Department for Levelling Up,
Housing & Communities

2021 Introduction of a new requirement on overheating in residential buildings

Affecting new domestic buildings and other residential buildings including care homes and halls of residence.

Final Stage Impact Assessment

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

Title: 2021 Introduction of a new requirement on overheating in residential buildings: Final Stage Impact Assessment **Lead department or agency:** DLUHC	Impact Assessment (IA) **Date:** 15/12/21 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Secondary Legislation **Contact for enquiries:** Enquiries.BR@communities.gov.uk

Summary: Intervention and Options

RPC Opinion: N/A

Cost of Preferred Option (in 2019 prices, 2020 PV for EANDCB, 2021 PV base year for all other calculations)			
Total Net Present Social Benefit	**Business Net Present Cost**	**Net cost to business per year (EANDCB)**	**Business Impact Target Status**
£505m	£2.3m	£0.3m	N/A

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

In response to *The Independent Review of Building Regulations and Fire Safety,* the Government set out its intention to fundamentally reform the building safety system so that residents remain safe in their homes.

The latest report from the Intergovernmental Panel on Climate Change (IPCC), published in 2021, states that each of the last four decades has been successively warmer than any decade that preceded it since 1850[1]. It is virtually certain that hot extremes, including heatwaves, have become more frequent and with continued global warming the frequency and intensity of these weather extremes is projected to increase. The Government must therefore make sure that homes and other residential buildings are able to cope with the warmer climate of the future.

Warmer temperatures and longer periods of sunny weather increase the risk of overheating in residential buildings, which has subsequent negative impacts on the heath of occupants. It is estimated that there are around 2,000 heat related deaths each year in England and Wales, with this number expected to more than triple by the middle of the century due to climate change[2].

The Heat and Buildings Strategy[3] outlines the Governments' commitment to accelerate low and no regret actions needed on the path to Net-Zero. This includes a commitment to future-proof buildings by setting high standards for new homes, making them climate change resilient by mitigating risks of overheating.

There are a range of market failures that exist meaning that the costs of overheating have not been fully accounted for by the market, and hence government intervention is needed to address the problem. These include a lack of information about adaptation opportunities and the risk of overheating, and limited incentives for building owners and developers to make improvements which would reduce the risk of overheating from homes. The Dame Judith Hackitt report highlighted that the "Lack of clarity on roles and responsibilities" was one of the "key issues underpinning the system failure", noting that "there is ambiguity over where responsibility lies, exacerbated by a level of fragmentation within the industry, and precluding robust ownership of accountability" [4]. Putting in place a robust new requirement for overheating mitigation is therefore essential in addressing the issue.

What are the policy objectives and the intended effects?

The policy objectives and intended effects are:

- To protect the health and welfare of occupants who may be at risk of overheating in residential buildings.
- To mitigate overheating through passive means and avoid the widespread uptake of mechanical cooling systems in line with the Government's net zero commitment.

[1] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] House of Commons Environmental Audit Committee, 2018. Heatwaves: adapting to climate change. Available online: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf

[3] Department for Business, Energy and Industrial Strategy, 2021. Heat and Buildings Strategy. Available online: https://www.gov.uk/government/publications/heat-and-buildings-strategy

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

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

Option 0: Do nothing. Do not introduce a new requirement on limiting overheating in residential buildings. This assumes that some occupants will choose to retrofit homes with air conditioning. 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.

Option 1: Preferred option. Introduce a new requirement for limiting overheating in new residential buildings. This is the **Government's preferred option** which requires developers to limit overheating in residential buildings at the point of construction. This is the most cost-effective point at which to include passive solutions of overheating mitigation, as retrofitting passive solutions are both costly and technically difficult. Taking measures to mitigate overheating will reduce health risks and reduce the likelihood that mechanical cooling will be installed in future. There is an increasing risk of buildings overheating in future years as a result of climate change and this new requirement will make sure homes today are future-proofed for a warming climate.

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:** 0.03	**Non-traded:** N/A	

Summary: Analysis & Evidence

Policy Option 1

Description: new requirement for limiting overheating in residential buildings

FULL ECONOMIC ASSESSMENT

Price Base	PV Base	Time Period	Net Benefit (Present Value (PV)) (£m)		
2019	2021	70	Low: £404m	High: £606m	Best Estimate: £505m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low				
High				
Best Estimate	£2.3 million			£2.3million

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

This policy will require a reduction in the amount of glazing which will be a cost saving, as the cost of glazing is more expensive than fitting a masonry wall. However, the reduction in window area may also reduce the value of the property, given that larger glazing area/windows can be a desirable feature. It is therefore assumed that these offset each other, meaning there is no net cost of the policy (further details in section 6).

The only cost is a familiarisation cost of £2.3m.

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

These changes are unlikely to have a substantial impact on the demand and supply for new homes. Consequently this has not been monetised.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low				£406 million
High				£608 million
Best Estimate	N/A			£507 million

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

The benefits (present value) include reduced mortality, valued at £53m, and a small carbon saving of £3m. These will be a benefit to the occupants and wider society.

The largest benefits of the policy are the cost savings made from not installing and running mechanical cooling systems in the policy compared to the counterfactual. This results in a capital and replacement cost saving of £362m and energy savings of £89m. These cost savings will mostly fall to occupiers, but there may be some cost savings for Private Rented Sector landlords and housing associations.

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

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

Key assumptions/sensitivities/risks	Discount	3.5%

The analysis has taken a common set of assumptions on fuel prices, emissions factors and valuation of energy use from 2021 Green Book Supplementary guidance. The low and high estimates are +/- 20% of the best estimate.

These changes will only require a change in design for residential buildings that do not have sufficient measures already in place to reduce overheating.

It is assumed in the counterfactual that, in the absence of any intervention, some occupants will choose to install retrofit measures to address summer overheating, leading to higher costs in the counterfactual case.

Assumptions have also been made about daytime occupancy rates in homes, using data from the ONS.

All calculations are in 2019 prices and 2021 present value expect the EANDCB calculation which is in 2019 prices and 2020 present value.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual)			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs: £0.3m	**Benefits:** N/A	**Net:** £0.3m Cost	N/A (non-qualifying provision)

Contents

1. Introduction

Background and scope of the proposal

1.1. This Impact Assessment (IA) supports the introduction of a new requirement to limit overheating in residential buildings in England. The analysis which underpins this IA focuses on the costs and benefits associated with introducing mitigation measures in residential buildings at the point of construction. As such, the policies will have an impact on the construction industry, manufacturers of construction products, and the building's occupants.

1.2. A new requirement has been added to Schedule 1 of the Building Regulations, called Part O: Overheating. This requires developers to reduce overheating risk in new residential buildings in England, by limiting unwanted summer solar gains and providing a means of removing excess heat.

1.3. The full policy is set out in the response document, *The Future Buildings Standard: 2021 Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for non-domestic buildings and dwellings; and overheating in residential buildings.*

Future work (outside scope of the impact assessment)

1.4. This Impact Assessment (IA) only details the impacts of the introduction of the requirement on limiting overheating in residential buildings.

1.5. Further IAs have been published alongside this one which provide an assessment of the other changes set out in the Future Homes Standard and Future Buildings Standards consultation responses, including changes to Part L and Part F of the Building Regulations for domestic and non-domestic buildings.

2. Problem under consideration

2.1. In response to The Independent Review of Building Regulations and Fire Safety, the Government set out its intention to fundamentally reform the building safety system so that residents remain safe in their homes, and to do so through a number of legislative and non-legislative measures.

2.2. The 2021 report from the Intergovernmental Panel on Climate Change (IPCC) stated that each of the last four decades has been successively warmer than any decade that preceded them, and that the global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years[5]. Hot extremes, including heatwaves, have become more frequent and more intense across most land regions since the 1950s, and with continued global warming, the frequency and intensity of these weather extremes is projected to increase. The Government must therefore make sure that homes and other residential buildings are able to cope with the warmer climate of the future.

2.3. The Climate Change Committee's (CCC) 2015 Progress Report to Parliament set out some recommendations in preparing for climate change. These adaptation measures included the recommendation that *'The Department of Health, in partnership with DCLG, should identify incentives for the uptake of passive cooling in existing homes, hospitals and care homes and introduce a new standard to prevent new homes overheating, and promote passive cooling in existing buildings*'[6].

2.4. In response to the recommendations from the CCC the Government commissioned research to better understand the overheating risk in new dwellings and possible options to help industry and others mitigate this risk[7].

2.5. The Heat and Buildings Strategy[8] also outlines the Government's commitment to accelerate low and no regret actions needed on the path to Net-Zero. This includes a commitment to future-proof buildings by setting high standards for new homes that are climate change resilient by mitigating risks of overheating.

2.6. Overheating occurs when the local indoor thermal environment presents conditions more than those acceptable for thermal comfort, or those that may adversely affect human health. Overheating in buildings poses a key risk for the health and productivity of occupants in the UK. It is estimated that there are around 2,000 heat related deaths each year in England and Wales, with this number estimated to more than triple by the middle of the century due to climate change[9].

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[5] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[6] Climate Change Committee, Reducing emissions and preparing for climate change: 2015 Progress Report to Parliament, Available online: https://www.theccc.org.uk/publication/reducing-emissions-and-preparing-for-climate-change-2015-progress-report-to-parliament/

[7] Ministry of Housing, Communities and Local Government, 2019. Research into overheating in new homes. Available online: https://www.gov.uk/government/publications/research-into-overheating-in-new-homes

[8] Department for Business, Energy and Industrial Strategy, 2021. Heat and Buildings Strategy. Available online: https://www.gov.uk/government/publications/heat-and-buildings-strategy

[9] House of Commons Environmental Audit Committee, 2018. Heatwaves: adapting to climate change. Available online: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf

2.7. The current criteria within Part L of the Building Regulations for new homes, which includes making provisions to deal only with excessive solar gain in summer months, is not sufficient in fully mitigating these risks. Part L is primarily focussed on energy performance rather than thermal comfort or health. Although there are a range of measures known to mitigate overheating risk, there is a knowledge gap in terms of the assessment of which properties are most likely to overheat, and what combination of measures will be most cost-effective in terms of mitigation.

2.8. The current system means that there is a lack of information about adaptation opportunities and the risk of overheating, and limited incentives for building owners and developers to make improvements which would reduce the risk of overheating from homes. The Dame Judith Hackitt report highlighted that the "Lack of clarity on roles and responsibilities" was one of the "key issues underpinning the system failure", noting that "there is ambiguity over where responsibility lies, exacerbated by a level of fragmentation within the industry, and precluding robust ownership of accountability" [10].

2.9. If passive measures to reduce overheating are not installed at the point of construction, there will be a greater uptake of air conditioning retrofit to reduce overheating, which has a much higher cost due to high running costs. This would also have negative environmental impacts due to the greater energy use and associated CO_2 emissions, hence would not be in line with the Government's Net-Zero commitment.

2.10. Introducing a new requirement on overheating into the Building Regulations will provide industry with a level playing field and a clear standard of the minimum adaptation measures needed to ensure new residential buildings are protected against overheating. Ensuring these passive cooling measures are included at the point of construction will avoid the need to retrofit with air conditioning in the future ensuring homes and residential buildings are resilient to climate change.

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

3. Rationale for intervention

3.1. Carbon emissions and other greenhouse gases trap heat in the atmosphere, leading to rising global temperatures and more extreme weather events. It's predicted that weather extremes, including heatwaves, will continue to become more frequent and more intense as climate change intensifies. Warmer temperatures increase the risk of overheating in residential buildings, which has subsequent negative impacts on the heath and productivity of occupants.

3.2. Building Regulations are the primary tool for setting new standards for homes that protect the welfare and safety of occupants. 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. There is currently no requirement for mitigating the risk of overheating included in the Building Regulations. This means that there is currently no legal basis for ensuring that developers are including climate change adaptation measures in homes in order to mitigate these risks, meaning homes are being constructed without being fit for a warmer climate in the future, risking the health and safety of their inhabitants.

3.3. Several market failures exist in the construction sector which means that, in the absence of government intervention, the market would not make the changes necessary to mitigate the risk of overheating in residential buildings of its own accord. Despite widespread reports of overheating, particularly in flats, there is limited evidence that the market is delivering new residential buildings that mitigate overheating risk. Introducing a new requirement on overheating in the Building Regulations can therefore help to overcome the following market failures that act as a barrier to action:

- **Imperfect Information**: There are several information failures that occur in the housing market about overheating. First, there is a lack of information on overheating risks and the possible mitigation measures. For many, overheating is currently uncommon in the existing housing stock. As climate change intensifies over time however, this will become more of an issue. Due to a lack of knowledge, people may not know how or what to look for in terms of mitigation measures when buying/renting a home, or developers may not be clear on what mitigation measures to take during construction. This could lead to home buyers/renters having to take costly retrofit measures (such as installing air conditioning) in the future to deal with rising overheating issues. In addition to the increased private costs from retrofitting, this could also lead to increased carbon emissions at the expense of wider society. By introducing a new requirement to prevent overheating in the Building Regulations, developers will be clear on their roles and responsibilities, understanding what adaptation measures they should be taking to mitigate the risk of overheating in new developments, ensuring that these costly unintended consequences are avoided.

- **Negative externalities:** overheating in buildings has been highlighted as a key risk to the health and productivity of people and businesses in the UK. It is estimated that there are around 2,000 heat related deaths each year in England and Wales, and due

to climate change, this number is expected to more than triple by the middle of the century[11]. This is a significant negative externality because the external costs associated with overheating are not taken into account when a developer is considering their private costs in market transaction prices. Limiting solar gains and providing a means for removing excess heat at the point of construction, will remove the need for expensive retrofitting or mechanical cooling later in the building's life.

- **Inequality:** Retrofitting fixed air conditioning units is expensive and both fixed and portable air conditioners consume a high amount of energy. The rising costs of these measures mean that those on the lower end of the income distribution may not be able to afford these mitigation measures. Consequently, this could lead to rising inequality both through the cost and impact of overheating, as only those that can afford mitigation measures will be able to effectively mitigate the risk of overheating. By requiring passive measures to be installed at the point of construction, this ensures that mitigating the risks of overheating is accessible to all.

[11]House of Commons Environmental Audit Committee, 2018. Heatwaves: adapting to climate change. Available online: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf

4. Policy objectives and new regulatory requirements

Policy objectives

4.1. Warmer temperatures increase the risk of overheating in residential buildings, which has subsequent negative impacts on the heath and productivity of occupants. The Government must therefore make sure that homes and other residential buildings are able to cope with the climate of both today and the warmer climate of the future.

4.2. Full details of the policy objectives for the new requirement on overheating in residential buildings are set out in the Future Building Standard response document. A summary of these policy objectives is provided here.

4.3. The policy objectives are:

- To protect the health and welfare of occupants who may be at risk of overheating in residential buildings.

- To mitigate overheating through passive means and avoid the widespread uptake of mechanical cooling systems in line with the Government's net zero commitment.

A new legal requirement

4.4. A new requirement has been added to Schedule 1 of the Building Regulations, called Part O: Overheating. This requires developers to reduce overheating risk in new residential buildings in England by limiting unwanted summer solar gains and providing a means of removing excess heat. Part O also requires that the overheating mitigation is usable by occupants and that the use of mechanical cooling is limited. A regulation has been introduced into Part 8 of the Building Regulations to ensure that the builder provides sufficient information to building owners, ensuring occupants are able to use the overheating mitigation strategy.

Residential buildings in scope

4.5. This requirement applies to new dwellings, including houses and flats. It will also apply to care homes, residential colleges, student halls of residence and other similar establishments where people sleep on the premises. The complete scope of the requirement can be found in Chapter 5 of the Future Buildings Standard response document.

Compliance methods

4.6. There are two methods for demonstrating compliance with the new overheating requirement of the Building Regulations provided in the Approved Document. These are:

a) The simplified method

b) The dynamic thermal modelling method

4.7. The simplified method provides maximum glazing areas and minimum free areas[12], which are simple to adopt and do not require any modelling. Standards are set based on both the location of the building and whether it is cross-ventilated. The full details of this method can be found in *Approved Document O: Overheating*.

4.8. The dynamic thermal modelling method provides design flexibility, as designers can demonstrate a building does not overheat according to CIBSE's TM59 assessment method. The dynamic thermal modelling method can be applied in any situation but may be particularly appealing to designers; that are using communal heating; where there is a microclimate not well reflected by the locations of the simplified method, or; the building is highly shaded. Buildings that cannot meet the usability requirements set out in the *Approved Document O: Overheating* with the simplified method should instead use the dynamic method for design flexibility.

4.9. *Approved Document O: Overheating* details acceptable strategies for reducing the overheating risk in residential buildings when following the dynamic thermal analysis method. This includes guidance on limiting unwanted solar gains and providing a means to remove excess heat from the indoor environment. Mechanical cooling can be used; to meet the overheating requirement under the dynamic thermal assessment however, it should be demonstrated that all possible passive means have been implemented before adopting mechanical cooling.

Usability for occupants

4.10. There is guidance in the Approved Document on making sure that overheating strategies are safe and usable by occupants, taking a systems approach to building safety as recommended by the Dame Judith Hackitt review. The guidance includes taking into account noise and pollution near the home, the safety, security and usability of the windows, and the effect this may have on occupant behaviour.

4.11. The guidance on security for openings is in addition to the existing security requirements of *Approved Document Q.* This guidance applies to the ground floor and other easily accessible bedrooms and is to make sure people do not feel at risk of crime when trying to cool their homes at night.

4.12. The guidance on safety risks is to reduce the likelihood of people falling out of open windows, where the windows are used as part of the overheating mitigation strategy. Guarding heights are set to 1.1 meters to reduce the risk of serious injury or death. Guidance on the maximum distance between the inside face of the wall and the maximum position of the window handle has been set at 650mm to limit the risk of over-reaching and falling out of windows when opening and closing them.

[12] Free area is the geometric open area of a ventilation opening.

Providing information

4.13. A new requirement has been added into Part 8 of the Building Regulations for the person carrying out the work to provide the building owner with information on the overheating strategy. For dwellings, this information should be provided within the Home User Guide format within the 2021 *Approved Document L, Volume 1: Dwellings.*

Transitional arrangements

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

4.15. Transitional arrangements 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 should not benefit from the transitional provisions and so it would need to comply with the new overheating requirements. The rationale and policy intent for this change to transitional arrangements is set out in the Future Buildings Standard response document.

4.16. In line with the energy efficiency and ventilation changes being made to the Building Regulations at the same time as this change, developers will have 12 months from when these regulations are enacted to commence work on each individual building site.

5. Analytical approach

Assumptions applicable to all analysis

5.1. A cost benefit analysis has been undertaken to assess the impact of the introduction of a new requirement to mitigate overheating as part of the Building Regulations. This Impact Assessment (IA) refines some of the assumptions used in the 2019 and 2021 consultation stage IA, reflecting improvements in the evidence base following consultation and further engagement with industry, with updates detailed below. The cost benefit analysis is based on a piece of research published by MHCLG[13].

5.2. The costs and benefits have been assessed for a range of representative cases (see *representative cases* section below) made up of different dwelling types, orientations, locations, weather files and occupancy profiles. These cases have then been scaled up to represent the English new build housing stock.

5.3. This policy applies to new residential buildings only. This includes new dwellings as well as other residential-type buildings where people sleep on the premises e.g. student halls of residence and care homes. The analysis has been done for new dwellings only as these make up the majority of all new residential-type buildings, and also reflect the approach taken in MHCLG's *'Research into overheating in new homes'* Phase 2 Report.

5.4. This IA is based on the Green Book and the accompanying supplementary guidance on the valuation of energy use[14]. This IA uses updated fuel prices, carbon values and emission factors.

5.5. 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.

5.6. A discount rate of 3.5% has been used for the first 30 years of the building's life and 3% for subsequent years. Mortality related benefits have been discounted using a health discount rate of 1.5% for the first 30 years and 1.29% in later years.

5.7. 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.

5.8. The appraisal time period for estimating the impact of the policy is 10 years which is consistent with that used in the 2021 Part L and Part F Impact Assessments for domestic and non-domestic buildings, and in other IAs associated with the construction industry.

[13] Ministry of Housing, Communities and Local Government, 2019. Research into overheating in new homes. Available online: https://www.gov.uk/government/publications/research-into-overheating-in-new-homes

[14] Department for Business, Energy and Industrial Strategy, 2019, Valuation of energy use and greenhouse gas emissions for appraisal Available online: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

5.9. For the analysis of new residential buildings, an asset life of 60 years is assumed. This provides a sufficiently long period to capture the benefits of the 'lock-in' impact of mitigation measures. 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. This means the benefits from capital cost & energy savings and mortality benefits have been estimated over a 70-year period for each new building. Learning rates have been applied to account for reductions in costs for domestic fixed air conditioning (see Appendix C).

Phase-in assumptions and transitional arrangements

5.10. For the purposes of this analysis, new build completion projections are used as a proxy for annual rate of new buildings in our modelling. For more details, please see Appendix A.

5.11. Table 1 shows the phase-in assumptions that have been made about the numbers of new homes which will be built to the new 2021 standards in the first few years of the policy. These consider the effect of transitional arrangements using feedback from the consultation and conversations with industry. Assumptions about the lead-in, build and completion times for domestic buildings were also used to determine the profile, with the time lag expected to be 2-3 years.

5.12. The new requirement on overheating is assumed to come into force in June 2022.

Table 1: Phase-in assumptions (% of works captured by the new overheating requirement)

	2022	2023	2024	2025 onwards
New Residential Buildings	5%	50%	95%	100%

Source: DLUHC

Demonstrating Compliance

5.13. There are two ways that developers can demonstrate compliance with the overheating regulations (see paragraph 4.6 for more information). For the purposes of the cost benefit analysis, the risk mitigation measures outlined in the Simplified Method (presented in Section 1 of Approved Document O: Overheating) were used. This sets both maximum areas of glazing to limit solar gain into the dwelling and minimum opening areas to allow the removal of excess heat from the dwelling. It is assumed that these measures are sufficient to mitigate overheating, meaning no further passive or mechanical cooling measures are needed in these properties. While there is the opportunity for developers to use the dynamic thermal modelling route of compliance for more design flexibility, the Simplified Approach is expected to be generally more cost-effective. Consequently, this IA has focussed only on the Simplified Approach.

Representative cases

5.14. A total of 192 representative cases were initially developed to represent the English new-build stock. These were comprised of 3 dwelling types, 4 orientations, 2 locations, 4 weather

files per location and 2 occupancy profiles. All of these factors impact on the overall risk of overheating. A full description of these representative cases can be found in Appendix B.

5.15. The specifications of some of the baseline dwelling types were sufficiently designed to already comply with the new policy i.e., both the glazing areas and openable window areas met the criteria in Paragraph 5.13. The level of required glazing in the Simplified Method is dependent on the orientation of the home. For example, homes where the living room window façade had a North, East or South orientation, were deemed to already comply with the policy (90% of homes, see Appendix B, Table B.1). For apartment units, those where the living room window façade had a North or East orientation were deemed to already comply with policy (50% of apartment units, see Appendix B, Table B.1). In these cases, the policy has no impact, meaning the costs and benefits are set to 0. This resulted in only 80 of the representative cases being impacted by the policy and thus included in the main cost benefit analysis.

5.16. Dynamic simulation modelling was undertaken using Integrated Environmental Solution (IES) software on the 80 representative cases – 80 for the application of the policy and 80 for the counterfactual. This provided internal temperatures in the dwelling, from which the mortality benefits were derived as described further below.

5.17. The costs and benefits for the 80 representative cases were calculated and then scaled by the average annual new dwelling completions to represent the English new-build housing stock. The scaling approach is detailed in Appendix B. The approach to calculating the costs and benefits is described in Section 6.

Counterfactual

5.18. The analysis has assumed that in the absence of the policy, a proportion of residents will choose to install retrofit measures over the building lifetime to address summer overheating, such as installing air conditioning units.

5.19. In addition, there is currently no national requirement to install overheating risk mitigation measures during construction – hence the introduction of this policy. However, the analysis has accounted for local overheating requirements, which will reduce or negate the impact of the policy change, as is the case for London.

Retrofitting air conditioning/ mitigating measures

5.20. Overheating is expected to become a more persistent problem over time. Consequently, it is expected that, in the absence of any intervention, some residents will choose to install retrofit measures to address summer overheating. It is assumed that these residents will install mechanical cooling (air conditioning), which is a common solution for reducing high indoor temperatures in other countries. In practice, there are several measures that could be used to mitigate overheating. It is however very difficult to estimate which retrofit measure would likely be chosen. Therefore, for the purposes of the cost benefit analysis, the common solution of mechanical cooling/air conditioning is used. Once mechanical cooling is installed, it is assumed that there is no additional benefit of the policy i.e., that homes with mechanical cooling in the counterfactual no longer overheat.

5.21. In the counterfactual, air conditioning is only retrofitted in dwellings which require risk mitigation measures to comply with the policy. This is assumed to be 10% of individual homes and 50% of apartment units. It is assumed that other homes do not need overheating mitigation measures as they already comply. Appendix B (Table B.1) describes the dwelling typologies (including orientation) that need further measures to comply with the policy.

5.22. The analysis assumes that fixed room air-conditioners will be retrofitted in the living room and bedrooms, instead of a central system. This is because of the practical challenges of retrofitting central systems in existing dwellings e.g. the effort and space required to install routing ductwork.

5.23. A literature review was undertaken to assess the uptake of domestic air conditioning when there are increased external temperatures[6]. From this, there was limited evidence available, so following discussions with an expert advisory group, the uptake rate for air-conditioning was calculated based on a formula derived from US data[15]. Uptake rates were calculated separately for the two different locations (as the uptake is dependent on weather conditions), and applied to the new-build housing stock in that location. Further details are available in previously published research.[6]

5.24. At the commencement of the policy, the model assumes that no homes in the North of England have air conditioning and around 5% of the homes in the South of England would have air conditioning in the absence of any policy intervention. This increases to an uptake rate of 27% and 82% in the North and South of England respectively at the end of the 70 year appraisal period.

5.25. A current Seasonal Energy Efficiency Ratio (SEER) of 4 has been assumed based on International Energy Agency data[16]. This is used to calculate the average energy usage of air conditioners at different points in the year.

5.26. An alternative to a fixed air conditioning installation is a portable air conditioning unit. Portable air conditioning has a number of advantages and disadvantages.

5.27. There are two key advantages of portable air conditioning:

a. Portable air conditioning has a lower and therefore more affordable up-front cost. The lowest cost option would be to have a single portable unit and move it between rooms as needed. This would cost approximately £250[17], which is significantly lower than the cost of the fixed unit (approximately £4,000-£5,000 based on installing 3 or 4 units in a dwelling). As explained below, having one portable unit does have some hassle costs, so an alternative is to have multiple units.

[15] Sailor D J, Pavlova A A (2003). Air conditioning market saturation and long-term response of residential cooling energy demand to climate change. Energy 28 (9): 941-951

[16] International Energy Agency, The future of cooling, 2018. Available online: https://www.iea.org/reports/the-future-of-cooling

[17] Department for Business Energy and Industrial Strategy, Cooling in the UK, 2021. Available online: https://www.gov.uk/government/publications/cooling-in-the-uk

b. It avoids the need to undertake any retrofit works to the building, which may not be possible for those renting a property.

5.28. However, there are disadvantages to using portable air conditioning as a long-term solution:

a. The energy efficiency of portable air conditioning is poorer than that of a fixed unit. Recent Government research suggests that fixed units could be 3 to 4 times more energy efficient[18].

b. It is necessary to exhaust the hot air from a portable cooling unit via an exhaust hose, ideally through an opening window or door to the outside. This can both limit the areas of the home in which portable cooling can be utilised, as well as the overall effectiveness of the unit.

c. If a sufficient number of portable units are not purchased, some of the habitable spaces may not be sufficiently cooled to mitigate the risk of overheating. Hence, there will still be some negative impact on health compared to implementing the policy.

d. Whilst there will be a one-off hassle cost associated with installing fixed air conditioning and the space it takes up, there will be continual hassle costs for portable units, particularly if only one unit is purchased. This is due to the time and effort involved in moving the unit between rooms and setting it up, especially as units can be relatively heavy and therefore difficult to move between rooms. To avoid these issues, and the fact that cooling is limited to a single space at any time, an alternative is to have multiple portable air conditioning units, which would lead to higher capital and running costs.

e. The additional noise associated with portable cooling units presents a particular challenge for bedrooms, where occupants may be unwilling to use them overnight to avoid disruption to their sleep.

5.29. Given these issues, only fixed air conditioning installations have been modelled in the main cost benefit analysis. Sensitivity analysis has been taken forward in Section 6 to assess the impact of portable units being installed instead of fixed air conditioning.

Local Authorities

5.30. The Building Regulations set standards for new buildings at the national level for England. Local Authorities (LAs) however have the power to set voluntary standards beyond the national requirements through local plans. Any commitments set out in local plans by LAs are public and legal commitments. In these cases, an adjustment needs to be made to the counterfactual, as some of the costs and benefits attributed to the new requirement for overheating mitigation will, instead, already be incurred due to the specific local commitments.

[18] Department for Business Energy and Industrial Strategy, Cooling in the UK, 2021, Table 17 https://www.gov.uk/government/publications/cooling-in-the-uk

5.31. Consequently, DLUHC have taken account for this in the counterfactual. The Greater London Authority, through the London Plan, have set out commitments for all major developments referable to the GLA to demonstrate compliance with CIBSE's TM59 standard[19]. The TM59 standard is also how the simplified method was produced and is used in the dynamic thermal modelling method. For the policy, this means that any costs or benefits for residential buildings in London are set to zero, due to the new standards duplicating those found in the London Plan.

[19] The London Plan 2021, Available at: https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

6. Estimation of costs and benefits

Summary of impacts

6.1. A summary of the impacts considered under this Impact Assessment (IA) is provided below in Table 2, relative to the counterfactual (Option 0: 'Do Nothing'). All figures are Net Present Values (NPV) over 10 years of policy and a subsequent 60-year life of the buildings. The figures represent the aggregate impact across the building mix.

6.2. Overall, the analysis is dominated by the financial cost savings associated with the policy. These cost savings reflect the avoidance of high capital and running/energy costs from retrofitting homes with domestic air conditioning (as in the counterfactual scenario). No cost savings are associated with the policy due to the replacement of window area with cheaper external wall components. This is discussed further below.

6.3. The overall net benefit of the Government's policy is estimated to be £505 million, with an equivalent annual net direct cost to business (EANDCB) of £0.3m over 10 years, in 2019 prices.

6.4. The savings/benefits made from not needing to install air conditioning will be enjoyed by occupiers avoiding high retrofit and running costs. There is a benefit of reduced mortality from implementing the policy and reducing the risk of overheating.

Table 2: Summary of costs and benefits (£m)	Dwellings
Transition costs (£m) Energy savings (£m) Incremental costs (£m)	(£2.3) £89 £362
Total financial benefit/(cost) (£m)	**£449**
Total carbon savings (£m)	£3
Mortality benefit (£m)	£53
Net benefit/(cost) (£m)	**£505**
Amount of energy saved (GWh)	2,847
Amount of CO2 saved - traded (MtCO2(e))	0.03

Updates to Analysis from the Consultation IA

6.5. There are several drivers for the difference in numbers compared to the consultation stage IA. These are as follows:

a. **Mitigation measures:** An updated risk mitigation package was used which reflects the amended policy. It consists of modifications to window openings: reduced glazing areas in flats (to 20% of floor area for south facing flats and 15% for west facing) and reduced glazed area in houses (to 15% of floor area for west facing houses). This represents the Simplified Method for the North and South of England, and results in reduced costs and benefits compared to the mitigation packages assessed at the consultation stage.

b. **Orientation of a home:** The original analysis was based on living rooms in all dwelling types facing south. Revisions to the Simplified Method since consultation has led to maximum glazing areas being set out depending on orientation (North, East, South, West). To align, the cost benefit analysis similarly evaluates the impact of the policy for each of the four orientations, which are weighted based on the likely percentage of buildings constructed at each orientation. The key impact of this was that most dwellings, due to their orientation, were deemed to comply with the Simplified Method without the need for additional overheating risk mitigation measures. Hence, this reduced the number of dwellings that the policy impacted on, reducing the overall cost savings and benefits from implementing the policy.

c. **Mortality benefits:** Mortality benefits have been introduced into the benefits analysis. This was calculated in the original research, but not included in the consultation stage IA. This has led to an increase in the overall benefits from the policy.

d. **Productivity benefits:** Productivity has been removed from the benefits analysis for the final IA. The productivity benefit is dependent on the quality of sleep. However, with London excluded from the impact analysis (see page 19), baseline solutions (without any policy intervention or retrofit measure) for the other two locations in the model were found to comply with the CIBSE TM 59 Criterion B for bedrooms. This assesses the overheating risk in bedrooms overnight, and so by complying with TM 59, there is no longer an impact from the policy on the quality of sleep and therefore on productivity.

e. Counterfactual costs: The capital costs for the fixed air conditioning have been reviewed and updated for this IA. The costs used in the consultation stage IA were based on the original research. The efficiency of the fixed air conditioning has also been improved from a seasonal energy efficiency ratio of 2.4 to a value of 4.0 to better reflect data on current performance of such systems, which resulted in a reduction of both the energy consumption and energy costs.

Costs

Loss in amenity value

6.6. For homes impacted by the policy, the Simplified Method requires a reduction in the amount of window glazing, with it being assumed that windows are replaced by increased external wall area. In principle, this would result in a net cost saving for developers, as glazing is more expensive than a masonry wall. The reduction of window area may however have a negative impact on the amenity value of the property, given that larger glazing area/windows can be a desirable feature (e.g. increased sense of space and greater daylight) which home buyers demand in a house/flat. This means that any reduction in costs from building with less window glazing is likely to be offset by the potential fall in the amenity value of the home.

6.7. Given the complexity and interaction between these factors, it is very difficult to assess the whether the loss in amenity value is equivalent to the cost saving of building with wall. Therefore, for the purposes of the analysis, these costs and cost savings have not been included in the main cost benefit analysis. Consultants have, however, attempted to give

an indication of the possible scale of the loss in amenity value, using the cost saving from reduced glazing as a proxy. As it is assumed that the loss in amenity value offsets any cost saving from building with reduced glazing, the level of saving represents the minimum loss in amenity value. It is estimated that on average, the cost saving from complying with the new requirements is around £1,600 per dwelling. As the policy affects 283,000 homes over the 10-year policy period, this amounts to a net present value of £356m.

Design Constraints

6.8. There may be an ongoing cost for developers due to the possible constraints placed on house designs from the policy. However, these hassle costs are likely to be small and are very difficult to identify, therefore these have not been monetised.

Window Openings

6.9. As detailed in Section 4, the policy includes guidance on security for openings in addition to the existing security requirements of Approved Document Q. This guidance particularly applies to ground floor and other easily accessible bedrooms. In such cases, it is recommended that open windows or doors can be made secure by using either (i) fixed or lockable louvred shutters or (ii) fixed or lockable window grilles or railings. Such additional security measures would not be typical for houses where bedrooms are not on the ground floor. This would be more relevant to ground floor flats and bungalows, which make up only a small percentage of total new-builds and amount to a significantly lower additional cost than the cost savings from the reduced window glazing, as detailed above. Consequently, it was deemed not proportionate to include in the main cost benefit analysis.

6.10. As also detailed in Section 4, guidance is included on safety risks to reduce the likelihood of people falling out of open windows, where the windows are used as part of the overheating mitigation strategy. In particular, guidance on the maximum distance between the inside face of the wall and the maximum position of the window handle has been set at 650mm. This limits the risk of over-reaching and falling out of windows when opening and closing windows opening outwards. This is not considered to unduly constrain the openable width of the window and, if necessary, a developer could elect to adopt an alternative approach, such as having windows opening into the room. Therefore, no costs or benefits have been included in the cost benefit analysis.

Transition/Familiarisation costs

6.11. There are transition costs incurred by businesses to familiarise their employees with the new technical requirements to protect against overheating in new residential buildings.

6.12. It is assumed that training is necessary for; developers and associated professional services to design the buildings to the new standards and procure the appropriate building components; for the supply chain to be ready to meet this demand, and; for building control to assess the building applications and work.

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

- Types of business/organisation that will be affected were identified. These included energy consultants, contractors, dynamic thermal modellers and building control.
- Types of familiarisation activity were identified. These included preparing training course material, self-study, CPD, and formal training courses.
- Consultation was undertaken with a small sample of these businesses and/or representatives of these businesses/organisations, to identify the time/cost likely to be incurred.
- The costs were then scaled up across the industry based on the number of businesses/organisations.

6.14. Table 3 shows the estimated average familiarisation time (in hours) for each type of affected business/organisation.

Table 3: Average familiarisation time (hrs) for each type of affected business

Consultant	Installer	Main Contractor/ Developer	Designer	Dynamic Thermal Modeller	Building Control
Overheating	7.5	3.75	3.75	7.5	15

6.15. In addition to the time for familiarisation, it is anticipated that some of the changes will also involve attendance at a training course. The cost of the training course has been included at an estimated £250 per day, with 50% of the courses being delivered at no cost by industry bodies. The analysis assumes that building control officers will attend 2 days of training courses to become familiar with the changes to overheating requirements.

6.16. Table 4 shows the estimated number of businesses/organisations that will need to become familiar with the changes:

Table 4: Estimated number of businesses that will need to familiarise themselves with the changes

	Consultant	Main Contractor/ Developer	Designer	Dynamic Thermal modeller	Building Control
Numbers of organisations	3,085	465	13,105	380	400

6.17. Using the HMT GDP deflator, this means that the estimated transitional costs in 2019 price year and 2021 base year is **£2.3 million.**

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

Cost Savings

Capital & replacement cost savings

6.19. The cost for mechanical cooling is included for those homes in the counterfactual that adopt that measure (see paragraph 5.24). Replacement costs are also accounted for with a replacement period of 15 years. Most of the system is expected to be replaced, however, components such as the power supply and condensate drain would not be expected to need replacing and therefore are omitted from the replacement cost.

6.20. Learning rates have also been applied to take into account the potential cost reductions of elements. Details of the costs for mechanical cooling are given in Appendix C.

6.21. The total capital and replacement cost saving is **£362m**. The cost savings from avoiding the high capital and running/energy costs from retrofitting homes with domestic air conditioning (including the energy costs below) dominate the cost benefit results. Avoiding the need to retrofit mechanical cooling is a significant cost saving from implementing the policy.

Energy cost saving

6.22. The energy cost savings from not using mechanical cooling/air conditioning has been included in the cost benefit analysis. Energy costs 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. The total energy cost saving is **£89m**.

Carbon cost saving

6.23. The carbon cost savings from not using mechanical cooling/ air conditioning has been included in the cost benefit analysis. This is valued in accordance with the supplementary Green Book guidance. The total carbon cost saving is a small saving of **£3m** due to only a small amount of carbon being saved.

Benefits

Reduced mortality

6.24. It is estimated that there are around 2,000 heat related deaths each year in England and Wales, with this number estimated to more than triple by the middle of the century due to climate change[20]. Introducing risk mitigation measures in homes can reduce daytime temperatures, leading to a reduction in the number of deaths from overheating.

[20] House of Commons Environmental Audit Committee, 2018. Heatwaves: adapting to climate change. Available online: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf

6.25. As developed in previous research undertaken for DLUHC, a three step approach was taken to quantify the mortality costs associated with overheating[21]. To note, mortality benefits were only assessed for dwellings with daytime occupancy, as only residents in dwellings at these times are exposed to maximum internal room temperatures. The approach is as follows:

a. **Step 1 - Risk of Mortality:** The previous research determined a relationship between an increased risk of mortality and the indoor temperature, accounting for the age and sex of the occupant. Dynamic simulation modelling was undertaken using Integrated Environmental Solution (IES) software on the representative cases. This determined the indoor temperatures for both the policy and the counterfactual. Data from the UK Time Use Survey was then used to understand the type of occupants living in different types of dwellings, broken down by age and sex. This identified the percentage breakdown of occupancy by gender and age bands for houses and flats. Combining these percentages with the indoor temperature analysis, the risk of mortality for different groups in different types of dwellings was calculated, both for the policy and the counterfactual.

b. **Step 2 - Number of years of life saved:** Using ONS life expectancy data, the risk of mortality was then converted into the number of life years saved, by age and sex. This gave a total of 1,668 life years saved for the risk mitigation strategy by dwelling type and location, relative to the counterfactual.

c. **Step 3 - Monetising the number of lives saved:** Using Green Book guidance, Quality Adjusted Life Years (QALY) were used to value the number of life years saved of all occupants living in a property. As per the Green Book, a single QALY equals £60,000.

6.26. This results in a benefit of the policy of **£53m**.

Sensitivity analysis

6.27. The counterfactual assumes that 100% of homes that take mitigation measures to reduce overheating will install fixed air conditioning units, with the cost benefit analysis dominated by the cost savings from these not being installed in the policy. It is possible however that some who choose to retrofit will choose to install portable cooling units instead over fixed. Consequently, consultants have taken forward sensitivity analysis to assess the impact of adopting portable air conditioning instead.

6.28. For the sensitivity analysis it is assumed that there is a portable air conditioning unit located in the same rooms that fixed air conditioning was located in i.e. one in each living room and bedroom. It is also assumed that the same cooling demand is met, with the only difference in energy use being that the SEER is 2.4 [22] compared to 4.0 for fixed air conditioning.

[21] Ministry of Housing, Communities and Local Government, 2019. Research into overheating in new homes. Available online: https://www.gov.uk/government/publications/research-into-overheating-in-new-homes
[22] Department for Business Energy and Industrial Strategy, Cooling in the UK, 2021, Table 17 Available online: https://www.gov.uk/government/publications/cooling-in-the-uk

6.29. The impact of the policy in the portable unit scenario compared to the fixed air conditioning scenario, is a reduction in the capital cost savings from £362m to £148m and an increase in the energy saving from £89m to £148m. Overall, this would lead to a lower cost saving of £353m compared to £505m in the fixed air conditioning scenario.

Caveats of Sensitivity Analysis

6.30. The sensitivity analysis assumes, like the main analysis for fixed air conditioning, that 4 portable air conditioning units are installed in individual homes and 3 portable air conditioning units in apartments. There are some considerations however which mean that, in reality, occupiers may choose a different method of mitigation. Due to proportionality, these considerations have not been analysed, but are explored below:

a. **Fewer Portable Units**: Occupiers may opt to have fewer portable units compared to the main sensitivity analysis. This would reduce both the capital and energy costs in the counterfactual. For example, if there was only 1 portable air conditioning unit in each dwelling, it would reduce both the capital and energy costs by 3 to 4 times depending on the dwelling type. Although this would lead to a downward pressure on costs, some of this would be offset by an increase in hassle costs from moving units between rooms. There would also be a reduction in comfort and health benefits from all rooms not being sufficiently cooled.

b. **Both Fixed and Portable Units:** Some homes may have a combination of fixed and portable units, or some homes may have all fixed or all portable. Depending on this combination, this could lead to an increase or decrease in the cost savings. Furthermore, some homes are likely to commence with portable units before progressing to fixed units as cooling demand increases, which would further reduce any cost saving over the longer term.

c. **Portable Unit trends**: Portable units are less effective in cooling a home than fixed units. This means that in early years when the need for cooling is lower, portable units may have higher demand than fixed air conditioning units. As external temperatures are projected to rise over time, over the longer term the demand for portable units may then fall as people opt for fixed air conditioning for more effective cooling. Continued hassle and noise costs associated with using portable cooling over a longer period may also lead to a fall in demand for these products.

7. Business Impacts

Equivalent Annual Net Direct Cost to Business (EANDCB)

7.1. The only cost to business that has been included in the EANDCB calculation is the familiarisation cost from getting up to speed with the new regulation. The familiarisation cost is estimated to be £2.3 million, which leads to a £0.3m annual net direct cost to business over the 10-year policy period. As per the HMG's official impact assessment calculator, the EANDCB has been calculated in 2019 prices, 2020 PV base year.

Table 5: EANDCB and Business Net Present Value (£m)

EANDCB	(£0.3)
Business Net Present Value	(£2.3)

7.2. This regulation is out of scope of the Business Impact Target.

Unquantified business impacts

7.3. **Design Constraints:** This new regulation will constrain design which will have an ongoing cost after the familiarisation, as designers must continue to ensure they meet this regulation. These hassle costs are likely to be small and are very difficult to identify, therefore these have not been monetised.

7.4. **Loss in amenity value**: As covered in paragraph 6.12, the policy leads to a reduction in the amount of window glazing in a compliant house. As bigger window areas can be more desirable for prospective buyers/renters, this can lead to a loss in amenity value, resulting in the sale/rent price of a property falling. In this case, it is likely there will be some cost to business. This is very difficult to calculate however, due to the level of complexity and variance by house type and is also made more complex by the fact that developers would save money from building with a masonry wall instead of glazing. Consequently, this has not been monetised.

7.5. **Retrofitting air conditioning/ mitigation measures**: In the counterfactual it is assumed that some occupiers will choose to retrofit fixed air conditioning units (see *Retrofitting air conditioning/ mitigation measures* Section, page 18). It is expected that the majority of these cost will fall to occupiers, however in some cases the costs may be covered by Private Rented Sector (PRS) landlords and Housing Associations (HA). The scale of this however is very uncertain, as the landlord/ HA is under no obligation to do so and is likely to have little incentive to retrofit fixed air conditioning units as they do not experience the benefits. Consequently, this has not been included in the EANDCB calculation. Any inclusion would lead to higher benefits and thus lower net costs to business from the policy.

Small and Micro Business Assessment *(SaMBA)*

7.6. Adroit Economics were commissioned to consult with key stakeholders to explore the extent to which SMBs would be disproportionately affected by the introduction of a new requirement to mitigate overheating.

7.7. **Small builders/developers:** from Adroit Economics' 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.

Mitigating the impact on small and micro businesses

7.8. The simplified method in Approved Document O: Overheating has been designed for use by small housebuilders. It provides maximum glazing areas and minimum window opening areas, allowing a means of compliance that does not require modelling and therefore provides certainty at design stage at a low cost. There was positive feedback from stakeholders to the consultation on the inclusion of a simplified method in the Approved Document, with industry stakeholders representing small businesses agreeing that this would be beneficial for them.

8. Wider impacts

8.1. The impact assessment has set out the direct costs to businesses and society, such as capital and replacement costs, as well as setting out the wider societal benefits, reduced mortality from overheating, and cost and carbon savings. There are, however, several considerations that may be indirectly affected by the introduction of a new requirement on overheating, or which may indirectly affect the potential impacts of the Building Regulations. These are explored below.

Economic and financial impacts

Competition

8.2. The principal markets affected by the 2021 policy are the markets for the development of new residential buildings, along with the supply chains to produce construction materials used in those developments, as well as the markets for products which reduce solar gain.

8.3. The introduction of new requirements to mitigate the risk of overheating in new residential buildings is expected to increase demand for products that reduce solar gain. There are a number of alternative solutions (such as lower g-value glazing and various methods of internal and external solar shading) and suppliers which should help ensure a competitive market for such products.

8.4. As a result of the new requirement on overheating in residential buildings from 2021, building developers would have to comply with these new targets. This could have two opposing effects. First, the requirement to add additional external or internal shading may increase build costs and as a result would see costs rise. However, an alternative method for reducing solar gains, that has been provided throughout this IA, would be to reduce window size and decrease build costs.

8.5. The overall effect on cost will therefore depend on how developers decide to comply with the new requirements. There are methods that are neutral or positive cost and it is expected that the most cost-effective route will be chosen. In either case, the impact on costs are expected to affect developers with similar house designs and developments in similar ways. Therefore, any competitive effects in the market for building development are likely to be negligible.

Innovation

8.6. The introduction of new requirements for the mitigation of overheating and the increase in demand for solutions such as lower g-value glazing and solar shading should encourage innovation among manufacturers to improve performance and/or reduce costs.

International Trade

8.7. The new 2021 requirement on overheating and the associated Approved Document do not set product standards. Therefore, HMG is not required to notify the World Trade Organization.

8.8. There could be some indirect economic impacts, particularly by encouraging innovation. If product innovation occurs, this could lead to the development of new products and higher demand in relevant markets. If there is global demand for these goods then businesses will be incentivised to sell their products abroad, thus increasing international trade. This could also lead to benefits for key UK sectors, such as manufacturing, if innovation takes place in a market where the UK holds a comparative advantage.

Social impacts

Housing supply

8.9. The government does not believe that the introduction of a requirement on overheating will have a material effect on the supply of homes. This is because the costs of the policy are very low and DLUHC, through the Approved Documents, have provided guidance to make it simple to comply.

Health and well-being impacts

8.10. The health and well-being impacts are central to this policy and are therefore covered in the main body of this impact assessment.

COVID-19

8.11. COVID-19 has had several implications for the construction industry. First, housing supply has been impacted by COVID-19, with the total number of new completions in 2020 being significantly lower than in previous years. This was due to 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 expected. It is therefore assumed that there should be no additional impact on housing supply in the longer term. 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.

8.12. Second, because of the pandemic more people are working from home. This may place a greater value on the importance of cool homes throughout the summer months, with the potential impact being even greater as fewer people decide to return to air-conditioned offices. This means that there could be additional benefits due to the 2021 changes, as more people will be benefiting from the passive measures introduced to mitigate the risk of overheating in their homes.

Environmental impacts

8.13. The environmental impacts of this policy are small but are covered in the main body of this impact assessment.

Administrative burdens

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

8.15. The consultation proposes a new regulation to require information on the overheating strategy to be given to the owner of a new residential building. There may be costs associated with collating, emailing and printing this information, but these are believed to be minimal due to this information being readily available from the design. Furthermore, some of this information may overlap with that being given for the purposes of ventilation and energy efficiency. Once this is collated for one dwelling it can be reused for any with the same design. It is estimated that this will cost in the order of <£10 per dwelling. The benefits gained from occupants using their overheating strategy effectively would likely outweigh the costs significantly.

9. Equalities assessment

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

i. Eliminate unlawful discrimination, harassment and victimisation and other conduct prohibited by the Act.

ii. Advance equality of opportunity between people who share a protected characteristic and those who do not.

iii. Foster good relations between people who share a protected characteristic and those who do not.

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

9.3. Throughout the development of the policies, 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 consultation on the policies were also carefully analysed, to identify any specific concerns which were raised in relation to any disproportionate impact the policies may have on individuals because of a protected characteristic.

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

9.5. This policy is expected to reduce inequality. In the absence of any intervention, and due to the high cost of retrofitting air conditioning in homes, those on the lower end of the income distribution may be unable to afford mitigating overheating. By requiring passive measures to be installed at the point of construction, DLUHC are ensuring that mitigating the risks of overheating is accessible to all.

Appendix A – Net Completions Projection

Below is the independent analysis conducted by Adroit Economics on the number of new domestic dwelling completions in England between 2022-2031. This is used in the cost benefit modelling to assess the impact of changes to the new requirement for overheating in residential buildings.

These estimates of new build completions are produced by an independent consortium, based on their analysis of a range of data sources that show recent trends in dwelling completions, coupled with economic projections. They are indicative, should be used for appraisal purposes only and do not represent an official forecast of changes in housing supply.

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

	Annual number of net completions									
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Total	225,012	229,512	234,102	238,785	243,560	245,996	248,456	250,940	253,450	255,984

Source: Adroit Economics

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

Although the range of available data sources provides a reasonable basis to estimate future trends, there inevitably are uncertainties and hence the projections should be treated with caution. Additionally, the figures in the projections above do not take account of the impacts of COVID-19 on housebuilding, hence are likely to be inflated.

Appendix B – Modelled cases

To undertake the cost benefit analysis, 192 representative cases were assessed. This comprised all combinations of 3 dwelling types, 4 orientations, 2 locations, 4 weather files per location and 2 occupancy profiles. All of these factors impact on the overheating risk and the costs and benefits of mitigating this risk. The costs and benefits from these 192 cases were then suitably scaled to represent the English new-build housing stock[23].

Locations (and weather files)

Two locations were evaluated: South of England and North of England. These locations were associated with weather data for Southampton and Nottingham respectively. Initial research considered five separate weather locations (including London) and it was considered that focussing on these two locations (and London) was sufficient to represent the range of overheating risk in different parts of England. The London region was omitted from this analysis, as detailed in the discussion on the counterfactual in Section 5 of the IA. Subsequently, it is assumed there is no impact from the policy in London.

Four weather files were used for each location.

- Both projected 2020s and 2050s weather data were used for this analysis. The 2020's weather data was applied from 2022 - 2040 and the 2050's data from 2041 - 2091[24].
- Both Test Reference Year (TRY) and Design Summer Year (DSY1) weather data were used for both time periods. The TRY data represents a typical year. The DSY1 data represents a moderately warm summer (i.e. warmer than a typical year).

Based on the current climate, DSY1 has a return period of 7 years i.e., it is expected that there is a 1-in-7 chance of temperature being equal or hotter than DSY1 temperature data[25]. The return period for future DSY1 weather data is unknown and is the subject of further research; however, 7 years is potentially an underestimate as the trend is for hotter than average summers to be more frequent in the future. For the purpose of calculating the benefits, a conservative assumption was used that the DSY1 weather conditions have a return period of 7 years. As the occurrence of DSY1 is probabilistic, each year gained one seventh of the benefit from mitigating overheating under DSY1 weather conditions and 6/7th of the benefits from TRY weather conditions.

Dwelling typologies

Three dwelling typologies were assessed: a semi-detached house, a single aspect apartment unit (windows on one side), and a dual aspect apartment unit (windows on two opposite sides). Initial research was undertaken on a larger sample of 9 dwelling types, with the results demonstrating that focussing on these three dwelling typologies sufficiently represented the overheating risk. The results for the two apartments was applied to all new apartments and the semi-detached house results was applied to all new houses [26].

[23] As noted below, due to the counterfactual, only 12 of these representative cases were used in the final cost benefit analysis

[24] 2020s weather data is representative of the time period 2011-2040. The 2050s weather data is representative of the time period 2041-2070. For the current analysis, the 2050s DSY and TRY data was also applied from 2071 onwards until 2091.

[25] CIBSE Weather Files 2016 release: Technical Briefing and Testing; available at https://www.cibse.org/getmedia/ce7a77e8-3f98-4b97-9dbc-7baf0062f6c6/WeatherData_TechnicalBriefingandTesting_Final.pdf.aspx

[26] Ministry of Housing, Communities and Local Government, 2019. Research into overheating in new homes. Available online: https://www.gov.uk/government/publications/research-into-overheating-in-new-homes

For each of the dwelling typologies, additional overheating risk mitigation measures were included to comply with the new policy, following the Simplified Method presented in Chapter 1 of Approved Document O: overheating. This is shown in Table B.1. The measures are intended to meet the CIBSE TM59 definition of overheating based on 'Category II buildings' which are associated with a normal expectation of usage which is reflective of the general population [27].

The Simplified Method requires window shading to be added to dwellings in the high-risk part of London, as other techniques were not sufficient to reduce indoor temperatures due to the high external temperatures. Whereas the approach for the rest of England was to reduce the size of glazing area for specific orientations. Not all orientations modelled for this IA have resulted in a need to change the glazed area, as the typical baseline building is already considered compliant. The cases where the mitigation specification differs to the baseline model (which is used for the counterfactual) are highlighted with **[brackets]**.

Table B.1: Measures to mitigate overheating risk used in IA

	Dwelling Glazing Area (as percentage of dwelling floor area)[28]							
	Orientation of façade with largest window area (living room in all models)							
	North		East		South		West	
	Baseline	Mitigation	Baseline	Mitigation	Baseline	Mitigation	Baseline	Mitigation
Single Aspect	25%	25%	25%	25%	25%	**[20%]**	25%	**[15%]**
Dual Aspect	25%	25%	25%	25%	25%	**[20%]**	25%	**[15%]**
Semi-detached house	20%	20%	20%	20%	20%	20%	20%	**[15%]**

*note London is included in the Simplified Method but excluded from the IA as explained in the Counterfactual discussion in Section 5.

For each dwelling typology, four different orientations were assessed; north, east, south and west. The Simplified Method sets out different mitigation measures by orientation and the cost and benefits analysis is dependent on the orientation. New dwellings will have different orientations, with Table B.2 shows the weighting applied to scale-up across the building stock. Given the lack of evidence, these proportions were agreed with expert Planning and Development consultants.

Table B.2: Housing split by orientation

	North	East	South	West
Apartments	25%	25%	25%	25%
Houses	40%	10%	40%	10%

Source: DLUHC, Quod

The costs and benefits for the dwelling typologies and locations were scaled up to a national level as set out in Table B.3 and Table B.4. In Table B.4 single aspect apartment results apply to 25% of new apartments and the dual aspect apartment results apply to 75% of new apartments. Research did not find any specific data on the split of single and dual aspect flats at the regional

[27] The overheating risk in the original research was based on 'Category I buildings', i.e. assuming that the dwellings have a high probability of being occupied by vulnerable and fragile persons at some point over their life.

[28] 25% of glazing area is modelled as frame

or national level. Therefore, the following splits were agreed with an expert advisory group supporting the original cost benefit analysis[29].

Table B.3: Housing split by region

	Split
London*	15.7%
North England	55.9%
South England	30.4%

Source: Average Annual New Housebuilding Completions 2016-21 (DLUHC Live tables 217 and 254)

Table B.4: Housing split by type

	House	Apartment	
		Single	Dual
London*	12.0%	22.0%	66.0%
North England	89.6%	2.6%	7.8%
South England	78.4%	5.4%	16.2%

Source: Average Annual New Housebuilding Completions 2016-21 (DLUHC Live tables 217 and 254)
**to note, London figures not used in this IA*

Occupancy

The total number of occupants for the apartments and the semi-detached house were based on the average number of occupants (i.e. the average number of adults and children). Data comes from the English Housing Survey (EHS) 2015-2016 dataset for flats and houses respectively. This means that the heat gains from occupancy assumed in the modelling broadly reflect the average across the stock. The average occupancy data from EHS is shown in Table B.5.

As there is limited regional variation, the occupancy data for all of England was applied across all locations.

Table B.5: Average occupancy data

Average number of occupants	North England	London	South England	All of England
Houses				
Adults	1.99	2.32	2.04	2.03
Children under 16	0.50	0.55	0.50	0.50
Total	2.48	2.87	2.54	2.54
Apartments				
Adults	1.41	1.71	1.50	1.53
Children under 16	0.15	0.43	0.29	0.28
Total	1.55	2.14	1.79	1.81
All dwelling types				
Adults	1.91	2.03	1.94	1.93
Children under 16	0.45	0.49	0.47	0.46
Total	2.36	2.52	2.41	2.39

Source: DLUHC

[29] Ministry of Housing, Communities and Local Government, 2019. Research into overheating in new homes. Available online: https://www.gov.uk/government/publications/research-into-overheating-in-new-homes

Two occupancy scenarios were assessed: daytime occupancy and no daytime occupancy. These capture, for instance, differences in exposure to elevated internal temperatures during the day, which in turn impacts on benefits accrued by the policy.

For each of the two scenarios, occupancy profiles were developed for the apartment and house typologies based on discussions with University College London and a broad steer from CIBSE TM59 occupancy profiles. These show the level of occupancy at different times of the day in different rooms. Full details of these profiles were previously published [26].

To scale up the benefits to the new build housing stock in England, the modelling results for the two occupancy scenarios described above have been weighted based on the data analysed from the UK Time Use Survey 2014-15.

The UK Time Use Survey (TUS) sample comprises 4,741 households (9,388 people) in England, Scotland, Wales and Northern Ireland, and is considered representative of the population. People in selected households completed a time diary exercise in which respondents were asked to record their daily activities. For this research, the data required from the TUS was on whether people were at home during the hottest hours of the day. This was defined as 3 or more hours at home between the hours of 11am-5pm. Weekend and weekday data was merged together using a weighting of 2/7 and 5/7 respectively.

The data was analysed by DLUHC and is summarised in Table B.6. Because of the small difference in results between houses and flats, the proportional split of daytime and non-daytime occupancy for all dwellings was used for the benefit analysis.

Table B.6: Split of daytime and non-daytime occupancy for new build stock

	Houses	**Flats**	**All dwellings**
Daytime occupancy	32.90%	31.83%	32.75%
No daytime occupancy	67.10%	68.17%	67.25%

Source: DLUHC

This split between daytime and no daytime occupancy was reviewed post-consultation to account for potential longer-term behaviour change following Covid. It may be expected that the percentage of daytime occupancy would increase as more people work from home. The impact of this would be an increased benefit of this policy as greater time would be spent in the buildings in which the risk of overheating is being mitigated. However, the scale of any projected increased in daytime occupancy is uncertain, and it is unclear whether this will be a short- or longer-term impact. Therefore, daytime occupancy rates have been kept the same as the initial analysis. If this was to increase, then there would likely be higher benefits from the policy.

Appendix C – Cost Breakdown

The developed costs are based on the expert view of AECOM's cost specialists, drawing on evidence from their internal cost datasets, recent published cost data and information provided by suppliers. The cost data is intended to reflect typical 2021 national costs.

Table C.1 provides details of the capital cost information used for the counterfactual to the proposed policy, namely, the cost of retrofitting mechanical cooling systems.

Table C.1: Cost data for retrofitted mechanical cooling systems

Component	Specification	Unit	New cost (£ per unit)
Split DX a/c system, comprising external wall mounted condenser, internal wall mounted fan coil unit and interconnecting refrigerant pipework	<1.5 kW	nr	£899
	1.5-3.0 kW	nr	£1,005
	3.0-5.0 kW	nr	£1,164
Condensate disposal; to local stack	N/A	nr	£79
Power supply to fan coil unit	13A	nr	£53
Room controller	N/A	nr	£79
Trade contractor preliminaries inc. commissioning	% of total	%	15%

Cost projections

For mechanical cooling systems, the potential for future reductions in cost through learning was estimated by Currie & Brown. It is expected that the current price unit cost of fixed domestic air conditioning systems will only reduce to a small extent in the future, due to the large size of the current market and limited potential for additional cost efficiencies. Installation costs within high rise apartments are also likely to be subject to only small learning benefits because, although these systems are not widely used in residential developments, the contractors installing services in apartments are likely to be familiar with the technology from other work. In housing, there may be more potential for cost reductions as there is currently a low level of adoption and associated supply chain capability. It is expected that future cost savings in high rise buildings would be no more than 5% by 2030 whereas in housing the future reduction may be as high as 15-20%.

Figure C.1 shows the future cost projections of domestic air conditioning. This is based on a cost reduction of 5% by 2030 for apartments and a cost reduction of 17.5% by 2030 for housing. These cost projections are relative to 2021 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 C.1 Projected variation in base costs as a result of learning