq17-07.pdf

Defra Economics Group (2007) The Social Cost Of Carbon And The Shadow Price Of Carbon: What They Are, And How To Use Them In Economic Appraisal In The UK, Defra, 2007
http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/background.pdf

Defra (WFD 2007) Draft partial regulatory impact assessment of environmental quality standards for implementation of the Water Framework Directive in the UK, Defra, 2007

Defra (IPPC 2005) Integrated Pollution Prevention and Control: Practical Guide (Ed.4), IPPC, 2005
http://www.defra.gov.uk/environment/ppc/envagency/pubs/pdf/ippcguide_ed4.pdf

Defra et al (July 2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 2), Defra, DOENI, SE, WAG, July 2007

Defra (March 2007) Draft Climate Change Bill, Defra, March 2007

EA (2008) Personal communication, Amin Anjum, Environment Agency for England and Wales, March 2008

EA Briefing Note (2007) The READ self-assessment tool, Helping you use resources wisely, Environment Agency, 2007

EC (2003) WID Waste Incineration (Scotland) Regulations, 2003

EC (2007) Environment: Commission takes steps to cut industrial emissions further, reference: IP/07/1985, 21/12/2007

EC (2008) Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System, reference: MEMO/08/35, 23/01/2008

EHMS (2004) East Harbour Management Services. Fossil Fuel Electricity Generating Costs. East Harbour Project EH110, Wellington, New Zealand, 2004

EHS (2008) Personal communication with Mike McGarry, IPRI, EHS, March 2008.

ENDS Report (No. 385 Feb 2007*) Water* Firms Respond to the Energy Challenge, pp34-38, Feb 2007

Ends report (2005), Door closes on waste oil outlets, February 2005

Entec (2002) Tightening Waste Water Treatment Works Emissions Standards: A Review of the Treatment Technologies and Their Impact on Climate Change, UK Water Industry Research Limited, 2002

Environmental Audit Committee (2007) House of Commons Environmental Audit Committee Emissions Trading: Government Response to the Committee's Second Report of Session 2006–07 on the EU ETS Eighth Report of Session 2006–07, October 2007

Environment Agency (2002) Horizontal Guidance Note IPPC H2, Integrated Pollution Prevention and Control (IPPC): Energy Efficiency, 2002

EUGRIS (2007) The legal meaning of waste, Professor Paul Bardos, 05/08/2007
http://www.eugris.info/DisplayNewsItem.asp?NewsID=454&

EU WISE (2007) Introduction to the new EU Water Framework Directive, Water Information System for Europe, 2007
http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

Netregs (2007) SME-nvironment 2007: Northern Ireland, NetRegs Survey, 2007
http://www.netregs.gov.uk/commondata/acrobat/smenvironment_2007ni_1856973.pdf

NI (PPC Regulations 2003) Statutory Rule 2003 No. 46 The Pollution Prevention and Control Regulations (Northern Ireland), 2003
http://www.opsi.gov.uk/sr/sr2003/20030046.htm

NI DOE (2007) Water Framework Directive, NI DOE, 2007
www.doeni.gov.uk/index/protect_the_environment/water/water_framework_directive_.htm

NI DOE (2007) North Eastern River Basin District Booklet, NI DOE, 2007

NICS (2005) Kilroot Power Station, News Release, 22 December 2005
http://archive.nics.gov.uk/eti/051223b-eti.htm

NIW (Dec 2007) Personal Communication with Northern Ireland Water, Energy Manager, 17th December 2007

NIW (2008) Personal Communication with Northern Ireland Water, January 2008

ODPM, SE, DOENI, WAG (2005) A Practical Guide to the Strategic Environmental Assessment Directive, ODPM, SE, DOENI, WAG, Sept 2005
http://www.ehsni.gov.uk/bm_sea_practicalguide.pdf

OPSI (2003) Waste Incineration (Scotland) Regulations, 2003 http://www.opsi.gov.uk/legislation/scotland/ssi2003/20030170.htm

OPSI (2003) Waste Incineration Regulations (Northern Ireland), 2003 http://www.opsi.gov.uk/Sr/sr2003/20030390.htm

Scottish Executive (2003), Regulatory Impact Assessment of the Waste Incineration Directive, Scottish Executive, 2003

Scottish Executive Environment Group (2003) Waste Incineration (Scotland) Regulations: Practical Guidance, SE, 2003

Scottish Government (March 2003) Regulatory Impact Assessment for Implementing the Waste Incineration Regulations In Scotland, the Scottish Government, March 2003

Scottish Government (September 2007) Drop in greenhouse gas emissions, Scottish Government, 18/09/07
http://www.scotland.gov.uk/News/Releases/2007/09/18095902

Scottish Power (CSR Website 2007) Scottish Power, Corporate Responsibility, Case Studies, Installation of Flue Gas Desulphurisation (FGD) Technology at Longannet, www.scottishpower.com

Scottish Water (2008) Climate Change Team, Scottish Water, Personal Communication, January 2008

SEPA (2005, 2007) Controlled Activities Regulations (CAR):
http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050348.htm#5

SEPA (2005) Introduction to the Controlled Activities Regulations, SEPA, 2005

SEPA (2007) The Water Environment (Controlled Activities) (Scotland) Regulations 2005 – A Practical Guide, SEPA, 2007

SEPA (2007) PPC webpages, SEPA, 2007
http://www.sepa.org.uk/ppc/legislation/index.htm

SEPA (Summer 2007) Waste Data Digest 7 - WDD7, 2005 and 2005/2006 data, SEPA, Summer 2007

SEPA (2002) The National Waste Plan 2003, SEPA website, 2003:
http://www.sepa.org.uk/nws/guidance/nwp_html/3.3.html

SEPA (2000) The Pollution Prevention and Control (Scotland) Regulations 2000: A practical guide for Part B activities, SEPA, 2000
http://www.sepa.org.uk/pdf/ppc/guidance/practical_guide_part_b_activities.pdf

SG (2008) Climate Change Consultation On Proposals For A Scottish Climate Change Bill, Scottish Government, Edinburgh, January 2008
http://www.scotland.gov.uk/Resource/Doc/210419/0055642.pdf

APPENDICES

Appendix I Quantitative data tables

Table 24 Scotland's greenhouse gas emissions by IPCC[51] sector ($ktCO_2e$)

IPCC Sector	IPCC sector name	Total GHG emissions ($ktCO_2e$)	Main GHG for sector	% main GHG	Extent of SEPA regulation
1A	Fuel combustion (power, industry, all transport etc)	47,577	CO2	98%	✔
5B	Cropland (liming)	6,554	CO2	100%	✔
4D	Agricultural soils	3,769	N2O	100%	✔
4A	Agriculture livestock (enteric)	2,845	CH4	100%	✕
5E	Biomass burning	1,665	CO2	100%	✔
1B	Power sector processes (not combustion)	1,436	CO2	67%	✔
6A	Landfill	1,228	CH4	100%	✔✔
2F	Air con, refrigeration, aerosols, electronics	863	HFC	85%	✔
4B	Agriculture livestock wastes	533	CH4	61%	✔
2A	Processes (Cement decarb & glass production)	377	CO2	100%	✔✔
2B	Chemical processes (household products etc)	202	CO2	88%	✔
6B	Sewage sludge decomposition	170	N2O	60%	✔✔
2C	Metal processes (aluminium production)	70	CO2	86%	✔✔
6C	Incineration (clinical waste & sewage sludge)	28	CO2	67%	✔✔
5G	Harvested wood	-69	CO2	100%	✕
5C	Grassland	-2,593	CO2	100%	✕
5A	Forest land	-10,133	CO2	100%	✕
Total		**54,522**			

Key

✔✔ Entire sector regulated
✔ Sector partially regulated
✕ Sector not permitted / licensed

Table 25 Northern Ireland's greenhouse gas emissions by IPCC sector ($ktCO_2e$)

IPCC Sector	IPCC sector name	Total GHG emissions	Main GHG for sector	% main GHG[52]	Extent of DOENI regulation
1A	Fuel combustion (power, industry, transport etc)	15,361	CO2	98%	✔
4A	Agriculture livestock (enteric)	2,101	CH4	100%	✔
4D	Agricultural soils	2,002	N2O	100%	✔
5B	Cropland (liming)	1,118	CO2	100%	✔
5E	Biomass burning	569	CO2	100%	✔
4B	Agriculture livestock wastes	512	CH4	66%	✔
2A	Mineral processes (cement decarbn, glass etc)	351	CO2	100%	✔✔
6A	Landfill	292	CH4	100%	✔✔
2F	Air con, refrigeration, aerosols, electronics	246	HFC	95%	✔
2B	Chemical processes (household products etc)	58	CO2	100%	✔
6B	Sewage sludge decomposition	57	N2O	60%	✔✔
6C	Incineration (clinical waste and sewage sludge)	10	CO2	65%	✔✔
5G	Harvested wood	-108	CO2	100%	✕
5A	Forest land	-648	CO2	100%	✕
5C	Grassland	-1,238	CO2	100%	✕
Total		**20,682**			

Key

✔✔ Entire sector regulated
✔ Sector partially regulated
✕ Sector not permitted / licensed

Source: Enviros analysis and Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007

51 IPPC Intergovernmental Panel on Climate Change
52 % main GHG is the percentage of the total sector emissions accounted for by that greenhouse gas

Table 26 Main emission sources by individual GHG, Scotland 2005 (kt CO_2e)

Gas	IPCC Sub sector name	IPCC code	Emission	Percentage of Scotland total emissions	Extent of SEPA regulation
CO2	Power stations	1A1a	14,057	26%	✔✔
CO2	Road Transport	1A3b	9,903	18%	✖
CO2	Residential Combustion	1A4b	7,551	14%	✖
CO2	Land Converted to Cropland	5B2	6,561	12%	✖
CO2	Other Industrial Combustion	1A2f	6,026	11%	✔✔
N2O	Agricultural Soils	4D	3,769	7%	✔
CO2	Refineries	1A1b	2,399	4%	✔✔
CO2	Commercial & Institutional Combustion	1A4a	2,120	4%	✔✔
CH4	Enteric fermentation - Cattle	4A1	2,021	4%	✖
CO2	Other Energy Industries 1A1c	1A1c	1,994	4%	✔✔

Source: Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007

Table 27 Main emission sources by individual GHG, Northern Ireland 2005 (kt CO_2e)

Gas	IPCC Sub sector name	IPCC code	Emission	Percentage of NI total emissions	Extent of EHS regulation
CO2	Power stations	1A1a	5,264	25%	✔✔
CO2	Road Transport	1A3b	4,641	22%	✖
CO2	Residential Combustion	1A4b	2,686	12%	✖
N2O	Agricultural Soils	4D	2,002	10%	✔
CH4	Enteric fermentation - Cattle	4A1	1,872	9%	✖
CO2	Other Industrial Combustion	1A2f	1,291	6%	✔✔
CO2	Land Converted to Cropland	5B2	1,138	6%	✖
CO2	Land Converted to Settlements	5E2	569	3%	✖
CO2	Agriculture - Stationary Combustion	1A4c	382	2%	✔
CO2	Cement - Decarbonising	2A1	343	2%	✔✔

Source: Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007

Table 28 Proportion of GHG from environmentally regulated sectors 2005

Country region	**Environmentally regulated emissions (kt CO2e)** *some emissions are only partially/indirectly regulated*	Percentage of total GHG emissions
Scotland	30,365	56%
Northern Ireland	9,282	45%

Table 29 Total greenhouse gas emissions for environmentally regulated industry in Scotland ($ktCO_2e$)

Regulatory area	Sector regulated by SEPA	Combustion	Process	Main Gas
Part B	Crushing and screening	-	-	not app.
	Pipe coating	-	-	not app.
	Degreasing plant	-	-	not app.
	Dry cleaning - solvent use	-	0.0	not app.
	Agriculture - stationary combustion	64.3	-	CO2
Part A & B	Cement production & batching	261.6	341.8	CO2
Part A	Power stations	14,157.5	-	CO2
	Refineries	2,415.9	-	CO2
	Sludge incineration	8.9	-	N2O
	Clinical waste incineration	18.6	-	CO2
	Agriculture livestock - pigs wastes	-	29.6	CH4
	Agriculture livestock - broilers wastes	-	16.9	CH4
	Gas production	494.9	-	CO2
	Gas separation plant - combustion	75.7	-	CO2
	Blast furnaces	5.5	-	CO2
	Iron and steel - combustion plant	51.6	-	CO2
	Other industrial combustion	4,420.8	-	CO2
	Glass - general	-	24.5	CO2
	Primary aluminium production - general	-	60.0	CO2
	Primary aluminium production - PFC	-	10.0	PFC
Water	Sewage sludge decomposition	-	169.9	N2O&CH4
	Agricultural soils	-	3,769.4	N2O
	Agrochemicals use	-	3.1	CO2
	Dairy cattle wastes	-	105.0	CH4
	Other cattle wastes	-	148.4	CH4
	Agriculture livestock - manure liquid systems	-	5.4	N2O
	Agriculture livestock - manure solid storage and dry lot	-	186.5	N2O
	Agriculture livestock - manure other	-	14.3	N2O
	Agriculture livestock - sheep goats and deer wastes	-	18.9	CH4
	Agriculture livestock - horses wastes	-	0.8	CH4
	Agriculture livestock - hens & other poultry wastes	-	7.1	CH4
Waste	Landfill	-	1,227.9	CH4

Source: Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007, and Enviros analysis

Table 30 Total greenhouse gas emissions for environmentally regulated industry in Northern Ireland (ktCO_2e)

Regulatory area	Sector regulated by EHS	Combustion	Process	Main Gas
Part B	Crushing and screening	-	-	not app.
	Pipe coating	-	-	not app.
	Degreasing plant	-	-	not app.
	Dry cleaning - solvent use	-	0.0	not app.
	Agriculture - stationary combustion	13.6	-	CO2
Part A & B	Cement production & batching	262.2	342.6	CO2
Part A	Power stations	5,287.2	-	CO2
	Refineries	0.0	-	CO2
	Sludge incineration	3.3	-	N2O
	Clinical waste incineration	6.3	-	CO2
	Agriculture livestock - pigs wastes	-	25.6	CH4
	Agriculture livestock - broilers wastes	-	20.3	CH4
	Gas production	-	-	not app.
	Gas separation plant - combustion	-	-	not app.
	Blast furnaces	-	-	not app.
	Iron and steel - combustion plant	-	-	not app.
	Other industrial combustion	823.4	13.3	CO2
	Glass - general	-	8.8	not app.
	Primary aluminium production - general	-	-	not app.
	Primary aluminium production - PFC	-	-	not app.
Water	Sewage sludge decomposition	-	57.5	N2O&CH4
	Agricultural soils	-	2,002.0	N2O
	Agrochemicals use	-	0.9	CO2
	Dairy cattle wastes	-	155.2	CH4
	Other cattle wastes	-	121.7	CH4
	Agriculture livestock - manure liquid systems	-	6.3	N2O
	Agriculture livestock - manure solid storage and dry lot	-	151.4287	N2O
	Agriculture livestock - manure other	-	17.3	N2O
	Agriculture livestock - sheep goats and deer wastes	-	5.1	CH4
	Agriculture livestock - horses wastes	-	25.6	CH4
	Agriculture livestock - hens & other poultry wastes	-	8.5	CH4
Waste	Landfill	-	292.4	CH4

Source: Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2005, AEA, August 2007, and Enviros analysis

Appendix II Qualitative literature review proformas

AIR QUALITY AND CLIMATE CHANGE : A UK PERSPECTIVE	
Publication details	Air Quality Expert Group, Defra 2007
Date of publication	2007
Web link	http://www.defra.gov.uk/environment/airquality
Report overview	
The Air Quality Expert group (AQEG) was asked by DEFRA and the Devolved Administrations to find synergies of air quality pollutants and climate change in order to identify areas where measures can be adopted to improve air quality (AQ) which will also help to ameliorate climate change (CC). This report was also aimed at examining trade-offs between these two areas where policy measures act in opposition. Mitigation measures for air quality and climate change are reviewed in the report and their interaction is summarised in the tables below, for each regulatory area, as it has relevance to minimising greenhouse gases from the environmentally regulated industries. The interlinked relationship between air quality and climate change impacts is also covered in the report, making two main points: (1) There is a relation between air quality pollutants and climate change. Pollutants such as nitrogen oxides, sulphur dioxide are reflective and cause a negative (cooling) radiative forcing of climate. Black carbon from diesel vehicles absorbs solar radiation and other aerosols creating positive (warming) radiative forcing. Air pollutants also have a significant effect on concentrations of carbon dioxide and methane through their impacts on ecosystem sources & sinks. (2) Changes in climate change have a correlation to chemicals in the air. Changes to air quality are governed by changes in pollutant emissions and the weather. According to the report, it seems likely that Climate Change will result in changes in ozone layer, increasing summer pollution episodes etc	
Regulation 1: Air quality in power generation sector	
Policy area	Air quality legislation – abatement techniques
Sector(s) affected	Energy generation, industry
Regulated?	Yes, regulated by both SEPA and EHS
Details of regulation	Air quality emission limits on SO2 and NOx implemented for power stations through Part A of PPC.
Why is regulation at odds with GHG reduction?	Installing an FGD system on power stations can lead to approximately a 3% increase in their CO2 emissions. Using FGD for SO_2 abatement consumes 2% of electrical power output of the power station driving large fans blowing flue gases through the FGD system (EHMS, 2004), leading to an increase in CO2. An additional impact is the CO2 released through wet scrubbing with limestone through the reaction: CaCO3 + SO2 = CaSO3 + CO2. This leads to an additional 1% CO2, giving a 3% CO2 increase overall. FGD results in a trade-off where CO2 emissions increase. Some NOx abatement techniques may increase CO2 emissions, but only to a small extent. Fuel switching in power stations from carbon intensive fuels to alternatives such as natural gas has a positive impact on both carbon emissions and air quality. Power stations are covered under PPC as the generator needs to show BAT which includes any changes to fuels used.
Quantified GHG impacts	Using FGD for SO_2 abatement leads to approximately a 3% increase in CO2 emissions from the power station.
Other options available?	Fuel switching to cleaner fuels would reduce the need for FGD and it would also reduce greenhouse gas emissions through improved fuel conversion efficiency.
Regulation 2: Agricultural sector – nitrates directive, CAP reform, general practices	
Policy area	Agricultural greenhouse gas emissions.

Sector(s) affected	Agriculture
Regulated?	Yes, regulated by both SEPA and EHS
Details of regulation	The agricultural sector is a significant source of N_2O and CH_4. POSTIVE IMPACT: Inorganic fertiliser use is predicted to decrease by 5%-10% between 2003 and 2020, meaning N2O emissions will reduce (Entec, 2004). NEGATIVE IMPACT: **CAP reform** is predicted to lead to a small (approximately 5%) increase in fertiliser-N use as set-aside become less attractive and the land reverts to cropping. However, this will be more than offset by the overall decrease in inorganic fertiliser use. MIXED IMPACT: Increased use of urea fertiliser could decrease N2O emissions by up to 21% (Entec, 2004) but at the same time increase ammonia emissions. Measures to reduce ammonia emissions such as land-spreading slurry to increase the amount of nitrogen in the soil, increase ammonia emissions. POSITIVE IMPACT: Measures taken as a result of the **Nitrates Directive** should help reduce emissions of N2O. Approximately 30% of N2O emissions from agriculture are from denitrification of leached nitrate in estuaries and other slow-moving waters. Therefore a reduction in nitrate leaching should reduce those indirect N2O emissions.
Why is regulation at odds with GHG reduction?	There is a trend of increasing N_2O and CH_4 emissions from current farming practices and the proportion of CH4 emissions from agriculture is expected to increase by 2020. Sources of agricultural emissions: Enteric fermentation & decomposition of manure waste (100% of CH_4 agricultural emissions). The latter also leads to 5% of agricultural N_2O emissions. Agricultural soil & crop emissions (including fertilisers) contribute about 95% of N_2O emissions.
Quantified GHG impacts	Increased use of urea fertiliser could decrease N2O emissions by up to 21% (Entec, 2004) but at the same time increase ammonia emissions.
Other options available?	Chemical inhibitors used for reducing the rate of nitrification in the soil, is likely to reduce N_2O emissions by a further 12%, in addition to switching to urea.
Regulation 3: Waste disposal	
Policy area	Waste legislation
Sector(s) affected	Waste disposal
Regulated?	Yes, regulated by both SEPA and EHS through the waste regulators.
Details of regulation	
Why is regulation at odds with GHG reduction?	Incineration with energy recovery (especially CHP) is found to provide net saving in GHG emissions from bulk Municipal Solid Waste incineration. But, the effectiveness of the policy depends on the energy source replaced. General waste, tyres, waste oil and sludges - which are incinerated in the UK lead to emissions of air quality pollutants - NOX, CO, PM, PAH. In order to reduce CH_4 emissions from MSW (which is usually sent to landfill) – energy intensive waste incineration plants are used instead which results in the emissions of the above mentioned air quality pollutants.
Quantified GHG impacts	Waste disposal in landfill sites accounts for roughly 20% of UK methane production.
Other options available?	Incineration with heat recovery offers an alternative with a lower impact on climate change.

WID FINAL RIA, SCOTLAND	
Publication details	Regulatory Impact Assessment For Implementing The Waste Incineration Regulations In Scotland, Scottish Executive
Date of publication	March 2003
Web link	NA
Report overview	
The RIA is concerned with the introduction of the regulations and following transposition into legislation in Scotland of the Waste Incineration Directive. It updates previous Regulatory and Environmental Impact Assessments (REIAs) undertaken at the draft Directive stages.	
Policy area	Air quality
Sector(s) affected	Waste incineration and co-incineration plants, Waste producers, Waste disposal authorities
Regulated?	SEPA
Details of regulation	The main aim of the regulation is to have measures in place to restrict pollution of air, land and water caused by waste incineration which is not covered by HWID and MWID. It sets emission limit values to air and water. The regulation is in place to regulate and monitor all waste incineration and co-incineration plants. Benefits of the regulation Reductions in air emissions of several pollutants including NOx and SO_2 particles. Other benefits include: • Health benefits • Reduced crop damage from ozone • Reduction in building damage from SO_2 • Reduction in soiling to particulates Costs of the regulation The RIA estimates the cost of WID compliance for affected sectors.

Cost of compliance with the waste incineration directive

Main process group	Sector	Total No of incinerators	Compliance cost for typical businesses (£kpa)	Total estimated costs (£kpa)
Waste Incineration	Municipal waste	2	29 to 350	145 to 200
	Clinical waste	5	28 to 52	130
	Sewage sludge	2	35 to 210	280 to 300
	Other waste	6	36 to 131	150
	Animal remains	15	40 to 380	85 to 760 (Note 1)
Waste oil Combustion Combustion	Waste oil burners	144 (Note 2)	0.8	9 (Note 4)
	Roadstone coating	30	20 (Note 5)	255 (Note 5)
	Wood burning	2 (Note 3)	0	0
	Paper burning	2	30	20
Co-Incineration	Cement / lime kiln burning waste	1 (Note 4)	160 to 1,100	data unavailable
	Power generation	3	data unavailable	data unavailable
Total		212	0 to 1,100	1074 to 1824

Why is regulation at odds with GHG reduction?	N/A
Quantified GHG impacts	This regulation will bring in benefits in reduction of SO_2 particles in the range of 1042-1086tpa.
Other options available?	More extensive monitoring of air emissions will enable non-conformances to be more quickly identified & rectified.

ADAS REPORT ON ORGANIC MATERIAL ADDITIONS TO ARABLE LAND	
Publication details	ADAS report "The effects of reduced tillage practices and organic material additions on the carbon content of arable topsoils".
Date of publication	2008
Web link	NA
Report overview	
The ADAS report reviews the best organic fertiliser options in terms of reduced greenhouse gas emissions. Although organic material additions reduce the need for inorganic fertiliser N additions they do result in nitrous oxide additions themselves, their main benefit in terms of GHG mitigation is increasing soil carbon storage. In terms of regulatory interactions, it could be said that the sludge cake and compost additions to land are a result of regulations to deflect these materials from landfill, and associated methane emissions.	
Policy area	Fertilising agricultural land
Sector(s) affected	Agriculture – dairy farming, crops
Regulated?	The Water departments of SEPA and DOENI regulate release to water from agricultural land, under the water regulations and the nitrates directive. Accurate records of fertiliser use must be kept by each farm, and regular testing carried out.
Details of regulation	The ADAS report researched the N2O emissions and increased soil organic carbon content (SOC) when manure, slurry, sewage waste and sludge cake were spread on land. Results suggest that the greatest savings in CO_2-C (on a per hectare basis) can be achieved from the application of digested biosolids cake, green waste compost and paper crumble in the range 1430-1640 kg/ha/yr, assuming typical annual application rates (ADAS 2008). Nitrous oxide emissions increased when dairy slurry and broiler litter were spread on land, but the increase in soil organic carbon from their application lead to an overall saving in carbon emissions[53] compared to inorganic manufactured fertiliser. Digested sludge cake and green waste compost have less readily available nitrogen and so release less N2O after spreading than other materials such as dairy slurry. In addition, cake and compost application also increased SOC compared to inorganic fertiliser application, leading to a high overall carbon saving for these two organic materials, as shown in the table below.

Net greenhouse gas savings (in C2O-C) following application of selected organic materials at a rate of 250kg/ha of total N

Manure type	Application rate (t or m^3/ha ds)	SOC increase (kg/ha)	Fertiliser manufacture change (kg/ha CO_2-C)	Net $N_2$0-N change (kg/ha CO_2-C)	Net CO_2-C saving (kg/ha)
Cattle (FYM fresh)	10.5	630	49	30	709
Dairy slurry	5.0	300	83	-50	333
Broiler litter	4.8	290	73	-50	313
Digested sludge cake	8.3	1500	34	15	1549
Green waste compost	23	1400	15	15	1430
Paper crumble	30	1800	-59	-100	1641

53 It is questionable whether increases in SOC or CO_2-C savings following farm manure additions can be counted as genuine carbon sequestration (ADAS 2008). Powlson *et al.* (2007a,b in press) stressed that increases in SOC at a given site due to the addition of organic materials could not necessarily be regarded as genuine C sequestration and that it was essential to consider the alternative fate of the materials if not applied to soils.

Appendix III Waste water treatment case studies

Waste Water Treatment Case Studies

The waste water treatment Case Studies A to C which follow are based on data from Scottish Water. The company provided information on the electricity consumption pre and post upgrade. Tightening standards under the Urban Waste Water Treatment Directive (UWWTD) have lead to the majority of the upgrades, particularly for the secondary treatment phase, requiring much more energy intensive plant. In addition, the Bathing Waters Directive and the Shellfish Directive result in the need for tertiary treatment such as sand filters followed by UV treatment to bring the water quality to the required standard.

Reason why needed – pollutants abated and environmental impacts avoided
There are several different key pollution issues affecting waste water treatment plants. Each of these is associated with various environmental impacts all of which are subjected to regulatory measures. These are listed below. Details of these pollutants will help inform the reader of the pollutants addressed in the Scottish Water case studies which follow.

Waste water pollutants, impacts and legislation applying to the pollutant

POLLUTANT	Details	Environmental Impact	Legislation
TSS (total suspended solids)	Dry-weight of particles suspended in water trapped by a filter.	Increased water turbidity, clog fish gills, reduced light penetration, reduced the dispersion of oxygen. Interfere with disinfection of drinking water. [1-2, 8]	UWWTD, DWR, WFD, Shellfish Directive
BOD (Biochemical oxygen demand)	Amount of oxygen, that consumed by bacteria from water when they oxidize organic matter.	Increase in BOD reduces the oxygen availability, hence the water ability to sustain aerobic life.	UWWTD, DWR, WFD, Shellfish Directive
COD (Chemical oxygen demand)	Chemical oxygen demand by crude sewage after one hour quiescent	Similar to BOD.	UWWTD, DWR, WFD
Ammonia (NH3+)	Ammonia is easily liquefied and solidified and is very soluble in water.	Can be toxic to fresh water organisms. Humans may suffer convulsions and even death.[4-8]	Water Supply Regulations, UWWTD, DWR, WFD
pH	pH is a measure of the acidic or basic (alkaline) nature of a solution.	Synergistic effects- runoff from agricultural, domestic, and industrial areas may contain iron, mercury or other elements. The pH of the water determines the toxic effects, of these substances. [4-8]	Water Supply Regulations, DWR, WFD
Faecal Coliforms	Used as indicators of faecal contamination of water.	Facilitate the contamination of water by pathogens, bacteria or viruses. Indicates a potential health risk for humans. [4-8]	Bathing Waters, Water Supply Regulations, UWWTD, DWR, WFD, Shellfish Waters
Faecal Streptococci	A subgroup of the genus streptococcus.	Indicates the presence of faecal pathogens in water.	Bathing Waters, Water Supply

	Found within stomachs and intestines of humans and animal.	Can cause diseases such as bacterial pneumonia, ear infection and bacterial meningitis. [4-8]	Regulations, UWWTD, DWR, WFD, Shellfish Waters
Total coliforms	A group of mostly harmless, but some are harmful, bacteria that live in soil and water and the gut of animals.	Above standard concentrations may indicate on the presence of faecal pathogens in water. [4-8]	Bathing Waters, Water Supply Regulations, UWWTD, DWR, WFD, Shellfish Waters

SOURCE:
1. Defra water issues: http://www.defra.gov.uk/ENVIRONMENT/water/index.htm
2. SEPA Waste Water Treatment: http://sepa.org.uk/regulation/waste/index.htm
3. Environment & Heritage Service (Northern Ireland) Water:http://www.ehsni.gov.uk/water.htm
4. Environment Protection Agency Wastewater Management http://www.epa.gov/owm/ http://www.epa.gov/enviro/html/icr/gloss_path.html
5. water-technology.net http://www.water-technology.net/projects/millbrook/
6. OFWAT: http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/Content/info24
7. Scottish Water: http://www.scottishwater.co.uk/portal/page/portal/SWE_PGP_HOUSEHOLD/SWE_PGE_HOUSEHOLD/SWE_HH_WSTWTR
8. Water Quality Tests: http://kywater.org/watch/cumberland/ParamFecal.htm

Case study A

Plant A has been upgraded from a Primary settlement capacity to a tertiary treatment capacity. Pre-upgrade counts have exceeded or reached the limits under the UWWTD and Bathing Waters Directives (for faecal coliforms 100 per 100ml, BOD 25 mg/l, and COD 125 mg/l). The upgrade associated with case study A was driven by Article 4 of the UWWTD which stipulates that "urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment as follows: - at the latest by 31st Dec 2000 for all discharges from agglomerations of more than 15000pe" (Directive 91/271/EEC) and additionally the nitrification/denitrification and tertiary part of the process was driven by Bathing and Shellfish Water standards. Article 4 of the UWWTD directive was a blanket standard based on population equivalents unlike COPA standards that it replaced which were set based on the dilution/dispersion of the watercourse into which the facility discharged.

Environmental drivers for plant upgrade

Population Equivalent 60g/head/day		Technology	Drivers for upgrade	Point of discharge
Pre	25000	Primary settlement	faecal coliforms counts exceed the limit, and BOD and COD counts reached the limits under the UWWTD and Bathing Waters Directives.	Bay via long sea outfall
Post	35000	Tertiary treatment: extended aeration, sandfilters and UV.		

GHG impact of the technology

Overall GHG emissions increased more than three fold from 435 equivalent CO_2 (t/yr) to 1467 equivalent CO_2 (t/yr) following the upgrade. However, Plant A undertook dissolved oxygen and UV optimisation measures to improve energy efficiency and improve the treatment process. Additionally, the building heating controls are being improved which will results in enhanced energy efficiency.

Annual costs of upgrade

Labour hours were 44 hours per week in the post-upgrade period and electricity costs have increased significantly per population equivalent of waste water treated.

Annual costs before and after plant upgrade

		Plant A	
	Units	Pre-Upgrade	Post-Upgrade
Labour Scottish Water cost per year	£/year		*£44,743*
Electricity cost per year (based 2007 for upgrade)	£/year	*£43,451*	*£165,008*
Total annual GHG emissions (process & electricity)	t/year CO2e	435	1,467
Design population equivalent	PE	25,000	35,000
Labour Scottish Water cost per year PER PE	£/year/PE		*£1.28*
Other labour cost per year PER PE	£/year/PE		
Electricity cost per year PER PE	£/year/PE	*£1.74*	*£4.71*
Annual GHG emissions PER PE	t/yr CO2e/PE	0.017	0.042

NB. Costs were calculated assuming labour costs of £20/hour and electricity prices of 6p/kWh

Case study B

Plant B has been upgraded from a Primary settlement capacity to a Stepped Aeration and sludge treatment centre. Pre-upgrade BOD and COD counts have reached the limits under the UWWTD Directive. Post upgrade total sludge volume is 2915 tds/yr.

Environmental drivers for plant upgrade

Population Equivalent 60g/head/day		Technology	Drivers for upgrade	Point of discharge
Pre	82700	Primary settlement	BOD and COD counts reached the limits under the UWWTD.	Estuary
Post	111250	Stepped Aeration and sludge treatment centre		

GHG impact of the technology
Overall GHG emissions increased three fold, from 491 equivalent CO_2 (t/yr) to 1485 equivalent CO_2 (t/yr), following the upgrade. Plant B undertakes optimisation operations of DO and sludge dewatering, site lighting and building heating controls. These measures will therefore help to reduce the increase in GHG emissions attributed to the expended treatment capacity.

Annual costs of upgrade
Labour hours increased from 98 hours per week in the pre-upgrade plant to 123 in the post-upgrade period, where 80 hours of the post upgrade labour is attributed to contractors operating the sludge treatment facility.

Annual costs before and after plant upgrade

		Plant B	
	Units	Pre-Upgrade	Post Upgrade
Labour Scottish Water cost per year	£/year	*£99,655*	*£43,726*
Contractor labour cost per year (sludge treatment)	£/year	*0*	*£81,351*
Electricity cost per year (based on 2007 data for upgrade)	£/year	*£ 57,338*	*£146,754*
Total annual GHG emissions (process & electricity)	t/year CO2e	492	1486
Design population equivalent	PE	82,700	111,250
Labour Scottish Water cost per year PER PE	£/year/PE	*£0.69*	*£0.44*
Other labour cost per year PER PE	£/year/PE		*£0.90*
Electricity cost per year PER PE	£/year/PE	*£0.69*	*£1.32*
Annual GHG emissions PER PE	t/year CO2e/PE	0.006	0.013

NB. Costs were calculated assuming labour costs of £20/hour and electricity prices of 6p/kWh

Case study C

Plant C has been upgraded from a preliminary treatment using settlement to an SBR and drum thickener treating facility. Pre-upgrade BOD and COD counts have reached the limits under the UWWTD. The upgrade associated with case study C was driven by Article 4 of the UWWTD which stipulates that “urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment as follows: - at the latest by 31 December 2005 for discharges to fresh-water and estuaries from agglomerations of between 2000 and 10000 p.e” (Directive 91/271/EEC).

Environmental drivers for plant upgrade

Population Equivalent 60g/head/day		Technology	Drivers for upgrade	Point of discharge
Pre	7488	Primary settlement	BOD and COD counts reached the limits under the UWWTD.	Estuary
Post	9230	SBR and drum thickener		

GHG impact of the technology

Plant C undertakes DO optimisation operations. These measures will help to reduce the increase in GHG emissions attributed to the extended drum and the new SBR treatment capacity. Overall GHG emissions increased from 25 equivalent CO_2 (t/yr) in the pre-upgrade period to 428 equivalent CO_2 (t/yr) in the post-upgrade.

Annual costs of upgrade

Labour hours increased from 4 hours per week in the pre-upgrade plant to 20 in the post-upgrade period. Massive increases in labour and electricity costs per population equivalent of sewage treated, result in significantly higher annual costs under the upgraded plant.

Annual costs before and after plant upgrade

		Plant C	
	Units	Pre-Upgrade	Post Upgrade
Labour Scottish Water cost per year	£/year	*£4,068*	*£20,338*
Electricity cost per year (2007 data for upgrade)	£/year	*£1,178*	*£48,749*
Total annual GHG emissions (process & electricity)	t/year CO_2e	25	428
Design population equivalent	PE	7,488	9,230
Labour Scottish Water cost per year PER PE	£/year/PE	*£0.54*	*£2.20*
Electricity cost per year PER PE	£/year/PE	*£0.16*	*£5.28*
Annual GHG emissions PER PE	t/year CO_2e/PE	0.003	0.046

NB. Costs were calculated assuming labour costs of £20/hour and electricity prices of 6p/kWh