Department for Levelling Up,
Housing & Communities

2021 changes to the energy efficiency requirements of the Building Regulations for non-domestic buildings

Affecting new non-domestic buildings and existing non-domestic buildings when relevant building work is carried out.

Final Stage Impact Assessment

Signed by the responsible minister: E. Hughes **Date**: 13th December 2021

Title: 2021 changes to the energy efficiency requirements of the Building Regulations for non-domestic buildings **IA/ RPC Reference No:** RPC-DLUHC-5128(1) **Lead department or agency:** DLUHC	**Impact Assessment (IA)** **Date:** 15/12//2021 **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: Green

Cost of Preferred Option (in 2019 prices, 2020 PV for EANDCB and BIT, 2021 PV base year for all other calculations)			
Total Net Present Social Benefit	**Business Net Present Cost**	**Net Cost to business per year**	**Business Impact Target Status**
£61m	£21.4m	£2.5m	£12.4m

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

Climate change is a significant domestic and global challenge, with the costs of greater carbon emissions likely to be experienced by those who are not responsible for their production. Non-Domestic Buildings, both new and existing, account for 9% of total UK emissions[1], with around 1.5 million non-domestic buildings in England.[2] The Clean Growth Strategy and the Heat and Buildings Strategy outlined how more must be done to decarbonise buildings for the Government to meet its ambitious commitment of achieving Net Zero emissions by 2050[3]. This includes reducing annual carbon emissions by more than half in the buildings sector by 2035 to meet the UK's Carbon Budget 6 targets.

The Heat and Buildings Strategy builds on that by giving more detail on the UK's overall approach to decarbonising buildings. It aims to provide a clear direction of travel for the 2020s; set out the strategic decisions that need to be taken this decade; and demonstrate how we plan to meet our carbon targets and remain on track for net zero by 2050. As part of that, it highlights the important role that improving the energy efficiency of non-domestic buildings must play.

Improving the energy efficiency of both domestic and non-domestic buildings via the performance-based targets set through the English Building Regulations represents a significant opportunity to reduce carbon emissions and put the UK on the right path to achieve its Net Zero target. These emissions have high social costs, such as lower air quality which can lead to worse health outcomes, as well as the longer-term impacts of exacerbating climate change.

There are a range of market failures that exist meaning that these social costs have not been fully accounted for by the market and hence Government intervention is necessary to address the problem. These include; the cost of climate change not being fully reflected in energy prices; a lack of information about energy efficiency opportunities and the negative consequences of climate change, and; limited incentives for building owners and developers to make improvements to buildings which would reduce carbon emissions from non-domestic buildings.

What are the policy objectives and the intended effects?

The policy objectives and intended effects are to:

- Reduce carbon emissions and improve the energy efficiency of buildings.
- Make sure that when building work is done to non-domestic buildings it is done to a high standard of energy efficiency.
- To introduce an interim uplift in standards which will help make sure that all parts of industry are ready to deliver the full Future Buildings Standard from 2025 (which we will consult on in 2023).

[1] Department for Business, Energy and Industrial Strategy (2021), 2019 UK Greenhouse Gas Emissions, Final Figures - Data Tables, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972606/final-greenhouse-gas-emissions-tables-2019.xlsx

[2] Department for Business, Energy and Industrial Strategy (2020), 'Non-domestic National Energy Efficiency Data-Framework'

[3] Department for Business, Energy and Industrial Strategy (2018), Clean Growth Strategy, https://www.gov.uk/government/publications/clean-growth-strategy

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

Policy Option 1: Do nothing. Keep existing energy efficiency standards for 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 2: Preferred option. A new target for new non-domestic buildings, which delivers a 27% improvement in CO_2 emissions on average per building compared to the existing 2013 energy efficiency standards (more details in paragraph 4.7). We expect this would be delivered by; very high fabric standards, which means lower levels of heat loss from windows, walls, floors and roofs; improved services such as lighting, and; low carbon technology such as heat pumps or photovoltaic panels. For existing non-domestic buildings, this will be delivered by an uplift to minimum standards for building fabric and services, to align with those required in new non-domestic buildings as appropriate.

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:** 0.4	**Non-traded:** 0.3	

Summary: Analysis & Evidence Policy Option 2

Description: New target for new non-domestic buildings that delivers a ~27% reduction in carbon emissions on average per building compared to 2013 energy efficiency standards. All figures are Net Present Values (NPVs) over 10 years of policy and a subsequent 60-year life of the buildings.

FULL ECONOMIC ASSESSMENT

Price Base	PV Base	Time Period	Net Benefit (Present Value (PV)) (£m)		
2019	2021	70	Low: £48.4m	High: £73.3m	**Best Estimate: £61m**

COSTS (£m)	**Total Transition** (Constant Price)	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	£3.8m		£396m
High	£5.8m		£595m
Best Estimate	**£4.8m**		**£496m**

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

The increased costs (present value) are £491m, plus transition costs of £4.8m. This comprises of £407m for the uplift of energy efficiency standards for new non-domestic buildings, £35m for increased fabric standards for existing non-domestic buildings, £35m for increased standards for replacement of building services in existing non-domestic buildings, and £14m for new standards for Building Automation and Control Systems (BACS) for new and existing non-domestic buildings.

For new buildings, the initial capital costs will be borne by developers, but may be passed on in the form of higher purchase costs for non-domestic spaces/higher rents for end users of the buildings. Over the medium-long term, costs may be passed to landowners as developers willingness to pay for land falls, however in the short term this is unlikely. For public buildings (schools and hospitals), some additional costs will be incurred by local or national government, who will, however, experience the benefit of lower fuel bills.

Maintenance and replacement costs will be borne by the building owners/occupiers, and hence will be a cost to business. For works to existing buildings, costs will be borne by the building owners/occupiers, again meaning replacement and maintenance costs are costs to business. For public buildings (schools and hospitals), the cost will be incurred by local or national government, who will, however, experience the benefit of lower fuel bills.

Transitional costs are likely to fall on businesses who will need to get their employees up to speed with the new standards. This includes employees such as contractors, architects, energy assessors and building control etc.

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

The changes are unlikely to have a substantial impact on the demand for new buildings. Consequently, this has not been monetised.

BENEFITS (£m)	**Total Transition** (Constant Price) Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	£0m		£445m
High	£0m		£667m
Best Estimate	**£0m**		**£556m**

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

The benefits (present value) include energy savings of £418m, which will be experienced by occupiers of both new and existing non-domestic buildings in the form of lower fuel bills. This includes businesses and HMG, who experience the benefits from publicly owned buildings.

Non-financial benefits including carbon savings and air quality savings of £138m. The total carbon savings are 0.7 $MtCO_2$(e). These will benefit society as a whole, with lower carbon emissions and improved air quality leading to better health outcomes, and reduced risk of longer-term impacts of exacerbating climate change, such as increased risk of extreme weather, flooding, high temperatures, water shortages and loss of ecosystems.

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

The energy savings to consumers/businesses will be greater than shown because of reduced payments for VAT which will be a cost to the exchequer. As per Green Book guidance, this has not been costed as it is considered to be a transfer between consumers/businesses and the government. No allowance is made for fuel security benefits, employment opportunities from developing energy saving or low carbon/primary energy products or spill-over benefits of innovation.

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

The analysis has taken a common set of assumptions on fuel prices, traded and non-traded carbon values, emissions factors and air quality damage costs 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, or in areas where Local Authorities require non-domestic buildings to be built to a higher standard.

All calculations are in 2019 prices.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual)			**Score for Business Impact Target (qualifying provision only):** £12.4m
Costs: £39.4m	**Benefits:** £36.9m	**Net Cost:** £2.5m	

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1. Introduction

Background and scope of the proposal

1.1. This Impact Assessment (IA) accompanies changes which are to be made to the energy efficiency requirements of the Building Regulations. Specifically, and as defined in the legislation, the energy efficiency requirements are those of regulations 23, 26, 28 and 29 and Part L of Schedule 1 of the Building Regulations 2010[4].

1.2. The changes will affect **new and existing non-domestic buildings** in England when undertaking activities classed as 'building work'[5]. This document outlines the costs and benefits associated with these changes, and which are incurred both at the point of construction and when work is carried out on existing buildings. The Building Regulations are a devolved matter and the changes in this impact assessment apply to England only. For further information on the Building Regulations, see the *Manual to the Building Regulations*.[6]

1.3. Most new non-domestic buildings are required to meet the energy efficiency requirements of the building regulations, including newly constructed offices, warehouses, hospitals, schools and hotels. Industrial units, workshops and agricultural buildings (unless very low energy use) are also required to comply. Some exemptions and relaxation in standards are provided (and are summarised in paragraph 2.5 of this document).

1.4. Existing buildings need to comply with Building Regulations whenever work classed legally as 'building work' under this legislation is carried out. This will include extensions, replacement of 'thermal elements' (such as windows or doors) and replacement of 'fixed building services' such as major components of heating or cooling systems.

1.5. Enforcement of the Building Regulations is undertaken via the Building Control process. More details on this process can be found in the *Manual to the Building Regulations*[6].

1.6. The policy changes are set out in the response document *The Future Buildings Standard: 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.*

Future work (outside scope of the impact assessment)

1.7. This Impact Assessment (IA) only details the impacts of changes to the energy efficiency requirements of the Building Regulations for new and existing non-domestic buildings. Additional IAs are also being published alongside this one which include; parallel changes to the energy efficiency requirements for new and existing dwellings; changes to the

[4] The Building Regulations 2010, https://www.legislation.gov.uk/uksi/2010/2214/contents/made
[5] Building Work is defined in Building Regulations 2010 https://www.legislation.gov.uk/uksi/2010/2214/regulation/3/made
[6] MHCLG (20220), Manual to the Building Regulations, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/901517/Manual_to_building_regs_-_July_2020.pdf

ventilation requirements of all new and existing domestic and non-domestic buildings, and; the introduction of new requirement on overheating in residential buildings.

1.8. This IA relates to the elements of the consultation response which are proposed to be introduced from 2021 and referred to as the ‘interim uplift to the Future Buildings Standard’. It does not consider the costs and benefits of the ‘full Future Buildings Standard’, which is proposed to be introduced from 2025. A full technical consultation and associated impact assessment for the full standard will be produced in 2023.

2. Problem under consideration

2.1. Climate change is a significant domestic and global challenge, with the costs of greater carbon emissions likely to be experienced by those not responsible for their production. In June 2019 the UK became the first major economy to legislate for Net Zero greenhouse gas emissions, a target the Government committed to meeting by 2050. In addition to this commitment to reach Net Zero the UK has ambitious interim targets, which are set out in the Carbon Budgets and Net Zero Strategy. This year the Government laid legislation for Carbon Budget 6, which will require a 78% reduction in emissions by 2035, relative to 1990 levels.

2.2. Non-Domestic Buildings, both new and existing, account for 9% of total UK emissions.[7] Carbon emissions have high social costs such as the reduction in air quality which can lead to worse health outcomes, and the longer-term impacts of exacerbating climate change, such as increased risk of extreme weather, flooding, high temperatures, water shortages and loss of ecosystems. Buildings remain the second largest carbon emitter behind the Transport sector, with HMG's Net Zero Strategy indicating that in order to meet Carbon Budget 6 targets, buildings must reduce annual emissions by more than half.[8] Improving the energy efficiency of both new and existing non-domestic buildings therefore represents a significant opportunity to reduce carbon emissions and support the Government in reaching its targets, whilst keeping energy costs down for consumers now and in the future.

2.3. The Heat and Buildings Strategy sets out the immediate actions and long-term signals proposed to reduce emissions from buildings. It recognises the need to do more to decarbonise the building stock by making buildings more energy efficient and by installing low-carbon heating systems. It sets out a commitment to increase standards for new-builds in the 2020s to ensure they are ready for Net Zero, including through the Future Buildings Standard (FBS) from 2025 and the 2021 interim uplift to the Building Regulations.

2.4. The performance-based targets set through the energy efficiency requirements of the Building Regulations are an important part of this, aiming to improve energy efficiency and reduce carbon emissions of new buildings, and avoiding the need to retrofit in future. The 2021 uplifts to the energy efficiency requirements as set out in the Future Buildings Standard consultation response will act as an important stepping stone towards the full FBS in 2025, setting a path towards the decarbonisation of new non-domestic buildings and support the scaling up of low carbon technologies to decarbonise our existing stock.

2.5. Some types of buildings are either exempt from the energy efficiency requirements of the Building Regulations, or have certain requirements relaxed in specific circumstances. Further details can be found the *Approved Document L2,* but these include:

a. Places of worship.
b. Small buildings (<50m^2).

[7] Department for Business, Energy & Industrial Strategy (2021), 2019 UK Greenhouse Gas Emissions, Final Figures - Data Tables, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972606/final-greenhouse-gas-emissions-tables-2019.xlsx

[8] Department for Business, Energy and Industrial Strategy (2018), Clean Growth Strategy, https://www.gov.uk/government/publications/clean-growth-strategy

c. Industrial units, workshops and non-residential agricultural buildings of low energy demand.
d. Carports.
e. Historic buildings, buildings in conservation areas and scheduled monuments.
f. Temporary buildings with a planned service life of less than 2 years.

Industrial units, workshops and non-residential agricultural buildings which are *not* of low energy demand do need to meet the energy efficiency requirements. It is recognised in these cases alternative routes to compliance for new buildings may be required and are outlined in *Approved Document L2.*

3. Rationale for intervention

3.1. Climate change is a significant domestic and global challenge, with the costs of greater carbon emissions likely to be experienced by those who are not responsible for their production. Improving the energy efficiency of non-domestic buildings represents a significant opportunity to reduce carbon emissions from the building stock, which is essential for the UK to meet its Climate Change Act targets[9]. Building Regulations should be used to achieve this only where 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. The Building Regulations are the primary tool for setting standards for new non-domestic buildings. While there are policies in place to encourage the uptake of retrofit of the existing stock, it is necessary that the Building Regulations set minimum standards for such work.

3.2. Several market failures exist which means that, in the absence of government intervention, the market would not make the changes necessary to decarbonise the non-domestic building stock of its own accord. In the absence of any intervention, the long lifetimes of buildings could lead to lock-in of lower energy efficiency levels for many years to come. Uplifts to the Building Regulations can help to overcome the following market failures that act as a barrier to action:

- **Negative Externalities:** polluters (builders and building occupiers) do not incur the true cost of the emissions they emit by heating and powering their offices, schools, warehouses, etc. This is because the costs of climate change and increased greenhouse gas emissions, such as reductions in air quality and the subsequent impacts on human health, are not reflected in the price consumers pay for fuel. Thus, the private cost they incur via fuel bills do not cover the full social cost of heating and powering buildings. This means the cost is not fully accounted for by the market, leading to the external cost falling on society. Even if an appropriately high and sustained carbon price were applied, the mix of other market failures can act as a barrier to action. This is inconsistent with the Polluter Pays principle and thus requires government intervention via uplifts to the Building Regulations to correct the market failure. This will improve the energy efficiency of non-domestic buildings both at the point of construction and during the building lifetime, and subsequently reduce overall energy use.

- **Imperfect information:** there are several information failures that can occur across the energy and construction market. First, owners and occupiers may not understand the benefits of better energy performance or what can be done to improve it. This means in the absence of any intervention, there will be a lack of incentives for consumers to make energy efficiency upgrades to their buildings. For example, for some existing non-domestic buildings, owners are unlikely to choose better performing windows even though this would reduce their energy bills. Second, a lack of information on potential changes in energy prices mean that building buyers, tenants and mortgage providers do not value better performing buildings more highly than worse performing

[9] Climate Change Act 2008, http://www.legislation.gov.uk/ukdsi/2019/9780111187654/contents

ones. This is the case at the point of construction, sale, or rent of a building. For most businesses, energy costs are typically too small a percentage of their operating costs to make energy efficiency a substantial consideration when choosing the building they will occupy. Hence, locking-in higher energy efficiency of buildings via uplifts to the energy efficiency requirements of the Building Regulations is an effective intervention in reducing building owners' exposure to volatile energy prices, by reducing their energy demand. Businesses/occupiers also lack information on how to save on energy bills, and the full extent of savings they would make as a result of energy efficiency measures. As a result, businesses are not incentivised to choose better performing buildings over worse performing ones and hence they are not driving demand for more energy efficient buildings. This means that Government intervention is required to improve the energy efficiency of buildings via uplifts to the Building Regulations.

- **Credit/Resource Constraints:** a failure to set high energy efficiency standards at point of build can lock a building into higher energy consumption. This gives businesses who do want to act limited scope to improve energy efficiency later, as any building work would be disruptive and expensive. Lack of capital, lack of information and a limited tolerance for disruption, can all act as barriers to businesses who may want to renovate and improve existing buildings, using interventions that would be cost effective in the medium or long term. The large upfront costs of energy efficiency upgrades can also take a long time to recover given the lengthy payback periods resulting from lower fuel bills, hence businesses who are credit constrained may lack the ability to refurbish their buildings to higher energy standards. Using the performance-based targets set through the Building Regulations to ensure that new non-domestic buildings are locked into higher energy efficiency standards at the point of construction, removes the reliance on building owners having enough capital to make the improvements themselves.

- **Split incentives:** for new non-domestic buildings, developers have low incentives to build better performing buildings as they do not enjoy the benefits of lower energy bills, nor do they receive the additional income from energy generated by renewable technologies installed in the building. They do however incur all the costs. For existing non-domestic buildings, the same barriers apply to rental properties such as rented office spaces, whereby the costs of improving the energy performance of the building would be borne by the landlord, but the benefits of lower energy costs and increased comfort would be realised by the building occupants. These misaligned incentives mean that in the absence of higher standards set through the Building Regulations, building owners and developers may fail to make improvements to the performance of buildings. Therefore, Government intervention via uplifts to the minimum standards set out in the Building Regulations is required.

- **Public goods**: many of the benefits of climate change mitigation that could arise through improved energy efficiency in buildings, for example cleaner air, are public goods. Due to their unique characteristics of non-rivalry and non-excludability, public goods are not provided in a free market as producers are unable to make a profit from supplying them. Therefore, Government intervention via the Building Regulations is required to correct this under-provision of public goods by the market.

3.3. Building Regulations and standards are widely recognised as an appropriate point of intervention to overcome these market failures in the construction sector. Action at the point of build has the advantage of locking in low carbon technologies and energy efficient design, reducing overall energy demand of the building and avoiding the need to retrofit in the future.

4. Policy objectives and changes in standards

Policy objectives

4.1. The UK Government has set into law a target to bring its greenhouse gas emissions to Net Zero by 2050, with the Heat and Buildings Strategy setting out the central role that decarbonising buildings must play it that. Non-Domestic Buildings, both new and existing, account for 9% of total UK emissions Achieving Net Zero will require significant improvements in the energy performance of both new and existing non-domestic buildings and decarbonisation of heating and hot water. The performance-based targets set through the Building Regulations are an important means of reducing the carbon emissions from non-domestic buildings and setting the right standards will ensure the Government is on track to meet its ambitious 2050 target.

4.2. Full details of the final policy for the new energy efficiency requirements for new and existing non-domestic buildings are set out in the Future Buildings Standard consultation response. A summary of these policy objectives and intended effects are provided below.

4.3. The policy objectives are to:

- Reduce carbon emissions and improve the energy efficiency of buildings through an uplift to the energy efficiency requirements of the Building Regulations.
- Instigate changes in specifications, skills and supply chains needed to stimulate innovation and learning in the sector, preparing industry for the Future Buildings Standard, which is proposed to be introduced from 2025.
- Ensure that when relevant work is done to existing non-domestic buildings, it is done to a high standard of energy efficiency, which limits CO_2 emissions.

Changes in standards

4.4. The Future Buildings Standard response document, and the accompanying technical documents, set out the full details on changes to the energy efficiency requirements of the Building Regulations for new and existing non-domestic buildings. The changes from current standards are outlined below.

Performance metrics for the new minimum energy performance requirements for new non-domestic buildings

4.5. The Future Buildings Standard response document details the following three performance metrics which are used to assess compliance against the energy efficiency requirements:

- Primary energy target;
- CO_2 emission target; and
- Minimum standards for building fabric and fixed building services.

Minimum energy performance requirements for new non-domestic buildings: Primary energy target and CO_2 emission targets

4.6. Part 6 of the Building Regulations 2010 allow the Secretary of State to set a minimum energy performance requirement for a new building in terms of target CO_2 and Primary Energy rates.

4.7. Energy performance requirements for new dwellings are set by modelling a theoretical building, called the notional building. This notional building is the same size and shape as the building that is actually being built, but with a specification that is defined in Building Regulation guidance. This specification includes the energy efficiency of the walls, floor, roof, windows and doors and includes building services such as heating systems, ventilation systems or solar panels with defined characteristics. There is a government approved calculation method for modelling the notional building and that produces the targets developers need to meet (e.g., a target carbon emission rate). This method is called the National Calculation Methodology (NCM) and is implemented through the freely available Simplified Building Energy Model (SBEM). The developer can choose how to meet the targets, providing flexibility and allowing innovation. The technical specifications of the notional buildings used for the 2021 uplift to the Building Regulations are provided in the *National Calculation Methodology Modelling Guide* which is published alongside this Impact Assessment.

4.8. Comparing the 2013 notional building specification and the 2021 specification results in a **27% improvement**[10] in CO_2 target rates[11]. This is expected to be achieved in buildings using readily available technologies, products and techniques. The 2021 specification is likely to require high building fabric standards which will reduce heat losses from windows, walls, floors and roofs; improved efficiency of building services such as lighting and heating systems, and; on-site low carbon technology such as photovoltaic panels. In the Future Buildings Standard consultation, an alternative option was also provided which would have delivered a 22% improvement. This option was rejected in favour of the 27% improvement option, as it delivers greater carbon savings to support HMG's Net Zero commitments in the short term. Further details are included in the consultation response document. The final average level of improvement chosen is close to, but slightly lower than the 30% improvement seen when comparing the equivalent notional specifications for domestic buildings. This reflects the different end uses and services which are used across the different types of non-domestic buildings, compared to those used in domestic buildings.

4.9. The changes to the performance standards have taken into account the advice of the Building Regulations Advisory Committee (BRAC), its working groups, and responses to the consultation. They are considered to be achievable as an interim increase to the energy efficiency standards for new non-domestic buildings. The increase in fabric and building services standards can be met by developers using common materials, construction techniques and products readily available on the market.

[10] Average saving per building
[11] Primary Energy is a new metric for the 2021 uplift and no comparison with 2013 has been made.

4.10. Likely routes for meeting the target for some common building types are set out below. Our analysis indicates that these routes to compliance are likely to be more cost-effective than other options. It is important to note, however, that it is possible to meet the performance standards through a variety of mechanisms and technologies, allowing flexibility in design to meet the individual circumstances of the building and support innovation. These examples are not intended to be prescriptive but are included as a way of demonstrating how requirements may be most likely to be met.

Offices and schools

4.11. Offices and schools are likely to meet the new standards by installing significantly more efficient building services than were required by the previous regulations. These are likely to include more efficient heating and hot water systems, efficient ventilation systems, as well as improvements to other services. These building types are also likely to install renewables, principally roof mounted photovoltaics. We would also expect an improvement in the thermal performance of the building fabric relative to the previous set of standards. As explored later in the IA, some offices and schools are already meeting the new uplift standards and the cost benefit analysis has been adjusted accordingly to include these in the counterfactual.

Hotels and hospitals

4.12. Hotels and hospitals are likely to meet the new standards through enhanced building services efficiency, the addition of renewables, and increasing fabric insulation standards. Because of the clinical or service needs of delivering large amounts of hot water quickly, the opportunities for reducing the energy consumption of domestic hot water for such buildings is more limited. As explored later in the IA, some hotels and hospitals are already meeting the new uplift standards and the cost benefit analysis has been adjusted accordingly to include these in the counterfactual.

Retail warehouses and distribution warehouses

4.13. New warehouses are likely to meet the new standards by installing renewables, principally roof mounted photovoltaics. For these building types, improving the thermal performance of the building fabric and the heating system efficiency may not be as an attractive route to meet the new standards as for other building types. This is because of their lower heat demand, and the technical difficulty of improving insulation standards in large, open structures. As explored later in the impact assessment, some warehouses are already meeting the new uplift standards and the cost benefit analysis has been adjusted accordingly to include these in the counterfactual.

Minimum standards for building fabric and fixed building services in new and existing non-domestic buildings

4.14. The consultation response document sets out the full policy changes to minimum standards of building fabric and building services in new and existing non-domestic buildings. The minimum standards, often referred to as ‘backstop standards’, are typically described in terms of U-values (thermal performance) or an efficiency metric for building services. These need to be achieved in most circumstances, alongside (for new buildings) the overall minimum energy performance requirements described in terms of CO_2 and Primary Energy outlined above.

Other changes to Approved Document guidance

4.15. In addition to the changes to the performance metrics, the standards have been revised in specific areas of the Approved Document guidance. Most notably, these include:

Building Automation and Control Systems (BACS) for new and existing non-domestic buildings

4.16. A BACS is a centralised system used to monitor and control a building's environment and services. The policy is that new and existing non-domestic buildings, where relevant work is being carried out and there is a heating system over 180kW, should be equipped with a BACS to avoid the need to retrofit the building later.

Simplifying and updating guidance

4.17. There have also been minor changes to guidance, principally to simplify the statutory guidance. The final Approved Document guidance is presented alongside this impact assessment and response document.

Implementation dates & transitional arrangements

4.18. These changes will be implemented 6 months after regulations and statutory guidance are laid (June 2022). This 6-month period is a standard period allowed for regulations to come into force, and in line with the period provided under previous iterations of the energy efficiency requirements, which provides the construction industry with time to familiarise themselves with the standard. The changes do not require a major shift in the materials used or construction practices employed today. For non-domestic buildings, following consultation, DLUHC considers this to be an appropriate time period for industry to respond to the changes implemented through the interim uplift.

4.19. Transitional arrangements for new non-domestic buildings will only apply to individual buildings on which work has started within a reasonable period. Where work has not commenced on a specific building covered by the building notice, initial notice, or full plans within a reasonable period, that building will not benefit from the transitional provisions and so it would need to comply with the latest set of energy efficiency standards.

4.20. In line with the reasonable period that was in place for the 2013 uplift in energy efficiency requirements, developers of new non-domestic buildings will have 12 months from when these regulations come into effect to commence work on each individual building. These arrangements will apply on a building by building (as opposed to site-based) basis.

4.21. The same transitional arrangements will apply for existing non-domestic buildings. They are however used less frequently because most of the work on these dwellings is started and completed within a short period of time.

5. Summary of Analysis

5.1. A summary of the impacts considered under this Impact Assessment (IA) are provided below in Table 1, relative to the counterfactual (Option 1). All figures are Net Present Values (NPVs) over 10 years of policy and a subsequent 60-year life of the buildings. Negative NPVs are given in parenthesis and represent costs. The figures represent the aggregate impact across the building mix.

5.2. Overall, the additional costs and benefits are significantly influenced by the high building fabric requirements. The preferred option delivers an overall estimated net benefit of £61 million compared to the baseline option and delivers carbon savings of 0.7 MtCO2(e).

5.3. For new buildings, the initial capital costs will be borne by developers, but may be passed on in the form of higher purchase costs for non-domestic spaces/higher rents for buyers/renters. Occupiers are likely to benefit from lower fuel bills. Over the medium-long term, development costs may become factored into the land prices and therefore passed onto landowners. However, in the short term this is unlikely. For public buildings (schools and hospitals), the cost will be incurred by local or national government, who will, however, experience the benefit of lower fuel bills. For all types of buildings, wider society will benefit from reduced carbon emissions and improved air quality.

5.4. Maintenance and replacement costs will be borne by the building owners/occupiers, and hence will be a cost to business. For works to existing buildings, costs will be borne by the building owners/occupiers, again meaning replacement and maintenance costs are costs to business. For public buildings (schools and hospitals), the cost will be incurred by local or national government who will, however, also experience the benefits of reduced fuel bills. For all types of buildings, wider society will benefit from reduced carbon emissions and improved air quality.

Table 1: Summary of costs and benefits for all Non-Domestic Buildings (social costs)

	Energy efficiency requirements 2021
Transition costs (£m)	(5)
Energy savings (£m)	418
Incremental costs (£m)	(491)
Total financial benefit/(cost) (£m)	(77)
Carbon savings - non-traded (£m)	61
Carbon savings - traded (£m)	61
Total carbon savings (£m)	122
Air quality savings (£m)	16
Comfort taking (£m)	-
Total Net benefit/(cost) (£m)	61
Amount of gas saved (GWh)	2,186
Amount of electricity saved (GWh)	10,979
Amount of CO_2 saved - non-traded (MtCO2(e))	0.3
Amount of CO_2 saved - traded ($MtCO_2$(e))	0.4

Cost effectiveness – non-traded (£/tCO_2)	0.6
Cost effectiveness – traded (£/tCO_2)	0.6

*Energy Savings are calculated using Long Run Variable Costs

Equivalent Annual Net Direct Cost to Business (EANDCB)

5.5. In line with Impact Assessment guidance, the energy savings in the social cost benefit analysis presented above is valued using the variable price of electricity and gas (to avoid the inclusion of transfer payments in the impact assessment). For the purposes of estimating the costs and benefits to business, energy savings have been valued at the retail price, as it is assumed that any energy savings experienced from higher energy efficiency would also fall to businesses occupying the building, other than publicly owned buildings such as schools and hospitals.

5.6. This leads to a small EANDCB cost of £2.5m over 10 years, in 2019 prices, 2020 base year. The net present value cost for business stands at £21.4m.

Table 2: EANDCB and Business Net Present Value (£m)

EANDCB	(2.5)
Business Net Present Value	(21.4)
Score against the Business Impact Target	(12.4)

6. Analytical approach

Assumptions applicable to all analysis

6.1. To assess the impact of these uplifts to the energy efficiency requirements of the Building Regulations, a cost benefit analysis has been undertaken. This Impact Assessment (IA) has revised assumptions used in the 2021 consultation stage IA, reflecting final policy positions, improvements in the evidence base following consultation and further engagement with industry, as well as most recent data.

6.2. This IA is based on the Green Book and the accompanying supplementary guidance on the valuation of energy use[12]. This IA considers updated fuel prices, the updated traded and non-traded carbon values and the Green Book emission factors which are used for appraisal purposes.

6.3. Energy savings are valued at the variable rate in macroeconomic calculations in accordance with the supplementary Green Book guidance. This is appropriate for social analysis and assumes that the retail energy savings enjoyed by the consumer occupying an energy efficient building does not fully reflect the social benefit.

6.4. A discount rate of 3.5% has been used for the first 30 years of the building's life and 3% for subsequent years.

6.5. Prices and estimates shown below are in 2021 base year, 2019 prices. This is with the exception of the EANDCB and Business Impact Target calculations, which are calculated using 2020 base year, 2019 prices as per official guidance.[13]

6.6. All figures in the impact assessment are in terms of the 'Do Nothing' and the final policy, Option 2.

Appraisal Time and Asset Life

6.7. 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, including the 2013 energy efficiency requirements Impact Assessment.

6.8. For the analysis of new buildings or extensions to existing 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 that there is a full appraisal of the 'lock in' impact of higher fabric standards. An example of this is the impact of higher external wall standards, which will have an impact over a long period of time, potentially the entire lifetime of the building. For building fabric insulation (external walls, floors, roofs) the assumed asset life is 60 years, except for external windows which have been assigned an asset life of 30 years. This is comparable with indicative values

[12] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

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

provided in Annex E of *BS EN 15459 Energy performance of buildings – Economic evaluation procedure for energy systems in buildings*.

6.9. For services, gas boilers have an assumed asset life of 15 years, 20 years for light fittings, 20 years for ventilation equipment, 20 years for thermostatic radiator valves (TRVs) to align with the asset life for heat emitters, and 10 years for lighting controls.

6.10. For the analysis of existing non-domestic buildings, the key policies are the replacement of controlled fittings (e.g., windows) and controlled services (e.g., boilers), and the installation of self-regulating devices (SRDs). For these, the asset life is assumed to be the same as for the measure itself. Hence, for replacement windows for example, the costs and benefits were determined over a 30-year asset life. In this example, given the 10 years of policy being assumed, the total appraisal period for existing non-domestic buildings is therefore 40 years, so that the full 30-year impact of a building constructed in year 10 is assessed.

6.11. Only the elements of lifecycle costs that differed from the costs incurred in the counterfactual were considered. For example, general repair and decoration costs were excluded from the analysis, as these would be common to all new construction or works to existing buildings, irrespective of the energy performance options presented in this document.

6.12. Replacement costs were assigned to specific components within a specification and avoided replacements of components that would be expected to have a longer lifespan. For example, boiler replacements did not include replacement of a hot water tank or the gas or water supplies. Replacement costs included an additional allowance for the costs of working in an existing property and for the disposal of the end-of-life components.

6.13. Consequently, the ongoing costs associated with maintenance and replacement along with the benefits from energy, air quality and carbon savings have been estimated over a 60-year period for each building, which provides a sufficiently long period to capture the benefits of fabric ‘lock-in’. Given the 10 years of policy being 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. Learning rates have been applied to account for reductions in costs for less mature technologies.

Phase-in assumptions

6.14. 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 our consultants in this sector. Assumptions about the lead-in, build and completion times for non-domestic buildings were also used to determine the profile.

6.15. For new non-domestic buildings, there is a longer time lag between planning and completion compared to the domestic market. Consequently, the non-domestic profile trails the domestic by a year (5% built in 2023 as opposed to 2022). Consequently, the phase-in assumptions have changed since the consultation stage IA to better reflect the above. This leads to 0% and 5% of non-domestic buildings being built to new standards in the first and second year of the policy (as opposed to 20% and 50%) but has a faster acceleration over the subsequent years to a 100% built to the new standard by 2026.

6.16. In the existing non-domestic sector, lead in times are typically much shorter with less building work (e.g., replacement of heating systems or windows) likely to require planning permission and transitional arrangements less likely to apply. It is therefore assumed that 50% of the works in 2022 are to previous standards, with 100% built to the new standard by 2023.

Table 3: 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%

Counterfactual

6.17. All assumptions and changes below apply to changes made to the counterfactual.

Energy efficiency requirements

6.18. To estimate the overall costs and benefits of the proposed policy options, we have modelled the changes in construction and installation costs, energy use and related CO_2 emissions using the standards proposed in the 2021 energy efficiency requirements. These are then compared with a counterfactual baseline of costs and energy use under the 2013 energy efficiency requirements.

Compliance

6.19. It is known that in some new buildings, there is a gap between the designed and as-built performance, known as the ‘performance gap’. While non-domestic buildings can appear to fully meet the energy performance standards through the paperwork submitted, in reality the building can fall short of these due to poor build quality.

6.20. For the purposes of modelling, 100% compliance is assumed as this is standard practice in estimating the impact of a regulation. However, 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.

6.21. When considering the performance gap, it should be noted that the lack of evidence applies equally to the counterfactual and the 2021 proposal. This means 100% of the design performance is assumed in both cases. As a hypothetical example, if a non-domestic building built to the 2013 requirements used 20% more regulated energy than the regulatory calculations assumed, and the non-domestic building built to the 2021 standards also used 20% more energy, there would still be a 27% reduction in CO_2 from the 2021 uplift. Where such a 20% gap existed for both the policy and counterfactual, and our analysis assumes full compliance, then our analysis will underestimate the absolute carbon saved from the change. In addition, this would ignore any reductions in the gap due to the 2021 guidance and processes which provide; more information to builders on how to follow the new requirements; more information for Building Control Bodies to assist building checks, and; more information for occupants to help them use their systems more effectively. This would mean there is likely to be an underestimate of the impact of the 2021 requirements on energy savings (up to 20% in the example above). There is, however, a variety of outcomes that could lead to either an under or overestimate of the impact of the 2021 uplift, which depends on the relative performance of the counterfactual versus the Part L 2021 proposal. Consequently, given the complexity and lack of robust evidence, DLUHC believe that a 100% compliance assumption is reasonable.

New Non-Domestic Buildings

Organisational Trends to Net Zero

6.22. Following extensive discussions with industry and planning consultants, feedback highlighted that corporate occupiers in non-domestic buildings are extremely interested in sustainability and net zero carbon buildings, with many already committing to ambitious Net Zero targets in their business plans. These organisations therefore demand that developers meet standards well above the current planned building regulations uplift. This is particularly the case for larger developments and for offices, where the potential tenant will often be a large corporate who has committed to zero carbon by a set date. Consequently, the following assumptions have been made:

Office Benchmark for Developments larger than 10,000m^2

6.23. Given that large offices are already being built to very high standards, it is assumed that any offices larger than 10,000m^2 built with air-conditioning are already being built beyond the 27% performance improvement set out by the regulation uplift. For modelling purposes two archetypes of offices are used, one a 2,100m^2 shallow-plan office and one a 12,100m^2 deep-plan air-conditioned office. Using CoStar data[14] to take a 5-year average, 55% of offices built were larger than 10,000m^2. It is therefore assumed initially that 55% of the 12,100m^2 offices would already be built to the 2021 energy efficiency requirements. For these offices, any costs and benefits associated with the policy would be 0, with the costs and benefits applied to the counterfactual.

[14] 2012-2017 Costar Data

Office Developments smaller than 10,000m²

Table 4: Proportion of offices in each floor area size band

Size Band	Proportion of total Floor sqm
Up to 2,500m2	19.8%
2,500-5,000	9.9%
5,000-7,500	7.6%
7,500-10,000	7.3%
10,000+	55.5%
Total	**100.00%**

Source: CoStar and NEED data[15]

6.24. For offices smaller than 10,000m², the splits in Table 4 are used to apportion between the air-conditioned office and naturally ventilated office archetypes. Based on planning and development consultants' expertise, large offices in the 7,500-10,000m² range are assumed to be air conditioned, whilst those offices up to 2,500m² are assumed to be naturally ventilated. For all other offices (2,500-7,500m²), it is difficult to identify and estimate which archetype this size band would fall into. Consequently, given limited evidence, a central estimate of 50:50 was taken to apportion them evenly between the two office types.

All other Non-Domestic Buildings Approach

6.25. For offices smaller than 10,000m² and all other non-domestic buildings, it is assumed that in the absence of the 2021 uplift, these buildings would start to converge to the 2021 energy efficiency requirements and beyond over the course of the appraisal period. This is due to many organisations already having stated ambitious commitments to cut emissions or reach Net Zero by a certain point in the next decade. For example, many firms and developers have a target of Net Zero by 2025, whilst NHS England have committed to an 80% reduction in emissions from NHS owned hospitals by 2032.

6.26. Planning and Development consultants have consequently produced the following decay rate profile (Table 5 below). This maps out the proportion of new non-domestic buildings being built to or beyond the standard in a given year.

Table 5: Proportion of non-domestic buildings under 10,000m2 meeting 2021 uplift or beyond voluntarily

Year	Proportion of Buildings
2021	10.0%
2022	15.0%

[15] Costar data has significant undercounts for small offices (0-250m2) but is the best available data for new build rates . Consequently, NEED (National Energy-Efficiency Data Framework) data was used to make an adjustment to the <2,500 m2 group to account for these smaller offices.

2023	20.0%
2024	25.0%
2025	30.0%
2026	37.5%
2027	45.0%
2028	52.5%
2029	60.0%
2030	70.0%

Source: Quod Consultancy

6.27. Planning and Development Consultants assumed that 10% of non-domestic buildings smaller than 10,000m^2 are already meeting the 2021 energy efficiency requirements or beyond today, with this rising to 70% by 2030. It is projected that there will be a steady rise in the proportion of buildings building at the level of the 2021 requirements or beyond up to 2025, which is when some firms have set targets for net zero/low emissions. Progress will then accelerate towards the 2030 target, which has been more widely adopted by organisations. This, therefore, assumes that 30% of non-domestic buildings smaller than 10,000m^2 will continue to adopt the regulatory minimum set by the 2021 uplift by 2030.

Local Authority Approach

6.28. The Building Regulations set energy efficiency performance standards for new non-domestic buildings at the national level. Local Authorities (LAs) however have the power to set voluntary standards beyond the national requirements through local plans. In these cases, an adjustment needs to be made to the counterfactual, as some of the costs and benefits attributed to the 2021 uplift will, instead, already be incurred due to voluntary local commitments.

6.29. The Greater London Authority, through the London Plan, have set out commitments for all new developments to have at least a 35% reduction beyond the baseline of the 2013 energy efficiency requirements of the Building Regulations. For the policy, this means that any costs, benefits or savings of London buildings are set to, 0 due to the London Plan going further than the 27% reduction set by the 2021 energy efficiency requirements. Using VOA data, the proportion of each archetype in London is as follows:

Table 6: Proportion of Non-Domestic Building Types in London

Office buildings	**26%**
Schools	**13%**
Public Hospitals	**13%**
Private Hospitals	**9%**
Hotels	**20%**
Retail Warehouse	**8%**
Distributional Warehouse	**7%**

Source: Valuation Office Agency (VOA) 2020/21 Data

6.30. Outside of London, DLUHC checked where LAs have clear requirements to meet the voluntary 'Excellent' standard set out by the Building Research Establishment Environmental Assessment Method (BREEAM). This benchmark was chosen after analysis produced by Currie & Brown, which showed that for all of the non-domestic archetypes, achieving a 'BREEAM Excellent' certification would exceed the uplift set out by the 2021 uplift.

6.31. From analysing a subset of Local Plans, it was found that, for non-domestic buildings, it is considerably less common for LAs to have voluntarily commitments to go further than the 2013 regulations. It was therefore agreed, following discussions with planning and development consultants, that an appropriate and proportionate approach would be to identify the top 30 LAs which had the highest average new non-domestic build rates over the last 5 years. VOA Local Authority time series data was used to identify the group, with DLUHC then sampling these local plans to see which had BREEAM 'Excellent' equivalent commitments included. The sample represented ~25% of the total non-domestic building stock.

6.32. The analysis concluded that 17% of Local Authorities in the sample have voluntarily committed to BREEAM Excellence equivalent. This proportion was then applied to the whole new non-domestic stock outside London, with the assumption that all others continue meeting the 2013 energy efficiency requirements.

Existing Non-Domestic Buildings

6.33. Organisational and local authority trends and policies relating to Net Zero are considerably less well developed for existing buildings than for new buildings. The variety of different types, ages and use of existing non-domestic buildings hinders the setting of well-defined standards and, although some certification standards do exist, they are not common requirements within organisational or local authority plans and policies. This was confirmed when analysing LA plans, where there was no evidence that LAs were asking for commitments on existing buildings further than the 2013 energy efficiency requirements. Businesses are also a lot more limited in how much they can retrofit an existing building, with many of their plans focussing on new builds. Consequently, in agreement with Quod, DLUHC concluded that it would not be appropriate to model organisational or local authority effects within the counterfactual for existing non-domestic buildings.

6.34. For existing buildings, changing the minimum standards for thermal elements and building services are the main policy changes. The counterfactuals for these changes are described in more detail in the relevant sections but take into account changes in standard industry practice and technologies since the last 2013 standards were set. In particular, it is recognised that industry is already installing higher efficiency heating, lighting and cooling systems when making changes to the existing building stock. Consequently the 2021 uplift has no impact on these, and any costs and benefits associated with the policy would be 0, with the costs and benefits applied to the counterfactual.

7. Estimation of costs and benefits

Overview

7.1. The policy changes will affect all new and existing non-domestic buildings in England. The impact of the proposed policy changes will be experienced at the point of construction for new buildings. For existing buildings, the policy changes will affect building work where this work has an effect on the energy performance of the building. All policy changes have been designed to save energy over the life of the building. The policy will have an impact on manufacturers of construction products, the construction industry, building owners and tenants. Given the long lives of the buildings affected there is considerable uncertainty about future values. Therefore, for this assessment, it is assumed that there is an indicative ±20% uncertainty on the central estimate.

7.2. The figures in the following analysis are based on central estimates.

7.3. The principal policies have been included in the Impact Assessment (IA) and are:

- Minimum energy performance requirements for new non-domestic buildings.
- Minimum standards for building fabric and fixed building services in new and existing non-domestic buildings.
- Other guidance changes:
    - Building Automation and Control Systems (BACS)
    - Self-Regulating Devices (SRDs) for New and Existing Non-Domestic Buildings
    - Technical building systems
    - Low temperature compatible heating emitters in new and existing non-domestic buildings
    - Energy forecasting
    - Simplifying and clarifying guidance
- Training and Familiarisation costs.
- Transitional arrangements.

7.4. A small number of other policies have been identified which relate to minor changes to the guidance, target setting, or which affect relatively few buildings. Given the nature of these changes, the impacts are expected to be negligible. Consequently, it was considered disproportionate to include these in the cost benefit analysis within this IA. These are as follows:

- Changes to the target setting which are specific to new modular and portable buildings.
- Changes to the target setting which are specific to new buildings heated by fuel oil, LPG, solid fuel or direct electric heating systems.
- Technical changes made in the calculation method for rooflight thermal performance.
- Changes made to the setting of a heat network backstop which affects connections to high-carbon existing heat networks.
- Changes made to the airtightness calculation protocols.

- Changes made to the list of cost-effective measures which are recommended whenever consequential improvements apply.
- Clarification of guidance on ductwork insulation.
- Clarification of guidance on oversizing of systems.
- Clarification of guidance on boiler weather compensation.
- Clarification of guidance on electric radiant heater controls.
- Clarification of guidance on high efficiency alternative systems.

Costs and Benefits Summary

7.5. For new non-domestic buildings, the initial capital costs will fall on the developers, and maintenance/replacement costs will be borne by the building owner but may be passed on in the form of higher purchase costs for non-domestic spaces/higher rents for buyers/renters. Over the medium-long term, costs may be passed to landowners as developers willingness to pay for land falls, however in the short term this is unlikely. For public buildings (schools and hospitals), the cost will be incurred by local or national government, but they will experience the benefit of lower fuel bills. The occupier/building owner will experience the benefits through reduced fuel bills.

7.6. For existing non-domestic buildings, it is the building owner who will be responsible for the cost, whilst the occupants will experience the benefits of reduced fuel bills. In the case of publicly owned non-domestic buildings such as hospitals and schools, local or national government will bear the cost, but will also experience the benefits of reduced fuel bills. For all types of building, wider society will benefit from reduced carbon emissions and improved air quality.

Table 7: Summary of costs and benefits for main policy groups

	New Non-Domestic Buildings	**Existing Non-Domestic Buildings**	**Guidance changes (BACs)**	**Total**
Transition Costs (£m)	(5)	(0.1)		(5)
Energy savings (£m)	308	77	33	418
Incremental costs (£m)	(407)	(70)	(14)	(491)
Total financial benefit/(cost) (£m)	(104)	7	19	(77)
Carbon savings - non-traded (£m)	17	25	19	61
Carbon savings - traded (£m)	42	14	5	61
Total carbon savings (£m)	58	39	25	121
Air quality savings (£m)	12	3	1	16

Total Net benefit/(cost) (£m)	**(33)**	**49**	**45**	**61**
Amount of gas saved (GWh)	675	922	589	2,186
Amount of electricity saved (GWh)	9,229	1,321	429	10,979
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	0.1	0.2	0	0.3
Amount of CO_2 saved - traded ($MtCO_2(e)$)	0.2	0.1	0	0.4
Cost effectiveness – non-traded (£/tCO_2)	403	748	235	0.6
Cost effectiveness – traded (£/tCO_2)	334	-	1,287	0.6

*Energy Savings calculated in Long Run Variable Costs.

Drivers of the change in costs and benefits relative to the consultation stage impact assessment

7.7. There are several drivers for the differences seen between cost and benefit estimates presented here and those included in the consultation stage IA. There have been several policy changes which have led to a fall in costs. In particular, the previous analysis included a large cost associated with producing energy forecasts using the CIBSE TM54 methodology, which is now no longer specified as the only route for energy forecasting in guidance. There have also been a series of changes made to the counterfactual to better reflect current industry practice (more details included in *Section 5. Analytical Approach*). Specifically, where it is deemed that the new standard is already being met, costs and benefits from policy are set to zero, with the costs and benefits being counted in the counterfactual. The cumulative effect of these changes reduce the net present value benefit of the policy, compared to that presented at consultation stage.

7.8. For existing non-domestic buildings, the counterfactual has been adjusted to reflect that standard industry practice is to already fit buildings with energy efficient lighting. This has led to reduced electricity savings and increased gas savings from the uplift compared to estimates presented at consultation stage. Overall, this has led to a modest level of carbon savings from the policy.

7.9. Finally, the government's approach to carbon valuation was updated in September 2021[16] to reflect the latest evidence, domestic and international targets, and wider context. Consequently, the values attributed to carbon saved used for this impact assessment are higher than those used at the consultation stage. This value change, alongside the savings in carbon made, has resulted in a significant increase in the net benefit of the policy compared to the consultation stage.

[16] HMG (2021) Valuing GHG Emissions in policy appraisal, https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal

Costs and Benefits: Minimum energy performance requirements for new non-domestic buildings (Primary energy target and CO_2 emission targets)

7.10. An outline of the policy changes relating to minimum energy performance requirements is included in paragraphs 'Changes in Standards' section above.

7.11. The assessment of costs and benefits has been undertaken using analysis of seven non-domestic building archetypes. These building types have been chosen based on those employed in the impact assessment of the effect of changes to the energy efficiency requirements in 2013. These have then been supplemented by the inclusion of a hospital building and a naturally ventilated shallow-plan office. All of these building types were also implemented for MHCLG's cost optimal analysis published in 2019[17]. The building types are summarised in Table 8.

Table 8: Non-domestic building types

Building type	Wall type	Floor type	Floor area (m²)
Office – deep plan, air conditioned	Metal frame	Raised	12,100
Office – shallow plan, naturally ventilated	Masonry	Ground-contact	2,160
Hotel	Masonry	Ground-contact	1,087
Hospital	Metal frame	Ground-contact	13,387
Secondary School (includes sports facilities)	Masonry	Ground-contact	7,864
Retail Warehouse	Metal frame	Ground-contact	4,962
Distribution Warehouse	Metal frame	Ground-contact	4,962

7.12. To assess the cost and benefits of the uplift of energy efficiency standards for new non-domestic buildings, we have commissioned industry consultants to produce modelled estimates of energy consumption and build costs for each of the seven archetypes. These have been done for both a 2013 compliant position, which forms the counterfactual, and the 2021 compliant position, which forms the policy position.

7.13. Table 9 and Table 10 show the specifications for each position as assessed for each building type.

7.14. The baseline 2013 specifications have been chosen to reflect, in the absence of any policy change, how new non-domestic buildings may be constructed today in compliance with the 2013 energy efficiency requirements.

7.15. Alternative baseline positions were examined, including the 2013 notional building specification and adjusted 2021 policy positions. The final specifications for the baseline were chosen in conjunction with our consultants.

[17] DCLG (2015), *Technical housing standards – nationally described space standard*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/524531/160519_Nationally_Described_Space_Standard____Final_Web_version.pdf; and MHCLG (2019), *Energy Performance of Buildings Directive: Second Cost Optimal Assessment for the United Kingdom (excluding Gibraltar)*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770783/2nd_UK_Cost_Optimal_Report.pdf

7.16. For warehouses, the baseline 2013 position mirrors the 2021 specification, with the exception of the installation of solar photovoltaic panels. Following conversations with technical consultants, DLUHC concluded that this position was a more realistic reflection of a current route to compliance under the 2013 standards, rather than simply using the 2013 notional specification. In particular, the 2013 notional specification includes poor performing lighting which is unlikely to be installed in a new warehouse constructed today. Although this may allow compliance to be achieved by relaxing other aspects of energy performance, there is limited potential to do this in warehouses, due to their limited use of building services and readily achievable fabric values.

7.17. For all other building types, we concluded that the 2013 notional position was the most representative route to compliance. Although a similar issue to warehouses is found with lighting in the other building types, these buildings are typically more highly serviced and provide greater potential for relaxation of other standards, while maintaining compliance. Any savings obtained through better lighting are more likely, therefore, to be taken through relaxation elsewhere.

Table 9: Specifications for Warehouses

Parameter			**Compliant with 2013 requirements**	**Compliant with 2021 requirements**
Fabric[18]	**Wall U-Value (W/m²K)**		0.26	0.26
	Roof U-Value (W/m²K)		0.18	0.18
	Floor U-Value (W/m²K)		0.22 (unless uninsulated is better)	0.22 (unless uninsulated is better)
	Window	1.60	1.60	1.60
		0.40	0.40	0.40
		71%	71%	71%
	Rooflight	1.80 (vertical) 2.10 (horizontal)	1.80	1.80 (vertical) **2.10 (horizontal)**
		0.40	**0.55 (top-lit buildings only)**	**0.40**
		71%	**60% (top lit buildings only)**	**71%**
	Airtightness		5	5
Services	**Lighting luminaire (llm/cW)**[19]		95	95
	Daylight lighting control[20]		Yes (Single zone daylight dimming)	Yes (Single zone daylight dimming)
	Occupancy Lighting Control[21]		Yes (auto on auto off)	Yes (auto on auto off)

[18] All values are area weighted.

[19] LOR assumed to be 1 in all cases.

[20] Only applied to areas with glazing.

[21] Only applied where functionally suitable.

	Parasitic power of automatic lighting controls[22]	0.1W/m²	0.1W/m²
	Display Lighting (llm/cW) (with time switching)	95	95
	Cooling SSEER[23] (where applicable excl. naturally ventilated)	Air conditioning with high efficiency chiller (SSEER 4.4)	Air conditioning with high efficiency chiller (SSEER 4.4)
	Ventilation Heat Recovery[24] (where applicable excl. naturally ventilated)	76%	76%
	Demand Control Ventilation	Gas-sensors (Speed-control)	Gas-sensors (Speed-control)
	Space Heating Generator Efficiency	Gas Boiler (93% efficiency)	Gas Boiler (93% efficiency)
	Domestic Hot Water Generator Efficiency	Gas Boiler (93% Efficiency)	Gas Boiler (93% Efficiency)
Renewables	**PV Area (% foundation area)**	**0%**	**40%**
	Panel efficiency	**NA**	**20%**
	Inclination Above Horizontal	**NA**	**To match pitch of roof (6°)**
	Orientation	**NA**	**South**
	Type	**NA**	**Monocrystalline**
	Ventilation	**NA**	**Moderately Ventilated Modules**
	Shading	**NA**	**None or very little (<20%)**
	Shading Factor	**NA**	**1.0**

*changes in specification in bold

Table 10: Specifications for other Buildings

Parameter			**Compliant with 2013 requirements**	**Compliant with 2021 requirements**
Fabric[25]	**Wall U-Value (W/m²K)**		**0.26**	**0.18**
	Roof U-Value (W/m²K)		**0.18**	**0.15**
	Floor U-Value (W/m²K)		**0.22 (unless uninsulated is better)**	**0.15**
	Window	**U-Value (W/m²K)** ***including frame***	**1.60**	**1.40**
		G-value	**0.40**	**0.29**

[22] Where both daylight-sensing and occupancy-sensing controls apply parasitic power will only be applied once.

[23] SSEER includes system delivery losses.

[24] Including summer by-pass.

[25] All values are area weighted.

		Light transmittance	**71%**	**60%**
	Rooflight	**U-Value (W/m²K)** ***including frame***[26]	**1.80**	**1.50 (vertical)** **1.80 (horizontal)**
	Rooflight	**G-value**	**0.55 (top-lit buildings only)**	**0.29**
	Rooflight	**Light transmittance**	60% (top lit buildings only)	60%
	Air tightness		3 (depending on building floor area)	3
Services	**Lighting luminaire (llm/cW)**[27]		**60**	**95**
Services	**Daylight lighting control**[28]		Yes (Single zone daylight dimming)	Yes (Single zone daylight dimming)
Services	**Occupancy Lighting Control**[29]		Yes (Manual on, auto off)	Yes (auto on auto off)
Services	**Parasitic power of automatic lighting controls**[30]		**Daylight: lesser of 3% of installed lighting load or 0.3W/m²** **Occupancy: 0.3W/m²**	**0.1W/m²**
Services	**Display Lighting (llm/cW)** (with time switching)		**22**	**95**
Services	**Cooling SSEER**[31] (where applicable excl. naturally ventilated)		**Air conditioning with air cooled chiller (SSEER 3.6)**	**Air conditioning with high efficiency chiller (SSEER 4.4)**
Services	**Ventilation Heat Recovery**[32] (where applicable excl. naturally ventilated)		**70%**	**76%**
Services	**Demand Control Ventilation**		Gas-sensors (Speed-control)	Gas-sensors (Speed-control)
Services	**Space Heating Generator Efficiency**		**Gas Boiler (91% efficiency)**	**Gas Boiler (93% efficiency)**
Services	**Domestic Hot Water Generator Efficiency**		**Gas Boiler (91% efficiency)**	**Gas Boiler (93% Efficiency)**
Rene	**PV Area (% of foundation area)**		**0%**	**20%**
Rene	**Panel efficiency**		**NA**	**20%**

[26] Rooflight U-values input into the current version of SBEM are based on vertical. SBEM then uses BR 443 conventions to convert to horizontal before simulation. It is proposed that convention is changed so that horizontal U-values are declared by supplies and input into SBEM directly (therefore not needing automatic approximate correction).
[27] LOR assumed to be 1 in all cases.
[28] Only applied to areas with glazing.
[29] Only applied where functionally suitable.
[30] Where both daylight-sensing and occupancy-sensing controls apply parasitic power will only be applied once.
[31] SSEER includes system delivery losses.
[32] Including summer by-pass.

	Inclination Above Horizontal	**NA**	**30°**
	Orientation	**NA**	**South**
	Type	**NA**	**Monocrystalline**
	Ventilation	**NA**	**Moderately Ventilated Modules**
	Shading	**NA**	**None or very little (<20%)**
	Shading Factor	**NA**	**1.0**

*changes in specification in bold

Additional Capital Costs

7.18. The increase in capital costs from achieving 2021 requirements, compared with the continuation of existing 2013 standards, are shown in Table 11. Further breakdown of the costs of the different elements is provided in Appendix B.

Table 11: Additional Capital Costs

	Additional capital costs compared to 2013 requirements (£/m^2 GIFA)	Additional capital costs compared to 2013 requirements (% increase in build costs)
Office – deep plan, air conditioned	£24	0.68%
Office – shallow plan, naturally ventilated	£29	1.14%
Hotel	£40	1.32%
Hospital	£23	0.51%
Secondary School (includes sports facilities)	£36	1.20%
Retail Warehouse	£75	4.15%
Distribution Warehouse	£51	2.82%
Average (based on build mix)	£24	0.68%

Source: Currie & Brown

7.19. The changes in energy use were assessed by using the SBEM building energy modelling software. Modified carbon emission and primary energy factors were used to rebase the 2013 standards and used to calculate the 2021 standards. These carbon emission and primary energy factors are in Appendix C.

7.20. A net floor area projection is used as a proxy for the annual build rate of new non-domestic buildings. These are then used to scale the results from the seven archetypes to a national level. Details are shown in Appendix A.

7.21. The costs and benefits for the uplift in the energy efficiency standards for new non-domestic buildings are shown in Table 12. The analysis indicates that the uplift has a net cost of £33m. This has fallen significantly from the consultation stage IA, largely due to more costs and benefits being attributed to the counterfactual through capturing organisational trends relating to net zero and local authority plans. Capital costs will fall on the developer, whilst the replacement and maintenance costs will fall on the building owners/occupiers. Private developers over the longer term may pass on costs to owners in the form of higher purchase prices, or to landowners through lower land values. All benefits will be experienced by the tenants in the form of lower fuel bills and by society through better air quality and reduced carbon emissions.

Table 12: Summary of results from cost benefit analysis (improved energy efficiency requirements for new non-domestic buildings)

	2021 energy efficiency requirements New non-domestic buildings
Transition Costs (£m) Energy savings (£m) Incremental costs (£m)	(5) 308 (407)
Total financial benefit/(cost) (£m)	(104)
Carbon savings - non-traded (£m) Carbon savings - traded (£m)	17 42
Total carbon savings (£m)	58
Air quality savings (£m)	12
Net benefit/(cost) (£m)	(33)
Amount of gas saved (GWh)	675
Amount of electricity saved (GWh)	9,229
Amount of CO_2 saved - non-traded ($MtCO_2$(e))	0.1
Amount of CO_2 saved - traded ($MtCO_2$(e))	0.2
Cost effectiveness – non-traded (£/tCO_2)	403
Cost effectiveness – traded (£/tCO_2)	334

Source: Currie and Brown

Costs and Benefits: Minimum standards for building fabric and fixed building services in new and existing non-domestic buildings

New non-domestic buildings

7.22. An outline of the policy changes relating to minimum building fabric and fixed building services in new and existing non-domestic buildings is included in paragraphs 4.3 above.

7.23. For new non-domestic buildings, the impact of changing these backstop standards is captured in the analysis of the increase in the overall energy performance requirements (i.e., CO_2 and Primary energy rate) described above. No additional effects of these changes are expected or included in this analysis.

Existing non-domestic buildings

7.24. For existing non-domestic buildings, the costs and benefits of the improved standards for new thermal elements and the replacement of controlled fittings.

7.25. The new guidance provides increased standards for replacement of controlled fittings. In particular, the minimum standard for windows is being improved to a U-value of 1.6 W/m^2K. A review of the market indicates that multiple windows are readily available at or above this standard, therefore it is assumed that there is no significant impact from raising minimum window standards.

7.26. New guidance also applies to new thermal elements, such as walls and floors. These are typically installed as part of extensions to existing non-domestic buildings. Analysis has been taken forward to assess the costs and energy savings associated with the policy change in extensions for two different types of building.

7.27. The energy saving benefits of these policy changes were determined using the SBEM model of non-domestic energy use. The scale of the policy changes to new thermal elements is relatively modest, so it was considered proportionate to limit modelling to two types of common extension: an air-conditioned office extension and a school building extension. The extension to the office building comprises of a two-floor extension on the top of the existing building. The extension to the school building comprises of a three-floor extension adjacent to the existing building. The plans for these extensions were developed by consultants, who recommended them as reasonable scenarios based on their experience of retrofit projects. Further details of these plans and model specifications are given in Appendix D. The energy savings of improving the standards was determined for each extension.

7.28. It is assumed that for the counterfactual, all works just meet the current 2013 standards. This is except for installing windows/doors and LED lighting, as market analysis showed that these are typically already achieving the new proposed standard. Details of the costs for the different elements are provided in Appendix B.

7.29. To scale up the costs and energy use to a national level, planning and development consultants took forward analysis to assess a suitable scaler. The results concluded that, of the total national floor area across existing non-domestic buildings, 50% was reasonably represented by the office extension and 50% by the school extension[33]. Adroit also took forward analysis to assess the annual build rate for both the total building stock and for non-domestic extensions. Adroit estimated that the total stock increased by 0.28% per annum, and that 0.5% of the total floor area of the existing non-domestic building stock were extensions[34]. The projection of the non-domestic total building stock is shown in Table 13, with more detail included in Annex A. Please note these are do not use net completion projections but new builds only.

Table 13: Projection of non-domestic total building floorspace stock

	Annual floorspace (m²)									
Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Total	533,000	534,000	534,000	535,000	535,000	536,000	537,000	537,000	538,000	538,000

Source: Adroit Economics

[33] The change in the efficiency of thermal elements is modest. Quod Consultancy were tasked with assessing the scaler. They concluded that a 50/50 split between extension types was an adequate split for the modelling of extensions.
[34] It is assumed that the annual build rate for extensions is 0.5% of the total floor area of the existing non-domestic building stock; source: the 2013 impact assessment assumed that extensions will be constructed to between 0.1 and 0.8 per cent of the existing stock of non-domestic buildings each year depending on building type.

7.30. Table 14 shows the results of this analysis. This shows a net cost of £17m of raising standards for new thermal elements.

7.31. There are several reasons the energy savings are smaller than the incremental costs:

- For non-domestic buildings, factors including higher internal heat gains and shorter hours of occupancy (which typically exclude the night-time when it is colder), tend to reduce the space heating demand in comparison to domestic buildings. This limits the energy savings from improved fabric standards.

- The additional external wall insulation required forms the majority of the incremental costs. For the non-domestic building extensions considered, it is assumed that the external walls have been insulated with a higher performing, thinner insulant which allows a target U-value to be achieved in a construction. This type of insulation is particularly prevalent in commercial buildings where the overall footprint is constrained (such as the roof top extension scenario), as the thinner wall can directly translate into more lettable / usable internal area - the value of which is significantly greater than the cost of the insulation.

Table 14: Summary of results from cost benefit analysis (increased fabric standards for existing non-domestic)

	Increased fabric standards (New thermal elements)
Energy savings (£m) Incremental costs (£m)	4 (35)
Total financial benefit/(cost) (£m)	**(31)**
Carbon savings - non-traded (£m) Carbon savings - traded (£m)	14 (0)
Total carbon savings (£m)	**14**
Air quality savings (£m)	1
Net benefit/(cost) (£m)	**(17)**
Amount of gas saved (GWh)	561
Amount of electricity saved (GWh)	(18)
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	0.1
Amount of CO_2 saved - traded ($MtCO_2(e)$)	0.0

7.32. For existing non-domestic buildings, the costs and benefits of the replacement/installation of controlled services have also been estimated. These include boilers, lighting, cooling and ventilation systems.

7.33. The uplift to the energy efficiency requirements includes improvements to the minimum efficiency standard for boilers. Following a review of the market, and in conjunction with our consultants, it was concluded that boilers are readily available at the minimum efficiencies and commonly installed and so, no costs or benefits are assigned to this change.

7.34. Likewise, the minimum standards for lighting installations in existing buildings have been increased. The new standards also represent a level which can readily be met by current lighting available on the market (e.g., LEDs), of which are commonly installed. Therefore, we have concluded that no costs and benefits should be assigned to the lighting changes in existing buildings.

7.35. The uplift also includes improvement to the minimum performance standard for comfort cooling. The analysis investigated the impact on split and multi-split air conditioning, as this was the most prevalent type of replacement cooling plant. The uplift strengthens the minimum Seasonal Energy Efficiency Ratio (SEER) to 5.0. In reviewing available products from major manufacturers, the products identified were typically at this improved level of performance or better. Hence, it is assumed that implementing this improved level of performance will not have a significant impact on a replacement air conditioning plant.

7.36. The remaining area of building services relates to the replacement of the air handling units (AHUs) in ventilation systems. The new standards strengthen the minimum standard for specific fan power of typical air handling units to 2.3 W/l/s. It is estimated that there are between 4,000 and 5,000 replacements[35]. It was concluded that this change does represent a change above the standards currently met in existing buildings.

7.37. The energy savings from these policy changes were determined using SBEM; assessing the energy savings for replacing the controlled services by the improved standard for the air-conditioned office and hotels. The fabric and services energy efficiency specifications were taken from the baseline of MHCLG's cost optimal analysis published in 2019[36]. The energy savings of improving the AHU standards were determined for each service and building type. It was assumed that 50% of the systems were installed in buildings similar to offices[37] and 50% installed in buildings similar to hotels[38]. Details of the costs for the different elements are provided in Appendix B.

7.38. The results were scaled up to national level using the assumed number of installations per year. Table 15 shows the results of this analysis. This shows a net benefit of £53m of raising standards for the replacement of AHUs. This has fallen significantly compared to the consultation stage IA, largely due to the assumption that businesses will already be installing highly efficient forms of lighting in the counterfactual.

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[35] Source: Pers. Comm. BSRIA

[36] DCLG (2015), *Technical housing standards – nationally described space standard*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/524531/160519_Nationally_Described_Space_Standard____Final_Web_version.pdf; and MHCLG (2019), *Energy Performance of Buildings Directive: Second Cost Optimal Assessment for the United Kingdom (excluding Gibraltar)*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770783/2nd_UK_Cost_Optimal_Report.pdf

[37] For the purpose of this analysis, it was assumed that an AHU would typically serve a floor area of around 1000m^2. The office building modelled has a floor area of 12,100m^2. To allow for this difference, the costs and benefits for the office building have both been reduced to 1/12th per building. This approach will be considered further for the final impact assessment.

[38] The change in the efficiency of ventilation systems s modest and, in conjunction with our consultants, we concluded that a simple 50/50 split between building types was proportionate approach for this analysis.

Table 15: Summary of results from cost benefit analysis (increased standards for replacement of controlled services for existing non-domestic)

	Replacement of controlled services
Energy savings (£m) Incremental costs (£m)	72 (35)
Total financial benefit/(cost) (£m)	37
Carbon savings - non-traded (£m) Carbon savings - traded (£m)	(1) 15
Total carbon savings (£m)	14
Air quality savings (£m)	2
Net benefit/(cost) (£m)	**53**
Amount of gas saved (GWh)	(17)
Amount of electricity saved (GWh)	1,403
Amount of CO_2 saved - non-traded ($MtCO_2$(e))	(0)
Amount of CO_2 saved - traded ($MtCO_2$(e))	0.1
Cost effectiveness – non-traded (£/tCO_2)	748
Cost effectiveness – traded (£/tCO_2)	-

Costs and Benefits: Other guidance changes

Building Automated Control Systems (BACS)

7.39. The policy change is to introduce a standard for new and existing non-domestic buildings, with heating/cooling systems over 180kW, to have an ISO compliant BACS as outlined in paragraph 4.16 above. This assessment estimates the net impact of introducing these standards in guidance in 2021, for (i) new buildings and (ii) existing buildings undertaking relevant building work.

7.40. It is assumed that a Class A BACS is ISO compliant. Some existing buildings will already have such a system, but others will have variants which are not ISO compliant. For this analysis, it has been assumed that the typical non-compliant system is a Class C BACS.

7.41. The analysis estimates the costs and benefits of this policy proposal over a 10-year appraisal period. To do this, the analysis estimates:

- the number of new buildings/refurbishments with systems over 180kW expected to have non-compliant BACS under the counterfactual;
- the cost of upgrading to a compliant BACS;
- the benefits of upgrading to a compliant BACS in terms of reduced energy usage and reduced CO_2 emissions.

7.42. Based on the threshold size of a building that will have a system of over 180kW, the analysis assumes that there are 340 new buildings built each year with a system over 180kW. It is assumed a further 840 existing buildings that will be undertaking relevant works will also have systems over 180kW.

7.43. Most of these buildings are expected to install a compliant BACS system under the counterfactual. This includes:

- 95% of buildings over 1,000sqm;
- buildings over 10,000sqm;
- Of the remainder, an increasing proportion of systems installed each year are expected to be compliant – increasing from 10% in 2021 to 70% in 2030 (see *Organisational Trends to Net Zero*).

7.44. On this basis, the analysis assumes that 239 buildings (c. 24 per annum) in scope (i.e., with a system over 180kW) are unlikely to install a compliant BACS under the counterfactual. Therefore, they are expected to be affected by the policy during the appraisal period (2022-31). This comprises of 38 new buildings and 201 existing buildings that are undertaking relevant work.

7.45. The analysis uses the area of building floorspace as the basis for estimating the cost of installing a BACS. The analysis assumes that the profile of the size of buildings installing BACS is the same as the existing stock profile.

7.46. The additional cost of installing a Class A BACS compared with a Class C BACS is estimated to range from £13 per sqm to £24 per sqm, depending on the size of the building and its use type. On this basis, the average net additional cost of the improvement from a Class C to a Class A BACS is estimated at £70,000 per building.

7.47. In total over the 10-year policy, the total cost of upgrading to a compliant BACS is estimated to be £14.1m (NPV). The analysis does not assume that there will be any difference in the maintenance or running costs for a Class A or a Class C BACS.

7.48. The analysis has quantified three benefits that derive from the policy: energy savings, reduced CO_2 emissions and improved air quality.

7.49. The analysis estimates that replacing a Class C BACS with a Class A BACS is likely to result in energy savings of between 20% to 32%, depending on the building use.

7.50. The analysis assumes that a typical BACS will last for 25 years and that the benefits of the improvement in a system will last throughout this period:

- First the monetised value of the energy savings is calculated using the long run variable cost of gas and electricity. The analysis suggests that the policy will achieve a £33.3m (NPV) energy saving over the 25-year lifespan of a BACS.

- Reduction in CO_2 emissions is monetised with reference to gas and electricity emission factors, applied to the traded and non-traded price of carbon (source from HM Treasury Green Book supplementary guidance[39]). The analysis suggests that the policy will

[39] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

achieve a CO_2 emission saving valued at £24.7m (NPV) over the 25-year lifespan of a BACS.

- Improvement in air quality is monetised with reference to air quality damage costs from primary fuel use (source from HM Treasury Green Book supplementary guidance[40]). The analysis suggests that the policy will achieve air quality improvements valued at £1.4m (NPV) over the 25-year lifespan of a BACS.

- Combined, these benefits are valued at £59.4m (NPV), thus offsetting the cost of implementing BACS.

7.51. The results of the analysis are shown in Table 16. The analysis suggests that a net benefit of £45m (NPV) is likely to derive from the policy.

Table 16: Summary of results for cost benefit analysis (Guidance changes: BACS)

Energy savings (£m) Incremental costs (£m)	33 (14)
Total financial benefit/(cost) (£m)	19
Carbon savings - non-traded (£m) Carbon savings - traded (£m)	19 5
Total carbon savings (£m)	25
Air quality savings (£m)	1
Net benefit/(cost) (£m)	45
Amount of gas saved (GWh)	589
Amount of electricity saved (GWh)	429
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	0.1
Amount of CO_2 saved - traded ($MtCO_2(e)$)	0.0
Cost effectiveness – non-traded (£/tCO_2)	235
Cost effectiveness – traded (£/tCO_2)	1,287

Costs and benefits: Self-Regulating Devices (SRDs) for New and Existing Non-Domestic Buildings

7.52. The Approved Document guidance has been clarified to state that SRDs should be installed in new and existing non-domestic buildings. In conjunction with our consultants, DLUHC concluded that all new and existing non-domestic buildings currently install SRDs in practice to meet the energy efficiency requirements. As such, DLUHC consider that this does not represent a policy change and there are no significant costs and benefits included in this impact assessment.

Costs and benefits: Technical Building Systems

7.53. When a technical building system is installed, replaced or upgraded, the overall energy performance of the complete system or altered part, as appropriate, should be assessed and the results should be documented and passed on to the building owner. This applies

[40] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

to new and existing buildings. There should be a negligible impact of this new guidance as this reflects standard industry practice for commissioning such systems.

Costs and benefits: Low temperature compatible heating emitters in new and existing non-domestic buildings

7.54. The guidance now states that new and existing non-domestic buildings should have a space heating system which can operate at a low temperature. This would be applicable when a whole wet heating system is replaced, including both the heating appliance and the emitters. This will make it easier to install low carbon heating in future.

7.55. For new non-domestic buildings, these costs have already been captured in the costs included under the *Minimum energy performance requirements for new non-domestic buildings (Primary energy target and CO_2 emission targets).*

7.56. For existing buildings, DLUHC consider that the type of work that would need to conform to these requirements is relatively rare, and consequently do not believe it is proportionate to assess the costs and benefits in this IA.

Costs and benefits: Energy forecasting

7.57. The guidance now states energy forecasts should be provided to building owners, which can be based on design calculations, benchmarks or other calculation methods (such as CIBSE's TM54 methodology)[41].

7.58. DLUHC do not consider that this represents a policy change, as forecasts of this type already form part of the Building Log Book, which is required under current standards. Therefore, no costs or benefits have been assigned to this element of the new guidance.

Costs and benefits: Additional commissioning guidance for building services in existing buildings

7.59. The new guidance asks for additional information on the energy performance of building services to be provided to building owners when a new system, or components of a system, are replaced in existing buildings. These requirements are clarifications of the requirements under regulation 40.

7.60. The most common situation where this guidance would be applicable is where a single component is replaced, for example a boiler is replaced but the distribution system and emitters remain unchanged. Where this occurs, guidance states that providing product datasheets for the new component would satisfy this requirement. These datasheets could be provided at a negligible additional cost and reflect current industry practice; therefore, no costs and benefits have been included in this IA.

7.61. A less common situation would be where an entire system is replaced, for example a boiler, the distribution system and the emitters. This type of work is most likely to occur when major refurbishment is being undertaken on a building. In such situations, it is likely that

[41] Note that this final policy represents a change from consultation stage, when only a TM54 methodology was proposed in guidance as a route to fulfil the requirement.

the required documented assessment of the performance of the building would already be available as part of the refurbishment design specifications. Providing these to building owners and occupiers, as part of this type of activity, reflects current industry practice and can be provided at negligible additional cost. No additional costs and benefits have been included in this IA.

Costs and benefits: Simplifying and updating guidance

7.62. The Approved Document guidance has been updated and clarified throughout. We consider that the other changes made are considered to have negligible cost and benefits, and thus do not consider it proportionate to include them in the cost benefit analysis.

Training and Familiarisation costs

7.63. Businesses will incur transition costs when employees have to familiarise themselves with the new technical requirements. Familiarisation costs are expected to be limited as:

- The overarching methodology for the energy efficiency requirements for new non-domestic buildings has not changed i.e., businesses will continue to use SBEM or dynamic thermal models to assess compliance for new non-domestic buildings;
- The higher standards that will come into force should be able to be met predominantly through straightforward amendments to current practices, rather than radical changes in the way new buildings are constructed.

7.64. The familiarisation costs that are likely to occur have been estimated through the following process:

- Identification of the types of business/organisation that will be affected;
- Identification of the types of familiarisation activity;
- Consultation was then undertaken with a small sample of these businesses and/or representatives of these businesses/organisations, to identify the time/cost likely to be incurred;
- The costs were then scaled up across the industry based on the number of businesses/organisations.

7.65. The types of organisation that will incur familiarisation costs include:

- Energy Consultants
- SAP Assessors
- Contractors
- Architects
- Engineers - energy modeller
- Building Control

7.66. Types of familiarisation activity are:

- Preparing training course material
- Self-study
- CPD (Continuous Professional Development)
- Training Courses

7.67. Developers and associated professional services personnel will require training to ensure that the designs of future buildings are compliant with the new regulations and that appropriate components are procured. It was also assumed that building control personnel would require training to enable them to assess the building applications and work to the new standards

7.68. Table 17 shows the estimated average familiarisation time (hrs) for each type of affected business/organisation.

Table 17: Average Familiarisation Time in Hours

	Energy Consultant	SBEM / NCM Assessor	Main Contractor/ Developer	Architect	Engineer - other	Engineer - energy modeller	Building Control
Requirements	2	0	3.75	0	0	24	0
SBEM	0	15	0	2.5	2.5	8	15

7.69. For SBEM, it is anticipated that the familiarisation time for SAP assessors and Building Control will be delivered through 2 days of training. The cost of the training courses has been included at an estimate £250 per day, with 50% of the courses being delivered at no cost by industry bodies.

7.70. Table 18 shows the estimated number of business/organisations that will need to become familiar with the changes.

Table 18: Estimated Number of Business/Organisations that Incur Familiarisation

	Energy Consultant	SBEM / NCM Assessor	Main Contractor/ Developer	Architect	Engineer - other	Engineer - energy modeller	Building Control
Numbers of organisations	3,085	3,427	465	13,105	12,592	380	400

7.71. Table 19 shows estimated total familiarisation costs.

Table 19: Estimated Total Familiarisation Costs

	Energy Consultant	SBEM / NCM Assessor	Main Contractor / Developer	Architect	Engineer - other	Engineer - energy modeller	Building Control	Total
Requirements	£ 0.2m		*			£ 0.3m		£0.5m
SBEM		£2.0m		£ 1.0m	£0.9m	£0.1m	£0.2m	£4.3m

*less than £0.1m

Transitional arrangements

7.72. The more stringent transitional arrangements will mean that the standard that developers need to build to will no longer apply indefinitely across whole development sites. This should mean that more buildings are built to the new standards sooner, which will result in greater energy and carbon savings, but may be more expensive to developers. Anecdotally, the transitional arrangements could also lead to faster build-out on sites, as developers may prefer the certainty of building to the same standards for the whole site.

7.73. Non-domestic buildings are more likely to be built as individual developments, or as part of relatively small development sites. This is in contrast to the domestic sector, where it is more common for one development site to include several hundred individual homes. For this reason, changes to transitional arrangements are likely to have considerably less impact in the non-domestic sector. Any impacts are expected to be negligible, therefore these have not been quantified as part of this Impact Assessment.

8. Business impacts

Equivalent Annual Net Direct Cost to Business (EANDCB)

8.1. In line with Impact Assessment guidance, the energy savings in the social cost benefit analysis presented above are valued using the variable price of electricity and gas (to avoid the inclusion of transfer payments in the impact assessment). For the purposes of estimating the costs and benefits to business, energy savings have been valued at the retail price, as it is assumed that any energy savings experienced from higher energy efficiency would also fall to businesses occupying the building.

8.2. Given that the cost to business only reflects costs for privately owned businesses, publicly owned buildings (NHS hospitals and public schools) were removed from the build mix for the calculation.

8.3. 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 fall on business.

8.4. The proposed changes for new and existing non-domestic buildings result in a small cost to business of £2.5m per year over the 10-year policy period.

8.5. The 10-year policy appraisal period was used in line with Green Book Guidance. This captures the majority (over 90%) of costs incurred by business from the regulation uplift, as many of the bigger costs, particularly capital and installation, occur in the first 10 years of the policy. However, this does mean that any replacement or maintenance costs for both new and existing buildings incurred in the following 60 years will not be included in the EANDCB calculation. For example, for maintenance costs of new non-domestic buildings, only maintenance costs occurring in the first 10 years will be included. No replacement costs for new buildings will be included in the calculation, as no replacements will occur in the first 10 years. For existing buildings, all of the costs incurred over the 10-year appraisal period will be for the replacement and maintenance of windows, doors and ‘fixed building services’, such as major components of heating or cooling systems.

8.6. Energy savings from the new requirements will be experienced by businesses occupying the buildings (except for publicly owned non-domestic buildings), whilst reduced carbon emissions and improved air quality are societal benefits. Given that the payback on fuel bills is over the long-term, appraising over the 10 years means that many of the energy savings experienced by businesses will only be a small proportion (10-15%) of the overall benefits experienced over the 70 years.

8.7. The alternative approach would be to include all costs and energy savings but calculate the EANDCB over 70 years rather than 10. This would result in the EANDCB becoming positive (small benefit to business), as over the 70 years, the benefits to business outweigh the costs. However, as most costs happen in the first ten years of the policy, and to remain consistent with Green Book guidance, it was decided to still appraise the EANDCB over the 10-year policy period.

Table 20: EANDCB and Business Net Present Value (£m)

EANDCB	(2.5)
Business Net Present Value	(21.4)
Score against the Business Impact Target	(12.4)

Small and Micro Business Assessment (SaMBA)

8.8. Small and Micro Businesses (SMBs) affected by the policy options considered in this impact assessment principally comprise of developers, constructors, architects, and other technical specialists. Some small and micro businesses in the manufacturing sector will also be affected by the new requirements, in particular window and door manufacturers. It is recognised that when costs are passed on over the longer-term to occupiers of the building, either in the form of higher rent or purchase prices, that some SMBs renting or purchasing these buildings will be affected. However, this is an indirect impact of the 2021 Uplift and, given that the policy delivers a small benefit to business, it was deemed disproportionate to take forward further analysis.

8.9. The number of small (10-49 employees) and micro (0-9 employees) businesses in the affected sectors are detailed below. These figures are from the ONS UK Business Counts dataset, broken down by employment band and 5-digit SIC code. For builders and developers, 99.5% of the 51,530 enterprises are small or micro. For architectural practices 99% of the 13,105 businesses are small or micro.

Table 21: Number of Small and Micro Businesses in scope of the regulation changes

Business (5-digit SIC code)	Micro businesses	Small businesses	Total number of businesses	SMBs as % of total
Builders and developers	49,330	2,005	51,530	99.5%
Architects	12,030	900	13,105	99%

8.10. For window and door manufacturers it is not possible to identify the exact number or proportion of SMBs in the sector from published statistics because of categorisation issues. Within the ONS 5-digit SIC code classification:

- Manufactures of timber windows and doors is included in the wider category of builders, carpentry and joinery – 98% of the 6,195 enterprises in this sector are SMBs.
- Manufacturers of plastic windows and doors are included within the wider category of manufacture of builders' ware of plastics – 88% of the 1,410 enterprises in this sector are SMBs.
- Manufactures of metal windows and doors have their own specific category – 93% of the 1,150 enterprises in this category are SMBs.
- Based on the statistics above, it is likely that over 90% of the enterprises in the window and door manufacturing sector are small or micro.

Impact on small and micro businesses

8.11. Adroit Economics were commissioned to consult with key stakeholders from the sectors mentioned above, to explore if SMBs would be disproportionately affected by the changes to the energy efficiency requirements, as set out in the response document. A summary of the findings from these discussions with industry are below:

1) **Small builders/developers:** 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 planning and development of non-domestic buildings.

2) **Small architects:** they also concluded that there will be no material impact or a limited additional impact on small architects. Familiarisation costs are expected to be similar across the industry irrespective of size of practice. Smaller practices typically rely on less formal means for information exchange than larger firms, so possibly require fewer formal training events than larger firms. Overall, though, it was felt that similar amounts of time per head, were likely to be required.

Mitigating the impact on small and micro businesses

8.12. 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 Buildings Standard.

9. Wider Impacts

Economic and financial impacts

Competition

9.1. The principal markets affected by this 2021 policy are the markets for the development of new non-domestic buildings and the refurbishment of existing non-domestic buildings. The supply chains for the production of materials used in the identified markets may also be affected and will likely need to change the types and number of different products they supply (for example, different thicknesses of insulation, or higher performance materials).

9.2. The proposed higher standards will mean that building contractors will have to comply with more stringent energy efficiency and building emissions targets: because of this, some capital costs, for example where additional materials are required, may rise. The need to develop and employ different construction techniques and methods may also result in additional time and financial cost to developers. As the changes in costs are expected to affect all building contractors equally, any competitive effects in the market for building development are likely to be negligible.

9.3. The improved efficiency standards may have an impact on manufacturers and suppliers to the construction industry, by increasing the demand for higher specification materials and products. Suppliers of low cost or low-quality products and materials may be adversely affected by the change in regulations and guidance because developers will use them less frequently. The change in regulations and guidance are also expected to provide opportunities for manufacturers and suppliers of low/zero carbon generation technologies and high energy efficiency products.

International trade

9.4. The more stringent energy efficiency standards are set out in Approved Document guidance and include standards for a range of products across the new and existing stock, including windows and doors, and boilers. Performance based standards are set through the Approved Document guidance, which does not mandate specific technologies or products to be used. Therefore, HMG is not required to notify the World Trade Organization (WTO).

9.5. However, given that many businesses will decide to follow the Approved guidance, this decision could lead to an increase in costs where the suggested standard is set above the current market level, leading to businesses needing to provide more efficient products. If these firms are unable to absorb the costs and are actively engaged in international trade, then this could lead to exports falling as these goods become less competitive. However, this depends on a wide range of factors, including; whether the market is predominantly domestic or international; whether England has a comparative advantage/disadvantage in these goods; the required standards overseas, and; the price of goods on the international market.

9.6. There could also be some indirect economic impacts, particularly by encouraging innovation. If product innovation occurs, particularly in lower carbon forms of heat, this could lead to the development of new products and higher demand in the clean growth/ renewable 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.

Innovation

9.7. Particularly with respect to raising the energy efficiency standards for new non-domestic buildings, there should be the potential for new firms to enter the market, due to the setting of higher standards and the flexibility for developers to choose building technologies to meet these standards. This should encourage innovation among manufacturers.

9.8. The proposed option for new non-domestic buildings is likely to result in an increased use of low and zero carbon generation technologies. There is competition in the supply of such technologies with a mix of large and small suppliers. As the cumulative production of such technologies rises, learning rate effects, coupled with competition, should bring down the unit cost. This learning effect has been built into the modelling of costs.

Social impacts

Housing supply

9.9. Other measures proposed for new non-domestic buildings will impact the construction industry more generally, but we do not anticipate these will result in impacts on housebuilding and housing supply.

Health and well-being impacts

9.10. There are potentially beneficial improvements in health and quality of life from the effect of increased energy efficiency on thermal comfort and better air quality. DLUHC is aware of the potential effects that tighter building envelopes could have upon indoor air quality and indoor temperatures in summer. Hence the parallel review of Parts F and L, and the introduction of a new requirement on limiting overheating in new residential buildings. Due to this, these impacts have not been included in this cost benefit analysis.

COVID-19

9.11. COVID-19 has had several implications for the construction industry. First, there was a near total shutdown of the construction industry in March 2020 as the pandemic hit, with border restrictions limiting the transportation of key construction materials. However, many of the impacts from COVID-19 are expected to be short lived, with long-term contraction not forecast. It is therefore reasonable to assume that, as the economy bounces back, there should be no additional impact on the construction industry in the longer term.

9.12. Second, more people started working from home during the pandemic, and this trend has continued. Whilst this does not have an impact across the majority of non-domestic buildings, this could lead to fewer people working from their offices over the short-medium term. Consequently, there may be less of a positive impact from increased energy efficiency on businesses' fuel bills for those who own/rent office space, as energy usage is lower already. However, this entirely depends on whether short-term trends in office use continue into the longer-term. In either case, even if the benefits are lower, there will still be positive impacts from locking-in higher energy efficiency of buildings on fuel bills and carbon savings. Lower use of offices could also lead to lower build rates for offices in the future, however there is no early evidence to suggest this.

9.13. For both, as the total appraisal period for this IA is 70 years (accounting for the policy period and building life), COVID-19 impacts are not included in this analysis.

Environmental impacts

9.14. The environmental impacts are central to this policy and are therefore covered in the main body of this impact assessment.

Administrative burdens

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

9.16. The 2021 standards include that the energy performance of installed building services should be assessed, documented and passed on to the building owner. It is already a Building Regulations requirement to carry out commissioning and to collate information. This change represents a formalisation of existing commissioning practices and means that the information will be handed over to building owners. The additional burden is therefore assumed to be nil.

10. Equalities assessment

10.1. 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.

10.2. 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.

10.3. 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.

10.4. 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.

11. Monitoring and evaluation

11.1. A full technical consultation on the Future Buildings Standard is planned to start in 2023, which will provide proposals for the technical detail and associated draft guidance of the full Future Buildings Standard. Ahead of the full consultation, there will be a period of extensive stakeholder engagement which will help to inform the consultation proposals.

11.2. The period of stakeholder engagement will include working with industry to monitor and evaluate the implementation of the 2021 uplift, with a focus on understanding the impact that the uplift is having and the way in which it is being implemented. An evaluation scoping exercise will be undertaken to establish the main evaluation questions that will then be included in the technical consultation. These questions will seek further feedback on the implementation of the 2021 interim uplift and explore any particular areas of interest that have been identified during the stakeholder engagement. The feedback that is received from consultees will be carefully analysed and the lessons that are learnt will be incorporated into the final policy of the Future Buildings Standard.

11.3. A statutory review clause to monitor and evaluate the impacts of the policy after 5 years has not been included in the 2021 uplift, since the policy is due to be monitored and reviewed in advance of that anyway, as set out above. Additionally, most of the changes are being implemented via changes to the Approved Documents rather than through SIs, and hence no statutory review clause is required.

Appendix A – Floorspace Projections

Below is the independent analysis conducted by Adroit Economics of floorspace projections broken down by building type. This is used in our cost benefit modelling.

Table A.1: Assumed projection of floorspace by 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
Hotel	245	245	245	245	245	245	245	245	245	245
Hospital	393	393	393	393	393	393	393	393	394	394
Secondary School (includes sports facilities)	634	634	634	634	634	635	635	635	635	635
Retail Warehouse	302	303	304	304	305	305	306	306	307	308
Distribution Warehouse.	942	946	950	954	958	962	967	971	975	979

Source: Adroit Economics Consortium

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 supply.

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

- Estimated stock of floorspace across 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),
- 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.
- Estimated the annual rate of new build floorspace – this was calculated as a percentage of 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 each year.

- 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.

Please note, these projections are not an estimate of the net change in building stock:

- They do not account for changes of use, conversions or demolitions, which are all elements of net change in stock;
- Nor do they capture the impact of policy interventions that could increase industry's capacity to build new buildings;
- Assessing these is outside the remit of this impact assessment.

Appendix B – Cost Breakdown

The developed costs are based on the expert view of Currie & Brown's cost specialists, drawing on evidence from their internal cost datasets, recent published cost data and information provided by suppliers.

The cost analysis is intended to reflect typical national costs from Q2-3 2019 that might be incurred by developers with a reasonably efficient supply chain, design development and construction processes. Costs incurred by individual organisations will vary according to their procurement strategies, the location of their activity (e.g., costs will be higher in London and the South East of England) and the detail of their product. These variations in design, location and delivery method could result in a cost range of +/-c20%. Notwithstanding these variations, the proportional uplifts associated with moving from one specification to another are likely to be similar across different market segments[42].

To provide context to the cost variations assessed in the study an indicative overall build cost (£ per m^2) for each building archetype was estimated using Currie & Brown internal data. This figure is indicative of the level of cost that might be expected for a building built in accordance with the requirements of Part 2013. The build cost should be taken as indicative only as it is sensitive to a wide range of design and specification variables in addition to the economies of scale and regional variations discussed previously.

Base costs for future years are those for the 2019 price year, and subject to adjustments for learning for technologies that have not yet reached a mature market position. It should be noted that construction costs can vary considerably and rapidly with market conditions, particularly where activity levels result in a change in the availability of skills and materials. In these situations, it is not unusual to see quite large (several percentage points) change in overall costs over a period of months.

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[42] Costs increases may be outside the described range for highly bespoke designs; however, these buildings are typically more expensive to build and so the relative impact on build costs may be similar or potentially smaller than for more typical buildings built in higher volumes.

Table B.1 includes details of the cost information used for new non-domestic building specification options, including any variations between building type, costs are only shown for those specifications that vary between the considered options.

Table B.1: Cost data for elements that vary between the selected specifications for new non-domestic buildings

Element	Specification	Unit	New cost (£ per unit)
Masonry External Wall – two dense block work leaves with insulated cavity and render finish	0.26 W/m².K	m² (element)	£232
	0.18 W/m².K		£239
Metal Frame External Wall – rainscreen, insulated cavity, particle board, metal stud wall and plasterboard	0.26 W/m².K	m² (element)	£359
	0.18 W/m².K		£375
Ground Floor – insulation and concrete slab and hardcore	0.22 W/m².K	m² (element)	£61-70 depending on building type[43]
	0.15 W/m².K		£66-76 depending on building type[43]
Raised Exposed Floor – insulation and concrete slab and screed	0.22 W/m².K	m² (element)	£41
	0.15 W/m².K		£46
Flat roof – membrane, insulation, concrete deck	0.18 W/m².K	m² (element)	£214
	0.14 W/m².K		£216
Pitched warehouse roof – insulated steel panels	0.18 W/m².K	m² (element)	£53
	0.14 W/m².K		£71

[43] The specification required to achieve the target u value varies as a result of the differing floor area to perimeter ratios in each archetype building.

Element	Specification	Unit	New cost (£ per unit)
Windows – including frame	1.6 W/m².K	m² (element)	£570
	1.4 W/m².K		£600
Airtightness	5 m^3 m^2 hr	m² Gross Internal Floor Area	£0
	3 m^3 m^2 hr		£5
Light fittings - general	60 llm/cW	m² lit floor area	£59 (£53 in Warehouses)
	95 llm/cW		£67 (£60 in Warehouses)
Light fittings - display	22 llm/cW	m² lit floor area	£45
	95 llm/cW		£60
Light controls - occupancy	Manual on / auto off	m² controlled floor area	£2.5
	Auto on / off		£0
Cooling - air cooled chiller	SEER 3.6	kW capacity	£160
	SEER 4.4		£180
Ventilation heat recovery	70%	m^3/second delivered air	£8,000
	76%		£8,200
Gas boiler	91%	kW capacity	£45
	93%		£45
Roof mounted - photovoltaic panels mounted on frames on accessible concrete flat roof	Variable costs for systems >4kWp	Per kWp installed	£1,100

Table B.2 includes details of the cost information used for non-domestic extension specification options and for replacement of controlled windows or doors in non-domestic buildings. The tables only show those specifications that vary between the considered options.

Table B.2: Cost data for elements that vary between the selected specifications for non-domestic extensions

Element	Specification	Unit	Cost (£ per unit)
Non-domestic external wall – rendered blockwork external leaf and PIR insulation	0.28 W/m².K	m² (element)	£230
	0.26 W/m².K		£232
Ground Floor	0.22 W/m².K		£139
	0.18 W/m².K		£143
Non-domestic flat roof	0.18 W/m².K		£260
	0.15 W/m².K		£262
Windows	1.6 W/m².K		£230
	1.4 W/m².K		£240
Doors (partially / unglazed) – composite only	1.8 W/m².K	Per door	£830
	1.4 W/m².K		£850

Table B.3 includes details of the cost information used for replacement of controlled services in non-domestic buildings, including any variations between building type, costs are only shown for those specifications that vary between the considered options.

Table B.3: Cost data for elements that vary between the selected specifications for non-domestic extensions

Element	Specification	Unit	New cost (£ per unit)
Ventilation – air handling units – small ($1m^3/s$) excluding any heat recovery systems[44]	2.6 W/l/s	m^3 / s	£14,500
	2.3 W/l/s		£16,000
Ventilation – air handling units – large ($13m^3/s$) excluding any heat recovery systems	2.6 W/l/s	m^3 / s	£3,900
	2.3 W/l/s		£4,300
Lighting – general – including fittings but excluding common works such as removal of existing fittings, etc.	60 llm/cW	m^2 Gross Internal Floor Area	£59
	95 llm/cW		£67

[44] It should be noted that specifying air handling units to deliver a specified fan power performance is complex and involves a wide range of project specific parameters. In this study it was assumed that no associated works to ducting were undertaken and that reductions in fan power per m3 supplied is achieved through the specification of high-quality units and potentially increasing the unit size to enable it to operate more efficiently.

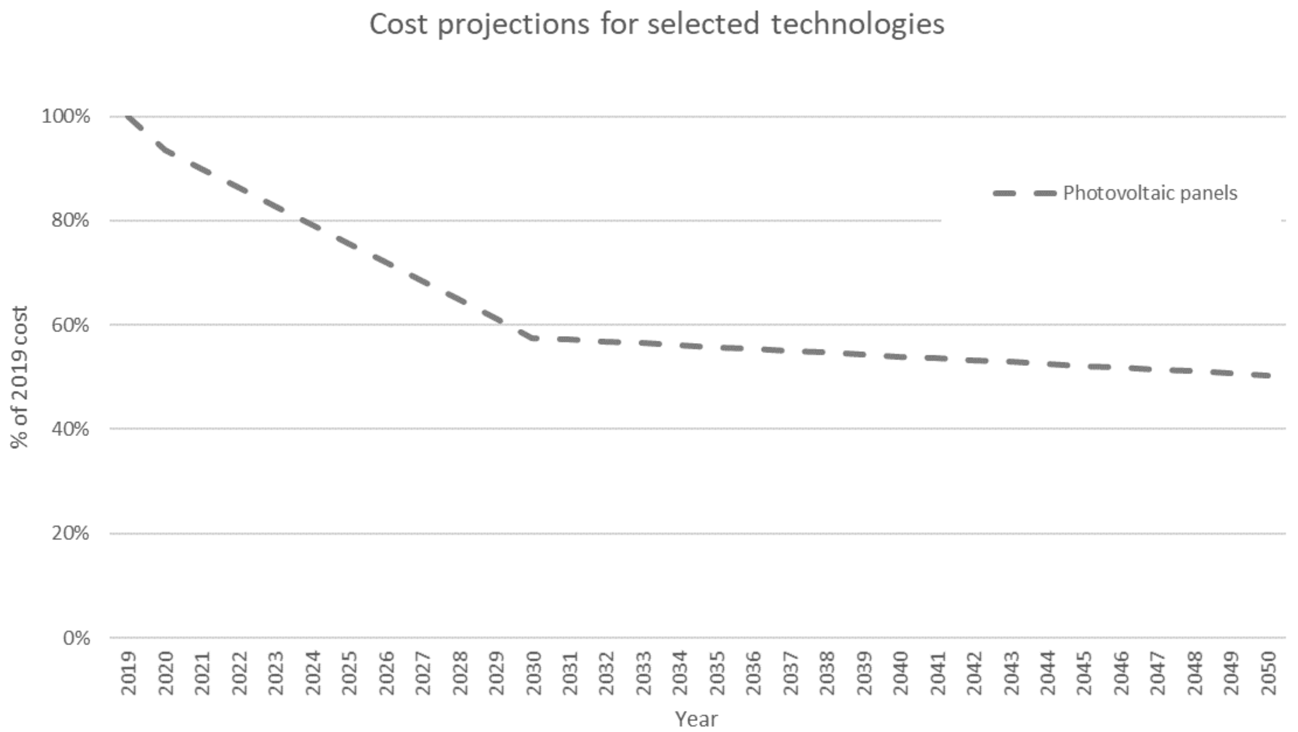
Cost projections

Cost projections were assigned to each specification option to capture any expected change in the current cost over time. For many building elements no adjustment was applied to the current costs because the technology is deemed mature and unlikely to experience a significant reduction in cost per unit of performance. This does not mean that cost in the future will be unchanged, only that it is not projected to change in a manner that is disproportionate to the wider construction cost base.

For less mature specifications, the potential for future reductions in cost through learning was assessed based on existing published cost projections or by applying appropriate learning rates to global market projections.

Figure B.1 shows the future cost projections of photovoltaic panels technologies which was the only technology relevant to this consultation where learning rates were applied. These cost projections are relative to 2019 costs and do not account for other economic and market factors that will impact costs over this period (e.g., market conditions, interest and exchange rates, skills availability and commodity prices).

Figure B.1 Projected variation in base costs as a result of learning



Appendix C – Primary energy and carbon factors

The below tables contain the calculated primary energy and CO_2 emission factors used to develop the 2021 options for energy efficiency requirements; these can also be found in SAP and SBEM. To note these are different to the carbon emission factors found in Green Book Supplementary Guidance, which are used for appraisal purposes.

Table C.1: Primary energy factors for electricity used in the analysis [kWh/kWh]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Standard tariff	1.602	1.593	1.568	1.530	1.487	1.441	1.410	1.413	1.449	1.504	1.558	1.604
7-hour tariff (high rate)	1.635	1.626	1.600	1.562	1.518	1.471	1.440	1.443	1.479	1.535	1.591	1.637
7-hour tariff (low rate)	1.521	1.512	1.488	1.453	1.411	1.368	1.339	1.342	1.376	1.428	1.480	1.522
Electricity sold to or displaced from grid, PV	1.715	1.697	1.645	1.567	1.478	1.389	1.330	1.336	1.405	1.513	1.623	1.718

Source: BRE, CO_2 and Primary Energy Summary Tables for AECOM 2019_04_26

Table C.2: Primary energy factors for other fuels used in the analysis [kWh/kWh]

	PEF
Mains gas	1.130
LPG	1.141
Heating oil	1.180

Source: BRE, CO_2 and Primary Energy Summary Tables for AECOM 2019_04_26

Table C.3: Primary energy factors for renewables in the analysis [kWh/kWh]

	PEF	Description of Application in Analysis
Renewable heat on-site	0	Applied to heat pumps and solar thermal. Both technologies offset demand and therefore primary energy for other heating fuels.
Renewable electricity on-site	0	PV – applied to portion of electricity generated by PV and used on-site (as calculated in draft National Calculation Methodology). The total electricity generated by PV also offsets grid-supplied electricity at the 'electricity sold to or displaced from grid, PV' PEFs in Table C.1 above.
Renewable electricity off-site (as part of grid mix, or exported to grid)	1	Affects grid electricity factors in Table C.1 above. PV – applied to portion of electricity generated by PV and exported to grid (as calculated in draft National Calculation Methodology). The total electricity generated by PV also offsets grid-supplied electricity at the 'electricity sold to or displaced from grid, PV' PEFs in Table C.1 above.

Source: BEIS/MHCLG, 21/06/19

Table C.4: Carbon emission factors for electricity used in the analysis [$kgCO_2e/kWh$]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Standard tariff	0.163	0.160	0.153	0.143	0.132	0.120	0.111	0.112	0.122	0.136	0.151	0.163
7-hour tariff (high rate)	0.171	0.168	0.161	0.150	0.138	0.125	0.117	0.118	0.128	0.143	0.158	0.171
7-hour tariff (low rate)	0.143	0.141	0.135	0.126	0.116	0.105	0.098	0.099	0.107	0.120	0.133	0.144
Electricity sold to or displaced from grid, PV	0.196	0.190	0.175	0.153	0.129	0.106	0.092	0.093	0.110	0.138	0.169	0.197

Source: BRE, CO_2 and Primary Energy Summary Tables for AECOM 2019_04_26

Table C.5: Carbon emission factors for other fuels used in the analysis [kgCO_2e/kWh]

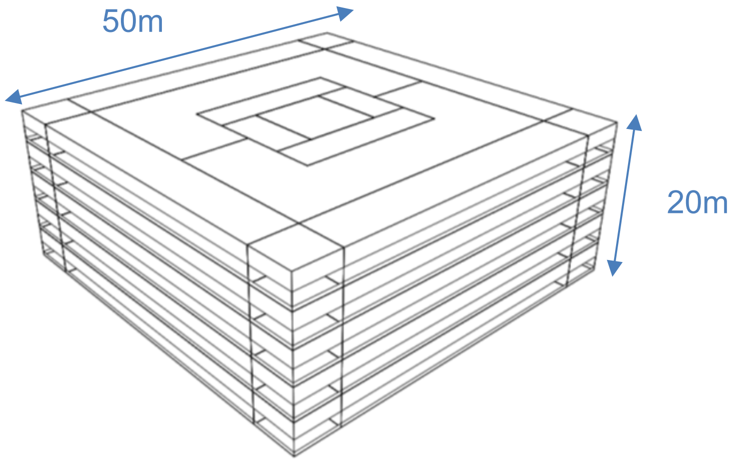
	CEF
Mains gas	0.210
LPG	0.241
Heating oil	0.298

Source: BRE, CO_2 and Primary Energy Summary Tables for AECOM 2019_04_26

Appendix D – Descriptions of the non-domestic extensions

<u>Deep-Plan Office</u>

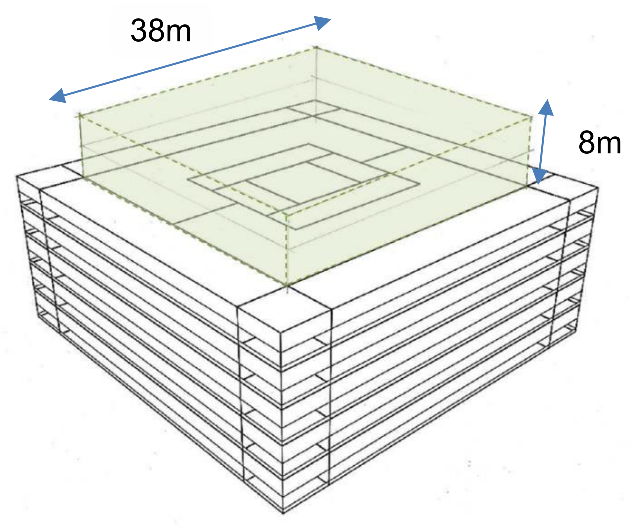
The existing office building is based on the deep-plan office building used in the impact assessment modelling for new non-domestic buildings with changes in specifications implemented to reflect an older building. This is a square five-storey building with strip glazing running around all four sides. A central atrium with 100m² footprint runs through the centre of the floorplate. The form of the existing part of the office building is described in Figure E.1.



Storeys:	5
Floor area:	12,100m²
Ground floor area:	2,500m²
Roof area:	2,500m²
External wall area:	4,000m² (includes glazing)
Glazed area:	1,500m²

Figure E.1: Screenshot of the office building form used for new non-domestic modelling

The modelled extension to this office building is a two-storey roof-top extension which is stepped back from the perimeter of the existing building. This extension includes a continuation of the central atrium through both new floors. The form of this extension is presented in Figure E.2.



Storeys:	2
Floor area:	2,688m² (excludes atrium void)
Ground floor area:	0m²
Roof area:	1,444m²
External wall area:	1,216m² (includes glazing)
Glazed area:	456m²

Figure E.2: Sketch of the office building form used for the existing building modelling with an extension

The building performance parameters for the existing building are based on the Energy Efficiency 2 (EE2) standard set out in Table 8.5d for an air-conditioned hotel in the *Energy Performance of Buildings Directive, Second Cost Optimal Assessment for the United Kingdom (2018)*. The cost optimal work did not include an air-conditioned office. The source data for the air-conditioned hotel was selected in preference to the naturally ventilated office building because this is a reasonable proxy for an air-conditioned office, and it was felt that the servicing strategy has a stronger influence on the building performance and the naturally ventilated building lacks several of the necessary parameters.

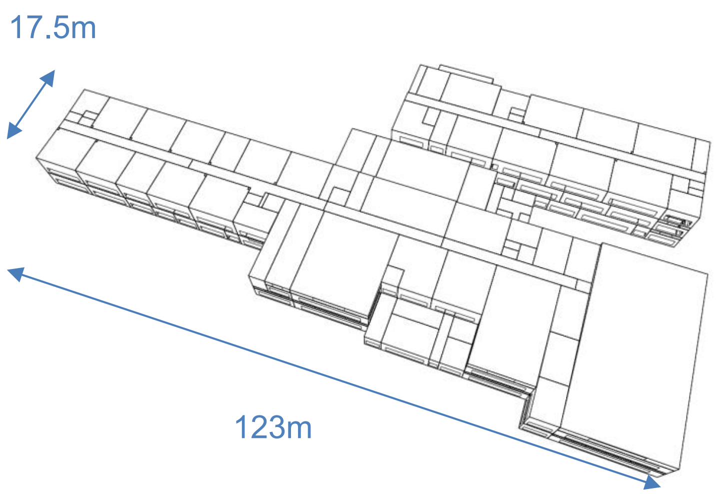
Table E.1 shows the key building performance parameters for the modelled existing building and the two variations on the modelled extension. The baseline comprises, in general, the current standards for new thermal elements; the exception is that the window specification is U=1.6 W/m^{2}K as whilst the current standard is U=1.8 W/m^{2}K, windows available on the market were found to be typically of a standard of U=1.6 W/m^{2}K or better. The proposal allows for improvements in the current standard, allowing for increases for both the thermal performance of external walls and glazing. The specification of building services for the extension is based on the current minimum requirements for an extension of this type, and it is assumed that an extension of this size would require additional central HVAC plant.

Table E.1: Key building performance parameters for the modelled office building and extension

Building Parameter		Existing Building	New Extension Options	
			Baseline	Proposal
Fabric	Roof U-value (W/m²K)	0.60	0.18	0.18
	External Wall U-value (W/m²K)	0.45	0.28	0.26
	Ground Floor U-value (W/m²K)	0.45	NA	NA
	Glazing U-value (W/m²K)	3.30	1.60	1.60
	Glazing G-value (W/m²K)	0.70	0.70	0.70
	Air tightness (m³/m²hr @50Pa)	15	15	15
HVAC	HVAC system type	Fan Coil Units	Fan Coil Units	Fan Coil Units
	Heating SCOP	0.78	0.86	0.86
	Cooling SSEER	2.20	4.00	4.00
	Central Specific Fan Power (W/l/s)	2.20	2.20	2.20
	Terminal Unit Specific Fan Power (W/l/s)	0.30	0.30	0.30
Lighting	Lighting Efficacy (llm/cW)	40	60	60
	Automatic Lighting Controls	None	Manual-on-auto-off	Manual-on-auto-off
	Automatic Lighting Controls Parasitic Power (W/m²)	NA	0.1	0.1

Secondary school

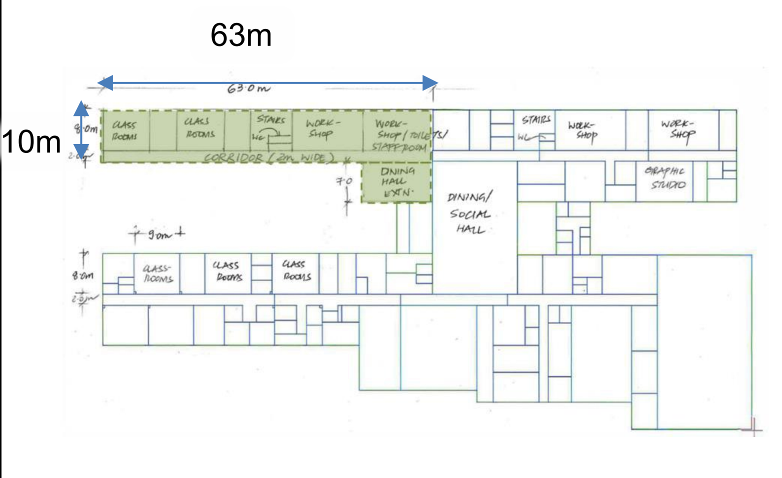
The existing school building is based on the secondary school building used in the impact assessment modelling for new non-domestic buildings with changes in specifications implemented to reflect an older building. This is a school with three wings emanating from a central core where dining, catering and office spaces are located. Two of the wings contain classrooms whilst the third is dominated by a double-height sports hall. Most of the building is two storeys, but one wing is three storeys and there are some areas which are a single storey high. The form of the existing part of the school building is described in Figure E.3.



Storeys:	1 to 3
Floor area:	8,012m²
Ground floor area:	4,379m²
Roof area:	4,379m²
External wall area:	4,247m² (includes glazing)
Glazed area:	1,271m²

Figure E.3: Screenshot of the school building form used for new non-domestic modelling

The modelled extension to this office building is a two-storey roof-top extension which is stepped back from the perimeter of the existing building. This extension includes a continuation of the central atrium through both new floors. The form of this extension is provided in Figure E.4.



Storeys:	3
Floor area:	1,952m²
Ground floor area:	719m²
Roof area:	719m²
External wall area:	1,550m² (includes glazing)
Glazed area:	527m²

Figure E.4: Sketch of the school building form used for the existing building modelling with an extension

The building performance parameters for the existing building are based on the Energy Efficiency 2 (EE2) standard set out in Table 8.5b for a secondary school in the *Energy Performance of Buildings Directive, Second Cost Optimal Assessment for the United Kingdom (2018)*; this standard is, in turn, based on the BRE Energy Conservation Guides.

Table E.2 shows the key building performance parameters for the modelled existing building and the two variations on the modelled extension. The baseline comprises, in general, the current standards for new thermal elements; the exception is that the window specification is U=1.6 W/m^{2}K as detailed for the office building above. The proposal allows for improvements in the current standard, allowing for increases for the thermal performance of external walls, ground floor and glazing. The specification of building services for the extension is based on the current minimum guidance for an extension of this type, and it is assumed that an extension of this size would require additional central HVAC plant.

Table E.2: Key building performance parameters for the modelled school building and extension

Building Parameter		Existing Building	New Extension Options	
			Baseline	Proposal
Fabric	Roof U-value (W/m²K)	0.60	0.18	0.18
	External Wall U-value (W/m²K)	0.45	0.28	0.26
	Ground Floor U-value (W/m²K)	0.45	0.22	0.18
	Glazing U-value (W/m²K)	4.80	1.60	1.60
	Glazing G-value (W/m²K)	0.70	0.70	0.70

	Air tightness (m^3/m^2hr @50Pa)	15	15	15
HVAC	**HVAC system type**	Radiators	Radiators	Radiators
	Heating SCOP	0.70	0.86	0.86
	Extract ventilation to WCs & stores	6ACH 0.4W/l/s	NA	NA
Lighting	**Lighting Efficacy (llm/cW)**	35	60	60
	Automatic Lighting Controls	Auto-on-off	Auto-on-off	Auto-on-off
	Automatic Lighting Controls Parasitic Power (W/m^2)	0.1	0.1	0.1