Title: Proposed regulation of the sales, distribution and marketing of: • Wet wood (>20% moisture) sold in units up to 2m^3 • Bituminous house coal • Banning manufactured solid fuels with sulphur content over 2%	Impact Assessment (IA)
RPC Reference no: RPC-4233(1)-DEFRA	**Date: 11 October 2019**
Lead department or agency: Department for Environment, Food and Rural Affairs **Other departments or agencies:**	**Stage: Final** **Source of intervention:** Domestic **Type of measure:** Secondary legislation
Summary: Intervention and Options	**RPC Opinion:**

Cost of Preferred (or more likely) Option – Option 2

Total Net Present Value	Business Net Present Value	Net cost to business per year (EANDCB)	In scope of One-In, Three-Out?	Measure qualifies as
£7,858.3m	- £109.3m	£11.7m	Out of Scope	

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

The UK must, under the National Emissions Ceilings Directive (NECD), reduce overall national emissions of particulate matter with a diameter of 2.5 micrometres or less ($PM_{2.5}$) alongside other key pollutants, to protect its citizens and environment from the resultant damage. Domestic burning of solid fuels is by far the largest source of $PM_{2.5}$ emissions. There is a strong body of evidence linking increased mortality to long-term exposure to PM. The domestic fuels market does not currently take into account this negative externality. Sulphur dioxide (SO_2) is another key pollutant emitted from the burning of domestic fuels. In recent years there has been an increase in the availability of cheap high sulphur smokeless fuels on the market. The government is taking action to protect the public and the environment from the damage caused by exposure to these pollutants (with co-benefits for reducing other toxic emissions to help meet its domestic, EU and International law obligations).

What are the policy objectives and the intended effects?

- A cleaner, healthier urban and rural environment, benefiting people and the economy.
- Reduce the impact on health and the environment from PM and SO_2 pollution (including reducing mortality from cardiovascular and respiratory diseases and from lung cancer).
- Address the lack of information whereby consumers are un-knowingly purchasing and burning fuels which are bad for their health and the environment and help consumers make the shift to cleaner alternatives.
- Contribute towards achieving our domestic, EU and International law obligations (2020), domestic, EU and International Gothenburg Protocol emissions ceilings for $PM_{2.5}$ and SO_2 and more stringent domestic and EU ceilings for the same pollutants for 2030.
- Make enforcement easier for Local Authorities by regulating at point of sale, rather than point of use.
- Reduce energy bills for consumers who are un-knowingly purchasing and burning low cost-efficient solid fuels, in particular wet wood.

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

Option 0: Baseline/Do nothing approach – continue with current voluntary arrangements and introduce no restrictions. This is the baseline against which the other options are assessed.

Option 1 – Voluntary approach –a government communications campaign alongside continued support for voluntary industry schemes promoting the sale of cleaner fuels.

Option 2 (preferred option) – regulating the sale, distribution and marketing of bituminous coal and wet wood (>20% moisture) when sold in units up to two metres cubed and restrictions on the sale and distribution of high sulphur manufactured solid fuels i.e. fuels with a sulphur content greater than 2%. An information campaign to raise public awareness of highly polluting fuels would be conducted alongside. This option delivers the best balance between realising the air quality and health benefits as soon as possible and managing the impact on households, businesses and local authorities.

Other options considered: **a) Regulating the sale of fuels in urban areas only**: approximately 50% of PM pollution comes from outside a local area; restricting legislation to urban areas would deliver less air quality benefit across the country; **b) modifying existing legislation** on smoke control areas; this is being taken forward under separate legislation **c) taxation** was felt not to deliver change at the pace needed to meet our legal obligations and **d) stove scrappage scheme** which had prohibitively high costs as compared with the proposed option.

Will the policy be reviewed? Yes **If applicable, set review date:** 12/2025

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:**	**Non-traded:** - 0.43	

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: Communications campaign targeted at raising public awareness of the negative health and environmental impacts of domestic burning alongside voluntary industry schemes.

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	**PV Base Year** 2020	**Time Period Years** 11	**Net Benefit (Present Value (PV)) (£m)**		
			Low: 28.2	**High: 367.1**	**Best Estimate: 128.1**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Cost** (Present Value)
Low	0.0	1	-0.1	**-1.3**
High	0.0		-0.1	**-1.1**
Best Estimate	0.0		-0.1	**-1.2**

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

The monetised business costs under Option 1 pertain to those businesses which voluntarily subscribe to the Ready to Burn scheme. The scheme currently covers less than 1 percent of businesses in the market although it should be noted this includes the biggest fuel manufacturers in terms of the tonnage of domestic fuel sold on the market. The costs to business will vary depending upon the size of business. There are also costs to government from the public information campaign. We have assumed the government will set aside £220,000 over a three-year period i.e. from 2020 to 2022 for the campaign. The funding will be subject to approval. The analysis shows a negative total cost (i.e. a saving) for businesses, households and the Government, estimated at less than £1.2 million for the 2020-2030 period in the central scenario.

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

No further costs to the business or household sector are anticipated under this scenario.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant	**Total Benefit** (Present Value)
Low	0.0	N/A	2.9	**27.1**
High	0.0		39.5	**365.8**
Best Estimate	0.0		13.7	**126.9**

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

Under Option 1 the benefits of reduction in air pollution arise as a result of a reduction in the consumption of wet wood and bituminous coal following the communications campaign. We use the UK damage cost valuation approach to estimate the benefits of reducing $PM_{2.5}$ and SO_2 emissions as set out in the Green Book supplementary guidance for valuing changes in air quality. The change in greenhouse gas (GHG) emissions is valued using the Green Book guidance and is monetised using BEIS non-traded carbon values.

We have assumed the communication campaign results in a 1 percent shift from wood purchased and burned wet into wood burned dry and from bituminous coal into manufactured solid fuel coal. The figure for the assumed effectiveness of the communications campaign is drawn from an analysis of a voluntary industry scheme that encourages the sale of cleaner fuels and a literature review. We estimate the central present value benefits from the associated reductions in $PM_{2.5}$ and SO_2 to be £126.9 million.

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 has not been monetised here. There are also secondary impacts that are likely to arise from the regulation e.g. supporting innovation in abatement equipment/green technologies and reductions in emissions of other pollutants and toxins such as arsenic, lead or mercury that have not been monetised as part of this analysis.

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

Low and high benefits represent the uncertainty in health benefits from improved air quality (damage costs). The high NPV combines low business costs with high damage cost valuation (high benefits), and the low NPV combines high business cost with low damage cost valuation.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m: Non-qualifying provision**
Costs 0.05	**Benefits: 0.0**	**Net: 0.05**	

Summary: Analysis & Evidence Policy Option 2 (Preferred option)

Description: Regulation of the sales, distribution and marketing of bituminous coal and wet wood (>20% moisture) sold in units up to $2m^3$ and restricting the sale of manufactured solid fuels with a sulphur content greater than 2%.

FULL ECONOMIC ASSESSMENT

Price Base Year 2017	PV Base Year 2020	Time Period Years 11	Net Benefit (Present Value (PV)) (£m)		
			Low: 1,647.9	High: 22,688.7	Best Estimate: 7,858.3

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant price)	Total Cost (Present Value)
Low	0.0	1	-1.3	**-6.5**
High	0.0		4.2	**46.6**
Best Estimate	0.0		1.4	**19.5**

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

The proposed regulation is likely to result in additional costs to businesses and potentially to households. The costs to businesses arise in the form of administrative and monitoring costs incurred from enforcing the proposed regulation as well as from loss in profits and from capital costs. Costs to households may occur due to the shift towards more expensive sources of energy but these are more than offset due to the higher energy density of the fuels being used following the ban.

The analysis shows a total cost for businesses, households and the Government, estimated at £19.5 million for the 2020-2030 period in the central scenario.

For businesses, the total net estimated cost to the solid fuel sector in terms of the profit lost as a result of the ban is £14 million over the 11-year period in the central scenario. It mainly results from lower volumes of wood sold due to the higher energy efficiency of dry wood compared to wet wood. In addition, a percentage of businesses selling wood will require investments in drying equipment, and subsequently incur an operating cost at an estimated £83 million cost in present value terms over the appraisal period. A significant share of profit losses from reduced activities in coal sales is recovered through increased sales of alternatives to coal.

The monitoring and administrative costs to be covered by businesses are anticipated to be £27 million in present value terms over the 11-year period in the central scenario.

There will also be some costs and benefits to households from switching fuels. Adjusting for the energy densities of the fuels under consideration and appliances' efficiency, we estimate total net benefit for households at £105 million over the 11-year period. The benefits to households that switch from burning wet wood to burning dry wood are expected to reach £111 million. Households substituting from coal to low sulphur manufactured solid fuels should also experience a saving of approximately £19 million over the same period. However, households switching from high sulphur solid manufactured fuels to low sulphur solid manufactured fuels are anticipated to experience an increase in total costs of approximately £24 million over the period based on current market prices.

There are some costs to government accruing from an information campaign to promote safer and cleaner fuels burning habits (£220,000 over 3 years) and local authorities' enforcement costs estimated at £1.2m over the 11-year period.

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

There may be indirect costs to businesses within the supply chain of fuel manufacturers impacted by the proposed regulation which have not been estimated as part of this analysis. The most likely impacts which have not been monetised are:

- Reduction in freight if people reduce the amount they burn (as they use more efficient fuels)
- Change in port activity resulting from variation in wood imports: likely to be a reduction in imports as demand is anticipated to decline due to the higher energy efficiency of dry wood
- Change in port activity resulting from variation in imports of coal and its alternatives

The impact of the proposed legislation on freight and port activity is relatively limited. Assessing the size of the impact faces significant level of uncertainty and conducting a study would have been disproportionate.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant	Total Benefit (Present Value)
Low	0.0	N/A	186.0	**1,694.6**
High	0.0		2,490.0	**22,682.2**
Best Estimate	0.0		864.8	**7,877.8**

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

The proposed regulation will reduce emissions of $PM_{2.5}$ and SO_2 resulting in an improvement in air quality for everyone, particularly for people living in households which burn wet wood and traditional bituminous house coal. The analysis uses the UK damage cost valuation approach to estimate the benefits of reducing $PM_{2.5}$ and SO_2 emissions as set out in the Green Book supplementary guidance for valuing changes in air quality. We use the latest DEFRA air quality damage cost values based on advice from COMEAP. These are likely to underestimate the benefits of the proposed regulation as they do not fully capture impacts on the environment from air pollution or other toxins from these fuels.

The reduction of greenhouse gas (GHG) emission is valued using the Green Book guidance and is monetised using BEIS non-traded carbon values. As volumes of fuels burned are reduced as a result of average higher energy efficiency, we estimate the carbon saving at £26 million.

We estimate the central present value benefits from the associated reductions in $PM_{2.5}$, SO_2 and GHG to be £7,878 million over the appraisal period and to be significantly higher than the costs of the regulation.

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 have not been monetised here. There are also secondary impacts that are likely to arise from the regulation e.g. supporting innovation in abatement equipment/green technologies and reductions in emissions of other pollutants and toxins such as arsenic, lead or mercury that have not been monetised as part of this analysis.

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

There is uncertainty around the scale of health benefits from improved air quality (damage costs) as well some uncertainty around the business costs. The high NPV combines low business costs with high damage cost valuation (high benefits), and the low NPV combines high business cost with low damage cost valuation.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m: Non-qualifying provision
Costs: 13.3	**Benefits: 0.0**	**Net: 13.3**	

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1. Executive Summary

1. In January 2019 the government published its Clean Air Strategy[1] which highlighted air pollution as the top environmental risk to human health in the UK. We know that air pollution is a major public health risk ranking alongside cancer, heart disease and obesity, and poses the single greatest environmental risk to human health.

2. Long term exposure to poor air quality reduces life-expectancy through increased risk of mortality from cardiovascular and respiratory illnesses and from lung cancer. Short-term exposure to poor air quality carries a morbidity burden over a wide range of cardiorespiratory health conditions.[2] It can cause harm to the natural environment resulting in reductions in yields of key food crops caused by ozone damage and changes to delicate nutrient balances causing some aspects of the ecosystem to thrive to the detriment of others.[3]

3. In the Clean Air Strategy Government set out its ambition to progressively cut public exposure to particulate matter pollution as suggested by the World Health Organisation. Government committed to set a new, ambitious, long term target to reduce people's exposure to $PM_{2.5}$ and intends to publish evidence to examine what action would be needed to meet the WHO annual mean guideline limit of 10 μg/m^3.

4. The purpose of this proposed legislation is in part to deliver the commitments in the strategy to phase out the most polluting fuels from domestic burning and contribute towards the above ambition, protecting consumers from more polluting fuels by phasing them out. Government aims to shift people's behaviours who use solid fuel to heat their homes to cleaner alternatives, such as those who burn wet wood to dry wood and those who burn coal to low sulphur manufactured solid fuels.

5. Feedback from the consultation on the proposed regulation demonstrated a wide range of divergent views, many who suffer as a result of other's burning favoured an outright ban on all domestic burning whilst others felt that legislation was not required, advocating a focus on education and advice. Having analysed all 500 responses, the final proposal represents a compromise between these two perspectives. The proposed legislation will regulate the sale of the most polluting solid fuels while mitigating the impacts on those that are most likely to be impacted by the proposed regulation.

6. This impact assessment considers various options to shift consumers towards burning cleaner fuels. It sets out the Government's assessment of the impacts associated with:

   - Consumers who burn wet wood shifting to dry wood.
   - Consumers who burn coal shifting to low sulphur manufactured solid fuels (MSF).
   - Consumers who burn high sulphur MSF shifting to low sulphur MSF.

7. For wood we have considered an appropriate cut off point to allow only the sales of dry wood. Our policy intention is to ensure that people who buy wood for immediate burning are only able to buy wood that is dry and ready to burn, but not to prevent people who buy wood in bulk for seasoning

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf
[2] COMEAP (2010) The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. Committee on the Medical Effects of Air Pollutants. Available from: https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-tohttps://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-ukparticulate-air-pollution-in-the-uk

[3] RoTAP (2012) Review of Transboundary Air Pollution: Acidification, Eutrophication, Ground Level Ozone and Heavy Metals in the UK. Contract Report to the Department for Environment, Food and Rural Affairs. Centre for Ecology & Hydrology.

at home from doing so. Our evidence, together with feedback from the consultation, suggests that wet wood is an inefficient product to burn, resulting in high cost per heat output. Therefore, we expect that people burning large volumes of wood will be burning wood that is dry. As such, we do not consider that a policy intervention is required to ban the sale of wood sold in large volumes. It will be a requirement for sellers of wet wood to provide appropriate advice on how to season wood to ensure that householders are well informed. A full ban on the sale of wet wood may result in an increase in foraging for wood and may disadvantage poor rural households who have always bought cheaper wet wood for home seasoning.

8. The Clean Air Strategy sets out the Government's legal commitments to improve air quality; the UK is required to reduce overall emissions of certain pollutants under the National Emissions Ceilings Directive (NECD) which has been transposed into UK law (The National Emissions Ceilings Regulations 2018). The NECD transposes the reduction commitments agreed by the EU and its Member States under the 2012 revised Gothenburg Protocol under the Convention on Long-range Transboundary Air Pollution. The UK is a signatory to the Convention and Protocol in its own right. The NECD sets ceilings on total national emissions of five key air pollutants i.e. nitrogen oxides (NOx), sulphur dioxide (SO_2), particulate matter ($PM_{2.5}$), non-methane volatile organic compounds (NMVOC) and ammonia (NH4) for 2020 (which correspond to the international obligations under the Protocol) and emission reduction commitments (ERCs) for the same pollutants for 2030. The reductions are set relative to emissions in 2005, the baseline year. The UK is meeting its current targets under the predecessor directive to the NECD (which lapses in 2019) and has done since the ceilings were first introduced in 2010.

9. Based on the National Atmospheric Emissions Inventory (NAEI), domestic burning of solid fuels is by far the largest source of $PM_{2.5}$ emissions, emitting more than manufacturing industries/construction and road transport combined[5]. Emissions from domestic burning can be reduced by improving the installation and maintenance of stoves; upgrading the appliance e.g. from an open fire to a stove; or burning cleaner fuels. Government has assessed all these options in discussion with stakeholders and considers that taking action on fuels is one of the most expedient and cost-effective approaches to reducing $PM_{2.5}$ emissions. This will be complemented by a dedicated communications campaign targeted at domestic burners, so as to improve awareness of the environmental and the public health impacts of burning.

10. According to 2016 projections, the Government is set to miss its legally binding targets for $PM_{2.5}$ for 2030 by 31 kilo tonnes if no further action is taken. It is therefore imperative that Government takes action to reduce emissions. There are many sources of $PM_{2.5}$ emissions including transport and industry. However, whilst emissions from these sources have reduced, the emissions from domestic burning are increasing and now account for the largest single contributing source. The proposed regulation will make a significant contribution towards the UK meeting its legal obligations.

11. Whilst $PM_{2.5}$ is our primary target pollutant, it is essential that any intervention does not shift consumers to another equally polluting fuel. Stakeholders have flagged that in recent years there has been an increase in cheap high sulphur manufactured solid fuels on the market. Sulphur dioxide (SO_2) is harmful to health and a target pollutant under the NECD. It can also corrode appliances. As such, Government proposes to apply sulphur standards to manufactured solid fuels.

12. During the consultation stage, some respondents suggested that those coal burners in fuel poverty may switch to burning wet wood or even waste wood as a result of this legislation. This switch across fuels is considered as part of our sensitivities to assess the impact on $PM_{2.5}$ emissions, and results presented in Annex 2 (part 1). The final policy proposal recommends a transition period to

[5] Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/778483/Emissions_of_air_pollutants_1990_2017.pdf

mitigate this risk and allow coal merchants and Government to work together and support householders during the transition to ensure they switch to cleaner fuels.

13. This concern was based upon an industry assessment that MSF are considerably more expensive than bituminous house coal. Our own analysis has found that MSF are in fact cheaper to burn on an energy density basis and as such households will save money on fuel costs. Whilst some fuel poor households may burn waste wood we do not expect that this policy intervention will result in an increase in waste wood burned. The communications campaign will include advice on the dangers of burning waste wood.

14. It was also highlighted that on an energy density basis, burning dry wood may result in more $PM_{2.5}$ emissions relative to burning coal. This presents a risk that if people who previously burned coal shift to burning wet or dry wood it may result in higher $PM_{2.5}$ emissions. This concern has been considered in detail and Government has concluded it should proceed with the proposed phase out of coal for several reasons:

    - We expect that people burning coal will shift to manufactured solid fuels and those burning wet wood will shift to dry wood and as such both shifts will deliver air quality benefits. This is partly because we expect people's point of supply to remain the same, with authorised coal merchants selling low sulphur manufactured solid fuel instead of coal.

    - The World Health Organization's International Agency for Research on Cancer has stated coal is a known carcinogen and, unlike wood, emits toxic metals such as arsenic when combusted.

    - The World Health Organization has also recommended that coal is phased out as a fuel for domestic heating and cooking; a recommendation they do not make for wood.

    - Government carried out further cost analysis and found that wood is significantly more expensive to burn than MSF on an energy density basis so it is unlikely that price sensitive consumers will switch from coal to dry wood.

15. Restrictions on the sulphur content of manufactured fuels used for heating will be introduced to avoid unintended consequences of consumers switching from one highly polluting fuel to another.

16. A range of options were considered for this analysis as set out in section 5 with two main options assessed in detail. These options are:

    - **Option 1:** A communications campaign targeted at raising the public's awareness of the negative health and environmental impacts of burning wet wood, bituminous coal and high sulphur manufactured solid fuels alongside continued support for voluntary industry schemes promoting the sale of cleaner fuels.

    - **Option 2:** Regulating the sale of wet wood, bituminous house coal and solid manufactured solid fuels with a high sulphur content, coupled with an awareness raising campaign.

17. Our analysis reveals the largest reductions in emissions are achieved under Option 2. We estimate that restrictions on the sale of wet wood (only) to abate 87.9 kilo tonnes (kt) of $PM_{2.5}$ emissions between 2020 and 2030. Restrictions on the sale of bituminous coal (only) are estimated to abate[6] 3.7kt of $PM_{2.5}$ under Option 2. Approximately 1.5kt of $PM_{2.5}$ emissions are abated from both wood and coal under Option 1.

[6] Emissions abatement are calculated as the reduction of emissions of pollutants proportionally to the reduction of volume of domestic fuel burnt, taking into consideration emissions factors published in the EMEP/EEA air pollutant emission inventory guidebook 2016. The source for wet wood emission factor is a preliminary study carried out by the University of Leeds and the University of Manchester.

Table 1: Cumulative PM2.5 emission reductions 2020 – 2030 for Option 1 and Option 2 (kT)

	Option 1	Option 2 (preferred option)
Wood	1.42	87.87
Coal	0.04	3.66
Total	**1.46**	**91.53**

Source: Defra estimates

18. The proposed regulation will contribute to government meeting its 2030 NECD Emission Reduction Commitments (ERCs) through the abatement of approximately 9.37kt of $PM_{2.5}$ (Option 2) in the year 2030 relative to the do-nothing scenario.

19. The regulation will also result in emissions reductions for other pollutants such as SO_2 and Nitrogen Oxide (NO_x). We estimate that Option 2 will abate a total of 24.9kt of SO_2 emissions between 2020 and 2030. The estimated reductions for NO_X pollutant are not reported in this analysis due to:
    a. The uncertainty in their emission factors particularly pertaining to wet wood and bituminous coal; and
    b. Significantly lower levels of abatement achieved relative to $PM_{2.5}$.

20. Reducing air pollution yields benefits in terms of improvements to public health and healthier eco-systems. The benefits associated with the improvements in air quality from the reduction in $PM_{2.5}$ and SO_2 emissions are estimated using the damage cost approach as recommended under the Green Book supplementary guidance for valuing changes in air quality.[7] This approach consists of multiplying the total reduction in the emissions of a pollutant by the associated damage cost. We use the latest available damage costs figures accounting for both the morbidity and mortality effects of air pollution. The $PM_{2.5}$ damage cost value used is specific to the domestic combustion sector while the SO_2 damage cost value used is the national average as no sectoral breakdown of the SO_2 damage costs was available at the time of writing.

21. The benefits accruing from a reduction in $PM_{2.5}$ and SO_2 under the proposed regulation on coal, wet wood and high sulphur manufactured solid fuel in the preferred Option 2 are estimated to reach £7,878 million in the central scenario and range from £1,695 million in the low scenario to £22,682 million in the high scenario over the period 2020 to 2030. Three sets of damage costs values are used to develop high, central and low scenarios. The variation in the damage costs reflects uncertainty in the evidence about mortality and morbidity impacts. We use higher damage costs where the associated health impacts are most prominent and consequently benefits assumed to be largest. The damage costs do not fully account for the health impacts and the environmental damage that arises from pollution and thus likely to underestimate the benefits to society from reducing pollution. However, they are the current best available evidence.

22. We also estimate that there will be benefits in the form of saving for households when switching to the proposed alternatives. Based on current market prices, both dry wood and low sulphur manufactured solid fuel (LSMSF) are less expensive to burn on an energy adjusted basis relative to wet wood and bituminous coal, respectively. Consumers switching from coal to low sulphur manufactured solid fuels and from wet to dry wood will benefit from a saving in fuel costs of about £130 million. For this analysis we have assumed all coal burning takes place on an open fire. There will be costs to households switching from high sulphur solid manufactured fuels to low sulphur

[7] The damage costs mainly reflect the mortality effects of air pollution and some of its impacts on morbidity, ecosystems and productivity. The damage costs will be updated this year to reflect a greater number of health impacts. Current version to air quality damage cost guidance found here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770576/air-quality-damage-cost-guidance.pdf

manufactured fuels of approximately £24 million in present value terms over the period based on current market prices. This implies a net household saving of £105 million.

23. There are business costs linked to the proposed regulation. The costs to fuel manufacturers from the regulation are primarily associated with monitoring and enforcement. Some wood burning business are likely to require investment in wood drying equipment and incur operating costs for those running drying kilns. We estimate the likely costs to industry from the regulation using data from the 'Ready to Burn' scheme, a voluntary industry scheme supported by Government which promotes the sale of dry wood. There will be a loss in profit to the coal and high sulphur manufactured fuel industry from restricting the sale of coal to the domestic sector market and a loss associated to the reduction in the volume of fuels sold due to better average energy efficiency of the fuels burnt. This loss is included in our estimated costs[8]. The total business cost is anticipated to be £124 million in the central scenario, ranging from £148 to £99 million in the low and high scenarios, respectively.

24. Whilst the purpose of the legislation is for domestic burning only, there may be some impact upon business as consumers that may burn solid fuels such as pubs/hotels or heritage industries. We acknowledge that the legislation may impact upon the supply of these fuels to businesses despite the fact that the domestic coal market represents less than 5% of national coal demand. For pubs/hotels we expect that the impact is positive as the alternative fuels burn more efficiently. For heritage industries concerns were raised during consultation on availability of supply. This is a wider concern due to the already occurring decline of domestic coal supplies however the 2-year transition period for coal is expected to allow businesses time to adjust and mitigate this concern.

25. In all three scenarios, we find the benefits arising from the implementation of the measures to significantly outweigh the costs for the preferred option. The table below shows the monetary values for the main components of costs and benefits[9].

Table 2: Present value costs and benefits of Option 2 (£m, discounted)

	Low scenario	High scenario	Central scenario
Costs fuel suppliers, households and regulatory body			
Loss in profit *	17.1	11.4	14.3
Monitoring costs*[10]	19.4	12.9	16.1
Administration costs*	12.9	8.6	10.7
Capital costs**	99.3	66.2	82.7
Household costs	-105.8	-105.8	-105.8
Government costs	3.8	0.2	1.4
Total costs	46.6	-6.5	19.5
Benefits from emission reductions			
Air quality pollutants	1,694.6	22,682.2	7,877.8
Net Present Value (NPV)	**1,647.9**	**22,688.7**	**7,858.3**

Source: Defra estimates
* Direct Business costs
** Direct Business costs - Wood businesses only

[8] However, a significant share of profit losses from reduced activities in coal sales may be recovered through increased sales of alternatives to coal as demand increases.

[9] The detailed description of these components are provided in the core of the document.

[10] Monitoring costs are the costs incurred by the regulatory body in monitoring fuel manufacturers to ensure that they comply with the proposed regulation. These costs will be passed to fuel manufacturers in the form of registration and fuel testing charges.

2. Problem under consideration

26. Many everyday activities essential for supporting lives and livelihoods can cause air pollution. Particulate matter emitted from the burning of domestic fuels such as wood enters the bloodstream and has been found in internal organs resulting in long term damage to human health as well as having more immediate impacts such as breathing problems or asthma attacks for some people.

27. Domestic burning is the single largest source of harmful $PM_{2.5}$ emissions in the UK. It accounts for approximately 38%[11] of the total emissions in 2016. This compares with industrial processes and road transport which account for 11% and 12% of $PM_{2.5}$ emissions respectively. The growth in domestic burning has been partly driven by an increase in restoration of open fires and installations of wood-burning stoves.[12] Stoves are now an additional form of heating for many households; for a minority they may be the sole heat source. This has inevitably resulted in a significant increase in the amount of wood burned domestically.

28. While domestic burning and other emissions have reduced significantly since the 1950s, the evidence on the adverse health impacts from air pollution has also grown during that time, showing that even at today's lower levels significant harm can be caused. We also have a better understanding of how pollution travels through the atmosphere and the negative externalities from air pollution. However, the awareness amongst burners of the impact upon health or indeed actions that can be taken to reduce this impact remains very low. It is important from a consumer protection perspective for Government to take action where necessary as well as educate the public on the harmful effects of burning solid fuels in the home and how they can minimise them.

3. Rationale for intervention

29. Air pollution is a classic negative externality. It imposes costs on people who are external to the transaction (in this instance the sale and purchasing of fuel). Without government intervention the market will not correct for the costs incurred by third parties from the purchasing and burning of fuels which are highly polluting. Regulating the sale of these fuels has health benefits for those households burning these fuels as well as for the communities in which they live. The proposed regulation would be implemented in conjunction with an information campaign to raise awareness of the health impacts associated with burning solid fuels. At present, labelling on solid fuels is confusing making it difficult for consumers to assess which fuels are less polluting and more efficient.

30. In our recently published Clean Air Strategy, the Government committed to phasing out the most polluting fuels from domestic combustion in England, the proposed regulation takes forward this commitment. The restrictions will deliver on Defra's wider objective for a cleaner, healthier environment, benefiting people and the economy. These will contribute to government achieving its 2030 NECD emission reduction commitments to reduce emissions of five key pollutants including $PM_{2.5}$ and SO_2, with the goal of halving negative health impacts from air pollution. It will also deliver the commitment set out in the Clean Air Strategy to phase out the most polluting fuels from domestic combustion.

31. Feedback from fuel retailers as part of the consultation indicated they have limited capacity to engage with another voluntary initiative, emphasizing that a regulatory approach is required to deliver a level playing field and the required change at scale. Large wood suppliers have also indicated a preference for legislation to deliver the speed and scale of change needed. The

[11] 38% is based upon the calculations in the National Atmospheric Emissions Inventory for 2016, which is the data used for the Clean Air Strategy. This data is uncertain given the difficulties in accurately estimating the extent and nature of domestic burning, evidence and is informed by a wide range of data sources, including data from BEIS and the stove and wood fuel industries. Of the total $PM_{2.5}$ emissions, approximately 36% arose from domestic wood. http://naei.beis.gov.uk/data/

[12] The Stove Industry Alliance have informed us that stove sales increased from around 130,000 in 2004 to 180,000 in 2014., whilst this doesn't capture the entire market it does capture a sense of the scale of the increase. This has plateaued from 2014 but remains in the order of 100,000s.

proposed measures should aid the monitoring and enforcement of smoke control areas (SCAs). The Clean Air Act 1993 gave local authorities (LAs) the power to declare SCAs where it is illegal to emit smoke emissions from domestic or industrial chimneys unless you are burning authorised fuels or using exempt appliances. It also regulates the sulphur content of manufactured solid fuels which can be burned in smoke control areas to 2% sulphur. This legislation was designed in the 1950s when most fuel was delivered by coal merchants, restricting what fuels could be delivered to addresses within SCAs. While this worked well at the time, the domestic fuel landscape has changed since then and today most fuel is purchased through shops, rather than delivered making the law in relation to SCAs less effective than it once was.

32. To address this, we are also considering how the Clean Air Act could be amended to make it more effective and easier to enforce. Together with the proposed fuels legislation, education and training, this will provide a coherent package of actions to reduce the health and air quality impacts from domestic burning.

33. In regulating the sale of traditional coal, the Government will need to make sure that consumers do not switch to another low-cost polluting fuel, such as high sulphur solid smokeless fuels or wet or waste wood. To mitigate this risk, Government is proposing to apply sulphur standards to manufactured solid fuels. This intervention will protect consumers from purchasing fuels that are harmful to both their health as well as their stoves and chimneys. We are also proposing to apply a transition period for sales of loose coal of 2 years from the introduction of the legislation. This will give the market and businesses time to adjust, enabling coal merchants to work with their long-established customers who buy in large volumes and are most likely to be impacted by the legislation; helping to ensure they switch to cleaner alternatives.

4. Policy objectives

34. The overarching policy objective of the proposed regulation is to deliver health benefits by reducing emissions of pollutants produced from burning of solid fuels for domestic heating purposes. The Government seeks to regulate the sale of smaller quantities of wood (more likely to be used immediately, and consequently burnt wet) i.e. wood sold in bags of less than 2 metres cubed. This seeks to ensure that people are not inadvertently burning wet wood while also allowing scope for consumers who have the capacity to purchase wet wood and dry it to continue to do so. The Government will also phase out the sale of bituminous coal and apply sulphur standards to all manufactured solid fuels. Evidence from a similar approach in Ireland on coal (but not wood) found that the restrictions on bituminous coal led to a significant reduction in respiratory problems and premature deaths from the effects of burning smoky coal in the existing 'Low Smoke Zones'. The restrictions in Dublin are widely cited as a successful policy intervention. It is estimated that around 8,000 premature mortalities have been averted in Dublin since the introduction of the smoky coal ban in 1990[13]. A study[14] shows that there was a decline in winter all age mortality by 1.25%, which equates to 1,923 lives saved per winter month in the USA after the reduction of domestic coal use. Another one[15] found areas that had previous higher domestic consumption of coal now have raised mortality levels including cardiovascular and respiratory diseases and certain cancers. The study shows that the correlations are strong, statistically significant and independent of all other dependent variables.

35. At present, many consumers are unaware of the impact on both their health (and of their neighbours') from burning these fuels. As set out in the Government's Clean Growth Strategy, our long-term aim is to phase out high carbon fossil fuels in homes off the gas grid during the 2020s. This policy will help transition towards that goal. Table 3 sets out the main solid fuels burned in homes and their estimated corresponding PM2.5 emissions in grams per tonne of fuel consumed.

[13] https://www.dccae.gov.ie/en-ie/environment/topics/air-quality/smoky-coal-ban/Pages/default.aspx

[14] Barreca, A., Clay, K. and Tarr, J. (2014). 'Coal, smoke, and death: bituminous coal and American home heating', Working Paper No. 19881, NBER

[15] Phillips DIW, Osmond C, Southall H, et al Evaluating the long-term consequences of air pollution in early life: geographical correlations between coal consumption in 1951/1952 and current mortality in England and Wales. BMJ Open 2018;8:e018231. doi: 10.1136/bmjopen-2017-018231

Table 3: The main solid fuels burned in the home and corresponding emission factors

Fuel	Description	$PM_{2.5}$ emissions in grams per tonne of fuel consumed[16]
House coal (or bituminous coal)	A naturally occurring mined product. $PM_{2.5}$ emissions are higher per unit energy than from smokeless fuels.	8.69
Smokeless coal (or anthracite)	A form of naturally occurring, mined, high-purity coal, authorised for use in smoke control areas	1.76
Manufactured solid fuels	Fuels manufactured from coal products with other ingredients that have low smoke emissions, however some do have high SO_2 emissions	1.60
Wet wood	A naturally occurring product. Newly felled wood has a high moisture content and creates a lot of smoke when burned, it has over double the emissions of seasoned or kiln dried wood. For our analysis, we assumed 30% moisture content wood.	28.87
Seasoned wood	Wood that has been left for up to 2 years to naturally air dry	7.21
Kiln dried wood	Wood that has been kiln dried to below 20% moisture	

Source: NAEI

Note: *significant uncertainty around these figures although they represent current best evidence*

5. Policy options considered

36. This section reviews all the policy options that have been considered and explains the rationale for selecting the most viable options for a full cost-benefit analysis. The policy development process has drawn on advice from industry representatives and wider stakeholders through a Call for Evidence and consultation undertaken in the second half of 2018. As air quality is devolved, the proposed measures are for England only. This is likely to mean that implementation of the regulation in the localities in England that border Scotland or Wales may be weaker if there is asymmetry in regulation between the home countries.

Option 0 (Baseline): Do nothing more.

37. The baseline option maintains the existing Ready to Burn voluntary approach with industry on wood to shift consumers away from burning wet wood to dry wood. There is no regulation on the sale of any fuels or government action to promote the sale of cleaner fuels.

Option 1: A voluntary approach promoting the sale of cleaner fuels

38. This option maintains the Ready to Burn scheme. In addition, government promotes the burning of cleaner fuels through a publicity campaign to deliver maximum behaviour change and engages with

[16] Source for all emission factors, except wet wood: EMEP/EEA air pollutant emission inventory guidebook 2016. Source for wet wood: preliminary study carried out by the University of Leeds and the University of Manchester.

retailers and fuel suppliers to consider a similar voluntary code on coal and high sulphur smokeless fuels to reduce their consumption.

Option 2: Regulating the sale of the most polluting fuels for domestic heating.

39. Option 2 considers the impact of restricting the sale, distribution and marketing of wet wood (sold in bags of $2m^3$ or less) and bituminous coal (sold in any volume) alongside an information campaign to raise public awareness of the health and environmental impacts of burning these fuels. Under this option, the Government also regulates the sale of high sulphur manufactured solid fuels to ensure consumers do not switch from coal to another equally harmful fuel. The proposed regulation will apply to fuel manufacturers. Regarding wood, the legislation will introduce a requirement for all suppliers of wood fuel sold in volumes under 2m3 to demonstrate that the fuel meets the required moisture levels, with a view to suppliers becoming members of the existing Ready to Burn certification scheme. For manufactured solid fuels, all suppliers will be required to demonstrate that the fuel meets the required sulphur and smoke emission limits, with a view to suppliers obtaining certification under a system based upon the existing Clean Air Act accreditation scheme. Under this option, retailers are given a transition period of one year to use up existing stocks. In line with feedback from the consultation, Government proposes to give an extra year to small foresters (producers of less than 600 m^3 of wood annually) and an extra 2 years for deliveries of loose coal through direct sales. The purpose of these extensions is to support any small foresters in the transition to selling dry wood or increasing volume of sales and to enable those people who burn high volumes of coal (and rely on this as their primary heating source) to work with their coal merchants to identify a suitable and cost-effective alternative. The proposed regulation is set out below in more detail.

Regulation on wood

- All wood sold for the purpose of domestic combustion in volumes under $2m^3$ must go through a certification scheme or the supplier must demonstrate that the fuel meets the required moisture levels.
- All wet wood sold for the purpose of domestic combustion over $2m^3$ must be sold with relevant advice on how to season the wood to make it suitable as a fuel.
- Small foresters producing 600 m^3 or less per year will be exempt for the first year; it will come into effect for them in 2021.

Regulation on bituminous house coal

- All bituminous house coal will be phased out from sale for domestic heating purposes.
- Direct sales of loose coal will have a longer transition period to 2022 to enable those who currently rely on house coal for their primary heat source to identify a cost-effective alternative.

Manufactured solid manufactured fuels

- All manufactured solid mineral fuels sold will need to be labelled to confirm they contain less than 2% sulphur and have less than 5g/h smoke emissions.
- Suppliers will need to get their products tested to confirm they comply.

Other options considered but not developed.

Regulating the sale and distribution of wet wood and traditional coal in urban areas only

40. Due to the population density, air quality is a bigger concern in urban areas in terms of health impacts and population exposure. For this reason, the benefits of reducing air pollution are higher for measures focused on urban areas than rural areas. This option was considered, but not developed further for a number of reasons:

I. Evidence from Ireland, where a coal ban had been previously implemented solely in urban areas, indicated there were significant problems with compliance. Consumers in urban areas were travelling to rural areas to purchase coal, weakening the impact of the legislation.

II. Particulate matter is transboundary and as such rural emissions can travel to urban areas – approximately 50% of $PM_{2.5}$ pollution is transboundary.

III. Restricting the regulation to urban areas would deliver less air quality benefits across the country and would make it harder to enforce the legislation.

41. In addition, a number of respondents to our Call for Evidence and consultation highlighted that nuisance burning is not just an urban issue and were supportive of nationwide measures.

Utilising existing legislation on smoke control areas

42. Government is in the process of revising and updating the current legislation on SCAs under the Clean Air Act 1993 to deliver better outcomes and ensure that it is easier to enforce.

43. It was considered whether this would be sufficient alone to address concerns on solid fuel burning and whether any action on fuels could be incorporated into these changes. It was concluded that, for the reasons set out above a nationwide approach on fuels was most appropriate to give a level playing field and deliver the best air quality outcomes. It was also concluded that secondary legislation would provide the most appropriate vehicle.

Taxation

44. We also considered tax as an alternative option to the proposed restrictions. Given the substantial health benefits from the proposed regulation, and the ease of substitution between highly polluting and less polluting fuels of the same type, it was felt that tax as a mechanism to incentivise the consumption of cleaner fuels would not deliver the abatement in pollution from burning domestic fuels necessary for the Government to meet it air quality obligations.

Stove scrappage scheme

45. Government also considered a stove scrappage scheme. Whilst such a scheme could deliver reductions in emissions, and therefore benefits as compared with open fires or old stoves, the cost of replacing stoves is in excess of £2,000 per household. This would make the cost of a scrappage scheme significantly higher than taking action on fuels. Additionally, the scrappage payment scheme implemented in Denmark in 2015 was found to be ineffective and poor value for the tax payer[17]. Government will include the benefits of upgrading appliances in its communications campaign.

Evaluation

46. The effectiveness of Option 2 will be evaluated through a series of channels and reviewed after five years. The policy will require proof of conformity to the legislation, such as certification of both firewood and manufactured solid fuel, as well as auditing of retailer compliance. This will produce useful data for evaluation: the number of certifications (for both firewood and manufactured solid fuels) applied for and approved, the volume of certified wood entering the market, the number of

[17] Danish Ecological Council (2016) Pollution From Residential Burning. Available from: https://www.clean-heat.eu/en/actions/info-material/download/danish-case-study-uk-11.html

audit checks, passes, and failures, as well as remedial actions taken to show measurement of compliance. The trends of certified wood produced and business size will also be reviewed.

47. We will also seek voluntary agreements with registered coal merchants and local authorities to gather information on consumers switching fuels in different regions and the number of enforcement actions taken on non-compliance. This information will be reviewed in the context of qualitative feedback from industry.

6. Methodology and cost/benefit impacts

48. The following section sets out the methodology used to assess the impacts of implementing legislation on the sale of wet wood and bituminous coal. The impacts are split into the categories which are set out in the remainder of this section. We assess the impact of the proposed legislation over 11 years commencing from 2020 when the regulation is intended to come into effect and the first costs related to it incurred. The benefits are estimated over the same period although they would last beyond that. The impacts are assessed based on information collected through discussions with stakeholders and from the Call for Evidence and public consultation held in 2018. The following impacts are considered.

Household costs

49. Household costs will be incurred by households switching away from high sulphur manufactured solid fuels to low sulphur manufactured fuels. However, they will be outweighed by the savings made from households who burn wet wood and traditional bituminous coal, switching to dry wood and low sulphur manufactured solid fuel respectively. The costs are estimated using the adjustment in volumes due to difference in energy density and the retail prices of the fuels. Based on responses from the Call for Evidence and the consultation, Defra commissioned research on the cost of relative energy densities for domestic fuels and we find dry wood to be 17% cheaper on an energy adjusted basis than wet wood based on current market prices. By comparison manufactured solid fuels are found to be 6% cheaper to burn on an energy adjusted basis relative to traditional coal. This new evidence is reflected in the analysis and will be published soon. Table 4 sets out the retail prices for the two sets of fuels.

Table 4: Retail prices for the fuels under consideration.

	Wet wood	Dry Wood
Retail price (£/tonne)	£226	£367
	Coal	Low sulphur manufactured fuel
Retail price (£/tonne)	£277	£383
	High sulphur manufactured fuel	Low sulphur manufactured fuel
Retail price (£/tonne)	£338	£383

Source: Defra estimates based on industry data from Call for evidence

50. We believe that there are two reasons why people are not currently adopting the most efficient fuels. First, there is a large difference in the retail face-value price between the cheaper and the more efficient fuels. Second, energy usage is often characterised by choice inertia in which households continue to use the same fuels they are used to consuming despite more efficient alternatives being available. We expect this policy will drive households to make more efficient choices by changing behaviours.

51. To estimate the impact of the proposed measures on households we assume:

    I. All consumers who comply with the regulation substitute to the direct cleaner alternative solid fuel and not to other fuels e.g. electricity or gas. Sensitivity analysis (cf. Annex 2 part 1) has been carried out to test the impact of this assumption as some respondents to the consultation did not feel there would be a clear switch.

    II. Full compliance with the regulation for coal is assumed given the limited number of fuel suppliers. A lower compliance rate of 40% in 2020 rising to 50% in 2021, 60% by 2022 and 70% by 2026 for wood is used for the analysis. Less than full compliance is assumed to reflect:

        a. Flexibility in the design of the regulation which is intended to allow consumers who wish to buy wet wood in large volumes and dry it before it is burned to do so.
        b. A large number of small retailers which makes the regulation harder to fully enforce.

    III. All consumers take into consideration the energy density of the fuel purchased and their appliance energy efficiency and, as a consequence, adjust the volume of fuel they purchase to maintain the same energy output as before the implementation of the legislation. Sensitivities around how well consumers adapt their behaviour, based on energy efficiencies and resulting net present values outcomes, are presented in Annex 2 (part 2).

    IV. All consumers who used to purchase wet wood in small quantities (below $2m^3$) before the legislation is implemented and decide to continue purchasing wet wood in volumes higher than $2m^3$ after the legislation will dry it before burning. This assumption is based on consultation responses indicating that nearly 70% of business respondents would be able to adapt to the legislation and dry the wood before selling it, reducing the supply of wet wood and opportunity to purchase it. In addition, it is anticipated that consumers who still wish to purchase wet wood in large quantities would have to store it before usage and are likely to do so in a dry space.

52. The assumed rise in compliance is due to commitments in the Government's Clean Air Strategy to launch a dedicated communications campaign with the aim of increasing public awareness on the health and environmental costs of burning wet wood. Varying the assumed compliance rate has drastic effects on the output, so we performed a break-even analysis estimating the level of compliance that would result in the net present value of the costs and benefits associated with the wet wood ban to be zero. We found that the yearly non-compliance rate would need to be 98%, which cannot be realistically expected. Further sensitivities are reported in the risks and assumptions section.

53. Based on this we estimate the net savings to households switching between the assorted fuels to be approximately £105 million in present value terms. This total net saving for households consists of a saving of: £111 million for households shifting from wet to dry wood; £19 million for those shifting from coal to low sulphur manufactured solid fuel; and an extra cost of £24 million for households shifting from high sulphur to low sulphur manufactured solid fuel.

54. Only households currently using high sulphur manufactured solid fuel are anticipated to incur a financial cost due to this legislation. Based on industry estimates of an average consumption of 3.5 tonnes per household, it is estimated that an approximate 12,500 households on average may be affected over the 2020-2030 period, each experiencing an average cost of £170 per annum.

55. However, it is likely that not all consumers will fully take into consideration the change of the energy efficiency of their consumption and immediately adjust the volume of fuel they purchase to maintain the same energy output as before the implementation of the legislation. It is expected that adjustment will take place progressively. In Annex 2 (part 2), a sensitivity analysis is conducted with

adjustments rate tested from 0% to 100%. We found that households benefit financially even if they adapt partially, with the breakeven point at 67%[18].

Monitoring and compliance costs

56. Monitoring and compliance costs are incurred by the regulator in enforcing the regulation. It is the cost of regular inspections and testing of fuels to ensure fuels sold on the market are compliant with the required standards. These costs are passed onto fuel manufacturers through fuel testing charges and annual registration fees to ensure that the monitoring scheme is sustainable.

57. We estimate the monitoring and compliance costs based on the Ready to Burn scheme, a voluntary industry scheme operated by Woodsure and supported by the Government that promotes the sale of dry wood. The intention under the legislation is that this scheme would become mandatory for all suppliers of wood in volumes under $2m^3$ to demonstrate compliance. Woodsure have provided Defra with data and information on their fee structure, the scheme's operational costs and the likely size of the market. We assume the charging structures remain unchanged with a similar scheme expanded as a result of the legislation. However, the monitoring and compliance costs are increased and decreased by 20% in the low and high scenarios respectively to reflect the possibility that there may be a variability in costs.

58. We estimate the associated monitoring and compliance costs for the proposed restrictions on wood to range from £16.9 million in the low scenario to £11.3 million in the high scenario in present value terms over the 11-year assessment period. The monitoring costs associated with regulating the sale of traditional bituminous coal are estimated to range from approximately £2.5 million in present value terms in the low scenario to £1.6 million in the high scenario for the preferred option over the period. The low and high scenarios reflect a +/- 20% adjustment from the central scenario should these costs turn out to be higher than has been reported. Table 6 sets out the estimated central monitoring and compliance costs associated with the restrictions on the sale of wet wood and traditional house coal under our preferred option in present value terms. The monitoring costs for coal industry are lower reflecting the smaller number of suppliers and distributors that would need to be regulated.

Table 6: Present value for monitoring costs for regulating the sale of wet wood and traditional coal (central scenario); £ millions

Fuel	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Wood	1.24	1.49	1.44	1.39	1.35	1.30	1.26	1.21	1.17	1.13	1.10
Coal +MSF	0.12	0.12	0.23	0.22	0.22	0.21	0.20	0.19	0.19	0.18	0.18

Source: Defra estimates based on the Ready to Burn scheme

Administrative costs

59. Administrative costs are incurred by the fuel manufacturers as part of the inspection. They typically represent the cost of the time spent by the manufacturer's quality control manager with the regulatory body assessing the fuel production and quality control records – including analysing the fuel mix and its content. These costs will be incurred by all manufacturers that sell wood or manufactured solid fuel for domestic heating purposes. Based on discussions with industry, it is assumed a fuel manufacturers' quality control manager would be required to spend a day and half each year in preparing for and participating in the inspection. This would be at a cost of £288 assuming an annual salary of £50,000 per annum for a quality control manager. We estimate the administrative and familiarisation costs to businesses (£288 * the number of businesses (3,702))[19] as a result of the proposed regulation on the sale of wet wood to range from £11.7 million in the low

[18] Households that reduce their usage of fuel by 67% of the total volume they should have reduced to maintain constant energy output will not see on average any change in their energy spending. However, they will benefit from higher energy output.

[19] Estimate provided by industry body.

scenario to £7.8 million in the high scenario in present value terms over the period 2020 to 2030. The estimates for bituminous traditional coal are £1.2 million in the low scenario and £0.8 million in the high scenario. Table 7 reports the yearly administrative costs in the central scenario arising from the proposed regulation.

Table 7: Present value for Administration costs related to regulating the sale of wet wood and coal (central scenario); £ millions

Fuel	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Wood	0.85	1.03	1.00	0.96	0.93	0.90	0.87	0.84	0.81	0.78	0.76
Coal + MSF	0.06	0.06	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08

Source: Defra estimates based on the Ready to Burn scheme

60. Suppliers and retailers selling wood in volumes over 2m^3 will be required to provide advice at point of sale to ensure that consumers are aware that the wood will require further seasoning before use. Information on how and for how long the wood should be stored prior to burning will also be required, Government has already issued guidance on storage and seasoning[20] which may be used by businesses to meet this requirement. We will not require business to print and distribute a leaflet, but some may choose to do so. Government has assessed the cost implications to businesses of this advice and concluded that they will incur little or no cost as a result of this advice requirement. This opinion has been confirmed by Woodsure based on their existing experience with the Ready to Burn Scheme. This is based upon the fact that relevant guidance is already available for suppliers and retailers to use both from Woodsure and Government. The requirement of the legislation will require an update to a consignment note and the provision of readily available information. We will not require business to print and distribute a leaflet although some may choose to do so.

Capital and operating costs (wood business)

61. **Capital costs**: Some wood suppliers will need to invest in drying kilns or covered space to season wood in order to comply with the proposed legislation. Based on discussions with stakeholders a kiln and the supporting fuel infrastructure are believed to cost between £70,000 and £80,000 for a drying capacity of over 1,800 tonnes of wet wood per year. The **operating costs** (labour, maintenance, insurance and others, boiler feedstock) are estimated at £16 per tonne. Covers to dry wood are estimated to cost £150 per meter squared with a capacity to season three tonnes per year. From an analysis of the consultation responses, we estimate that half of wood businesses that will incur some capital costs to dry their wood will invest in a kiln drier while the other half will invest in construction of covered areas for the processing, storing and seasoning of timber and processed firewood.

62. Based on the most robust sources of evidence available, we estimate that 42% of wood is sold wet. We are using the average from two separate surveys - the BEIS Domestic Wood Use Survey published in 2016[21] showing that 42.2% of wood is sold wet and the Kantar survey on "Burning in UK homes and gardens" commissioned by Defra, showing that 42.6%[22] of wood is sold wet. We are confident in the figures as the findings from the two surveys are also consistent[23] with industry expert views. Following expert advice recommendations, we are treating wood as wet if it has been seasoned for less than one year[24].

[20] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903131256_Seasoning_Wood_Web_Feb_2019_V5.pdf

[21] https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey

[22] The Kantar study on "Burning in UK homes and gardens" is due to be published shortly

[23] It should be noted that the results from these two surveys on the proportion of wood burned wet are also consistent, with a figure of 22.5% for the BEIS survey and of 24.9% for the Kantar survey

[24] "Firewood that has been air dried and stored under cover for at least 12 months (or 2 summers) can be dried down to around 20% moisture content (depending upon species, climate and storage) and may be suitable for burning on the day purchased" - https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903131256_Seasoning_Wood_Web_Feb_2019_V5.pdf

63. There is some uncertainty regarding the size of additional capital investment required to raise existing wood drying capacity to a level that meets the expected demand from consumers following the enactment of the proposed legislation. Based on our consultation and discussions with industry experts, wood producers are likely to respond in one of 4 ways to comply with the legislation for quantities of wood sold wet:
    - Season it using existing spare drying capacity;
    - Scale up and sell only in volumes over 2m3 – potential customers would be both domestic and larger businesses with drying capacity;
    - Build home-made cover storage or drying kiln;
    - Invest in cover space or drying kiln.

64. It should also be noted that the Government anticipates that, initially, there may not be full compliance to the legislation by wood producers due to the flexibility in the design of the regulation and the large number of small retailers which makes the regulation harder to fully enforce. This has been reflected in the analysis[25].

65. While the consultation, as well as insights from discussions with industry experts and the anticipated partial compliance, indicates that a significant share of wood producers will not invest in drying facilities, we are using a very conservative approach in assessing the cost to business in terms of capital investment and operating costs. The calculation of cost to business assumes that all wood[26] sold wet in quantities of 2m3 or more will require to be seasoned under cover space or dried in kiln when the legislation starts and will require investing in cover space and drying kilns.

66. We are incorporating in the analysis the most reasonable level of uncertainty: we have conducted sensitivity analyses around the chosen figure whereby we assess the sensitivity of key variables on cost to business, in particular capital and operating costs for wood businesses, to a range of values:

    - Sensitivity to the proportion of wood burned wet (24%) - see Annex 2 part 3: we used data ranging from 10% to 80% for the proportion of wood burned wet.

    - Sensitivity to the proportion of wood businesses that will require to invest in drying facilities (42%) – see Annex 2 part 4. The central estimate for capital costs is £82.7 million. We performed a sensitivity analysis around the share of businesses that we anticipate will incur some capital costs, ranging from 10% to the maximum of 42%. The sensitivity results show that the capital costs may range from £57.0 to £82.7 million over the 11-year period. Through our engagement with the sector, we are informed wood suppliers who sell less than around 600m^3 of wet wood a year may find it unprofitable to invest in kilns and some may scale up their bag sizes to avoid being caught by the regulation. Suppliers who sell more than 600m^3 of wet wood will find it profitable to invest in kilns or covers.

Loss in profits (coal and wood business)

67. The impact on profits of businesses in the coal, manufactured solid fuel and wood sectors is calculated using estimates of profit margins in the relevant industry[27], change in volume of the fuel sold following the implementation of the legislation and retail prices. The changes in the volume of fuel sold following the policy result from the lower or higher energy efficiency[28] of the alternative fuel used (e.g. shift from wet to dry wood) following the legislation. A sensitivity analysis is conducted to evaluate the impact on business profits of households' behaviour in relation to the adjustment of the

[25] See Annex 2 - Part 6 related to the sensitivity of the results to the level of compliance for wood with the legislation

[26] Small forest businesses will be given an additional year to meet the legislative requirements and are therefore assumed investing in drying facilities only on the second year of the implementation of the legislation.

[27] For profit margin in coal: IBISWorld Industry Report B05.100 Hard Coal Mining in the UK. August 2018
For profit margin in wood: Forestry & Wood Products Industry Profitability Ratios, published by CSIMarket: https://csimarket.com/Industry/industry_Profitability_Ratios.php?ind=105 – accessed on 28 June 2019

[28] The energy output of the various fuels considered is calculated based on the data on energy density and appliances efficiency from a report commissioned by Defra to be published at the same time of this impact assessment.

volume of fuel they purchase to maintain the same energy output as before the implementation of the legislation (cf. Annex 2 part 2).

68. Based on this approach, there will be a loss in profits to the coal industry estimated at £14.7 million as a result of the ban on the sale of traditional bituminous coal. The calculation takes into consideration the 2-year transition period whereby deliveries of loose coal direct sales are allowed. The loss in profits to businesses selling high sulphur manufactured solid fuel is anticipated to reach £18.2 million due to the ban of sales. There will also be a net loss in profits to the wood industry estimated at £15.9 million as a result of the ban on the sale of wet wood. The calculation accounts for the reduction of sales of wood due to the shift by households from wet to dry wood which has a higher energy output and for the 2-year transition period for small foresters. This reduction in profit due to lower volumes sold is partially offset by the higher price of dry wood (cf. Table 4).

69. While loss in profits are anticipated to occur in the coal, wood and high sulphur manufactured solid fuel markets, the increased sales of low sulphur manufactured fuel are expected to generate £34.5 million of additional profits, as coal and high sulphur manufactured solid fuel users shift to this product.

70. The calculation of overall profit loss to all industries involved takes into account the reductions of the volume sold experienced by business following the policy due to the higher energy efficiencies of dry wood and low sulphur MSF when compared to wet wood and coal. Consequently, while dry wood and low sulphur MSF fuels have a higher retail price (table 4), the higher energy content of these fuels reduces the overall quantities sold by industry leading to profit losses in in the coal, wood and high sulphur manufactured solid fuel markets.

71. Over the period, we estimate the total net loss in profits to solid fuel businesses to be approximately £14.3 million in present value terms based on fixed current market prices in the central scenario. The loss in profits is expected to range between £17.1 million in the low scenario taking into consideration a 20% discount and £11.4 million in the high scenario using a 20% mark-up. Coal and high sulphur MSF businesses can recover profit losses through the sale of low sulphur MSF.

Table 8: Loss in profits by industry sector (central scenario) (£m)

£m	Bituminous coal	High sulphur manufactured solid fuel (HSMSF)	Low sulphur manufactured solid fuel (LSMSF)	Wood	**Total, net**
Loss in profits	+14.7	+18.2	-34.5*	+15.9	**+14.3**

Source: Defra estimates based on industry data from Call for evidence
* Increase in profit

72. In this analysis, changes in business profits due to reduced sales of coal and wood and increased sales of low sulphur manufactured fuels are considered as direct costs/benefits to businesses. The regulation restricts economic activity from the coal and high sulphur manufactured solid fuel (total ban) and wet wood (limited ban) sectors and provides direct opportunity for the low sulphur manufactured fuel producers to increase sales as the product represents the next best alternative to coal. We have calculated the net change in profits for facilitating understanding of the impact on businesses.

Costs to business as fuel consumers

73. The purpose of the legislation is for domestic burning only and would not cover other businesses that may burn solid fuels such as pubs/hotels or heritage industry add but they will still be required to abide by any relevant restrictions in their areas such as smoke control area. We acknowledge that the legislation may impact upon the supply of these fuels to businesses despite the fact that the domestic coal market represents less than 5% of national coal demand. This is however already an issue as the national market for coal is currently declining particularly due to the reduced use of coal for electricity generation (56% of the demand in 2018).

74. For pubs/hotels, as there is a readily available more cost-effective alternative, we consider that it would be cost beneficial to them in any event to switch to the alternative fuels. Government intends to work with these businesses to advise on the benefits of cleaner fuels to their customers. A recent survey of local authorities showed that smoke is observed much less often from such chimneys than residential ones in smoke control areas, so this may imply that these businesses are already burning the least smoky fuels.

75. The heritage industry raised concerns at consultation as to whether a ban on the sale of domestic house coal would impact on the cost and availability of supply for this sector. This was set in the context of existing concerns given the phasing out of coal for power generation and declining domestic supply. The All Party Parliamentary Group on Heritage Rail undertook an enquiry. This did not quantify the direct costs to this sector from a ban on the sale of domestic coal but did recommend that a longer transition period be included in government plans. This has been taken into account in our proposals with a longer transition period being given to the phasing out of coal.

Costs to Government and Local Authorities

76. In line with the Government objective to minimise burdens on local authorities, the legislation requires business to demonstrate that their fuel meets the legislation requirements. We aim to progressively lead business to obtain certification guaranteeing that they comply with the legislation which will be enforced in partnership with Local Authority officers at a cost estimated at £1.2 million in present value terms over the 11-yeat period of assessment.

77. For wood the legislation will introduce a requirement for all suppliers of wood fuel sold in volumes under 2m3 to demonstrate that the fuel meets the required moisture levels, with a view to suppliers becoming members of the existing Ready to Burn certification scheme. For manufactured solid fuels, all suppliers will be required to demonstrate that the fuel meets the required sulphur and smoke emission limits, with a view to suppliers obtaining certification under a system based upon the existing Clean Air Act accreditation scheme. In line with the Government objective to minimise burdens on local authorities, the main compliance requirement will be through an industry led certification based on discussions with the Local Government Association.

78. The proposed regulation will also be accompanied by a Government communications campaign to raise awareness of the impacts of burning solid fuels. It is estimated that this would run over 3 years at an approximate cost of £210,000 in present value terms.

7. Health and the environmental benefits

79. The beneficial impacts of the measures are considered in terms of the 'damage avoided' if emissions reductions are achieved. This is calculated in money terms using the damage cost approach. The damage cost approach is part of the official Government 'Green Book: Guidance on Valuing Impacts from Air Quality'. The damage costs predominantly capture the health benefits from reduced emissions. The analysis uses the most recently published damage costs and is consistent with the approach used in support of the government's recently published 'Air quality plan for nitrogen dioxide'.[29] The damage costs values used are standardized to 2017 prices (using GDP deflators) and uplifted by 2% per annum, in line with Green Book guidance. The uplift captures the higher willingness to pay of the population, and therefore value of health benefits as income (economic growth) rises.

80. Three sets of damage costs have been developed for the high, central and low scenarios. The variation reflects different mortality and morbidity impacts being included in the different scenarios. The damage costs are higher in the 'High Range' where the associated health impacts most prominent and consequently benefits assumed to be largest. The monetised benefits are also

[29] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/633270/air-quality-plan-detail.pdf

impacted by the compliance rates assumed i.e. how many people currently burning highly polluting fuels substitute to the cleaner fuels under discussion.

Table 9: Present value benefits from the proposed regulation on the sale of wet wood, coal and HSSMF (central scenario) (£m)

Fuel	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Wood	317.30	572.88	680.54	673.67	722.43	715.11	760.07	750.14	740.35	730.68	721.14
Coal	37.39	32.94	53.84	45.93	38.23	30.74	28.08	25.49	22.97	20.52	18.13
HSMSF	19.12	16.84	14.63	12.48	10.39	8.35	7.63	6.93	6.24	5.57	4.93

Source: Defra estimates

81. **Carbon benefits**: This policy leads globally to carbon saving resulting from lower quantity of wood and MSF needed to achieve the same heat output. The costs/savings are valued using the Green Book guidance and are monetised using BEIS non-traded carbon values. As a result of the proposed regulation, we estimate the carbon saving to be £ 26.9m for Option 2 and £0.24m for Option 1 in present value terms over the appraisal period.

Other non-monetised benefits

82. It is important to note when applying and interpreting damage cost functions, a number of impacts are not taken into account in the quantification; these include impacts on ecosystems e.g. lower acidification and eutrophication of soils (associated with reductions in soil and surface water contamination, reducing acidity) and some morbidity impacts arising from air pollution. The analysis does not monetise the benefits from lower emissions of black carbon. Burning solid fuel is a significant source of black carbon, itself a strong positive climate forcer. Similarly, we have not monetised the benefits arising from a reduction in other pollutants such as NO_X due to uncertainty in their emission factors related to the burning of solid fuels.

Impact of a communications campaign

83. Under both Options 1 and 2, we adjust the baseline to reflect a change in burning habits owing to a Government information campaign. The campaign is intended to raise the public's awareness of the health and environmental impacts of burning solid fuels. Its impact is dependent on the existing level of public awareness of the damage caused by burning polluting fuels. If public awareness is high and consumers still choose to burn polluting fuels, then a communications campaign is unlikely to result in any behavioural change.

84. However, if public awareness is low, there is scope for such a campaign to have an impact. Initial evidence on public awareness as to how harmful burning wet wood/bituminous coal and high sulphur fuels is to human health and the environment suggests that awareness is low. In the absence of robust information, we have conducted an extensive literature review[30] on previous

[30] Maibach, E.W., Roser-Renouf, C. and Leiserowitz, A., 2008. Communication and marketing as climate change–intervention assets: A public health perspective. *American journal of preventive medicine*, *35*(5), pp.488-500.

Weiss, J.A. and Tschirhart, M., 1994. Public information campaigns as policy instruments. *Journal of policy analysis and management*, *13*(1), pp.82-119.

Maibach, E.W., Roser-Renouf, C. and Leiserowitz, A., 2008. Communication and marketing as climate change–intervention assets: A public health perspective. *American journal of preventive medicine*, *35*(5), pp.488-500.

Montague, M., Borland, R. and Sinclair, C., 2001. Slip! Slop! Slap! and SunSmart, 1980-2000: Skin cancer control and 20 years of population-based campaigning. Health Education & Behavior, 28(3), pp.290-305.

communication campaigns and assessed a range of impacts, ranging from little to no impact (0.5% change) to a 2 % change in the total wood consumed as the upper bound. We use 1% reduction a year in the tonnage of wet wood which is purchased and burned wet as the central estimate. We assume those consumers/households who change their consumption habits in response to the campaign do not switch back to consuming highly polluting fuels after the campaign. A recent survey by the Stove Industry Alliance has indicated that 29% of respondents recognised the brand Ready to Burn but as yet quantitative data of the percentage of households who have switched is not available.

Baseline estimates for coal and wood burning activity

Estimated wood baseline and projection

85. The proposed restrictions regulate the sale of wet wood sold in bags of less than $2m^3$. Based on consultation with industry, we estimate a total of 1.8 million tonnes of wood sold in England in 2016, the latest year for which data were available. Based on the BEIS and Kantar survey data[31] and consultation with the industry, 42% of the volume of wood in England was sold wet, of which 80% was sold in bags of two metres cubed or less, corresponding to 610,510 tonnes.

86. Based on the BEIS and Kantar surveys, 24% of the total quantity of wood sold in bags of two metres cubed or less is burned wet, corresponding to 430,792 tonnes. This is the quantity which would have fallen within scope of the proposed legislation in 2016.

87. We project the tonnage of wet wood burned over the 2020-2030 period by applying growth rates from scaling the historic NAEI wood consumption data using a trend drawn from the Energy and Emissions Projections (EEP) 2015 activity data.[32] The NAEI reports annual estimates of pollutants emitted based on the Digest of UK Energy Statistics 2017 (DUKES), produced by (BEIS) and the EEP, which projects future energy use and greenhouse gas emissions in the UK. Based on the NAEI growth rates, we project the total tonnage of wet wood purchased and burned wet for domestic heating purposes to grow from 504,962 tonnes in 2020 to 519,719 tonnes by 2030 in the absence of any Government intervention.

Estimated coal baseline and projection

88. Similar to wood, we rely on consultation evidence from industry to estimate our coal baseline. Using data from industry, we estimate 155,000 tonnes of coal were burned in England for domestic heating purposes in 2017, falling to 92,071 tonnes in 2020. This is a significantly lower estimate than the DUKES (BEIS energy statistics) estimate of 434,208 used in the pre-consultation IA. During consultation, the coal industry advised that they viewed the DUKES figure as an overestimate. We worked with the industry to collate sales data for 2017 and have used these industry figures, as opposed to official BEIS figures. We estimated that this provides a more accurate figure and reduces the risk of overestimating the benefits. The reported tonnage is projected forward to 2030 using a similar methodology to that used to project the wood baseline.

Estimated manufactured solid fuels baseline and projection

89. The baseline for manufactured solid fuels is estimated using evidence taken from consultation with industry. The proposed policy will restrict the sale of high sulphur (more than 2% sulphur content) manufactured solid fuels. We estimate approximately 77,429 tonnes of manufactured solid fuels

Jackson, T. 2005. *Motivating sustainable consumption*. SDRN.

Abrahamse, W., Steg, L., Vlek, C. and Rothengatter, T., 2005. A review of intervention studies aimed at household energy conservation. *Journal of environmental psychology*, *25*(3), pp.273-291.

Steg, L., 2008. Promoting household energy conservation. *Energy policy*, *36*(12), pp.4449-4453.

Prochaska, J.O. and DiClemente, C.C., 1983. Stages and processes of self-change of smoking: toward an integrative model of change. *Journal of consulting and clinical psychology*, *51*(3), p.390.

[31] Sources: BEIS Domestic Wood Use Survey published in 2016 and Kantar survey on "Burning in UK homes and gardens" commissioned by Defra, to be published shortly.

[32] The EEP does not have a specific field for manufactured solid fuel or wood. We have used 'Other Solid Fuel' as a proxy for MSF and 'Biofuels' as a proxy for Wood.

(corresponding to about 30% of manufactured solid fuels) sold in 2020 contained sulphur content above the proposed restriction. The consumption of high sulphur manufactured fuels in the baseline is projected forward to 2030 using a similar methodology to that used to project the tonnages for wood and coal.

90. Under this Option retailers are given a transition period of one year to use up existing stocks. In line with feedback from the consultation, Government proposes to give an extra year to small foresters (producers of less than 600 m^3 of wood annually) and an extra 2 years for deliveries of loose coal direct sales. The purpose of these extensions is to support any small foresters in the transition to selling dry wood or increasing volume of sales and to enable those people who burn high volumes of coal (and rely on this as their primary heating source) to work with their coal merchants to identify a suitable and cost-effective alternative. The proposed regulation is set out below in more detail.

91. Table 10 reports the baseline projected tonnages of wet wood, coal and high sulphur manufactured fuels in the baseline, as well as quantities for Option 1 and Option 2 for the forecast period. The tonnage of wet wood burned is projected to rise while the tonnage of coal burned for domestic heating purposes is projected to decline in line with a fall in the use of coal for energy generation.

Table 10: Projected tonnages (000s) of wet wood, coal and high sulphur manufactured solid fuels burned by households in England 2020 – 2030.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Tonnage projections baseline											
Wood (wet)	504,692	506,957	509,222	511,486	513,751	516,015	516,756	517,497	518,237	518,978	519,719
Coal	92,071	82,311	72,551	62,791	53,032	43,272	40,109	36,946	33,783	30,620	27,457
HSMSF	77,429	69,221	61,013	52,806	44,598	36,390	33,730	31,070	28,410	25,750	23,091
Tonnage projected: Voluntary approach with communications campaign (Option 1)											
Wood (wet)	499,645	501,887	504,129	506,371	508,613	510,855	511,588	512,322	513,055	513,788	514,522
Coal	91,151	81,488	71,826	62,164	52,501	42,839	39,708	36,576	33,445	30,314	27,183
HSMSF	76,655	68,529	60,403	52,278	44,152	36,026	33,393	30,759	28,126	25,493	22,860
Tonnage projected: Regulatory approach with communications campaign (Option 2)											
Wood (wet)	363,379	253,478	203,688	204,594	179,813	180,605	155,027	155,249	155,471	155,693	155,916
Coal	46,036	41,156	-	-	-	-	-	-	-	-	-
HSMSF	-	-	-	-	-	-	-	-	-	-	-

Source: Defra estimates

92. It is worth recalling that under Option 2 a transition period of one year is given to small foresters (producers of less than 600m3 of wood annually) and an extra 2 years for the delivery of loose coal through direct sales. The purpose of these extensions is to support any small foresters in the transition to selling dry wood or increasing volume of sales and to enable those people who burn high volumes of coal (and rely on this as their primary heating source) to work with their coal merchants to identify a suitable and cost-effective alternative. This transition periods impact the projected tonnages of wet wood and coal anticipated to be purchased at the beginning, in particular with the volume of coal used for domestic heating only falling to zero in 2022.

Emission projections

Table 11: Emission projections in kilo tonnes of $PM_{2.5}$ related to a ban on the sale of wet wood and traditional coal.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Emission projections baseline											
Wood	14.57	14.64	14.70	14.77	14.83	14.90	14.92	14.94	14.96	14.98	15.01
Coal	0.80	0.72	0.63	0.55	0.46	0.38	0.35	0.32	0.29	0.27	0.24
Emission projections voluntary approach with communications campaign (Option 1)											
Wood	14.45	14.51	14.57	14.64	14.70	14.77	14.79	14.81	14.83	14.85	14.88
Coal*	0.79	0.71	0.63	0.54	0.46	0.37	0.35	0.32	0.29	0.26	0.24
Emission projections regulatory approach with communications campaign (Option 2)											
Wood	11.09	8.25	7.01	7.04	6.42	6.45	5.81	5.82	5.82	5.83	5.84
Coal*	0.46	0.41	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.04	0.03

Source: Defra estimates
* Including emissions from low sulphur MSF used as alternative to coal

93. We use emission factors to estimate $PM_{2.5}$ emissions emitted from burning wet wood and coal. An emission factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors are applied to fuel burning activity to estimate the emissions emitted from burning these fuels. We use emission factors from the NAEI which are primarily taken from the EMEP/EEA[33] guidebook that contains internationally-agreed upon emission factors for a wide range of activities and pollutants. The guidebook contains emission factors for wood, coal and manufactured solid fuel but not for wet wood. To estimate the emissions from burning wet wood, we use emission factors from a joint study by the University of Leeds and the University of Manchester[34]. The study team burned wood in a representative stove and undertook a wide range of measurements on the emissions. We use their emission factors to estimate emissions from burning wet wood. Table 11 above sets out estimated $PM_{2.5}$ emissions arising from burning purchased wet wood and bituminous coal for domestic heating purposes over the projected period under the different scenarios.

8. Results

Key costs and benefits of implementing legislation on the sale of wet wood and traditional bituminous coal

94. This section details the estimated costs and benefits that are likely to result from restrictions on the sale of wet wood, bituminous coal and low sulphur manufactured solid fuel. The results present analysis for an 11-year assessment period commencing in 2020, when the first costs will be incurred. From 2030 onwards, the impacts are assumed to be similar in the absence of any changes to legislation. A discount rate of 3.5% is used to derive the present value cost and benefit as per Green Book guidance with all costs and benefits reported in 2017 prices. In the remainder of this section, the monetised impacts are outlined in more detail.

[33] EMEP: European Monitoring and Evaluation Programme, a body of the Convention on Long-Range Transboundary Air Pollution. EEA: European Environment Agency, a European Union body.
[34] https://www.sciencedirect.com/science/article/pii/S0016236118319859

Monetised costs to households, business and government

95. As shown in Table 12 below, the proposed regulation is expected to result in savings to households of £84 million over the period. Total costs to business are anticipated to be £55 million. They mainly arise from investments in kilns or covered space for wood producers to dry their wood (£21m) and from monitoring and administrative costs, estimated at £27 million. They also include loss in profit to producers and distributors of wood (£7 million) as consequence to the lower volumes of wood needed by households due to the shift to dry wood with higher energy efficiency.

Table 12: Present value costs (£millions) related to a ban on the sale of wet wood, traditional coal and high sulphur manufactured solid fuels under our preferred option in the central scenario.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Costs to households											
Wood*	-6.14	-9.32	-10.85	-10.53	-11.07	-10.74	-11.19	-10.83	-10.48	-10.14	-9.81
Coal*	-2.03	-1.75	-2.99	-2.50	-2.04	-1.61	-1.44	-1.28	-1.13	-0.99	-0.86
MSF	4.34	3.75	3.19	2.67	2.18	1.72	1.54	1.37	1.21	1.06	0.92
Costs to business											
Wood	34.02	12.70	9.58	9.29	9.00	8.72	8.36	8.08	7.82	7.56	7.31
Coal	0.27	0.25	0.47	0.44	0.41	0.38	0.36	0.34	0.33	0.31	0.30
MSF*[35]	- 0.44	- 0.38	- 0.32	- 0.27	- 0.22	- 0.17	- 0.16	- 0.14	- 0.12	- 0.11	- 0.09

Source: Defra estimates
* Negative figures mean that shift in activities (including fees paid) result in net saving/profit

Monetised benefits to the environment and human health

96. The main benefits that accrue from the proposed regulation on the sale of wet wood and bituminous coal relate to the reduction in air pollutant emissions and in particular $PM_{2.5}$ which can result in higher mortality rates for people with cardiovascular and respiratory diseases. We estimate the proposed regulation on the sale of wet wood and bituminous coal to lower $PM_{2.5}$ emissions in 2020-2030 by 91.5kt in our preferred Option 2, as reported in Table 13 below. This compares to 1.4kt abated in Option 1.

Table 13: Total emission reductions of $PM_{2.5}$ (in kt) of air pollutants from 2020 to 2030 compared to baseline

	Option 1	**Option 2 (preferred option)**
Wood	1.42	87.87
Coal	0.04	3.66
Total	**1.47**	**91.52**

Source: Defra estimates

[35] The shift from high to low sulphur manufactured solid fuels is anticipated to lead to improved profits for businesses due to the higher price and unit profit of low sulphur manufactured solid fuels.

97. The restrictions on the sale of high sulphur manufactured fuels in Option 2 are estimated to abate 24.9kt of SOx emissions (in addition to the abatement of 6.6kt originating from the coal ban) but do not yield reductions in $PM_{2.5}$ emissions.

98. Table 14 sets out the combined indicative annual benefits related to regulation on the sale of wet wood and bituminous traditional coal, as well as restrictions on the sale of high sulphur manufactured fuel. The benefits are estimated by applying the damage cost functions to the reduction in emissions. Not surprisingly, the largest benefits arise from the restrictions on the sale of wet wood.

Table 14: Year-on-year breakdown of $PM_{2.5}$ and SOx emissions benefits (£m, 2017 prices, discounted) central damage cost values

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Option 1											
Wood	12.12	11.46	11.34	11.23	11.11	11.00	10.86	10.72	10.58	10.44	10.30
Coal	0.70	0.62	0.54	0.46	0.38	0.31	0.28	0.25	0.23	0.21	0.18
HSMSF	0.19	0.22	0.19	0.16	0.13	0.11	0.10	0.09	0.08	0.07	0.06
Option 2											
Wood	317.30	572.88	680.54	673.67	722.43	715.11	760.07	750.14	740.35	730.68	721.14
Coal	37.39	32.94	53.84	45.93	38.23	30.74	28.08	25.49	22.97	20.52	18.13
HSMSF	19.12	16.84	14.63	12.48	10.39	8.35	7.63	6.93	6.24	5.57	4.93

Source: Defra estimates

99. Under Option 2 a transition period of one year is given to small foresters (producers of less than 600m3 of wood annually) and an extra 2 years for the delivery of loose coal through direct sales. This transition periods lower the projected benefits from the reduction of emissions from wet wood and coal during the transition periods.

100. The damage costs used are a key sensitivity in the analysis. The main driver behind the differences in the figures presented in Table 15 is the differences in valuing human health in the damage cost calculations, where the high and low damage costs represent the uncertainty around the central range. The sensitivity in damage costs captures the uncertainty surrounding the valuation of health benefits for a given level of emission reductions. It should be noted that in all three scenarios the level of emissions reduction does not change but the damage cost applies changes.

Table 15: Present Value of environment and human health benefits (2020 – 2030); legislation on the sale of wet wood and bituminous coal (Option 2) – in £m

Sensitivity			Best estimate
Pollutant	Low damage costs	High damage costs	Central
Wood $PM_{2.5}$ and SO_2	1,564	21,314	7,384
Coal and LSMSF $PM_{2.5}$ and SO_2	76	1,021	354
HSMSF SO_2	27	322	113
GHG	27	27	27
Total (£m)	**1,694.6**	**22,682.2**	**7,877.8**

Source: Defra estimates using published damage costs

101. Both wood and coal smoke are known to emit other toxins as well as $PM_{2.5}$. A range of academic studies and monographs have demonstrated a strong correlation between the chemicals released through burning coal and increasing mortality from a wide variety of diseases, including cancer. It has not been possible to quantify these costs within this impact assessment and as such the above estimates may be an underestimate.

Greenhouse gas monetised benefits

102. Carbon dioxide (CO_2) contributes to climate change, so any actions that can be done to help reduce the amount of CO_2 in the atmosphere can help to tackle climate change. Burning fossil fuels such as coal, gas and oil releases their stored carbon into the air as CO_2. By contrast harvested wood for bioenergy is accounted as carbon neutral, with the CO_2 absorbed as young trees grow compensating for that released by burning. Manufactured solid fuels emit higher CO_2 emissions than bituminous coal. However, when considered on an energy density basis there is a reduction in CO_2 emissions. The reduction in coal consumption should also reduce black carbon which has well known climate effects but is not assigned a CO2e value and as such is not quantified in this impact assessment.

Table 16: Total CO2e emission decrease by 2030 (kT), non-traded:

Fuel	CO_2e emission decrease (kt) Option 1	CO_2e emission decrease (kt) Option 2
Coal	0.90	76.2
Wood	3.86	353.8
Total	**4.76**	**430.0**

Source: Defra estimates using BEIS guidance

Progress towards UK's legally binding air pollution reduction commitments

103. The UK is required to reduce overall emissions of certain pollutants under the National Emissions Ceilings Directive which has been transposed into UK law. For $PM_{2.5}$ the UK is required to reduce its emissions in 2030 by 46% (69kt) from 2005 levels. Table 17 reports the contribution of the proposed regulation towards these targets. Our emission projections show that without further intervention, we are expected to miss our 2030 emission reduction commitment for $PM_{2.5}$ by 31kt.[36] Option 1 delivers reductions of 0.1 kt of $PM_{2.5}$ emissions in the year 2030. Option 2 delivers 7.5kt of $PM_{2.5}$ reductions in the same year. Other measures beyond this proposed policy will therefore be required to achieve the 2030 emissions reduction commitments.

Table 17: Projected emissions reductions from the baseline in 2030

	Option 1 $PM_{2.5}$ (kt)	Option 2 (preferred) $PM_{2.5}$ (kt)	Projected gap between baseline and NECD $PM_{2.5}$ emission reduction commitments for 2030
Wood	0.13	9.17	
Coal	0.00	0.21	
Total	0.13	9.37	30.70[37]

Source: Defra estimates based on NAEI

[36] For further information, see the UK Informative Inventory Report (1990 to 2016): https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1803161032_GB_IIR_2018_v1.2.pdf

[37] This is the amount by which we are projected to miss our 2030 emission reduction commitment without further intervention.

Summary of the results

104. In all three scenarios the benefits of the preferred option are assessed to outweigh the costs for the measure related to restrictions on the sale of wet wood and coal.

Table 18: Present value benefits and costs of restrictions on the sale of wet wood and coal over an 11-year period (2020 – 2030 in 2017 prices, £ millions) for Option 2

	Low scenario	High scenario	Central scenario
Costs fuel suppliers, households and regulatory body			
Loss in profit *	17.1	11.4	14.3
Monitoring costs*[38]	19.4	12.9	16.1
Administration costs*	12.9	8.6	10.7
Capital costs**	99.3	66.2	82.7
Household costs	-105.8	-105.8	-105.8
Government costs	3.8	0.2	1.4
Total costs	46.6	-6.5	19.5
Benefits from emission reductions			
Air quality pollutants	1,694.6	22,682.2	7,877.8
Net Present Value (NPV)	**1,647.9**	**22,688.7**	**7,858.3**

Source: Defra estimates
* Direct business costs
** For wood sellers only

9. Risks, assumptions and uncertainties

105. There is significant uncertainty in the data on which the analysis for this impact assessment relies. To minimise this uncertainty as much as possible, we have used a wide variety of data sources and issued a Call for Evidence as well as consulted on the proposed legislation. Whilst the majority of responses to the Call for Evidence were qualitative, we did receive some further quantitative evidence to validate our analysis. In addition, we have an extensive survey underway to build stronger evidence of the level of domestic burning. This research is complete and is currently being quality assured so has been used to validate or change our assumptions. The key uncertainties are set out below. Where there is variation between different estimates, in most cases we have based our analysis on the more methodologically conservative estimate to ensure that this IA does not overestimate the potential benefits.

- **Proportion of wood burned wet**: The proposed regulation on the sale of wet wood restricts its sale in bags smaller than 2m^3. The regulation is designed to tackle the sale of wet wood in small bags which is likely to be burned wet while still allowing space for consumers who may wish to buy wood wet and dry it before burning it. To estimate the impacts, we have assumed that 80% of all wood is sold in bags of two metres cubed or less of which 24% is burned wet.

  Our estimate of 24% of wood burned wet is based on the most robust sources of evidence available. We are using the average of the data from the BEIS Domestic Wood Use Survey published in 2016[39] showing that 22.5% of wood is burned wet and from the Kantar survey on "Burning in UK homes and gardens" commissioned by Defra and to be published shortly, showing that 24.9% of wood is burned wet. The findings from the BEIS survey is consistent with those from the Kantar survey[40]. We are counting as wet wood all wood seasoned for less than

[38] Monitoring costs are the costs incurred by the regulatory body in monitoring fuel manufacturers to ensure that they comply with the proposed regulation. These costs will be passed to fuel manufacturers in the form of registration and fuel testing charges.
[39] https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey
40 It should be noted that the results from these two surveys on the proportion of wood bought wet are also consistent, with a figure of 42.2% for the BEIS survey and of 42.6% for the Kantar survey (taking into consideration only responses from individuals who knew if the wood they purchased was wet or seasoned)

one year as expert advice recommends[41] to season wood for at least one year. Our approach to estimate the proportion of wood burned wet was validated by the Forestry Commission.

We are incorporating in the analysis the most reasonable level of uncertainty: we have conducted a sensitivity analysis (see Annex 2 part 3) around the chosen figure whereby we assess the sensitivity of key variables such as cost to business and total benefit to a range of values (10% to 80%) for the proportion of wood burnt wet. The higher level of 80% was included as one respondent from the consultation was of the opinion that the proportion of wood burned wet to be up to 80%. There is no evidence to support this particular view but we have however included this level in our sensitivity analysis.

We have also conducted a sensitivity analysis to assess the impact of the assumed level of wood sold in sold in bags of two metres cubed or less. The assumed proportion of 80% was derived from consultation with the industry. The sensitivity analysis provides a reasonable range of 60 to 100%. The results can be found in Annex 2 part 5.

- **Fuel heat consumption ratio / conversion factor:** The analysis takes into account energy densities of different fuels when estimating the quantities of wood and low sulphur MSF consumed following the ban. The higher energy densities of dry wood and low sulphur MSF when compared to wet wood and coal, respectively, implies that less of the more efficient fuel will need to be consumed by households to achieve the same heat output. This in turn leads to households experiencing a net saving following the policy while businesses experiencing a net loss. The conversion factor assumed when comparing fuels of different energy efficiencies is therefore a key input in the analysis. We base our conversion factor on a Defra commissioned study assessing the heat output of six different fuels on three different appliances, which will be published in conjuncture with this impact assessment. The assumed conversion factors are presented in Table 19. It is possible that households will not respond fully to the increase in energy content of their chosen fuels following the introduction of the policy and continue to use the same quantities of fuel as previously, possibly due to choice inertia or lack of knowledge. To address this risk, we have performed extensive sensitivity analysis around this input in Annex 2 (part 2). It presents the cost and benefit breakdown at various levels of response by households. 100% uptake is our central scenario and implies that households realise all of the quantity reductions available due to higher heat content of low emissions alternatives, if they keep the overall energy output the same. 0% uptake implies that households continue to use exactly the same quantity of fuel as they previously have, producing overall higher energy output, and consequently not realising the available savings.

Table 19: Fuel heat consumption ratio

	Wet wood	Dry Wood	Coal	Low Sulphur MSF	High sulphur MSF
Fuel heat consumption ratio	1	1.96	1	1.47	1.47

Source: Defra estimates based on a commissioned study[42]

- **Volumes of wood sold**: we estimate the volume of wood sold in England by scaling estimates of the total amount of wood sold in the UK for which there is data. Estimates of wood sold in the UK are highly variable. The official Government estimate relies on the 2016[43] BEIS domestic

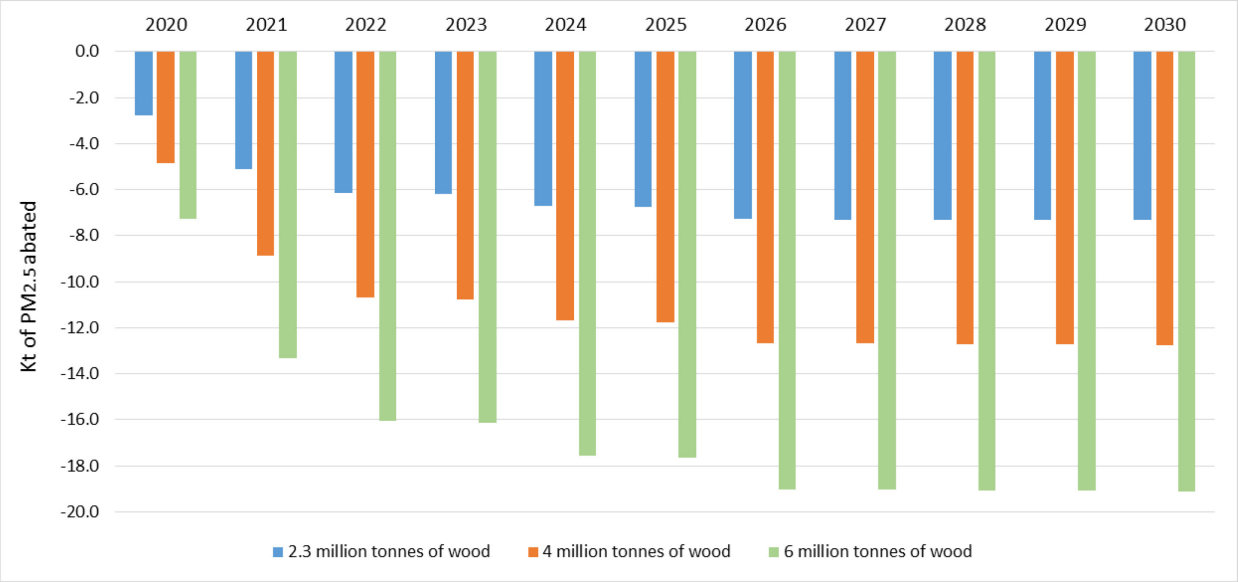
[41] "Firewood that has been air dried and stored under cover for at least 12 months (or 2 summers) can be dried down to around 20% moisture content (depending upon species, climate and storage) and may be suitable for burning on the day purchased" - https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903131256_Seasoning_Wood_Web_Feb_2019_V5.pdf

[42] The moisture content for kiln dry wood and for wet wood used in this analysis are 15% and 30%, respectively. The moisture content in a typical wet wood log is likely to be higher than 30%, in some cases substantially higher, implying that the analysis is likely to systematically underestimate and be 'on the safe side' of the benefits to households and of the policy overall.

[43] https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey

wood survey which estimates 6 million tonnes of wood is sold in the UK in 2015. This estimate is viewed with scepticism in the wood industry. Commercial stakeholders in the wood industry and the Forestry Commission estimate approximately 2.3 million tonnes of wood is sold in the UK each year. We use the industry estimate for our analysis. It is possible that the true volume of wood sold lies somewhere between the two estimates. Using Monte Carlo simulations to generate random estimates between the lower bound 2.3 million, average of 4 million and upper bound of 6 million with 1000 trials, we test the $PM_{2.5}$ abatement impact under these varying estimates. The chart below shows the results under different estimates.

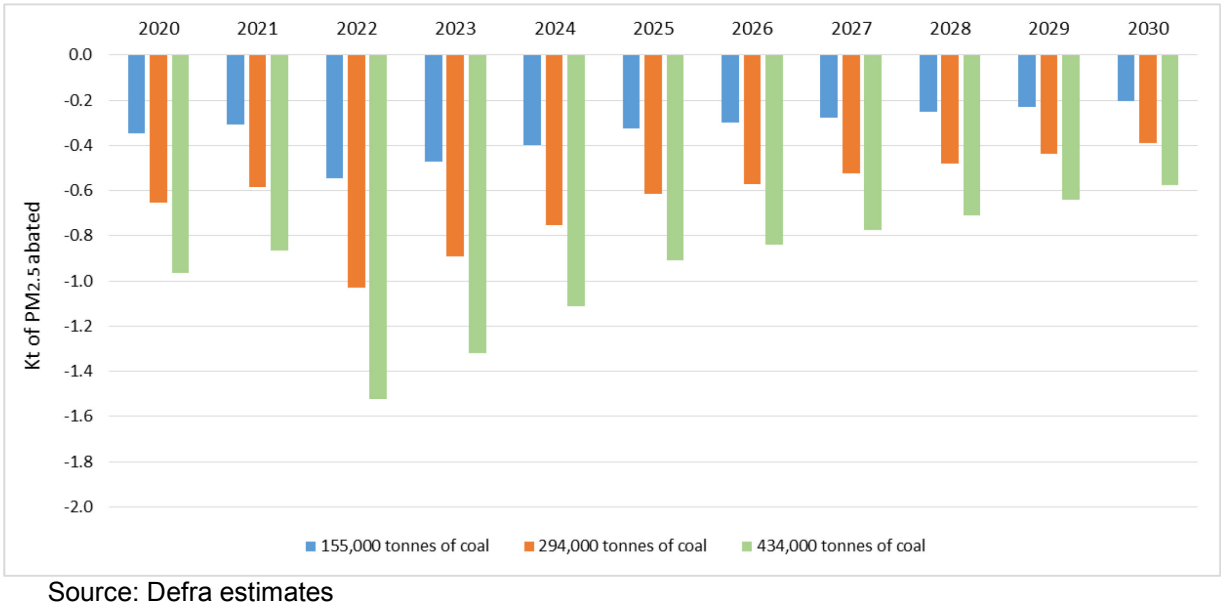
Figure 1: $PM_{2.5}$ abatement in England under varying estimates of wood volumes sold in the UK



Sources: Defra estimates

- **Volume of coal sold for domestic heating purposes**: The NAEI reports that approximately 434,000 tonnes of coal burned for domestic heating purposes in 2016. Responses from industry as part of the consultation point to a significantly lower volume of 155,000 tonnes of coal sold for domestic heating purposes. We worked with industry to collate sales figures for 2017 which found a total tonnage of domestic house coal sold as 155,000 tonnes. We use this lower industry estimate in this impact assessment. Figure 2 reports estimates of $PM_{2.5}$ emissions abated with proposed restrictions on the sale of coal under different 2017 quantity estimates of coal sold.

Figure 2: $PM_{2.5}$ abatement in England under varying estimates of coal volumes sold in the UK



Source: Defra estimates

- **Replacement fuel for coal burners:** It is expected that households who currently use coal as a primary or secondary source of domestic heat will switch to low sulphur manufactured solid fuels, as this is the next best value fuel source available (although there is regional variation in the difference in comparative cost), other than free fuel such as foraged wood. Switching to foraged wood is unlikely due to the quantity of material required. Furthermore, it is assumed that if free wood is available as a domestic fuel it will already be used and a ban on coal purchases will not increase its consumption. Annex 2 (part 1) develops a sensitivity analysis around the emissions abated and resulting NPV if assumed that a proportion of fuel poor households switch to wood following the coal ban.

- **Emissions factors:** Emission factors used in this analysis are aggregated from the internationally-accepted emission factors published jointly by the European Environment Agency (EEA) and the UNECE European Monitoring and Evaluation Programme (EMEP). The EEA/EMEP emission factors are quoted for different appliance types and applied to the UK technology mix as assessed by Defra's NAEI contractor. The EEA/EMEP emission factors are based on experimental measurements of the burning of dry wood. There are no published emission factors for wet wood as assessed by the universities of Leeds and Manchester. There is significant uncertainty in this comparison because of the different appliance types used which will impact on the estimated abatement and as such the benefits of the proposed measure.

- **Damage cost functions**: When measuring the impact of emissions, an impact pathway approach is preferred in some circumstances. An impact pathway approach uses atmospheric modelling to estimate the spatial distribution of changes in emission from a specific source. This approach is time consuming and costly. In the case of the measures under consideration, 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 largely not to those on morbidity (short-term impacts). Secondly, they do not explicitly capture the full impacts to ecosystems and cultural heritage.

- **Compliance to the regulation**: Full compliance with the regulation for coal is assumed given the limited number of fuel suppliers. However, based on Government's experience, a lower compliance rate for wood was used for the analysis. Compliance level to the proposed legislation has a significant impact on its outcome, both in terms of costs to business and of air quality improvement. We performed sensitivity analysis the level of compliance of both wood business and consumers in Annex 2 part 6.

10. Measurement of the impact on micro and small enterprises

106. Small and micro-businesses (SMBs) 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.

107. The Better Regulation Framework Manual defines micro and small businesses according to a staff headcount. Micro-businesses are those employing up to 10 full time employees as 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.

108. The proposed regulation on the sale of wet wood has the potential to impact on SMBs that sell wood fuel. Evidence collected from our Call for Evidence suggests that there are about 3,400 businesses selling wood in England, with the very large majority being SMBs. The nine largest market participants selling each over 10,000 m3 of wood hold together only about 16% of the market. On this basis, it is assumed that a full exemption of small businesses is not compatible with achieving a large part of the intended benefits of the measure. Furthermore, it is estimated viable for most SMBs to mitigate costs through two strategies. Either scale-up the bag sizes in which they sell wood to avoid falling into scope of the proposed regulation or by choosing to switch from selling wet wood to dry wood, which many seem to have the capacity and the will to do so. Consultation responses indicated that nearly 70% of business respondents would be able to comply with the regulation right away, reducing the risk of unintended consequences. These businesses may need to invest in capacity to dry wood either via covered space or the purchase of kilns. In return, they would benefit from selling their product at a higher price.

109. While a full exemption of wood small businesses cannot be considered in this case, the Government acknowledges that it may be harder for small forest businesses to come into compliance in the short term and as such they will be given an additional year to meet the legislative requirements.

110. Similarly, our Call for Evidence suggests that a large majority of coal manufacturers and distributors are SMBs. There are only 3 businesses out of just over 400 country wide selling over 6,000 tonnes of coal and not classified as SMBs. These operations are estimated to have a total market share of about 5%. On this basis, it is assumed that a full exemption of small businesses is not compatible with achieving a large part of the intended benefits of the measure. Furthermore, it is estimated viable for most SMBs to mitigate costs as many of them already sell low sulphur manufactured solid fuels or would have the opportunity to switch to low sulphur manufactured solid fuels instead of coal.

111. While a full exemption of coal small businesses cannot be considered in this case, to support those relying on coal as their primary heat source, bulk deliveries will have 2 additional years to come into compliance. This should also support small registered coal merchants to make the transition who traditionally deliver coal and have a long-established customer base.

112. The additional 2 years is to support the industry in adapting to the change, this is also intended to support other SMBs who rely on coal such as the heritage industry. Concerns were raised at consultation that the phase out of domestic coal could impact upon their supply chain, they recommended a transition to support these businesses adapt to legislative changes.

11. Competition assessment

113. The competition assessment guidelines set out four questions to establish whether a proposed policy is likely to have an effect on competition.[44] In particular, the assessment needs to establish whether the requirement to comply with the measures 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?

114. A brief summary of the four questions and a response considering the requirement is presented in the table below.

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

Competition assessment filter questions

Do the proposed measures	Response	Comment
Q1. …directly limit the number or range of suppliers?	No	The proposed measures legislation on the sale of wet wood and bituminous coal do not seek to directly limit the number of suppliers.
Q2. …indirectly limit the range of suppliers?	No	The proposed measures may limit the range of suppliers. The proposed requirement does not prevent entry or exit from the market for any firm. For coal as there is a small number of suppliers the burden will fall on a few businesses with potentially large impacts. With a decline in coal and an increase in demand for manufactured solid fuels, businesses who are able to adapt may benefit. For wood where a supplier does not have the space or kiln drying facilities to dry wood or the distribution network to only deliver in large volumes this could impact upon their businesses. In some areas government grants are available to support the transition. The majority of wood businesses responding to our Call for Evidence suggested that they could adjust. The wood fuel market consists of five medium sized firms and a large number of small sized enterprises. While administration and monitoring cost are likely to be a larger relative cost for smaller businesses, they are unlikely to be large enough to push new firms out of the market, or provide a disincentive for new firms to enter the market. We estimate the average annual present value cost to business from the proposed legislation to be about £3000 a year (in a near worst case scenario) per wood business, mainly due to capital investment for drying, and approximately £300 a year per coal business to phase out the sale of bituminous coal.
Q3. …limit the ability of suppliers to compete?	No	The proposed regulation would mean that all domestic fuel manufacturers have to comply with the existing voluntary schemes on 'ready to burn' and 'mineral fuels'. The intervention should not limit the ability of suppliers to compete.
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.

115. Overall, the proposed measures for existing fuel suppliers and new market entrants could have a small impact on competition in the short term. The administrative and monitoring costs that companies across different sectors would be facing are unlikely to result in significant burden affecting profitability and commercial viability of these enterprises. The associated costs will be imposed across the board for those firms that are not already part of the Ready to Burn and 'mineral fuels scheme'.

12. Distributional impacts

Impact on fuel poor households

116. Fuel poverty occurs where a low-income household is living in a home which cannot be kept warm at reasonable cost (fuel costs are above the national median level) and were these households to spend that amount, they would be left with a residual income below the official national poverty line. These households often live in older homes with poor levels of insulation and inefficient heating. Fuel poverty is a devolved issue and each nation has a separate measure of fuel poverty, with an associated strategy to tackle the issue. It is estimated that approximately 2.5 million households[45] in England live in fuel poverty.

[45] BEIS - Annual Fuel Poverty Statistics in England, 2019 (2017 data)

117. The fuel poverty statistics for England show that homes which are not heated by mains gas, or are 'off-grid', are more likely to be fuel poor (15.9%) and when off-grid households are fuel poor, they are more likely to be severely fuel poor.

118. The BEIS fuel poverty households' dataset reports there were 26,000 households in fuel poverty burning solid fuels in 2017. During consultation stage, concerns were raised around the impact of the interventions on those in fuel poverty, and whilst this is the minority of burners, Government was explicit in its intention that the policy should not adversely impact upon those households. It was felt that the policy on coal would have the greatest impact on those households who rely on coal as their primary heat source.

119. A study was carried out on coal to consider the costs of shifting from coal to low sulphur manufactured solid fuels (MSF), taking into consideration energy density of each fuel. The findings are presented in Annex 3. The results show a significant regional variation in the price of fuels. They demonstrate that on an energy density basis all households would save money on fuel costs if switching from coal to the cheaper of the two options considered low sulphur manufactured solid fuels when burning on an open fire[46]. The results show that most households would save money on fuel costs even when switching from coal to the more expensive of the two smokeless fuels considered.

120. However, households currently using high sulphur manufactured solid fuel are anticipated to occur a financial cost due to this legislation. Based on industry estimates of an average consumption of 3.5 tonnes per household, it is estimated that an approximate 12,500 households on average over the 2020-2030 period may be affected, experiencing each an average cost of £170 per annum.

121. The shift from wet wood to dried wood brings even higher financial benefits to households. On average for open fire, old and modern stoves, kiln dried wood on an energy adjusted basis is 2.4 cheaper than wet wood (with 30% moisture)[47].

122. Therefore, given the potential cost savings for all households (except those using high sulphur manufactured solid fuels) and health benefits an exemption was not appropriate. An extra period of time of two years to come into compliance for direct deliveries of loose coal is proposed to enable coal merchants[48] to work with their customers to identify an alternative source of fuel that would work with their heating system and of one year for small foresters to adapt. The aim of this transition period is to support both these small businesses and these householders in switching to cleaner fuels.

Impact on rural areas

123. Rural areas are areas outside settlements with populations of 10,000 or more people and make up over 80% of England's land and are home to around 17% of the English population. Thriving rural communities are vital to the English economy. A fifth of us live in rural areas and they are home to a quarter of England's businesses, and generate 16.5% of the English economy. Rural areas also face particular challenges around distance, sparsity and demography and it is important that the domestic fuel regulation consider these properly. In particular:

• Demographics: There is a higher proportion of households in rural areas using wood and coal burning as their primary source of energy.

[46] It is not recommended that coal is burned on other appliances.

[47] The data are based on a report commissioned by Defra to be published at the same time of this impact assessment.

[48] Government intends to work in partnership with the Approved Coal Merchant scheme to support this transition.

• Fuel Poverty: Fuel poverty is proportionately more prevalent in rural areas, with a larger fuel poverty gap for households in rural villages, hamlets, and isolated dwellings[49]. The section above on the impact on fuel poor households is particularly relevant in the rural context.

• Service infrastructure: Households in rural areas are more likely to have no gas supply or opportunity to access the grid because of the distance from the gas network[50]

• Access to services: The combination of distance, transport links and low population density in rural areas can lead to challenges for access to solid fuel distributors, as rural households are required to travel longer distance to purchase solid fuel. Should some solid fuel providers close their operations as a consequence of the domestic fuel regulation, this would further intensify the stress on rural households.

124. As part of the regulation formulation, we considered the scale of the possible impacts on rural areas and put in place measures to adapt the policy to address them:

- Small foresters (producing 600m^3 or less per year): Many small foresters produce small quantities of firewood as a secondary activity that supports their main business. Government policies have encouraged this in recent years in order to diversify rural businesses. They usually sell to consumers in their local area. It is estimated that 20% of firewood produced is sourced from small foresters, often in bulk quantities, Defra research (currently being quality assured) suggests that 13% is sourced from landowners or farmers for English indoor wood burners. A requirement to season and certify their wood may deter them from selling it in this way; instead they may sell their wood to wood dealers or just let the wood rot on the land. Consumers who currently rely on such products would then lose their source of fuel. Alternatives (switching to gas or electricity, visiting retailers to purchase wood, or arranging for home deliveries of wood) can be limited for typical rural consumers. Furthermore, small foresters will have a reduced revenue and business diversity. On this basis, the Government adjusts its policy by providing small foresters an additional year to come into compliance, in particular to season their wood. Additionally, those that sell in bulk will benefit from the exception for quantities sold in over 2m^3.

- Direct deliveries of coal/solid fuel: On the basis of the public consultation conducted in relation to this proposed regulation, it appears that direct deliveries of coal play a greater role in rural communities, due to the additional difficulties in visiting a fuel retailer in person and the large quantities required where it is the primary source of heating. From our consultation with the industry, there are no technical constraints for consumers to replace their coal and high-sulphur manufactured fuels with low-sulphur manufactured fuels. It is therefore expected that coal merchants will sell these products instead. However, to ensure a smooth transition and allow small businesses to adapt, direct sales of loose coal will have a transition period of two years.

- Air quality: We would expect a particularly strong positive impact on air quality in rural areas because domestic burning has a greater contribution to air quality there (compared to urban areas, where typically industrial activity and transport emissions play a proportionally greater role).

[49] Defra – Statistical Digest of Rural England – May 2019 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805011/05_Statistical_Digest_of_Rural_England_2019_May_edition.pdf

[50] NEED Analysis - Areas and types of properties off the gas grid - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/266468/off_gas_grid.pdf

Annexes

Annex 1: Post-Implementation Review (PIR) Plan:

Basis of the review: As soon as reasonably practicable after the end of the period of three years from the date on which these Regulations come into force, Government will carry out a review of the effectiveness of the regulatory provisions.

Review objective: Objective of the review is to assess whether the policy has resulted in the projected reductions of $PM_{2.5}$ and SO_2 emissions. Given the large contribution domestic combustion has on overall $PM_{2.5}$ emissions, the review will aim to study the progress made in working towards the 2030 NECD targets.

Review approach and rationale: The review would be based on data monitoring and further modelling on the achievability of 2030 NECD targets, either through the NAPCP process or a domestic alternative reporting mechanism. Social research and a scan of stakeholder views around domestic combustion patterns may also be used to compare the changes in choice of domestic combustion fuel at the household level.

Baseline: The current (baseline) position against which the change introduced by the legislation can be measured are the projected emissions of $PM_{2.5}$ and SO_2. The current business-as-usual estimates will be comparable with the actual emission levels following the introduction of the legislation and at the time when PIR is carried out to measure the success of the policy.

Success criteria: The policy will be successful if a considerable fall in $PM_{2.5}$ emissions is observed by the projected review date. By 2025, the anticipated reductions compared to the baseline under the preferred option is to reach approximately 36kt.

Monitoring information arrangements: The policy will require proof of conformity to the legislation such as certification of both firewood and manufactured solid fuel, as well as auditing of retailer compliance. This will produce useful data for evaluation: the number of certifications (for both firewood and manufactured solid fuels) applied for and approved, the volume of certified wood entering the market, the number of audit checks, passes, and failures, as well as remedial actions taken to show measurement of compliance. Additional requirements for data monitoring for the review are already in place as there are statutory inventory reporting obligations, in which emissions of major air pollutants from domestic combustion need to be reported.

Annex 2: Sensitivities

Part 1: Coal switch to wood following the ban.

One specific issue raised in the consultation questioned whether following the ban on house coal, households that are at the risk of fuel poverty will still choose to switch to smokeless fuels or if they might instead opt to switch to wood. According to the 2016 English Housing Survey there are 49,000 households using coal as their primary heat source, of which approximately 7,700 are fuel poor. This represents approximately 18% of all coal consumption in England, and implies that if a large proportion of these households choose to burn wood following the coal ban, the policy could result in unintended consequences due to increased $PM_{2.5}$ emissions. The rise in emissions would be attributed to two factors. First, wood carries a lower energy content than coal and consequently more wood needs to be burnt for the displaced quantity of coal, and second, emissions would rise relative to a situation in which all coal users switch to solid smokeless fuels, since wood carries a higher $PM_{2.5}$ emission factor than smokeless fuels, as shown in table 3.

To address this risk, we performed a sensitivity analysis assuming that 50% of fuel poor households that use coal as the primary source of energy switch to using wood as their primary source, and compared resulting emissions and NPV. Within wood consumption, we assumed the same compliance rate as in the main analysis (40% in year 2020 rising to 60% by 2023). The results from this sensitivity analysis are presented in table 20 below. The results show that while the relative amounts of $PM_{2.5}$ emissions increase, consequently decreasing the benefits, the absolute NPV of the policy remains overwhelmingly large and positive.

Table 20: Comparing emissions and NPV under sensitivity on coal-wood switch

	Full switch to smokeless fuels	Partial switch to wood	Difference
Total PM2.5 Coal Emissions following policy (kT)	1.34	10.99	+9.65
Total NPV of Option 2 following policy (£m)	7,858	6,902	-957

Source: Defra estimates

Annex 2 - Part 2: Adaptation rates to change in energy efficiency.

The analysis assumes that all consumers take into consideration the energy density of the fuel purchased and their appliance energy efficiency when choosing the fuel for domestic combustion. If this is correct, then following the legislation consumers will adjust the volume of fuel they purchase to maintain the same energy output as before the implementation of the legislation. However, this may not be the case, especially soon after implementation. To address this risk we performed sensitivity analysis of the results on the share of households adapting their fuel consumption to keep their energy output at the same level as before the ban, taking into consideration the change in energy density of the fuels, at the 0%, 25%, 50%, 75% and 100% level of adaptation. The results for the central scenario are presented in the table 21 below.

Table 21: Impact of household fuel volume adaptation to improved energy efficiency, in £m

Summary results	0%	25%	50%	75%	100%
Loss in profit	-67.5	-34.5	-13.8	2.4	14.3
Monitoring	16.1	16.1	16.1	16.1	16.1
Administrative costs	10.7	10.7	10.7	10.7	10.7
Capital costs	162.3	142.4	122.5	102.6	82.7
Total business cost	121.7	134.8	135.6	131.9	123.9
Household costs	469.2	237.0	91.6	-22.3	-105.8
Government costs	1.4	1.4	1.4	1.4	1.4
Total costs	**592.2**	**373.2**	**228.6**	**111.0**	**19.5**
Air quality improvement	**6,757.5**	**7,207.0**	**7,495.1**	**7,715.1**	**7,877.8**
TOTAL NPV Option 2 (£m)	**6,165.2**	**6,833.8**	**7,266.4**	**7,604.1**	**7,858.3**

Source: Defra estimates

Annex 2 - Part 3: Sensitivity of the results to the proportion of wood burned wet before the proposed ban, in £m

The analysis assumes that the proportion of wood burned wet is 23.7% based on the average of the BEIS Domestic Wood Use Survey published in 2016[51] showing that 22.5% of wood is burned wet and of the Kantar survey on "Burning in UK homes and gardens" commissioned by Defra and to be published shortly, showing that 24.9% of wood is burned wet. However, there is a certain level of uncertainty and this may have a significant impact on the impacts of the legislation. To address this risk we performed sensitivity analysis of the results on the share of wood burned wet before the ban, assuming that this share could range from 10% to 80%. The results for the central scenario are presented in the table 22 below.

Table 22: Sensitivity of the results to the estimated proportion of wood burned wet, in £m

Wood sold wet	18%	35%	42%	53%	71%	89%	100%	100%	100%
Wood burnet wet	**10%**	**20%**	**24%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**
Loss in profit	*5.1*	*11.8*	*14.3*	*18.5*	*25.2*	*31.9*	*36.2*	*36.2*	*36.2*
Monitoring	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*
Administrative costs	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*
Capital costs	*54.4*	*75.1*	*82.7*	*95.7*	*116.4*	*137.0*	*150.4*	*150.4*	*150.4*
Total business cost	86.4	113.7	123.9	141.1	168.4	195.8	213.5	213.5	213.5
Household costs	-41.6	-88.4	-105.8	-135.3	-182.1	-229.0	-275.8	-322.7	-369.6
Government costs	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Total costs	**46.2**	**26.7**	**19.5**	**7.2**	**-12.3**	**-31.8**	**-61.0**	**-107.9**	**-154.7**
Air quality improvement	**3,595.8**	**6,719.3**	**7,877.8**	**9,842.8**	**12,966.3**	**16,089.8**	**19,213.3**	**22,336.9**	**25,460.4**
TOTAL NPV Option 2 (£m)	**3,549.6**	**6,692.6**	**7,858.3**	**9,835.6**	**12,978.6**	**16,121.6**	**19,274.3**	**22,444.7**	**25,615.1**

Source: Defra estimates

[51] https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey

Annex 2 - Part 4: Sensitivity of the results to the proportion of wood businesses that require to invest in drying facilities following the legislation

There is some uncertainty regarding the size of additional capital investment required to raise existing wood drying capacity to a level that meets the expected demand from consumers following the enactment of the proposed legislation. Based on our Consultation and discussions with industry experts, wood producers are likely to respond in one of 4 ways to comply with the legislation for quantities of wood sold wet:

- Season it using existing spare drying capacity;
- Scale up and sell only in volumes over 2m3 – potential customers would be both domestic and larger businesses with drying capacity;
- Build home-made cover storage or drying kiln;
- Invest in cover space or drying kiln.

While the consultation and from discussions with industry experts indicate that a significant share of wood producers will not invest in drying facilities, we are using a very conservative approach in assessing the cost to business in terms of capital investment and operating costs. The calculation of cost to business assumes that all wood sold wet (42% of the total) in quantities of 2m3 or more will require to be seasoned under cover space (21%) or dried in kiln (21%) when the legislation starts and will require investing in cover space and drying kilns. The central estimate for this cost is £82.7 million. However, there is a certain level of uncertainty and this may have a significant impact on the impacts of the legislation on wood businesses. To address this risk we performed a sensitivity analysis of the results on the share of wood businesses that would need to invest in drying facilities. The results for the central scenario are presented in the table 23 below.

Table 23: Sensitivity of the results to the estimated proportion of wood businesses that need investing in drying facilities, in £m

Summary results	Kiln = 5% Cover = 5%	Kiln = 7% Cover = 7%	Kiln = 10% Cover = 10%	Kiln = 15% Cover = 15%	Kiln = 21% Cover = 21%
Loss in profit	14.3	14.3	14.3	14.3	14.3
Monitoring	16.1	16.1	16.1	16.1	16.1
Administrative costs	10.7	10.7	10.7	10.7	10.7
Capital costs	57.0	60.2	65.0	73.1	82.7
Total business cost	98.2	101.4	106.2	114.2	123.9
Household costs	-105.8	-105.8	-105.8	-105.8	-105.8
Government costs	1.4	1.4	1.4	1.4	1.4
Total costs	**-6.2**	**-3.0**	**1.8**	**9.8**	**19.5**
Air quality improvement	**7,877.8**	**7,877.8**	**7,877.8**	**7,877.8**	**7,877.8**
TOTAL NPV Option 2 (£m)	**7,884.0**	**7,880.8**	**7,876.0**	**7,868.0**	**7,858.3**

Source: Defra estimates

Annex 2 - Part 5: Sensitivity of the results to the proportion of wood sold in small quantities.

The analysis assumes that 80% of wood that is sold is sold in bags less than or equal to $2m^3$. This assumption affects all of the costs and benefits under assessment, except for monitoring and administration costs. There is a certain level of uncertainty and this may have a significant impact on the impacts of the legislation on wood businesses. To address this risk, we performed a sensitivity analysis of the results on the share of wood businesses that would need to invest in drying facilities. The results for the central scenario are presented in the table 24 below.

Table 24: Sensitivity of the results to the estimated proportion of wood that is sold in quantities of 2m3 of less, in £m

Summary results	60%	70%	80%	90%	100%
Loss in profit	*10.3*	*12.3*	*14.3*	*16.3*	*18.3*
Monitoring	*16.1*	*16.1*	*16.1*	*16.1*	*16.1*
Administrative costs	*10.7*	*10.7*	*10.7*	*10.7*	*10.7*
Capital costs	*62.0*	*72.4*	*82.7*	*93.1*	*103.4*
Total business cost	99.2	111.5	123.9	136.2	148.5
Household costs	-105.8	-105.8	-105.8	-105.8	-105.8
Government costs	1.4	1.4	1.4	1.4	1.4
Total costs	**-5.2**	**7.1**	**19.5**	**31.8**	**44.1**
Air quality improvement	**7,877.8**	**7,877.8**	**7,877.8**	**7,877.8**	**7,877.8**
TOTAL NPV Option 2 (£m)	**7,883.0**	**7,870.6**	**7,858.3**	**7,846.0**	**7,833.6**

Source: Defra estimates

Annex 2 - Part 6: Sensitivity of the results to the level of compliance for wood with the legislation

General assumption made in terms of compliance with the legislation

Compliance level to the proposed legislation has a significant impact on its outcome, both in terms of costs to business and of air quality improvement. The Better Regulation Framework Manual (2015)[52] states "*When planning to introduce a regulatory measure, costs and benefits should assume 100% compliance, unless there is evidence of the contrary. However, differing levels of compliance should also be investigated through sensitivity analysis."*

Full compliance with the regulation for coal is assumed given the limited number of fuel suppliers. However, based on Government's experience, a lower compliance rate of 40% in 2020 rising to 50% in 2021, 60% by 2022 and 70% by 2026 for wood was used for the analysis. Less than full compliance is assumed to reflect:

a. Flexibility in the design of the regulation which is intended to allow consumers who wish to buy wet wood in large volumes and dry it before it is burned to do so.
b. A large number of small retailers which makes the regulation harder to fully enforce.

The assumed rise in compliance is due to commitments in the Government's Clean Air Strategy to launch a dedicated communications campaign with the aim of increasing public awareness on the health and environmental costs of burning wet wood.

Specific assumption made for cost to business

Following consultation with the Regulatory Policy Committee (RPC) secretariat, we have assumed that wood businesses will bear cost corresponding to a situation where they fully comply (100%) with the legislation. This decision was taken to minimise risk that the assessment underestimates cost to wood business. The central cost to wood business is estimated at £123.9 million.

Sensitivity analysis

As there is a certain level of uncertainty on the level of compliance by wood business and this has a significant impact on the costs of the legislation on wood businesses, we performed a sensitivity analysis of the results on the share of level of compliance by wood businesses. The results for the central scenario are presented in the table 25 below. The results show that costs to business decreases to £80.6 million of wood businesses is line with compliance of wood burners (40% in 2020 rising to 50% in 2021, 60% by 2022 and 70% by 2026). The net benefit on the society increases from £7.858 billion to £7.902 billion.

[52] The latest version of the Better Regulation Framework Guidance (August 2018) does not advise on this matter.

Table 25: Sensitivity of the results to the level of compliance of wood businesses with the legislation, in £m

Summary results	2020 = 40%; 2021=50%; 2022=60%; 2024=65%; 2026=70%	75%	100%
Loss in profit	8.3	10.3	14.3
Monitoring	16.1	16.1	16.1
Administrative costs	10.7	10.7	10.7
Capital costs	45.4	62.0	82.7
Total business cost	80.6	99.2	123.9
Household costs	-105.8	-105.8	-105.8
Government costs	1.4	1.4	1.4
Total costs	**-23.8**	**-5.2**	**19.5**
Air quality improvement[53]	**7,877.8**	**7,877.8**	**7,877.8**
TOTAL NPV Option 2 (£m)	**7,901.6**	**7,883.0**	**7,858.3**

Source: Defra estimates

A similar sensitivity analysis is conducted to assess the impact of the level of compliance of wood burners with the legislation. The analysis assumes a compliance rate of 40% in 2020 rising to 50% in 2021, 60% by 2022 and 70% by 2026. The sensitivity analysis presented in table 26 shows that the net benefit on the society increases from £7.858 billion to £12.663 billion if full compliance is assumed.

Table 26: Sensitivity of the results to level of compliance of wood burners with the legislation, in £m

Summary results	2020 = 40%; 2021=50%; 2022=60%; 2024=65%; 2026=70%	75%	100%
Loss in profit	14.3	14.3	14.3
Monitoring	16.1	16.1	16.1
Administrative costs	10.7	10.7	10.7
Capital costs	82.7	82.7	82.7
Total business cost[54]	123.9	123.9	123.9
Household costs	-105.8	-128.3	-172.8
Government costs	1.4	1.4	1.4
Total costs	**19.5**	**-3.0**	**-47.5**
Air quality improvement	**7,877.8**	**9,507.3**	**12,615.5**
TOTAL NPV Option 2 (£m)	**7,858.3**	**9,510.3**	**12,663.0**

Source: Defra estimates

[53] The air quality improvement remains stable across the sensitivity analysis as it not linked to the level of compliance by wood business but to the level of compliance by wood burners

[54] Business costs remain stable across the sensitivity analysis as it not linked to the level of compliance by wood burners but to the level of compliance by wood business

Annex 3: Shifting from coal to low sulphur manufactured solid fuels – Cost/savings analysis for households

A study was carried out on coal to consider the costs of shifting from coal to low sulphur manufactured solid fuels (MSF), taking into consideration energy density of each fuel. The results show a significant regional variation in the price of fuels. They demonstrate that on an energy density basis all households would save money on fuel costs if switching from coal to the cheaper of the two options considered low sulphur manufactured solid fuels when burning on an open fire[55]. The results show that most households would save money on fuel costs if switching from coal to the more expensive of the two options considered.

Table 27: Regional, energy efficiency adjusted cost analysis for coal and smokeless fuels

Fuel	Location	£ Cost per kg (as received)	% Efficiency achieved	Cost per useful kWh output (pence)	Cost per average coal usage (pence)	Annual additional cost compared to house Coal
British House Coal	Northumberland	£ 0.34	26.43	£ 15.61	£ 1,343.77	0
	Harrogate	£ 0.31	26.43	£ 14.23	£ 1,225.20	0
	Derbyshire	£ 0.34	26.43	£ 15.79	£ 1,359.58	0
	Warwickshire	£ 0.35	26.43	£ 15.88	£ 1,367.49	0
	Oxfordshire	£ 0.40	26.43	£ 18.36	£ 1,580.91	0
	Norfolk	£ 0.44	26.43	£ 20.01	£ 1,723.19	0
	Hampshire	£ 0.51	26.43	£ 23.41	£ 2,015.66	0
	Cheshire	£ 0.35	26.43	£ 16.07	£ 1,383.30	0
	Cornwall	£ 0.40	26.43	£ 18.18	£ 1,565.10	0
	Yorkshire	£ 0.31	26.43	£ 14.23	£ 1,225.20	0
Smokelss Fuel 1	Northumberland	£ 0.50	41.02	£ 15.79	£ 1,359.12	£ 15.34
	Harrogate	£ 0.51	41.02	£ 15.97	£ 1,375.30	£ 150.09
	Derbyshire	£ 0.53	41.02	£ 16.60	£ 1,429.23	£ 69.65
	Warwickshire	£ 0.57	41.02	£ 17.73	£ 1,526.31	£ 158.82
	Oxfordshire	£ 0.59	41.02	£ 18.48	£ 1,591.03	£ 10.12
	Norfolk	£ 0.54	41.02	£ 16.91	£ 1,456.20	-£ 266.99
	Hampshire	£ 0.60	41.02	£ 18.79	£ 1,618.00	-£ 397.66
	Cheshire	£ 0.55	41.02	£ 17.23	£ 1,483.16	£ 99.87
	Cornwall	£ 0.48	41.02	£ 15.10	£ 1,299.79	-£ 265.31
	Yorkshire	£ 0.49	41.02	£ 15.35	£ 1,321.36	£ 96.16
Smokelss Fuel 2	Northumberland	£ 0.46	38.29	£ 15.57	£ 1,340.34	-£ 3.43
	Harrogate	£ 0.34	38.29	£ 11.47	£ 987.79	-£ 237.41
	Derbyshire	£ 0.39	38.29	£ 13.34	£ 1,148.36	-£ 211.22
	Warwickshire	£ 0.39	38.29	£ 13.34	£ 1,148.36	-£ 219.13
	Oxfordshire	£ 0.41	38.29	£ 13.78	£ 1,186.76	-£ 394.15
	Norfolk	£ 0.42	38.29	£ 14.03	£ 1,207.70	-£ 515.49
	Hampshire	£ 0.42	38.29	£ 14.03	£ 1,207.70	-£ 807.96
	Cheshire	£ 0.39	38.29	£ 13.34	£ 1,148.36	-£ 234.94
	Cornwall	£ 0.45	38.29	£ 15.08	£ 1,298.46	-£ 266.64
	Yorkshire	£ 0.39	38.29	£ 13.30	£ 1,144.87	-£ 80.34

Colour legend	
	Cost
	Negative cost (savings)

[55] It is not recommended that coal is burned on appliances other than open fire.