ANNEX B

Title: Prevention of Air Pollution from Shipping - Implementation of Directive 2012/33/EU **IA No:** **Lead department or agency:** Department for Transport / Maritime and Coastguard Agency **Other departments or agencies:** DEFRA	Impact Assessment (IA) **Date:** 07/11/2013 **Stage:** Consultation **Source of intervention:** EU **Type of measure:** Secondary legislation **Contact for enquiries:** Jonathan Simpson, Head Environmental Policy, MCA

Summary: Intervention and Options

RPC Opinion: AMBER

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present**	**Net cost to business per year** (EANCB on 2009	**In scope of One-In, Two-**	**Measure qualifies as**
£ NQ	£m NQ	£m 81 - 555	No	**NA**

What is the problem under consideration? Why is government intervention necessary?

Air pollution seriously impacts on human health, the environment and the economy. Despite significant improvements air pollution remains problematic and sulphur emissions from shipping are expected to account for over half of all EU sulphur emissions by 2020. As a result the EU has agreed new limits for the sulphur content of marine fuels to bring them in line with other transport modes. To ensure UK vessels and vessels operating in UK waters adhere to the new requirements legislation must be amended. Government intervention is necessary as sufficient voluntary action has not occurred to-date despite continued growth of emissions and those that have opted to self regulate will be placed at a significant competitive disadvantage.

What are the policy objectives and the intended effects?

The objective is to reduce the emissions of polluting substances that result from the combustion of certain fuels. This shall be achieved by imposing limits on the sulphur content of such fuels or permitting alternative technology that delivers at least the same reduction in emissions. This will ensure that emissions from UK ships, and ships in UK waters will fall. It is intended that such measures will also produce health and environmental benefits for those residing in the UK, especially within the locality of a maritime hub. Emissions of Particulate Matter (including Black Carbon) released into the atmosphere are also expected to fall resulting in a number of health benefits.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Five options were given initial consideration (see Annex 1), then reduced to two - full transposition and a 'Do Nothing' scenario that forms the baseline for this impact assessment. The preferred option is full transposition of the Directive without 'gold plating' and maximum use of the flexibility provided in the Directive to minimise costs on industry where possible. The text of the Directive does not allow for alternatives to regulation but the transposition will be as 'light-touch' as possible while retaining the benefits. While 'Do Nothing' was investigated, the growing emissions burden from the sector compared to other emitters renders this option difficult to defend .

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 07/2019

Does implementation go beyond minimum EU requirements?			**No**		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	MicroNo	< 20 **No**	SmallNo	Medium Yes	Large Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** NQ	**Non-traded:** NQ	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible SELECT SIGNATORY: ..... **Date:** .....

Summary: Analysis & Evidence

Policy Option 1

Description: Transposition of EC Directive 2012/33

Full Implementation

Price Base Year 2013	PV Base Year 2015	Time Period Years 10	Net Benefit (Present Value (PV)) (£m)		
			Low: NQ	**High:** NQ	**Best Estimate:** NQ

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	**NQ**		**£89m**	£476m
High	**NQ**		**£606m**	£6679m
Best Estimate	**NQ**		**£348m**	£2945m

Description and scale of key monetised costs by 'main affected groups'

The direct costs to the UK shipping industry are expected to be passed on to its customers. To approximate the total impact on UK businesses, we have estimated the cost of abatement systems or additional cost of fuel based on UK flag vessels in UK waters (lower bound of cost estimates), and the cost of abatement systems or additional cost of fuel based on vessels trading to UK ports (upper bound of cost estimates). The best estimate is based on the central scenario, not an arithmetic average.

Other key non-monetised costs by 'main affected groups'

Diversion of heavy fuel oil to other markets with possible loss of income to seller. Potential diffuse costs to supply chain due to hauliers seeking alternative routes, plus impacts of modal shift. Possible costs to UK refining industry (expected to be passed on the industry's customers). Wider societal impacts as a result of changes to operating practices within the shipping community.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	**NQ**		**NQ**	NQ
High	**NQ**		**NQ**	NQ
Best Estimate	**NQ**		**NQ**	NQ

Description and scale of key monetised benefits by 'main affected groups'

We intend to monetise benefits for the post-consultation impact assessment, as we are seeking additional evidence through the consultation and through commissioned research.

Other key non-monetised benefits by 'main affected groups'

Reduction in life years lost and respiratory and cardiovascular hospital admissions due to reduced emissions of particulate matter as well as reductions in NO_2, SO_2 and ozone. Quality of life through improved air quality in affected areas (ports and harbours). Reduction in associated environmental impacts: acid rain, acidification, eutrophication and restoration of ecosystem services. Diversification in fuel supply with resulting benefits to fuel suppliers and refineries. Creation of a more stable market for abatement technology developers. Reduced impact on built environment (acid deposition) and savings in restoration costs.

Key assumptions/sensitivities/risks **Discount rate** 3.5

The cost analysis relies on a number of assumptions, which are more fully explained in the evidence base. The key assumptions are around: future fuel price fluctuations and supply, costs of abatement technology, future fuel price premia and fuel consumption, take up of fuel to abatement technology ratio and the use of alternative fuels – Methanol, Liquefied Petroleum Gas, Liquefied Natural Gas, Hydrogen.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			In scope of	Measure
Costs: 81m-555m	**Benefits:** NQ	**Net:** NQ	No	**NA**

1. Problem Under Consideration

1.1 Air Pollution

The main concern arising from the current sulphur content of marine fuels is air pollution. Air pollution means the introduction by humans, directly or indirectly, of substances into the air resulting in harmful effects of such a nature as to endanger human health, harm living resources and ecosystems and material property[1]. Pollutants of particular concern include particulate matter (PM), oxides of sulphur (SO_X), oxides of nitrogen (NO_X), and ozone.

When sulphur is released into the atmosphere (usually through combustion) oxides are produced that result in acids being formed within the atmosphere. The sulphur dioxide (SO_2) that forms is an acidic gas that can then combine with water to form acid rain (wet deposition). When the particles remain dry (do not bond with water) dry deposition can occur as the particles remain in the atmosphere. The 'release' of the acid from the atmosphere can have a range of effects including acidification.

1.2 Health Impacts

As well as being emitted directly, particulates can be formed in the atmosphere from reactions between other pollutants, of which SO_2, NOx, non-methane volatile organic compounds (NMVOCs) and ammonia (NH_3) are the most important. Health effects of PM are caused after their inhalation and penetration into the lungs. The smaller the particles, the deeper they penetrate into the lungs. Emissions of NO_X, SO_2 or NMVOCs can react together to form low level ozone which at higher levels can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Several European studies have reported that current ozone concentrations in Europe have health effects, especially in the summer, and that daily mortality rises with increases in ozone exposure.[2]

The health impacts of sulphur as a pollutant occur when tiny airborne particles are inhaled and then pass into the lungs. The small scale of the particles enables them to pass through the tissue of the lung and enter in to the blood stream from where they can be spread around the body. The main health impacts are associated with the exposure to air pollutants from shipping and can be split into acute (short term) and chronic (long term) health impacts. The short term effects on an individual can be seen as respiratory problems that are often alleviated once exposure is reduced. Long term exposure can lead to permanent reductions in lung function, such as asthma, chronic bronchitis, heart and circulatory diseases. Further complications can occur as many of the fine particles may be carcinogenic.[3]

Within the scientific community, it is now accepted that exposure to air pollution damages human health[4]. As SO_2 is the pre-cursor to particulate pollution in the form of fine sulphate particles, separating the health effects of sulphur and particulate matter (PM) is difficult. In 1998 the Committee of the Medical Effects of Air Pollution[5] (COMEAP) estimated that during 1998, 24,000 people died prematurely as a result of exposure to air pollution, with thousands more hospitalised.[6] In 2008, the burden of particulate air pollution in the UK was estimated to be equivalent to nearly 29,000 deaths and is expected to reduce the life expectancy of everyone in the UK by 6 months on average, at a cost of around £16 billion per year.[7]

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[1] 1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION (LRTAP 1979)
[2] WHO, 2008, Air quality and health, Fact sheet no 313 (http://www.who.int/mediacentre/factsheets/fs313/en/).
[3] House of Commons, Environmental Audit Committee, Air Quality, Fifth Report of Session 2009-2010, Vol 1.
[4] COMEAP (2010) 'The Mortality Effects of Long Term Exposure to Particulate Air Pollution in the United Kingdom' Available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317137012567
[5] http://www.comeap.org.uk/
[6] http://www.publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/229/22905.htm
[7] https://www.gov.uk/government/policies/protecting-and-enhancing-our-urban-and-natural-environment-to-improve-public-health-and-wellbeing

1.3 Impacts on the Built Environment

Building degradation often occurs as the acids formed by sulphur within the atmosphere 'attack' the fabric of buildings, often resulting in buildings that have survived for many hundreds of years undergoing a sudden deterioration in condition. The impacts of acid deposition can be seen on a variety of materials other than stone, including paint, zinc, carbon-steel, nickel and some types of plastic. Most structures undergo some level of deterioration due to acid deposition.[8]

The impact of the deterioration suffered by buildings can vary, often depending on the cultural importance of the building. A building or structure that has a particular importance such as Westminster Abbey or Nelsons Column cannot only loses the features that make it of cultural importance but may also suffer from 'knock on' impacts such as a decline in income from tourism as the visual impact of the buildings is lost. Less tangible impacts may also occur as such buildings often have emotional and spiritual value to those that visit them.[9] Economic impacts can then arise as maintenance, repair and restoration costs are incurred in order to reverse existing or prevent future damage. It should be noted that these costs can be incurred by all building owners not just to owners of buildings of historic importance.[10]

1.4 Wider Social Impacts

Increased levels of air pollution can have a negative societal impact as areas that are heavily impacted by air pollution can become less desirable as a place to live. This combined with a perceived reduction in quality of life due to poor air quality can threaten social cohesion as communities develop feelings of disadvantage and dissatisfaction due to being unable to afford to live in areas where the quality of life is perceived to be better. This effect has the potential to impact the value of properties in an area, with recent work carried out by environmental economists highlighting the relationship between air quality and housing value (notably Chay and Greenstone 2005, Journal of Political Economy). Research into this area by Imperial College, London, suggests that poor air quality disproportionately impacts the poorer sectors of society[11]. The reports went on to suggest that areas of poor air quality resulted in areas becoming socially deprived.[12]

1.5 Environmental Impacts

Air pollution can affect an ecosystem in a variety of ways. The deposition of sulphur into the environment results in the acidification of both aquatic and terrestrial (soil) environments. Impacts can be direct, affecting the function of vegetation and indirect by influencing the ratios of nutrients in soils and waters which in turn impact on the ecology of the area.[13]

Experiments have shown that acid rain can have a negative impact on crop yields, due to damage to the protective layer of wax on the leaves of plants which results in a disruption to the gaseous exchange in the plant, effectively resulting in the suffocation of the plant. This has been shown to result in lower crop yields and is particularly evident in crops of beets, carrots and broccoli. This is an effect that has also been seen in other vegetation, such as woodland species.[14]

Acidification of freshwater can bring about the gradual changes in the flora and fauna of the impacted area resulting in changes in the local food chain. Acidification of soil through the process of acid deposition can result in chemical changes in the composition of soil. This may result in ecosystem impacts as organisms that have developed to thrive in a particular soil may not be able to survive if the chemical composition of the soil changes. This can often lead to wide ranging

[8] Watkis, P. Holland, M. Hurley, F. Pye, S. (2006), 'Damage Costs of Air Pollution', AEA Technology Environment, March 2006
[9] Navrud, S & Ready R.C. (eds), (2002), Valuing Cultural Heritage (Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artefacts). Cheltenham. Edward Elgar
[10] Watkiss, P. et al (2000), 'Impacts of Air Pollution on Building Materials', accessed 07/0/13 from http://arirabl.org/Publications_files/Buildings-PollAtmos.pdf
[11] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/1024.pdf
[12] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/1024.pdf
[13] http://www.air-quality.org.uk/
[14] http://ucce.ucdavis.edu/files/repositoryfiles/ca4007p9-62962.pdf

environmental impacts within a community as the soil and organisms within it is often the basis on which a food chain and community is based. The result of this type of acidification is a loss of biodiversity within the area impacted.[7]

Within the UK, studies[15] have shown that a number of sensitive environments, such as bogs, heathlands, grasslands, woods and aquatic environments continue to show an increase in the levels of acid deposition exceedence. Of the 78051km^2 monitored within the UK, 45928km^2 (58.8%), continue to suffer from excessive acidification including 73.5% of bogs (4009km^2) and 39% of freshwater sites (652 out of 1752). The recently completed pHish (Powys Habitat Improvement Scheme) Project invested over £2million to improve the fishery of the River Wye that had suffered from excessive acidification, resulting from acid rain. The work undertaken included the liming of the water system to return the pH of the water to the natural level to enable the return of native flora and fauna. The project has successfully improved the water quality of the river systems resulting in the reintroduction of salmon fisheries to significant stretches of the watercourse.[16]

Although ecosystem effects often occur, individual organisms can be exposed to air pollutants through inhalation, ingestion or absorption. Once contaminated by a pollutant an individual's response can vary greatly and be dependant on a wide variety of factors (level of tolerance, time and duration of exposure, age, sex, health factors and species) that may play an important role in an individual's reaction. These impacts can be particularly harmful to fish, aquatic invertebrates and amphibians. The loss of which can impact on the wider food chain.[7]

A number of diffuse impacts on human activity occur as a result of the direct impact of air pollution on the environment. These include loss in leisure value of a building that may erode due to acid deposition, loss of sports facilities (fishing, water sports) due to a deterioration in the water quality, and loss of the aesthetic value of the natural environment as an ecosystem deteriorates (loss of forestry for walking etc).

1.6 Sulphur Content of Marine Fuels

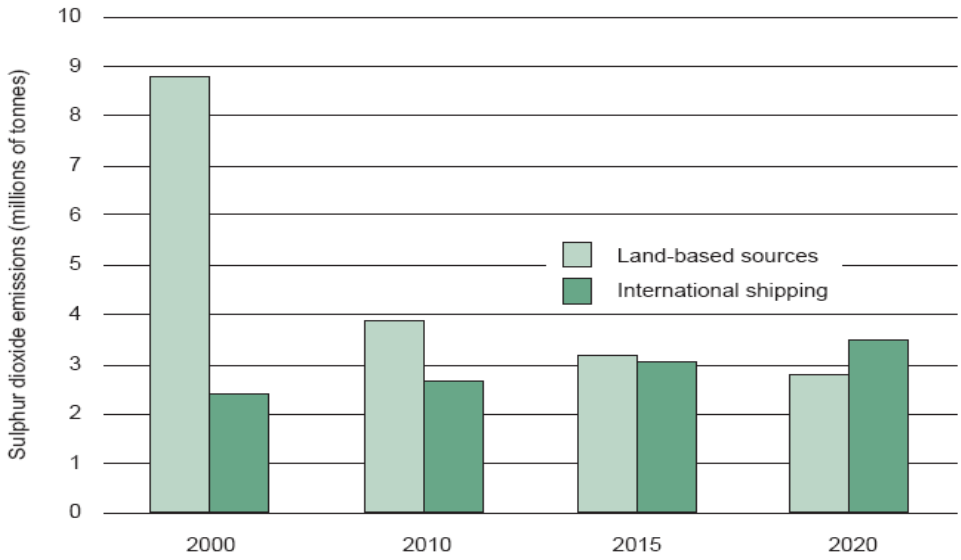
The impact of air pollution, as outlined above, has been recognised globally and in response, steps have been taken to reduce the release of contaminants into the atmosphere.

In recent years, the EU has tackled the problem of air pollution by limiting the sulphur content of fuels (Directive 1999/32/EC). This has resulted in a reduction of the levels of sulphur emitted by land-based sources and air transport. However, air quality in Europe, and in the UK, is failing to meet all the standards set by EU/UN Gothenburg protocol. Further steps are therefore required to reach the targets set. These steps have included looking at other sulphur emitting industries. As the combustion characteristics of marine engines, along with the wide-spread use of unrefined fuel, results in significant amounts of SO_2, NO_X and particulate being released into the atmosphere, shipping has now become the focus of efforts to reduce air pollution.

With the world's largest shipping fleet and more than 80,000 vessels estimated to call at European ports every year it is easy to see that shipping related to the EU is having a significant impact on the atmosphere, and, as an island nation surrounded by major shipping routes, the air quality in the UK[17]. To date, emissions from maritime sources have not received the same level of scrutiny as land-based sources resulting in shipping continuing to emit sulphur at unacceptable levels. In fact, the relative level of pollution associated with the shipping sector continues to increase (vessels are expected to be responsible for over 50% of sulphur emissions in the EU by 2020[18], Figure 1) and marine fuel remains significantly 'dirtier' on average than that used by other modes of transport.

[15] Hall, J. (2009), Updates to UIK Critical Loads and Exceedances September 2009', Centre for Ecology & Hydrology, Environment Centre Wales
[16] http://www.wyeuskfoundation.org/projects/phish.php
[17] Transport Committee - Sixteenth Report, *Sulphur emissions by ships*, February 2012 http://europa.eu/rapid/press-release_MEMO-10-401_en.htm
[18] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmtran/1561/156104.htm

Figure 1: EU sulphur dioxide emissions by source.



1.7 Current Limits on Sulphur in Transport Fuel

Sulphur emissions from the aviation and shipping sectors have, to date, been addressed to a more limited extent than emissions from land-based sources. The disparity of permissible levels of sulphur between other modes of transport and air and sea transport is highlighted in Table 1 below.

Table 1: Maximum allowed sulphur content of transport fuels, parts per million

Mode of Transport	Maximum allowed sulphur content (parts per million)
Railway	10
Cars and Lorries – Petrol	10
Motor Vehicles - Diesel	10
Non-road mobile machinery (farm vehicles etc)	10
Aviation Fuel (safety limit)	3000
Inland Waterways	10
Shipping (Current, pre 2015) Emission Control Area	10000
Shipping (post 2015) Emission Control Area	1000
Shipping (Current, pre 2020) Non Emission Control Area	35000
Shipping (post 2020) Non Emission Control Area	5000

Sources: see footnotes 19, 20 and 21
Note: With the exception of aviation and shipping, the limits are drawn from EU requirements.

Aviation is currently being looked at in detail but is already significantly cleaner than shipping with aviation fuel currently averaging 600ppm globally. The maximum limit for aviation is currently the subject of studies by the European Union and US. The objective of these studies is to significantly

[19] http://www.ukpia.com/industry_issues/fuels/sulphur-free-petrol-diesel-and-non-road-fuels.aspx
[20] https://www.easa.europa.eu/rulemaking/docs/research/EASA_SULPHUR_Project_11-01-2010.pdf
[21] DIRECTIVE 2012/33/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL , of 21 November 2012, amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels

reduce the maximum sulphur content of aviation fuel. A 15ppm maximum by 2020 has been suggested as achievable by US funded studies.

As can be seen in Table 1, the fuel used by shipping contains far more sulphur than other fuel types. Marine fuel has been unique globally in increasing in average sulphur content since the UN began monitoring levels. It is considered likely that this is the result of fuel refiners and blenders disposing of excess elemental sulphur and lower quality feedstock through marine fuel. Following work undertaken within the International Maritime Organisation (IMO) to reduce the levels of sulphur emitted through the operational practices of shipping, the EU published Directive 2012/33/EU which introduces sulphur content limits for marine fuels drawn from the agreed international standards. The limits included within the Directive have been developed in order to bring shipping further in-line with other transport modes whilst still being achievable within a pre-determined timeframe.

1.8 Background to IMO, MARPOL Annex VI and EU Directive

The ownership and management chain of any ship can involve many countries, whilst the ships themselves spend their economic life moving between different jurisdictions. There is, therefore, a need for international standards to regulate shipping which can be adopted and accepted universally. The body responsible for this is the International Maritime Organisation (IMO). The IMO is a specialised agency of the United Nations with 167 Member States and three Associate Members. The work of the IMO is a comprehensive body of international conventions, supported by hundreds of recommendations governing every facet of shipping. The International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78[22], to which the United Kingdom is a signatory, provides an international regulatory regime governing the prevention of pollution from ships. It is a legal instrument composed of various documents which form a single whole. It sets out criteria which parties are required to adopt including obligations, application, violations, etc. The obligations agreed by the Parties to the Convention in the articles and regulations relate to different types of ship-generated pollution.

In response to the growing awareness of shipping's contribution to the problem of air pollution and as the IMO's senior technical body on marine pollution related matters, the Marine Environment Protection Committee (MEPC) oversaw the development of a new annex to MARPOL.

MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships was adopted in 1997 and entered into force in October 2005 to set limits on SOx and NOx emissions from ship exhausts. It included a global cap of 4.5% by mass on the sulphur content of fuel oil and also set provisions allowing for special Sulphur Emission Control Areas (SOx ECAs, 'SECAs') where either the sulphur content of fuel oil used on board ships must not exceed 1.5% by mass, or ships must fit technologies to achieve equivalent SOx emissions. Limits on emissions of NOx from diesel engines were also set. A map of the North Sea SECA is shown in Annex 2.

At the same time as this, the EU Sulphur Content of Marine Fuels Directive (Directive 2005/33/EC) entered in to force in July 2005. This Directive amended the Sulphur Content of Liquid Fuels Directive (Directive 1999/32/EC) to limit the sulphur content of marine fuels, linking it to MARPOL Annex VI, and to specifically limit the sulphur content of fuel burnt within the European SECAs.

The international community recognised that the requirements of MARPOL Annex VI needed to be strengthened in order to produce a meaningful reduction in air pollution. The renegotiation process lasted two years. Discussions were extensive during this period with significant support within the IMO, led by a lobbying group formed by Finland, Norway and Germany, for a 0.1% global limit on sulphur content of marine fuels. One industry representative (Intertanko) favoured a distillate-based solution with less stringent sulphur limits while the bulk of the shipping industry favoured less stringent revisions to the global and SECA limits and the permitting of alternative compliance systems. The UK supported the shipping industry in vigorously opposing the global 0.1% limit, and the distillate monofuel concept, as there was little economic or environmental evidence to support such a standard. The UK was also at the forefront of the group that championed the inclusion of an

[22] IMO (2011), International Convention for the Prevention of Pollution from Ships (**MARPOL**).Consolidated Editin 2011, International Maritime Organization, London, 2011

alternative technology clause, thus giving industry another option in meeting the requirements of the revised Annex VI. The major achievements for the UK and the shipping industry during these negotiations were the removal of the 0.1% global limit, the introduction of a phased introduction of the stricter sulphur limits in fuel and the availability of the option to use alternative technologies.

These negotiations resulted in a revised text for MARPOL Annex VI which, at the time, had the full support of the international shipping industry, who had worked beside the UK to achieve a proportional and meaningful outcome. Following these negotiations, the revised MARPOL Annex VI was adopted in October 2008.

Following this outcome at the IMO the European Commission, as a part of a strategy to reduce atmospheric emissions from seagoing ships, published (in 2010) the proposal for a Directive that would mostly align European legislation with the MARPOL revision. In recognition of the work undertaken at the IMO, and in support of the sectors of the shipping industry that were early adopters of the requirements of the revised Annex VI, the UK lobbied hard within the EU to minimize any divergence of the proposed Directive from the revised MARPOL Annex VI and opposed those elements of the proposal that would have 'gold plated' the requirements of MARPOL. In particular, the UK lobbied extensively to ensure that the use of alternative technologies and the MARPOL fuel availability clause, which ensures that operators are protected if compliant fuel is unavailable, were included in the Directive. Both of these elements, which were developed at IMO to support the shipping industry in meeting the requirements of MARPOL Annex VI, are now, largely through the efforts of the UK negotiating strategy, included within the Directive.

Although negotiations resulted in the new Directive closely aligning with the international standard contained in the revised MARPOL Annex VI, the Directive does not completely mirror Annex VI.

The requirements that the proposed legislation will enact are as follows:

- The sulphur limits for ships operating within a designated SECA must not exceed 1% (from July 2010) and 0.1% from 1 January 2015.
- Outside of designated SECAs, a global cap of 3.5% will be introduced from 18 June 2014. It should be noted that the 3.5% limit came into force internationally on 1 Jan 2012 through MARPOL Annex VI so this change is purely to bring the EU regime into line with MARPOL. This limit will be further reduced to 0.5% on 1 January 2020. This differs from the revised Annex VI which will undertake a review by 2018 to assess the feasibility of the 0.5% global cap and will only implement the cap if the review supports it.

It should also be noted that MARPOL Annex VI includes a range of regulations aimed at reducing the NOx emissions from vessels. The EC does not currently have competence on this issue but is looking at how these emissions can be reduced across the Community. The Directive that is to be transposed does not therefore contain any of the NOx requirements of MARPOL Annex VI and as such there will be no reference to the MARPOL NOx requirements within the proposed legislation or this impact assessment. Further legislation will be developed when the IMO is satisfied that the NOx requirements are achievable and proportional to the threat posed to the environment.

2 Policy Objectives

The objective is to reduce the emissions of sulphur that result from the combustion of certain fuels that are used by the shipping industry. The aim is to achieve this by imposing limits on the sulphur content of such fuels or permitting the use of alternative technology that delivers at least the same reduction in emissions. This will ensure that sulphur emissions from UK ships, and ships in UK waters will fall.

The intended effect of this objective is to bring about an improvement in the air quality in the UK, which in turn will produce benefits for those residing in the UK, especially for those that reside within the locality of a maritime hub. An improvement in air quality is expected to lead to improvements in health, resulting in reduced social costs and increased quality of life; benefits to the environment,

including the built environment, through a reduction in acid deposition; and a range of economic benefits resulting from reduced costs to society due to the impacts of air pollution.

In addition to the reduction in sulphur, the proposed legislation is also expected to result in a reduction in the volume of Particulate Matter and Black Carbon released in to the atmosphere. This will also bring about health, environmental and economic benefits.

By implementing the proposed legislation the UK will be in full compliance with all its current international obligations with regards to MARPOL Annex VI and Directive 2012/33/EU, with the effect of the UK avoiding infraction proceedings.

3 Rationale for Government Intervention

There is ample evidence to show that air pollution has wide and varied negative impacts, impacts that affect the UK and its population. Scientific data and numerous studies demonstrate that shipping is now one of the major contributors of sulphur to the atmosphere. The global nature of shipping and air pollution requires a large scale response, such as MARPOL Annex VI. The EU has demonstrated, through the evidence provided by its own impact assessment[23], that a regional response is also appropriate to further improve air quality of its member states.

The shipping industry currently imposes costs on the health of the population, the natural environment and the built environment, for which the industry does not take full responsibility. These negative impacts are known as 'external costs'. In this case the external costs refer to the costs that arise from pollutants the shipping industry emits into the atmosphere. Environmental legislation widely applies the 'Polluter Pays' principle based on the acceptance that those that cause damage should bear the responsibility for any corrective action required to offset negative impacts. This principle is also used for external costs. In the case of the emissions from shipping, which result in external costs to the wider community, there has been no attempt to strongly apply the polluter pays principle or any significant attempt by the polluter, in this case the shipping industry in aggregate, to minimise its impact or to compensate and offset the associated external cost. As shipping now represents a significant and growing element of the sulphur emissions in the EU, and self regulation has not resulted in any aggregate reduction, it is considered that there is a need for government action to ensure that these externalities are addressed.

While some early adopters within the shipping industry have sought to reduce emissions by burning lower sulphur fuel in advance of the implementation dates, or investing in research into after-treatment systems (scrubbers) they have been a notable minority, with few shipowners investing significantly in research and development into the issue of air pollution. This is likely in part due to the revisions to Annex VI being adopted as the global economy suffered a significant recession with a resulting fall in freight rates.

The UK fully supports the aims of MARPOL 73/78 to bring about a reduction in all pollutants from shipping and as such is a signatory to the MARPOL Convention. As a signatory to the Convention the UK has treaty obligations to enact the appropriate Regulations. Similar treaty obligations also arise from the UK's membership of the EU. Failure to implement the requirements of the Directive would lead to infraction proceedings resulting in economic penalties for the UK. There is also a risk of reputational damage to the UK should we fail in our international obligations.

There is also an economic argument for reducing emissions as the impacts resulting from poor health or a degradation of the environment have been well documented. The costs and benefits section of this impact assessment will further demonstrate the economic arguments for action to reduce sulphur emissions.

DfT works closely with Defra and other partners to help deliver the Government's commitments on air quality. The Government is committed to creating a greener transport system by supporting the green economy and reducing the environmental impacts of travel and transport. Intervention by the

[23] http://ec.europa.eu/environment/air/transport/pdf/ships/sec_2011_918_en.pdf

Government in the matter of air pollution from shipping will aid in the delivery of these commitments and to meet other EU requirements.

The air quality policy adopted by the European Union has involved two complementary approaches; controlling emissions at source, and the setting of long-term ambient air quality objectives. All Member States of the European Union must comply with Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe and the 4th Air Quality Daughter Directive (2004/107/EC). The UK must also comply with the National Emissions Ceilings Directive (2001/81/EC), which sets national emission limits for four pollutants; sulphur dioxide, oxides of nitrogen, volatile organic compounds and ammonia. This Directive will help control emissions at source by reducing emissions from shipping. This will assist the UK with complying with the air quality Directives (2008/50/EC, 2004/107/EC, 2001/81/EC) and failure to meet these obligations may lead to infraction.

The transposition of the current Directive will introduce into UK legislation a set of regulations that are, in the medium term, a very stable policy option. The phased introduction of the different fuel standards results in the final standard being implemented over five and a half years. This represents a period of time during which the shipping industry can be assured of the regulatory framework with which it must comply. It also enables the owners and operators of vessels to plan a strategy in order to meet the requirements of the Directive, without being worried that the policy may change or the goal posts may move. This offers an incentive for investment in the technologies that have been developed to meet the proposed emission standards.

The shipping industry can be further assured of the consistency of the emissions standards by the presence of the SECAs that have already been established within the North and Baltic seas. As the SECAs have already been established there is no further scope for sulphur emissions to be tightened within these waters, once again enabling shipping operators and owners to be secure in the knowledge of what is required of them.

4 Policy Options

Five policy options were originally considered within the implementation strategy. After consideration of the five options and their implications, two options have been brought forward to this impact assessment. Further details of the three options considered unsuitable to carry forward are included in Annex 1.

The two options that were given further consideration by the policy team were:

1. Do nothing. Maintain the existing sulphur limits, but do not implement the new requirements.
2. Full Transposition. Transpose the Directive in full – using ‘copy out’ wherever possible and taking advantage of all the derogations that are available for Member States. Apply a proportionate and targeted compliance regime.

4.1 Do Nothing

Although the Do Nothing option was given some consideration, we regard it as an unrealistic option. The reasons for this are outlined below. Nevertheless, the Do Nothing scenario forms the baseline of the cost benefit analysis, in order to illustrate the expected impacts of the proposed regulations. The costs and benefits of the Full Transposition option have therefore been estimated against a baseline that the forthcoming standards and EU directive do not exist.

To not implement the requirements of the Directive would undermine the Government’s policy to deliver improvements to air quality. Failing to implement would also be inconsistent with the UK’s international Treaty obligations and the cross-government negotiating position agreed by the Environment Audit Committee to implement the revised MARPOL Annex VI. This would also put the UK at the risk of infraction and would have economic implications for the UK in the form of substantial fines. Generally the European Court of Justice consider the failure to transpose

measures that protect human health to be among the more serious breaches of treaty obligations with resulting infraction fines being at the higher end of the scale. These costs are explored in more detail in Section 11 of this impact assessment but would be in the region of an £8m fine followed by daily charges of between £9,000 and £590,000.

Failure to implement the Directive would put the UK's international reputation at risk. During negotiations for the Directive, the UK fought hard to ensure close alignment between the Directive and the revised MARPOL Annex VI and lobbied hard to ensure that the final Directive provided the shipping industry with timescales and alternative compliance opportunities to enable the aims of the Directive to be met whilst taking into consideration the concerns of the shipping industry. Failure to then 'follow through' and implement a Directive, that the UK was so instrumental in shaping, would harm the UKs reputation within the EU and would make it harder for the UK to find support from other Member States during any future negotiations.

Additionally the Directive implements MARPOL Annex VI, to which the UK is a party, and a failure to transpose the Directive would place the UK in breach of its wider treaty commitments insofar as the Directive implements elements of MARPOL. This would have wider implications for the UK's reputation at IMO and could be particularly problematic as the IMO work to address CO_2 emissions draws heavily on the work undertaken under MARPOL Annex VI.

Within the broader economy, the Do Nothing option would undermine the engineering innovations that have been supported by UK equipment manufacturers who have invested heavily in developing 'scrubber' technology. However, it is possible that this loss to the manufacturing industry could be offset by the savings that a sub-sector of the shipping industry could make by not having to implement the requirements of the Directive. There is no quantitative evidence to support this assertion either way.

Under the Do Nothing scenario, the UK would not transpose the EU Directive and current limits on the sulphur content of marine fuel would remain in place in UK waters. In international waters, MARPOL Annex VI limits would apply and it is very likely that a large share of vessels operating in UK waters would comply with lower sulphur limits, either due to their flag state's regulations, due to declining availability of high sulphur fuels or due to the inability to switch between fuels en route. A small share of vessels would probably continue to use high sulphur fuels, mostly UK flagged vessels operating exclusively in UK waters, and these vessels would not therefore incur the higher costs associated with using lower sulphur fuel or installing abatement technology. The operators of these vessels are the ones directly affected by the proposed regulations. It is also possible that some other vessels would switch to high-sulphur fuel or would switch off their scrubbers as they enter UK waters in order to reduce their operating costs. The extent to which this would take place and the impact it might have are extremely uncertain and cannot be estimated.

4.2 Full Transposition

Transposition of all the requirements of the Directive would avoid the negative implications of the Do Nothing option and in particular avoid the potential for significant financial penalties due to non-compliance with European law.

The full costs and benefit analysis of the Full Transposition option is the focus of this impact assessment. It should be noted that while a detailed analysis of the costs has been developed many of the benefits are more diffuse and as a result have not been fully monetised at this stage. Further work is planned to better understand these elements in parallel with consultation in order to inform the final impact assessment.

5 Costs

5.1 Monetised Costs

5.1.1 Background

The approach for estimating compliance costs for the shipping industry is set out in the impact assessment for the revised MARPOL Annex VI, which was prepared by Entec[24] for the Maritime and Coastguard Agency in 2009[25] ("Entec (2009)") covering the period 2010-2020, as follows:

1. Identification of the key abatement measures that could be implemented in order to comply with the emission requirements, namely fitting seawater scrubbers and switching to low-sulphur fuels
2. Estimation of the unit cost of the selected abatement measures (cost per vessel for fitting seawater scrubbers, or cost per tonne of fuel switched).
3. Development of three fuel price premium scenarios up to 2020 to account for the cost of switching to more expensive low-sulphur fuels.
4. Development of three scenarios that reflect a different abatement measure uptake to consider different combinations of numbers of vessels switching fuels and installing scrubbers[26].
5. Estimating total costs for the shipping industry of the 'with policy' scenario[27]
6. Entec presented cost estimates on three bases:

    - total number of vessels within their "study area" (which is significantly larger than UK waters and is based on an emissions inventory Entec developed for Defra in 2008, see map in Annex 2);
    - vessels calling at UK ports in the study area;
    - UK-flagged vessels in the study area.

Which of these three bases the costs are calculated on, will significantly affect the results. We expect that during the appraisal period used in this impact assessment (2015 – 2024), a large number of vessels in the study area will comply with lower sulphur limits, regardless of the UK's transposition of the Directive on the basis that they are required internationally by the revised MARPOL Annex VI, which is now in force, and by the EU Directive being transposed by other EU Member States. There may also be practical obstacles to the continued use of high-sulphur fuels. Under the Do Nothing scenario, only a share of all vessels in the study area would continue to use high-sulphur fuels when operating in UK waters. Therefore we base our range of cost estimates on the two smaller groups of vessels considered in Entec (2009)

- vessels calling at UK ports in the study area, which informs the upper bound cost estimates
- UK-flagged vessels in the study area, which informs the lower bound cost estimates

Vessels calling at UK ports in the study area are the larger of the two groups of vessels and are also the group of vessels against whom the MCA could take enforcement action if necessary.

In the absence of any UK legislation it can be expected that the majority of ships calling at other European Member States ports as well as the UK will comply with the requirements regardless. This is due to a combination of the risk of enforcement by Port State Control in another member state and the potential for a vessel to fail flag state inspections if it was found to be out of compliance. In terms of the ship types modelled by Entec (2009) we would expect broad compliance across the fleet regardless of type. A minority of deep water vessels (primarily Tanker, Container and Bulker traffic) could potentially avoid detection for a longer period as they would be less frequently seen by other EU member states but it is considered less likely they will take the risk as the overall share of low sulphur fuel they would be expected to consume will be low compared to an ECA-bound ship.

The only vessels where a significant risk of non-compliance may exist is for purely domestic traffic where a lack of UK powers would allow ongoing non-compliance.

[24] Entec, an environmental and engineering consultancy, was acquired by AMEC in 2010 http://www.amec-ukenvironment.com/

[25] http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

[26] See section 3.6 from Entec (2009) for further details

[27] A wide range of expected costs was developed to reflect current uncertainty in the shipping industry's likely compliance responses.

5.1.2 Costs associated with fuel switching

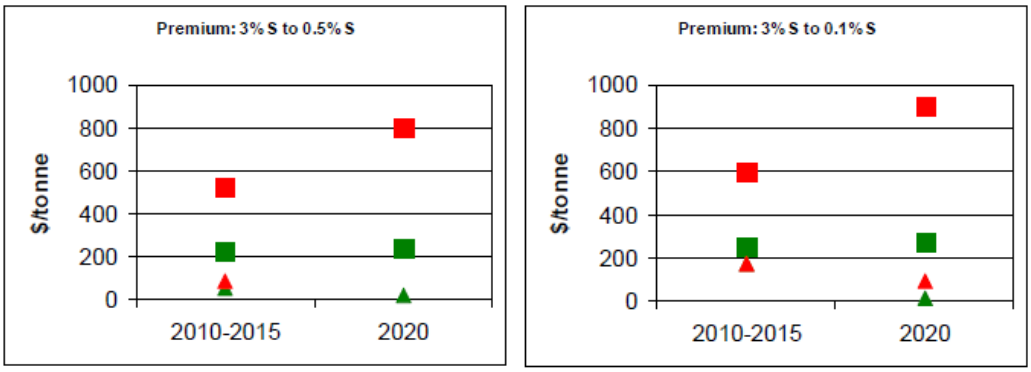
A key aspect of estimating the cost of this new regulation is the assumed price differential between high sulphur fuels and low sulphur fuels, or the 'fuel premium'. Assumptions on future fuel consumption also significantly affect the results. The fuel premium scenarios and assumptions on future fuel consumption are discussed in more detail below.

Although by far the biggest cost for switching to lower sulphur fuels is the fuel premium, other additional costs may be incurred if additional tanks and piping are necessary and if modifications / adjustments on fuel pumps, fuel injection systems, lubrication systems and fuel tanks are required[28]. Although these potential additional costs are acknowledged, they have not been incorporated in the total cost estimates, firstly because the percentage of the total fleet that may require such modifications is unknown and secondly because the cost associated with dual systems may already be incurred under the 'Do Nothing' scenario, with different sulphur content requirements for SECAs, for ships at berth in EU ports and for ships outside UK waters.

5.1.3 Fuel Premium

Forecasts of the likely price premium of lower sulphur fuels are extremely uncertain. The uncertainty goes beyond the difficulty inherent in price forecasting in general as it depends critically on the behaviours and investment decisions of both shipping operators and refineries[29]. There were three fuel premium scenarios presented in Entec (2009). The report compared these price premium estimates with those in existing literature[30] and concluded that the Entec price estimates are consistently higher than price premia in the reviewed literature (Figure 2).

Figure 2 – Low sulphur fuel price premium estimate comparison



Note: squares = Entec estimates, triangles = literature estimate, red = high, green = low.

Using higher fuel price premium assumptions means that Entec (2009) arrives at significantly higher cost estimates than other analyses assessing the costs of implementing the revised limits on the sulphur content of fuel.

To take account of other evidence, this impact assessment therefore uses the low and central fuel price premium estimated by the Entec analysis but takes a high price premium assumption (capped at $350/t for 0.1% sulphur fuel compared to 1% sulphur fuel) from the results of a more recent literature review presented in a report commissioned by the UK Chamber of Shipping[31]. A check of Rotterdam bunker rates over the six months to the end of September 2013 also suggested a high price premium of $350/t could be an appropriate assumption. Table 3 below shows the price premium assumptions used in this impact assessment. These ranges are also comparable to those used in the European Commission's impact assessment.

Table 3 - Price premium for fuels with 0.1%S compared to 1.5%S ($/t)

[28] Further information on these additional costs are detailed in Appendix I to the Entec (2009) report
[29] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*
[30] See Appendix A of Entec (2009) for a full discussion
[31] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*.

	Low	Central	High
2015	225	271	350
2020	244	329	350
2024	244	329	350

Source: Low and central estimates for 2015 and 2020, Entec (2009). High estimates based on AMEC (2013) and data on Rotterdam bunker rates. 2024 estimates are DfT assumptions.

Global fuel costs have shown significant volatility over the previous decade largely linked to issues of supply (major refinery shutdown or accident) or major geopolitical events (recent events in Libya), the differential between fuel costs has remained relatively consistent however. There is significant uncertainly in forecasting the price premium as uptake of alternative technology, new emissions rules in non-EU states and development of new fuel sources (shale gas for example) have an effect but the above values are consistent with other studies and represent a reasonable estimate based on current market behaviour.

5.1.4 Fuel consumption

One of the key assumptions in estimating the costs of the new limits is the growth rate in fuel consumption.

Entec (2009) assumed an annual growth rate of 1% to 2020. This was consistent with assumptions used at the time in other analysis for Government[32]. This impact assessment assumes a 1% growth rate from 2015 until 2020 in the 'Do Nothing' scenario and no growth in fuel consumption between 2020 and 2024 as illustrated in Table 4.

Table 4 – Fuel consumption assumptions (kt) for vessels calling at UK ports in the study area

	Do Nothing	Uptake Scenario A	Uptake Scenario B	Uptake Scenario C
2015	4,561	4,431	4,561	4,561
2020	4,794	4,613	4,638	4,863
2024	4,794	4,613	4,638	4,863

Source: 2015 and 2020 assumptions are from Entec (2009), see Appendix L. 2024 assumptions are DfT (no change from 2020) Further detail on the Scenarios can be found on p16 of this Impact Assessment.

There are significant uncertainties around future fuel consumption. Engine efficiency improvements for new vessels have not been fully accounted for and therefore the fuel consumption assumed and the resulting cost estimates could be lower. At the same time, there could be an increase in demand due to economic growth. The zero growth estimate for 2020-2024 has been arrived at as it is expected that a combination of efficiency improvements mandated by the IMO combined with low/no expected growth in transport demand in EU Waters[33] will result in no significant increase in fuel consumption.

The IMO community have agreed that International shipping will be subject to mandatory requirements to improve efficiency over the next twenty years. This measure (the Energy Efficiency Design Index - EEDI) will require existing ships to account for their energy usage and require new ships to be increasingly more efficient. These changes will occur over an extended period as the fleet is slowly replaced with more efficient ships and the measures do not apply to all vessels but it is expected that individual ships will be 20-35% more efficient than an existing design by 2025. This may result in significant reduction in fuel consumption across the marine industry (and potentially

[32] For example, *Carbon Pathways Analysis, Informing Development of a Carbon Reduction Strategy for the Transport Sector,* July 2008 http://www.dft.gov.uk/pgr/sustainable/analysis.pdf

[33] The Committee on Climate Change central demand scenario for shipping (2011) assumes zero growth to 2050 http://archive.theccc.org.uk/aws/CCC%20Review%20of%20UK%20Shipping%20Emissions%20-%20Supporting%20Analysis.pdf

lower the market price of fuel) but will be partly offset by the growth of the industry in absolute terms.

5.1.5 Costs associated with fitting scrubbers

Evidence reviewed by AMEC[34] in their report for the UK Chamber of Shipping suggested that scrubbing technology does offer a potentially feasible option for some operators to comply with the SO_X limit for some of their fleet; and that systems can remove 90-95 % of SO_2. AMEC noted that exhaust gas scrubbers are still an emerging technology for shipping and this evidence should be compared with the experience of operators who have both installed test bed prototype and full scale scrubber systems and those in negotiations with potential suppliers of the technology. In those instances where scrubbers have been installed, the evidence suggests that important design and operational lessons are still being learnt.

The method used to determine the cost of scrubbers in this impact assessment is set out in Appendix I to the Entec (2009) report. Fitting a scrubber would allow lower cost higher sulphur content fuel to be used in SECAs resulting in fuel cost savings compared to the 'Do Nothing' scenario. Installation, maintenance and operating costs (including the costs of additional fuel required to operate a scrubber and the costs associated with disposal of the sludge produced) have been taken into account[35]. However, barriers to implementation (for example, space required on a vessel for a scrubber) and some other costs (for example, staff training) have not been assessed quantitatively in this impact assessment. It could be argued that the capital costs of installing a scrubber for vessels that operate in both UK and international waters are not strictly additional to the Do Nothing scenario in this impact assessment as a vessel choosing that compliance option would incur that cost regardless of implementation in the UK (because it would not be able to operate in international waters without demonstrating compliance). The capital costs have been included in this analysis and the results may therefore mean that the costs presented are an over-estimate.

Entec (2009) applied capital costs per unit of an engine's installed power to the estimated engine size of each vessel type/size to obtain capital and operating costs of installing scrubbers for each vessel category and size. Auxiliary engines of bulk carriers, general cargo, tankers and "other vessels" are assumed to run marine gas oil in the 'Do Nothing' scenario. For these vessel categories, scrubbers would only be necessary for main engines. Running costs will be significantly lower if using a scrubber with heavy fuel oil rather than a distillate fuel. For all other vessel types, costs of scrubbers include both main and auxiliary engines. When Entec carried out their research in 2009 industry representatives expected that costs of scrubbers could decrease as the technology becomes more widespread. A 50% decrease in costs by 2020 has also therefore been considered[36]. While the scrubber industry have not provided any detailed, further information to date, it is expected that an increase in orders combined with experience of installation will reduce the cost of marine scrubber systems in coming years – power station systems are significantly less costly on a kilowatt per hour basis in part due to greater simplicity but also in part due to commonality of parts and economies of scale. This issue will be explored further in the consultation process.

It is noted that some misgivings exist in relation to the efficacy of scrubbing systems within the shipping industry but the concept is well proven in non-marine applications (power generation) and a growing number of shipowners are announcing significant investments in the equipment. Both a major ferry operator and a cruise vessel operator have announced scrubber retrofit programmes in 2013 and it is expected that more operators will follow. The assumption in this impact assessment that uptake of scrubbers does not really commence until 2020 may be pessimistic which would mean that the costs presented may be an over-estimate. Discussions with the abatement technology providers have suggested that the Entec figures of Capital Expenditure and Operational Expenditure have changed with a suggestion that CAPEX may be slightly too low while OPEX may be too high. This issue will be subject to specific questions in the consultation document.

[34] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*
[35] See section 5.1.3 of Entec (2009) for further details
[36] See Appendix C to Entec (2009)

Finally, it is important to note that fitting scrubbers to vessels will increase the difficulty of monitoring vessels' compliance with the Regulations, as vessel owners could choose to install scrubbers, but not to operate them. This would be in the operators' interest as they would be able to reduce their fuel consumption, as the scrubbers would not require any energy. The regulator would not be able to check whether the scrubbers were in operation on a voyage by comparing the fuel consumption and route data, as the uncertainty would be greater than the additional fuel required to operate the scrubbers. One possible method for monitoring compliance would be for the regulator to require operators to record the disposal of sludge from scrubbers and compare this with the route and fuel type data. However, this is not a robust method of checking compliance and could involve additional administrative costs.

By 2020 it is likely that a combination of fuel switching and installation of abatement technologies will be used to comply with the new requirements. This impact assessment uses Entec's uptake scenario B which assumed that 90% of vessels switch to lower sulphur fuels and 10% of vessels install seawater scrubbers by 2020 as the central case[37]. The AMEC report for the UK Chamber of Shipping suggested that technical and practical issues associated with scrubbing technology would mean that the only viable means of meeting the sulphur requirements will be through switching to lower sulphur fuel. However, other evidence (notably the recent announcements by DFDS ferries and Carnival Cruises[38]) suggests the use of scrubbers could account for greater than 10% of abatement activity to meet the requirements. Increased use of scrubbers would reduce the costs of compliance with the new sulphur limits.

While the issue will be explored during the consultation it is expected that successful deployment of scrubber systems by 'blue chip' operators such as DFDS and Carnival will significantly increase interest and investment in the technology. DNV[39] suggested in a recent report that by 2020 thousands of globally trading vessels could be carrying scrubber systems. They suggested initial uptake in the 'low hundreds' annually from 2015 along with the use of liquefied natural gas (LNG) on a wide scale. The DNV work suggests it is possible that 20-30% of ships globally will be using scrubbers in 2020 under certain fuel price scenarios with a further 30% equipped to use LNG fuel, these rates will vary significantly depending on the behaviour of global fuel prices and the global picture for fuel supply. It should be noted however that the DNV work represents a 'snapshot' and the levels of uptake suggested have been questioned by industry.

5.1.6 Conclusions on compliance costs to the shipping industry

The approach used by Entec (2009) has been set out above[40] and resulted in three scenarios[41]:

- Uptake scenario A assumed the only response to the new sulphur limits was fuel switching;
- Uptake scenario B (described above) assumed that 90% of vessels switch to lower sulphur fuels and 10% of vessels install seawater scrubbers by 2020; and,
- Uptake scenario C, which is based on the results of a modelling exercise to assess the economic viability of investing in scrubbing technology vs fuel switching[42].

[37] The 90:10 split assumed by Entec was based on an IMO publication: IMO (2007), *Revision of MARPOL ANNEX VI and the NOx Technical code, Input from the four subgroups and individual experts to the final report of the Informal Cross Government/Industry Scientific Group of Experts Note by the Secretariat, Sub-committee on bulk liquids and gases, 12th session, Agenda item 6, 28 December 2007* http://www.endseurope.com/docs/80213b.pdf

[38] Carnival are understood to be investing in part as a result of a structure approach to compliance in North America which will see the company phasing in compliance systems over a period of years.

[39] Shipping 2020 - Det Norske Veritas, 2012

[40] The approach used in this impact assessment to estimate the costs of complying with the new sulphur limits is as set out in Entec (2009), however, a number of assumptions have been updated (for example, exchange rate assumptions, fuel price premium assumptions) and the results presented here are consistent with the Green Book appraisal and evaluation guidance. The appraisal period has been extended beyond 2020 by assuming costs remain constant thereafter.

[41] Fuel consumption savings as a result of the switch to distillates have been taken into account in the analysis and are estimated at around 4.5% of fuel consumption. Furthermore, additional fuel consumption as a result of the use of scrubbers has been taken into account and is estimated to be around 1.7%.

[42] Uptake scenario C is based on the results of a modelling exercise undertaken, assessing the rational economic behaviour of the different types of vessels, (see Appendix F in Entec (2009) for details). The results suggest that, by 2020, for all types and sizes of vessels and for all fuel price premium scenarios, it would make economic sense to invest in scrubbers instead of switching to distillates. During the period 2010-2015 switching fuels is a more cost-effective option to

The European Commission impact assessment also presented results assuming compliance through fuel switching or scrubber technology uptake i.e. scenarios A and C described above. This is discussed further in Section 8 below.

5.1.7 Monetised cost estimates for the UK shipping industry

Using the analysis in Entec (2009), we have uprated the cost estimates for scrubbers to 2013 prices using HMT's GDP deflator, have amended the high fuel premium estimate to $350/ton and have also updated the $/£ exchange rate assumption using the average for the year to 31 March 2013. We have assumed that costs stay constant over the period 2020 to 2024.

The cost ranges implied by the three different uptake scenarios are presented in Table 5 below. As noted above, Entec (2009) reported that industry representatives expect that costs of scrubbers could decrease as the technology becomes more widespread so a 50% decrease by 2020 has therefore also been presented in brackets in Uptake Scenario C for 2020 and 2024.

Table 5 – Annual costs to the UK shipping industry in 2015, 2020 and 2024 (£ million, discounted to 2015)

A) Upper range of cost estimates, based on vessels calling at UK ports

Scenario	Fuel price premium	2015	2020	2024
Uptake Scenario A (100% fuel switching)	Low	342	423	368
	Central	412	568	495
	High	525	557	486
Uptake Scenario B (90% fuel switching, 10% scrubbers)	Low	342	462	402
	Central	412	590	514
	High	525	568	495
Uptake Scenario C (100% scrubbers (cost of scrubbers falls by 50% by 2020))	Low	375	871 (435)	759 (379)
	Central	443	866 (433)	755 (377)
	High	554	852 (426)	742 (371)

B) Lower range of cost estimates, based on UK-flagged vessels in the study area

Scenario	Fuel price premium	2015	2020	2024
Uptake Scenario A (100% fuel switching)	Low	54	63	55
	Central	65	85	74

comply with the new sulphur requirements. After 2015, SWS starts to become a more economically favourable alternative for most vessel types and fuel premium scenarios. Accordingly, this scenario assumes that all vessels will switch fuels to comply until 2015. During the period 2015-2020, only new vessels will install SWS and in 2020 both new and existing vessels will adopt SWS for compliance. This scenario does not take into account potential barriers to implementation such as the space requirements of the technology, limited production capacity in the scrubbers market or aesthetic considerations as detailed in Appendix I to Entec (2009).

	High	83	90	79
Uptake Scenario B (90% fuel switching, 10% scrubbers)	Low	54	64	56
	Central	65	82	72
	High	83	87	76
Uptake Scenario C (100% scrubbers (cost of scrubbers falls by 50% by 2020))	Low	58	94 (47)	82 (41)
	Central	69	93 (47)	81 (41)
	High[43]	86	90 (45)	78 (39)

The new sulphur limits have different impacts for different vessel types in different regions. The AMEC report for the UK Chamber of Shipping[44] examined potential impacts on the UK short sea shipping industry in detail. As the North Sea area (which includes the Channel) is a SECA, vessels operating in these areas will be required to comply with a 0.1% sulphur limit from January 2015. As noted above, AMEC assumed that compliance with this limit would be due to fuel switching rather than any use of abatement technologies. It is also assumed that the increases in fuel costs will be fully passed onto consumers in the form of higher ticket prices and this will result in some modal shift away from ferries to road journeys threatening the viability of some routes. The AMEC report highlights particular risks to short haul ferry operators where alternatives (such as the Channel Tunnel) exist and competition is particularly fierce amongst ferry operators.

Noting that there are practical limits to the level of modal shift that can occur in the UK it is also possible that a geographic shift will occur with some shorter routes (less impacted by fuel cost increases as a percentage of ticket cost) being preferred over longer open water routes. This would be a risk in cases where the cost to hauliers of the longer haul route was greater than the additional cost of road transport. A number of operators of longer cargo routes are understood to be investigating scrubbers or alternative fuels as a result of this with one operator currently undertaking engineering studies for the feasibility of running their vessels on LNG.

The European Commission (EC) impact assessment[45] and its supporting studies also examined the risk of potential modal shift. The EC concluded that although several studies assessed the effect of the increased fuel prices and the potential shifts in transport modes, and it is undisputed that the transport pattern in SECAs will change, no coherent conclusions emerged as to the pattern of those changes.

5.1.8 Alternative Fuels

This impact assessment has focused on the use of scrubber systems on vessels burning conventional marine fuel. However, it is likely that a significant number of ships will opt for alternative fuels, such as Liquefied Natural Gas (LNG) or Methanol, post-2015.

LNG is already utilised as a viable alternative to traditional heavy fuels within shipping. Some industry estimates[46] suggest that, as a result of the new requirements in the Directive, up to 30% of ships could be utilising dual-fuel or pure gas engines by 2020. The UK currently has little infrastructure in place to fully support the use of LNG by vessels calling at its ports, and although there has been significant investment in LNG in other parts of Europe, such as in the Baltic, the UK

[43] Entec have different fuel price premiums for the 100% scrubber scenario, assuming that high fuel prices drive down scrubber cost faster.
[44] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*
[45] http://ec.europa.eu/environment/air/transport/pdf/ships/sec_2011_918_en.pdf
[46] Shipping 2020 – DNV 2012

has not seen similar levels of investment. With only one operator who calls at UK ports showing significant interest in operating LNG fuelled ships, and with even this operator intending to refuel at continental ports in order to reduce investment costs, there is little prospect of further investment in the UK at this time.

Methanol is another alternative to traditional heavy fuels that offers significant cost savings. At current spot prices, Methanol is currently around $50[47] cheaper than even high sulphur fuel and around $400[48] cheaper (at wholesale) than low sulphur marine fuel. A trial of two Methanol fuelled vessels is currently taking place in the Baltic, the recent results of which have been very positive. Interest in Methanol is growing as one operator has indicated intent to move 24 ships over to the fuel once testing is completed. Methanol has some important drawbacks (notably in terms of energy density) but offers a potentially significant cost saving to operators of short sea services such as ferries although an increase in demand will likely reduce the cost saving somewhat.

The picture for alternative fuels is rapidly changing as interest in them increases. This will be explored in detail in the consultation as it is considered likely that an increased uptake of such fuels will contribute to a reduction in the overall cost of compliance.

5.2 Non-Monetised Costs

It has not been possible to monetise some of the potential costs that the proposed legislation could have, due to high uncertainty and limited availability of evidence. We will review this section after the consultation subject to evidence being submitted.

5.2.1 Costs to the Refining Industry

The revised sulphur content limits will impact the UK refining industry as the balance of demand for low and high sulphur fuels shifts. Entec (2009) found that the introduction of the 0.1% sulphur limit in SECAs in 2015 will result in ships / operators switching to marine gas oil (unless widespread adoption of scrubbers takes place). As a consequence, the demand for diesel, gas and oil in North West Europe will increase, which would drive prices up. As the marine fuel demand in SECAs constitutes only a very small share of global fuel consumption, Entec (2009) concluded that the impact would not be enough to drive big investments (for instance in hydrocracking[49]) and it is likely the additional low sulphur fuel will be imported into the EU. However, the expected global switch to distillates to meet the 0.5% sulphur limit in 2020 would be expected to have significant impacts for the refining industry.

Any additional costs incurred by refineries to meet sulphur limits would be expected to be passed through to end consumers in the form of higher fuel prices and are therefore captured in the fuel price premium assumptions discussed below.

The UK Government is taking a lead on this issue within the IMO and will be submitting a paper to the next meeting of the IMO MEPC to urge states to begin work on an assessment of fuel availability. While this work at IMO will not be complete in time to inform the final version of this IA the Government will be carrying out internal analytical work on the issue and will incorporate this where appropriate.

5.2.2 Costs to Other Fuel Users

As summarised above it is assumed that any increase in fuel production costs will be passed on to the end user. This could impact the wider community as fuel for domestic use and personal vehicles is likely to increase.

There is also the possibility that road hauliers may incur cost by seeking alternative sea routes to those they would have used prior to the proposed legislation entering into force in order to minimise the length of the sea voyage.

[47] Rotterdam Spot Market 14 October 2013
[48] Rotterdam Spot Market 14 October 2013
[49] Hydrocracking is a process that can be used to convert heavier residual oil into lighter distillate grades

5.2.3 Administrative and Enforcement Costs

As part of its commitment to port state control, the MCA inspects a proportion of ships calling at UK ports. The MCA considers that proposed UK Regulations would not involve any additional administrative costs for the MCA above those of the existing inspection programme since any new requirements would be incorporated into existing MCA in-house training.

There is a potential for abatement systems such as scrubbers to complicate enforcement efforts – such vessels would not be subject to the same testing for the sulphur content of their fuel with the focus of enforcement effort being directed towards confirming the abatement system has an appropriate type approval, and is being operated and maintained in line with the approval. It is unlikely this would create any significant cost burden on the regulator but could complicate training.

A further complication noted previously would be the scenario where an unscrupulous operator deactivated their abatement system while operating in an Emissions Control Area. This is very similar to the 'magic pipe' scenario with oil pollution where a rogue operator actively circumvents pollution prevention equipment to cut costs. A similar approach would need to be taken in these cases with the enforcement body looking more broadly at vessel management and examining records for evidence of falsification. While this may complicate an Inspectors work it is not expected to raise costs to the public sector.

If the UK undertakes an enhanced monitoring and sampling programme to ensure that vessels are in compliance with the proposed regulations there would be an additional resource burden on the MCA. This would come in the form of additional equipment costs and the possible need for specialist training to use the equipment. Discussions in the EU have centred on mandatory fuel sampling programmes, use of remote sensing systems such as LIDAR, and the installation of Continuous Emissions Monitoring Systems (CEMS) on ships. The UK is arguing for a pragmatic, intelligence led approach to enforcement based upon the low observed level of non-compliance seen under the current sulphur regime.

These potential costs have not been monetised as it is uncertain whether the MCA will complete such monitoring and sampling activities and as such has not yet evaluated the potential costs of the equipment and training requirements. Work is ongoing through EMSA (with significant UK input) to determine the extent to which sampling activity will be needed. The final version of this Impact Assessment will contain a more detailed analysis as the picture within the EU develops.

5.3 Summary of Costs Analysis

For a detailed break down of cost estimates, see Annex 3

Table 6: Summary of costs

	Key assumptions and uncertainties	Non-monetised impacts	Monetised impacts (average annual)	Monetised impacts (total – present value)
Costs to the UK shipping industry	• Future values of fuel price premium (this impact assessment has used assumptions that are significantly higher than in other literature) • Future costs of scrubbers • Possible technical and practical issues associated with scrubber use	• Risk of modal shift away from shipping • Use of alternative fuels could reduce costs	£89m to £606m based on the central scenario. Best estimate is the mid-point £348m	£476m to £6,679m based on the central scenario Best estimate is the mid-point £2945m

	• Future fuel consumption • Future fleet numbers and average engine size of vessels			
Costs to the UK refining industry	• Impact on the refining industry will depend on the extent to which fuel switching takes place compared to installation of scrubbers, costs are assumed to be passed on to ship operators through fuel premia		Captured in the fuel cost analysis	Captured in the fuel cost analysis
Administrative and enforcement costs	Considered minimal as enforcement elements remain broadly similar to the existing regime			

5.4 Estimated Annual Net Cost to Business

Even though there are benefits to businesses of reduced buildings damage, we are currently not able to monetise these benefits. Therefore the estimated annual net cost to business is made up only of the increased cost of fuel (or alternatively the cost of using scrubbers for abatement). Discounting the cost estimates for the central scenario back to 2009 prices gives an EANCB estimate ranging from £81m to £555m. (See Annex 3)

6 Benefits

6.1 Non-Monetised Benefits

As identified below a significant range of identified benefits have not yet been monetised as the modelling is currently not considered adequately robust. It is our intention to continue working on these aspects during the consultation period and commission additional work in order to improve the robustness of the work and where possible monetise the benefits more fully.

6.1.1 Expected health benefits for the UK

Poor air quality is a significant public health issue. Exposure to air pollutants causes a number of effects on health including: wheezing; coughing; worsening of asthma; changes in lung function; deaths and hospital admissions from respiratory and cardiovascular diseases.[50] The burden of particulate air pollution in the UK in 2008 is estimated to be equivalent to nearly 29,000 deaths and is expected to reduce the life expectancy of everyone in the UK by 6 months on average, at a cost of around £16 billion per year.[51] The main health impacts are associated with the exposure to air pollutants from shipping and can be split into acute (short term) and chronic (long term) health impacts.

Table 7[52] below summarises the health benefits associated with the emission reductions expected in 2020 from the implementation of the revised MARPOL Annex VI Regulations, as shown in Entec (2009). The Entec (2009) analysis shows that the most significant impact of air quality on health in

[50] http://www.comeap.org.uk/air

[51] https://www.gov.uk/government/policies/protecting-and-enhancing-our-urban-and-natural-environment-to-improve-public-health-and-wellbeing

[52] Source: Table 6.3, Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL*

http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

the UK is the reduction in long term life expectancy associated with exposure to airborne particles.[53] Lifetime (80 years) exposure to current levels of PM_{10} from anthropogenic sources in the UK contributes to an average loss of life expectancy of about 3-7 months.[54] The range in estimates is due to uncertainty in the ratio of concentrations of PM_{10} to those of $PM_{2.5}$. The smaller $PM_{2.5}$ particles are thought to have the greatest health impacts.

The predicted average gain of life expectancy associated with the estimated reduction in shipping emissions in this study is around 5-10 days per person.[55] Given that the reduction in exposure will result from lower concentrations of combustion generated and secondary particles which would both be largely within the $PM_{2.5}$ size range, it is likely that the gain in life expectancy would be towards the upper end of the predicted range.

The health benefits resulting from reducing air pollutant emissions from shipping have been estimated by Entec (2009) using the gridded ship emissions inventory for UK water for Defra.[56] The inventory uses estimates of health impacts by the Institute for Occupational Medicine.[45]

Table 7: Summary of estimated health benefits in 2020 from reduced sulphur emissions

	Units	Associated reductions in PM_{10} emissions	Associated reductions in NO_2 emissions	Associated reductions in SO_2 emissions	**Total**
Acute mortality (life expectancy losses assumed to be in poor health)	Estimated reduction in deaths per year brought forward	227	**-**	24	251
	Estimated reduction in number of years of life lost per year assuming 2-6 months loss for every death brought forward	38-114	**-**	4-12	42-126
Chronic mortality (life expectancy losses assumed to be in good health)	Estimated reduction in number of years of life lost per year	10,993-21,986	-	-	10,993-21,986
Respiratory hospital admissions	Estimated reduction in respiratory hospital admissions per year	240	3	20	263
Cardiovascular hospital admissions	Estimated reduction in cardiovascular hospital admissions per year	180	-	-	180

Source: page 40, Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL* http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

[53] Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL* http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

[54] Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL* http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

[55] Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL* http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

[56] Entec (2008) UK Ship emissions Inventory, Final report for Defra, October 2008

The approach used to estimate health benefits in the Entec (2009) report is summarised below:

- The impact of the revised MARPOL Annex VI regulations on baseline UK concentrations has been estimated (based on emission data that assume a 90:10 uptake of switching fuels and fitting scrubbers[57]) by utilising the FRAME model (this work was undertaken by the Centre for Ecology and Hydrology, CEH on behalf of Entec);
- Health impacts have been estimated by incorporating baseline data on incidence of health endpoints of interest based on national statistics (acute and chronic mortality, hospital admissions, etc.) and applying the most applicable exposure-response relationships (this work was undertaken by the Institute for Occupational Medicine, IOM). These estimates were outlined in Entec (2009) and have been used in this impact assessment.
- Appropriate valuation data were then applied to the health impacts, consistent with the Interdepartmental Group on Costs and Benefits 2007 (IGCB)[58] practice and Treasury Green Book guidance.

If we were to use Entec's monetised health benefits estimates for 2020 and apply them to the entire appraisal period, uplifting them to 2013 prices, the benefits estimate would be:

Table 8: Average annual benefits 2015-2024 (Present value, £2013 prices, columns do not add due to rounding)

	Associated reductions in PM_{10} emissions	Associated reductions in NO_2 emissions	Associated reductions in SO_2 emissions	**Total**
Estimated reduction in number of life years lost	£397-790m		£0.5-£0.7m	£397-790m
Estimated reduction in respiratory hospital admissions	£0.6-2.7m	£0.01-0.03m	£0.05-0.2m	£0.7-2.9m
Estimated reduction in cardiovascular hospital admissions	£0.4-2m			£0.4-2m
Total	**£398-795m**	**£0.01-0.03m**	**£0.6-0.9m**	**£398-795m**

To be consistent with the cost estimates, one approach might be to use the same share of benefits estimates as for cost estimates, i.e. pro-rata them for the smaller vessel categories. This would generate benefits estimates as below:

Table 9: Average annual benefits 2015-2024 (Present value, £m 2013 prices)

[57] Developed for Defra by Entec and adjusted for the purposes of the Entec (2009) report ;

[58] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221088/pb12637-icgb.pdf

	Associated reductions in PM_{10} emissions		Associated reductions in NO_2 emissions		Associated reductions in SO_2 emissions		**Total**	
	Low	High	Low	High	Low	High	Low	High
Pro-rata 35% for vessels calling at UK ports	139	278	0.0	0.0	0.2	0.3	**139**	**278**
Pro-rata 6% for UK-flag vessels in the study area	24	48	0.0	0.0	0.0	0.1	**24**	**48**

However, we are not sufficiently confident in the robustness of this approach due the following reasons

- In Entec (2009), health benefits were estimated for 2020 as this is when the global sulphur limits are going to be implemented, based on all vessels in the study area (see Annex 2). The Entec report states explicitly that the benefits are only valid for 2020.

- There is considerable uncertainty around which share of the benefits estimated by Entec is driven by the new 2015 sulphur limit for SECAs (which forms part of both MARPOL and the Directive) and which share of benefits is driven by the 2020 sulphur limit outside SECAs. We would need to know this in order to extrapolate benefits for the years before and after 2020.

- It is also unclear to what extent these benefits are driven by emissions close to shore. SECAs such as the English Channel/North Sea are located in high-traffic density areas located in close proximity to major population centres and as such are likely to result in a significant reduction of localised air pollution with resulting health benefits. To accurately assess the benefits from implementing the Directive in UK waters, we would need to better understand which share of the benefits is due to emissions reductions close to the UK coast. The Entec report does not provide any information on this.

- There is also significant uncertainty around which share of the benefits can be assumed to arise from either “UK-flag vessels in the study area” or “vessels calling at UK ports”.

We find that this does not provide us with a robust enough basis for a monetised estimate of health benefits for the appraisal period relevant to this impact assessment at this stage. We will however work to quantify and monetise as far as possible the significant benefits that are expected from this policy measure, including health benefits from reduced ozone exposure, which were not included in the Entec (2009) study. Therefore we are commissioning work in order to include monetised estimates of health benefits and reduced buildings damage in the final impact assessment.

Additional analysis undertaken by Entec (2009) suggested further health benefits per year, which were not monetised in their report[59] and which we are not able to monetise for this impact assessment before or after consultation, since these impact categories are not part of recommended UK appraisal methodology.

- around 300 fewer Accident and Emergency visits;
- 1,500 fewer GP consultations for asthma;
- 2,500 fewer GP consultations for respiratory illness; and
- a predicted decrease in symptomatic days in individuals with asthma of approximately 5%.

[59] Entec (2009) have not provided evidence for how these benefits have been estimated.

- Over a million people across the UK may experience a small reduction in the number of days in a year that they experience symptoms, although the vast majority of people, including those with pre-existing respiratory illness, will experience no benefit.
- The day to day variability in pollen count, fungal spore count and weather, plus exposure to respiratory infections, will have a considerably greater impact on respiratory health.
- The revised Regulations may also result in reduction of around 6,000 to 12,000 in the number of new cases of chronic bronchitis in a year.

6.2 Other benefits

Non-monetised benefits include benefits that will occur to the environment due to a reduction in atmospheric pollution. As detailed above there are a range of environmental impacts that occur as a result of sulphur emissions. No attempt has been made as a part of this impact assessment to place a value on the ecosystem services (including nutrient cycling, crop, timber & livestock production, clean water) which have been impacted by air pollution and therefore no figure is included to represent the benefits to the environment of the introduction of the proposed regulation. It is assumed that savings to the UK will be realised through a reduction in the need for remedial work to be undertaken in the future and the continued uninterrupted provision of ecosystem services within the UK. Other non-monetised benefits to the environment include the cultural appreciation of unpolluted ecosystems, for example the enjoyment of walking in a biodiverse environment which is free of pollution or the value received by enjoying an unpolluted fishery.

Further environmental benefits will be achieved through the reduction in Particulate Matter and black carbon which will occur as a result of the introduced regulation. As these pollutants are outside the scope of the proposed regulation the benefits associated with a reduction of these pollutants as a 'by-product' of the desired outcome have not been monetised as the effort involved was considered disproportionate.

Although there will be an economic benefit to the owners of buildings that have previously been affected by acid deposition it is not possible to monetise the cost savings that will occur when the level of sulphur in the atmosphere reduces. Restoration costs may still be incurred by those responsible for buildings that have been eroded by acid deposition but the costs of maintenance and restoration of affected buildings is expected to reduce over time.

Other non-monetised benefits include improvement in the quality of life of members of society that benefit from an improvement in air quality. Wider societal benefits to areas that may have been considered undesirable due to the poor air quality may result in such areas becoming more sociably desirable. Studies within the United States have demonstrated that as air quality improves house prices increase.[60] These studies show that an improvement in air quality can lead to an increase in the value of the properties, which in turn can lead to societal improvements.

There may be benefits to the agricultural sector as soils and water courses recover from the impact of air pollution, resulting in better crop yields and a reduction in the amount of additional nutrients that need to be added to help crop growth.

A possible diversification in the fuel supplies may benefit fuel suppliers and refineries. This possible benefit has not been monetised as predictive data is not available to quantify a possible benefit. This has also been highlighted as a potential cost, which highlights the amount of uncertainty as to what is likely to happen within the fuel production and supply market once the Directive enters into force.

A number of UK technology manufacturers have invested in developing and producing the 'scrubber' equipment that could be used to meet the requirements of the regulation. These companies are likely to benefit as demand for the technology increases.

[60] http://web.mit.edu/ceepr/www/publications/reprints/Reprint_227_WC.pdf

7 EU & European Neighbours' Cost/Benefit Analysis

The Commission's impact assessment concluded that the cost / benefit ratio associated with the new limits under MARPOL Annex VI are highly favourable. Full compliance would realise benefits of between €3 and €13 for every €1 spent, whilst for the emission control areas (ECAs) the benefits are at least between €5 and €25 for every €1 spent.

The methodology underlying the Commission's impact assessment differs significantly from the methodology used for this impact assessment, which follows UK Government appraisal guidance. This is especially relevant for benefits estimates, where UK methodology:

- uses the value of life years lost rather than the value of a statistical life
- includes fewer categories of health impacts for monetising benefits

Once these factors are taken into account, the benefits estimates in the Commission's impact assessment relevant to the UK would be largely consistent with the benefits estimates in this impact assessment.

The prevailing westerly wind within the English Channel and North Sea make the actions taken by the UK of interest to our continental neighbours. As a proportion of the pollution emitted within UK waters will reach landfall and impact upon populations within Europe, the UK has agreed to share its impact assessment with the French Administration responsible for implementation of the Directive in France. This sharing of information will be reciprocated by the French. It should therefore be noted that the actions of the UK will bring about benefits to other members of the EU. These benefits will not be monetised within the UK impact assessment as they are not accrued within the UK or by UK citizens, however this does not diminish the value of the benefit to others.

8 Implementation and Delivery Plan

The transposition of the Directive must be completed by 18 June 2014. The Directive will be implemented through secondary legislation using the Merchant Shipping Prevention of Pollution Regulations. The new legislation will be laid before parliament during May 2014 with the expectation that the legislation would enter into force in June of that year.

Upon entry into force all UK vessels and vessels in UK waters will be obligated to be compliant with the requirements of the new legislation (i.e. 3.5% sulphur content outside SECAs from 18 June 2014 and 0.1% in SECAs from 1 January 2015). Once the legislation enters into force the shipping industry would have until 2015 to plan how they are going to meet the reduced sulphur limits within the Sulphur Emission Control Areas (SECA) of the North and Baltic Seas and until 2020 to assess how to meet the reduction in sulphur limits outside of SECA. This, along with the fact that the industry has been aware of these changes for a number of years (since late 2008) prior to the EU publishing Directive 2012/33/EU, should give ample time for ship operators and owners to source compliant fuel or implement alternative methods of compliance.

The timescales are sufficient to allow the Maritime and Coastguard Agency to adapt and develop the required survey and inspection regime that will be necessary to ensure compliance with and enforcement of the requirements of the Directive.

Supporting documentation in the form of Merchant Shipping Notices will be used to educate and inform the maritime industry and other relevant organisations about the regulatory requirements of the proposed legislation.

9 Enforcement, Sanctions and Monitoring

The proposed legislation provides for inspections of vessels to be completed; this is in line with normal international maritime law. These inspections would be completed as a part of the MCA Port

State Control Inspections. Under the existing Regulations, the MCA is able to carry out a survey and inspection regime to ensure compliance with the requirements laid down in MARPOL Annex VI. The proposed Regulations would also include the facility for the MCA (or appointed personnel) to survey and inspect vessels in accordance with the requirements of the Directive. There would therefore be no change in the work completed by the MCA to ensure compliance. As such, there would be no additional enforcement costs as a result of the proposed transposition of the Directive.

Enforcement would be carried out by the MCA as part of its existing enforcement activities, which is carried out under a regime of proportionate and targeted compliance surveys. The proposed Regulations would provide sanctions for non-compliance. This would include provisions for a fine not exceeding the statutory maximum on summary conviction in some cases, or on conviction on indictment, a fine not exceeding the statutory maximum (£25,000) In the case of a conviction in the Crown Court, the proposed Regulations would allow for a fine established by the Court. These penalties are in line with those for other maritime pollution offences and are considered to be proportionate to the nature of the offences.

Provisions would also exist whereby a ship may be detained in UK waters should a surveyor suspect that an offence under the proposed legislation has taken place.

Collection of data and monitoring information would take place through the survey and inspection regime. When a survey or inspection takes place the details and findings of the operation is recorded as a part of the MCA's normal operational practices. This data would be available for review and monitoring purposes.

10 Risks and Assumptions

There are a number of risks and assumptions that have been identified and considered as having a possible impact on the accuracy of this impact assessment and on the success of the proposed legislation. If further evidence or supporting documentation is required in order to ascertain the level of risk or to support/disprove the assumptions made, then this will be asked for as a part of the consultation process. It is acknowledged that there are some areas within this impact assessment that may need to be re-addressed following the consultation process.

10.1 Risks

Failure to complete the transposition of the Directive could result in infraction proceedings being taken against the UK by the EU, resulting in possible financial penalties, damage to the UK's reputation and negative publicity. The current minimum lump sum penalty set by the ECJ formulae for fines for the UK is approx £8m, with an additional daily fine of between £9,000 and £590,000. As the UK has previously come close to infraction proceedings on sulphur emissions it is likely that the fines imposed will be higher than the minimums indicated.

European Commission Penalty Calculations

The guidance set out by the Commission in document SEC (2005)1658 as amended by SEC (2010) 923, recommends that the European Court of Justice (ECJ) imposes penalties in the form of a lump sum payment for failing to comply with the first ECJ judgment up to the date of the second ECJ judgment with additional penalty payments in the form of a daily fine continuing from the date of the second judgment until compliance..

The formula for the lump sum penalty is:

Basic flat rate lump sum payment (€210 per day) x coefficient for seriousness (on a scale 1 to 20) x 'n' factor (17.54 for the UK, based on capacity of the Member State to pay and the number of votes it has in the Council) x number of days of infringement.

The formula for the daily fine from the date of the second ECJ judgment is the multiple of:

Basic flat rate penalty payment (€640 per day) x coefficient for seriousness (on a scale 1 to 20) x coefficient for duration (1 to 3 calculated at a rate of 0.1 per month from the date of the first judgment to the second, reaching the maximum after 2 ½ years) x 'n' factor (17.54 for the UK).

Other risks include:

- Some sectors of the shipping industry may be unable or unwilling to meet the requirements of the proposed legislation. This could impact on the effectiveness of the policy.
- The data used and assumptions made do not match the reality once the legislation enters in to force resulting in a failure to see the expected benefits.
- The ratio of fuel use to equipment fitting may be different from that used to assess costs and benefits.
- Fuel prices, fuel premiums and scrubber costs may develop differently from the scenarios assumed in the impact assessment.
- Reliance on stakeholders to provide appropriate evidence or advice in order to support the impact assessment and implementation of the Directive. As a part of the consultation process a number of questions and requests for information will be put to interested stakeholders. The responses received will be used to further refine this impact assessment to ensure that a more accurate assessment of the impacts associated within the proposed regulation can be presented. There is a risk that stakeholders may not respond to this request and as such the information on which the impact assessment is based may be limited.
- Some of the data and sources used in creating the impact assessment may be considered dated but in many cases represents best available information.
- The introduction of the legislation may result in modal shift away from maritime transport resulting in associated impacts on specific sectors of the industry (ferries) (job losses). This is an area of the impact assessment that will be elaborated on through the consultation process, with the consultation package requesting further evidence, if available, from industry to support this theory.
- Some sectors continue to push for changes to the regulatory measures which include limited, or staged implementation of the package. If misgivings within the shipping sector over the costs of the measure result in changes to the requirements then the total benefits from the introduction of the measures will be reduced with a commensurate reduction in costs. (It should be noted that there is, at present, no facility within the Directive for a Member State to issue exemptions or provide for a staged application of the measure)
- Other Member States do not implement the requirements of the Directive, leaving UK shipping at a competitive disadvantage and reducing the positive impacts seen as a result of the Directive.

- There is an impact on fuel types (road, heating etc) which have not been taken into account in this impact assessment. Changes in fuel demand could lead to impacts on other fuel types which could lead to costs of benefits to sections of the community which are outside the scope of this impact assessment.
- Failure to implement the Directive could draw direct criticism from other EU countries who may (depending on wind direction) become victims of the air pollution emitted in UK waters. If formal complaints were made, infraction proceedings could follow. Such a situation could also result in difficulties in diplomatic relations between the affected parties and the UK as the transboundary impact of sulphur remains a sensitive issue in central Europe due to the historic problem of acid rain.
- Failure to implement the Directive would impair the UK's international standing at IMO as the UK would have failed to implement the international requirements covered by the Directive in time. This could have a significant effect on our ability to act in ongoing debates at IMO on air pollution issues (including NOx and Black Carbon) and on wider atmospheric policy issues such as Greenhouse Gas.

10.2 Assumptions

This impact assessment makes the following key assumptions:

- Once legislation enters into force compliance within the UK shipping industry will achieved.
- The standards will be implemented globally on the dates indicated to ensure a level playing field globally and within the EU. Ensuring UK shipping is not left at a competitive disadvantage
- Base year for costs and benefits is 2013
- Health benefits will be observed
- Adequate fuel and suitable technologies will be available
- The ratio of fuel switching to use of technology will be 90:10 in 2020
- Alternative fuels are not (at present) a viable alternative to low sulphur fuels or fitting equipment
- Exemptions are not available and will not be issued.
- Fuel costs and fuel consumption forecasts are as detailed in the costs and benefits section of this impact assessment and offer a fair forecast, using current information.
- Costs remain constant post-2020
- An increase in the use of low sulphur fuels by shipping does not result in an increase in the cost of fuels in other areas (road use, heating fuel etc.)

11 Wider Impacts

11.1 Competition Assessment

Provided all Member States implement the requirements of the Directive in a timely manner there will be no impact on competition within the maritime industry as a result of the proposed regulations. If Member States do not implement the requirements of the Directive and the UK does it is possible that UK organisations may be put at a competitive disadvantage. However, any Member States failing to implement the Directive will be subject to infraction proceedings by the Commission.

The Directive will not impact on competition within the equipment manufacturers market as it does not stipulate how to ensure the reduction in sulphur emitted from vessels. This sector will therefore be subject to open competition.

Ferry operators have expressed concern that the implementation of the Directive could lead to modal shift away from sea transportation systems to land-based modes. To date there is no firm evidence to support this assertion but this possibility has been highlighted as an area for further exploration through the consultation process. It should be noted that a number of the operators that have raised such concerns, operate vessels from the UK and may be responsible for employing UK citizens within the locality of port operations but are not UK owned companies.

11.2 Small Firms Impact Assessment

The MCA does not expect that any of the ships that would be affected by the proposed Regulations to be owned and operated by small firms. To flag a vessel on the UK register, the owner/company has to demonstrate a link to the UK. The company does have to be UK registered, but in practice this could be through a PO Box address registered at Companies House. The complicated nature of the maritime industry makes it hard to firmly establish the size of the company and proportion of that company that operates within the UK. However, the MCA considers that the high value of the vessels involved and the operating costs of those vessels suggest that such firms are unlikely to be classified as small. In addition, any firms that have less than 250 employees in the UK often have much larger international parent companies backing them. It is also a complicated exercise to ascertain how many people working within a UK registered company are actually employed in the UK, the large number of those employed will be on the vessels which are often crewed by different nationalities. In addition, the offices of these organisations are also not always located within the UK.

The impact on smaller operators will be directly proportional to the number and size of vessels operated. As smaller vessels will require smaller scrubber units or will burn less fuel, any impacts on small firms are considered to be proportionate to the contribution of their operation to the total mass of sulphur emitted.

Discussions with UK bunker supplies have not resulted in any concerns being expressed by the industry. However, the industry will have a further opportunity to provide evidence of any impacts on business through the consultation process.

All scrubber and alternative equipment manufacturers now fall outside of the description of a small firm as a number of larger firms have brought out the original technology developers who would have met criteria of a small firm in the UK.

11.3 Health Impact Assessment

A specific health impact assessment has not been undertaken. The major driver behind this policy and proposed legislation is the need to improve air quality, the consequences of which will be an improvement in public health, resulting in cost saving to the NHS and Industry. Details regarding the expected health impacts are included within the main body of this impact assessment.

11.4 Green House Gas Impact Assessment

The main greenhouse gas which will be affected by the transposition of the Directive will be carbon dioxide (CO_2). Entec (2009) found that whilst in some sectors would see a net reduction in carbon dioxide production others would see an increase.

Increases in CO_2 emissions of between 10-25% are likely to result from increased energy use by refineries in order to meet increased demand for marine distillate fuels[61]. An increase in fuel consumption by those vessels that use abatement technologies and the reaction of waste waters from the technologies with seawater as it is discharged.

[61] Entec (2009) *Impact Assessment for the revised Annex VI of MARPOL*
http://www.dft.gov.uk/mca/impact_assessment_-_revised_annex_vi_-_july_2009.pdf

Reductions in carbon dioxide may result from vessels switching fuels, resulting in less fuel being consumed, reduction in the amount of the residual oil sludge being burnt as less residuals are produced by distillate fuels. The more efficient nature of distillate fuels will means less fuel will have to be carried by vessels, resulting in less CO_2 being burnt per unit of cargo. It is also a possibility that ship operators will undertake slow steaming or operate at the optimum ships speeds to become more efficient which may result in fuel savings and as such further reduction in CO_2 emissions.

Any low sulphur fuel that is produced within EU refineries should not result in any net increase in emissions as the refineries will need to comply with the cap of the EU emissions trading scheme (ETS). This will mean that any increase in emissions will need to be offset elsewhere in the EU ETS but at a cost to the refinery industry. However, if fuel is imported from outside of the EU there may be a net increase in CO_2 emissions.[58]

11.5 Other Impacts

Local communities situated in the locality of a maritime hub are likely to benefit from improved air quality and an associated increase in standard of living particular as marine engines tend to generate the highest levels of particulate while under manoeuvring loads within port limits.

11.6 One In Two Out

We consider these regulations to be out of scope of OITO, since they transpose an EU Directive without any "gold plating".

We believe that our approach to transposition is consistent with the Government guidance[62]. In designing the policy instrument, the Maritime and Coastguards Agency and the Department for Transport

a. will ensure that the UK does not go beyond the minimum requirements of the measure which is being transposed;
b. have considered implementing EU policy and legal obligations through the use of alternatives to regulation but found this not to be an option for the current Directive;
c. endeavour to ensure that UK businesses are not put at a competitive disadvantage compared with their European counterparts;
d. will use copy out for transposition where it is possible
e. ensure the necessary implementing measures come into force on (and not before) the transposition deadline specified in the Directive, which is 18 June 2014
f. will undertake a post-implementation review on the actual costs and benefits incurred by the measure in order to inform a statutory review after five years in 2019 and every five years thereafter.

[62] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229763/bis-13-775-transposition-guidance-how-to-implement-european-directives-effectively-revised.pdf

Annex 1

When considering the transposition of Directive 2012/33/EU five policy options were originally considered. The options considered were:

A. Do nothing - Maintain the existing sulphur limits under the MS Act, but do not implement the new requirements.

B. Partial transposition – Only transpose those elements which shipowners consider are 'affordable' - e.g. do not transpose the 0.1% sulphur limit for the emission control areas which some shipowners consider would be too expensive for them.

C. Partial transposition - Transpose those elements which are precisely aligned with MARPOL Annex VI, but nothing else.

D. Transpose the Directive in full – using 'copy out' where appropriate and taking advantage of all the derogations that are available for Member States. Apply a proportionate and targeted compliance regime.

E. Implement the full Directive with additional measures to enhance environmental protection and public health – eg: additional limits on vessels in UK waters outside the ECAs.

Options A and D have been discussed in full as a part of this impact assessment. The remaining options were previously discarded as a part of the policy decision making process.

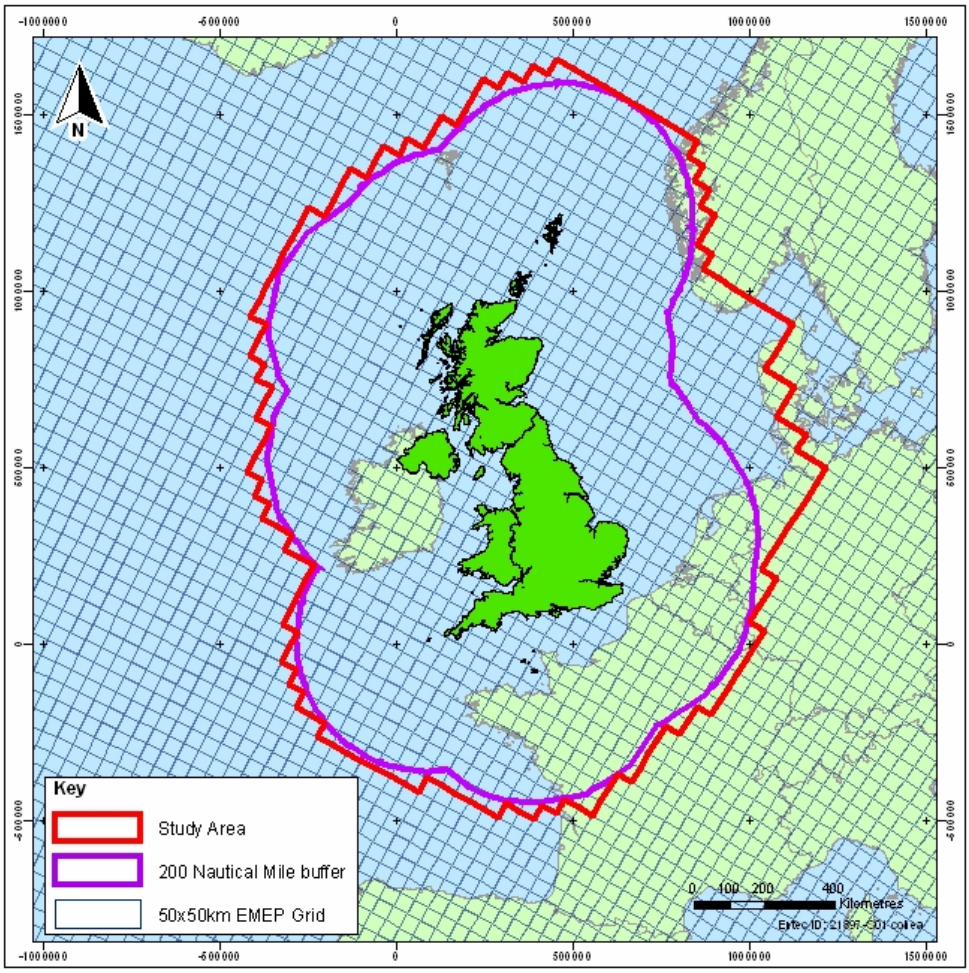
Option B (partial transposition) was discarded as it fails to meet the Government's policy to deliver improvements to air quality and is not consistent with our international Treaty obligations or the cross-government negotiating position agreed by EAC to implement the revised Annex VI. Whilst this option would benefit ferry operators operating inside the ECAs, it would undermine equipment manufactures who have invested heavily in developing 'scrubber' technology. There would also be a risk of infraction proceedings being launched against the UK.

During negotiations, the UK pressed for a closer alignment between the Directive and MARPOL Annex VI, without any gold-plating, similar to the option outlined in C. However, no agreement on this approach could be reached between Member States so to transpose only those elements of the Directive that align with MARPOL Annex VI would result in a partial transposition of the Directive. Like options A and B, option C puts the UK at risk of infraction. It should be noted that the Commission was disappointed by the lack of 'environmental ambition' in the Directive, we would expect it to challenge any watering down of the requirements by Member States.

One area where the Directive could be extended would be to extend the stricter 0.1% sulphur limit that applies to the North Sea and the Baltic Sea in 2015 and apply it to all UK waters. This would increase the benefits to the environment and public health, and could also minimise any distortion in competition between ports and ship operators within the ECA and those outside. This option was also opposed by the UK during negotiations when a unilateral proposal to apply stricter limits was suggested. As 'Gold Plating' goes against the Governments policy of reducing regulation, this option is not considered viable, as it gold-plates the Directive and the requirements under MARPOL Annex VI.

Annex 2.

Study area Map of UK waters as defined in Entec (2008)[63]



Map of the North Sea's Sulphur Emission Control Zone[64]

[63] UK Ship emissions Inventory, Final report, October 2008, Report for Defra
[64] http://www.dnv.com/binaries/marpol%20brochure_tcm4-383718.pdf

Annex 3

		Annual cost before discounting, average 2015-2024, £million		Total cost 2015-2024, discounted, £million	
		Lower bound	Upper bound	Lower bound	Upper bound
		Cost base: UK flagged vessels in the study area:	Cost base: vessels calling at UK ports in the study area:	Cost base: UK flagged vessels in the study area:	Cost base: vessels calling at UK ports in the study area:
	Fuel premium 1	69	453	588	3,850
Uptake A	Fuel premium 2	91	594	770	5,036
	Fuel premium 3	100	623	849	5,322
	Fuel premium 1	70	478	599	4,056
Uptake B	**Fuel premium 2**	**89**	**606**	**757**	**5,133**
	Fuel premium 3	98	628	833	5,360
	Fuel premium 1	93	760	786	6,318
Uptake C	Fuel premium 2	96	775	811	6,475
	Fuel premium 3	98	795	841	**6,679**
50% scrubber cost reduction					
	Fuel premium 1	55	436	**476**	3,697
Uptake C*	Fuel premium 2	58	454	504	3,873
	Fuel premium 3	62	481	544	4,133
	Min	55	436	**476**	3,697
	Max	100	795	849	**6,679**
	Central	**89**	**606**	757	5,133
	Min[1]	69	453	588	3,850
	Average	82	590	696	4,994
	[1]without scenario C*				

The best estimate for costs is the average of the lower bound and upper bound estimates for Uptake B, Fuel Premium 2

central estimate average total cost	**£2,945m**
central estimate average annual cost	**£348m**

EANCB (2009 prices)			
		Lower Bound	**Upper bound**
Based on Annual cost before discounting, average 2015-2024 (2013 prices)		**Cost base: UK flagged vessels in the study area:**	**Cost base: vessels calling at UK ports in the study area:**
	Fuel premium 1	63	414
Uptake A	Fuel premium 2	83	543
	Fuel premium 3	91	570
	Fuel premium 1	64	438
Uptake B	**Fuel premium 2**	**81**	**555**
	Fuel premium 3	89	574
	Fuel premium 1	85	695
Uptake C	Fuel premium 2	88	709
	Fuel premium 3	90	727
50% scrubber cost reduction			
	Fuel premium 1	51	399
Uptake C*	Fuel premium 2	53	416
	Fuel premium 3	57	440
	Min	51	399
	Max	91	727
	Central	**81**	**555**
	Min[1]	63	414
	Average	75	540
	[1]without scenario C*		