Department for Levelling Up,
Housing & Communities

2021 changes to ventilation standards of the Building Regulations for domestic and non-domestic buildings

Final Stage Impact Assessment

Signed by the responsible minister:

Date: 13th December 2021

Title: 2021 changes to ventilation standards of the Building Regulations in domestic and non-domestic buildings: Final Impact Assessment **Lead department or agency:** DLUHC	Impact Assessment (IA) **Date:** 15/12/21 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Secondary Legislation **Contact for enquiries:** Enquiries.BR@communities.gov.uk

Summary: Intervention and Options

RPC Opinion: N/A

Cost of Preferred Option (in 2019 prices, 2020 PV for EANDCB, 2021 PV base year for all other calculations)

Total Net Present Social Benefit	**Business Net Present Cost**	**Net cost to business per year (EANDCB)**	**Business Impact Target Status** Non qualifying provision
N/A	£46.0m	£2.2m	N/A

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

In response to *The Independent Review of Building Regulations and Fire Safety,* the Government set out its intention to fundamentally reform the building safety system so that residents remain safe in their homes. A review of current policies in ventilation highlighted key issues which needed to be addressed in order to improve health and safety.

The importance of ventilation has also been highlighted as a key risk for the health and productivity of people and businesses in the UK. The standards for ventilation aim to improve the safety of residents and users by improving compliance with current requirements and introducing new measures, including those to mitigate the risks of airborne infection.

There are a range of market failures that exist meaning that the costs of poor ventilation have not been fully accounted for by the market. Hence Government intervention is necessary to address the problem and prevent a lock-in of poorer ventilation in buildings. These include:

- The cost of poor ventilation not being fully reflected in prices;
- A lack of information about better ventilation opportunities and the negative consequences of poor indoor air quality, and;
- Limited incentives for building owners and developers to make improvements to buildings which would improve ventilation from non-domestic buildings.

What are the policy objectives and intended effects?

The policy objective is to improve ventilation in new and existing domestic and non-domestic buildings through changes to guidance for Part F of the Building Regulations.

The intended effect is to protect the health of occupants in buildings through improved internal air quality and reduced risks of the spread of illness.

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

Policy Option 0: Do nothing. Keep existing standards of Part F for domestic and non-domestic buildings. This is the counterfactual option and so all costs and benefits are appraised relative to this situation, which means it has a baseline cost and benefit of zero.

Policy Option 1: Preferred option. Introduce new and simplified guidance for ventilation standards for both new domestic and non-domestic buildings, and for existing buildings when relevant work is done. This is the Government's preferred option as it aims to improve compliance with the Building Regulations; ensuring that the appropriate ventilation standards are achieved.

Is this measure likely to impact on international trade and investment?		No		
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** N/A	**Non-traded:** N/A	

Summary: Analysis & Evidence

Policy Option 1

Description: Introducing new standards and simplified guidance for ventilation in new domestic and non-domestic buildings, and existing domestic and non-domestic buildings where relevant building work is done.

FULL ECONOMIC ASSESSMENT

Price Base	PV Base	Time Period	Net Benefit (Present Value (PV)) (£m)		
2019	2021	70	Low: N/A	High: N/A	**Best Estimate: (£46.0m)**

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	£0.6 million			£36.8 million
High	£0.9 million			£55.2 million
Best Estimate	**£0.8 million**			**£46.0million**

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

The increased costs (present value) for **non-domestic** buildings are £46m capital costs, plus transition costs of £400,000. This comprises of an addition to guidance recommending that air quality monitors are installed in certain occupiable rooms.

The only costs for **domestic** buildings are transition costs of £400,000.

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

Impacts on supply of new buildings are likely to be insignificant. Any costs related to changes in guidance to support compliance with existing requirements are not included in the main cost benefit analysis. These are however explored in the Impact Assessment through sensitivity analysis.

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

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

Due to the level of uncertainty, the benefits of improved ventilation are not monetised as part of the main cost benefit analysis. Sensitivity analysis has been taken forward to illustrate the potential magnitude of benefits from improved ventilation for both domestic and non-domestic buildings.

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

No allowance is made for employment opportunities from improving ventilation or spill-over benefits of innovation as these impacts are likely to be insignificant. Benefits due to improved compliance with existing requirements are not included but have been explored outside the main cost benefit analysis.

Key assumptions/sensitivities/risks	Discount rate	3.5%

The analysis has taken a common set of assumptions from 2021 Green Book Supplementary guidance. The low and high estimates are +/- 20% of the best estimate.

These changes will not have an impact on organisations that are already going further than the proposed uplifts.

All calculations are in 2019 prices.

Sensitivity analysis has been taken forward to illustrate the potential magnitude of benefits from better indoor air quality.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:** N/A
Costs: £2.2m	**Benefits:** £0	**Net:** £2.2m Cost	

Contents

1. Introduction

Background and scope of the proposal

1.1. This Impact Assessment (IA) supports the introduction of new ventilation standards for domestic and non-domestic buildings. The analysis which underpins this IA assesses the impacts associated with introducing new guidance to support people doing building work to comply with standards more easily. As such, these policies will have an impact on the construction industry, manufacturers of construction products, building owners, and their occupants. Changes in standards are included in the main cost benefit analysis.

1.2. The changes are set out in the response documents for the two-part consultation on changes to the ventilation standards of the Building Regulations. These are; The Future Homes Standard: 2019 Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for new dwellings, and; The Future Building Standard: 2021 Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for non-domestic buildings and dwellings, and; overheating in new residential buildings.

1.3. For domestic buildings, these changes include:

a. Simplifying the approach for determining the ventilation rate and system design requirements for a dwelling.
b. Updating the way that ventilation systems are presented in Approved Document F, Volume 1: Dwellings to reflect common design practices.
c. Introducing guidance designed to reduce the ingress of external air pollution into the main body of Approved Document F, Volume 1: Dwellings, and updating its technical content.
d. Making technical changes to guidance for ventilation systems in line with the latest evidence and understanding.
e. Simplifying the structure and content of guidance relating to Part F.
f. Recommending that trickle vents be installed in certain situations when windows are replaced in homes.
g. Introducing a new method for assessing ventilation when energy efficiency work is done to existing buildings to ensure any lost ventilation is replaced.

1.4. For non-domestic buildings, these changes include:

a. Reviewing the way that ventilation systems are presented in Approved Document F, Volume 3: Buildings other than dwellings to reflect common design practices.
b. Bringing guidance designed to reduce the ingress of external air pollution into the main body of Approved Document F, Volume 2: Buildings other than dwellings.
c. Making technical changes to guidance for ventilation systems in line with the latest evidence and understanding.
d. Simplifying the structure and content of guidance relating to Part F.
e. Recommending trickle vents be installed in certain situations when windows are replaced in buildings other than dwellings.

f. Adding new guidance to mitigate the risk of transmission of airborne infection.

Future work (outside scope of the impact assessment)

1.5. This IA details the impact of changes to the guidance of Part F: ventilation for domestic and non-domestic buildings. Further IAs have been published alongside this one in associated areas, which include changes to Part L of the Building Regulations for domestic and non-domestic buildings and the introduction of Part O of the Building Regulations to reduce overheating risk in residential buildings.

2. Problem under consideration

2.1. In response to Dame Judith Hackitt's review, *The Independent Review of Building Regulations and Fire Safety,* the Government set out its intention to "fundamentally reform the building safety system so that residents are, and feel, safe in their homes". Recommendation 6.2 of the Dame Judith Hackitt review stated that "There should be a periodic review (at least every five years) of the effectiveness of the overall system of building regulation including accountabilities, responsibilities, guidance, and the effectiveness of the regulator."[1] In line with this, DLUHC's review of current policies in ventilation highlighted key issues which needed to be addressed to improve the health and safety of residents and users.

2.2. As part of a systems approach to building regulation, and as recommended by The Independent Review of Building Regulations and Fire Safety, it is important that we make sure that policies to improve the energy efficiency of new homes do not have unintended consequences and increase health and safety risks. The Future Homes Standard and Future Buildings Standard consultations therefore include proposals on ventilation standards to safeguard the health of building residents and users.

2.3. Reducing carbon emissions from both the domestic and non-domestic building stock represents a significant opportunity to support the Government in reaching its targets. This year the Government laid legislation for Carbon Budget 6, which will require a 78% reduction in emissions by 2035, relative to 1990 levels. Many energy efficiency works may make homes more airtight. While this will reduce heat loss, many older homes may only be ventilated through infiltration (air leaks through the building fabric) which can be reduced by such work. The health of occupants and structural integrity of the building must be maintained by the provision of sufficient ventilation throughout the building.

2.4. COVID-19 has shown the importance of ventilation in reducing the spread of infection and has been highlighted as a key risk for the health and productivity of people and businesses in the UK. The proposals for ventilation improve the safety of building residents and users, by simplifying and clarifying guidance to improve compliance and introducing new standards in the guidance to mitigate the risks of airborne infection.

2.5. Together, all the changes proposed across the Future Buildings Standard and Future Homes Standard consultations provide a pathway towards creating homes and buildings that are fit for the future, better for the environment, affordable for consumers to heat, and healthier to live in.

[1] Independent Review of Building Regulations and Fire Safety: Final Report, 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf

3. Rationale for intervention

3.1. Building Regulations should be used only when it can be shown that the market would not make these changes of its own accord, or that other measures (regulatory or otherwise) are not already driving this change.

3.2. Several market failures exist which means that, in the absence of government intervention, the market would not make the changes necessary to ensure there is appropriate ventilation in homes and non-domestic buildings. In the absence of any intervention, the long lifetimes of buildings could lead to a lock-in of lower ventilation levels and therefore poorer indoor air quality for many years to come. It is more costly to retrofit improvements to ventilation than it is to build new buildings with good levels of ventilation. Improvements to the Building Regulations' statutory guidance can help to overcome the following market failures that act as a barrier to action:

a. **Split Incentives & Negative Externalities:** Builders in both new and existing buildings do not incur the cost of poor building standards and poor indoor air quality. This is because the poor provision of ventilation in new buildings and the subsequent impacts on human health are not reflected in the transaction prices of property markets. Consequently, the private cost incurred in the market is less than the full social cost, resulting in a negative externality. Furthermore, there is insufficient evidence to suggest there is a price premium for correctly ventilated new buildings. This means that even if developers were to build high quality and well-ventilated buildings, they are not likely to receive a higher price when selling the building, therefore they have no incentive to do so. There are additional externalities for non-domestic buildings. Given there is no profit made from providing adequate ventilation, this may result in adverse working conditions for employees, potentially leading to reduced productivity and increases in absence due to sickness. The policies proposed can correct for some of these externalities. For example, the provision of CO_2 monitors should increase the effectiveness of ventilation systems. This should improve the levels of ventilation in non-domestic buildings when air quality is poor, increasing productivity and reduction in sickness.

b. **Imperfect Information:** Most builders, landlords and occupants may be unaware of what existing ventilation their buildings may have, or whether it is of a sufficient standard. Many more people may be unaware of the dangers that poor ventilation can lead to. Damp and mould, as some of the potential consequences of poor ventilation, may lead to the degradation of the building fabric. Pollutants inside buildings, such as Volatile Organic Compounds (VOCs), have adverse effects on health. An information failure could mean there is a lack of market demand for suitably ventilated buildings, paired with a lack of supply of suitably ventilated buildings. By providing more information to builders, routes to compliance are clearer and so new dwellings and non-domestic properties will have good levels of ventilation, preventing any adverse side effects associated with this.

c. **Behavioural Biases:** There may be behavioural inertia, where occupants are unwilling to act to improve buildings. This includes disproportionately valuing convenience in the short run over long term benefits, which will result in fewer provisions for adequate

ventilation. The inconvenience of improving ventilation in an existing building (for example supplying new buildings with trickle vents) may be difficult to recoup in the consumer's eyes, as the benefits of good ventilation are not necessarily monetary. Therefore, some consumers may not be willing to pay a price premium for good ventilation.

d. **Capital Constraints:** A lack of capital can act as a barrier to businesses acting to renovate and improve existing buildings ventilation, despite these works proving cost-effective in the medium or long term. The reliance on building owners having enough capital to make the improvements themselves is removed by ensuring new buildings meet adequate provisions for ventilation at the point of construction.

4. Policy objectives

Policy objectives

4.1. Full details of the policy objectives for the ventilation standards of new and existing domestic and non-domestic buildings are set out in the Future Buildings Standard and Future Homes Standard response documents. A summary of these policy objectives and intended effects are provided below.

4.2. The policy objective is to improve ventilation in new and existing domestic and non-domestic buildings through changes to guidance for Part F of the Building Regulations.

4.3. The intended effect is to protect the health of occupants of buildings through improved internal air quality and reduced risks of the spread of illness.

Simplifying Approved Document F guidance for all buildings

4.4. Approved Document F has been rewritten into Approved Document Volume 1: Dwellings, and Approved Document Volume 2: Building other than dwellings. The Domestic Ventilation Compliance Guide has been incorporated into Approved Document Volume 1: Dwellings and it is has been made clear what the minimum standards are by removing best practice guidance. Repetition has also been reduced and the standards are easier to check against for Building Control Bodies.

Approved Document F guidance change for new domestic buildings

4.5. A simplified method for determining the size for background ventilators in naturally ventilated dwellings has been adopted. The revised guidance removes the need for a designer to carry out any calculations or make assumptions. Instead, a simple table specifies the size of ventilator that should be selected, based upon the room end-use. This simplification has led to a new set of equivalent areas for background ventilators in naturally ventilated dwellings. These are 8,000mm^2 in most habitable rooms and 4,000mm^2 in bathrooms for dwellings with multiple floors. For single-storey dwellings, these are 10,000mm^2 in most habitable rooms and 4,000mm^2 in bathrooms.

4.6. For continuous mechanical extract systems, the Government has increased the minimum level of background ventilators from 2,500mm^2 to 4,000mm^2 per habitable room. This will ensure that air can be drawn through the background ventilators, accounting for the expected pressure differentials.

4.7. The size of these minimum background ventilators has been adjusted from initial proposals for both natural and continuous mechanical extract systems. This is to balance adequate indoor air quality with minimising the impact on supply chains and reducing the risk that large ventilators will cause draughts.

4.8. In line with the consultation proposals, we suggest that a commissioning sheet and checklist should be provided when ventilation systems are installed. This should include both design

flow rates and maintenance requirements. The information should be provided in a clear manner, for a non-technical audience. A copy of the completed commissioning sheet in Appendix C of Approved Document F, Volume 1: Dwellings should be provided to the owner of the dwelling.

New requirement for existing domestic buildings

4.9. The full changes to the ventilation policy for existing domestic buildings are set out in Chapter 7 of the Future Buildings Standard response document. New standards have been set for ventilation when undertaking energy efficiency measures in existing buildings.

4.10. The new ventilation standards will include the provision of guidance on what ventilation measures are needed because of historic and current energy efficiency work that has been done to the dwelling. This is through a Simplified Method, comprised of three categories:

a. Category A defines buildings with little or no work done to them since they were built. It is likely there is a good ventilation provision through infiltration.

b. Category B defines a building with some minor energy efficiency work done to it since it was built. It is likely these buildings will need additional ventilation through systems specific advice, provided in the Approved Document for background or mechanical supply and extract ventilation.

c. Category C defines a building with multiple major energy efficiency work done to it. It will either need expert advice to develop background ventilation solutions or to follow system specific advice for mechanical supply and extract ventilation.

Approved Document F guidance change for existing domestic buildings

4.11. Part F guidance has been changed to set a standard that background ventilators should be fitted to all replacement windows, unless it can be demonstrated that the work has made the building no less compliant with Part F the Building Regulations. This includes those where the original window did not have a background ventilator. This is to ensure that when the airtightness of a home is increased due to the replacement window, this is replaced by purposeful ventilation and that there is not a build-up of pollutants in rooms.

4.12. In line with the consultation proposal, we will align the system-specific guidance on work done to existing homes with that of new homes.

4.13. In line with the proposals for new domestic buildings, we suggest that a commissioning sheet and checklist should be provided when ventilation systems are installed in existing dwellings. This should include both design flow rates and maintenance requirements. The information should be provided in a clear manner, for a non-technical audience. A copy of the completed commissioning sheet in Appendix C of Approved Document F, Volume 1: Dwellings should be provided to the owner of the dwelling.

Approved Document F guidance change for non-domestic buildings

4.14. Chapter 4 of the Future Building Standard response document outlines the changes to ventilation standards in both new and existing non-domestic buildings. This includes updating guidance to include the most recent industry standards and implementing measures to mitigate the transmission of infection via aerosols in certain non-domestic buildings. Only some of the policy measures proposed at the consultation stage have been implemented, which has significantly reduced the costs of the policy presented in the consultation stage IA. In particular, proposals for increased ventilation capacity in offices were not progressed.

4.15. New standards have been introduced for air quality monitoring (for example the installation of CO_2 monitors) which should be installed in offices. We will also extend the scope of air quality monitoring to other occupiable rooms, specifically 'high risk' rooms where there may be a risk of airborne infection. Further guidance is provided in Approved Document F: Building other than dwellings.

4.16. Approved Document Volume 2: Buildings other than dwellings also now includes guidance on recirculating systems, stating that such designs should operate in 'outdoor air only mode' (or include a HEPA filter or UVC air cleaning system). Other changes to guidance include stating an outdoor air supply rate for common spaces and requiring extract fans in bathrooms to be able to operate in an always on mode.

Transitional arrangements

4.17. Transitional arrangements are used to smooth the transition to new standards in the implementation of building regulations; these arrangements allow some building works to be built to previous standards for a specified period.

4.18. Transitional arrangements will only apply to individual buildings on which work has started within a reasonable period. For the previous set of guidance to apply a building notice, initial notice or full plans would have to have been given to the Building Control Body by 15 June 2022, with the building work started on the building by 15 June 2023. Otherwise, a building would need to comply with the latest set of ventilation standards. This approach is slightly different to previous changes to the Approved Documents. The rationale and policy intent for this change to transitional arrangements is set out in Chapter 3 of the Future Buildings Standard response document.

5. Analytical Approach

Assumptions applicable to main Cost Benefit Analysis

5.1. The main cost benefit analysis figures assume 100% compliance with Part F requirements by following Approved Document F guidance, as this assumption is commonly used in building regulation analysis. The changes for domestic buildings focus primarily on improved guidance to support compliance with the building regulations, except for a new standard for ensuring that ventilation does not get worse when energy efficiency retrofit is undertaken. For non-domestic buildings, changes also focus on improved guidance, but with a new standard to mitigate the risk of transmission of infection via aerosols through the provision of air quality monitors (CO_2 monitors).

5.2. Consequently, this means that the only costs and benefits associated with the policy are:

a. Training and familiarisation costs for both domestic and non-domestic buildings;
b. Costs from extending the ventilation requirement for building work on existing homes, and;
c. The provision of air quality/CO_2 monitors in non-domestic buildings.

5.3. Sensitivity analysis has been taken forward to look at the possible impacts from improved guidance.

5.4. Prices and estimates shown below are in 2021 base year, 2019 prices. This is except for the EANDCB and Business Impact Target calculations, which are calculated using 2020 base year, 2019 prices as per official guidance.[2]

5.5. As per Green Book Guidance, a discount rate of 3.5% has been used for costs and estimates of non-health benefits in the first 30 years of the building, with 3% for subsequent years. For health-related benefits, a 1.5% discount rate has been used over the 10-year appraisal period.

5.6. The appraisal time period for estimating the impact of the policy is 10 years which is consistent with other IAs associated with the construction industry. For the analysis of new dwellings or new non-domestic buildings, an asset life of 60 years is assumed. The total period for the IA is therefore 70 years so that the full 60-year impact of a building constructed in year 10 is assessed. This helps to ensure there is a full appraisal of the 'lock in' of ventilation standards.

5.7. Annex A provides more detail on domestic and non-domestic build growth rates used in the cost, benefit and wider analysis.

5.8. For more detail on assumptions applied to the modelling, please see '*2021 changes to the Energy Efficiency Requirements of the Building Regulations for Non-domestic Buildings'* IA[3].

[2] HMG (2021) Impact Assessment Calculator User Guide, https://www.gov.uk/government/publications/impact-assessment-calculator--3

[3] Available here: https://www.gov.uk/government/publications/2021-uplift-to-energy-efficiency-standards-improved-ventilation-and-new-overheating-requirement

Phase-in Assumptions for Non-Domestic Buildings

5.9. The following phase-in assumptions have been made for the proportion of new and existing non-domestic buildings which will be built to the new 2021 standards as opposed to the 2013 counterfactual. These take into account the effect of transitional arrangements, discussions with industry and the experience of consultants in this sector. Assumptions about the lead-in, build and completion times for non-domestic buildings were also used to determine the profile.

Table 1: Phase-in assumptions (% works captured by 2021 uplift)

	2022	2023	2024	2025	2026 Onwards
New Non-Domestic	0%	5%	50%	95%	100%
Existing Non-Domestic	50%	100%	100%	100%	100%

5.10. In the existing non-domestic sector, lead times are typically much shorter with less building work (e.g., replacement of windows) likely to require planning permission and transitional arrangements less likely to apply.

Counterfactual

Compliance

5.11. In some buildings there is a gap between the designed and as-built performance, known as the 'performance gap'. While buildings can appear to fully meet the ventilation standards through the paperwork submitted, in reality, the building can fall short of these due to incorrect product selection and/or poor installation quality. The costs and benefits of changes in guidance that may help reduce the performance gap have been discussed below. However, they are not included in the main cost benefit modelling, as these are not new standards. The CBA also assumes 100% compliance with the standards, which is standard practice in estimating the impact of a regulation change. The issues causing this gap are complex and, whilst some evidence has been produced, overall, there remains insufficient evidence to provide a sufficiently robust estimate of the size of the gap, or how widespread the problem is.

5.12. For new homes in September 2019, MHCLG published research[4] which evaluated whether the ventilation provisions recommended in the 2010 edition of Approved Document F (ADF) of the Building Regulations provide satisfactory indoor air quality in new homes. A key secondary aim was to establish the extent to which installed ventilation systems comply with the minimum ventilation provisions recommended in ADF.' This studied 80 homes across 7 developments in England.

5.13. The study found that only a small number of homes met the minimum ventilation provisions recommended in ADF:

[4] Aecon Limited and Ministry of Housing, Communities & Local Government (2019), 'Ventilation and Indoor Air Quality in New Homes', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835208/Research_-_ventilation_and_indoor_air_quality.pdf

a. **Naturally ventilated homes:** Only 2 of the 55 homes visited met the guidance in ADF with respect both to trickle ventilator provision and intermittent extract fan airflow rates. Only 9 of the homes met the minimum extract fan flow rates. A number of fans tested provided less than half the recommended flow rate; this accounted for a quarter of all fans. Only 50% of homes met the minimum trickle ventilator areas, with homes ranging from 60% below to 107% above the recommended area.

b. **Homes with continuous mechanical extract:** Only one of the 25 homes visited met the guidance published in ADF with respect to both continuous extract fan airflow rates and trickle ventilator provision. The key reason for this is that, in nearly all cases, the extract fan flow rates were below those recommended. In normal mode (i.e., low rate) whole-dwelling extract airflow rates ranged from 85% below to 8% above the recommended flow rate. Although trickle ventilators met the minimum free-area requirements in all the homes, for two of the three developments sites which had dMEV installed, trickle ventilators were installed in the same rooms as the extract fans. This is in contrary to guidance in ADF and may reduce the ability of extract fans to draw air through the whole house.

5.14. Whilst the study does provide an indication that there is a gap between the design and built performance for ventilation in new homes, the sample of homes is small. Therefore, for the purposes of the cost benefit analysis, an assumption of 100% compliance is still used. This applies to both the counterfactual and the 2021 proposal in the main cost benefit analysis.

Organisational Trends to Net Zero

5.15. As per the '2021 changes to the energy efficiency requirements of the Building Regulations for non-domestic buildings' IA[2], it was agreed an adjustment needed to be made to the counterfactual to take into account that corporate occupiers have commitments to reach Net Zero. These organisations, therefore, demand that developers meet standards well above the current planned building regulations uplift. Following discussions with industry consultants, it was concluded that it is reasonable to assume any building that was being built to higher energy efficiency requirements would also likely be going further than the Ventilation standards. Consequently, the same assumptions have been applied to the non-domestic Part F analysis. For more information, please read the '*2021 changes to the energy efficiency requirements of the Building Regulations for non-domestic buildings'* IA.[3]

Sensitivity Analysis

5.16. There is a high degree of uncertainty and lack of evidence around some of the estimates and assumptions made to model the costs and benefits. To reflect this uncertainty, sensitivity analysis has been performed around some of the key assumptions where evidence is limited.

6. Estimation of costs and benefits

Overview

6.1. The policies included in the cost benefit analysis are:

a. **Training and familiarisation costs** – these are included because these are the costs that industry incur from having to become familiar with the new guidance.
b. **Costs of CO_2 / air quality monitoring in some new non-domestic buildings** – these are included because this is a new element added to Part F guidance.
c. **Costs of extending the requirement for building work on existing homes**, so as not to worsen ventilation to all types of energy efficiency work.

6.2. The policies not included in the cost benefit analysis are:

a. Additional guidance which results in improved compliance with existing standards in new and any domestic buildings undergoing building work improvements.
b. Additional guidance which results in improved compliance with existing standards in new and any non-domestic buildings undergoing building work improvements.
c. Costs and benefits of setting a standard for existing domestic buildings to replace ventilation lost due to window replacements (controlled fittings) – this is improved guidance and is already a requirement.
d. Commissioning sheet and checklist being provided to the owner of the building – this is a minor change and is included in administrative burdens.

Costs and Benefits of New standards in Domestic and Non-domestic Buildings

6.3. The costs of changes to Part F standards (as set out in paragraph 6.1) are included in the main cost benefit analysis. For benefits, given the level of uncertainty of possible impacts, these are not included in the main cost benefit analysis. To illustrate the possible scale and value of benefits available from improved ventilation, however, sensitivity analysis has been taken forward below.

1. Transition/ Familiarisation Costs (Domestic and Non-domestic)

6.4. There are transition costs incurred by businesses to familiarise their employees with the new technical standards and requirements for ventilation. The changes to Part F standards will simplify the guidance for both domestic and non-domestic buildings.

6.5. It is assumed that training is necessary for developers and associated professional services to design the buildings to the new standards and procure the appropriate building components for the supply chain to be ready to meet this demand.

6.6. The familiarisation costs that are likely to occur have been estimated by Adroit Economics through the following process:

a. Types of business/organisation that will be affected were identified. These included consultants, contractors, installers and building control.

b. Types of familiarisation activity were identified. These included preparing training course material, self-study, continuing professional development (CPD), and formal training courses.
c. Consultation was undertaken with a small sample of these businesses and/or representatives of these businesses/organisations, to identify the time/cost likely to be incurred.
d. The costs were then scaled up across the industry based on the number of businesses/organisations.

6.7. Table 2 shows the estimated average familiarisation time (in hours) for each type of affected business/organisation.

Table 2: Average familiarisation time (hrs) for each type of affected business

	Consultant	Installer	Main Contractor/ Developer	Engineer
Domestic	2	2	3.75	2
Non-Domestic	2	2	3.75	2

6.8. Table 3 shows the estimated number of businesses/organisations that will need to become familiar with the changes:

Table 3: Estimated number of businesses that will need to familiarise themselves with the changes

	Consultant	Installer	Main Contractor/ Developer	Engineer
Numbers of organisations	3,085	1,865	465	380

6.9. Using the HMT GDP deflator, this means that the estimated total transitional costs in 2019 price year and 2021 base year are **£0.8 million**.

6.10. Please note that this estimate should be treated with caution, as the scale and process for training and dissemination may be different across industry and business for this set of standards.

2. New Part F standards for Non-domestic Buildings: CO_2 / air quality monitoring

6.11. This section includes costs for additional standards as set through Approved Document F2: Buildings other than dwellings. The Government will proceed with including standards for air quality monitoring. In the context of ventilation performance standards, air quality monitoring is typically used as an indicator of overall air quality. This allows the comparison of indoor and outdoor air, for example, or to be used to directly control ventilation levels. Maintaining good levels of air quality is likely to support better productivity and health.

6.12. This impact assessment therefore considers the impact of the revised guidance on air quality monitoring in offices. The updated guidance also states that air quality monitors

should be installed in rooms where; aerobic activity is likely to take place (e.g., gyms); singing or loud speech are likely to take place, or; where members of the public are likely to gather in large numbers. It is very difficult to identify data on the number of or size of these types of room in new buildings without significant research. Consequently, analysis has not been taken forward for these. Given the magnitude of benefits compared to the costs of installing air quality monitors in offices (explored below) however, it is likely that for 'higher risk' rooms, the benefits would outweigh any costs by an even greater magnitude.

6.13. For the purposes of this IA, it was deemed disproportionate to take forward other analysis to quantify the costs and benefits from guidance changes which reflect current standard practice, as this is likely to affect only a very small number of buildings and therefore result in very low additional costs. These include revisions to guidance on recirculating systems, outdoor air rates in common spaces and extract fans.

Costs of CO_2 / air quality monitoring in offices (included in main Cost-Benefit analysis)

6.14. The costs and benefits for the standards for air quality monitors in offices have been quantified. It is assumed that guidance to provide air quality monitoring will be complied with by the provision of CO_2 monitors. Spaces smaller than $50m^2$ and larger than $320m^2$ are excluded from the policy but have been unable to be excluded from the analysis, as it is extremely difficult to estimate the number of rooms that are in these size bands. Consequently, the costs and benefits for offices are likely to be overestimates.

6.15. Following discussions with industry, an average installation and replacement cost was assumed of £7.40 per square meter of gross internal office space, to provide an adequate number of CO_2 monitors as per the new guidance in the 2021 uplift. This takes into account the unit cost, energy connection, labour costs, and any additional installation costs.

6.16. As per the CIBSE Guide M guidance, the analysis has assumed that CO_2 monitors have a lifespan of 8 years. Therefore at the end of the eighth year, businesses will face some replacement costs. This includes labour and the unit cost of the CO2 monitor, equalling f £3.40 per square meter of gross internal office space. The remaining £4 of the total £7.40 installation cost is comprised of additional ducting and wiring that is assumed to have a lifecycle of 25 years. Therefore, over the 60-year asset life, offices are assumed to have 7 replacement cycles of CO_2 monitors and 2 replacement cycles of the required ducting and wiring, in addition to the initial installation cost of both.

6.17. These costs are aggregated and then multiplied by the annual average new build floor area projections. The present value cost of introducing CO_2 monitors is then calculated for the total 70-year appraisal period. This leads to a present value cost of £46m for offices.

Benefits of CO_2 / air quality monitoring in offices (outside of main Cost Benefit Analysis modelling)

6.18. Increased ventilation in offices leads to improved air quality which results in several benefits, such as increased productivity and a reduction in sick leave due to respiratory illness. To illustrate the possible scale of benefits available from improved ventilation in offices due to new standards on the provision of air quality monitors, DLUHC has produced some

indicative analysis. In this analysis, it is assumed that CO_2 monitors result in increased levels of outdoor air being delivered into offices, and the reduction in any ventilation performance gap. The extent to which equivalent outdoor air rates are increased is uncertain, so different scenarios at different changes in outdoor air flow have been examined.

6.19. There are significant overlaps between the two different estimates of benefits, with some improvements potentially being double counted. (increased productivity and reduced sickness absence). Therefore, these cannot be combined as this would lead to an overestimate of the benefits. Caution should also be expressed when interpreting the value of benefits. To prevent overestimating any benefits, increases in productivity and reduction in sick leave has only been assumed for the offices' first year of use.

Benefit 1: Increased productivity

6.20. Whilst it is not the only factor that may affect workplace performance, poor or inadequate ventilation can be a factor for worse workplace productivity. Poor or inadequate ventilation and high pollutant loads can lead to uncomfortable working conditions, thus affecting an employee's productivity (for example, cognitive ability). If productivity falls, this can have negative consequences for business output. By improving the ventilation of offices, indoor air quality can be improved, thus reducing the impact on a worker's productivity and business output.

6.21. The REHVA Guidebook on Indoor Climate and Productivity in Offices[5] took forward research of multiple studies over the last 20 years, assessing the possible impacts of better indoor air quality on increased productivity of employees. Given the complexity of the issue and lack of other available evidence, DLUHC has used this as the basis for quantifying the possible benefits from the policy. The following approach has been taken forward:

a. Based on analysis of the case studies presented, it can be estimated that each additional Litre per second (L/s) per person of outdoor air in an office leads to a ~1% reduction in employee dissatisfaction.

b. For every 10% reduction in employee dissatisfaction with indoor air quality, a 1.1% increase in productivity can be assumed.

c. Approved Document Part F states that offices should be provided with 10 L/s per person of outdoor air. By comparing this to the REHVA study (which has a base position of 6 L/s per person), we can examine how improvements in outdoor air rates may be able to contribute to enhanced productivity.

d. There is limited evidence to explain the relationship between outdoor air provision, pollutant load and levels of reported dissatisfaction. Therefore, for the purposes of this indicative analysis, it is assumed that outdoor air provision and pollutant load equally

[5] REHVA Guidebook No 6, 'Indoor Climate and Productivity in Offices', 2007, Case Study 1

explain levels of employee dissatisfaction. Using the findings from the study and applying it to the policy position, this leads to an approximate estimate of a 0.74 percentage point reduction in employee dissatisfaction, from every 1 L/s per person increase in outdoor air supply.

e. To monetise increases in productivity, Gross Value-Added data (GVA) was used. As this differs between regions, particularly between London and other English regions, ONS regional GVA data[6] was considered to be the best proxy. Table 4 shows a breakdown differentiating between the two.

Table 4: Value of annual additional work per employee due to increased productivity (£)

Change in Outdoor Air Provision	Outside of London	London
High: Δ 4 L/s per Person	£200	£280
Upper Central: Δ 3 L/s per Person	£150	£210
Upper Lower: Δ 2 L/s per Person	£100	£140
Low: Δ 1 L/s per Person	£50	£70

f. The above scenarios explore the potential impacts of increases of outdoor air provision. If office ventilation increases by 4 L/s per person, this achieves greater decreases in the level of dissatisfaction, and therefore higher increases in productivity, resulting in a higher value of additional work done. This equals £280 per year for a typical London worker and £200 for a typical non-London worker. However, lower increases in the outdoor air provision and therefore smaller decreases in the number of workers feeling dissatisfied, results in lower values of additional work done - £70 for a typical London worker and £50 for a typical non-London worker.

g. The 'State of the Estate' Report produced by the Cabinet Office[7] suggests that each private-sector office typically has a utilisation rate of 9.8 metres squared per employee. Using a central estimate of the size of a small, naturally ventilated office and a large, air-conditioned office, this leads to around 130 employees on average in a small office, whilst in a larger air-conditioned office, it is estimated there will be around 890 employees.

h. The total additional productivity from reducing employee dissatisfaction through increases in indoor air quality can then be estimated, by multiplying; 1) the value of work done per employee; 2) the number of employees per office, and; 3) the number of new-build offices that would not have achieved better ventilation without the policy intervention.

i. In the high scenario where all offices increase their provision of outdoor air by 4 L/s per person, this could lead to present value benefits of £163m. In a scenario where more buildings are already providing more outdoor air (9 L/s per person) and therefore only increase ventilation by 1 L/s per person, the present value benefits are £41m.

[6] ONS (2021), 'Gross Value Added', https://www.ons.gov.uk/economy/grossvalueaddedgva

[7] Cabinet Office (2020), 'State of the Estate in 2019-20', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/979276/State-of-the-Estate-in-2019-20.pdf

Table 5: Total NPV of Additional work done over the appraisal period (£)

Change in Outdoor Air Provision	Total
High: Δ 4 L/s per Person	£163,309,040
Upper Central: Δ 3 L/s per Person	£122,481,780
Lower Central: Δ 2 L/s per Person	£81,654,520
Low: Δ 1 L/s per Person	£40,827,260

Benefit 2: Reduction in sick leave due to respiratory illness

6.22. In 2019, 138.2 million days were lost through sickness absence in the UK, equating to 4.2 days per worker. Of this, 5.6 million days (4%) were due to respiratory conditions. There are several studies that identify indoor office conditions as factors that may cause sick leave due to respiratory illness.

6.23. When an employee is less absent due to illness, this leads to more output per worker, adding value to their employer and the wider economy. The ONS provides statistics to evaluate the value-added per hour of work by an employee, by employment location.

6.24. The REHVA Guidebook on Indoor Climate and Productivity in Offices examined the impact of sick leave due to respiratory illness because of an increase in the outdoor air supply. Case Study 4 attempts to assess the impact of increasing the outdoor air supply rate to 10, 15 and 20 L/s per person on the reduction of sick leave. This is split into a low and high impact scenario based on the existing level of sickness in an office. The low-impact scenario assumes that improvements in ventilation will have minimal impacts on the reduction of respiratory illness, as there is already a high level of sickness in the office. The high-impact scenario assumes that improvements in ventilation will have a greater preventative impact on respiratory illness when there are low levels of sickness in the office (in the absence of the policy, more respiratory illnesses would develop). The following approach is taken (all numbers are rounded to the nearest £10):

a. Using the REHVA Guidebook, an increase of 10 L/s per person in a small office of 72 employees results in a decrease of 78 sick days in the high-impact scenario and 66 sick days in the low impact scenario.

b. Therefore, for every 1L/s per person increase in the outdoor air supply, a decrease of approximately 0.1 sick days can be assumed in the high impact scenario and 0.05 sick days in the low impact scenario.[8]

c. Approved Document Part F states that offices should be provided with 10 L/s per person of outdoor air. By comparing this to the REHVA study (which has a base position of 6 L/s per person), we can examine how improvements in outdoor air rates may be able to contribute to reduced sickness absence. Under the high-impact scenario, an increase of 4 L/s per person would result in a decrease in sick leave due to respiratory illness by 0.4 days per employee. Where ventilation has a lower impact

[8] REHVA Guidebook No 6, 'Indoor Climate and Productivity in Offices', 2007, Case Study 4

on sickness rates, but the outdoor air supply is still increased by 4 L/s per person, this is reduced to 0.2 days per employee.

d. The gross value added per hour of a typical London employee is £50 and the outside London average is £30. This means a sick day in London (at 7.5 hours per day) may cost the employer and economy £360 in London, whilst outside London, it costs £240 in lost work.

e. This can be valued by multiplying the daily GVA of an employee by the decrease in absence, as shown in Table 6.

Table 6: Value of additional work done per employee per year due to decreased sick days due to respiratory illness (£)

	High-Impact	Low-Impact
Outside London Average	£110	£50
London	£150	£70
Weighted average	£120	£60

f. These numbers can then be scaled up to understand the total benefit of the policy over the appraisal period, using forecasted annual build areas of offices by size.

Table 7: Net Present Benefit Values of Reduced sick days due to respiratory illness (£)

Change in Outdoor Air Provision	High-Impact	Low-Impact
High: Δ 4 L/s per Person	£88,377,040	£42,212,140
Upper Central: Δ 3 L/s per Person	£66,282,780	£31,659,100
Lower Central: Δ 2 L/s per Person	£44,188,520	£21,106,070
Low: Δ 1 L/s per Person	£22,094.260	£10,553,030

g. Consequently, the estimated present value benefit of reduced sick days, due to increasing the provision of outdoor air by 4 L/s per person, is £88.4m in the high-impact scenario. Under a the low- impact scenario, the total policy effect is a benefit of £42.2m. Offices may however already be approaching the outdoor air provision standards in Approved Document F; therefore, if the increase in outdoor air provision is 1 L/s per person, the realised benefits from the policy are lower at £11m.

h. It should be noted that this analysis does not attempt to include any assessment of the potential benefits of the policy during future epidemics or pandemics, where aerosols are dominant forms of transmission. It also assumes similar office occupancy levels to historic trends, which may be inherently different in the longer-term due to recent trends.

Summary of Non-Domestic Benefits

6.25. As there are significant overlaps between the two benefits of reduced sick days and productivity, these cannot be combined as this would lead to an overestimate of the total policy benefits. Therefore, each should be considered separately. Taking productivity

benefits first, guidance changes in air quality monitoring would have a net benefit as a policy in almost all scenarios. For the reduced sick days, half of the high-impact scenarios (a 4L/s or 3L/s per person increase) would lead to an overall net benefit of the policy. For all low-impact scenarios, the costs would outweigh the benefits. These benefits however have only been appraised for 10 years rather than the 70-year period the costs have been appraised over. They also do not take into account the cumulative annual benefits accrued in each new office, as they only assess the first year the CO_2 monitors are installed. Therefore, it is highly likely that in any scenario, the benefits of the provision of air quality monitors in office spaces are greater than the costs.

3. *New standards (including Regulation 4) for existing homes: Energy efficiency retrofit*

6.26. When energy efficiency work is carried out on an existing dwelling, this may result in an improvement in the airtightness (a reduction in infiltration) of this property. Many older homes are ventilated through infiltration, and this will result in under-ventilation of the property with an associated risk of damp, mould and poor indoor air quality.

6.27. The Building Regulations 2021 introduce a new legal requirement that where energy efficiency work is done to an existing building, ventilation must either meet the Part F standard by the time the work has finished or, at least, must not have been made worse in relation to it. A lot of types of building work that would increase the energy efficiency of a building, for example replacing windows or doors, were already subject to this legal requirement. The new provision makes sure that when *any* energy efficient retrofit work is carried out, for example wall insulation, ventilation should be adequate or, at least, not be made worse. Guidance has been provided to cover the most common circumstances where energy efficiency measures are likely to reduce background ventilation levels and recommend necessary additional ventilation provisions.

6.28. The guidance has been structured to cover different categories of energy efficiency retrofit projects. Projects defined as either ‘Category B’ and ‘Category C’ are deemed to require additional ventilation because of energy efficiency retrofit; Category C projects typically have a greater improvement to the airtightness of the building. Any substantive energy efficiency retrofit project will fall into one of these two Categories.

6.29. The most common retrofit work that would result in a project being categorised in Category B or C is solid wall insulation (SWI). It is very difficult to find available data on the total annual number of SWI installations in England. The best data available that can be used as a proxy is the number of SWI installations that were carried out under government schemes in Great Britain. This shows that in 2019, 12,087 SWI’s were installed in homes in Great Britain.

6.30. All government insulation schemes must be done to PAS 2030 and 2035 standards which require adequate ventilation, meaning these would comply with the new Part F requirements. There are other types of work that would result in this category; however, these are underfloor insulation which are rare and window replacements which are covered below in the section on replacement windows. It was therefore considered disproportionate to assess the costs and benefits of these changes where they would currently affect few homes. While such measures are currently rare, they are likely to become more common

over the coming decade to meet net zero targets. These changes will safeguard against homes being retrofitted and lessening adequate ventilation.

Guidance Changes for Domestic Buildings: Sensitivity Analysis

6.31. The main cost and benefit analysis only includes the impact of new policies/additions to the guidance. For changes and simplifications in guidance, the costs and benefits of changes for domestic buildings (as set out in paragraph 6.2) are not included in the main cost benefit analysis, as these are not new requirements and therefore place no additional burdens on industry. Sensitivity analysis has, however, been taken forward to illustrate the possible scale of impacts that improved simpler, clearer guidance may have on reducing any unintentional non-compliance with the existing standards.

1. Simplifying guidance in new domestic buildings to improve non-compliance

6.32. There are a number of changes to Approved Document F volume 1: dwellings. Many of the changes are intended to simplify the guidance. The analysis here focuses on where the improved guidance has led to an increase in ventilator sizes. The equivalent analysis has not been undertaken for non-domestic buildings. This was deemed disproportionate as there are considerably fewer in number and mechanical ventilation is more prevalent.

Increased background ventilator sizing for naturally ventilated systems

6.33. The policy change is to simplify the guidance for naturally ventilated systems. Because of this, it is very likely to result in an increase in the size of background ventilators for naturally ventilated homes.

6.34. The percentage of new homes impacted per year is estimated based on the number of new homes that are currently naturally ventilated. Data for new homes made available from EPCs lodged on the Energy Performance of Buildings Register suggests that 73% of new homes are naturally ventilated.

6.35. For simplicity, it is assumed the increased trickle ventilator area on average can be based on the semi-detached home. This results in the need for two additional background ventilators – one of 5,000mm^2 and one of 10,000mm^2 equivalent area. The total capital cost of these trickle ventilators per home is £17.

Increased background ventilator sizing for continuous mechanical extract ventilation systems

6.36. The policy change is for the size of background ventilators to be increased from 2,500mm^2 to 4,000mm^2 equivalent area in habitable rooms for continuous mechanical extract ventilation (MEV) systems.

6.37. The percentage of new homes impacted per year is estimated based on the number of new homes that currently have an MEV system. Data for new homes made available from EPCs

lodged on the Energy Performance of Buildings Register suggests that this comprises 24% of new homes.

6.38. The total cost per home is estimated to be £6. This is based on approximately 4 background ventilators per home on average.

Costs (outside of main Cost-Benefit Analysis)

6.39. The present value costs are £36m. Given these costs are incurred due to clearer guidance regarding existing requirements, these have not been included in the headline figures of this IA, which illustrate the costs and benefits of additional burdens due to new requirements only.

Benefits (outside of main Cost-Benefit Analysis)

6.40. It is difficult to quantify the benefits from the change in size of ventilation systems due to simplified guidance, and available evidence is limited. Consequently, no benefits have been quantified for this policy, although it is expected that this could lead to some health benefits and reduced remediation costs in the future.

2. Changes in guidance in existing domestic buildings: Replacement windows

6.41. Approved Document F 2010 currently specifies that where the original windows are not fitted with background ventilators, and the room is not ventilated adequately by other means, it is good practice to fit background ventilators or an equivalent means of ventilation. The Building Regulations 2010 require that replacing a controlled fitting (a window or door) should not make a building any less compliant with the requirement of Part F of the Building Regulations.

6.42. Approved Document F1 2021 improves the guidance on compliance with that requirement. The guidance set out in the Approved Document is that background ventilators (or an equivalent means of ventilation) should be provided when replacing existing windows, or it should be proved that the home is no less compliant with Part F than before the work.

6.43. None of the following costs or benefits have been included in the main cost benefit analysis, as these are from changes in guidance rather than a new requirement. Any impacts are therefore a result of improved guidance reducing unintentional non-compliance with the existing standards. There is also a lot of uncertainty around the assumptions used to estimate the benefits, particularly for health-related benefits. Consequently, it was deemed inappropriate to include in the main cost benefit analysis.

6.44. For the following analysis of existing domestic buildings, where work tends to be on simpler and smaller projects, it is assumed that 100% of the works are to the new standards from June 2023.

Costs (outside of main Cost-Benefit Analysis)

6.45. To assess the cost of this impact the following has been assumed:

a. There are 2,530,000 windows are replaced per year[9].

b. Existing dwellings predominantly do not have continuous mechanical ventilation systems. Hence, the analysis is based on ventilator sizes for naturally ventilated dwellings. It is assumed that there is an installation of 8000mm2 of background (trickle) ventilators in each window (the proposal is for a minimum of 8000mm2 for habitable rooms and kitchens and a minimum of 4000mm2 for bathrooms).

c. 50% of windows currently installed already have sufficient background ventilators and 50% of windows installed do not have any background ventilators installed[10]. Hence, it is only the latter window installations that are subject to this policy.

d. The additional cost of installing a window with an 8000mm2 background ventilator compared to installing a window without a background ventilator is £2 (source: Currie and Brown).

6.46. The analysis estimates a present value cost of £10m. This has not been included in the main cost benefit analysis as this cost is associated with improved guidance rather than a new requirement, thus improving any unintentional non-compliance with the existing regulations.

Benefits (outside of main Cost Benefit Analysis)

6.47. Increased ventilation leads to improved indoor air quality which provides several benefits, including; improved health and wellbeing, NHS savings, productivity gains and reduced remedial cost of repairing mould and damp damage. To illustrate the possible scale of benefits available from improved ventilation in homes, due to better guidance on compliance/trickle vents being put in for replacement windows, DLUHC and consultants have produced indicative analysis. This focusses on the possible benefits from reduced remediation costs from repairing damp and mould damage and improved health.

Benefit 1: Reduced Remediation Costs

6.48. Whilst not the only cause, poor or inadequate ventilation can be a causal factor for damp and mould in homes. If significant damp or mould is present, then occupiers/landlords may have to pay for the wall/home to be repaired or redecorated. Improving the ventilation of homes can reduce the problem of damp and mould in a property and thus reduce the costs incurred by occupiers/landlords.

[9] Based on data reported by Competent Person Schemes

[10] Ministry of Housing, Communities & Local Government (2021), 'Future Buildings Standard Consultation IA', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/953664/201209_Future_Buildings_Standard_consultation_IA.pdf

6.49. AECOM have taken forward analysis to provide a high-level indicative estimate illustrating the possible scale of this saving, focussing on the guidance of having trickle vents when installing a replacement window. The following approach was taken:

1. Estimating the number of homes with trickle ventilators installed

a. It is estimated that there are 2,530,000 window replacements each year.[10]

b. Some replacement windows will already have sufficient background ventilators. From the consultation stage IA[11], it is assumed that 50% of windows currently installed already have sufficient background ventilators. This gives 1,260,000 windows with insufficient background ventilators.

c. Using data from the Competent Persons Scheme on window notifications, on average there were 3.64 windows replaced per home in 2018-19. These are either full or partial window replacements.

d. This leads to ~350,000 homes needing replacement windows with trickle ventilators (1,260,000/3.64).

2. Estimating the number of homes with significant damp issues

6.50. Substantive research would be needed to determine how many homes have significant damp and mould issues due to windows without trickle ventilators, and how much this could be reduced by installing trickle ventilators on replacement. Key questions include; 1) how many homes have significant damp or mould; 2) how much of this is caused by under-ventilation, and; 3) how much of this under-ventilation is because of windows not having trickle ventilators installed.

a. Evidence is very limited in this space. The English Housing Survey (EHS) reported that in 2019, 3.4% (around 1 in 30 homes) have some form of damp.[12] This is not split down any further and does also not attempt to estimate causality. Given both the complexity and lack of other available evidence, consultants decided to use the EHS estimate as an upper limit for the analysis. Therefore, it is assumed that 3.4% of homes will have significant damp or mould issues.

b. Applying the 3.4% to the number of dwellings that have replacement windows, this amounts to around 11,800 dwellings per year. Similarly, to the evidence on damp, there is limited evidence on how much trickle ventilators would reduce the level of damp through improved ventilation. This will depend on a variety of factors, including the original level of ventilation in the property and the amount of moisture and other pollutants generated in the property and surrounding area. Following engagement with industry, consultants agreed to assume that at a maximum, only 10% of homes that

[11] Ministry of Housing, Communities & Local Government (2021), 'Future Buildings Standard Consultation IA', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/953664/201209_Future_Buildings_Standard_consultation_IA.pdf

[12] Ministry of Housing, Communities & Local Government (2020), 'English Housing Survey, Headline Report, 2019-20', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945013/2019-20_EHS_Headline_Report.pdf

have damp would have significant levels of damp and mould due to not having trickle ventilators installed. This leads to an upper estimate of ~1,180 dwellings having significant damp and mould issues due to no trickle ventilators in windows.

3. Estimating the total benefit from reduced remediation

a. From engagement with industry, consultants found that the estimated cost for mould removal and redecoration is around £2,100 per home. If a home was to not have trickle vents fitted and developed significant damp and mould issues, then in addition to the remediation cost outlined, trickle vents would also need to be installed to avoid future issues. The cost of retrofit installation of a window with a trickle vent is estimated to be £35. For a dwelling with 6 window replacements, this equals £210. Consequently, the full cost of remediation is £2,310.

b. It is assumed that if a home does not have mould and damp issues and has windows fitted with trickle vents, they would only incur the cost of installing the trickle vent now. This is estimated to be £2 per trickle vent, so would be £12 per home. No other remediation costs would be incurred in the future. Therefore, it is assumed that the monetary benefit of installing windows with trickle vents per new home is £2,298.

c. Consequently, the present value benefit of reducing remediation by installing windows with trickle vents is £25m over the 10-year policy appraisal period. This has not been included in the main cost benefit analysis as this cost is associated with improved guidance for an existing standard, rather than a new standard.

Benefit 2: Health Benefits

6.51. Poor ventilation can increase the incidence and severity of respiratory conditions. There is a high social benefit of improving respiratory health, as this means fewer people will fall ill, resulting in fewer sick days. According to the British Lung Foundation, the total cost of all respiratory illnesses in the UK in 2014 was estimated to be £165 billion, including intangible costs, which represent the costs associated with pain, suffering and excess mortality[13]. Excluding these intangible costs, it is still estimated that the total cost to the UK is £11.1 billion, representing 0.5% of UK GDP in 2019. 4.4% of sick days are attributed to respiratory illnesses.

6.52. Calculating the impact of improved ventilation due to more trickle vents on health is extremely complex and will be determined by a variety of factors. This includes what proportion of respiratory illnesses are caused by poor ventilation, how much ventilation is improved by installing a trickle vent, and how much this improved ventilation would reduce respiratory illness. Given the level of uncertainty, DLUHC has first taken forward switching value analysis to illustrate what magnitude of health benefits would be needed for the policy to be cost effective. For the purposes of this analysis and given the uncertainty, the monetary benefits from reduced remediation have not been included.

[13] The British Lung Foundation (2017), 'Estimating the Economic Burden of respiratory illness in the UK', https://cdn.shopify.com/s/files/1/0221/4446/files/PC-1601_-_Economic_burden_report_FINAL_8cdaba2a-589a-4a49-bd14-f45d66167795.pdf?13095010944508481 69

6.53. The present value cost of replacing windows with trickle vents is £10m. Assuming a willingness to pay per quality-adjusted life year (QALY) of £60,000, the policy would therefore need to save 167 QALYs over the period of the policy in order to be cost-effective.

6.54. To assess whether the policy may produce this level of QALYs and be cost-effective, DLUHC used two reports to make an indicative estimate of the number of QALYs saved. Given that the reports have different approaches, they are used as a higher and lower estimate.

6.55. For the higher estimate, the 2010 DCLG study *'Costs and benefits of fitting trickle ventilators in replacement windows*' [14] is used. This estimates the total number of QALYs saved by fitting windows with trickle ventilators vs windows without trickle ventilators, over a 10-year time horizon. The study assumes approximately 760,000 dwellings have replacement windows fitted, estimating that this leads to a total saving of 616 QALYs. This amounts to a QALY saving per dwelling of 0.0008.

6.56. For the lower estimate, the published BRE *'The Cost of Poor Housing'* report is used. This looks at the number of QALYs saved from removing category 1 mould and damp from a home. The report estimates that there is a QALY saving per dwelling of 0.002.

6.57. As described on page 29, there is an estimated annual figure of ~350,000 dwellings which have replacement windows with trickle ventilators. Multiplying this by the higher and lower estimates of QALY savings per dwelling and by the 10 years of the appraisal period, gives the following results:

Table 8: Estimates of QALYs and their values

	QALYs saved	Value (£m)
High estimate	1,388	£76m
Low estimate	118	£6m

Summary of Benefits

6.58. The indicative sensitivity analysis estimates that the benefits from reduced mould and damp remediation are £25m over the 10-year appraisal period. There is a lot of uncertainty on the health benefit estimates, but the analysis gives a high estimate of £76m and a low estimate of £6m over the 10-year policy appraisal period.

6.59. Given that the present value cost of installing trickle vents in replacement windows is £10m, this means that even if there were no health benefits, there would still be an overall net benefit of the policy of £15m, due to the £25m estimated benefit from reduced remediation. These benefits have not been included in the main cost benefit analysis as this cost is associated with improved guidance rather than a new requirement.

[14] Department for Communities and Local Government (2010), 'Costs and benefits of fitting trickle ventilators in replacement windows', https://webarchive.nationalarchives.gov.uk/ukgwa/20100909092926/http:/www.communities.gov.uk/publications/planningandbuilding/trickleventilators

7. Business impacts

Equivalent Annual Net Direct Cost to Business (EANDCB)

7.1. The main cost benefit analysis only includes the costs and benefits incurred from new standards set out in Part F guidance. These are air quality monitors for offices and familiarisation costs for both domestic and non-domestic (energy efficiency retrofit has no costs or benefits). Therefore, these are the only costs included in the EANDCB calculation. All other impacts are from improvements/changes to guidance which will increase compliance with existing requirements, rather than increase costs.

7.2. Capital, installation and transition costs are all expected to fall on the building developer, with some maintenance and replacement costs falling on the business occupier. Consequently, all costs of the policy due to new requirements fall on business. There are no monetary benefits that will fall to business. As per Green Book guidance, the EANDCB is calculated over a 10-year policy appraisal period.

7.3. The proposed changes result in a small cost to business of £2.2m per year over the initial 10-year policy period.

Table 10: EANDCB and Business Net Present Value (£m)

EANDCB	(2.2)
Business Net Present Value	(46.0)
Score against the Business Impact Target	N/A

Small and Micro Business Assessment *(SaMBA)*

7.4. Adroit Economics was commissioned to consult with key stakeholders to explore the extent to which SMBs would be disproportionately affected by the changes to the ventilation requirements as set out in the response document.

7.5. From Adroit's consultations, they concluded that the changes would have no material disproportionate impact on this group of SMBs. This is because, when contracting, it is typical for small builders to work on a procurement basis with the necessary technical work taken on by others, hence the builder will buy in the necessary expertise and pass on the cost. Additionally, SMB builders do not typically engage in the planning and development of non-domestic buildings.

Mitigating the impact on small and micro businesses

7.6. Due to the negligible disproportionate impact expected on SMBs from the regulation change, there is no specific mitigation planned for this specific sector. DLUHC will, however, continue to proactively engage with industry as the interim uplift is introduced, including representatives of small and micro businesses. This will be done alongside additional research relating to routes and barriers to compliance for SMBs for the full Future Homes & Buildings Standard.

8. Wider impacts

8.1. This impact assessment has set out the direct costs to businesses and society, such as capital, replacement and maintenance costs, as well as setting out the wider societal benefits. There are, however, several considerations that may be indirectly affected by the uplift in standards or changes in guidance, or which may influence the potential impacts from the Building Regulations. These are explored below.

Economic and financial impacts

Competition

8.2. The principal markets affected by this 2021 policy are the markets for the development of new buildings and the refurbishment of existing buildings. The supply chains to produce materials used in the identified markets may also be affected and may need to change the types and number of different products they supply (for example, ventilator sizes, CO_2 monitors and windows with trickle vents installed) due to more clear and where applicable, additional, guidance.

8.3. The improved standards may have an impact on manufacturers and suppliers to the construction industry by increasing the demand for higher specification materials and products. These should however affect developers with similar designs and developments in similar ways. Therefore, any competitive effects in the market for building development are likely to be negligible. There may be some impact on suppliers of low cost or low-quality products and materials, who may be adversely affected by the change in regulations and guidance because developers will use them less frequently.

Innovation

8.4. The policies above may raise levels of innovation in the ventilation industry, particularly for products where new standards are being set such as CO_2 monitors. The greater clarity and emphasis placed on sufficient ventilation provided by the new guidance may also stimulate innovation in this area.

International Trade

8.5. The ventilation standards are set out in Approved Document guidance and include standards for a range of products across the new and existing stock, including trickle ventilators in windows and mechanical ventilation systems. Performance-based standards are set through the Approved Document guidance, which does not mandate for specific technologies or products to be used. Therefore, HMG is not required to notify the World Trade Organization.

8.6. There could be some indirect economic impacts, particularly by encouraging innovation. If product innovation occurs, this could lead to the development of new products and higher demand in relevant markets. If there is global demand for these goods then businesses will be incentivised to sell their products abroad, thus increasing international trade. This could

also lead to benefits for key UK sectors, such as manufacturing, if innovation takes place in a market where the UK holds a comparative advantage.

Social impacts

Housing supply

8.7. The government does not believe that the changes to Approved Document F 2021 will have a material effect on the supply of homes.

Health and well-being impacts

8.8. The health and well-being impacts, although central to this policy, are complex to calculate and are therefore uncertain. Sensitivity analyses to illustrate the potential magnitude of impacts have been covered in the main body of this impact assessment.

COVID-19

8.9. COVID-19 has shown the importance of ventilation in reducing the spread of infection and has been highlighted as a key risk for the health and productivity of people and businesses in the UK. Our proposals for ventilation improve the safety of building residents and users by simplifying and clarifying guidance to improve compliance and introducing new measures to mitigate the risks of airborne infection.

Environmental impacts

8.10. The government does not believe that the changes to Approved Document F 2021 will have a material environmental impact.

Administrative burdens

8.11. Administrative burdens are identified as the costs to business occurring from having to provide supplementary information due to legal requirements.

8.12. For Part F, this consultation is proposing to introduce new guidance to provide information about the commissioning of ventilation equipment to building owners and occupants. There are costs associated with collating, emailing and printing; but these are believed to be minimal. The benefits of improved compliance would likely outweigh the costs significantly.

9. Equalities Assessment

9.1. Under the Equalities Act 2010, all public authorities are required to have due regard of the need to:

- **a.** Eliminate unlawful discrimination, harassment and victimisation and other conduct prohibited by the Act.
- **b.** Advance equality of opportunity between people who share a protected characteristic and those who do not.
- **c.** Foster good relations between people who share a protected characteristic and those who do not.

9.2. This means there is a statutory duty to consider the impacts of the policy changes outlined in this Impact Assessment (IA) on people with the protected characteristics of age, disability, gender reassignment, marriage or civil partnership, pregnancy and maternity, race, religion or belief, sex, and sexual orientation.

9.3. Throughout the development of the policies in this impact assessment, the Government has assessed the potential impact on those with protected characteristics. Various processes and sources have helped to inform this assessment, including extensive engagement with a wide range of stakeholders and a review of all the correspondence that has been received in relation to the proposals. The responses to the two-stage consultation on the policies were also carefully analysed, to identify any specific concerns which were raised in relation to any disproportionate impact the policies may have on individuals because of a protected characteristic.

9.4. Where appropriate, policies have been amended and mitigating measures put in place. The assessment has concluded that there is no evidence that the final policies covered by this impact assessment will have a disproportionately negative impact on individuals with protected characteristics.

Appendix A – Net Completions Projection

Below is the independent analysis conducted by Adroit Economics of the number of net completions broken down by building type. This is used in our cost benefit and wider modelling. These estimates of new build completions are produced by an independent consortium. They are indicative and should be used for appraisal purposes only and do not represent an official forecast of changes in housing supply.

Table A.1: Assumed projection of net completions by dwelling type

Building Type	Annual number of net completions									
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Detached* house	71,000	73,000	75,000	76,000	76,000	76,000	76,000	76,000	76,000	76,000
Semi-detached house	57,000	58,000	60,000	61,000	61,000	61,000	61,000	61,000	61,000	61,000
Terraced house	38,000	40,000	41,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
Flats	65,000	67,000	69,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000

*Bungalows have been included in the detached house category, and represents around 5% over its total
Source: Adroit Economics

Please note, these projections are not an estimate of 'net additions', which is the figure usually used to calculate changes in housing supply. They do not account for change of use or conversions, which are a significant element of net addition but is outside the remit of this impact assessment; nor does it capture the impact of policy interventions that could increase industry's capacity to build new houses.

Table A.2: Assumed projection of floorspace by non-domestic building type

Building Type	Annual floorspace increase (000m^2)									
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Office – deep plan, air conditioned	466	464	462	460	458	456	454	452	450	448
Office – shallow plan, naturally ventilated	776	777	778	779	780	780	781	782	783	784

Source: Adroit Economics Consortium

The following sequence of assessments were undertaken to arrive at the future floorspace projections:

a. Estimated stock of floorspace across a range of building use types – this was calculated using several sources, including the most recent VOA statistics for business floorspace and previous analysis of the volume of non-business floorspace to inform the Non-Domestic Energy Efficiency Data Framework (ND-NEED).

b. Estimated annual change in the floorspace stock– this was estimated based on the annual average change in business floorspace area between 2014-19 from VOA statistics and applying average rates to the non-business sectors.

c. Estimated the annual rate of new build floorspace – this was calculated as a percentage of the total stock. The estimate was derived from figures for 2012-17 provided by a commercial data provider that tracks new building developments across the UK. The analysis assumes the same percentage build rate increase each year.

d. Matched the building use floorspace to the reference building types used for cost modelling - The analysis made assumptions to best match the floorspace for building use types (retail, office, industrial etc) with the reference building types (office – deep plan; office shallow plan etc) that were used for estimating the cost impact of the policy. Data on building size, coupled with advice from planning consultants informed these assumptions.