Title: Amendments to environmental permitting regulations to improve air quality by transposition of Medium Combustion Plant Directive and application of emission controls to high NOx generators in anticipation of the 2020 NOx emission ceiling within the Gothenburg Protocol	Impact Assessment (IA)
IA No: DEFRA2039	**Date:** November 2016
Lead department or agency: Department for Environment, Food and Rural Affairs	**Stage:** Consultation
Other departments or agencies: Department for Business, Energy, & Industrial Strategy, Welsh Government	**Source of intervention:** EU
	Type of measure: Secondary legislation
Summary: Intervention and Options	**RPC Opinion: Green (fit for purpose)**

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB 2014 prices)	**In scope of One-In, Three-Out?**	**Measure qualifies as**
£1687.4m	-£386.5m	£29.2m	Out of Scope	Non-qualifying provision

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

Medium combustion plants (MCPs) are a major source of air pollutants which can cause harm to human health and are largely unregulated at present. Additionally, domestic energy market incentives are leading to an increase in high NOx (oxides of nitrogen) emission generators, which are a subset of MCPs and have the potential to exceed the Gothenburg 2020 NOx emission ceiling and hourly NO_2 (nitrogen dioxide) limits set in the EU Ambient Air Quality Directive (EU-AAQD). Transposition of the MCPD will not adequately address the risks these generators pose to air quality and to our compliance with the NOx emission ceiling and AAQD so additional regulation is needed and quick action required to avoid further rapid increases in NOx emissions from generators. Government is committed to improving air quality and meeting its legal air quality standard obligations and must transpose the MCP Directive by December 2017 to avoid infraction and associated fines.

What are the policy objectives and the intended effects?

The objective of the measures proposed is to improve air quality and deter a further increase in the use of high NOx emitting generators. These measures will reduce emissions and concentrations of key pollutants harmful to human health and the environment. This will help the UK comply with international air quality guidelines, national emission ceilings and the EU-AAQD. We intend to use well-established legal frameworks and implement requirements in a way which maximises compliance and air quality benefits, whilst at the same time keeping operator costs and burdens to a minimum and avoiding any impact on energy security.

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

Option 0 - Do nothing: Continue with unrestricted use of MCPs, resulting in high levels of emissions

Option 1- Transpose the MCPD into domestic legislation, making use of available flexibilities and exemptions where possible, and adopt a risk based approach to permitting, compliance and enforcement. Emissions growth from high NOx emitting generators continues and has to be dealt with through future policy to avoid non-compliance with emission ceilings and AAQD limit values. **Option 2** – Transpose the MCPD as in Option 1 and enable compliance with AAQD limits and emission ceilings by addressing growth in emissions from high NOx emitting generators by introducing emission controls.

Option 2 is preferred as it will deliver significant benefits to public health and the environment and prevent an increase in high NOx emitting generators - avoiding potential breach of EU and international air quality limits and standards.

Will the policy be reviewed? Yes **If applicable, set review date:** 04/2019

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.	**Micro** Yes	**< 20** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** 0.1		**Non-traded:** 1.7

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 Medium Combustion Plant Directive (MCPD)

FULL ECONOMIC ASSESSMENT

Price Base Year 2014	**PV Base Year** 2018	**Time Period Years** 15	**Net Benefit (Present Value (PV)) (£m)**		
			Low: 385.2	**High:** 1931.8	**Best Estimate:** 1251.5

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Cost** (Present Value)
Low	0.0	N/A	9.7	**105**
High	0.0		41.4	**449.3**
Best Estimate	0.0		19.1	**207.6**

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

For the implementation of Option 1 proposals, all monetised costs in this assessment are treated as direct costs to business. While some enforcement and administration costs will fall to regulators, we propose that they recover costs from operators through permitting and subsistence fees. Monetised costs comprise costs of making plant compliant with emission limits (abatement costs), emissions monitoring, reporting and permitting and annual enforcement fees. The full impact of MCPD applies from 2030, when all plant must meet its requirements and all Emission Limit Values (ELVs) are in force. For operators required to comply with emission limits, the present value (PV) abatement cost over the assessment period is £126.1m (2018-2032). For all MCPs within scope (also including those exempt from ELVs) additional costs faced over the assessment period include administration (£34.7m, PV), and inspections and monitoring (£46.6m, PV).

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

For some impacts evidence is not available or collecting it would be disproportionately costly. These include transitional costs such as communications, guidance, training of regulators and creating tools for permitting and monitoring. These will depend on the choice of regulator which is still to be determined. The costs are considered to be relatively small and uncertain so are not monetised. It is assumed future policies are implemented to address emissions from high NOx generators; costs of these or of missing legal obligations are not monetised.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Benefit** (Present Value)
Low	0.0	N/A	79.7	**834.4**
High	0.0		194.5	**2036.8**
Best Estimate	0.0		139.4	**1459.1**

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

The MCPD will reduce emissions of air pollutants resulting in an improvement in air quality. Monetised benefits represent the benefits of improved air quality on human health and from reduced greenhouse gas emissions. The central PV benefit is £1459.1m over the whole appraisal period, capturing benefits from reduced emissions of NO_x (£788.2m), particulate matter known as PM or dust (£477.3m) and Sulphur dioxide (SO_2) (£157.8m), and greenhouse gases namely carbon dioxide (CO_2) (£35.9m). Benefits relate to plant within scope of this IA (England and Wales only), but implementation of the MCPD across the rest of the EU will also improve air quality in England and Wales because air pollution is a transboundary issue.

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

The monetised benefits are likely to substantially underestimate the full social benefit. Reducing emissions of air pollutants will benefit natural ecosystems, biodiversity and the wider environment which cannot be monetised. It is not possible to monetise all health impacts either. Other secondary impacts that have not been monetised include supporting innovation in abatement equipment/green technologies. This would support increased sales and revenue for the supply chain to these industries and monitoring companies

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5

Plant numbers are uncertain: low and high estimates indicate the associated uncertainty in total compliance costs. Low and high benefits represent the uncertainty in health benefits from improved air quality (damage costs). The high NPV combines low plant numbers (low cost) with high damage cost valuation (high benefits), and the low NPV combines high plant numbers with low damage cost valuation. Full compliance with MCPD by operators is assumed.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: 0.0**
Costs 15.7	**Benefits: 0**	**Net: -15.7**	

Summary: Analysis & Evidence Policy Option 2

Description: Transposition of MCPD and introduction of emission controls for generators to enable compliance with AAQD and 2020 National Emissions Ceilings

FULL ECONOMIC ASSESSMENT

Price Base Year 2014	**PV Base Year** 2018	**Time Period Years** 15	**Net Benefit (Present Value (PV)) (£m)**		
			Low: 620.0	**High:** 2566.1	**Best Estimate:** 1687.4

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Cost** (Present Value)
Low	0.0	N/A	32.9	**354.9**
High	0.0		36.6	**394.4**
Best Estimate	0.0		35.9	**386.5**

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

The monetised costs for Option 2 include the costs of implementing the MCPD as described under Option 1 plus the additional costs from implementing controls on generators with high NOx emissions in order to enable compliance with the 2020 NOx ceiling and AAQD. Therefore, the total present value costs under Option 2 over the assessment period (2018-2032) include the cost of fitting abatement to comply with proposed emission limits (£152.8m), monitoring and compliance costs (£49.2m), and administration costs (£36.7m). In the energy balancing markets, the measures are expected to incentivise a switch from diesel to gas, with higher build costs of £147.8m.

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

Some impacts have not been monetised either because the evidence is not available or collecting the evidence would be disproportionately costly. In addition to those demonstrated in Option 1, the higher build cost of gas could represent an increased cost to the consumer through energy prices. However the impact is likely to be minimal as electricity from the energy balancing market represents a very small proportion of consumer energy prices; therefore it is deemed disproportionate to monetise. Some plants may also see a reduction in revenue as a result of shorter operating hours, however due to the lack of information around individual plant earnings; this hasn't been possible to monetise.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Benefit** (Present Value)
Low	0.0	N/A	96.1	**1014.5**
High	0.0		276.4	**2921.0**
Best Estimate	0.0		196.4	**2074.0**

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

The benefits include those under Option 1 plus additional benefits from controls on generators with high NO_x emissions from further air quality and greenhouse gas benefits (£1,973.6m and £100.4m PV, respectively, for Option 2). The additional benefits under Option 2 are valued based on the reduced emissions from fitting additional abatement technology and the switch from diesel to less polluting gas. The total PV benefit is £2074m.

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

The monetised benefits are likely to substantially underestimate the full social benefit. Reducing emissions of air pollutants will benefit natural ecosystems, biodiversity and the wider environment which cannot be monetised. It is not possible to monetise all health impacts either. Other secondary impacts that have not been monetised include higher sales of abatement equipment/green technologies and increased revenue for monitoring companies and test houses, as well as increased development of low emission technologies.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5

The two key assumptions from Option 1 apply to Option 2. The high and low range in health benefits is applied for Option 2 however the central plant scenario from Option 1 is used for all scenarios in Option 2. An additional key uncertainty for Option 2 regards how the controls affect future investment in generators. The low and high scenarios demonstrate two extremes. The high cost assumes no change in the number of projected diesel plants, and the low cost assumes all projected diesel capacity entering the energy market switch to gas. The low NPV combines low benefits (low damage costs) with high costs (100% switch to gas) for plants in energy markets, and the high NPV vice versa.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: 0.0**
Costs: 29.2	**Benefits: 0**	**Net: -29.2**	

Table of Contents

1. Executive Summary

Air pollution harms our health and wellbeing. The combined impact of Nitrogen Dioxide (NO_2) and Particulate Matter (PM) pollution in the UK is estimated to lead to the equivalent of approximately 50,000 premature deaths per year, at a cost of around £30 billion per year. Air pollution also damages biodiversity and reduces crop yields.

Combustion plants with a thermal rated input between 1 and 50MW, (henceforth designated Medium Combustion Plants (MCPs) are a significant, currently largely unregulated source of emissions of air pollutants (Oxides of Nitrogen- NO_x, PM, Sulphur dioxide- SO_2) which impact on air quality. In addition, schemes intended to increase capacity and provide balancing services in the electricity market are incentivising greater use of particularly polluting generators, which are a subset of the medium combustion plant category. These generators are primarily diesel and emit very high NO_x emissions relative to other forms of generators within the MCP size range. High NOx emitting generators can lead to local NO_2 concentrations capable of causing harm to human health and have the potential to cause breaches in hourly NO_2 air quality limits set in the Ambient Air Quality Directive. The aggregate impact of emissions from all generators also affects national UK emissions totals and compliance with ceilings sets through the Gothenburg Protocol and National Emission Ceilings Directive. The numbers and use of diesel generators are projected to increase rapidly over the next few years due to domestic energy market incentives, including the Capacity Market. This is likely to lead to an avoidable increase in national NOx emissions, which the UK has international (and European) obligations to reduce.

The Medium Combustion Plants Directive came into force in December 2015 and targets MCPs by setting emissions limit values (ELVs) that bring pollution down to safer levels nationally. It also helps meet the international/EU ceilings on key air pollutants. In order to continue operation of medium combustion plants in breach of the ELVs, owners will have to fit technology to abate emissions and regularly test emissions to prove compliance. The UK negotiated a number of important flexibilities to minimise costs and burdens to operators.

However, the provisions of the Directive will not curb the anticipated increase in high NOx generators and the consequent expected breaches of the Ambient Air Quality Directive Limits and upcoming NOx emission ceiling which are set for the protection of human health. For example most diesel generators operate for less than 500 hours and therefore would be exempt from the provisions of the MCPD. While the NOx ceiling will not come into effect until mid-2018, quick action is needed to curb an anticipated but avoidable rise in national NOx emissions from high NOx generators and we intend to tackle this issue through additional measures targeted at electricity generating plants. Under Option 1 it is assumed these additional measures are developed and introduced later, while Option 2 considers developing these measures now. Taking action early will reduce burdens on businesses by proactively preventing the proliferation of high NOx generators which would subsequently have to be retrofitted at a high cost to businesses. It also gives existing operators more time to prepare as waiting until the NOx ceiling has been transposed gives a very limited time to consider measures in time to meet the 2020 requirements. Controls on high NOx generators will take effect from 2019 – once the ceilings will be in place. We are consulting on MCPD and controls for high NOx generators jointly to make the combined impact of these proposals clear to industry.

This impact assessment considers options for applying emission controls to MCPs, by transposing the MCP Directive, and the introduction of measures for electricity generating plants emitting high levels of NOx in England and Wales to ensure compliance with the other international commitments. Scotland, Northern Ireland and Gibraltar are laying their own legislation to transpose the Directive. This impact assessment compares the baseline option (Option 0) where no emission controls are introduced with:

a) Option 1 where the MCPD in transposed into domestic legislation, making use of available flexibilities and exemptions where possible and adopting a risk-based approach to permitting, compliance and enforcement. Emissions growth from high NOx emitting generators continues and has to be dealt with through future policy to avoid non-compliance with emission ceilings and AAQD limit values, and

b) Option 2, which transposes the MCPD as under Option 1 and introduces emission controls for high NOx emitting generators, required to enable compliance with air quality limits and to curb avoidable increases in national NOx emissions due to current energy market incentives.

We intend to regulate emissions from MCPs by amending the Environmental Permitting (England and Wales) Regulations 2016[1]) to transpose the Medium Combustion Plant Directive (MCPD), which will result in over 10,000 plants becoming subject to emission controls. The EPR currently regulates some combustion plants, mostly including those over 20MW. It therefore offers an approach to implementation, which is well understood and will provide clarity for operators and promote compliance, while keeping enforcement costs low. MCPs in the 1-50MW range are a very diverse group of plants and so we intend to follow a risk based approach to implementation by using the flexibilities provided in the Directive, to avoid disproportionate costs to operators and an impact to energy security.

Under Option 1, new plants will be required to comply with emission controls from 2018. Plants already in operation by that date will be given longer to comply with the ELVs recognising the high number of plants

[1] http://www.legislation.gov.uk/ukdsi/2016/9780111150184/contents

affected and to allow operators time to make the necessary changes. We will also allow later compliance dates for gas compressor plants supporting the national grid, where earlier retrofitting will be very difficult to achieve and for district heating and biomass plants, to enable a longer time for investment for these sustainable technologies. We will exempt most plants which operate up to on average 500 hours per annum, from ELVs because they are responsible for a very small proportion of emissions and therefore the costs of abatement will be disproportional. We will also extend this exemption to 1000 hours for plants operating in an emergency when providing support for remote islands. However, we will be testing the application of the 1000 exemption in the event of exceptionally cold weather during consultation. Lastly, in line with government policy we will be applying the flexibility for a higher NOx ELVs for engines operating between 500-1500 hours under this Option. However because modelling indicates that emissions at these levels could pose a risk to local air quality controls have been applied under our preferred Option, Option 2, this will protect local air quality and apply to any engine that may cause a breach of Ambient Air Quality Directive Limits.

Under Option 2, in addition to the requirements set out for Option 1 above, we propose earlier use of a specific ELV which is more stringent than some ELVs allowed under MCPD to deter market entry of high NOx generators, and encourage cleaner alternatives. The proposals exempt plants used to provide power during site emergencies and provide plants operational prior to December 2016 and those with Capacity Market agreements from 2014 and 2015 auctions (Tranche A generators) with additional time to meet stringent emissions limits. However plants with high emissions will be required to meet controls aimed at protecting local air quality unless they run for less than 50h per annum. Installations operational after December 2016 (Tranche B generators) would be expected to meet tight emissions standards aimed at protecting local and national air quality unless they are exempt e.g. because they operate for less than 50 hours per year or because they are used to provide back-up power during site emergencies. These controls will also be introduced through an amendment to the EPR. These controls should help to enable compliance with national emission ceilings and the Ambient Air Quality Directive while minimising the impact on energy security.

Our analysis demonstrates that it is highly cost-effective to apply both the proposed MCPD controls and proposed emission controls to high NOx generators.

Results for the preferred option (Option 2)

The forecasted reductions in emissions from a national level as a result of these controls are presented for the preferred option in Table 1.1, below.

Table 1.1 Emission reductions delivered in 2030 by proposals assessed in the impact assessment, in Kt and as a percentage of total UK emissions.

Kt (%)	SO2	NOx	PM	CO_2
Option 2	16 (11%)	16 (3%)	3.1 (2%)	229

The central NPV estimate of Option 2 is £ £1,687m which includes the benefits from transposing the MCPD and the additional measures for generators emitting high levels of NOx. The full costs and benefits are presented in Table 1.2 below.

Table 1.2 Costs and benefits of Option 2 (£m, discounted)

2018-2032	LOW (£m)	HIGH (£m)	CENTRAL (£m)
Costs (cost to operators)			
Abatement costs	126.3	258.6	152.8
Administration costs	36.7	36.9	36.7
Monitoring costs	46.7	59.4	49.2
Operational/capital cost of technology switch	184.8	-	147.8
Total	394.4	354.9	386.5
Benefits (emissions reductions)			
Air Quality pollutants	932.0	2,802.4	1,973.6
CO2 (Traded)	2.9	4.5	3.6
CO2 (Non-Traded)	79.6	114.1	96.8
Total	1014.5	2,921.0	2,074.0
NPV	620.0	2,566.1	1,687.4

*Please note any differences due to rounding.

Table 1.2 presents the costs and benefits that have been monetised. However, while as far as practicable all the impacts have been quantified and monetised, some impacts have not been quantified. The key impacts which were not quantified are the wider environmental societal benefits through improvements to ecosystems due to the reduction in emissions. Additionally, under Option 2, the revenue loss experienced by the reduced running hours from high NOx generators in Tranche A, and the benefits to other plants who meet the proposed limits of greater access to revenue streams is not included. As there are costs and benefits to different plants, this is likely to be an economic transfer (revenue loss for one plant in the market is a revenue gain to another plant in the market) and likely to have minimal impact.

2. Introduction

Air pollution harms human health and the environment. The combined impact of NO_2 and PM pollution in the UK is estimated to lead to the equivalent of up to 50,000 premature deaths per year, at a cost of around £30 billion per year. Air pollution also damages biodiversity and reduces crop yields

Some of the health effects caused by exposure to elevated levels of pollution are outlined below:

Table 2.1 Health effects for very high levels of pollutant emissions

Pollutant	Health effects at very high levels
Nitrogen Dioxide (NO_2),	Collated research by COMEAP into the health impacts of NO_2 has shown that it is reasonable to associate NO_2 in outdoor air with adverse effects on health, including reduced life expectancy. As part of this report, it was established that there were likely to be short term and long term effects as Short-term exposure to NO_2 has been linked to some direct effects on respiratory morbidity, while Studies of long-term exposure to NO_2 report associations with all-cause, respiratory and cardiovascular mortality, children's respiratory symptoms and lung function.
Sulphur Dioxide (SO_2) and Ozone (O_3)	These gases irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases
Particulates (PM, which includes PM_{10} and $PM_{2.5}$)	Fine particles ($PM_{2.5}$) can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases

Air quality is a transboundary issue which needs to be addressed at an international level, by reducing emissions from all sources. The Medium Combustion Plant Directive (MCPD) is designed to reduce emissions from combustion plants with a thermal input between 1 and 50MW, which are largely unregulated across Europe as they fall between the scope of Industrial Emissions Directive (which regulates plants and sites over 50MW) and the Eco-design Directive (which applies to certain combustion appliances below 500KW).

Air pollution is measured in two different ways; by total emissions and concentrations. Emissions are the discharge of a pollutant from a specific source, in this case combustion plants and generators. Total emissions are regulated by the 1999 Gothenburg Protocol, under which States agreed to cap their annual emissions of certain pollutants by 2010 as a reduction from 1990 levels. The Protocol was amended in May 2012, which set more stringent targets for reducing emissions and added new limits for other airborne pollutants, as a percentage of 2005 levels by 2020. The EU National Emissions Ceilings Directive is the European legislation that implements the limits agreed under The Gothenburg Protocol. The Directive sets annual limits for each pollutant, including NOx, which Member States had to achieve by 2010 and each year thereafter.

In 2015 the European Commission brought forward revised proposals to build on the Directive by setting 2020 ceilings (in accordance with the revision to the Protocol) and additional 2030 emissions ceilings. The continuing aim being to reduce the significant impacts air pollution can have by reducing domestic and transboundary emissions. These proposals were agreed earlier this year and need to be transposed by mid-2018.

The Ambient Air Quality Directive sets limits for both short term and annual pollution concentrations.

The MCPD was supported by the UK as it will introduce cost effective reductions in pollutant emissions. It will provide an estimated 24% of the action needed to reduce SO2 and 9% to reduce NOx emissions, to meet the 2030 national emission ceilings. The Directive also provides important flexibilities and exemptions where costs are deemed to be disproportionate, overly burdensome or pose a risk to energy security. The Directive came into force in December 2015, with a 2 year transposition deadline. Following the conclusion of the MCPD negotiations a large number of diesel engines made successful bids into the Capacity Market in 2015. This raised concerns because diesel generators have high NOx emissions relative to other forms of energy generation applying for the capacity market and the installations proposed are not subject to regulatory emissions controls.

In recent years there has been a significant drop in the amount of spare capacity in the Great British (GB) power system, as coal and nuclear power stations have been decommissioned and replaced by intermittent forms of generation such as wind and solar. The Capacity Market is Government's key policy tool to bring forward sufficient reliable electricity capacity to ensure we maintain a secure supply of electricity. The Capacity Market operates as an adjunct to the energy market and other revenues that can be earned from electricity balancing contracts and network charging arrangements. It is technology neutral, allowing any type of capacity to participate provided it otherwise complies with relevant legislation. 'T-4' Capacity Market auctions seek to procure capacity four years in advance of the required delivery window, and award 'capacity agreements' to those successful. These agreements have one year duration for existing capacity, and up to 15 years for new generating capacity. A capacity agreement is not a contract, but it places a number of statutory delivery obligations on the holder in return for an ongoing payment stream over the period of the agreement.

Two T-4 auctions have already been held, the first was in December 2014 which awarded agreements for the delivery period starting in October 2018, and second in December 2015 for the delivery period starting in October 2019. A third T-4 auction will be held in December 2016, followed by the first of the annual 'T-1' auctions, which will be held one year ahead of delivery offering 1-year agreements (only) to top-up/fine tune the capacity requirement as needed for the coming delivery year. In response to swifter decline in capacity margins than previously expected, a further 'supplementary capacity auction' was announced in 2016, and will be held in early 2017 to secure capacity for the October 2017 – September 2018 delivery period.

Diesel generators can ramp up to full power quickly, have low building costs and do not require a connection to the gas grid. These characteristics mean that diesel generators provide an important energy security function to sites such as hospitals, schools and data centres in the event of emergencies such as power cuts. They are also well placed to provide frequency response services and additional standby capacity for the National Grid through contracting into services such as Short Term Operating Reserve (STOR)[2]. The use of generators for these "energy balancing" services can be profitable for investors, and their location on the distribution network means they can also earn further revenues – known as 'embedded benefits'. These revenues arise as a result of the 'TRIAD' methodology used to recover the costs of building and maintaining the electricity transmission network. This methodology *charges* (larger) generators connected at the transmission level, but *pays* generators connected at the distribution level provided they are able to respond to peak demand signals (which diesel generators are well-placed to do as a result of their fast response times. These embedded benefit revenues are significant, and are currently forecast to rise – although Ofgem (the Energy Market Regulator) is currently considering steps to address this, due to concerns it is distorting competition. Additional capacity for the GB electricity system can be provided by less polluting generators but Capacity Market agreements are awarded to bidders on the basis of price so diesel installations that can readily access other income streams are able to out-compete other less polluting plants – resulting in additional emissions which could be avoided.

When the December 2015 T-4 auction results were available Defra commissioned initial modelling to understand the impact of more high NOx emitting generators on air quality. The modelling indicated that the 2020 national NOx emission ceiling agreed under the Gothenburg Protocol could be missed due to the additional emissions from these generators. In addition it indicated that these generators may pose a risk to local air quality by exceeding concentration limits for hourly levels of NO_2 set by the EU Ambient Air Quality Directive. This limit is the same as that advocated by the World Health Organisation in their guidelines for the protection of public health. In response to these findings Defra decided to carry out further analysis with a view to developing regulation to tackle this issue.

The numbers and use of diesel generators are projected to increase rapidly over the next few years due to domestic energy market incentives, including the Capacity Market. This is likely to lead to an avoidable increase in national NOx emissions, which the UK has international (and European) obligations to reduce. The MCPD will not provide the controls required to adequately address this problem so quick action is needed to address it. The Gothenburg Protocol set a national cap on annual emissions and it is up to countries to decide how these ceilings will be met. The 2020 ceilings agreed in 2012 will come into force when the revised National Emissions Ceiling Directive is transposed (due mid-2018). Latest emission projections suggest in 2020 the UK will meet the NOx ceiling with a margin of just 1.3kt – however these projections do not take account of the growth in emissions from diesel generators. The additional capacity from the 2014 and 2015 auctions is estimated to result in 0.9kt of additional NOx emissions in 2019. Therefore the continued growth of high-emitting generators expected without further action will likely cause the 2020 ceiling to be exceeded delaying action in this area risks imposing unnecessarily burdens on operators who would have little time to deliver reductions before 2020.

The system of incentives set up to ensure sufficient capacity on the GB energy market (including the Capacity Market) could not have been foreseen when the EU Ambient Air Quality Directive was first transposed, or when the 2020 emission ceiling was agreed. So it is now necessary to take this additional action on high NOx generators in order to enable compliance.

In March 2016 DECC's consultation on further reforms to the Capacity Market highlighted the role of diesel generators in contributing to harmful levels of air pollutants. The document announced Defra's intention to consult later in 2016 on options, including legislation, which would set binding emission limit values on relevant air pollutants from diesel engines, with a view to having legislation in force no later than January 2019 and possibly sooner. We do not intend for these additional measures to be implemented until after the ratification of the Gothenburg protocol.

[2] http://www2.nationalgrid.com/uk/services/balancing-services/reserve-services/short-term-operating-reserve/

Existing legislation and controls (see Fig 1 for overview)

Combustion activities are a large source of air pollution and so are already subject to some emission controls. Figure 1 demonstrates how the proposals considered in this impact assessment fit within current EU and domestic emission controls.

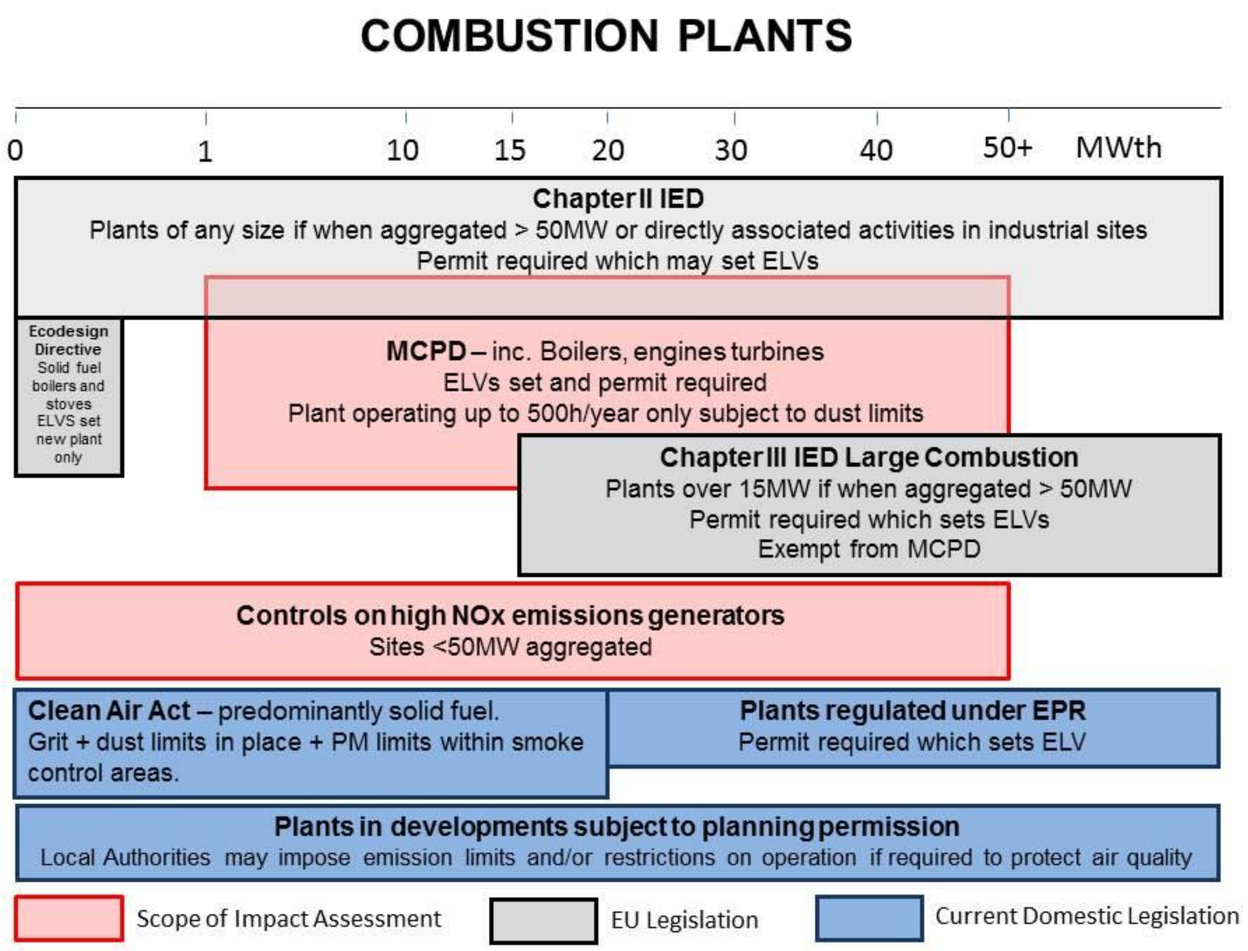
Emissions from some combustion plants, including all those over 20MW, are currently regulated under the Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EPRs). These regulations transpose the Industrial Emissions Directive for plants on industrial sites with aggregated power over 50MW, and implement domestic provisions for plant between 20 and 50MW. The EPRs requires all plants in scope to have a permit, which set controls on emissions to air and requires operators to regularly test emissions and be subject to regular inspections.

The Clean Air Act 1993 controls the emission of dark smoke and places restrictions on the type of fuel and appliance which can be used in smoke control areas. The Act also specifies minimum stack heights for some plant. .

In addition, installation of combustion plants may be subject to planning permission, where their impact to local air quality is assessed. If the assessment indicates that air pollutant concentrations at a sensitive receptor (e.g. a location where people are likely to be present or a sensitive habitat) are likely to exceed those set in the Ambient Air Quality Directive, local authorities may require these plants to mitigate their impact on local air quality.

Generators providing services through the Short Term Operating Reserve[3] are likely to be subject to a local air quality assessment through the planning process. However many combustion plants including diesel generators installed mainly for the purposes of providing back-up and located within existing buildings are unlikely to be subject to planning requirements.

Figure 1: Regulatory landscape for Combustion Activities



[3] See glossary for definition

New proposals

MCPD

The Directive (*Annex I*) will introduce a system of registration/ permitting for 1-50MW plant, emission limits for nitrogen oxides, sulphur dioxide and particulate matter and mandatory periodic monitoring of emissions by operators. MCPs typically provide power or heating for industrial sites and large buildings (offices, schools, prisons, hospitals) and include boilers, engines, turbines and backup generators supporting Scottish Islands, National Grid and nuclear power stations. Through negotiations, the UK secured a number of exemptions and flexibilities e.g. for offshore plant, remote islands when connection to the power grid fails, gas compressors supporting the National Grid and the smaller most prolific plant, to minimise burdens and mitigate impacts on energy security. The MCPD also allows an exemption from emission limits for plants which operate a limited number of hours (less than 500 hours); given that abatement costs may outweigh the benefits provided by a small emission reduction. In addition the Directive allows MS to establish National systems and rules for managing permitting, enforcement and compliance.

Permitting will be required for operation of all plants in scope of the Directive. From December 2018 all new plants will need a permit and from January 2024 existing plants over 5MW and from January 2029 existing plants between 1 and 5MW must be permitted. All plants operating on solid fuels and those which operate on average more than 500 hours per annum will be required to comply with emission limits - from December 2018 for new plants, from January 2025 for existing plants over 5MW and from January 2030 for existing plants between 1 and 5MW. Periodic emissions monitoring will be required for all plants – for carbon monoxide and for the pollutants where emission limits apply. Several flexibilities and exemptions apply to certain types of plants, as presented on section 6.

High NOx Generators

In addition to the MCPD controls, Government is proposing to introduce controls on generators with high NOx emissions in order to curb the anticipated increase in NOx emission resulting from domestic energy market incentives and protect local air quality. The controls will help to ensure that we are compliant with NOx emissions ceilings (which will be more stringent in 2020) as well as the hourly concentration limits set in the Ambient Air Quality Directive, and as such is not gold plating of the MCPD. The proposals (outlined in detail in Section 6) seek to improve local air quality and reduce national emissions at a pace which does not undermine energy security. Addressing growth in emissions from high-NOx generators is necessary to ensure the 2020 emission ceiling, in particular is met and controls are also a cost-effective source of emission reductions looking ahead to the 2030 emission ceilings (as an indication, in 2030 the cost of additional controls under Option 2 are around £5,000 per tonne of NOx abated while the NOx damage cost applied for 2030 is just under £16,000 per tonne).

It is clear that action will be required to address emissions from high NOx emitting generators to ensure compliance with our international (and European) obligations. For option 1 it is assumed that this action is developed at a later date – for instance, waiting until the 2020 emission ceilings have been transposed. Option 2 considers developing measures now. This has the advantage of giving operators greater warning of future policy enabling them to make informed investment decisions, which could reduce their overall costs of compliance.

Proposed legislative approach

For Option 1 we intend to transpose the MCPD by amending the existing EPRs to include a new schedule for MCPs and address any overlapping requirements in the main body of the Regulations. We will also amend the Clean Air Act, again to prevent any double regulation.

For Option 2 we will proceed as above but append 2 new schedules to the EPRs; one for MCPs and one for high NOx generators.

Operators will be required to hold a permit for plants which fall within the scope of both MCPD and generator controls and amendments to the EPRs will seek to;

1) Comply with requirements of the MCPD and
2) Comply with hourly concentration limits set in the Ambient Air Quality Directive
3) Stem the projected increase in numbers of heavily polluting plant in favour of cleaner technology

These proposals will also help the UK to comply with the National Emissions Ceilings for NOx.

To make the combined impact of these proposals clear to industry we are consulting on these proposals jointly.

Devolved Administrations

This Impact Assessment covers joint amendment of the EPRs by England and Wales to transpose MCPD and introduce controls on generators with high NOx emissions. Scotland, Northern Ireland and Gibraltar are laying their own legislation to transpose the Directive. Since very few of the Capacity Market diesel installations from the 2015 auctions were located in Scotland, the Scottish Government is still reviewing the case for adopting controls for generators with high NOx emissions.

2.1 Definitions

Described below are the definitions of key terms used through this document. A full glossary of terms can be found in Section 0.

a) MCPD

New and existing plant - Definitions for new and existing plants are provided in Article 3 of the MCP Directive. These are important as the emission limit values that apply to each, and date of application, differ between the two.

- ***An existing combustion plant*** is defined as one that is "*put into operation before 20 December 2018 or for which a permit was granted before 19 December 2017 pursuant to national legislation provided that the plant is put into operation no later than 19 December 2018."*

- ***A new combustion plant*** is defined as any plant other than an existing combustion plant i.e. any plant put into operation after 19 December 2018.

Plant type: Articles 6(3) and 6(8) allow for different treatment of plant that operates fewer than 500 hours per annum. However within this hourly limit plants can be broadly split into 2 categories based on their role for energy security and overall contribution to total emissions, so for the purpose of this assessment plants have been identified as follows.

- ***Working plant*** = those operating on average more than 500 hours per year which are subject to compliance with emission limits.

- ***Stand-by plant*** = plant installed alongside working plant to provide for additional demand at peak times or in case of shut down of the main working plant, and operating fewer than 500 hours per year.

- ***Back-up plant*** = plant installed to provide emergency electricity generation in times of interruption to supply of mains grid electricity, operating rarely and normally much less than 500 hours per year (assumed to be less than 50 hours).

Abatement technology refers to techniques and technologies used to reduce pollutant emissions, Primary abatement prevents formation of pollutants and includes a switch to fuels which result in lower emissions, retrofitting of existing plant (e.g., by changing the burners) and selection of new plant with lower emission. Secondary abatement removes pollutants from the exhaust gases, such as filters for dust or selective catalytic reduction to destroy NOx.

MW; Megawatts – in this Impact Assessment unless otherwise stated this refers to Mega Watts of thermal input.

b) High NOx Generators

Installation: Diesel generators which provide power for the energy market often have arrays of small generators with a thermal input less than 10 MW each. It is therefore proposed that controls will be applied to Installations, and defined as follows in accordance with the Environmental Permitting Regulations Schedule 1:

(a) a stationary technical unit where one or more activities are carried on, and

(b) any other location on the same site where any other directly associated activities are carried on and references to an installation include references to part of an installation.

Emissions in mg/Nm^3: milligrams per normalised cubic metre. Normalised emissions are converted to reference conditions, which are the same as those used to set Emission Limit Values under the MCPD.

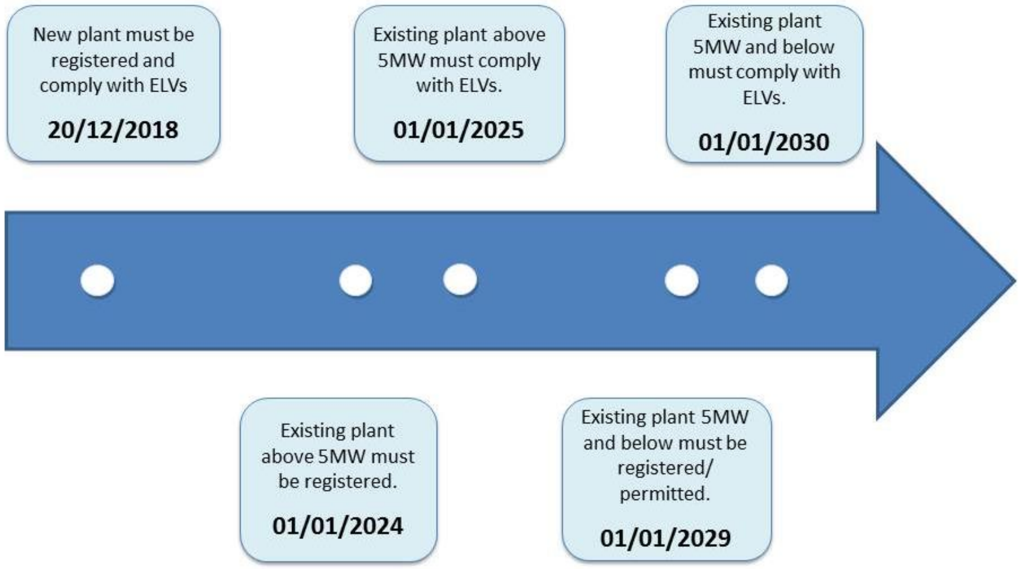
The definitions for **MW, working, standby and backup plant**s remain the same as MCPD. In addition, plants are further categorised as:

- **Tranche A**: Generators installed before 1 December 2016, those with a Capacity Market Agreement following the 2014 and 2015 auctions, including those that are not operational by 1 December 2016 and those for which a Feed-in Tariff preliminary accreditation application has been received by Ofgem before 1 December 2016.

- **Tranche B**: Any generators other than a Tranche A generators.

2.2 MCPD Key Dates

Figure 2: timescale for implementation of the MCPD



2.3 MCPD Key Obligations

2.3.1 Operator

Operators are required to:

- Obtain permits for plants by set deadlines and update them as required; monitor emissions within four months of registration/permitting dates. An existing permit can be updated or combined to include MCPD requirements; permits issued under Chapter II of IED are considered compliant.
- Monitor emissions at a set frequency, ensure plants meet ELVs and keep non-compliance to a minimum.
- Record information regarding operation of plants.
- Keep records or information proving the effective continuous operation of secondary abatement.
- Keep start up and shut down periods as short as possible.
- Report certain non-compliances with ELVs to the regulator, and cease operation if requested by the regulator, when plants are causing significant degradation to local air quality.

2.3.2 Regulator

Regulators are required to:

- Set up a system for permitting or registration of combustion plants.
- Determine which permit conditions apply based on plant characteristics. Update or combine existing permits. Update the permit or registration when notification received by the operator of any planned change to MCP which would affect the applicable emission limits.
- Establish a regime of compliance checks to enforce the MCPD and controls on generators with high NOx emissions.
- Publish, including on the web, a register with information about combustion plants permitted.
- Require operator to take any measures necessary to ensure that compliance is restored without undue delay.
- Order suspension of plant operation when non-compliance with emission limits is causing a significant degradation to air quality.
- Report data to Defra as required and to enable meeting reporting requirements to the Commission.
- Judge whether multiple plants on an installation should be aggregated.
- Deal with reports from operators (e.g. lack of low sulphur fuels, non-compliance due to equipment faults) and set conditions for continued operations (e.g. adjustments to reduce emissions, time-bound exemption from compliance with ELVs).
- Set out a system for requesting data and information held and retained by operators for compliance with the Directive and in response to access to information requests by the public.

2.3.3 Member State

Member states are required to:

- Implement the Directive, and made decisions on whether and how to apply the flexibilities and exemptions allowed.
- Submit reports to the Commission with estimates of annual pollutant emissions from MCPs in 2021 (CO only) 2026 and 2031 (all pollutants).
- Report use of derogations from compliance with emission limits.
- Assess the case for applying stricter emission limits in zones which are non-compliant with the Ambient Air Quality Directive (following the provision of a report by the Commission for which no date has been set).

2.4 Plant numbers

Up to 10,000 working plants are expected to need to comply with emissions limits under MCPD with around 90% in the 1-5MW range, running in the main on natural gas, but also solid and liquid fuels, including biomass and biogas. In addition, up to 15,700 plants are estimated to be stand-by and up to 9,000 backup plant, both of which are mostly exempted from MCPD emission limits but nonetheless required to carry out some administrative tasks limited emission monitoring and undergo enforcement measures.

Controls for generators with high NOx emissions will be applied to an estimated 3,200 installations by 2030 (nearly all –over 95%- would be classed as standby i.e. operating for less than 500 hours), although if further plants are projected in the capacity market, then this figure will increase year on year. Calculation of plant numbers is presented in the methodology section, where there is an explanation of how total plant numbers filter through compliance requirements and eligibility for specific exemptions in section 6 (table 6.3).

3. Problem under consideration

Addressing air pollution requires action at local, national and international level, to address both hotspots and background pollutant concentrations. Indeed, about one third of air pollution is transboundary and this justifies taking action across Europe. Existing domestic legislation already places emission limits on combustion plant largely those above 20MW, while EU Ecodesign legislation applies emissions standards for some combustion plant up to 500KW. The proposals assessed in this document are designed to deliver cost-effective emission reductions for plants with thermal input less than 50MW which will deliver improved air quality by introducing emission controls and driving a move to lower emissions technology. However, only the proposals under Option 2 meet the requirements for transposition of the MCPD while maintaining compliance with air quality limits and making a significant contribution to meeting national emissions ceilings.

MCPD

Transposition of this Directive will help to improve air quality and meet emission ceilings by applying emission limits to a large number of plants which are currently unregulated. The scope of the Directive is wide ranging with the vast majority of plant in the 1-5MW range, a significant proportion of which are low risk gas boilers with low levels of emissions.

The MCPD should be transposed in a way which maximises benefits to air quality by ensuring high level of compliance, while avoiding unnecessary costs to operators and regulators by making best use of available flexibilities. In transposing MCPD Member States are required to:

a) Decide whether to implement the exemptions provided, recognising the general Government principle to apply exemptions in full.

b) Implement National systems or approaches in terms of permitting, enforcement and compliance.

Our proposed approach to transposition is presented in Section 6, including application of the allowed exemptions and flexibilities.

High NOx Generators

Diesel generators (also referred to as compression ignition engines) produce high levels of NOx emissions but have not previously been regulated because they have typically been used for emergency back-up power and therefore only run for very limited periods. However, their use for non-back-up purposes is now increasing in response to recent energy market incentives and is projected to rise rapidly over the next few years. Modelling carried out by the Environment Agency indicates that installations of the type and operating pattern used for energy balancing are capable of breaching legally binding hourly local air quality limits set for the protection of human health.. Consulting about this policy will assist businesses by discouraging them from buying high NOx emitting generators which may subsequently need to be retrofitted. As the cost of retrofitting existing generators can be higher than the cost differential between diesel and non-diesel generators, initiating the policy process now will help businesses make the most appropriate investment decisions.

On a MW basis diesel engines are cheap to buy relative to other generation assets, do not rely on a connection to the gas grid and are able to ramp up to maximum power quickly. This profile makes them able to access greater profit for providing energy balancing services than other forms of electricity generation because although the fuel is relatively expensive much of the income available for providing energy balancing services is in the form of “availability payments”. This profile means diesel generators are outcompeting less polluting alternatives in the Capacity Market (for example the average base case emissions of NOx from diesel engines is 1200mg/Nm3 compared to a base case of 190mg/Nm3 for gas engines) and this is leading to a rapid increase in their numbers and hours of use which poses concerns for air quality.

4. Rationale for Intervention

Combustion plants emit air pollutants (NOx, SO_2, and PM) that can have a seriously harmful impact on human health and the environment. However, when deciding how much to use their plant, operators may not be aware of, and are not impacted by, the cost they impose to society of the air pollution from their operations. This is known as a negative externality. If combustion plants were impacted by the true cost of their operations (i.e. taking account of the cost of the pollution), they may operate differently.

The Government has a commitment to improving the air we breathe and reducing the emissions and concentrations of harmful pollutants. One of Defra's key objectives for 'Creating a Better Place for Living' is to ensure a cleaner and healthier environment, including cleaner air. Hence the rationale for intervention is reflected by the drive to deliver health and environment benefits through cost-effective improvements to air quality, ensuring operators have sufficient time to make the transition to comply with controls on combustion plants.

MCPD

Some plants, in the main those larger than 20MW are already subject to emission controls in the UK and in the future solid fuel plants up to 500KW will be subject to placing on the market standards (through the EU Ecodesign Directive), which leaves a wide regulatory gap. Emission controls under the UK Clean Air Act are focused on burning solid fuels in urban areas only, which is relevant only for a small minority of MCPs. Furthermore as the original Clean Air Act is now 60 years old, with the exception of smaller wood burners, the limits are so loose that most modern plant easily meet the requirements and therefore are not driving change. Regulation is therefore required to apply cost-effective emission controls for this important source of air pollution which incentivise the development and uptake of cleaner technology.

High NOx generators

The energy market is driving an increase in use of generators with high NOx emissions, such as diesel engines, because energy balancing services are procured only on the basis of cost. The resulting impact is a market failure, where revenue incentives encourage the use of diesel generators by not taking into account the social cost of their operation e.g. damage to public health caused by pollution. Emissions from generators of the type used for energy balancing markets are not regulated at present and the MCPD will not provide sufficient control on emissions from these plants, many of which will be exempt from the ELV requirements due to their short running times. Additional measures are therefore needed for electricity generating plant with high NOx emissions to correct this market failure.

5. Policy Objectives

The policy objective is to improve air quality across the UK, which will assist in meeting the requirements of the Ambient Air Quality Directive and revised National Emissions Ceilings in 2030. We will achieve this through the introduction of new controls for high NOx generators and by transposing the MCPD.

Effective transposition of the MCPD will avoid the risk of infraction and due to transboundary impacts implementation by the rest of the EU will further improve air quality in the UK. The MCPD provides for a number of flexibilities, which Member States may choose to apply. It also allows Member States to determine the appropriate approach to enforcement, monitoring and permitting. We intend to apply a number of exemptions and flexibilities to keep costs to businesses to a minimum and ensure that they are not at a competitive disadvantage with businesses in other Member States. We intend to test the need for an exemption related to emergency use in exceptionally cold weather via public consultation. We will also adopt a risk based approach to enforcement and permitting to keep costs and burdens to a minimum whist still protecting and improving air quality. Operators of small low risk plants demonstrating compliance with the requirements will benefit from a light touch approach, whilst the higher risk plant and operators which fail to comply with their obligations will be subject to more stringent approach with increased controls applied.

The policy objective of the controls on emissions from generators with high NOx emissions is to improve local and national air quality by reducing emissions from this source and curbing the increase in the use of plant with high NOx emissions without having a detrimental effect on energy security. The proposals also seek to increase the incentive for cleaner technologies to replace more polluting generators in the energy balancing market.

6. Analysis of Options

The Impact Assessment has a 15 year assessment period which begins in 2018, when the first costs arising from implementation of the MCPD will be incurred by plant operators, and involves a calculation of the total net present value for the period. This 15 year appraisal period is needed to cover full implementation of the MCPD (complete in 2030).

From 2030 onwards, all plant in scope of the MCPD and diesel controls will be subject to permitting and compliance with ELVs and monitoring, so the impacts will have reached a steady state and in future years will differ only as a result of new plants replacing existing plants on reaching the end of their operating life. As such, a 2030 annualised steady state figure is presented to indicate the potential impact in subsequent years beyond the appraisal period.

No decision has yet been made on who will be the regulator responsible for enforcement of the Directive and diesel controls. Regulator costs were estimated based on the activities required for enforcement, which should not depend on the regulator appointed.

6.1 Option 0: Baseline

A baseline scenario in which there is no implementation of the MCPD or emission controls on diesel engines is estimated. It is relative to this baseline that the impacts of implementing MCPD and emission controls on high NOx emitting generators are assessed. The detailed methodology for estimating the number of plants and their emissions in the baseline scenario can be found in Section 7.1, but a summary of estimated plant numbers in 2011, 2018 and 2030 is presented in Table 6.1.

Table 6.1 Estimated numbers of working, standby and back-up combustion plants

Plant type	2011	2018	2030
Working	9,930	9,983	9,430
Standby	4,891	5,856	15,696
Backup	8,940	8,940	8,940

The table above shows that an overall reduction in number of working plants is expected under business as usual between 2011 and 2030. This reduction reflects assumptions in the projections of energy efficiency improvements and a shift to renewable energy in line with the UK Carbon Budgets. The number of stand-by plants is projected to increase, as previously noted, in response to energy market incentives.

6.2 Option 1: Implementation of the MCP Directive in England and Wales

Under this option, the MCP Directive is implemented in England and Wales.

Table 6.2 and Figure 6.1set out the scope and requirements in the Directive. Many of the requirements are fixed and will simply be 'copied out' into domestic transposing legislation. However as noted in Section 3, there are a number of exemptions to the ELV requirements which Member States may choose to apply and areas of flexibility where Member States can implement a national system or scheme. In this section we will present the proposed approach to implementation and explain how we intend to deal with exemptions and flexibilities provided in the Directive and the rationale behind our proposed approach. Other sub-options considered are presented and discussed in the Annex 1.A.

Figure 6.1 Scope of MCPD and high NOx generator emission controls

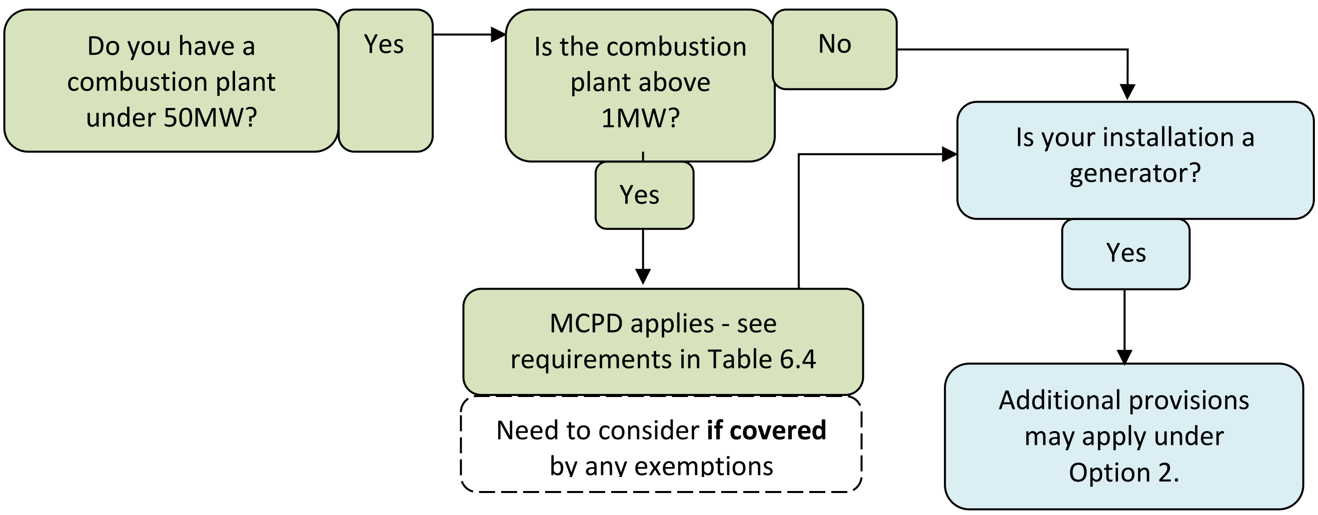


Table 6.2 MCPD operator requirements and timescale of application

Average Annual Operating Hours	Plant age	Plant Size (MW)	Permit needed for operation	ELVs (see Annex II of the Directive and table 6.4 for exceptions)		Monitoring Need for CO and pollutant for which ELVs apply within 4 months of permitting and then:
Up to 500hours	New	1-5	From 20/12/2018	Only for dust when using solid fuels.	From 20/12/2018	Every 1,500h of operation, or at least every 5 years.
		5-20				Every 500h of operation, or at least every 5 years.
		20-50				
	Existing	1-5	From 1/01/2029		From 1/01/2030	Every 1,500h of operation, or at least every 5 years.
		5-20	From 1/01/2024		From 1/01/2025	Every 500h of operation, or at least every 5 years.
		20-50				
More than 500hours	New	1-5	From 20/12/2018	As set out on Annex II of the Directive	From 20/12/2018	Every 3 years
		5-20				
		20-50				Annually
	Existing	1-5	From 1/01/2029		From 1/01/2030	Every 3 years
		5-20	From 1/01/2024		From 1/01/2025	
		20-50				Annually

In presenting the preferred approach we have grouped the requirements into 4 key themes:

1) Abatement costs – costs incurred by operators which employ abatement techniques to comply with the emission limits set out in the Annex II of the Directive for both new and existing plant
2) Administrative costs – costs incurred by regulators and operators for plant permits, data reporting, maintaining and updating data records.
3) Compliance checks –costs incurred by the regulator and operator when carrying out compliance checks.
4) Emissions monitoring – costs incurred by operators to meet the emission monitoring requirements in the Directive.

6.2.1 Abatement costs

The abatement costs for operators are determined according to the emission limit values (ELVs) applied and when these come into force. The Directive presents a number of options where Member States can implement ELVs that are less stringent or only apply at a later date for specific sub-categories of MCP. Our proposal is to transpose all ELV flexibilities (except the cold weather exemption) as set out in Table 6.3.below, and the impact of applying these flexibilities is presented in Table 8.. This approach will be fully tested as part of a public consultation.

Table 6.3 Proposed approach for application of ELV flexibilities allowed in the MCP Directive and how they are included in the Impact Assessment

Flexibility	Proposed approach and rationale	Incorporated in analysis?
1) Exemption from Annex II ELVs for existing plant operating less than 500 hours per year	Applied in full – in line with government policy. For most plant operating a limited number of hours, compliance with ELVs is not proportionate considering the limited emission reductions achieved. However some plant with high emissions will breach Ambient Air Quality Limits. For this subset of plants compliance with a lower ELV is proportionate to the emissions reductions achieved so we have addressed this issue under our preferred Option (Option 2).	Yes
2) Extension of time exempted in 1) above to 1000h for plant supplying heating in exceptionally cold weather.	Views will be sought in consultation on need for this exemption.	No - no data is available on the need for the extension in exceptionally cold weather
3) Extension of time exempted in 1) above to 1000h for plants in islands when the power supply is interrupted.	Applied in full – this is expected to be a very rare event where additional flexibility in the exemption from compliance to ELVs may be needed to allow	No – very rare event so probability and impact have not been quantified.

	power supply to be restored.	
4) Delay in requirements for existing plant in Small and Micro Isolated Systems (SIS and MIS)	Applied in full - there are a very small number of such plants in England and Wales, flexibility enables plants in such difficult locations longer time to achieve compliance.	No - disproportionate to estimate costs and benefits.
5) Delay in requirements for certain existing plant supplying heat to public district heating networks	Applied in full – this will affect a low number of plants and district heating is a sustainable technology supported by Government. The flexibility is time limited and will therefore have limited impact on air quality.	Yes
6) Delay in requirements for certain plant firing solid biomass	Applied in full – very few plants will be affected and biomass is a sustainable technology supported by Government and this flexibility allows operators a longer time to comply with the Directive, with little impact on air quality.	Yes
7) Delay in requirements for certain plant used to drive compressor stations in national gas transmission system	Applied in full – this flexibility is required to allow enough time for upgrading the national gas grid, but impacts a very small number of plants. UK argued strongly for this requirement during negotiations	No - disproportionate to estimate costs and benefits.
8) Exemption from Annex II ELVs for new plant operating less than 500 hours per year	Applied in full, – in line with government policy. For most plant operating a limited number of hours, compliance with ELVs is not proportionate considering the limited emission reductions achieved. However some plant with high emissions will breach Ambient Air Quality Limits. For this subset of plants compliance with a lower ELV is proportionate to the emissions reductions achieved so we have addressed this issue under our preferred Option (Option 2).	Yes
9) Increase in NOx ELV for new engines operating between 500-1500 hours provided they are applying primary abatement measures	Applied in full, in line with government policy. However modelling indicates that these limits could result in harm to human health and consequently a breach of Ambient Air Quality Directive Limits. Engines with higher ELVs that could pose a threat to local air quality are therefore subject at least to an air quality assessment under our preferred Option 2.	Yes

<u>Abatement technology requirements excluded from the analysis</u>

It has been necessary to exclude some requirements relating to abatement technologies from the analysis as described below:

- The less stringent ELVs or later application of ELVs for plants firing solid woody biomass, straw, coke oven gas, heavy fuel oil, blast furnace gas, biogas; gas turbines operating less than 70% load; plant in Micro Isolated Systems (MIS) or Small Isolated Systems (SIS)[4] and slow speed engines (<1200 rpm) were not incorporated into the analysis as the baseline plant estimates do not distinguish these sub-categories of plant and given that the numbers of such plant are considered to be low the impact of these exceptions is anticipated to be negligible (well within the wider uncertainties and more likely to be within the rounding differences of the results) and the resources required to incorporate these into the analysis is disproportionate. The exclusion of these exceptions means the results will very slightly over state the compliance costs and the emission reductions (benefits) of the Directive.
- The Directive requires that Member States assess the need to apply more stringent ELVs in zones or parts of zones where air quality limits are exceeded. Application of such ELVs will be informed by a report to be produced by the European Commission for which there is no publication date. Government is implementing a plan for reaching compliance with air quality limits and by 2020 only six zones are expected to remain non-compliant. As a result, the number of plants potentially subject to more stringent ELVs will decrease over time and it is not possible to estimate the impact of this provision. Therefore it was excluded from the analysis,

[4] Defined in Directive 2009/72/EC concerning common rules for the internal market in electricity as:
'small isolated system' means any system with consumption of less than 3 000 GWh in the year 1996, where less than 5 % of annual consumption is obtained through interconnection with other systems;
'micro isolated system' means any system with consumption less than 500 GWh in the year 1996, where there is no connection with other systems;

- Application of fuel consumption weighted ELVs when plants use multiple fuels are excluded from analysis due to the uncertainty and complexity in establishing the range of possible fuel mixes, resulting emissions and ELVs applicable. The results of the analysis could under or over-state the compliance costs and benefits as a consequence of this are not being considered.
- Some MCPs are already subject to environmental permitting in the UK, either because they come in scope of the Industrial Emissions Directive or because they are regulated under domestic provisions (20-50MW plant) - for all these plants, there is a requirement to apply the MCPD ELVs as a minimum. Plant regulated under IED are estimated to represent 5% of total MCPs (see table 7.2) but emission controls applied depend on type of industrial installation and where they are located, how they are used and number of operating hours, so it was disproportionate to review what current controls are being applied and as a result the analysis is likely to overestimate costs and benefits of implementing the MCPD.
- For plant regulated under domestic provisions (only 10 at present) it is proposed that any stricter limits currently applied for existing plant be retained because they have been proven cost effective and plant are already in compliance. For new plant, the emission limit for dust in biomass plant is slightly more stringent in domestic provisions than in MCPD, so we intend that these plants will require bespoke permits to allow application of the most appropriate ELV. All other MCPD ELVs are more stringent than currently required under domestic provisions Due to the small number of plant, the costs and benefits of this approach have not been quantified.

6.2.3 Administrative costs

Choice of regulator and cost recovery

Member States are required to determine the regulators or competent authorities for MCPD. The current view is that it should be shared between EA and LAs to maintain current status quo i.e. high risk plant regulated by EA and lower risk plant by LAs. However this is to be tested in consultation. The choice of regulator should not make a material impact on costs, although appointing a single regulation (such as the EA) would result in lower transitional costs for training and development of tools to implement the MCPD.

In line with other sectors regulated under EPR, we propose that regulators will recover most of their costs from the operators in the form of permitting and subsistence fees. Costs have been estimated for this Assessment however the actual fees and charges to be applied will be developed in discussion with the regulator appointed, and subject to public consultation. In addition, regulators will have the following costs which cannot be recovered from operators and are not quantified in this Assessment:

a) Setting up costs – staff training and development of systems for permitting, managing compliance checks and publication of the public on line register of plant as required by the Directive. These costs have not been quantified because we have not yet decided on the regulator so there is considerable uncertainty, and it would be disproportionate to consider further.
b) Dealing with non-compliance – the proposals are designed to maximise compliance and so the costs associated with non-compliance are not quantified.

Approach to permitting

The Directive allows for a registration or permitting system to be adopted and following consultation with regulators. We propose that MCPs will be subject to environmental permitting since this enables cost recovery in the form of a permitting charge and subsistence fees. However, we will follow a risk based-approach where, for the large majority of plants (including those exempted from compliance with ELVs), the permitting process will involve submission of the information specified in the Directive, which will automatically determine the permit conditions needed to comply with the Directive requirements. This standard permit approach is not expected to create an additional burden in relation to a registration approach (other than the collection of enforcement fees) and provides clarity to operators regarding their obligations. For a small minority of high risk plant and those where the regulator has flexibility to apply higher emission limits (see Table 6.3), bespoke permits will be required to ensure their conditions protect local air quality. This goes beyond minimum requirements of the Directive for high risk plant but is required for compliance with air quality standards and to enable application of domestic emission controls already in force for 20-50MW plant where they are stricter than those applied under the MCPD.

Compliance check costs

Member States must set up a system of environmental inspections or other measures to ensure compliance with the Directive. Based on consultation with operators and regulators, routine site inspections were deemed unnecessary to enforce the Directive for all but the high risk 20-50MW (which are already subject to this type of inspection under the EPRs). During desk-based compliance checks regulators will be expected to check data and documentation submitted by the operator covering emissions testing, operation of abatement equipment and reporting of operating hours. Compliance check frequency will be tailored to plant risk, as is currently the case for activities already regulated under EPR. For the purpose of the impact assessment, assumptions were made about proportion of plants in the high, medium and low risk categories, but the categorisation will continue to be developed in discussion with regulators and industry and subject to consultation. The following 2 compliance check scenarios have been analysed:

- Scenario 1: all MCPs are subject to scheduled compliance checks supported by mandatory reporting of data to enable the checks;
- Scenario 2: all MCPs are subject to random compliance checks for which regulators request operators to submit data;

The frequency of compliance checks under both scenarios is presented on Table 6.4. Random compliance checks are assumed to be more effective to promote compliance, therefore the frequency of checks is reduced under Scenario 2. The risk categorisation and frequency of checks may be adjusted to reflect eventual certification schemes developed by industry. This is tested for Option 1 in Section 8.4 as this is a key impact of implementing the MCPD (Option 2 carries forward the preferred option as this is not a key sensitivities of the additional measures). Scenario 2 is the preferred option which was used for estimating implementation costs, however both scenarios, the compliance checks proposed and the risk based approach will be tested in the public consultation.

Table 6.4 Frequency[5] of compliance checks for the two scenarios

Checks per annum[6]	High risk[7] 1 working plant[8]	Medium risk 1104 working plants	Low risk 8079 working plants (plus those defined as back-up/stand-by)
Scenario 1 – scheduled compliance checks			
Plant required to comply with ELVs	20-50MW 1 site inspection 1-20MW 1 remote check	20-50MW 1 remote check 1-20MW 0.3 remote check	20-50MW 0.5 remote check 1-20MW 0.3 remote check
Plant exempt from compliance with ELVs (to note the current proposal is to deem all low risk)	20-50MW 1 remote check 1-20MW 0.5 remote check	20-50MW 0.5 remote check 1-20MW 0.3 remote check	20-50MW 0.3 remote check 1-20MW 0.2 remote check
Scenario 2 – random compliance checks[2]			
Plant required to comply with ELVs	20-50MW 0.5 site inspection 0.5 remote check 1-20MW 0.5 remote check	20-50MW 0.5 remote check 1-20MW 0.3 remote check	20-50MW 0.2 remote check 1-20MW 0.17 remote check
Plant exempt from compliance with ELVs (to note the current proposal is to deem all low risk)	0.17 remote check		

Non-compliance

The burden for regulators and operators from non-compliance with the Directive is not estimated; non-compliance may result in operators moving to a higher risk category, which will lead to more frequent compliance checks, recovered through annual fees. The legislation will contain powers for criminal prosecution, but it is anticipated that these will act as a deterrent and be used only in very rare instances where operators persistently fail to achieve compliance with the Directive, particularly when this impacts on local air quality

Member states are required to specify when non-compliance with ELVs must be reported by operators to the regulator, and how. This provision is required to enable regulators to order a plant to cease operation if it is causing significant degradation to air quality. We intend to restrict reporting of non-compliances with ELVs only to those which may cause a problem to local air quality. These are expected to be rare events, so its administrative cost has not been estimated.

[5] Frequencies are indicative

[6] 0.5 = one check every two years; 0.3 = one check every 3 years; 0.2 = 1 check every 5 years; 0.17 = 1 check every 6 years.

[7] For the purpose of this assessment, 20-50MW plant operating on solid fuels were assumed high risk, remaining plant using solid and liquid fuels other than gas oil were assumed medium risk, and all other plant (those using gas oil and gaseous fuels) were assumed low risk.

[8] Number of operating plants in 2030

Emissions Monitoring Costs

Operators are required to monitor emissions every three years for 1-20MW plants and every year for plants over 20MW. The Directive also allows Member States to lower frequency of monitoring for plants which are exempt from compliance with Annex II ELVs and we intend to apply this flexibility as these plants will be operating less than 500 hours as standby only and therefore the impact on air quality will be low. MS are required to determine the monitoring standards and we are working with industry and regulators to establish a suitable approach. For the purpose of this impact assessment the cost of emissions monitoring is estimated based on monitoring standards currently applied to plant over 50MW in the UK i.e. MCERTs. However, for the majority of MCPs (those using natural gas and gas oil) which are only required to monitor NOx and CO emissions this standard is considered disproportionate. Therefore we are working with industry to agree cheaper and less stringent methods possibly utilising existing plant maintenance systems. For the purpose of this impact assessment we have assumed that MCERTs is required for all plant and therefore the monitoring costs are significantly overestimated.

MS must also decide whether to require continuous monitoring, feedback from stakeholders was clear in this regard. Continuous monitoring was deemed expensive and should not be required - however if operator chooses to apply it then it should be considered an acceptable alternative. We will test this approach in consultation.

6.3 Option 2: Implementation of the MCP Directive and additional emission controls for generators

Under this option, the MCP Directive is implemented in England and Wales as set out in Option 1 but additional requirements will be placed on these generators as outlined in the proposals below. All parts of these proposals (e.g. limits, hours restrictions and installations affected) will be subject to consultation. Further details of how the proposals outlined below were developed and the options considered are provided in the Annex 1.B.

Proposals to control emissions from generators

From 1 January 2019 and subject to the requirements of the MCPD in relation to plant that are MCPs, all generators[9] will require a permit to operate, except:

a) Back-up generators (generators operating to supply power during an on-site emergency e.g. a power cut which do not test for more than 50 hours per year)
b) Generators operating on a site that is the subject of a nuclear site licence[10]
c) (until 2025) Tranche A generators[11], with a rated thermal input of 5-<50MW_{th} and with an emission <500mg/Nm^3 and Tranche A generators, with a rated thermal input of 5-<50MW_{th} and operating <50 hours/year
d) (until 2030) Tranche A generators 1-<5MW_{th}

Unless otherwise specified below, the regulator will be required to exercise their permitting functions so as to ensure that at least the four following standard requirements are applied to the generator[12] though the permit:

- a NO_x ELV of 190mg/Nm^3 [13]
- where secondary abatement is required to meet the 190mg/Nm^3 it must be met within 5 minutes of the generator commencing operation
- there must be no persistent visible emission
- where the generator relies on secondary abatement to meet the 190mg/Nm^3 NOx ELV, emissions must be

[9] "Generator" means:
- any single stationary electricity generating combustion plant; or
- any group of stationary electricity generating combustion plant located at the same site and providing electricity for the same purpose,

with a rated thermal input of between 1MWth and 50MWth, including any MCP, but excluding any plant subject to the provisions of Chapter II or Chapter III of Directive 2010/75/EU (the industrial emissions Directive).

[10] A nuclear site licence issued by the Office for Nuclear Regulation

[11] "Tranche A generator" means any generator that:
- comes into operation before 1 December 2016; or
- is the subject of a Capacity Market Agreement for new capacity arising from the 2014 or 2015 auction (including those which have not come into operation by 1 December 2016); or
- for which a Feed-in Tariff preliminary accreditation application has been received by Ofgem before 1 December 2016.

"Tranche B generator" means any generator other than a "Tranche A generator"

[12] Except:
- any Tranche B generator used at a site to which it is not reasonably practicable to supply mains power; or
- any Tranche B back-up generator for which the operator has demonstrated to the regulator a genuine need to carry out routine testing for more than 50 hours per year.
- Any tranche A generator with a rated thermal input 5-<50MW with NOx emissions 500mg/Nm^3 or greater

In these cases, the regulator will exercise their functions as necessary to ensure that the conditions set in permits will ensure that generators will not give rise to a breach of standards specified in Annex XI of the Ambient Air Quality Directive.

[13] under the MCPD reference conditions for engines and turbines (see Annex C)

monitored every 3 years.

Where the regulator considers there may be a risk to air quality standards resulting from the operation of the generator, an operator will be expected to quantify the impact of emissions on sensitive receptors, *e.g.* by air dispersion modelling, incorporating as necessary, for example, any proposals for appropriate dispersion, abatement and restrictions on operating hours. The Regulator, accounting for the results of such assessment, will be required to apply any further or different requirements as are necessary to ensure any breach of Ambient AQ Directive Annex XI standards is avoided.

In relation to the generators described at c) and d) above, the regulator will not be required to apply the standard requirements or any additional requirements to safeguard local air quality where operation of the generator is required only for the purpose of a legally binding pre-existing supply contract or agreement[14], in which case the standard requirements and any additional requirements to safeguard local air quality will be applied from the date the contract/agreement expires.

Abatement costs

Generators that are required to meet the proposed emissions limit specified (190mg/Nm^3) may incur costs for fitting secondary abatement such as Selective Catalytic Reduction. Generators that are required to hold a permit with site-specific conditions to protect local air quality may also be required to fit dispersion or abatement equipment or to modify running hours to ensure that hourly air quality limits are not exceeded at sensitive receptors surrounding the generator.

Administrative burden

Generators over 5MW in size with high NOx emissions (in excess of 500mg/Nm^3 for Tranche A and 190mg/Nm^3 for Tranche B) are considered to pose a risk of breaching local air quality limits if they operate for more than 50 hours per year and therefore we propose that operators should be required to hold a permit with site specific conditions for these facilities unless they are exempt and regulators will recover their costs through permitting. Operators of generators that run for more than 50 hours per year may be required to carry out dispersion modelling to ensure that air quality limits are not breached at the sensitive receptors in the vicinity of the generator.

We propose that operators with working and standby generators between 5 and 50 MW that would otherwise be required to hold a bespoke permit will be required to prove that the emissions from the site do not exceed the specified limits – in estimating costs we have assumed that this will be done through an emissions test.

Monitoring costs

In addition to the monitoring requirements set out on Option 1, we propose that generators that are required to meet the standard requirements set out in the proposals will at least be required to undertake a single emissions test at the point the plant is commissioned to prove the emissions do not exceed the emissions limit. Installations that rely on secondary abatement to achieve these limits will require a test at least once every 3 years.

Compliance check costs

We have assumed that random compliance checks should be carried out on generators required to hold a permit in accordance with the approach for high risk operations in the MCPD as outlined in section 6.2.3. The remaining installations will be subject to compliance checks as set out in Table 6.4 under Scenario 2.

The burden for regulators and operators from non-compliance with the Directive is not estimated; non-compliance may result in operators moving to a higher risk category, which will lead to more frequent compliance checks, recovered through annual fees. The legislation will contain powers for criminal prosecution, but it is anticipated that these will act as a deterrent and be used only in very rare instances where operators persistently fail to achieve compliance with the Directive, particularly when this results in an impact to local air quality.

Emissions Testing and Monitoring Costs

The cost of emissions testing is based on meeting current MCERTS standards, which are currently applied to plant over 50MW in the UK. We have assumed;

- that all installations will need to be tested at the point of commissioning and
- that it takes a single day to test all plant sited on a single installation and
- that the same cost will apply to each installation regardless of size and that monitoring will be carried out every 3 years.

We will look at alternative monitoring methods as indicated in section 6.2 above.

[14] A contract or agreement to supply capacity or electricity to National Grid made before 1 December 2016

7. Methodology

The proposed controls on combustion plants aim to bring about beneficial impacts for the environment and human health. The intended benefits of these controls would be delivered via reductions in emissions of air pollutants, and the proposed costs would fall mainly on operators.

The methodologies for Option 1 and Option 2 will both assess the implementation of the MCPD; however Option 2 proposes further measures for high NOx generators to help avoid breaches of hourly limits for NO_2 set under the Ambient Air Quality Directive, which required additional impacts to be measured. The methodology for the majority of impacts in both options is the same; therefore it is not detailed twice. However, there are supplementary impacts from the additional measures in Option 2 so the different methodology for calculating these is detailed below.

The overwhelming majority of the additional plants that would be impacted in Option 2 are classified as standby (categorised as running for less than 500 hours), so the additional costs and benefits calculated use the characteristics of a standby plant.

The following section will identify where the methodologies overlap for both options and where methodologies purely apply to Option 2. The impacts can be split into the following areas, which are detailed fully in the remainder of Section 7.

Impacts for both Options:

COST IMPACTS

- **Emission Abatement Costs** – These are the costs that will be incurred by plants which will require abatement to meet the emission limits - for purchasing, fitting and operating abatement technology. (see **Section 7.2**)
- **Administrative, Monitoring and Compliance Costs** will consist of permitting, reporting, monitoring and compliance checks (inspections). These costs will fall to both plant operators and regulators; however, most of these costs will be recovered from operators. These costs will be incurred by all plants falling in scope of the MCPD and controls for generators vary by type, size and complexity of the plant. (See **Sections 7.5 and 7.6**). Costs relating to start-up (registration process, raising awareness for new regime), training of regulators and some of the costs of non-compliance cannot be recovered and will be funded through Defra's delivery budget.

Under the MCPD guidelines, working plants would need to comply with ELVs if necessary, and complete all of the administrative and compliance requirements. Exempt plant (predominantly back-up and stand-by plant) will need a permit (under administration costs), monitor emissions for carbon monoxide (CO) only and complete compliance (inspection) checks. The distinction between new and old, and size of plant governs when they have to carry out requirements (as set out in Section 6). Under Option 2, as outlined in Section 6, it is proposed that electricity generating plants (typically in the standby category) will be required to meet stringent NOx ELVs. This means they would have to fit abatement, and will have higher responsibilities in the other cost categories (monitoring, inspection, permitting etc.).

BENEFITS TO THE ENVIRONMENT AND HUMAN HEALTH

- **Monetised Benefits –** The emissions limits will reduce air pollution from MCPs. This provides monetised benefits to society, mainly as improved human health. There are also co-benefits between air quality and (GHGs) greenhouse gases (CO_2) which have been monetised and included.
- **Non-monetised benefits –** Damage costs do not capture all health benefits so there are additional health impacts that are non-monetised. Furthermore, there are also wider environment benefits from reduced emissions such as improvements to ecosystems but these benefits are not possible to monetise.

Additional Impacts for Option 2

These additional impacts have only been captured for the electricity generating plants (primarily high NO_X generators) affected by the controls under Option 2.

<u>Monetised</u>

- **Infrastructure and operating costs –** for Tranche B plants, the cost of implementing the measures suggests that some projected capacity provided by diesel would instead be supplied by gas as that becomes more cost-effective. This cost will consider the difference in the cost of constructing and operating a gas plant when compared with a diesel plant. This includes the change in fuel, as plants will face reduced fuel costs from running gas which is cheaper than diesel.

  Benefits of technology switch – it is anticipated that some of the forecast plants in Tranche B would become gas (spark ignition engines or turbines) instead of diesel (compression ignition engines) as gas is a cleaner technology and would be able to meet the emission limits set in the measures. Gas is significantly cleaner than diesel for both NO_X but it also emits lower levels of other pollutants including CO_2, SO_2 and PM resulting in higher benefits from the switch.

Non- monetised

- **Revenue and fuel savings –** Many generators in Tranche A that are unable to meet the measures set out in Section 6, will face the choice between abatement or a reduction in operating hours. Those who choose to reduce their hours will face a reduction in revenue equal to the revenue earned in the baseline with unrestricted baseline and the revenue earned with a reduced 50 hour running time. They will also experience a fuel saving as they will be running for less time. It is assumed however, that there would be enough existing and new capacity available to fill the hours reduced. There is a minimal risk that due to the complex nature of the electricity generating contracts, it may not be as easy to switch contracts and a shortfall of supply could be anticipated. However given new capacity forecasted alongside the extended time period for plants in Tranche A to meet the conditions of the additional measures, the risk would be insignificant. As a result, this cost can be considered an economic transfer where the impact will be balanced by one part of the energy market facing a cost in terms of lost revenue (but a saving in fuel) and another plant benefits (from additional revenue but additional fuel costs) benefit so no net impact. However as there is little per plant data available, we are currently unable to estimate the level of revenue earned by each plant particularly due to the numerous revenue streams available. This is an area that we plan to consult on.
- **Energy security and resilience** – the implementation of a slower period of introduction of a conservative ELV for installations in Tranche A is expected to minimise disruption to the energy market. Many of these plants have agreed contracts which, if they are unable to honour due to ELV restrictions, may lead to a reduction in the total generation capacity. While these plants are not considered to be substantial contributors to the overall capacity, they do play an important role of supporting energy supply in peak times. Therefore ensuring that these plants are able to fulfil their contracts is important, and the extended timeframe should minimise the risk of disruption. It was deemed disproportionate to monetise this as these plants form a small proportion of UK energy generation and with the staggered approach to the measures– it is unlikely to cause an impact on energy security. However we intend to consult on this for the final impact assessment.

The costs and benefits from changes in emissions are calculated as the difference between the introduction of the policy options against a baseline where the MCP Directive (Option 1) and emission controls on generators (Option 2) are not implemented. The baseline is introduced in section 6 and the methodology for its calculation is explained in Section 7.1. Both options ensure operators comply with relevant ELVs, fitting abatement technology where needed. Operators of many of the generators affected by the proposals to limit emissions from high NOx emitting generators under Option 2 also have the ability to reduce operating hours to ensure compliance.

7.1 Baseline

As the plants under consideration are not generally regulated at present (unless connected to an IED regulated installation or in the range 20-50MW), numbers and type of plant had to be estimated.

The estimation is based on fuel consumption and projections from the NAEI/BEIS, incorporating assumptions about size, technology type (boiler, engine, turbine), and operating hours from EU averages. The majority of the analysis is based on data gathered and/or derived for the Commission study (Amec Foster Wheeler, 2014). The assumptions and data are based upon the best available evidence (Figure 7.1), however it must be noted that it came from a diverse range of sources, which introduces some uncertainty.

The remainder of this subsection details the estimation process.

Figure 7.1 Baseline steps and corresponding inputs

Baseline Estimation Steps

1. **Estimate number of plants**
2. **Estimate the capacity of plants**
3. **Identify the sectoral distribution of plants**
4. **Estimate the fuel consumption of plants**
5. **Identify current emission levels using average plant emissions**
6. **Estimate projected total annual emissions**

Inputs

European Commission sector data

Load factors[1] from Entec (2006)

Activity forecasts (Ricardo-AEA 2014 NAEI)

EMEP CORINAIR emissions guide

Capacity Market Auction results (2014, 2015)

Energy price forecasts (BEIS)

CO_2 emission factors

Step 1: Estimate number of plants

A baseline scenario in which there is no implementation of the MCPD or emission controls on generators is estimated. It is relative to this baseline that the impacts of implementing MCPD and emission controls on high NOx emitting generators are assessed.

The baseline scenario was created through estimation of the number of MCPs currently operating in England and Wales, with associated capacity, sectoral distribution, average operating hours and unabated emissions. National fuel consumption data and average plant size and working hours per sector were used to estimate plant numbers per fuel.

The estimated plant numbers and assumptions about operating hours and unabated emissions by plant type, size and fuel used were used to estimate total emissions from 2011 through to 2030, against which the emission reductions achieved by transposing the MCPD and applying controls on high emission generators were calculated. Sections below detail the methodology used to calculate the base year and projected baseline demonstrated in Table 7.1. Please note that this table presents the number of plants in scope of the regulation at a given point in time; therefore, the increase in years 2024 and 2029 correspond to timings of the MCPD.

Table 7.1 Plant numbers by capacity size and category

Number of plants	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant numbers by capacity and age															
Existing 1-5 MW	-	-	-	-	-	-	1,184	1,138	1,099	1,060	1,021	982	943	904	865
Existing 5-50 MW	-	-	-	-	-	-	-	-	-	-	-	15,976	15,364	14,752	14,141
New	-	1,852	3,380	4,909	6,438	7,966	9,495	10,864	12,243	13,621	15,000	16,379	17,756	19,132	20,508
Total	**-**	**1,852**	**3,380**	**4,909**	**6,438**	**7,966**	**10,679**	**12,003**	**13,342**	**14,682**	**16,021**	**33,337**	**34,062**	**34,788**	**35,514**
Plant number by category															
Working	0	267					2,316	2,534				9,191	9,184	9,176	9,168
Stand-by	0	1,438					7,130	8,116				19,099	19,836	20,573	21,310
Back-up	0	146					1,232	1,354				5,047	5,043	5,039	5,036
Total	**0**	**1,852**					**10,679**	**12,003**				**33,337**	**34,062**	**34,788**	**35,514**

2011 baseline

Table 7.2 provides a summary of the number of plants for the 2011 baseline estimate in scope of the MCPD in England and Wales, with a summary of the estimated emissions from these plants in 2011. From 2018, when MCPs start to register, more accurate plant numbers will become available, which will be utilised for subsequent post implementation assessments.

There is reasonable data on current plants over 20MW because they are already subject to environmental permitting in the UK and registered under the EU Emissions Trading Scheme, however these represent a small number of the plants in scope. Data on number and location of plants smaller than 20MW was very incomplete and so the number was estimated using assumptions based on the best available evidence as described in this report. Additionally, much of the dataset used in this study has been based upon the Impact Assessment which underpinned the Commission MCP Directive Proposal (Amec Foster Wheeler, 2014).

Table 7.2 Summary of England and Wales baseline dataset (estimation for 2011)

Source	Number	Total Capacity (MWth)	Fuel consumption (PJ)	SO2 emissions (t)	NOX emissions (t)	PM emissions (t)
Working plants	**9,930**	31,102	370	31,123	38,950	5,813
Standby	**4,891**	15,319	9	818	1,023	153
Backup	**8,940**	21,233	2	723	1,550	194

2030 baseline projection

Using supplementary data from the NAEI team and European data (Amec Foster Wheeler, 2013), it was possible to split plants into size category (capacity class) by fuel type (gas, oil, solid fuels and biomass).

Less information was available for plants running shorter hours. Therefore, following consultation with National Grid on the capacity available in existing energy balancing market revenue streams (600MWe), specifically short run hour streams such as STOR (Short Term Operating Reserve), the figures from the European data were deemed too low for diesel and gas plants, and were updated accordingly. This existing capacity was sense checked with results of 2014 and 2015 Capacity Market auctions where plants bidding identified as existing or new build. The vast majority of these are assumed to be 1-5MW, which is typical of plants with shorter operating hours.

The total number of plants in operation was projected to 2032 using growth figures for each fuel type derived from data provided by the NAEI team (in 2013). A growth threshold of 10% was assumed; meaning it was assumed that a change in activity less than 10% could be met by the existing number of plants as part of the flexibility in their working output capacities. A change beyond the threshold would result in a decrease or increase in number of plants needed.

Whilst the main dataset has been derived for three main capacity classes, data from the NAEI team was used to help categorise the plants.

Following the outputs of the 2015 Capacity Market Auction provided by BEIS, additional gas and diesel standby plants have been projected to reflect the increase demonstrated in the auction. This was estimated to be between 500MWe-1000MWe (central estimate of 700MWe) biannually following from 2014/2015 results.

Incorporating the evidence specified and with additional consultation with stakeholders, it is therefore estimated that in 2018, there will be around 5,900 standby plants, which increases to 15,700 by 2030.

It is also estimated that there are up to 8,940 back-up plants based on industry consultation throughout the appraisal period. These are highly likely to be diesel, based on the characteristics required of a back-up plant.

For both options, back up plants will need a permit, face monitoring for CO and will be subject to compliance (inspection) checks. Under Option 2, plants with high NOx emissions (the majority of which are assumed to be standby plants) would be subject to additional measures. The rest are assumed to be working plants.

Under both options, projected numbers of plants and their age were based on estimating the renewal rate associated with an estimated lifetime of 36 years. Lifetime was assumed to be twice the average plant age (18 years) as indicated by data from the consultation. This approach resulted in an estimation of 33% of plants classified as new and 67% as existing in 2030 for working plants as categorised by the MCPD definition.

The forecast dataset for working plants for 2030 is presented in Table 7.3 separating the number of new and existing plants.

Table 7.3 Summary of England and Wales baseline working plant dataset (projection for 2030)

Numbers of existing plants	Numbers of new plants	Total Capacity (MW)	Fuel consumption (PJ)	SO2 emissions (t)	NOX emissions (t)	Dust emissions (t)	CO_2 emissions (t)
6,122	**3,061**	28,587	340	20,283	33,474	3,781	18,139,241

This table shows that an overall reduction in number of working plants and emissions is expected under business as usual between 2011 and 2030. This reduction reflects assumptions in the projections of energy efficiency improvements and a shift to renewable energy in line with the UK Carbon Budgets.

Step 2: Estimate the capacity of plants

The estimation of the total capacity of combustion plants has been undertaken using the EU average capacity per plant shown in

Table 7.4 below[15], multiplied by the numbers of projected plants in 2030. The average plant size in each capacity class was determined from complete data gathered from Member States both on numbers of plants and the capacity per plant in Amec Foster Wheeler (2012) and the more recent study published in February 2014 from the European Commission. The EU averages and data sets include Member States who already regulate MCPs.

Table 7.4 Assumed average capacity per plant

Capacity Class	Assumed EU average plant capacity (MW)
1-5 MW	2.4
5-20 MW	9.5
20-50 MW	29.5

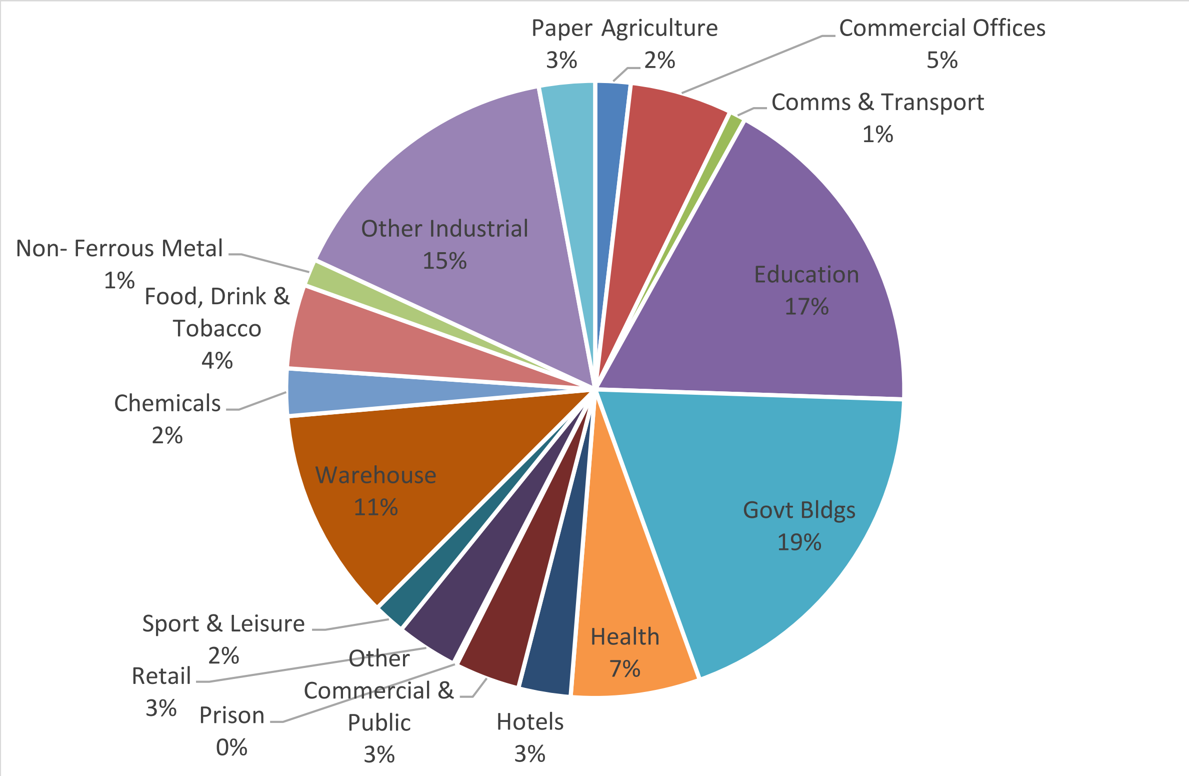
For working plants, an additional sensitivity scenario has been performed to demonstrate the impact of varied numbers of plants. An upper estimate for plant numbers is estimated by applying the bottom end of each capacity range (i.e. 1, 5 and 20 MW) as more plants would be needed to keep the capacity consistent. The lower estimate for plant numbers has been estimated by applying the top end of each capacity range (i.e. 5, 20 and 50 MW) as higher capacity per plant would result in fewer numbers of overall plants. This is presented towards the end of the results section.

Step 3: Identify the sectoral distribution of plants

Information on the number of MCPs operating in the UK across different business sectors was developed in collaboration with Ricardo; this is illustrated in Figure 7.2 below. This information was used to develop the assessment on distributional effects, as presented later in this report. The assessment undertaken by Amec Foster Wheeler did not include the additional standby plants assessed in Option 2 as the ELVs set in the MCPD are for plants operating over 500 hours, therefore the cost impact split between industries is based on plants operating for longer hours. However, as there is little data on the specific industries of standby plants, it is assumed the sector split for stand-by plant would be broadly similar to plants that operate for longer hours, which is something we plan to consult on. Section 11 details the business impact assessment.

[15] Amec Foster Wheeler (2012)

Figure 7.2 Sectoral split of Medium Combustion Plants in UK



Source: Ricardo-AEA, 20 October 2014.

<u>Step 4: Estimate the fuel consumption of plants</u>

Total fuel projections and capacity etc. are used to estimate plant numbers as above. Once plant numbers are estimated, their fuel consumption must be estimated in order to calculate emissions.

Fuel consumption has been estimated by using:

- Projected number of plants as estimated above, average capacity data from the Commission study, and;
- An assumed average load factor of 37% under 8,760 hours i.e. 3,241 hours per year

The average load factors were calculated using the same data regarding utilisation of MCPs in different industrial sectors used by Ricardo to derive the initial plant numbers. This approach assumes the emission factors remain constant over time as there is no reason for this to change under business as usual (BAU).

<u>Step 5: Identify current emission levels</u>

Current annual emissions from MCPs in the UK have been derived based on assumed operating hours and emission rates from these plants. These emissions are based on a combination of the "general case" ELVs developed and applied in the Commission study (essentially the maximum values applied to national legislation across Europe), emission factors derived from the EMEP CORINAIR emissions guidebook (primarily for biomass SO_2 emissions) and data that have been returned by stakeholders as part of the informal consultation for this study.

It should be noted that natural gas boilers are the largest and most common contributors to NOx emissions from MCPs. As existing and new plants have different ELVs, the split was done for these two categories separately. Information is based on real plant performance, and what percentages of each type of plant (new/old and size) have BAU emission levels already below the MCPD ELVs. The is data collated in 2014, and assumed to apply for all years 2018-2032 as without MCPD. Annex 1.C provides the number of each abatement technology actually fitted by 2030 to plant that need to abate in order to meet ELVs and the scale of how many are already compliant with emissions limits. This is also introduced further in section 7.2 below.

For those standby plants entering revenue contracts, the run times of the plants are assumed to be lower than regular standby plants. This is because generators, specifically diesel, typically run for less time as they are used for fast response or reserve capacity and often do not need to run for long periods of time. Consultation with industry, National Grid and BEIS has verified the shorter run time; therefore it is assumed that these plants will run for an average of 30-300 hours per year. It is likely that this could be lower for diesel generators where fuel is more expensive and higher for gas generators, where fuel is cheaper therefore an estimate of 100 hours was chosen, which will be consulted upon.

Additionally, consultation with industry identified that for gas standby plants; there are many examples of plants operating higher than the base case ELV proposed in the MCP Directive. In order to correct for this, 20% of gas engines and turbines are assumed to have higher base case emission of 1500mg/Nm^3. This is a conservative approach as on average, gas emissions are typically lower.

Step 6: Estimate total annual emissions

Base case emissions have been estimated based on projected fuel consumption, the emission levels described above and application of specific flue gas volumes.

These basecase emissions are demonstrated in Table 7.5 below.

Table 7.5 Basecase emissions of all plants under the MCPD

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Quantity SO2 (t/yr)	23,862	22,342	22,050	21,757	21,464	21,172	20,879	20,893	20,893	20,893	20,893	20,620	20,552	20,483	20,415
Quantity NOx (t/yr)	37,183	36,605	36,222	35,839	35,456	35,074	34,691	34,427	34,254	34,081	33,908	33,735	33,563	33,391	33,219
Quantity PM (t/yr)	4,460	4,186	4,127	4,069	4,010	3,952	3,893	3,888	3,878	3,867	3,856	3,846	3,835	3,824	3,814

The results section presents the impact of the controls on combustion plants on emissions reductions. This impact is additional to existing legislation such as the Gothenburg Protocol, EU legislation and UK legislation.

7.2 Impacts from Abatement Costs

The base case emission levels for each capacity class, fuel and combustion plant type are compared against the scenario limit values to determine the required emission reductions. This indicates whether additional abatement measures would need to be implemented in order to meet the scenario limit values.

Option 1

Abatement costs come from the best available evidence sourced by Amec Foster Wheeler, which includes the recent Amec Foster Wheeler study for the Commission (Amec Foster Wheeler, 2014). The modelling identifies the most suitable abatement technology for each sub-group of plant. Suitability for each sub-group depends on the necessary emissions reduction required for each pollutant, the type of combustion plant technology (boiler, engine, or turbine), whether it is new or old, and its fuel type and capacity class. Annex 1.C presents the methodology in further detail with a list of measures and assumptions. The summary of option 1 in the results section presents this on a per plant basis.

Plants that are required to change their behaviour in order to comply with MCP have all been assumed to fit the most cost-effective abatement technologies to meet ELVs. Please see Annex 1.E for details supporting this assumption. The number of MCPs potentially affected is presented in Table 7.6. Not all of the plants will need to fit abatement as some are able to comply with the MCP ELVS already under business as usual, so for those plants the compliance costs are zero in the averages and year-on-year impacts (Annex 1.C details the estimated scale). As discussed in the remainder of this section, they will nonetheless incur admin (registration, reporting etc.) and monitoring costs.

It is possible for plants (and units) with an input of less than 50 MW to be covered by the IED in situations where the aggregated capacity on site is more than 50 MW or if they are "directly associated activities with a technical connection" to other IED activities. Exact data on the numbers that are “directly associated” in the UK are not readily available. We have included an approximate estimate based on findings in Amec Foster Wheeler (2013) (5% of 1-5 MW, 10% of 5-20 MW and 40% of 20-50 MW) for use in the administrative burdens assessment as it is assumed that they will incur lower costs due to the plant already being covered by a permit. (See impacts for administration burden in this section).

Table 7.6 Number of MCPs affected by size and type and their share as IED installations (2030)

Capacity	Turbines	Engines	Boilers	Total	Share of total	Proportion of MCPs that are directly associated to an IED installation	Number of IED associated plants
1-5 MW	41	21,397	10,965	32,402	95%	5%	1,620
5-20 MW	57	485	1,101	1,643	5%	10%	164
20-50 MW	2	2	13	17	<1%	40%	7
Total	100	21,884	12,079	34,062			**1,791**

However, abatement costs are assumed to still be incurred as, whilst a plant may be included in a permit, it does not necessarily have to meet any minimum ELVs. If there are instances where directly associated MCPs are set ELVs then the results of the analysis may be over-estimated, depending how strict those ELVs are.

Some types of plant, namely natural gas boilers are assumed to reach compliance with the ELVs set and therefore do not face the cost of abatement.

Annex 1.A lists the cost of abatement technology considered in this study, along with the number of working plants that will need to fit each abatement technology in 2030 to comply with MCP. Section 8.2 in the results section presents the associated present value costs.

Option 2

In addition to the approach taken for working plants, all generators that wish to continue to operate in order to generate revenue will be required to meet additional controls.

If a plant choses to fit abatement, the method of selecting the appropriate abatement equipment will be the same as working plants but the costs faced will be lower than for larger plants and those that operate for longer hours. This is because the abatement equipment may cost less for smaller plant and because abatement requires reagent to operate effectively - the amount of reagent used will increase as the operating hours increase. If plants need to fit abatement to meet the requirements, the majority of which would be diesel, original operating costs, as outlined above, would apply to plants that run for 2000 hours per year. Plants (generators) that enter revenue streams would typically run for shorter times of approximately 100 hours on average[16]. Therefore for these plants, the cost of operation (not installation cost) was reduced down to 1/20th of the cost to ensure consistency with their shorter run times.

It is assumed that the cost of the abatement fitted would have to be outweighed by the benefit of the revenue streams possible in order for plants to choose to fit the abatement.

7.3 Operating and construction costs

Option 2 only

The controls to protect human health from high NO_X emitting plants will result in additional costs for diesel installations such as additional abatement costs or reduced operating times; therefore some of the forecasted diesel capacity would be taken up by gas plants.

Following consultation with industry stakeholders and BEIS, it has been identified that there are different construction costs for diesel and gas plants[17]. Other plants were not considered as a significant proportion of the bids into the capacity market were from diesel and gas sites. Diesel plants are typically cheaper to install, although due to the high fuel costs, they are more expensive to run. For gas plants, the price of gas means they are inexpensive to run but the build costs are relatively higher.

In order to capture this difference, industry and other government departments have provided initial cost estimates on the build costs of a diesel or gas plant. Due to the sensitivity of the data, an annualised cost for each plant size has been provided and shown in Table 7.7 below. We intend to consult on these cost estimates as there is limited information on the fixed costs for smaller plants, such as infrastructure costs, which account for a substantial part of the overall plant costs.

It is assumed that the infrastructure cost would be split over the site (it would only require one gas line to be built etc.) therefore the cost would be split between the plants on this site.

Using BEIS fuel forecast estimates for gas and diesel, the following Table 7.7 demonstrates the difference in cost per year over an expected 15 year plant lifetime (*Consultation question – do you agree with this plant lifetime?*).

[16] As these plants aren't required to register, there is little information available around operating hours. Discussions with National Grid suggest that plants in revenue streams such as TRIAD can operate between 30 – 200 hours. Therefore 100 hours is assumed as an average that is applied to all standby plants in energy balancing markets, which we will test during consultation.

[17] Where diesel plants are referred to this means compression ignition engines and where gas plants are referred to it means spark ignition engines or turbines

The difference between diesel and gas is relatively high for plants below 20-50MW. This, in part, can be explained by the fixed costs being appropriate to a larger plant but also because of the assumed run time of the plant. A direct switch has been assumed so this cost difference required diesel and gas to run for the same period of time, 100 hours. In reality, gas is likely to run for longer periods (400- 500 hours), so a comparison for this run time would increase the price of diesel versus gas.

Table 7.7 Operating and Construction Costs

	Diesel engines annualised cost (£/year)	Gas engine annualised cost (£/year)	Cost increment Gas vs Diesel (£k/year)
1-5MW	£61,614	£69,420.	7.81
5-20MW	£234,440	£258,453	24.01
20-50MW	£594,439	£593,586	-0.85

7.4 Impacts from administrative costs

Option 1

Administrative burden

The permitting, compliance check and reporting elements set out in Articles 5, 8 and 11 of the Directive will result in a range of one-off and recurring activities by regulators and MCP operators. Costs associated with different elements of administrative burden will depend on the actions required, the number of MCPs affected for each action, and the associated timing, frequency and level of expertise (tariff per hour) required in those actions.

Plants that are estimated to need a bespoke permit

- 20-50MW plant using solid fuels
- Plants benefiting from the delay in application of Annex II ELVs because they are used for district heating or use solid biomass as the main fuel
- Plants in non- compliant zones or part of zones

All other plants need a standard permit. MCPs that fall under the 500 operating hours' exemption are required to record hours of operation. The administrative cost of this has been considered in all scenarios run by the model.

The complexity and consequent time estimated for issuing a bespoke permit is higher than standard registration. The costs are therefore higher for bespoke permits.

In instances where existing MCPs are already covered by an IED permit, costs associated with record keeping and compliance check requirements are assumed to be covered under the business as usual administrative costs. For registration related activities, 70% of costs are assumed to be covered by business as usual administrative burdens, as the majority of the information required in the Annex I would have been already provided in the permit. As presented in table 7.2, in the abatement costs impact section above.

Key assumptions used to calculate tariff per hour are summarised in Table 7.8. These have been uplifted to 2014 prices using the GDP deflators available from HM Treasury.

Table 7.8 Tariff per hour (2014 prices)

Elements of total tariff	Public administration	Energy sector	Source
Hourly wage	15.34 £/h	16.93 £/h	ONS UK. Patterns of Pay: Results from the Annual Survey of Hours and Earnings, 1997 to 2012; table: Full-time employees' pay by industry sector (SIC 2007)c, United Kingdom, April 2008 - 2012; data: Median hourly earnings excluding overtime (£); sector - Public administration and defence; compulsory social security and Electricity, gas, steam and air conditioning supply, 2012p
Overhead costs per hour	30%	30%	Amec Foster Wheeler assumption
Non-wage costs per hour	30%	30%	Amec Foster Wheeler assumption[18]
Total tariff per hour	**£24.25**	**£26.76**	

[18] Based on Eurostat (2015): Labour cost, wages and salaries, direct remuneration (excluding apprentices) - NACE Rev. 2 [lc_ncost_r2]. According to this, in the UK 2012 total labour cost was higher than wages and salaries by 27% in the electricity, gas, steam and air conditioning supply sector and by 29% in public administration and defence; compulsory social security.

A list of activities associated with administrative burden imposed on operators and regulators by the Directive including estimated time required to carry out the tasks (Amec Foster Wheeler estimates) is detailed in Annex 1.D of this document, where the key categories of activity per plant are listed.

Ranges are presented and the specific hours within the range depend upon whether bespoke or standard, size, and whether new or old plant.

One-off

- Permitting: notification to CA competent authority by operator. Production of Standard or Bespoke Permit **Operator between 4 – 130 hours and regulator between 2 – 65**
- Developments of the MCP register by CA. 37.5 hours. **Regulator 37.5 hours.**

Recurring

- Subsistence reporting[19]. **2.5 – 50 hours for operators, and 1-25 hours for regulators.**
- Record keeping. **7.5 hours for operators.**
- Reporting: three reports to the Commission (2021, 2026 and 2031). **Regulator 37.5 hours.**

The Directive requires three reports to be submitted to the European Commission over the course of 10 years. Associated costs were assumed to be spread equally over this time period. No explicit cost estimates were developed for notifications of malfunctions and planned changes, as the potential number of MCPs affected is highly uncertain. However, in both instances the additional administrative burden costs are likely to be very small and will fall to Defra and the regulator.

<u>Additional administration estimation assumptions:</u>

The administrative costs include a paper based communication channel between the regulator and operator. It is likely that an online system would be in operation which is likely to be less costly and therefore the costs included in this assessment should be considered the maximum (worst case). If an operator is responsible for multiple MCPs of the estimated average size, the administrative costs would scale up proportionately.
The regulator may seek to develop a centralised and digital based central portal by the time the MCP directive comes into force. This approach would make data more readily available, to meet publication and reporting requirements in the Directive. This approach would deliver savings in administration costs for regulators when processing permit applications, and may reduce administration costs for industry.

<u>Compliance Checks</u>

In the context of compliance checks (i.e. inspections) administrative burden was estimated in accordance with different approaches:

- Approach 1: all MCPs are subject to scheduled compliance checks supported by mandatory reporting of data to enable the checks;
- Approach 2: all MCPs are subject to random compliance checks for which regulators request operators to submit data;

Table 6.6 in Section 6 outlines the compliance (inspection) check approach, and how it depends on the risk categorisation of the plant. The underlying assumptions on hours and activities are set out in the table in Annex 1.B.

<u>Summary of administration and compliance check costs</u>

Table 7.9 presents total one-off upfront costs of administration and compliance (inspection costs). For the average plant, this is approximately £161. Of this amount, £50 (32% of £162) is directly paid by the regulator.

Table 7.9 One-off administrative costs to operators and regulators for working and standby plants (£k, 2014 prices)

One-off administrative burden costs, £k 2014			Equivalent annual costs 2030, £k 2014		
MCP operators	Regulators	**Total**	MCP operators	Regulators	**Total**
3,583	1,624	5,208	311	141	452

Table 7.10 and Table 7.11 show the recurring, annualised administration cost faced by each plant size in 2030, when the legislation is fully in place. Table 7.10 demonstrates the contribution of the inspection and remote check costs from each scenario on the overall administrative costs, and Table 7.11 presents the other administration costs that contribute to the total overall admin burden by plant size.

[19] The directive requires subsistence reporting and record keep for at least 6 years.

Table 7.10 Annualised inspections and remote checks costs in 2030 by plant size (£k, 2014 prices)

	Annual inspections and remote checks burden - Approach 1			Annual inspections and remote checks burden - Approach 2		
Capacity (MW)	**MCP operators**	**Regulators**	**Total**	**MCP operators**	**Regulators**	**Total**
1-5	0	1,266	1,266	0	560	560
5-20	0	69	69	0	27	27
20-50	0	1	1	0	0	0
Total	**0**	**1335**	**1335**	**0**	**587**	**587**

Table 7.11 Annualised other administrative costs (without inspections and remote checks) in 2030 by plant size (£k, 2014 prices)

	Annual administrative burden (without inspections and remote checks)		
MCPs size	**MCP operators**	**Regulators**	**Total**
1-5 MW	5,305	786	6,091
5-20 MW	316	46	361
20-50 MW	3	1	4
Total	**5,624**	**832**	**6,456**

The preferred inspection approach is spot checks, Approach 2. As such, the overall admin cost (inspection plus other) translates into £207 per annum per plant on average. Of this amount, £42 (20% of £207) is directly paid by the regulator.

Please note that the average includes all plant (working, back-up and standby in 2030). As such, back-up and stand-by plant which are exempt from compliance with ELVs would pay below the average, working plant requiring a standardised permit a small multiple above the average, and plants requiring a bespoke permit potentially a multiple of the average. This is because of the level of complexity and consequent effort for compliance checks, reporting, and other administration differs by plant category.

We propose charging operators appropriate fees to recover regulator costs, which is consistent with the EPR (Environmental Permitting Regime) and other cost recovery schemes, thus avoiding additional burdens on public finances.

As an indication, the authority will charge an upfront and annual subsistence fee; to recover the regulator costs outlined above, where up front could cover the one-off and annual subsistence the recurring amount. The specifics of the charges will fall under the remit of a separate review Defra is conducting into local authorities recharging structures. We welcome views in consultation and will provide further details in the final impact assessment.

It should be noted that the regulator has not been selected, but the choice will have a cost neutral impact on regulator costs. The work will be the same and costs will be mostly recovered. For the estimation in this impact assessment, all costs to regulators are considered direct costs to business as per BEIS guidance on fees and permitting. This is detailed in the EANCB section (Section 0).

As stipulated under BEIS guidance, upfront permitting/registration and all other costs quantified in this impact assessment are not considered transitional and are all estimated as non-transitional. Therefore transition costs will be in costs not quantified in this impact assessment. They include communications, guidance, training of regulators and setting up of tools for permitting and to carry out compliance checks

Option 2

Under the MCP Directive, standby plants are assumed to face permitting costs, monitoring CO and light-touch compliance (inspection) checks; however those generators (the majority standby) face additional administration costs compared to those faced in the MCP Directive.

Permitting costs

One-off permitting costs

We have assumed that Tranche A electricity generating plants operating for longer than 50 hours in 2018 would face a standard emissions test in order to see if they breach 500mg/Nm^{3}ELV. This cost is annualised over a lifetime of 15 years. If this is the case, plants will be required to get a permit and undertake dispersion modelling to see if they are likely to cause a breach. The costs for these actions are outlined in Table 7.12 below.

Table 7.12 Additional administration costs for electricity generating plants breaching proposed ELV's

	One-off permit costs (2014 £)
Standard Emissions Test	1,000
Permitting	2,500
Bespoke Modelling	5,000
Total	**8,500**

The population data demonstrates that 50% of plants are likely to be in an urban location. Therefore, it is assumed that only the plants in rural locations would choose to obtain a permit with site-specific conditions in order to operate for longer hours because they will be less likely to impact on local receptors and would see the cost of applying for the permit to be outweighed by the revenue to be generated.

In 2024, it is assumed that those generators with a permit with site-specific conditions that operate in excess of 50 hours are operating for energy balancing markets or would otherwise be affected by MCPD and would therefore reduce hours rather than meeting the lower ELV which would require them to fit abatement which would be of greater cost. As a result, the permit costs are annualised over a seven year period as those plants that hold a bespoke permit would only hold them until 2025.

These costs would be on a site by site basis as often standby plants are not individual units on sites but can be clusters of three or more. Additionally, the emissions of a site (installation as defined in the Environmental Permitting Regulations) should be considered rather than individually as this would change the level of emissions faced by local receptors and could cause a greater impact on health. The capacity market outputs suggest and average site size of 20MW therefore it is assumed that these costs would be spread between ten plants (to represent a site) as average diesel plants are 1-5MW, so a midpoint of 2MW is assumed. For larger sites, three plants per site are assumed as demonstrated by data collected for assessment of working plants affected by the MCP Directive.

Table 7.13 Number of plants assumed per site estimate

Capacity	Plants per permit
1-5MW	10
5-20MW	3
20-50MW	3

Recurring permitting costs

For those plants which become operational after 1 December 2016 that choose to fit abatement, a permit would be required to operate. New diesel plants are the only engine type that are likely to breach the ELV as new diesel engines are forecast to continue to have high basecase emissions of 1200mg/Nm^3. Plants will be treated in the same way as high risk plants under the MCPD proposals, as outlined in Section 6.3.

These estimates were made using an assumption of hourly wage in the energy and public sectors, together with an estimate of the time taken to complete various tasks associated with permitting (as outlined for Option 1). All costs would be borne by the regulator in the permitting process and are assumed to then be passed onto the operator.

As with the one-off costs of permits, the costs of the permit are applied on a site by site basis. The costs in the table below are converted into a per plant cost using the same assumption of numbers of plants per site as above. These costs are different to Option 1 as they reflect the lower number of operating hours expected by these standby plants (100 hours instead of >500hours), and therefore lower resource to verify as part of the permitting process.

Table 7.14 Annualised recurring permitting costs per site, 2030

Capacity (MW)	Annual recurring costs per site (£,2014 prices)
1-5	1,725
5-20	1,725
20-50	2,891

7.5 Impacts from loss of operating hours – revenue and fuel savings (Non-monetised - Option 2)

Tranche A plants that operate for longer than 50 hours per year are near to a receptor and are unable to comply with the ELV of 500mg/Nm^3 in 2018 will be subject to an assessment and may be required to disperse or abate emissions or may choose to reduce operating hours. This reduction in hours represents a potential revenue loss for these plants.

Additionally, the revenue earned by plants in Tranche B has the potential to dictate their behaviour in terms of whether forecasted plants will remain as diesel. If the cost of abatement to meet the proposed ELV's outweighs the potential revenue earnings, then cleaner technology that can meet the ELVs more cost-effectively is likely to replace diesel.

There is limited publicly available information on the amount each plant earns from participating in the electricity generating services. Therefore, we consulted with industry experts and National Grid to give an indication of the potential revenue available. Table 7.15 demonstrates the conclusion of this data gathering exercise, and highlights the multiple options available to plants. Following this consultation, there was a clear consensus that plants operating in these streams are likely to be able absorb the cost of fitting standard abatement to meet the proposed ELVs.

Question for consultation: Do you agree with the figures shown in the table below?

Table 7.15 Revenue streams available to electricity generating plants (estimates from National Grid and industry experts)

Service/ revenue stream	Definition	Capacity of diesel in service (MWe)	Availability payment (£/MWe)[1]	Hours Available/ annum*	Utilisation payment £/MWhr[1]	Utilisation Hours	Total payment (diesel) /kW/yr
FFR	Plants that operate for Firm Frequency Response provide a fast balancing service for fluctuations in frequency. Plants are paid for hours available and hours utilised.	200	£7/or less assume £4 off-peak	20/day	£69-235/MWh	5 (est.)	£33 (est.)
STOR	Plants that operate for Short Term Operating Reserves are typically contracted. Paid for hours available and hours utilised.	650 (450 Short Term 200 Long Term)	£3-8/MW per hour [£3 only not operating over winter, £8 all year)	10.5/day [3,860 hours of availability]	£130-150/MWh Short term, £235/MWh Long term	13835MWh (diesel total 2014) 20 hrs Short term, Long term STOR runs very infrequently (assume 1 hr)	£14.18 (est.)
Triad Avoidance (TNUoS)	During Nov-Feb, when energy use is high, generators connected to the distribution network are paid if they use their generators during "Triads" (the three half hour periods of peak demand for energy). Large industrial and commercial users run their generators to avoid drawing power from the transmission network during Triads to avoid transmission charges.	420	n/a (TRIAD payments for specific hour(TRIAD payments for specific hours)	n/a (TRIAD payments for specific hours)	£69-235/MWh	30-250	£45 (est.)
DSR	Demand side response aims to ensure a secure,	400 approx.	n/a (DSR payments for specific	n/a (DSR payments for specific	£69-235/MWh	9 (est.)	Not confirmed

	sustainable and affordable electricity system. However diesel generators can provide services through DSR providers. DSR diesel with STOR and FFR contracts are not captured in the figures above. These figures were not provided by National Grid and have been estimated on the basis of discussions with industry.		hours)	hours)			
DUoS	DuoS (Distribution Use of System) charges are levied by the UK's regional DNOs (Distribution Network Operators) and go towards the operation, maintenance and development of the UK's electricity distribution networks. Payments for specific hours run.	Not confirmed	n/a (TUoS payments for specific hours)	n/a (TUoS payments for specific hours)	£56-94/MWh	Min 5hrs	Not confirmed

However, in order to prevent high concentrations of NO_2 and reduce overall NO_X emissions from generators providing these services, NO_X abatement needs to be active quickly. This is because emissions of NOx build up quickly within the first 20minutes of operation and the running time of diesel generators acting for these services tends to be fairly short. The proposed limit of 5 minutes decreases the ability for plants to fit appropriate abatement, particularly Tranche A plants which are less likely to see abatement as a cost effective decision over their remaining lifetime.

In order to continue to operate, some plants in Tranche A will therefore choose to reduce their hours to 50 (the average operating time of standby plants in revenue streams is assumed to be 100 hours based on stakeholder consultation and National Grid information) as they consider the cost of abatement higher than the revenue loss incurred.

As there is little information around the location of plant in relation to a sensitive receptor, population data has been used in the UKIAM model[20] to categorise the geographical distribution of sites of diesel units, based on the 2015 plants from the 2015 capacity auction. This demonstrated that approximately 50% would be in a rural or suburban location where there is likely to be less risk of a sensitive receptor in close proximity to the installation. Therefore it could be assumed that 50% of generators would cause undue health impacts due to their position near sensitive receptors and would therefore reduce their hours. A lower ELV of 190mg/Nm^3 for plant that are not exempt in 2025 would mean that any plant which could benefit from an exemption from permitting (in particular back-up generators providing power on-site during an emergency) would reduce their hours in 2025. We have therefore assumed that the remaining 50% of plants would reduce their hours in 2025 as this action would be more cost effective than fitting abatement that would be active within 5 minutes. Arrays of diesel engines located on sites with no power demand will not be able to benefit from this exemption and would be required to fit suitable abatement to operate for any purpose other than to fulfil a contract or agreement made before 1 December 2016. Information on how many generators are in sites of this kind is relatively weak so it is possible the costs of abatement are underestimated. We will seek further information on this point during the consultation.

We have assumed these plants would incur a revenue loss by reducing their hours available from 100 to 50, along with a fuel saving from the reducing running hours (greater savings for diesel as the fuel cost is higher). Consultation with BEIS and industry experts has suggested that it is very likely that they can continue to operate profitably with more limited hours, and this would be a cheaper option than fitting abatement.

It is worth noting that we do not assume that capacity overall will reduce due to the new capacity projected to come through, therefore revenue can be treated as a transfer from one area of the energy market to another. This

[20] For more detail on the UKIAM - https://www.imperial.ac.uk/environmental-policy/research/environmental-quality-theme/current-projects/iau/iam/ukiam/

is because other plants which meet the emission limits will be able to benefit from these available revenue streams and will be paid to provide this capacity. However, in the short term diesel is viewed as relatively cheap due to low build costs, although running costs (from fuel) are higher. Therefore if new capacity (Tranche B) is being filled by alternative plants such a gas, which can be more expensive to build, there may be a very marginal increase in the cost to consumer in the short term. This is detailed in Section 13.

Overall, the cost to the plant running shorter hours will be a benefit to those plants that will take up the requirements of the contract, which demonstrates a redistribution of income from one plant to another with no net societal cost faced.

Information on the number of revenue streams each plant is in or will be able to enter is not available, therefore this impact is not monetised, but we will consult on this to incorporate into the final Impact Assessment.

7.6 Monitoring costs

Option 1

In order to ensure that plants would comply with the advised ELVs and continue to protect human health, Article 6 of the Directive requires Member States to ensure that MCP operators carry out monitoring of emissions in accordance (as a minimum) with the requirements set out in Annex IV. This Annex requires periodic monitoring of SO_2, NOx and particulate matter (where relevant) to be undertaken at least every three years for plant between 1 and 20MW and at least annually for plant above 20MW.

The proposed monitoring costs are estimated based on the number of MCPs affected, pollutants monitored and data on monitoring costs. The type of pollutants to be monitored by MCP operators depends on whether an ELV is set down in Annex II for the plant concerned. Overall:

- Natural gas fired plants (engines, gas turbines and other plants) are required to monitor NOx emissions only;
- Plants fired by gaseous fuels other than natural gas are required to monitor NO_X and SO_2 emissions only; and
- Plants using other fuels (liquid or solid depending on the type of MCP) are required to monitor NO_X, SO_2 and particulate matter.
- Standby plants using biomass and other solid fuels are required to monitor PM only
- CO monitoring is required for all plants including those exempt from meeting emissions limits under MCP.

Information on the number of MCPs estimated to be affected per capacity band, type and frequency of monitoring required is summarised in Table 7.16.

Table 7.16 Monitoring requirements and assumptions (number of plants in 2030)

Capacity	CO and NO_X emissions (natural gas fired plants)	CO, NO_X and SO_2 emissions (plants firing gaseous fuels other than natural gas)	CO, NO_X, SO_2 and PM emissions (plants firing other liquid and solid fuels)	Frequency	CO and PM emissions (biomass and other solid fuels standby and back-up)	CO emissions (gaseous and liquid fuels standby and back-up)	Frequency
1-5 MWth	6,769	60	1,440	Every 3 years(1)	210	23,923	Every 5 years(1)
5-20 MWth	774	7	123	Every 3 years(1)	36	703	Every 5 years(1)
20-50 MWth	9	0	1	Annually	0	5	Annually*

*Biannually and triennially will be considered for the final implementation.

Information on the costs of monitoring and meeting MCERTS was provided by an MCERTS accredited monitoring consultancy (anonymous for commercial confidentiality)[21] and was deemed reasonable by regulators and operators engaged. MCERTS is the UK Monitoring Certification Scheme for Environment Agency of England (EA) & Natural Resource Wales (NRW). It provides the framework for businesses to meet quality requirements. Compliance with MCERTS gives the EA confidence in the monitoring of emissions to the environment.

The monitoring costs cover the sampling by an accredited UK monitoring company and provision of an emissions monitoring report to the operator. These monitoring costs and the main underlying assumptions are detailed in Table 7.17.

[21] An additional sensitivity using a set of monitoring costs provided by Defra has been analysed and provided to Defra separately.

Table 7.17 Monitoring cost data and assumptions (£)

Capacity (MW)	NO_X, SO_2 & PM monitoring costs (£, 2014 per activity)*	NO_X & SO_2 monitoring: share in total costs**	NO_X & SO_2 monitoring costs (£, 2014 per activity)	NO_X monitoring: share in total costs***	NO_X monitoring costs (£, 2014 per activity)	Additional costs of monitoring CO (£, 2014 per activity)****	Assumptions
1-5	£2,133	75%	£1,600	50%	£1,066	£600	Assumed average plant size of 3MW, 1 hour of measurements for NOx and SO_2, 3 samples for dust and other parameters also measured (oxygen, temperature and pressure).
5-20	3,555	75%	£2,666	50%	£1,777	£600	Assumed average plant size of 12.5MW, 2 hours of measurements for NOx and SO_2, 3 samples for dust and other parameters also measured (oxygen, temperature and pressure).
20-50	6,297	75%	£4,723	50%	£3,198	£600	Assumed average plant size of 35MW, 4 hours of measurements for NOx and SO_2, 3 samples for dust and other parameters also measured (oxygen, temperature and pressure).

* Independent estimate (2013). Figures provided by MCERTS accredited monitoring consultancy (anonymous for commercial confidentiality).
**Plants fired by gaseous fuels other than natural gas are required to monitor NO_X and SO_2 emissions, in which case 75% of the costs are assumed.
***For natural gas fired plant only monitoring of NO_X is necessary, in which case only 50% of the costs is assumed.
****Amec Foster Wheeler assumption - refers to the cost of monitoring CO simultaneously with the monitoring of the other pollutants.
The plants already covered under an IED permit are assumed to still be required to carry out emissions monitoring activities under the Directive as they do not necessarily have to be monitored under business as usual.

The figures should be interpreted as a maximum cost, because MCERTS was developed for larger, more complex plants than those under consideration in this impact assessment. At present there is no viable alternative. The industry may seek to develop a lower cost method to meet standards under the requirements of MCPD. In practice, the MCP community may seek to develop a less resource intensive monitoring process that meets the standards set out in the directive, thereby reducing the costs as set out in this impact assessment.

The monitoring costs also reflect the fact that most plant will determine SO_2 emissions from fuel sulphur content rather than monitoring.

Table 7.18 below demonstrates the annualised monitoring costs for each plant type. These costs are from 2030 when all stages of the MCP Directive are implemented. All working plants would be affected, whereas standby and backup plants are required to monitor for CO, and only standby plants fired with solid fuels are required for PM as well as CO emissions.

Table 7.18 Total annual monitoring costs to operators including CO (£k, 2014 prices)

Capacity (MW)	Working natural gas fired plants, CO and NO_X	Working plants fired by gaseous fuels other than natural gas, CO, NO_X and SO2	Working plants fired by other solid or liquid fuel, CO, NO_X, SO_2 and PM	Standby plants firing solid fuels CO and PM	Standby plants firing gas and liquid fuels, CO	Backup plants firing gas and liquid fuels, CO	Total
1-5 [(1)]	3,722	43	1,299	70	1,799	1,072	8,005
5-20[(1)]	607	7	169	17	84	0	885
20-50	36	0.4	10	1	2	0	48
Total	4,365	51	1,477	88	1,885	1,072	8,938

Monitoring costs occurrence frequency assumed to be 0.33 per year for working plants sized 1-20MW and 1 for working plants sized 20-50MW. For standby and backup plants, the frequency is assumed to be 0.2 per year for plants sized 1-20MW and 0.5 for plants sized 20-50MW

Table 7.19 presents this per plant on an annualised basis.

Table 7.19 Per plant annual monitoring costs from 2030 to operators including CO (£k, 2014 prices)

Capacity (MW)	CO and NO_X emissions (natural gas fired plants)	CO, NO_X and SO_2 emissions (plants firing gaseous fuels other than natural gas)	CO, NO_X, SO_2 and PM emissions (plants firing other liquid and solid fuels)	CO and PM emissions (biomass and other solid fuels standby)	CO emissions (gaseous and liquid fuels standby and back-up)	Frequency
1-5	0.6	0.7	0.9	0.3	0.1	Every 3 years[(1)]
5-20	0.8	1.0	1.4	0.5	0.1	Every 3 years[(1)]
20-50	4.0	-	10.0	-	0.4	Annually

Option 2

As those plants that are part of the energy balancing markets would now be expected to meet the proposed ELV of 190mg/Nm^3, monitoring in addition to that expected in the MCPD will be required to ensure that this limit is being met. Therefore any plant choosing to fit technical abatement would need to monitor emission levels to demonstrate compliance. Specifically, in addition to all concerned plants needing to initially complete a test, they will subsequently also need to regularly monitor emissions.

The costs of monitoring for these plants would extend to monitoring NOx along with the cost of CO monitoring, which is required by all standby plants in the MCP Directive. All relevant plants will monitor and record emissions of CO every 5 years under the MCPD requirement, whereas the NOx monitoring must be done every 3 years for generators using abatement equipment to achieve the required ELV. Each plant must be monitored rather than each site, as the ELVs apply to stacks (to monitor emissions at the flue) not sites. The costs have been calculated as in Option 1, scaled for smaller individual plants with shorter operating hours, and are demonstrated in Table 7.20 below.
Note these costs are primarily only those additional to Option 1, and do not capture those anticipated in MCPD (e.g. PM monitoring) aside from CO monitoring, which is included as it is applicable to all Standby plants.

Table 7.20 Monitoring costs per plant

Plant Size	NOx and CO only monitoring costs (£, 2014 per activity)
1-5MW	**£1,066**
5-20MW	**£1,777**
20-50MW	**£3,198**

7.7 Benefits to the Environment and Human Health

Emission Reductions

Total emissions reduced for SO_2, NO_X and PM are estimated by applying abatement efficiencies to the fuel specific emissions.

The abatement efficacies are those from the specific abatement measures selected in the compliance modelling. Specifically, the model compares the baseline (unabated) emission concentration for the plant type against the relevant MCPD ELV or measures to meet energy balancing markets to determine if a reduction in emission concentration is required, and if so, what percentage reduction is needed. The model then selects the relevant measure to achieve the required reduction; for example, if a reduction of 50% is needed and there are measures suitable for that category of plant able to achieve 40% reduction or 70% reduction, then the measure achieving 70% reduction is applied to ensure compliance. Consequently, the emission reduction modelled is higher than would be needed purely to comply. For most abatement measures, this is a realistic situation. A small number of measures (FGD, SCR and SNCR) could in practise be set up to only achieve the required reduction without an overshoot, and reduce slightly the operational costs.

(1) Monetised Benefits - Air Quality

The beneficial impact is considered in terms of the damage avoided if emissions reductions are achieved. For example, the avoided negative health outcome, quantified through a reduction in chronic (deaths brought forward) mortality and acute (sickness) impacts resulting in respiratory and cardiovascular hospital admissions. This 'damage' avoided is calculated in money terms using a damage cost. The IGCB damage cost functions form official government Green Book guidance on valuing impacts from Air Quality. They predominantly capture the health benefits from reduced emissions[22].

As damage costs are sensitive to factors such as geographic location of emission sources and meteorology, there are damage cost functions for particulate matter (PM) and NO_X that are categorised by geographic area. For the purpose of the MCP analysis and additional measures for high NO_X generators, we have calculated a weighted average damage cost specific to each pollutant that is based on the sectors involved (based on sectoral split as per Figure 7.1). This is to enhance representativeness of damage costs in relation to specific MCP impacts.

Table 7.21 below presents the damage cost weighted by the average of the sectors involved.

Table 7.21 Damage Cost Functions for SO_2, NO_X and PM (£2014 per tonne of pollutant reduced)

	Central Estimate	Low Central Range [b]	High Central Range [b]
NO_X [c]	£11,672	£4,669	£18,675
SO_2	£1,753	£1,417	£1,992
PM [c]	£29,200	£22,862	£33,182

a) Based on IGCB damage cost functions (IGCB, 2012 for SO_2 and PM – Defra, 2015 for NO_X).
b) Variation between the central values reflects uncertainty about the lag between exposure and the associated health impact.

The damage cost functions have been inflated to 2014 prices (using GDP deflators), and additionally uplifted by 2% per annum until 2014. In years beyond 2014, they are only uplifted by 2% per annum when applied to future year emission reductions. The uplift captures the higher willingness of the population to pay, and therefore value of health benefits as incomes (economic growth) rises.

(2) Greenhouse Gases (GHGs)

A change in greenhouse gas emissions was also calculated from a change in fuel consumption. The implementation of abatement also results in the abatement of greenhouse gases, mainly carbon dioxide. We have monetised the environmental benefit of reduced CO_2 using the central BEIS traded and non-traded carbon values to calculate the impact.

Non-monetised Benefits

It is important to note when applying and interpreting damage cost functions that a number of impacts are not taken into account in the quantification; this includes impacts on ecosystems and cultural heritage. Therefore, the benefits estimated through the application of damage cost functions may be underestimated.
Not all impacts can be fully monetised; there are additional benefits that are non-monetised associated with reductions in soil and surface water contamination, reducing acidity and the potential for these substances to bio-accumulate in the food chain and humans. Reduction in the emissions of organic substances should also lead to a downward trend in the release of carcinogens[23]. The monetised air quality health impacts also do not include all

[22] *The PM10 and SO2 estimates, in addition, include the impact of building soiling and the impact on materials respectively". (Defra, 2013, Valuing impacts on air quality: Supplementary Green Book guidance).*

benefits to human health. Therefore there are also additional impacts to human health not captured in monetised benefits.

Option 2 only

Emission reductions from reduced hours and change in fuel type

Alongside the emission reductions estimated as a result of the additional restrictions for existing plants within the energy balancing markets choosing to apply abatement efficiencies, there are additional emission reductions from reduced operating hours, compared to basecase emissions.

For plants operational before December 2016 and those with 2014/5 Capacity Market agreements, it is assumed that a proportion choose to reduce their hourly run time as it would be more cost effective for the plant than fitting abatement. This reduction in hours therefore reduces the level of emissions. This reduction is modelled by calculating the difference in the annual waste gas flow rate multiplied by the level of emissions in the basecase of 100 hour run time compared to the scenario of reduced run time of 50 hours. Please see section 6.2 for details of ELVs under the option.

For plants which become operational after 1 December 2016, it has been assumed that a proportion of the forecasted diesel capacity would be replaced by gas as the measures for high NOx generators would deter diesel from entering the energy balancing market. While we assumed that there would be no additional benefit in the NOx reductions from an abated diesel generator and a gas generator (both assumed to meet 190mg/Nm^3), gas generators have lower SOx, PM and CO_2 emissions as gas is a cleaner fuel for multiple pollutants and GHG's. These additional benefits have been captured as part of the assumed technology switch from diesel to gas.

Monetised environmental benefits

Air Quality benefits: The potential benefits of the reduced emissions from the assumed reduced hours and change in fuel are calculated using the application of damage cost functions as outlined above. The same weighted average of the damage costs has been applied, as in the previous section, to capture the spread of plants across different industries and locations. This is something we intend to consult upon as little data is currently available on the precise industries and locations of these plants.

CO_2 emissions: The environmental benefit of reduced CO_2 from the assumed reduced hours and change in fuel has been calculated using the central BEIS non-traded carbon values.

7.8 Operating hour exemption

For Option 1

Article 5(2) of the Directive includes an exemption for MCPs operating less than 500 hours per year from ELVs unless firing solid fuel. In order to assess the impact of this derogation, we estimated how many plants would be above and below 500 hours on average per year. We have estimated that up to 24,640 plants will be back-up and standby by 2030 (see section 7.1), in both cases operating fewer than 500 hours per year, and thereby exempt.[24]

For Option 2

Exemption for MCPs operating less than 500 hours per year outlined in Article 5(2) of the Directive will continue to apply. However a subset of working and standby plants in the MCPD (generators) would be subject to additional measures under this option.

7.9 Further assumptions and uncertainties

The analysis assumes that most working plants operating in England and Wales will have to meet the standard ELVs for existing and new MCPs as set out in Annex II of the Directive and otherwise (see Section **6.2**). Footnotes to these tables in the directive have been reflected in the model where different ELVs are set for the size-fuel-plant type categories used within the model. Other footnotes present different ELVs for specific fuel or plant types which form a sub-section of the categories within the model. Those have not been reflected in the analysis given the uncertainty in the number of plants which fall into such sub-categories. Therefore, in some cases further separate analysis has been performed to consider some of these footnotes and incorporate them into the results presented in this report.

A more comprehensive discussion on key risks and assumptions is discussed in Section 9, along with results from sensitivity testing key assumptions. Section 9 also presents a full assumptions log.

[24] However, there are emissions controls for PM for solid fuel burners running below 500 hours, which is included in this assessment.

8. Results

8.1 Overview

Table 8.1 and Table 8.2 demonstrate the total impacts of each option. Monetised health and environmental benefits of Option 1 across the 15 year appraisal period, relative to do nothing (Option 0) are £1464m, against costs of £208m, in present value (today's terms). For Option 2, over the 15 years, there are £2079m in benefits against £387m of cost, compared to the baseline. The next subsection summarises each cost and benefit category.

Table 8.1 Cost and benefits for Option 1 (£m, PV)

2018-2032	Low Scenario (high costs/low benefits) (£m)	High Scenario (low costs/high benefits) (£m)	CENTRAL (£m)
Costs (costs to operators)			
Abatement costs	276.8	60.2	126.1
Administration costs	72.2	20.1	34.8
Monitoring costs	100.3	24.8	46.6
Total	449.3	105.0	207.6
Benefits (emission reductions)			
Air Quality pollutants	816.5	1,982.8	1,423.2
CO_2	18.0	54.1	35.9
Total	834.4	2,036.8	1,459.1
NPV	385.2	1,931.8	1,251.5

Table 8.2 Cost and benefits for Option 2 (£m, PV)

2018-2032	Low Scenario (high costs/low benefits) (£m)	High Scenario (low costs/high benefits) (£m)	CENTRAL (£m)
Costs (cost to operators)			
Abatement costs	126.3	258.6	152.8
Administration costs	36.7	36.9	36.7
Monitoring costs	46.7	59.4	49.2
Operational/capital cost of technology switch	184.8	-	147.8
Total	394.4	354.9	386.5
Benefits (emissions reductions)			
Air Quality pollutants	932.0	2,802.4	1,973.6
CO_2	82.5	118.6	100.4
Total	1014.5	2,921.0	2,079.0
NPV	620.0	2,566.1	1,692.5

*Please note any differences due to rounding.

8.2 Key costs and benefits of Option 1: Implementing the MCP Directive

Overview

This section details the estimated costs, emission reductions and wider administrative requirements for MCPs in England and Wales following the implementation of the MCP Directive. The results present the outcome over a 15 year assessment period. The assessment begins in 2018, when the first costs will be incurred, and ends in 2032, where it would be anticipated that the MCP Directive will have been implemented in full.

Year-by-year results (i.e. annualised costs for individual years) are presented throughout this section, to show the staging of the MCP directive requirements on different types of plant. However, from 2030 onwards, the impacts will be similar for future years given that there are no further changes to MCP Directive requirements from that year. The only changes will be as a result of the closure of existing plants on reaching the end of their operating life and opening of new plants, and changes in the projected use of different fuel types. As such, a 2030 annualised[25] steady state figure is presented throughout this section to indicate the potential impact in subsequent years beyond the appraisal period.

The main ranges around the central estimate represent the two key sensitivities. The first is the number of plants, which due to the lack of data, is the main sensitivity surrounding the total cost impacts of the directive. The second is the variation in the damage cost values attributed to benefits reduced emissions. It is standard HMT Green Book practise to present the uncertainty in valuing human health. It should be noted that the benefits range is independent to plant numbers as it is assumed that total emissions reductions are the same in all plant number scenarios, they are just spread over more or less plants. Alongside these key sensitivities, further assumptions and flexibilities are sensitivity tested where presented but are not included in the main ranges. For example, the results of two inspection options are presented in the inspection section, but only the preferred option is carried forward in all other headline figures.

All prices are in 2014, and a 3.5% discount rate has been used in present value figures as per Green Book guidance. The base year for the NPV is 2018.

In the remainder of this section, each of the following monetised impacts is discussed in more detail:

COSTS

- **Emissions abatement costs for plant operators –** Compliance with the MCP will lead to additional costs for plants between 1-50MW that are not exempted from compliance with emission limits. These plants may need to fit abatement in order to reduce their NOx, PM and SOx emissions to meet the ELVs set in the MCP. These costs will vary depending on the plant type and the age of the plants with the most cost effective abatement measure chosen. This will result in an additional cost to operators of between £60.2m and £276.3m in present value terms over the first 15 years. Our central estimate is this will lead to an additional cost of £126.1m in present value terms for businesses.
- **Administrative and Compliance costs –** These costs include operator and regulator time and effort for processing an environmental registration/permit, compliance (inspection) checks, and data reporting (the costs borne by regulators are anticipated to be mostly passed on to operators). The Directive is flexible in how these inspection requirements are carried out so a range of options were sensitivity tested. We estimate the implementation of the MCP Directive will result in an administrative cost to business of between £20.1m and £72.2m in present value terms over the first 15 years. Our central estimate is this will lead to an additional cost of £34.8m in present value terms.
- **Monitoring costs –** The costs include the fees for an accredited consultant to conduct the monitoring surveys and prepare a monitoring survey report to the operator annual or tri-annually in order to meet the Directives monitoring requirements. This will result in an additional cost to operators of between £24.8m and £100.3m in present value terms over the appraisal period. Our central estimate is this will lead to an additional cost of £46.6m NPV for businesses.

MONETISED BENEFITS TO THE ENVIRONMENT AND HUMAN HEALTH

- **Monetised air quality benefits –** The main benefit of the implementation of the MCP directive will arise from the reduction in air pollutant emissions. By reducing the number of plants operating without abatement and ensuring that these plants are monitored for their emission levels, this will improve air quality and benefit human health and the environment. We estimate human health benefits in terms of emissions reduced of NO_X, SO_2, and PM of between £816.5m and £2,036.8m in present value terms,

[25] Total annualised cost = annualised CAPEX + annual OPEX
Where:
Annualised CAPEX = CAPEX x (discount rate / (1-((1+discount rate)^-lifetime))
Where:
discount rate = 3.5% (Greenbook)
lifetime = 15 years (assumed for all measures)
To calculate the total annualised cost for 2030, we identify what abatement measures are required in 2030 and sum up the total annualised cost. This is known as the equivalent annual cost (EAC). It is the cost per year of owning and operating an asset over its entire lifespan, and is appropriate to compare against annual benefits in a specific year to determine the economic cost effectiveness.

with a central estimate of £1,423.2m for England and Wales. This figure captures the reduction in both chronic mortality effects (which consider the loss of life years due to air pollution) and morbidity effects (which consider changes in the number of hospital admissions for respiratory or cardiovascular illness).

- **Monetised Green House Gas (CO_2 Emissions) Benefits**
  – Certain measures intended to reduce emissions of air quality pollutants also affect CO_2 emissions from UK plants. As some of the larger plants would fall into the scope of the EU Emissions Trading System (ETS), the reduction in costs to UK businesses of purchasing extra EU ETS allowances from abroad is assessed. Therefore, any change in CO_2 emissions in the UK is valued using the traded cost of carbon. Smaller plants will fall under the non-traded value of carbon, where although they are not traded as part of the EU ETS, the emissions still contribute to the global carbon value and need to be considered and as other industries may not need to abate as much as a result. We estimate that total reduction in CO_2 emissions will lead to additional present value benefits of between £18m and £54.1m, with a central estimate of £35.9m.

8.3 Abatement costs

The abatement costs to plants consist of the cost of abatement technology needed to meet the ELV's within the MCP Directive. As outlined in Section 7.2, the abatement costs represent a collation of best available data on the cost of abatement equipment in order to meet the conditions in the MCP Directive. As this varies depending on data source, a range was created to combine the different estimates. As set out in section 7, for working plants that are already compliant with MCP ELVs under business as usual, the abatement costs are set to zero – i.e. only the relevant costs compared to the baseline are included.

The central year on year breakdown is shown in Table 8.3 where the annual total cost of abatement increases over the appraisal period as each stage of the MCP Directive is introduced. The table below also demonstrates where stages with a greater number of plants are impacted (2025, 2029) come into effect, as shown by the higher cost. The final column presents the total cost over the appraisal period in discounted, present value terms.

Table 8.3 Year on year cost of abatement for working plants (£m, 2014 prices, discounted)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Cost																
£m	0.00	3.92	3.96	4.14	4.30	4.45	19.14	6.22	6.11	6.10	6.09	38.82	7.80	7.62	7.45	**126.2**
Low Cost																
£m	0.00	1.87	1.89	1.98	2.06	2.12	9.16	2.97	2.92	2.92	2.91	18.45	3.73	3.64	3.56	**60.2**
High Cost																
£m	0.00	8.70	8.78	9.20	9.50	9.85	37.75	13.28	13.06	13.06	13.04	90.62	17.07	16.69	16.31	**276.3**

Note: any differences in totals due to rounding. Low cost plant numbers are halved and in high cost plant numbers are doubled.

<u>Sensitivity of the central cost estimate</u>

The table above also presents differences in totals if the number of plants is changed. The assumptions used in these sensitivity tests are one of the two key sensitivities covered in Section 9 on risks and assumptions.

Table 8.4 below also provides an additional source of uncertainty compared to the central scenario and is separate to the uncertainty on plant numbers. In Table 8.4 below, the same plant numbers are in all three scenarios, where high are low are presented in the range in brackets. The range illustrates the uncertainty on abatement costs, and demonstrates the abatement cost from various, alternate information sources. It is presented as the average annualised impact from when the full set of ELVs comes into effect (from 2030). The range of total annual compliance costs is between £11.3 million and £23.3 million annually from 2030, with a central estimate of £17.3 million. From this figure, £9.5 million is expected from existing plants and £7.8 million from new plants. Costs detailed below are annualised and shown separately for existing plants, new plants and total plants across pollutants.

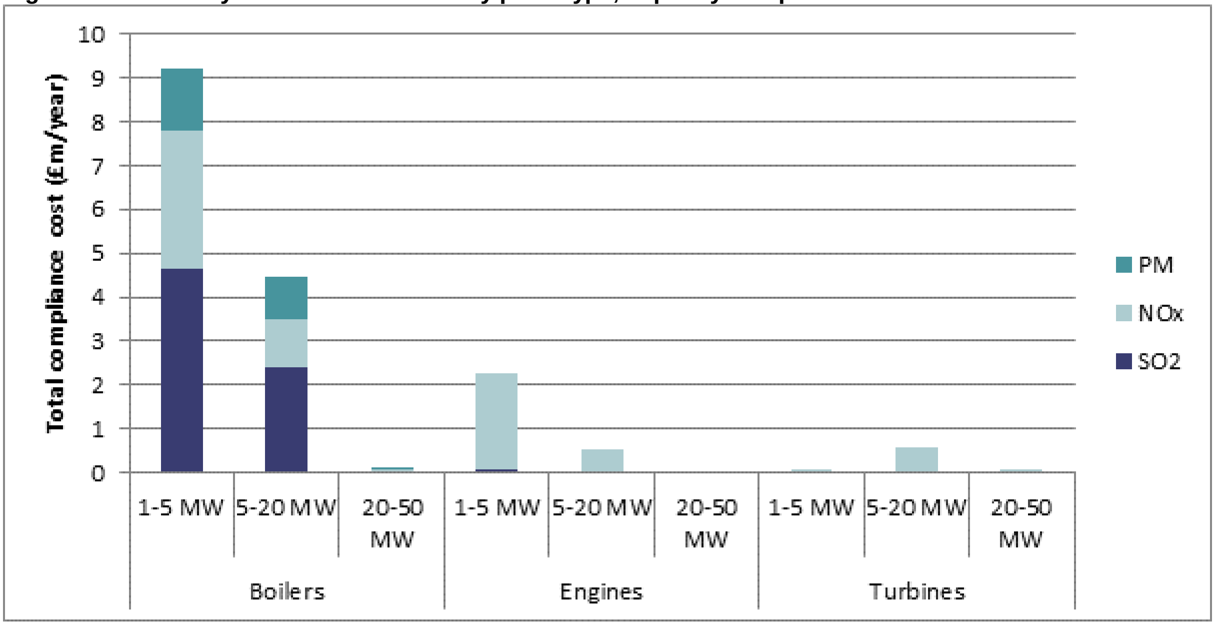
Table 8.4 Average annualised abatement costs in 2030 for existing, new and total plants (£m, 2014 prices, low-high range presented in brackets for totals)

	SO_2	NO_X	PM	Total
Existing plants	4.7 (4.6-4.7)	2.8 (0.7-4.9)	1.7 (1.2-2.3)	9.2 (6.5-11.9)
New plants	2.5 (2.5-2.5)	4.9 (1.6-8.1)	0.2 (0.2-0.2)	7.6 (4.3-10.8)
All plants	7.2 (7.2-7.2)	7.7 (2.3-13.1)	1.9 (1.4-2.5)	16.8 (10.8-22.7)

The numbers in the table below reflect all working plants and those standby plants with ELVs. The additional 0.5m to reach 17.3m is not attributable to a specific pollutant, due to cross pollutant costs.

Figure 8.1 further demonstrates the compliance costs by plant type, capacity and pollutant. Note a large proportion of costs are associated with 1-5MW boilers as this is the most common category of MCPs.

Figure 8.1 Summary of abatement costs by plant type, capacity and pollutant



8.4 Administrative and Compliance (Inspection) costs

The administration costs faced by plants are for operator and regulator time and effort for processing an environmental registration/permit, inspection, and reporting. Registration, compliance (inspection) checking and reporting activities required under the Articles 5, 8 and 11 of the Directive will result in a range of one-off and recurring costs to regulators and MCP operators. Registration costs[26] will affect both working and standby and back up plants. Recurring costs are lower for standby plants, being limited to record keeping, reporting operating hours and light touch compliance (inspection) checks.

The central year on year breakdown is shown in Table 8.5, where the annual total administrative cost increases over the appraisal period as each stage of the MCP Directive is introduced. The final column presents the total cost over the appraisal period in discounted, present value terms.

Table 8.5 Year on year administrative costs for working plants (£m, 2014 prices, discounted)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Cost																
£m	0.00	0.62	0.83	1.06	1.29	1.49	2.08	2.18	2.26	2.38	2.48	4.04	4.73	4.72	4.63	**34.8**
Low Cost																
£m	0.00	0.34	0.46	0.59	0.71	0.83	1.25	1.25	1.27	1.34	1.40	2.41	2.75	2.78	2.71	**20.1**
High Cost																
£m	0.00	1.35	1.79	2.31	2.78	3.22	4.16	4.48	4.71	4.96	5.19	8.19	9.77	9.71	9.56	**72.2**

Low cost plant numbers are halved and in high cost plant numbers are doubled.

<u>Sensitivity on the number of plants</u>

The key driver behind the differences in the scenarios in table 8.5 above is the differences in the number of plants. The assumptions used in these sensitivity tests are one of the two key sensitivities covered in Section 9 on risks and assumptions.

<u>Inspection scenario sensitivity tests</u>

Alongside the one- off costs stated in section 6.5, MCP operators and regulators will incur recurring costs associated largely with compliance check and reporting requirements. The MCP Directive does provide flexibility for the EU member state to set the number of inspections required in order to meet the reporting requirements, therefore the sensitivity in Table 7.9 presents total one-off upfront costs of administration and compliance (inspection costs). For the average plant, this is approximately £161. Of this amount, £50 (32% of £162) is directly paid by the regulator.

[26] The registration and reporting costs are based on a worst case scenario. The administrative costs include a paper based communication channel between the regulator and operator. The environment agency intends to develop a central portal that will reduce costs from digitising and automating parts of the process. Therefore, the costs included in this assessment should be considered the maximum (worst case).

Table 7.9 in the methodology section demonstrates estimates of administrative costs for operators and regulators under two different inspection scenarios in order to demonstrate the impact of varying the number of inspections.

8.5 Monitoring costs

The monitoring costs are the costs faced by operators to conduct the monitoring annually or tri-annually in order to meet the Directives monitoring requirements. This may be done in house or via an independent test house. Compliance with the monitoring requirements set out in the Directive would result in costs of £46.62m (NPV, in 2014 prices as shown in Table 8.6). The estimated costs include the fees for an accredited consultant to conduct the monitoring surveys and prepare a monitoring survey report to the operator. Depending on the size and type of MCP, monitoring surveys differ in terms of their frequency and pollutants monitored. The final column presents the total cost over the appraisal period in discounted, present value terms.

Table 8.6 Year on year monitoring costs (2014 prices, undiscounted)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Cost																
£m	0.00	0.35	0.77	1.17	1.54	1.89	2.21	2.34	3.38	4.34	5.24	6.07	5.92	5.77	5.62	**46.62**
Low Cost																
£m	0.00	0.19	0.37	0.63	0.78	1.01	1.14	1.18	1.75	2.35	2.84	3.29	3.18	3.13	3.03	**24.87**
High Cost																
£m	0.00	0.77	1.68	2.53	3.31	4.04	4.72	4.95	7.21	9.32	11.27	13.08	12.77	12.47	12.17	**100.30**

a) In low cost plant numbers are halved and in high cost they are doubled.

Sensitivity on the number of plants

The key driver behind the differences in the scenarios in Table 8.6 above is the differences in the number of plants. The assumptions used in these sensitivity tests are one of the two key sensitivities covered in Section 9 on risks and assumptions.

8.6 Monetised Benefits to the Environment and Human Health

The main benefit of the implementation of the MCP directive will arise from the reduction in air pollutant emissions. By reducing the number of plants operating without abatement and ensuring that these plants are monitored for their emission levels, this will improve air quality and have a positive impact on human health and the environment (including greenhouse gases).

Emissions reductions of air pollutants

Fitting abatement will reduce the level of emissions from each MCP as detailed in the table below where, in the year 2030, 14kt SO_2, 12kt NO_X, 2.6kt PM and 111kt CO_2 are estimated to be reduced compared to the baseline. The table shows the total estimated annual emission reductions in 2030 by plant type, which represents the impact when all stages of the MCP have been implemented.

Table 8.7 Total annual emission reductions (kt) from 2030

	SO_2			NO_X			PM			CO_2		
	Existing plants	New plants	Total	Existing plants	New plants	Total	Existing plants	New plants	Total	Existing plants	New plants	Total
Total	9.17	5.29	14.46	6.29	5.54	11.83	1.72	0.87	2.59	77.26	33.81	111.07

Combined contributions from both standby and working plant

Carbon emissions

While the fitting of abatement will directly impact the reduction in SO_2, NOx and PM, CO_2 is reduced largely due to improved efficiencies associated with well managed low NOx burners (such as fuel efficiencies). Table 8.7 in the previous section summarises CO_2 emissions reduction in 2030.

Table 8.8 shows the disaggregation by fuel and plant type to demonstrate that the vast majority of the CO_2 emission reduction is achieved in boilers using natural gas. The emission reductions achieved by this measure are partially offset by other abatement measures (that use parasitic energy), such as Selective Catalytic Reduction (SCR), and therefore increase CO_2 emissions.

Table 8.8 Annual CO_2 emissions reduction in 2030, by plant type and fuel

Emissions change (kt)

	Biomass	Other solid fuels	Gas oil	Other liquid fuels	Natural gas	Other gaseous fuels
Boilers	0.0	-1.5	-4.9	-5.6	123.4	-0.3
Engines	0.0	0.0	-1.4	0.0	0.0	0.1
Turbines	0.0	0.0	-0.0	0.0	1.3	0.0
Total	0.0	-1.5	-6.4	-5.6	124.7	-0.2

Damage costs

The impact of the reduction in emissions due to the implementation of the MCP Directive has been valued in line with best practice as set out in Green Book Supplementary guidance[27].

The Green Book guidance recommends the impact pathway approach in many circumstances when impacts are above £50m annually. While the bespoke impact pathway approach was considered, however, in this circumstance, the uncertainty around the spatial distribution of plants and their operating patterns meant that damage costs are more appropriate. The damage costs used in these assessments are detailed in the methodology section.

(1) Monetised benefits – Air Quality

Table 8.9 below provides a total of the estimated indicative annual benefits associated with the MCP Directive. It is based upon applying the damage cost functions to the volume of emissions reduced over the time period. The range presents the uncertainty associated with valuing health benefits in the damage costs. It is one the two key sensitivities as presented in Section 9. (The other key sensitivity is the number of plants). Please note that in all three scenarios the level of emissions reduction does not change. The sensitivity captures the uncertainty surrounding the valuation of health benefits for a given level of emissions reduction. The benefits are also independent on plant numbers. This is because total emissions reduced are the same in all three plant number scenarios; they are just spread over more or less plants.

Table 8.9 Indicative annual benefits for existing, new and total plants in 2030 (£m, 2014 prices, low-high range presented in brackets for totals)

Totals	SO_2	NO_X	Dust	Total
Existing plants	24 (19-27)	98 (39-157)	74 (58-84)	196 (117-268)
New plants	14 (11-16)	86 (35-138)	38 (30-43)	138 (76-197)
All plants	38 (30-43)	185 (74-296)	112 (87-127)	334 (191-465)

The full year on year breakdown is provided in Table 8.10 where the profile of the emission reduction benefits can be seen as each stage of the MCP Directive comes into effect. The table also illustrates that benefits increase across the appraisal period until 2030, where they are largely constant, and subsequently affected only by a reduction in plant in the baseline. The final column presents the total cost over the appraisal period in discounted, present value terms.

Table 8.10 Year-on-year breakdown of emissions benefits (£m, 2014 prices, discounted) Central damage cost values

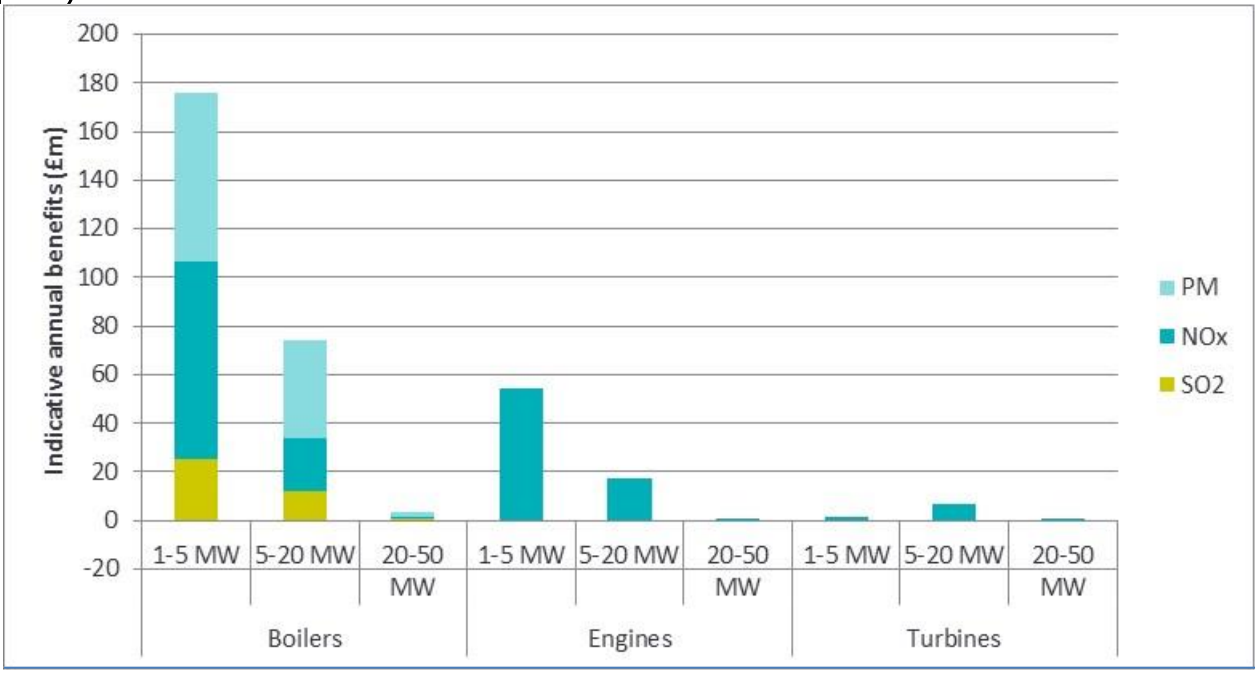
Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
SO_2	0.0	1.0	1.9	2.7	3.5	4.3	5.1	12.4	12.8	13.1	13.5	13.8	24.9	24.6	24.2	**157.8**
NO_X	0.0	5.8	11.2	16.5	21.6	26.6	31.5	54.6	58.2	61.7	65.0	68.3	122.2	122.4	122.5	**788.2**
PM	0.0	2.8	5.1	7.4	9.6	11.8	13.9	40.6	41.3	41.9	42.4	43.0	73.9	72.5	71.2	**477.3**
Total	**0.0**	**9.5**	**18.2**	**26.6**	**34.8**	**42.7**	**50.4**	**107.7**	**112.3**	**116.7**	**121.0**	**125.1**	**221.0**	**219.5**	**217.9**	**1423.2**

The largest volume of air pollutant emissions reduction in 2030 comes from SO_2 as seen in table 8.7, although the monetised health impact is the lowest. This is because health impacts differ between pollutants as presented in previous tables. It must be noted, however, the absolute volume of emissions reduction makes an important contribution to national emissions ceilings.

Figure 8.2 summarises the benefits for each capacity class disaggregated by pollutant and technology. It can be observed that the majority of benefits are associated with plants ranging 1-5MW, due to the majority of plants being included in this category. It also highlights how the benefits associated to SO_2 only represent a small proportion of the indicative total benefits.

[27] **Damage cost guidance** - http://www.defra.gov.uk/environment/quality/air/air-quality/economic/damage/

Figure 8.2 Annual benefits in 2030 disaggregated by technology, pollutant and capacity class (£million per year, 2014 prices)



(2) <u>Greenhouse gas monetised benefits</u>

This section breaks the carbon impacts down into traded/non-traded. Table 8.11 and Table 8.12 present year-on-year monetised greenhouse gas benefits, for traded and non-traded respectively. Table 8.13 presents the total of traded and non-traded.

Table 8.11 Traded carbon benefits, discounted (£m, 2014 prices)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Benefit																
£m	-	0.00	0.00	0.01	0.01	0.02	0.02	0.08	0.09	0.10	0.11	0.13	0.27	0.28	0.30	1.4
Low Benefit																
£m	-	-	-	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.7
High Benefit																
£m	-	0.00	0.01	0.02	0.03	0.04	0.05	0.14	0.15	0.17	0.18	0.20	0.41	0.43	0.45	2.3

Table 8.12 Non-Traded carbon benefits, discounted (£m, 2014 prices)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Benefit																
£m	-	0.18	0.35	0.50	0.66	0.81	0.95	2.66	2.71	2.74	2.78	2.81	5.47	5.80	6.03	34.5
Low Benefit																
£m	-	0.1	0.2	0.3	0.3	0.4	0.5	1.3	1.4	1.4	1.4	1.4	2.7	2.9	3	17.3
High Benefit																
£m	-	0.27	0.52	0.76	0.99	1.21	1.43	3.98	4.06	4.13	4.17	4.23	8.27	8.70	9.08	51.8

Table 8.13 Total carbon benefits, discounted (£m, 2014 prices)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central Benefit																
£m	-	0.18	0.35	0.51	0.67	0.83	0.98	2.74	2.8	2.85	2.89	2.94	5.73	6.08	6.33	35.9
Low Benefit																
£m	-	0.1	0.2	0.3	0.3	0.4	0.5	1.3	1.4	1.4	1.4	1.5	2.9	3	3.2	18
High Benefit																

£m	-	0.28	0.53	0.78	1.01	1.25	1.48	4.12	4.21	4.30	4.35	4.43	8.67	9.12	9.53	54.1

Damage cost sensitivity

The assumptions used in these sensitivity tests are one of the two key sensitivities covered in Section 9 on risks and assumptions. The key driver behind the differences in the figures below is the differences in valuing human health in the damage cost calculations, where the high and low in Table 8.14 below represent the uncertainty around the central range.

Table 8.14 NPV per environmental and human health benefits

NPV over 15 years (2018 - 2032)			
	Sensitivity		Central Estimate
Pollutant	*Low Benefit*	*High Benefit*	*Best*
Carbon (traded and non-traded cost saving)	17.97	54.06	35.87
NOx	315.26	1,261.09	788.16
SO_2	127.53	179.31	157.76
PM	373.69	542.36	477.27
Total	**834.45**	**2,036.82**	**1,459.06**

8.7 ELV flexibilities scenarios

As detailed in Section 6, Analysis of Options, the Directive includes several flexibilities for Member States to apply less stringent ELVs for specific plants. These flexibilities are being implemented and have therefore been included in the headline costs and benefits. However, the impact of not applying these flexibilities has been considered, to see the impact this would have on the costs and benefits of the MCP Directive. The costs and benefits presented in this section are additional to those presented in the main analysis for Option 1.

The main flexibility is the 500hr exemption which enables those MCPs operating for less than 500 hours per year to be exempt from meeting the ELVs set in the MCP. With an estimated 24,879 plants (back-up and standby) in 2030 affected by this flexibility, there is a significant impact if it is not applied. This should not be compared to the impacts of the additional measures in Option 2 as these impacts affect a specific subsection of plants (high NOx generators) which excludes all back-up plants.

If the 500 hour exemption is not implemented (i.e. all standby AND backup plant are required to comply with the ELVs), costs will increase by 940% whereas the benefits (emission reductions) will increase by only 5%. The increase in benefits is very low as these plants only run for a small amount of time and therefore have low emissions. This is predominantly true of back-up plants which are thought to operate for very few hours (20 hours or less). The increase in costs is high as there are a large number of such plants that would be required to fit abatement to meet the ELVs, monitor and be subject to reporting and compliance (inspection) checks. The increase in cost is slightly higher than realistic as the costs are based on an average plant, as opposed to reflecting the characteristics of standby and backup plants. Additionally, costs to the operator are purely incorporated as the full abatement costs with no consideration given to the capacity of some plants generating sufficient revenue to absorb these costs.
Due to the lack of information about these plants, it was deemed disproportionate to fully adjust the costs.

Table 8.15 demonstrates the impact in 2030. For example, total abatement costs would increase by 162.6m, to 179.9m in 2030 i.e. additional to the 2030 figures for the main scenario in Table 8.19.

Table 8.15 Impact on costs without 500hr exemption in 2030

Change in costs without 500 hour exemption					
Capacity class	**Total abatement costs (£m/yr)**	**Total admin burden (£m/yr)**	**Total monitoring cost (£m/yr)**	**Total costs (£m/yr)**	**Total monetised benefits (£m/yr)**
1-5 MW	156.0	3.0	15.9	174.9	10.5
5-20 MW	6.5	0.1	0.6	7.2	4.4
20-50 MW	0.1	0.0	0.0	0.1	0.2
1-50 MW	**162.6**	**3.1**	**16.4**	**182.2**	**15.1**

There are additional flexibilities with a smaller impact that will be implemented. Consideration has been given to what the additional costs and loss in benefits would be if these flexibilities were not adopted. The results are presented in Table 8.16 below. In interpreting the impact and context, reference should be made to Section 6, where the flexibilities are detailed, including which flexibilities are being emphasised in consultation.

Table 8.16 Impact of costs and benefits for the low, high and central scenarios of total plant number

Specific ELV case	Year[1]	Number of plants affected[2]	Change in total compliance costs (£m/year)	Change in total monetised benefits (£m/year)	Change in emissions (ktpa)		
					NOx	**SO2**	**PM**
District* Heating	2025	38 - 108	0.15 – 0.45	2.9 - 8.8	0-0.2	0.1 -0.4	0 - 0.14
Solid biomass	2025	~40	0.1	1.1 (0.9 – 1.3)	-	-	0.03
NOx ELV flexibility for engines fitted with primary abatement operating 500 – 1500 hpa	2025	~120	0.7	12.6	0.9	-	-
Shortage of low sulphur natural gas	no detailed assessment as such an event is very unlikely	~1,400	-	-	~0	0.2	0.08
Shortage of low sulphur fuel	no detailed assessment as such an event is very unlikely	~600	-	-	~0	7.0	~0-

1) No significant difference between 2025 and 2030 as plant numbers change by <1%
2) There is a high uncertainty in projected plant numbers for these specific sub-categories, which is the main sensitivity for the impact of these specific ELVs
3) Each of the other flexibilities is assessed independently
*Includes solid biomass plants providing district heating and located in AQMAs, since they cannot benefit from the less stringent flexibility applied to biomass plants

8.8 Summary of results for Option 1

Table 8.17 Present value of central costs and benefits over 15 year appraisal period (2018 – 2030), £m 2014 prices

£m, 2015		Sensitivity		Best estimate
Scenarios		**Low Scenario**	**High Scenario**	**Central**
OPTION 1	PV Costs	449.3	105	207.6
	PV Benefits	834.4	2,036.8	1,459.1
	NPV	385.2	1,931.8	1,251.5

In all three scenarios, low, high and central, the preferred option for compliance (inspection) and other admin costs is presented. The difference in costs between scenarios is due to different assumed plant numbers, and the difference in benefits due to differences in the valuation of human health for a given level of emissions reduction. The high scenario NPV combines low cost with high benefits, and the low scenario NPV vice versa (high costs and low benefits). A breakdown of the compliance and emissions benefits contribution is provided below.

Costs

The full costs to MCP operators in England and Wales is demonstrated in the table below with a central estimate of £207.6m. Varying the number of plants, we can see the range around this central figure is £105m - £449m. Fuel consumption is unchanged, and therefore emissions (benefits) would remain constant between scenarios.

Table 8.18 NPV of costs and benefits for the low, high and central scenarios of total plant number

Scenario	Total number of working plants (2030)*	NPV compliance costs (£m)	NPV administrative costs (£m)	NPV monitoring costs (£m)	Total Costs (£m)
Low Costs	4484	60.2	20.1	24.8	105.0
Central Costs	9,430	126.2	34.8	46.3	207.6
High Costs	21,956	276.3	72.2	100.3	449.3

*The scenarios also increase the number of back-up/stand-by plant. Their impact is smaller as they are exempt from ELVs.

Table 8.19 below presents this on an annualised basis in 2030, when the MCP is fully in place. Table **8.**20 presents this on a per plant basis.

Table 8.19 2030 annualised costs and benefits (central scenario) (2014 prices, undiscounted)

Capacity Class	Total abatement cost (£m/yr)	Total admin burden (£m/yr)	Total monitoring cost (£m/yr)	Total costs (£m/yr)	Total monetised benefits (£m/year)
1-5MW	11.5	7.1	8.0	26.6	231.7
5-20MW	5.6	0.4	0.9	6.9	98.2
20-50MW	0.2	0.0	0.0	0.2	4.1
1-50MW	17.3	7.5	8.9	33.7	334.0

Table 8.20 Average annualised 2030 cost per plant (2014 prices, undiscounted)

Capacity Class	Number of working plants	Average total cost per working plant (inc. compliance, admin burden and monitoring) £k/yr*	Number of plants	Average total cost per plant (inc. compliance, admin burden and monitoring) £k/yr**
1-5MW	8,479	2.2	32,402	0.7
5-20MW	940	7.0	1,643	4.1
20-50MW	11	21.0	17	14.1
1-50MW	**9,430**	**2.7**	**34,062**	**0.9**

Please note that averages do not include permitting fees and charges that will be recovered by regulators as set out in Section 7.4
*Column presents average costs for plants required to meet ELVs. For working plants that are already compliant with ELVs under business as usual, the abatement cost is zero.

** Column presents average costs for all plants, including those required and not required to meet ELVs.

For the main analysis, it has been assumed that costs will be funded through internal finances as per the results in the previous section. However, in practice, some firms would have to fund some of the upfront CAPEX through external financing. Costs as a function of a firm's ability to finance is given consideration in the distributional impacts assessment in the following section.

Devolved Authority Disaggregation

The original analysis was produced for a UK perspective. However, this impact assessment presents plant numbers for England and Wales, emissions reductions and consequent costs and benefits, and not those of the UK. The disaggregation from the UK results was based on 84% of plants being located in England, 7.5% in Scotland, 5.2% in Wales and 3.1% in Northern Ireland. It was assumed that plants are distributed equally regardless of capacity, technology and fuel type.

8.9 Key costs and benefits of Option 2: Implementing the MCP Directive and additional capacity market regulations

This section details the estimated emission reduction and associated costs of the additional capacity market measures. The central estimated costs and benefits associated with implementing the MCP Directive as outlined in Option 1 are added to these impacts to present the full Option 2. Some tables present the impact of the additional measures separately to demonstrate their standalone effect and this is clearly labelled.

The results present the outcome over a 15 year assessment period. The assessment begins in 2018, when the first costs will be incurred, and ends in 2032, where it would be anticipated that the MCP Directive will have been implemented in full.

Year-by-year results (i.e. annualised costs for individual years) are presented to demonstrate the impact per individual year when the measures on those plants that are part of the energy balancing markets come into effect. Under MCP, from 2030 onwards, the impacts will be similar for future years given that there are no further changes to MCP Directive requirements from that year. The only changes will be as a result of the closure of existing plants on reaching the end of their operating life and opening of new plants, and changes in the projected use of different fuel types. However, although the numbers of plants are not projected further than 2032, the growth in plants as a result of the capacity market could mean a growth in the numbers anticipated.

The main ranges around the central estimate represent the two key sensitivities. The first is the anticipated behaviour change of new (operational from 1 December 2016) plants which, due to the uncertainties around the impact of the measures, is the main sensitivity surrounding the total cost impacts of the directive. The scenarios tested are as follows:

Scenario 1: No change in diesel, all diesels fit abatement

Scenario 2: 80% of projected diesel capacity becomes gas

Scenario 3: 100% of projected diesel capacity becomes gas

The second is the variation in the damage cost values attributed to reduced emissions. It is standard HMT Green Book practise to present the uncertainty in valuing human health.

Sensitivities in Option 1 such as number of plants and permitting approaches are not repeated for Option 2 as they are not seen as the key uncertainties of the additional measures proposed for plants taking part in the energy balancing market, therefore the impacts on all working, standby and back up plants not impacted by these additional measures are assumed to represent the central case in Option 2.

All prices are in 2014, and a 3.5% discount rate has been used in present value figures as per Green Book guidance. The base year for the NPV is 2018.

In the remainder of this section, each of the following monetised impacts is discussed in more detail:

COSTS

- **Abatement costs for plant operators –** Compliance with the MCP Directive and additional measures for electricity generating plants will lead to additional costs for plants between 1-50MW and lower that are not exempt from compliance with emission limits. These plants may need to fit abatement in order to reduce their NOx, PM and SOx emissions to meet the ELVs set in the MCP. These costs will vary depending on the plant type and the age plant as the most cost effective abatement measure chosen. [28]Central estimate is this will lead to an additional to baseline cost of £153m (£126m and £259m) in present value terms for businesses
- **Administrative and compliance (inspection) check costs –** These costs include operator and regulator time and effort for processing an environmental registration/permit, compliance checks, and data reporting (the costs borne by regulators are anticipated to be mostly passed on to operators). Along with the central option from Option 1 for plants affected by the MCPD, the costs include the additional permitting requirements and compliance checks required by the additional measures for high risk electricity generating installations (those with high NOx emissions). Central estimate is this will lead to an additional to baseline cost of £36.7m in present value terms for businesses
- **Monitoring costs –** The costs include the fees for an accredited consultant to conduct the monitoring surveys and prepare a monitoring survey report to the operator annual or tri-annually in order to meet the Directives monitoring requirements. Central estimate is this will lead to an additional to baseline cost of £49.2m (range between £46.7m and £59.4m) in present value terms for businesses
- **Cost of switching plant type in projections –** Under Option 2, it is assumed that the capacity of some forecasted diesel standby plants would be replaced by gas as gas will not have to fit abatement as it is assumed to meet the ELV. This cost captures the difference of building and running a gas plant as opposed to diesel (capital and operating costs). The range presented will capture the varying levels where this change in fuel type occurs. Central estimate is this will lead to an additional to baseline impact of £149m (range- £0 – where no switch occurs -and £185m) in present value terms for businesses

Non-monetised costs

- **Revenue loss for plant operators –** Under Option 2, some standby plants operating before 1 December 2016 or those with successful bids in the 2014 and 2015 Capacity Markets which are in revenue contracts will choose to reduce their hours instead in response to the additional measures set. This will

[28] The cost effectiveness analysis should not be compared to the 500 hours exemption analysis in Option1 as the number of plants assessment is different along with the methodology in terms of costs included and benefits taken into account.

be considered as a transfer as it is assumed that overall capacity would still be needed so other compliant plants would now be able to take up these contracts, therefore revenue would transfer from one non-compliant plant to another compliant plant. However, it is a cost faced by the plants considered within this scope but due to the lack of information around specific revenue streams, it cannot be monetised.

MONETISED BENEFITS TO THE ENVIRONMENT AND HUMAN HEALTH

- **Monetised air quality benefits –** The main benefit of the implementation of the MCP directive will arise from the reduction in air pollutant emissions. By reducing the number of plants operating without abatement and ensuring that these plants are monitored for their emission levels, this will improve air quality and benefit human health and the environment. This captures the reduction in both chronic mortality effects (which consider the loss of life years due to air pollution) and morbidity effects (which consider changes in the number of hospital admissions for respiratory or cardiovascular illness).
  Option 2: The additional measures introduced under Option 2 increase the air quality benefits from Option 1 by £550.4 in present value terms, bringing the Option 2 total to £1973.6m.

- **Monetised CO_2 Emissions benefits** – Certain measures intended to reduce emissions of air quality pollutants also affect CO_2 emissions from UK plants. As some of the larger plants would fall into the scope of the EU Emissions Trading System (ETS), the reduction in costs to UK businesses of purchasing extra EU ETS allowances from abroad is assessed. Therefore, any change in CO_2 emissions in the UK is valued using the traded cost of carbon. Smaller plants will fall under the non-traded value of carbon, where although they are not traded as part of the EU ETS, the emissions still contribute to the global carbon value and need to be considered and as other industries may not need to abate as much as a result.
  Option 2: The additional measures introduced under Option 2 increase the Green House Gas benefits from Option 1 by £64.5 in present value terms, bringing the Option 2 total to £99.3m.

8.10 Abatement costs

The central year on year breakdown is shown in the table below where the annual total cost of abatement increases over the appraisal period as each measure is introduced. The table below also demonstrates where stages of the additional measures (2024, 2029) come into effect and a greater number of plants are impacted, as shown by the higher cost.

Table 8.21 Year on year cost of abatement for working and standby plants (£m, 2014 prices) Central Scenario [80% of diesel standby plant capacity projected switches to gas], discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
CENTRAL – Scenario 2 – additional measures only																
£m	0	0.0	0.4	0.7	1.0	1.3	1.5	1.9	2.1	2.4	2.7	2.9	3.1	3.3	3.5	**26.7**
CENTRAL – Scenario 2 – with Option 1 central costs																
£m	0	3.9	4.3	4.8	5.3	5.7	20.7	8.1	8.2	8.5	8.7	41.7	10.9	10.9	10.9	**152.8**

Note: any differences in totals due to rounding

As demonstrated by the tables above, under the central scenario, only 20% of projected diesel would continue to operate and therefore would fit abatement. This results in relatively low costs of abatement as other forms of fuel (gas) is assumed to meet the ELV with no additional abatement required.

Sensitivity of the behaviour change

Anticipated behaviour change of plants is a key driver of the cost of abatement. If more plants switch to gas, then fewer need to fit abatement equipment.

Therefore we have sensitivity tested two more extreme scenarios, where there is no change or 100% change in fuel. As there is currently little evidence to suggest that the available abatement is capable of being useable in 5 minutes, Scenario 1 – where 100% of forecasted diesel plants will continue to be diesel – is unlikely. This scenario is demonstrated in the table below, and has been tested with all projected diesel plants fitting abatement to meet the ELV set in the measures. However, as there is little known about technology available to meet these measures, the scenario uses the costs of current abatement, which cannot meet the timeframe, therefore the costs presented are likely to be an underestimate?.

Scenario 3 demonstrates where 100% of projected diesel fuel is filled by gas. No abatement costs are included as it is assumed that gas plants meet the ELVs set, as a result, the cost is £0m.

Table 8.22 Year on year cost of abatement for working plants (£m, 2014 prices) Low Scenario [100% change to gas in plants projected], discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
LOW Overall – Scenario 3 – additional measures only																
£m	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
LOW Overall – Scenario 3 – with Option 1 central costs																
£m	-	3.92	3.97	4.15	4.31	4.46	9.15	6.23	6.12	6.11	6.10	38.83	7.82	7.63	7.47	**126.26**

Table 8.23 Year on year cost of abatement for working plants (£m, 2014 prices) High Scenario [No change in fuel of plants projected], discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
HIGH Overall – Scenario 1– additional measures only																
£m	-	0.1	1.8	3.5	5.0	6.4	7.7	9.2	10.6	12.0	13.2	14.3	15.4	16.3	17.2	**132.5**
HIGH Overall – Scenario 1 – with Option 1 central costs																
£m	-	4.03	5.80	7.59	9.26	10.81	26.80	15.42	16.75	18.07	19.28	53.13	23.16	23.92	24.63	**258.7**

8.11 Administrative and compliance (inspection) check costs

The administration costs are the costs faced by plants for operator and regulator time and effort for processing an environmental registration/permit, inspection, and reporting.

Permitting, compliance checking and reporting activities required under the Articles 5, 8 and 11 of the Directive will result in a range of one-off and recurring costs to regulators and MCP operators, which are included in the total cost. Additional permitting costs will be undertaken by those plants that fit abatement to meet an ELV set in the measures for plants in the energy balancing market.

In Option 1, standby plants in the MCP Directive are classified as low risk when they register and seek a permit, however with the Environment Agency modelling, diesel generators with base case emissions of 1200mg/Nm^3 are likely to cause a breach in recommended local air quality hourly limits and therefore, meeting the lower ELV of 190 mg/Nm^3 is important so as not to risk a breach. Therefore those diesel plants that may choose to apply for a permit with site-specific conditions have been reclassified as high risk as they would need to be monitored to ensure they are meeting the conditions of the permit.

Permitting costs will affect back up, working and standby plants. In order to avoid double counting where plants have been reclassified as high risk, the cost difference between the two approaches has been accounted for, and the breakdown for registration and administrative costs per plant is demonstrated below.

Table 8.24 Recurring administrative costs per site (2014, £/year)

	Recurring cost per site (2014 £/year)		
	1-5MW	**5-20MW**	**20-50MW**
Registration: subsistence (high risk)	868.8	868.8	2,035.4
Registration: subsistence (low risk)	91.2	91.2	91.2
Registration: subsistence (high risk - low risk)	**777.7**	**777.7**	**1,944.2**

The administration cost will not change materially between scenarios as it is assumed that the same number of plants would be registering and the same number of existing plants will apply for a permit with site-specific conditions which is the only additional administration cost faced by plants in Option 2. The earlier cost in 2018 faced under Option 2 demonstrates the earlier registration cost for plants operating for electricity generating purposes.

Table 8.25 Year on year cost of administration for plants in the energy balancing market (£m, 2014 prices), discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
CENTRAL- additional measures only																
£m	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**1.9**

CENTRAL- with Option 1															
£m	0.1	0.8	1.0	1.3	1.5	1.7	2.3	2.3	2.3	2.4	2.6	4.1	4.8	4.8	4.7	**36.7**

8.12 Monitoring costs

The monitoring cost captures the cost of monitoring whether a plant is meeting an ELV which would include the fees for an accredited consultant to conduct the monitoring surveys and prepare a monitoring survey report to the operator annual or tri-annually in order to meet the Directives monitoring requirements. For all plants, this must include CO monitoring.

However, with the additional measures under Option 2, there are plants which would have to monitor NOx emissions. These are the plants that chose to fit abatement, which will need to monitor to ensure they are not breeching the ELV. The cost per plant is highlighted in the table below.

Table 8.26 Additional NOx Monitoring costs for installations (sites) under Option 2

Recurring cost per site (2014 £/year)		
1-5MW	***5-20MW***	***20-50MW***
746.24	746.24	746.24

The results are presented in the three tables below. The variation shown through the low to high range is driven by the proportion of capacity expected to remain as diesel. Diesel plants would have to meet an ELV which therefore requires them to undertake additional compliance checks as they are categorised as high risk due to their high base case emissions, risking a breach of the recommended hourly limit. In Scenario 1, all forecasted diesel remains as diesel, which results in higher monitoring costs.

Table 8.27 Year on year cost of monitoring (£m, 2014 prices), discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
CENTRAL – Scenario 2 – with Option 1																
£m	-	0.4	0.8	1.2	1.6	2.0	2.4	2.5	3.6	4.6	5.5	6.3	6.2	6.1	6.0	**49.2**
LOW Overall – Scenario 3 – with Option 1																
£m	-	0.4	1.0	1.5	2.0	2.5	2.9	3.2	4.4	5.5	6.5	7.4	7.4	7.3	7.3	**59.4**
HIGH Overall – Scenario 1 – with Option 1																
£m	-	0.4	0.8	1.2	1.5	1.9	2.2	2.3	3.4	4.3	5.2	6.1	5.9	5.8	5.6	**46.7**
CENTRAL – Scenario 2 – additional measures only																
£m	-	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	**2.6**

8.13 Impact of capacity switching fuel types (plants entering energy balancing agreements)

This represents the impact faced if some of the capacity forecasted were filled by gas instead of the projected diesel in the baseline. The cost of building a gas plant over a diesel plant is higher in terms of build cost, although the cost to run the plant is cheaper due to the low fuel costs.

The results below demonstrate that in the central scenario where 80% of the forecasted diesel plants have a direct switch to gas, there would be a relatively significant cost of £147.8m.

This impact has been sensitivity tested by testing the extreme cases where 100% of capacity would continue to be diesel (Scenario 1) or 100% of the capacity would be filled by gas (Scenario 3). This has highlighted that a 100% switch to gas may be unlikely due to the higher cost of set up. However, it is worth noting that these costs assume an exact switch of run time and plant size in order to allow a direct comparison. In practise, it is likely that gas would run for longer hours which, if compared, would represent a different picture due to the higher running cost of diesel.

Table 8.28 Year on year cost of capacity fuel switch (£m, 2014 prices), discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Central																
£m	-	0.11	2.05	3.85	5.53	7.09	8.54	10.27	11.87	13.35	14.71	15.97	17.13	18.19	19.16	147.82

Table 8.29 Year on year cost of capacity fuel switch (£m, 2014 prices), discounted

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
High Overall – Scenario 1																
£m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Overall - Scenario 3																
£m	-	0.14	2.56	4.81	6.91	8.86	10.67	12.83	14.83	16.68	18.39	19.97	21.41	22.74	23.95	184.77

8.14 Revenue Impacts (Option 2 – non monetised)

Plants in Tranche A would face a revenue loss by reducing their hours. This impact is assessed purely for existing plants as these plants are already built and the measures would restrict their ability to operate as in the baseline, if they breach the measures set. The cost is also not included in the overall cost figures, as it is not a true cost to society because the cost is seen as a redistribution of income from one plant to another (See Section 0).

With plants entering contracts before 2016, it is assumed that 50% of these plants will reduce their hours to 50 hours (to the identified safe running time from the Environment Agency modelling) in 2018 and face revenue loss from this point, while we have assumed that the rest of the existing plants would reduce their operating hours to 50 hours in 2024, when stricter ELVs will need to be met. The 50% behaviour change in each year represents the urban/rural split as outlined in Section 7. As little in known on the exact placement of plants and their distance from a receptor, we will consult upon this assumption.

The cost of loss revenue is likely to be mitigated somewhat by the fuel savings from reducing running hours (cost of operating for 100 hours compared with the cost of operating for 50 hours), however is still proposed to be significant to these plants.

Plants in Tranche B would not be impacted as these plants are not yet built so do not face a revenue loss compared to the basecase. As a result there would be no changes between scenarios as these scenarios affect the behaviour of investors choosing the fuel type of plants they intend to build.

Additionally, there is a risk that the combination of contracts currently undertaken by these plants may result in 50 hours being unviable by 2025 therefore these plants may close. If this is the case, then the revenue would be double the amount anticipated.

8.15 Monetised benefits to the environment and human health

Emissions reductions of air pollutants

Table 8.30 below highlights the total emission reductions of key pollutants as a result of the implementation of the MCP, and further reductions associated with controls specific to high NOx polluting generators. The total column under each pollutant presents the impact of Option 2 (additional controls plus Option 1).

Table 8.30 Total emission reductions (kt) 2018-2032

SO_2			NO_X			PM			CO_2		
MCP	Additional measures	**Total**	MCP	Additional measures	**Total**	MCP	Additional measures	**Total**	MCP	Additional measures	**Total**
89.4	16.2	**105.6**	74.4	36.9	**111.4**	16.34	4.2	**20.6**	653.5	1,816	**2,469.7**

Table 8.31 demonstrates the full breakdown of these emission reductions by pollutant across the entire period, demonstrating the profile of reductions.

Table 8.31 Year-on-year breakdown of emissions reduction by pollutant for Option 2 (kt/yr)

Quantity abated (kt/yr)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
SO2	0.1	0.7	1.2	1.8	2.4	2.9	3.5	7.9	8.3	8.7	9.2	9.6	16.3	16.4	16.6
NOx	0.2	0.9	1.6	2.4	3.1	3.9	4.6	7.6	8.3	9.0	9.7	10.4	16.0	16.5	17.0
PM	0.0	0.1	0.2	0.3	0.4	0.6	0.7	1.6	1.7	1.8	1.9	1.9	3.1	3.1	3.1

The level of emission reduction has been sensitivity tested for each scenario as different plants have difference base case emissions. Under Scenario 1, it is assumed that all projected diesel remains as diesel. As a result, the emission reductions are relatively low as diesel only reaches 190mg/Nm3 when fitted with appropriate abatement.

Under Scenario 3, it is assumed that all projected diesel will switch to gas. New gas plants are assumed to have a lower basecase emission level in other pollutants so additional abatement of SOx and PM would occur, therefore a higher number of gas plants in the future results in higher emission savings than the other scenarios compared to the base case.

<u>Carbon emissions</u>

The table below highlights the total emission reductions of carbon as a result of the implementation of the additional measures for plants entering energy balancing agreements. This amounts to a cumulative saving of 1,163 kt of CO_2 in the central scenario.

Table 8.32 Total CO2 emissions reduction 2018-2032 in each scenario

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total
Central Scenario 2 (kt/yr)																
CO_2	13.8	27.2	32.9	38.7	44.4	50.2	55.9	98.6	102.6	106.6	110.6	114.5	118.5	122.5	126.5	1,163
Low Overall Scenario 3 (kt/yr)																
CO_2	13.8	26.9	28.8	30.7	32.6	34.5	36.3	74.2	73.4	72.6	71.8	71.0	70.2	69.4	68.6	774.8
High Overall Scenario 1 (kt/yr)																
CO_2	13.8	27.2	33.9	40.7	47.4	54.1	60.8	104.7	108.7	112.7	116.7	125.4	130.6	135.8	140.9	1,253.4

Combined contributions from both standby and working plant

Similarly to the emission reductions of NO_X, SO_2 and PM, the variations of the projection of future plants have a substantial impact on the level of emissions saved.

<u>Monetised Benefits - Air Quality</u>

<u>Damage costs</u>

The Green Book guidance recommends the impact pathway approach in many circumstances when impacts are above £50m annually. While the bespoke impact pathway approach was considered, however, in this circumstance, the uncertainty around the spatial distribution of plants and their operating patterns meant that damage costs are more appropriate.

<u>Indicative benefits of additional measures</u>

The table below demonstrates the benefits generated as a result of the additional measures for plants entering the energy balancing market. The central case of Scenario 2 demonstrates that implementing these measures would generate £614.9m benefits, of which £276.3m is from fitting abatement and reducing hours, while 338.6 is from the fuel switch.

Scenario 3 creates higher benefits as new gas plants have lower base case emissions for other pollutants (PM and SOx) and therefore the reductions in emissions are higher, while Scenario 1 demonstrates lower benefits due to abated diesel only reaching the ELV set and not further.

Table 8.33 Monetised benefits from measures on plants entering the energy balancing market (PV, £m, 2014 prices)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
Scenario 2 - Abatement Measures and Reduced Hours	3.6	7.0	8.1	9.1	10.0	10.9	11.7	20.8	21.1	21.3	21.5	21.6	21.8	22.0	22.2	**232.7**
Scenario 2 - Fuel (technology) switch.	0.0	0.2	3.8	7.2	10.6	13.8	17.0	20.8	24.6	28.2	31.7	35.1	38.4	41.6	44.7	317.6
Scenario 2 Total	3.6	7.2	11.9	16.3	20.6	24.7	28.7	41.7	45.6	49.5	53.2	56.7	60.2	63.6	66.8	550.4
Scenario 1 Total	3.61	7.13	10.78	14.18	17.34	20.26	22.97	34.68	37.60	40.29	42.74	44.99	47.36	49.73	51.88	891.1
Scenario 3 Total	3.61	7.21	12.11	16.85	21.42	25.83	30.09	43.40	46.66	49.81	52.87	59.69	63.46	67.08	70.59	1,141.4

The total from Scenario 2 should be added to the total air quality benefits from Option 1 central scenario to calculate the total air quality benefit from Option 2. The total benefits in the central scenario for Option 2 are £1,423.2m (Option 1 central) + £550.4m (Option 2 Scenario 2) = £1,973.6m for the central scenario (not including GHG benefits).

Monetised Benefits – Greenhouse gasses

The table below demonstrates the benefits of reducing carbon emissions generated as a result of the additional measures for plants entering the energy balancing market and implementing the MCPD. The central case of Scenario 2 demonstrates that implementing these measures would generate cumulative benefits of £98.1m.

Table 8.34 Carbon benefits 2018-2032 (discounted)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total NPV
CM Additional Measures (Scenario 2)																
£m	0.9	1.7	2.0	2.3	2.6	2.9	3.2	5.5	5.7	5.8	5.9	6.0	6.1	6.7	7.3	64.5
MCP																
£m	0	0.2	0.3	0.5	0.7	0.8	1.0	2.7	2.8	2.8	2.9	2.9	5.7	6.1	6.3	35.9
Option 2 Total carbon																
£m	0.9	1.9	2.3	2.8	3.3	3.7	4.2	8.2	8.5	8.6	8.8	8.9	11.8	12.8	13.6	100.4

8.16 Summary of results

Table 8.35 Present value of total costs and benefits over 15 year appraisal period (2018 – 2032), £m 2014 prices

£m, 2014		Sensitivity		Best estimate
Scenarios		**Low**	**High**	**Central**
OPTION 2	PV Costs	394.4	354.9	386.5
	PV Benefits	1014.5	2,921.0	2,074.0
	NPV	**620.1**	**2,566.1**	**1,687.4**

*Where 100.4m of benefits are from GHG and the remainder Air Quality.

Table 8.35 demonstrates the total costs and benefits for the impact of the implementation of the MCPD and the additional measures for those plants in the energy balancing market. All three scenarios carry forward the number of plants from Option 1 and Approach 2 for compliance (inspection) checks.

Scenario 2 is the central scenario for costs and for high/low benefits (damage costs). The high overall scenario combines low cost (Scenario 1) with high benefit, and the low overall scenario combines high cost (Scenario 3) with low benefit. That is, the range presents the sensitivity around the assumptions on behaviour change of diesel to gas (Scenario 1-3) and the valuation of health benefits for a given reduction in emissions (Scenario 2).

Compliance Costs

The full costs to MCP and high NOx generator operators in England and Wales is demonstrated in Table 8.36 below with a central estimate of £386.5m. The low cost scenario is Scenario 1 and the high cost Scenario 3.

Table 8.36 NPV of costs for the low, high and central scenarios of behaviour changes (including Option 1)

2018-2032	LOW COST (£m)	HIGH COST (£m)	CENTRAL (£m)
Costs			
Abatement costs	258.6	126.3	152.8
Administration costs	36.9	36.7	36.7
Monitoring costs	59.4	46.7	49.2
Cost of fuel (technology) switch	-	184.8	147.8
Total	**354.9**	**394.4**	**386.5**

For the main analysis, it has been assumed that costs will be funded through internal finances as per the results in the previous section. However, in practice, some firms would have to fund some of the upfront CAPEX through external financing. Costs as a function of a firm's ability to finance is given consideration in the distributional impacts assessment in the following section.

<u>Monetised Air Quality Benefits</u>

The benefits of implementing the MCPD and the additional measures are demonstrated in Table 8.37 and Table 8.38. The low and high scenarios of plants changing fuel type result in a more limited range as the key additional benefits are from reduced PM and SOx when the technology switches from diesel (compression ignition engines) to gas engines or turbines. These scenarios result in a range from £1.87bn to £1.98 bn. The low and high scenarios of plants changing fuel type result in a smaller expanded range due to the additional benefits gains from reduced PM and SOx when the technology switches from diesel (compression ignition engines) to gas engines or turbines. These scenarios result in a range from £1,869m to £1,993m.

Table 8.37 demonstrates the range with varying damage costs which is very significant with a central estimate of £1.98bn, with variations of the damage costs on the central scenario showing a range from £932m to £2.8bn.

The low and high scenarios of plants changing fuel type result in a smaller expanded range due to the additional benefits gains from reduced PM and SOx when the technology switches from diesel (compression ignition engines) to gas engines or turbines. These scenarios result in a range from £1,869m to £1,993m.

Table 8.37 PV for air quality impacts with varied damage cost scenarios 2018-2032 (£m, 2014 prices)

	LOW (£m)	HIGH (£m)	CENTRAL (£m)
Abatement measures and hours reduction	932.0	2,338.8	1,661.0
Benefit of technology switch	-	463.6	317.6
Total	**932.0**	**2,802.4**	**1,973.6**

Table 8.38 PV of reduced air pollution with varied plant fuel projection scenarios 2018-2032 (£m, 2014 prices)

	LOW (£m)	HIGH (£m)	CENTRAL (£m)
Abatement measures and hours reduction	1,868.8	1,607.7	1,661.0
Benefit of technology switch	**-**	391.2	317.6
Total	1,868.8	**1,993.9**	**1,973.6**

<u>Authority Disaggregation</u>

The original analysis was produced for a UK perspective. However, this impact assessment presents plant for England and Wales, emissions reductions and consequent costs and benefits, and not those of the UK. The disaggregation from the UK results was based on 84% of plants being located in England, 7.5% in Scotland, 5.2% in Wales and 3.1% in Northern Ireland. It was assumed that plants are distributed equally regardless of capacity, technology and fuel type.

8.17 Options results summary

The previous section demonstrates that the NPV for Option 2 is higher than Option 1 (£1688m compared to £1,252m) suggesting that it should be the preferred Option. However, this is purely based on a monetary assessment. Therefore, while it is the preferred Option from a monetary assessment, it also meets an additional policy objective of curbing the avoidable increases in national NOx emissions due to current energy market incentives.

Therefore, Option 2 is the preferred option for the following reasons:

a) It provides the greatest protection of public health, delivering air quality improvements valued at over £1.9 billion with additional benefits in reducing carbon emissions. It also clearly demonstrates the UK government’s commitment to protecting human health through improving air quality.

b) It enables the UK to comply with important air quality legislation by effectively transposing the MCPD while still ensuring the safe hourly NOx levels laid out in the AAQD and curbing increase in high polluting generators and encouraging their replacement with cleaner technologies thus contributing towards the NOx emissions ceiling, which will become more stringent from 2020.

9. Risks & assumptions

9.1 Key Sensitivities

The key uncertainties and sensitivities relate to the underlying data used to develop the baseline. Some methodological features also increase the sensitivity of the model to certain input data. Key uncertainties and sensitivities are listed below.

Plant capacity, and therefore fuel consumption and associated total emissions, are based on mean plant capacity data from EU averages. The same average capacity is assumed for every plant within the same size category, regardless of fuel or technology type. This results in total emission reduction and associated benefits being highly influenced by this assumption.

Number of Plants

Prior to MCP Directive implementation, operators of plants below 20MW have not been required to register the type of their plant or their activities e.g. operating hours. The limited information on the number of plants below 20MW is therefore a key sensitivity in estimating the impact of the implementation of the MCP Directive. When the MCP directive takes effect and plants start to register and permit, the estimations may be improved for the post implementation review.

The number of plants is the basis of the analysis. In general, the overall costs to operators move in proportion to working plant numbers. The share of each plant type in the total also influences the results. The central scenario is the analysis includes 9,430 working plant in 2030. To present impact of the assumption, the low scenario for Option 1 includes 4,484 working plants – i.e. it halves the number, while the high scenario for Option 1 include 21,956 plants i.e. it doubles the number The Option 1 scenarios also increase/decrease the number of back-up/stand-by plant but their impact is smaller as they are exempt from ELVs.

Relatively limited data was received from stakeholders so the majority of the analysis is based on data gathered and/or derived for the Commission study and estimations in number of plants and projections in activity data from the NAEI.

Additional standby plants have been estimated based upon the current capacity market results. These may not be representative of the additional growth expected, as this only represents two years. However, the costs and benefits would be proportionate to one another and therefore any impact can be scaled down and adjusted if consultations suggest that the projections have been over or under estimated.

For the baseline, the main limitation relates to current total emissions by plant type, size and fuel. As these plants are generally not regulated at present (unless connected to an IED regulated installation), in many cases emissions are not monitored. The levels assumed in the baseline influence what further actions are assumed to be required to meet the ELVs (i.e. abatement measure selection and associated costs) and emissions reductions achieved, and therefore the results are significantly influenced by the chosen values. For NOx emissions from natural gas boilers (which represent a high proportion of total NOx emissions from MCPs) it was possible to derive emission levels from actual data. However, for the rest non-factual information from consultation with experts and stakeholders was used as a proxy, which increases the level of uncertainty.

The parameter for the current total emissions by plant type, size and fuel emissions is based on fuel consumption which, in turn, is based on assumptions on load factors and a single set of average plant capacity data from EU averages. The same average capacity was therefore assumed for every plant within the same size category, regardless of fuel or technology type. This will be further refined following the registration of these plants as there will be a full data set of number of plants, running hours and emission levels.

There is very limited data on the number of plants entering into the energy balancing market so the analysis is based on data from the capacity market results along with additional information on the capacity available in current energy balancing markets. Additionally, the number of additional diesel and gas plants projected to enter energy balancing markets is based on 2014/2015 results from the capacity market, which is may not be representative of future increases. However, due to the limited information, these auction results provided the only available indicator to the expected growth of these plant types.

The number of back-up plant is less influential because of exemptions applicable to them.

Damage cost functions

When measuring the impact of emissions, an impact pathway approach is preferred in some circumstances. An impact pathway approach models the spatial distribution of changes in emission from a specific source. This approach is time consuming and costly. In the case of the MCP Directive, such an approach is disproportionate.

For this impact assessment, damage costs were used to calculate the indicative impact of emission changes. Damage costs are standardised average values of the impact to society of a given change in emissions. Damage cost values are published in the Green Book guidance, and are used as standard practice throughout government.

A limitation is that damage costs are a UK average, and not specific to the geographical source of emissions change. For example, they don't adjust for the site specific population exposure to the pollution, where reductions in pollutants in a more densely populated region would generate greater benefits. Moreover, damage costs are an underestimate for two reasons. Firstly, they capture partial health impacts, such as those to mortality – cost of life years brought forward – but not to those on morbidity – short-term impacts. Secondly, they do not explicitly capture impacts to ecosystems and cultural heritage.

Option 2

The degree to which operators choose to switch from diesel to gas engines in response to the proposals is the largest source of uncertainty for several reasons, which we intend to consult on before the final stage of the impact assessment.

Firstly, gas and diesel plants are assumed to be interchangeable with regards to plant characteristics and revenue earnings. There is little data available on individual plants and therefore little is known of the precise revenue sources of each plant and the capacity available in each revenue stream in the energy balancing market. Therefore the assumption of access to revenue streams such as payments from supply to the capacity markets, STOR and TRIAD may not be a representative income rate for all plants, particularly as gas plants are more likely to enter markets where longer running times are required due to the lower fuel cost. However, there is little available data on this, so we cannot monetise the impacts which are likely to be significant to plants in Tranche A (although it is assumed they could continue to operate profitably at 50 hours).

Similarly, the average running time for each plant is assumed to be the same in order to complete a cost comparison of building gas over diesel installations. However, with the cheaper fuel, the running hours of gas are likely to be longer so the cost difference will not be truly representative.

The central scenario assumes that the majority of diesel generators would be unable to fit abatement that would be effective within 5 minutes of operation but assumes that some installations (20% of diesel generators) would apply abatement. With technological development, abatement that can easily achieve emissions reductions to the required level within the time limit may become widely available and cost-effective, and therefore diesel installations would be more likely to adopt abatement. If this becomes the case, then there is uncertainty as to whether there would be the predicted reduction in diesel.

9.2 Other sensitivities

Abatement measures

Plants are grouped into status categories. Each status category is a specific combination of plant characteristics, such as new/existing, capacity class, technology, fuel and pollutant(s) under consideration. For example, one status category would be existing, 1-5MWh, boiler, natural gas, and NOx. For each status category, the model is only able to choose one abatement measure; therefore, one abatement measure is selected and applied to all plants within each status category.

In practice, plants that fall within a status category will have different emissions reductions needed to meet an ELV, and therefore a different level of abatement effort, and associated cost than assumed. The impacts on emissions and compliance cost estimated are expected to be modest, as a result of averaging and aggregating. However, in some circumstances, as operators will choose abatement measures which are the most cost effective for their specific plants, costs could be an underestimate.

Table 9.1 provides an overview of some relevant assumptions and associated uncertainties. During consultation we hope to gather further information which can enable the quantification of many of these uncertainties and welcome feedback from stakeholders to inform this.

Table 9.1 Assumptions and associated uncertainties around impacts

Assumption	Associated uncertainty

Number of plants and respective emissions – due to the lack of data on plants <50MW data, limited data was gathered and/or derived for the Commission study and activity data from the NAEI. Data from the capacity market auction results and the	The number of plants is a key driver to the costs as the assumed number of plants in each category correlates with the levels of emissions and therefore level of abatement required to meet the ELVs set in the Directive and the measures for the high NOx generators. As result, should there be substantial variation from the assumed number of plants; the costs could be very different from what we have calculated in the assessment.
The change in number of diesel or gas plants in the future is entirely depending on operators reactions to the proposed measures. It has been assumed that operators of some diesel plants bidding into the capacity market after 2016 will not see the measures as a viable investment, and therefore, the capacity would be filled by gas plant.	The proportion of diesel capacity that switches to gas depends on whether investors continue to see diesel as a viable option. Currently, we assume that the time limit set on abatement efficacy is not easily possible with readily available technology (in the central scenario we assume that only 20% of diesel plants are able to fit appropriate technology). However, should this change, the current revenue streams mean that diesel can viably fit abatement and continue to operate.
The number of plants entered into energy balancing contracts before 2016 that choose to reduce their hours is based on an assumption of where they are located.	It is assumed that some plants in contracts would rather reduce hours than take a permit with site-specific conditions and fit abatement. Many of the generators will already have been subject to an air quality assessment through the planning process and will have fitted dispersion equipment to achieve Ambient Air quality limits in the vicinity of the plant. In addition the Environment Agency modelling makes conservative assumptions, so a larger number of plants are less likely to cause a breach of the hourly limit and impact a receptor.
All Tranche A generators will be operating 50 hours or less in 2025	Tranche A back-up generators (those that provide power on-site during an emergency) will be able to reduce operation to 50 hours routine testing to avoid permitting in 2025. This would be more cost effective than fitting abatement to achieve the 190mg/Nm^3 limit. However arrays of diesel engines located on sites with no power demand will not be able to benefit from this exemption. These generators would be required to fit suitable abatement to achieve the limit to operate for any purpose other than to fulfil a contract or agreement made before 1 December 2016. It is uncertain how many of these generators there might be in Tranche A so this assumption will be tested during the consultation. .

Current emission levels

Assumptions had to be made about current emissions since data available is limited. An average emissions level of each category and type of plant is assumed as individual data on existing plants is not available. Therefore if the actual plants are cleaner or more polluting, the benefits would vary accordingly.

10. Distributional Effects

Small and micro-businesses can be affected disproportionately by the burden of regulation. New regulatory proposals are designed and implemented in a manner aiming to mitigate disproportionate burdens where appropriate. As such, the default assumption set in the Better Regulation Framework Manual (June 2013) is that there will be a legislative exemption for small and micro-businesses where a large part of the measure can be achieved without including small and micro-businesses within the scope of the policy proposal.

The Better Regulation Framework Manual defines micro and small businesses according to a staff headcount. Micro-businesses are those employing up to 10 FTE staff members while small businesses employ between 11 and 49 FTE staff. The Manual provides guidance on Small and Micro-business Assessment including a range of potential mitigation measures if the proposed policy option does have an impact on small and micro-businesses.

10.1 Sectors affected

MCPs are found in a broad range of industrial, commercial, public and non-industrial sectors.

Industrial Sectors

For some of the industrial sectors, Eurostat Structural Business Statistics (SBS) provides data on enterprise size categories thus allowing for a preliminary assessment of Small and Micro Business Assessment (SMBA)-relevance to be made. The key sectors where SMB may be affected include metals, pulp and paper, chemical industry, textiles, food production, car manufacturing etc.

However, a number of factors limited the possibility of a full sectoral mapping by enterprise size:

- Eurostat SBS does not provide sectoral enterprise size data for some sectors (in particular, a number of non-industrial sectors – see below), thus limiting the analysis;
- For those sectors where Eurostat provides enterprise size categories, it is extremely unlikely that the sector-wide average proportion of micro-size enterprises (i.e. 59% to 87%) would be observed for 1-50 MW combustion plants. It is anticipated that this high proportion of micro enterprises relate to much smaller combustion plants (i.e. <1 MW) which are outside of the scope of the Directive. Furthermore, in a number of cases, such combustion plants are typically a part of a bigger complex requiring more than 9 employees to maintain and operate, and therefore it is highly unlikely that any micro-size enterprises would operate them. For example, in non-industrial sites, a 1 MW boiler would supply space heating and hot water for a building of around 12,500 m2 – i.e. an office for about 2,500 people.
- In addition, whilst the dataset developed in this study is based on numbers of individual MCPs, in many cases an enterprise will own and operate more than one MCP. However, no data is available on the average spread of numbers of individual plants by enterprise. This may mean that the numbers of SMEs potentially affected is likely to be overstated. The remainder of this section covers the major sectors where the largest impact is expected.

A number of the plants within 1-50 MW are directly associated to an IED regulated installation (particularly the larger ones), which are unlikely to be an SME and are assumed to be large-size enterprises. Furthermore, 20-50 MW plants (aggregate level) are already captured under the EU ETS and are unlikely to be micro or small enterprises.

Based on these arguments, it can be, therefore, assumed that no plant operators are micro-sized enterprises, although some of the installations could fall within the small enterprise category. If the assumption doesn't hold, such cases are expected to be so rare that it isn't proportionate to assess further.

Non-industrial and commercial sectors

In addition to the sectors discussed above, 1-50MW plants can also be found in a very wide range of non-industrial sectors such retail trade and warehousing, hotels, commercial services and telecommunications. Over 28% of the total estimated numbers of MCPs operating in the UK are assumed to operate in these sectors.

Data available suggests that higher proportion of micro enterprises are within these sectors, when compared to manufacturing industries. However, commercial, retail and warehousing properties hosting MCPs larger than 1 MW are unlikely to be micro-sized enterprises, although some could potentially fall within the small enterprise category.

Education and health

In addition to commercial services, 24% of the total estimated number of MCPs operate in education and health sectors (hospitals, universities, schools etc.) with the large majority of these being public sector entities financed from state budget (e.g. NHS). Furthermore, such organisations typically employ a large number of employees and educational or health premises with a combustion plant on site are likely to be larger than on average.

In some cases, these installations (also those in the private ownership) are operated and owned by specialist companies providing such services. As such, the size of the organisation(s) using the output of a combustion plant (e.g. a hospital) may not be the same as the size of the enterprise operating it. In addition, in many cases, an enterprise owns and operates more than one MCP. It is unlikely that any of these plant operators are micro-sized enterprises although some could potentially fall within the small enterprise category.

Public sector

Furthermore, about 19% of the MCPs operate in government buildings. Operation of these MCPs is not associated with private businesses and the operations are financed from the state budget.

If the building is government occupied rather than government owned we would expect the cost to be passed through by the energy service company or landlord to the tenant (government) so the cost is ultimately borne by the state budget. (The explanation within the health and education section above is also applicable here).

Agricultural sector

Finally, 2% of the estimated numbers of MCPs are operating in the agricultural sector[29]. On average, agricultural sector in the UK is characterised by a 4.7 employee per agricultural enterprises. However, agricultural holdings hosting a MCP of 1 MW and above are likely to be larger than average enterprises, and therefore more labour intensive. In particular, relevant activities in agricultural sector include heating large poultry farms and horticulture (greenhouses growing salad, tomatoes, cucumbers, peppers and ornamentals), which employ a large number of pickers.

As micro business is defined as having less than 11 employees, the above examples where an MCP would be used wouldn't fit into this employment category due to the labour intensity implied by farms large scale of activities associated with the use of MCPs.

There are, however, estimates of a large number of on-farm driers in cereals production. It is expected that Small and Micro businesses that uses driers, a majority would operate less than 500h per annum on average so would be exempt from the MCPD. Operates exceeding 500h per annum would be expected to be larger enterprises.

Electric power generation sector

For the additional measures for high NOx emitting generators, the sector which will be affected is the electric power generation sector. Analysis of ONS business population estimates[30] suggests that around 97% of businesses in this sector are small and micro businesses but that these businesses employ only around 15% of all workers in the sector. If the number of workers employed is assumed to be proportional to the size of the business, we can estimate that large and medium businesses have a combined market share of around 85% in this sector. This is felt to be a sensible assumption given a lack of evidence.

It is unclear to what extent the businesses in the Capacity Market are representative of the electric power generation sector as a whole. However due to a lack of evidence on this, it has been assumed that the business population in the Capacity Market is broadly similar to the overall business population of the sector. We will look to improve our evidence base on small and micro businesses in the Capacity Market during the consultation.

10.2 Distribution of health impacts

Benefits are derived from the reduction of emissions to air and associated avoided costs for reduction of damage to society. For this reason it isn't meaningful to distribute these benefits across sectors. The IGCB damage cost functions "*include estimates of the health impacts (both deaths and sickness) of all four pollutants. The PM10 and SO2 estimates, in addition, include the impact of building soiling and the impact on materials respectively". (Defra, 2013, Valuing impacts on air quality: Supplementary Green Book guidance)* so those vulnerable to respiratory and heart disease, i.e. old, young, those with existing conditions, and people living in areas with higher ambient air pollutant concentrations (urban areas) will be more adversely affected and therefore the damage avoided is higher from reducing emissions.

[29] Annual Business Survey (ABS) (2012). SECTION A (PART) - AGRICULTURE, FORESTRY AND FISHING

[30] ONS Business Population Estimates (2015), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/467445/bpe_2015_detailed_tables.xls

11. Measurement of the Impact on Micro and Small Enterprises

Option 1

The impact of the Directive on micro and small enterprises relates to whether the operators are able to meet and absorb the costs of compliance i.e. costs associated with meeting the ELVs as well as the administrative costs associated with the regulation (including compliance (inspection) and monitoring). These costs can then be assessed by comparing the compliance and administrative cost per plant against the level of financial resources available to the operator for investment. Average estimated costs per MCP (annualised) range between £2,200 for each of the MCPs 1-5 MW up to £21,000 per 20-50 MW MCP (working MCPs and standby MCPs using solid fuel with ELV).

The impact on micro and small enterprises in terms of total costs per plant compared to gross operating surplus (GOS) per operator[31] is assessed. The assessment suggests that in the case of small enterprises (10-49 FTE), the expected annual compliance and administrative cost per enterprise in manufacturing sector when assuming 1 MCP per company ranges from 0% to 3% of GOS for the MCPs of 1-20 MW. For the 20-50MW size band, the share increases from 1% to 9% with casting of metals being the most affected sector. Assuming 3 MCPs per small enterprise in manufacturing sectors results in the range of 0% to 18% of GOS (for the MCPs of 1-20 MW). For the 20-50MW size band, the share increases to 4% to 27% with casting of metals being the most affected sector.

For commercial sectors the share of total annual costs within GOS is between 0%- 4% (for the MCPs of 1-20 MW). For the 20-50MW size band, the share increases from 2% to 11% with retail trade and hotels being the most affected sectors. Similarly, assuming a larger number of MCPs per company (3 MCPs per small enterprise) results in a higher range of 0% to 11% of GOS (for the MCPs of 1-20 MW). For the 20-50MW size band, the share increases to 7% to 35% with retail trade and hotels being the most affected sectors.

As would be expected, all of these values increase significantly when 9 MCPs are assumed per enterprise (reaching 103% of GOS for some sectors). However, it must be noted that an enterprise with this many MCPs is very unlikely to qualify as a small enterprise. Whilst the values are relatively high for the 20-50MW MCPs, it is considered extremely unlikely that any of these plants would be operated by small enterprises given total number of such MCPs.

Option 2

Our evidence base around small and micro businesses in the energy balancing market is relatively weak compared to the evidence base for MCPs and this is something that we are looking to improve during the consultation. However if we assume that businesses in the market are broadly representative of the electric power generation sector as a whole, we can calculate some indicative impacts on small and micro businesses as a result of the proposed policy changes for high NOx emitting generators.

In order to calculate these indicative impacts, the overall costs which are likely to vary with market share (abatement costs and the cost of switching fuel) have been multiplied by the total market share controlled by small and micro operators. Then, the costs which are more likely to vary with the number of businesses (administrative costs and monitoring costs) have been multiplied by the percentage of total businesses in the sector which are small and micro. These costs have then been added together to get a rough estimate for the total costs to small and micro businesses for the 15 year appraisal period of between £31m and £35m. This is far lower than the equivalent expected costs to medium and large businesses of between £113m and £157m. While these numbers are necessarily indicative estimates due to the lack of evidence, they do suggest that the great majority of the burden from this policy is likely to fall on medium and large businesses.

[31] GoS = capital available to companies after paying operating expenses from income, which allows them to repay their creditors, to pay taxes and eventually to finance all or part of their investmen[t]. Considering that GOS can be used for financing investment, total cost per plant are compared against GOS per operator to assess the economic impacts of proposed regulation. However, the GOS does not take into account depreciation or amortisation. The implication is that GOS may slightly overestimate the funds available for new investment for companies with high existing capital intensity.

Table 11.1 Estimated costs to small and micro business from the policy changes for high NOx generators (2018-2032)

	LOW (£m)	HIGH (£m)	CENTRAL (£m)
Costs which are assumed to vary by market share			
Abatement costs	0.2	132.5	26.7
Cost of fuel switch	184.8	-	147.8
Costs which are assumed to vary by number of businesses			
Administration costs	2.7	3.0	2.8
Monitoring costs	0.1	12.7	2.6
Total costs to small and micro businesses	30.5	35.1	31.4
Total costs to medium and large businesses	157.3	113.1	148.5

Consideration has been given to excluding small and micro businesses from the scope of the policy however doing so would reduce the benefits of the policy (perhaps by around 15%, based on the market share) and the indicative analysis at this stage suggests that this policy will not place a disproportionate burden on these businesses. If new evidence emerges at the consultation, we will reassess whether it would be appropriate to exclude small and micro businesses from the policy.

Guidance and communications will be developed for plant operators which will be expected to reduce and further minimise any impacts for micro and small business impacts.

11.1 Key sectors

Education, health and public sector
Environmental compliance cost in the public sector, including MCPs operated in the government buildings, prisons, public educational and health care facilities are likely to be covered from the operating and maintenance budgets of these organisations.

Agricultural sector
When considering the average net farm income in England and Wales, compliance cost in agricultural sector would constitute one fifth to five times the average net annual income, suggesting significant burden. It should be noted, however, that agricultural enterprises operating MCPs larger than 1 MW are likely to be larger than the average farming companies in the UK.

Furthermore, the absolute majority of the MCPs falling within the scope of the Directive are gas fired boilers and engines of 1-5 MW (accounting for 94% of the total number of the MCPs). In this case, the share of the total annual compliance costs in the net farm income for poultry and horticultural farms is 3% and 4% respectively (assuming one MCP per farm). When considering the costs for gas fired engines and boilers within the relevant size band specifically (as opposed to the average annual costs across all plant types and fuels), the share decreases to 2% of the average farm impact.

11.2 Financial and Affordability

While the assessment considers the average annual costs per enterprise, compliance costs would involve upfront capital costs that need to be financed either through own or borrowed resources. If firms seek to spread the upfront capital costs over a number of years, they will have an additional cost of capital financing. This cost is not included in the average annual cost.

11.3 Direct Costs and Benefits to Business Calculations (following One-In-Three-Out methodology)

Following the EANCB requirements, costs and benefits calculated here use a 2014 price base year and a 2015 PV base year. Consistent with the EPR (Environmental Permitting Regime), and other cost recovery schemes, we envisage charging operators appropriate fees to recover regulator costs, thus avoiding additional burdens on public finances. (Please see Section 0 for details). As such, the costs to business include all abatement, administration, compliance (inspection) and monitoring costs associated with the MCPD.

Under Option 1, the equivalent annual cost to business is estimated to be £15.7m, with no equivalent annual benefits to business estimated. Overall this gives an EANCB of -£15.7m, a net cost to business. As this is EU driven regulation, and the implementation doesn't go beyond the minimum EU requirement, it is out of scope of 'One-in, Three-out' in accordance with the current methodology.

Under the preferred option (Option 2), the overall net cost to business increases to -£29.2m, which includes the benefit of fuel savings to firms switching from diesel to gas. Therefore the additional EANCB as a result of the high NOx emitting generator measures is -£13.5m. This element of Option 2 is considered out of scope of 'One-in, Three-out'.

The additional measures for this option are intended to address an issue which will affect our ability to meet NOx emissions ceilings, particularly those contained within the amendment to the Gothenburg protocol. By consulting on this policy before the next Capacity Market auction in December 2016 we will send a signal of our future intentions to businesses. This should encourage them to invest in alternatives to the high NOx emitting generators which are currently incentivised by the Capacity Market mechanism. This will allow businesses maximum flexibility compared to if we delayed because the costs of retrofitting high NOx generators can be greater than the additional costs of purchasing a lower NOx generator at the outset.

In addition to helping us to comply with the NOx ceilings, particularly 2020 emissions ceiling, the additional measures in Option 2 help to ensure that we do not exceed hourly NOx limits set out in the 2008 EU Ambient Air Quality Directive. The impacts of this directive were initially estimated when it was first transposed.[32] However the incentives created by the Capacity Market were not foreseen at the time because the Capacity Market policy had not been created. Therefore all of the impacts calculated in this policy will be additional to the impacts calculated in the original analysis for this directive.

We do not intend for these additional measures to be implemented until after the ratification of the Gothenburg protocol and therefore they will not constitute gold plating of the NOx emissions ceiling. Developing the proposals now rather than delaying, such as until the revised ceilings are transposed, give operators fair warning of what is intended without bringing forward requirements on them. This will enable new operators to choose the least cost path to future compliance – which could mean continuing with a diesel generator and fitting abatement equipment in the future or opting for an alternative fuel.

These measures are necessary to comply with both the NOx emission ceiling in the Gothenburg Protocol (for all generators) and the Ambient Air Quality Directive (for generators with a capacity greater than 5MW). All impacts from Option 2 are therefore out of scope of One-In, Three-out as a result of being necessary to comply with EU requirements. At this stage it is not possible to determine what portion of the impacts from the high NOx generators measures should be attributed to which directive however we will look to more accurately apportion the impacts of the additional measures to the relevant directives following the consultation.

All costs and benefits have been assessed at 2015 prices and uplifted to 2015 PV base year. However the Equivalent Annual Net Cost to Business (EANCB) figure is calculated at 2014 (real) prices and 2015 Present Value base year. Methodology is consistent with the Green Book and supplementary guidance.

[32] Defra (2007) 'An Economic Analysis to inform the Air Quality Strategy: Updated Third Report of the Interdepartmental Group on Costs and Benefits'
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221088/pb12637-icgb.pdf

12. Competition assessment

The competition assessment guidelines[33] set out four questions to establish whether a proposed policy is likely to have an effect on competition. In particular, the assessment needs to establish whether the requirement to comply with the emission limit values for the plants with a thermal input of 1-50 MW would affect the market by:

- Directly limiting the number or range of suppliers?
- Indirectly limiting the number or range of suppliers?
- Limiting the ability of suppliers to compete?
- Reducing suppliers' incentives to compete vigorously?

A brief summary of the four questions and a response considering the requirement is presented in Table 12.1.

Table 12.1 Competition Assessment Filter Questions

Do the proposed requirement to carry out a CBA	Response	**Comment**
Q1. …directly limit the number or range of suppliers?	No	The proposed requirement to comply with the proposed ELVs does not seek to directly limit the number of suppliers
Q2. …indirectly limit the range of suppliers?	No	The proposed requirement to comply with the proposed ELVs is not likely to limit the range of suppliers. In particular, the proposed requirement does not prevent entry or exit from the market for any of the sectors affected, e.g. Electricity Supply Industry (ESI), refineries, iron and steel, chemical industry, commercial and public sector entities etc. Furthermore, anticipated compliance and administrative costs are driven by the size of the MCP (1-5 MW, 5-20 MW and 20-50MW) and apply same requirements across different sectors and ownership models. In terms of suppliers of abatement technologies aiming to reduce pollutant emissions, these are manufactured by a range of companies ranging from the engineering or chemical companies to the energy specialist. For example, the energy giants Siemens (DE), Hitatchi (DE) and Alstom (FR) all provide multiple abatement techniques for various pollutants (NOX, SOX, PM and others). Other leading engineering European companies such as ABB (CH), Andritz (AT) and Fluor (UK) provide a wide range of abatement technologies such as SCR, FGD and electrostatic precipitators (ESP). Some manufacturers are more specialised. For instance, Howden (UK) is a leading provider of rotary regenerative heat exchangers which are used for FGD and SCR. The British company Johnson Matthey is a leader in providing chemical catalysts. Whilst a majority of the abatement technologies manufacturers are large companies, there is a significant number of SMEs involved in the installations or the fitting of these technologies. Moreover, some more specific (specialist) technologies, particularly relevant for combustion engines, may be developed by smaller manufacturers. Overall, there is no one dominant supplier or dominant approach across the installations affected by the proposed regulation. Furthermore, the requirement to comply with the proposed ELV does not specify application of any particular abatement technology leaving the choice to the operators.
Q3. …limit the ability of suppliers to compete?	No	The proposed regulation would bring smaller scale combustion processes in line with regulation for combustion plants greater than 50 MW, thereby reducing any (potential) perverse effect on these installations at the threshold above and below 50 MW.
Q4. …reduce suppliers' incentives to compete rigorously?	No	The proposed requirement does not seek to limit the incentives for suppliers to compete. In particular, application of the rules across the board would impose similar constraints on all operators.

Overall, the requirement to comply with the ELVs for existing and new MCPs with a thermal input of 1-50 MW is unlikely to have adverse impacts on competition.

Additional compliance and administrative costs that companies across different sectors would be facing may result in significant burden affecting profitability and commercial viability of these enterprises. However, application of the new requirements for the MCPs between 1-50MW would impose similar constraints on all operators across the board.

[33] OFT http://www.oft.gov.uk/shared_oft/reports/comp_policy/Quick-Guide1-4.pdf

13. Social impact assessments

In general terms, when an operator is faced with additional compliance and administrative costs, a range of potential responses exist ranging from absorbing the additional cost through reduction of profit margins up to fully passing these on within the prices of products and services. The companies could also aim to reduce their cost base, for instance, by cutting labour and/or other production costs.

13.1 Distributional impact on households

Implementation of this Directive will affect a wide range of manufacturing sectors, such as metal production and processing, chemical industry and manufacturing of refined petroleum products, commercial sector including retail, hotels, warehousing among other sectors and agriculture.

Enterprises faced with additional annual compliance and administrative costs will be aiming to pass on these costs to the fullest extent possible through the prices of their products and services. Potential impacts on electricity and consumer product prices would be of particular relevance to consider.

First of all, it should be noted that the absolute majority of the plants falling within the scope of the Directive are gas fired boilers and engines with the capacity of 1-5 MW (working and standby plants). In relative terms, this group of MCPs accounts for 94% of the total number of plants. In practice, these plants will be hosted across a multitude of sectors generating energy for a business' own consumption and acting as standby plants as opposed to being part of the national grid and indirectly affecting electricity prices.

Furthermore, it should be noted that annual compliance and administrative costs as a proportion of GOS for the MCPs between 1 and 5 MW range from 0% to 2% (1 MCP per company), 1% to 6% (3 MCPs per company) and 2% to 18% (9 MCPs per company) in the case of manufacturing and commercial sectors.

Under Option 2, this cost may be slightly higher for those plants classified as high risk under the additional measure for the plants entering energy balancing markets; however this is likely to fall under the range estimated.

Under Option 2, in the central scenario (Scenario 2) and Scenario 3, we forecast an increase in gas used to fill future capacity as it would be able to meet ELVs without requiring additional abatement. However, the increase in gas may potentially impact the cost of electricity, through a change in the cost of the energy balancing services. This cost is currently included on consumer energy bills and represents around 1% of the electricity bill. Currently diesel is primarily used in the energy balancing market as it responds to demand quickly and cheaply. Therefore a switch to gas has the potential to increase consumer energy prices because gas is a more expensive option to respond to energy balancing requirements due to the setup of gas services. This will be offset in part by the lower fuel costs from running a gas plant but there is the potential for energy prices to marginally increase to the consumer, which National Grid have initially estimated to be around 0.2%.

An increase in energy prices is most likely to affect households as energy costs make up a large portion of a households income. An ongoing concern in energy policy is that increases in energy prices may be regressive in nature (i.e. impact more on lower income households) as lower income groups spend a larger proportion of their disposable income on energy compared to higher income groups. An ONS study estimated that the poorest fifth of households spent 11% of their income but the richest fifth spend 3%.

However, as the cost of energy balancing services is a small proportion of the overall electricity cost, this increase in electricity prices is likely to have a very marginal impact.

13.2 Employment and Labour Markets

Overall, implementation of the regulation may have positive secondary impacts on the level of employment in abatement technology suppliers, while potentially having adverse primary impacts in sectors that will incur additional compliance and administrative costs. Secondary impacts (costs and benefits) have not been explicitly monetised in this assessment but primary costs have.

Implementation of regulations requiring fitting of abatement technology will lead to costs for the firms affected whilst also representing income for firms that manufacture and install these technologies. When considering supply of abatement technologies, the UK and EU as a whole has a well-established abatement technology supply chain as the majority of the technologies currently being applied by LCPs are also relevant for these smaller plants. The counter argument is that while the operators of MCPs are expected to be able to pass (some of) the costs of installing necessary equipment on to consumers, additional abatement costs might result in adverse impacts on employment.

It is unclear how these two effects will reach a balance but it might be a reasonable assumption that the effect will in aggregate be fairly neutral. The effects of additional costs on firms might be more pronounced in sectors open to international competition such as metal processing, food production, chemical industries etc. The relative scale of combustion plant within the total operations of the enterprise (and costs) constitutes another important factor that will affect the ability of enterprises to absorb additional costs. Distributional sector analysis suggests that in the case of a company operating one MCP, the proportion of annual compliance and administrative costs within the enterprise’s GOS, depending on the size of the MCP, ranges from 1% to 9% in the metal production and chemicals sectors.

14. Conclusions

Air pollution harms our health and wellbeing. The combined impact of Nitrogen Dioxide (NO_2) and Particulate Matter (PM) pollution in the UK is estimated to lead to the equivalent of approximately 50,000 premature deaths per year, at a cost of around £30 billion per year. Air pollution also damages biodiversity and reduces crop yields.

Combustion plants in the 1-50MWth range (Medium Combustion Plants, MCPs) are a significant, largely unregulated source of emissions of Oxides of Nitrogen- NO_x, PM, Sulphur dioxide- SO_2) which impact on air quality. An important tool for controlling emission from this source- the MCPD came into force in December 2015 and must be transposed within 2 years. The legislation was fully supported by UK during negotiations as it represents a cost effective way of controlling emissions and offers a number of important exemptions and flexibilities necessary to keep burdens on business low and any impacts on energy security to a minimum. Furthermore as AQ is transboundary effective controls across Europe will benefit to UK population.

However since MCPD came into force we have learned that schemes intended to increase capacity and provide balancing services in the electricity market are incentivising greater use of particularly polluting generators, which are in the main a subset of MCPs. These generators are primarily diesel and emit very high NO_x emissions relative to other forms of generators within the MCP size range and can lead to local NO_2 concentrations capable of causing harm to human health and have the potential to cause breaches in hourly NO_2 air quality limits set in the Ambient Air Quality Directive (AAQD). These High NOx Generators are relatively cheap to run for short period and therefore it is currently financially attractive for operators to install large arrays of these plants which will lead to lowering of air quality. Unfortunately the MCPD does not provide sufficient controls for these high NOx generators, or serve to deter an increase in use and therefore further measures are required to prevent breaches of air quality legislation and impact on human health and environment.

This impact assessment has assessed two main options for applying emission controls to MCPs. These options are:

a) Option 1 where the MCPD in transposed into domestic legislation, making use of available flexibilities and exemptions where possible and adopting a risk-based approach to permitting, compliance and enforcement. Emissions growth from high NOx emitting generators continues and has to be dealt with through future policy to avoid non-compliance with emission ceilings and AAQD limit values, and

b) Option 2, which transposes the MCPD as under Option 1 and introduces emission controls for high NOx emitting generators, required to enable compliance with air quality limits and to curb avoidable increases in national NOx emissions due to current energy market incentives.

The results of the analysis of these two options are presented in the table below:

Table 14.1 Central NPV of each impact for Options (2018-2032)

2018-2032	Option 1 (£m, PV)	Option 2 (£m, PV)
Costs (cost to operators)		
Abatement costs	126.1	152.8
Administration costs	34.7	36.7
Monitoring costs	46.6	49.2
Operational/capital cost of technology switch		147.8
Total	207.5	386.5
Benefits (emissions reductions)		
Air Quality pollutants	1,423.2	1,973.6
CO2 (Traded)	1.4	3.6
CO2 (Non-Traded)	34.5	96.8
Total	1,459.1	2,074.0
NPV	1,251.5	1,687.4

*Please note any differences due to rounding.

Option 2 is the preferred option for two key reasons:

a) It provides the greatest protection of public health, delivering air quality improvements valued at over £1.9 billion with additional benefits in reducing carbon emissions. It also clearly demonstrates the UK government's commitment to protecting human health through improving air quality.

b) It enables the UK to comply with important air quality legislation by effectively transposing the MCPD while still ensuring the safe hourly NOx levels laid out in the AAQD and curbing increase in high polluting generators and encouraging their replacement with cleaner technologies.

The impacts assessed within the document are based on the best available knowledge of the current MCPs and high NOx generators active within the UK along with the assumed behaviour of these plants when faced with these restrictions. However, it is recognised that there are uncertainties around the modelling and the implementation and delivery of our preferred option. Therefore, this is not the final assessment of options and it is essential that additional or improved information provided during consultation be included to ensure the best approach is developed and implemented.

Annex

A. Additional options considered for transposition of the MCPD

In addition to the options presented in Table 6.3, Section 6, alternative options for transposing the MCPD could involve (1b) applying controls earlier than required by the directive for new and/or existing plants; and (1c) setting stricter emissions limits than the directive. The options are assessed in the table below.

Annex Figure 1 Option selection

Option	Discussion
Apply earlier emission controls for new plant	The MCPD requires new plants to be permitted and in compliance with ELVs from 20 December 2018, one year after the deadline for transposition. This timescale is justified to allow sufficient time for transposition, to develop the processes and guidance required for implementing the Directive, and to raise awareness of the requirements for plant operators, many of which may have not prior experience with environmental permitting. It was therefore considered that earlier application of emission controls for new plants would not be appropriate – except for plants subject to additional controls under Option 2, where the intention is to drive behaviour change.
Apply earlier emission controls for existing plant	Application of earlier emission controls to existing plants could deliver earlier improvement to air quality. However, there are a very large number of existing plants (particularly 1-5MW plants) which will require permitting, retrofitting to achieve compliance with ELVs and possibly modifications to the flue to allow monitoring emissions, so a long timescale for implementation is helpful. In addition, this timescale will promote decommissioning of older plants before the deadline for compliance with ELVs and their replacement with new plants using cleaner technology, which typically have to comply with more stringent ELVs. Under Option 2 earlier emission controls are proposed for some existing combustion plant because their use is projected to increase and they have sufficiently high NOx emissions to pose a concern for local air quality.
Application of stricter ELVs	The MCPD ELVs were selected to provide a minimum emission standard which can be applied to the wide variety of combustion plants in scope of the Directive. Application of stricter ELVs would deliver greater emission reductions but they may not be achievable in all situations, and so would require a more bespoke approach to setting emission limits, which would increase permitting costs. However, for existing 20-50MW plant subject to emission controls under domestic provisions which are more stringent than those required by the MCPD, the domestic provisions will be retained because plant are already in compliance. In addition, under option 2, stricter emission controls and bespoke permits are proposed for some existing combustion plant because their use is projected to increase and they have sufficiently high NOx emissions to pose a concern for local air quality. The MCPD states that the European Commission will produce a report on the emission levels achievable applying best available technology, and associated costs, which will have to be considered when setting emission limits for plants in zones or parts of zones non-compliant with the Ambient Air Quality limits. This report will allow reviewing the case for applying stricter ELVs.

B. Development of proposals for controlling emissions from high NOx generators

The Environment Agency modelling identified that installations of generators with high NOx emissions posed a risk to local air quality by causing high local concentrations of NO_2 which exceed legally binding limits set for the protection of human health.

The modelling used conservative assumptions about emissions levels and high-risk configurations of generators and was used to identify size, time and emission limits beneath which breaches of the EU Ambient Air Quality Directive (where concentrations of NO_2 exceed 200 micrograms per cubic metre more than 18 times per year) would be unlikely (occur less than 1 in 20 years). The modelling indicated that a breach was unlikely for;

- large installations (just under 50 MW) with emissions less than 190mg/Nm^3,
- large installations (just under 50 MW) of diesel plant with very high emissions (>3000mg/Nm^3) that operate for 50 hours
- small installations (5MW)

unless they were located within 150m of a sensitive receptor (place where people are likely to be exposed).

When the modelling was complete several options for controlling emissions were assessed. Due to the lack of data about plants <50MW, particularly those with a shorter run time, this was a qualitative assessment. BEIS and National Grid were involved in the policy development process and asked to review the likely impacts of possible control options for generators on energy security and balancing services.

The questions considered were:

1. *Would the options substantially reduce the risk of a breach of hourly air quality limits for NO_2 and therefore adequately protect human health?*

2. *Would the options control the contribution of the energy balancing market to national NOx emissions?*

3. *Would the options result in a risk to energy supply?*
   Energy Security is an important consideration that needs to be factored in, especially over the next few years when the outlook for security of supply is tight. Diesel generators are used to provide back-up power to sites and can provide capacity to the electricity generating network thereby contributing to security of supply. These generators are used to smooth demand on the electricity transmission system as they operate during times of peak demand to avoid Transmission Network Use of System Charges (a practice known as triad avoidance). They also provide energy balancing services through the Short Term Operating Reserve and Firm Frequency Response. They have shorter build times than other installations which is an advantage in addressing potential short-term security of supply issues. It is therefore important that some diesel generators are able to continue to operate until sufficient capacity of less polluting installations is available to fulfil this function.

4. *Would the options present an acceptable cost to business?*

Annex Figure 2 Qualitative Assessment of potential options considered for controlling emissions from high NOx generators

#	Option	Local Air Quality	National Air Quality	Energy Security	Cost to Business	Result of assessment
1	Do Nothing					*Continued increase in diesel generators resulting in increased risks to human health*
2	Ensure all installations (Tranche A and Tranche B and emergency back-up plant) meet 190mg/Nm^3 in 2019					*Option would result in a serious risk to energy security at important sites including hospitals as many back-up installations used to provide power to sites during emergencies do not meet this ELV and would have to fit costly abatement or close. Installations pre-dating 2016 may face high costs for retrofitting secondary abatement (costs 40% higher for retrofitting secondary abatement than fitting to new– which may cause new projects to be cancelled, exacerbating the energy security risk.*

3	Do not allow any installations emitting over 190mg/Nm^3 to enter into balancing contract/ capacity agreements					*Option would result in a risk to energy security over years when the spare capacity of the system is likely to be limited as currently many installations predating December 2016 do not meet this ELV and would have to fit costly abatement*
4	Ensure Tranche B installations meet 190mg/Nm^3 in 2018 but do not regulate existing installations					*Installations predating December 2016 which typically have higher emissions than newer plant have greater incentive to run for balancing market causing a risk to local air quality*
5	Introduce a transition period (until December 2024) for Tranche A installations to meet 190mg/Nm^3 if operating for the energy balancing market and ensure that Tranche B installations meet 190mg/Nm^3 if operating for the energy balancing market in 2018					*Enabling Tranche A to continue to supply the energy balancing market with emissions unabated until December 2024 reduces risk for energy security but in the short term these installations could present a risk to local air quality. Installations operational from December 2016 would be required to meet ELV to ensure lower risk to Air Quality.*
6	Introduce a transition period (until December 2024) for Tranche A and Tranche B installations to meet ELV of 190mg/Nm^3					*Enabling all installations to have a period of time before meeting an ELV reduces the risk for energy security. However the projected increase in the number of polluting plants is likely to lead to an avoidable increase in National emissions and larger numbers of breaches of hourly NO_2 concentration. It is also more costly to retrofit, new installations would be better to fit abatement at the time of construction.*
7	In addition to option 5 require Tranche A and Tranche B installations with emissions in excess of 190mg/Nm^3 and operating over 50 hours per year from 2018 to undertake a local air quality assessment and abate emissions/ reduce hours appropriately					*This option would require a large number of existing gas installations that exceed emissions of 190mg/Nm^3 to carry out local air quality assessments in 2018 and as few are thought likely to cause significant air quality impacts the costs of this are thought likely to be disproportionate. The additional costs to business may also cause some early closures of these plants resulting in a slightly increased risk to energy security.*
8	In addition to option 5 require Tranche A installations with					*The majority of gas installations have emissions below 500mg/Nm3 and will*

	emissions in excess of 500mg/Nm^3 and operating over 50 hours per year from 2018 to undertake a local air quality assessment and abate emissions/ reduce hours appropriately			*not require a local air quality assessment under this option. These gas plants have lower emissions than diesel installations and their emissions we think that most are unlikely to cause local air quality issues given the very conservative assumptions used in the EA's modelling.*
9	In addition to Option 8. Ensure all future emergency back-up plant meet 190mg/Nm^3 from 2018			*Option may result in a risk to energy security at important sites including hospitals as diesel generators which have high NOx emissions provide the cheapest and most easily installed form of back-up energy provision. Secondary abatement is costly and discussions with industry suggest it can also affect the reliability of the plant which is undesirable for emergency use.*

The options screening led to four key conclusions;

1. In order to protect energy security of the electricity transmission network installations operational before December 2016 and those with Capacity Market agreements from 2014 and 2015 auctions, including those that are not yet operational, should be given some time to reach an ELV of 190mg/Nm^3

2. Installations operational from 1 December 2016 should be required meet the ELV of 190mg/Nm^3 at the point of installation if they are to be used to provide power for the energy balancing market. This avoids unnecessary contributions to National Emissions because new generators with low NOx emissions are available to fulfil this function. The 190mg/Nm^3 limit is likely to lead to high levels of compliance with local air quality limits. The cost of fitting abatement at the point the installation is commissioned is less than retrofitting abatement.

3. Back-up generators required to provide emergency power a site should be allowed to continue unabated and future plant used for this purpose should not be required to abate emissions.

4. Measures to protect local air quality should be aimed at the most polluting plant (those with NOx emissions above over 500mg/Nm^3) in order to ensure that costs to business are not disproportionate

The proposals we are consulting on are based on this assessment of potential options and seek to balance the need to retain sufficient electricity generating capacity with the need to protect air quality. The limits proposed take account of the Environment Agency's modelling but have been adapted to ensure that impacts on energy security are minimised and costs to businesses are proportionate. The proposals therefore introduce lighter controls on existing generators and those with existing supply contracts and Capacity Market agreements for an interim period.

The recommendation from the EA's report to require a site-specific assessment within 150metres of the installation was not included in the proposals because this would be difficult to enforce.

<u>Exemptions</u>

The proposals exempt back-up generators used during emergencies and for up to 50 hours of routine testing. We are also proposing that installations providing power at nuclear sites should on the basis that these sites are licences under a separate regulatory regime which ensures that back-up generators are only used for supplying power to the site and cannot be used to generate power for export off-site.

Additional requirements for installations with Secondary Abatement

The proposals include a requirement for installations relying on secondary abatement to achieve emission limits within 5 minutes operation. This is because SCR operates effectively only when the catalyst has reached a high temperature and discussions with industry suggest this can take 30-60 minutes on large diesel generators. The short running time of diesel generators providing energy balancing services (average 20 min- 2 hours) means that the catalyst may not have time to come up to temperature and may not substantially improve either local concentrations or national emissions on this basis. Discussions with industry indicate that some SCR Systems might already be able to reduce emissions from diesel engines to suitable levels within this timeframe.

For future installations (operational after 1 December 2016) the limits recommended in the EA's report have been adopted because it is likely to drive the use of widely available cleaner technology (e.g. lean burn gas engines) in the energy balancing market, acting to curb emissions from this source without compromising energy security. The 190mg/Nm_3 limit also aligns with the MCPD ELV for diesel plant.

The 50 hour limit derived from the modelling has also been adopted in the proposals because discussions with industry indicate this would enable adequate testing of back-up generators and associated cooling systems for most applications including hospitals. The site-specific permitting requirement for Tranche A plant operating more than 50 hours may act as a disincentive for operators to extend running hours to undertake additional energy balancing services, particularly for installations with the highest emissions, those in areas with high background concentrations of NO_2 and those with nearby sensitive receptors.

C. Abatement measures and Costs methodology

The impact assessment model is based on an abatement matrix which details abatement measures for each pollutant (NO_X, SO_2 and PM), technology type (boiler, engine and turbine), fuel and capacity class, alongside its abatement efficiency and costs. After entering the set of ELVs, the model compares these against baseline emission levels (projected into the relevant year) and calculates the necessary emission reduction needed to achieve the ELVs. Given the reduction needed, the model selects the most cost effective measures and calculates total emission reduction and costs. These figures are based on the data from the abatement matrix, multiplied by the number of plants applying those measures. The process is done separately for new and existing plants. It is done separately because an adjustment factor has been applied to the costs of the abatement measures to reflect the lower cost of installing abatement as part of installation of a new plant when compared to the higher cost of retrofitting a measure to an existing plant.

Compliance costs for potential abatement measures are based on the abatement matrices developed by Amec Foster Wheeler for the Commission in recent studies. A number of literature sources were reviewed in order to compile information on possible abatement measures for MCPs and associated pollution abatement efficiencies and costs. The following sources were reviewed:

- JRC (2007) Small combustion installations: Techniques, emissions and measures for emission reduction. Joint Research Centre;
- AEA (2007) Assessment of the benefits and costs of the potential application of the IPPC Directive (EC/96/61) to industrial combustion installations with 20-50 MW rated thermal input. Final Report to the European Commission;
- (Summary of) Best Available Techniques in Small 5-50 MW Combustion Plants in Finland;
- EGTEI (2010) Options for limit values for emissions of dust from small combustion installations < 50 MW;
- VITO (2011) Beste Beschikbare Technieken (BBT) voor nieuwe, kleine en middelgrote stookinstallaties, stationaire motoren en gasturbines gestookt met fossiele brandstoffen;
- ECN (2008) Onderbouwing actualisatie BEES B: Kosten en effecten van de voorgenomen wijziging van het besluit emissie-eisen stookinstallaties B;
- Amec Foster Wheeler's multi pollutant abatement measures database.

The majority of the costs are taken from VITO (2011), with some additional costs taken from AEA (2007) and Amec Foster Wheeler (2013). Figures are inflated to 2014 prices in all cases[34]. The literature sources include a range of costs for measures, which represent the uncertainty around the cost estimates for the abatement measures and variation in installation specific variables, and so a low and high range of costs are used in this analysis. A list of abatement measures is provided on table 7.10. For some abatement measures, the low and high costs are the same, which is assumed to reflect a single underlying cost data source; whilst for other abatement measures (SCR and SNCR in particular) there is a significant difference between the low and high costs.

The abatement measure for the reduction of SO_2 emissions from the combustion of other gaseous fuels is assumed to be as per the installation of end of pipe SO_2 treatment at liquid-firing plants (wet and dry FGD). It is known however that some of the plants firing other gases will be at refineries and steelworks where it may be more cost effective to desulphurise fuel feedstock's rather than fit end-of-pipe SO_2 abatement. As such, for this measure, the assumed costs that have been assumed may be an overestimate, and should be considered as conservative.

Identify the abatement measures

Abatement measures and their associated emission reduction efficiencies are based on the abatement matrices developed by Amec Foster Wheeler for the Commission in recent studies (Amec Foster Wheeler, 2014). Annex Figure 3 lists a consolidated version of the abatement measures considered in the MCPD Impact Assessment as well as their abatement efficiency and the technologies and fuels affected. Where a range is shown for abatement efficiency this indicates different efficiencies are expected when the measure is applied to different size-fuel-technology type categories. Abatement efficiencies presented are an indication of the emission reduction that the measure can achieve on average and are therefore suitable for modelling the impact across groups of plant; the reduction realised in individual plant could be slightly higher or lower depending on site specific features.

[34] Capital (CAPEX) and operational (OPEX) costs have been identified in the reference sources to allow for flexibility in annualising the data; default values of a 3.5% discount rate and an annualisation period of 15 years have been used in the central case. Costs have been presented in 2014 prices using the GDP deflators available from HMT (ONS June 2015).

Annex Figure 3 List of measures considered in the MCPD IA and their associated abatement efficiency

	Technologies that can fit this measure	Fuels affected	NO_x abatement efficiency	SO_2 abatement efficiency	PM_{10} abatement efficiency
Combustion modification - assumed EGR (Exhaust gas recirculation)	Boilers	Biomass, Other solid fuels, Liquid fuels.	30%	-	-
Cyclone	All technologies	Biomass, Other solid fuels, Liquid fuels.	-	-	65%
Dry FGD (flue gas desulphurisation)	All technologies	Other solid fuels, Liquid fuels, Other gaseous fuels	64% - 80%	-	-
ESP (Electrostatic precipitator)	Engines and turbines	Liquid fuels, Natural gas	-	-	97%
Fabric filter	All technologies	Biomass, Other solid fuels, Liquid fuels	-	-	95% - 99%
Fuel switch to 0.1%S Liquid fuels	All technologies	Liquid fuels	-	90%	50%
Fuel switch to natural gas	Boilers	Other solid fuels	50%	100%	99%
Low NO_x burner	Boilers	Natural gas, Other gaseous fuels	30%	-	-
Low NO_x burner / Advanced lean burn	Engines and turbines	Natural gas, Other gaseous fuels	40% - 50%	-	-
SCR (Selective catalytic reduction)	All technologies	All fuels	70% - 90%	-	-
SNCR (Selective non-catalytic reduction)	All technologies	All fuels	35% - 45%	-	-
Water injection	Engines and turbines	Liquid fuels, Natural gas	60%	-	-
Wet FGD	All technologies	Biomass, Other solid fuels, Liquid fuels, Other gaseous fuels	-	94%	99% - 100%

Annex Figure 4 List of measures considered in the MCPD IA and their associated uptake frequency

Pollutant	Measure	Number fitted in 2030	
		New	Existing
NOx	Lean burn / low NOx burners	2202	4447
	water injection	297	4
	EGR	7	308
	SCR	237	119
	SNCR	175	321
SO2	WFGD	271	305
	DFGD	0	204
	Fuel switch	7	13
PM	Total cyclone	71	242
	Filters	51	204

Please note the number of fitted is not the number of plants. Some plants need to fit multiple abatement technology to meet ELVs for multiple pollutants. Some plants required to meet emissions limits are already compliant under BAU and therefore do not need to fit abatement technology.

A summary of this information is presented in the abatement matrices (Annex Figure 4) for each of the 1-5 MW, 5-20 MW and 20-50 MW capacity classes, for boilers, engines and turbines above. Expanded versions of these abatement matrices are used within the model to automatically identify which abatement measure would be required to achieve compliance with the scenario ELVs. Given that to date the majority of MCPs have not been regulated, there has been no driver to optimise emissions performance. A threshold has been set at 10% emission reduction. Below 10%, it is assumed modifications to existing equipment and operating practice can be implemented to achieve the necessary reduction with minimal additional cost[35]. If an emission reduction of greater than 10% is required, then the lowest cost measure that can achieve the required reduction is selected.

An adjustment factor has been applied to the costs of the abatement measures to reflect the lower cost of installing abatement as part of installation of a new plant, compared to the higher cost of retrofitting a measure to an existing plant. For primary measures, this premium is assumed to be 60%, consistent with Amec Foster Wheeler's recent modelling for the Commission's impact assessment. For secondary measures, the premium is 40%. This is 60%/40% adjustment is for CAPEX only. The CAPEX/OPEX distinction matters for some measures such as pure fuel switch, where there is no CAPEX in some applications.

[35] An assumption consistent with the Commission study

Some types of plant, namely natural gas boilers are assumed to reach compliance with the ELVs set and therefore do not face the cost of abatement. As this is also the most frequent type of plant it has been assessed and presented in Annex Figure 5.

Annex Figure 5 NOX average emission level, proportion of plants and relative contribution of NOX emissions from natural gas boilers already compliant or non-compliant with MCPD.

Capacity Class	Emission Levels (mg/Nm^3)		Proportion of plants		Relative contribution (NO_X)	
	Compliant	**Non-compliant**	**Compliant**	**Non-compliant**	**Compliant**	**Non-compliant**
Existing plants						
1-5 MW_{th}	120	290	70%	30%	50%	50%
5-20 MW_{th}	130	230	80%	20%	69%	31%
20-50 MW_{th}	150	280	60%	40%	45%	55%
New plants						
1-5 MW_{th}	70	190	20%	80%	8%	92%
5-20 MW_{th}	80	170	30%	70%	17%	83%
20-50 MW_{th}	70	200	10%	90%	4%	96%

The values in the table above are based on information on real plant performance and what percentages of those have BAU emission levels below the MCPD ELVs. The figures are for data collated in 2014 and assumed to apply for all years 2018-2032 as without MCPD.

D. Administration and compliance activities

Annex Figure 6 List of administrative activities considered

Administrative activities	Type of activity	Frequency	Affected party	Time required per operator or regulator per activity (hours) by type of permit	Assumptions*
Permit application to CA by operator (new plants)	one-off		Operators : (per MCP)	Standard: 4 Bespoke: 130	Assumed to be electronic and based on readily available information
Permitting: CA to start permitting process within 1 month (new plants)	one-off		Regulator (per MCP)	Standard: 2 Bespoke: 65	Assumed to be electronic and does not include corrections/revisions of submitted information
Permitting: notification to CA by operator (existing plants WHERE annex I information has not been provided before)	one-off		Operators : (per MCP)	Standard: 4 Bespoke: 130	Assumed to be electronic and based on readily available information
Permitting: development of the MCP register by CA	one-off		Regulator (total)	37.5	Assumed to cover development of the register template by the CA either as a spreadsheet to be posted on-line, or to be incorporated into available existing registers (but excludes any specific IT costs in this case)
Permitting: subsistence	recurring	Once per year	Operators (per MCP)	Standard: 2.5 Bespoke: 50	Assumed to be electronic and concise
Permitting: subsistence	recurring	Once per year	Regulator (per MCP)	Standard: 1 Bespoke: 25	Assumed to be electronic and does not include corrections/revisions of submitted information
Record keeping (for at least 6 years)	recurring	Once per year	Operators (per MCP)	7.5	Assumed to be electronic using an existing record keeping system (to an extent part of a day-to-day installation management)
Compliance check: environmental inspection	recurring	High risk: (1) once per year (2) once every two years	Regulator (per MCP)	15	Assumed to involve a site visit (with limited travel time). Does not include corrective actions and follow ups/ checks.
Compliance check: environmental inspection	recurring	High risk: (1) once per year (2) once every two years	Operators (per MCP)	7.5	Assumed to involve a site visit. Does not include addressing any corrective actions and follow ups.
Approach 1, Approach 2 - Compliance check: remote check	recurring	Low risk: (1) once every 3 years (2) once every 10 years Medium risk: 1-20MW: once every 3 years, 20-50MW: (1) once per year (2) once every 2 years	Regulator (per MCP)	7.5	
Compliance check: recording of malfunctions	recurring	Once every 5 years	Operators (per MCP)	1	Assumed to be electronic using an existing record keeping tool (to an extent part of a day-to-day installation management)
Reporting: three reports to the Commission (2021, 2026 and 2031)	recurring	As required by reporting year	Regulator (per report)	37.5	Assumed to be based on compilation of readily available information received and stored by the CA. Does not include data checks and corrections (assumed to be part of daily operation)

* It is assumed within the activities set out above, the costs associated with the collection of annual fees is covered.

E. Behavioural response assumptions

The behavioural assumption is supported by a demand for heat by the majority of operators, combined with the fact that boilers will remain the primary supply. This is because district heating systems are not widespread in the UK and it is therefore unlikely to be a viable alternative option for the representative operator to connect to a network to provide their primary heat needs. That is to say, technical barriers matter as well as economic considerations.

For engines and turbines generating electricity, there could be two alternatives to fitting abatement:

1. Stop auto-generating electricity and switch to buying from the grid. This will result in higher cost per unit of electricity and may also require an upgrade to the supply contract and/or physical connection, also at additional cost.

2. To purchase or hire portable gensets, which do not fall under the MCPD but instead have emission limits under NRMM standards. Given the low number of expected cases of such a switch, a comparison of the costs and benefits of the MCPD against the NRMM standards has not been performed.

For engines and turbines operating as cogeneration, the above considerations for heat and electricity both apply. For all plant types nearing the end of their operational life, an alternative to fitting abatement may be early closure and replacement with new compliant plant. This would come with the associated cost premium for compliance with MCPD new plant ELVs and the early write off of remaining asset value. Technological changes that may alter incentives over time would not be anticipated until after the appraisal period of this assessment either.

In specific circumstances, where one of the outlined alternative options is lower in cost than fitting abatement, the option may be taken and therefore the behavioural response for some operators may be different than the one assumed to be representative of the vast majority of operators. Due to the relative small scale and uncertainty it was not considered further.

Glossary

Terminology	Definition
Abatement technology	*In this report* refers to techniques and technologies used to reduce pollutant emissions, Primary abatement prevents formation of pollutants and includes a switch to fuels which result in lower emissions, retrofitting of existing plant (e.g., by changing the burners) and selection of new plant with lower emission. Secondary abatement refers to technology which removes pollutants from the exhaust gases, such as filters for dust or selective catalytic reduction to destroy NOx.
Amec Foster Wheeler	Amec Foster Wheeler Foster Wheeler plc is a British multinational consultancy, engineering and project management company headquartered in London, United Kingdom that provided analysis for this impact assessment
AQ	Air quality
AQMAs	Air Quality Management Areas
Back-up plant	Plant installed to provide emergency electricity generation in times of interruption to supply of mains grid electricity, operating rarely and normally much less than 500 hours per year (assumed to be less than 50 hours).
BEIS	Department of Business, Energy and Industrial strategy
CA	Competent Authority
Capacity Market	The Capacity Market is Government's key policy tool to bring forward sufficient reliable electricity capacity to ensure we maintain a secure supply of electricity.
CAPEX	Capital Expenditure
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Combustion plant	Any technical apparatus in which fuels are oxidised in order to use the heat thus generated
Cyclone	A type of filtration system fitted to abate pollution impacts of Biomass, Other solid fuels, Liquid fuels.
DEFRA	Department for Environment Food and Rural Affairs
DRGD	Dry Flue gas Desulphurisation
EA	Environment Agency
EANCB	Equivalent Annual Net Cost to Business
EGR	Exhaust Gas Recirculation
ELVs	Emission Limit Values; means the permissible quantity of a substance contained in the waste gases from a combustion plant which may be discharged into the air during a given period
EMEP CORINAIR	Emission Inventory Guidebook

Energy Market	Energy market is the trade and supply of energy
EPR	Environmental Permitting Regulations
ESI	Electricity Supply Industry
ESP	Electrostatic Precipitators
ETS	Emissions Trading Systems
FGD	Flue gas Desulphurisation
Filters	Form of abatement where different materials are fitted to plants to filter out particulate pollution
FTE	Full time Equivalent
GB	Great Britain
GHGs	Greenhouse gases
Government	Defra and Welsh Government
GOS	Gross Operating Surplus
IED	Industrial Emissions Directive
IGCB	Interdepartmental group on costs and benefits
Installation	(c) a stationary technical unit where one or more activities are carried on, and (d) any other location on the same site where any other directly associated activities are carried on,
Kt	Kilo tonne
KW	Kilowatt
LA	Local Authority
LCP	Large Combustion Plant
Lean burn/low NO_X burners	A form of abatement using larger quantities of air in the fuel mix for internal combustion engines.
MCERTS	Monitoring Certification Scheme
MCP	Medium Combustion Plant
MCPD	Medium Combustion Plant Directive
Member states	Members of the European Union
mg/Nm^3	Milligrams per normalised meter cubed
MIS	Micro Isolated Systems
MS	Member State

MW	Megawatt - a unit of power equal to one million watts Unless otherwise stated the use of MW in this report refers to MW thermal
MWth	Thermal rated input in MW – the maximum fuel energy rate of the combustion plant.
MWe	Megawatts electric - electric output of a power plant in megawatt. The relationship between thermal input and electrical output of a generator depends on its efficiency – an engine that is 33% efficient would have a thermal input 3 times greater than its electrical output.
NAEI	National Atmospheric Emissions Inventory
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxide
NPV	Net present value
ONS	Office of National Statistics
OPEX	Operating expense
PJ	Peta joules
PM	Particulate Matter
PM_{10}	Particulate Matter 10 micrometres or less in diameter
$PM_{2.5}$	Fine particulate matter (2.5 micrometres or less in diameter)
PV	Present Value
Rpm	Revolutions per minute
SBS	Structural business statistics
SCR	Selective catalytic reduction
SIS	Small isolated systems
SMBA	Small and micro business assessment
SME	Small and medium sized enterprises
SNCR	Selective non-catalytic reduction
SO_2	Sulphur Dioxide
Solid Fuels	Refers to fuel made of solid substance, typically coal or wood
SO_X	Oxides of Sulphur
Stand-by plant	Plant installed alongside working plant to provide for additional demand at peak times or in case of shut down of the main working plant, and operating fewer than 500 hours per year.
STOR	Short Term Operating Reserve

t	Tonnes
T-1	Capacity Market auctions held one year ahead of delivery offering 1-year agreements (only) to top-up/fine tune the capacity requirement as needed for the coming delivery year.
T-4	T-4' Capacity Market auctions seek to procure capacity four years in advance of the required delivery window, and award 'capacity agreements' to those successful
TRIAD	The Triads are defined as the three half-hours of highest demand on the Great British electricity transmission network between November and February each year. The triad charging system is a tool used by National Grid to smooth demand for electricity at peak times and is used to recover the costs of building and maintaining the electricity transmission network. The cost of electricity for large industrial and commercial users of electricity whose consumption is half hourly metered is determined by their demand during the Triads. Large users of energy therefore have an incentive to reduce their demand during the Triads by running their generators to avoid drawing power from the transmission network during Triads (this is known as Triad avoidance). Generators connected at the distribution level are paid to produce power during the Triad peaks. Some generator operators are contracted by large energy users (or third parties on their behalf) to run during periods when triads are likely. Triads are declared by National Grid retrospectively so generators are run whenever the operator believes a triad is likely to occur.
UK IAM	UK integrated assessment model (UKIAM) he UK integrated assessment model (UKIAM), has been developed using Defra funding by Imperial College London to investigate cost effective strategies for reducing UK emissions which maximise improvements in environmental protection in the UK while complying with future UK emission ceilings imposed to reduce transboundary air pollution in Europe. UKIAM brings together information on projected UK emissions of SO2, NO2, NOX, NH3, CO2, N20, CH4, PM10 and PM2.5 to calculate the simultaneous effect of abatement measures on a combination of pollutants, and comparison of future scenarios. This includes calculating the effects with respect to changes in greenhouse gas emissions as well as human exposure to air pollution, urban air quality, and the natural ecosystems.
WFGD	Wet Flue gas Desulphurisation
Working plant	Operating on average more than 500 hours per year which are subject to compliance with emission limits.