FUTURE (P)ROOF

Building resilience of the UK's roofs for a changing climate

SUMMARY

CHARITABLE TRUST
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UNIVERSITY OF Southampton

This research project, undertaken by the University of Southampton, investigates the impact that climate change will have on roofs covering the existing stock of buildings across the UK. It was commissioned by the NFRC Charitable Trust under the Trust's *'Sustainability'* charitable aim.

Whilst there has been a welcome focus recently on how the UK will achieve net-zero carbon emissions *(mitigation)* to keep global temperatures below 1.5 degrees, there has perhaps been less attention given to how to best prepare for the inevitable changes to the climate (adaptation).

The Committee for Climate Change (CCC) recently said that *"climate resilience remains a second order issue, if it is considered at all"* and that *"policies are being developed without sufficient recognition of the need to adapt to the changing climate"*.

This research helps to address this issue, as it relates to the built environment, specifically for the UK roofing sector, in both the residential and commercial sectors. It looks at outputs from the UK's climate change projections, then applies it to the context of both domestic and commercial roofing in the UK, and then makes a number of recommendations on what can be done to best prepare for these eventualities.

Overview of UK climate change

In a UK context from the mid-1970s to the Mid-2010s, there has been a:

- **4.5 per cent rise in annual mean rainfall.** The period from 2008 to 2017 was 4 per cent wetter than 1981 – 2000 and 11 per cent wetter than 1961 – 1990.
- **0.9 °C rise in average annual temperatures.** The top ten warmest years on record have all occurred since 1990.
- **9.2 per cent rise in sunshine levels.** This is most noticeable in winter and spring, where there is 14 per cent more sunshine than the 1961 average.
- **UK wide increases in extreme weather events.**

Looking ahead, these trends are set to intensify, and future climate projections suggest that what is considered to be an anomaly today will become the norm in future decades.

Broadly speaking, over the next half-century the UK is expected to:

- Experience warmer and wetter winters with hotter and drier summers.
- Have a higher frequency and intensity of extreme weather events, notably heatwaves and torrential rain.
- Have clearer skies in summer, but this will not be uniform across the UK.
- The frequency of storms, however, are not expected to increase.

Risks facing the UK from climate change

This research looked at a range of built forms from across 15 cities in the UK and how they are likely to be impacted by climate change. It identified flooding and overheating as the two greatest risks facing the UK from climate change.

Torrential rain and flooding

Higher levels of torrential rain will not only increase the probability of water ingress penetrating buildings through the roof fabric but will also lead to wider catastrophic flooding, the likes of which we have seen in recent years.

River, surface and groundwater flooding, as a result of extreme winter rainfall events and increases in average winter rainfall, is regarded as a medium building risk today by the Climate Change Risk Assessment (CCRA3), in terms of both building damage and productivity loss. This will rise to a high risk by 2080.

The CCRA estimates that 1.8 million people are living in homes which are in areas of significant river, surface water or coastal flooding, and those in the most deprived areas are at most risk.

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Overheating

This research considers two thresholds for overheating between 25 and 28°C for the operative temperature of living rooms and 24 and 26°C for bedrooms.

Overheating is already a big problem in the UK, and it is expected to worsen in the future. Taking Islington, London as an example, its average temperature is expected to rise by 3.3 °C by the 2080s and its daily maximum temperature is expected to increase from 22.2 °C for the reference period to 27.9 °C for the 2080s.

This is a public health risk, especially for the elderly. According to the Committee for Climate Change, it is estimated that there are about 2,000 heat-related deaths each year in England and Wales. This number is expected to triple to over 7,000 by the mid-century as a result of climate change. It also has a productivity impact, as more and more people now work from home at least a few days a week, as well as it affecting the quality of sleep. The domestic sector is much more volatile than the non-domestic sector to overheating as families use their homes in a variety of ways.

Loft conversions and insulation are a popular way to create extra living space in the UK's small and expensive housing stock, but because of their typical loft characteristics (top floor, directly under roof) and usually of lightweight construction, loft conversions are prone to overheating. Islington and Plymouth were two cities in the study where lofts and dormer conversions were the most vulnerable to overheating, and this is predicted to cause serious issues by 2030.

Flats are also at risk, particularly those with overglazed single-sided ventilation. This is exacerbated by low thermal mass construction methods such as timber or steel-framed buildings. Certain public buildings such as schools, are also at risk, due to their construction type. A building that is marginal in terms of overheating risk today, will not perform appropriately in the future.

How roofing can help

Resilience can be defined as the capacity to recover quickly from extreme events. In terms of the built environment, this relates primarily to heatwaves, flooding, drought, cold, storms, and strong winds. Energy provision can also be included in this.

The question this research asks is, fundamentally, how can we ensure that roofs that we construct or retrofit today will be fit for purpose in 20, 30 or 50 years time?

The report finds several ways that roofing can contribute to building the resilience of the built environment, to adapt to these changes in our climate through the following technologies:

- **Conventional *(consolidated technologies).***
  These are technologies that are consolidated in the market currently in both the residential and non-residential sectors, such as enhanced levels of insulation and improving airtightness.

- **Cool *(highly reflective coatings).***
  A cool roof is one that is designed to reflect more sunlight and absorb less heat than a conventional roof, typically flat or low sloped. A highly reflective type of paint, sheet covering, tiles or shingles can be used to achieve this.

- **Green *(vegetated).***
  These are ballasted roofs that cover a conventional roof (typically flat) with a waterproofing later, growing medium (soil) and vegetation (plants),

- **Blue *(vegetated with enhanced stormwater attenuation capacity).***
  These are roofs that are designed to slow the drainage of rainwater collected above a roofs waterproof element, unlike conventional roof's which allow rainwater to drain quickly away from the roof.

All of these technologies have to be associated with adequate insulation to provide resilience against the cold.

When considering the two greatest risks posed to the UK from climate change, flooding and overheating, it is clear these technologies can help mitigate the effects. Roofs, particularly green and blue roofs, have the potential to address the impact of flooding both at the individual building level and the wider neighbourhood scale, through water attenuation. This should become a key issue for planning in cities where roofs must act as a rainfall run-off attenuator.

These technologies can also be used to contribute to the reduction of overheating risk and cooling demand during heatwaves. The research found that well-insulated roofs that were air tight and had enhanced night ventilation and a medium/light coloured roof, can significantly reduce the risk of overheating, even over the long term.

Therefore, in buildings prone to overheating risk, it will be necessary to consider the colour and reflectivity of the roof material, improve ventilation *(especially night ventilation)* and create hybrid forms of ventilation and mechanical cooling, particularly in buildings located in the South such as Plymouth and London. Elsewhere in the UK, the focus should be on increasing thermal capacity and optimising ventilation without the need for mechanical cooling.

Fabric first retrofits that involve increasing insulation levels are critical to reducing energy consumption and providing more comfortable winter conditions, but the design of these must consider the risk of overheating.

Across all of the locations considered in the research, in July peak conditions *(such as a heatwave)*, the net radiative balance is much lower for cool, green and blue roofs compared to conventional roofs, and this advantage was consistent across all the locations in the UK from South to North, helping to maintain a comfortable temperature in the buildings and reducing demand for air conditioning. These technologies also reduce local air temperatures, helping to lower the Urban Heat Island Effect.

Rooftop spaces can also play an active part in the energy system by incorporating renewable technologies such as solar PV, solar thermal and hybrid solar thermal and PV. For example, PV at scale on city roofs in Southampton could contribute to 25 per cent of the city's electrical demand. Another study found that Great Britain has the theoretical potential to generate 238 TWh/year from rooftop solar. In comparison, the UK had a total electricity demand of 330 TWh/year in 2020

Finally, anticipated changes to the UK's climate also highlight that the maintenance of roofs, particularly their drainage systems, will become ever more critical to help ensure fewer roof failures.

The report clearly demonstrates the whole UK roofing industry, including both pitched and flat roofing, has a huge role to play in helping the UK adapt and build resilience to climate change.

Barriers to building roofing resilience

There are a number of barriers to the adaptation of innovative roofing technologies, however, which are primarily at the policy, legislation and planning level. There are also financial barriers due to the higher cost of these technologies.

For the construction industry, there needs to be a greater investment in green skills and training.

Finally, as these new technologies develop they are being limited in their application due to constraints within the current building regulations and the approved document guidance that support those regulations. The sector must work with the Department for Levelling Up, Housing & Communities (DLUHC) to ensure this doesn't become a significant barrier.

Recommendations

Based on the findings of the research, NFRC, therefore, recommend the following:

FOR INDUSTRY

1. The roofing industry has skills gaps in the design and installation of new technologies. The industry must therefore embed and invest in green skills throughout the existing and future roofing workforce. Green skills can be used to help promote new entrants to the sector. Manufacturers have a key role to play here.
2. The roofing industry must review current apprenticeship frameworks to ensure they integrate the green skills needed by the sector and that these are available nationwide.
3. Roofing contractors should consider diversifying their business and upskilling their workforce to include green technologies. For example, roofers should take advantage of the uplift in Part L and offer Built-In Solar PV installation.
4. Designers should consider the reflectivity of the materials they are specifying when designing building types that are at risk of overheating.

FOR GOVERNMENT

5 The UK Government and the Devolved Nations should incentivise the retrofitting of public buildings to ensure they are prepared for a warmer and wetter climate. In particular, for schools, alongside these retrofit projects, pupils should be taught about the work and why it's important.

6 The Department for Business, Energy and Industrial Strategy (BEIS) should introduce a National Retrofit Strategy to support homeowners to retrofit their property to support resilience. This should also include insulation, measures to reduce overheating as well as supporting energy resilience through retrofitting Built-In Solar PV and solar thermal. This should be accompanied by guidance for homeowners.

7 The Department for Education and the Devolved Nations should review current construction qualifications to ensure they place more emphasis on green skills.

8 The Department for Environment, Food and Rural Affairs (DEFRA) should use this evidence as part of the 2022 UK Climate Change Risk Assessment and prioritise the use of cool, blue, and green roofs, as well as solar PV, as part of the National Adaptation Strategy. The Devolved Nations should do the same for their own risk assessments and adaptation strategies.

9 The Department for Levelling Up, Housing and Communities (DLUHC) should place greater emphasis on blue, green and cool roofs in the National Planning Policy Framework (NPPF), their planning policy guidance and design guide.

10 The Department for Levelling Up, Housing and Communities (DLUHC) should bring forward the Future Homes Standard for new build homes from 2025 to 2023 to ensure all new homes are built to a net-zero standard and include Built-In Solar PV.

11 The Department for Levelling Up, Housing and Communities (DLUHC) should fast-track proposed changes to the building regulations concerning overheating and ensure these cover retrofitting, loft conversions and extensions, as well as new build.

12 The Department for Levelling Up, Housing and Communities (DLUHC) should update the Standard Assessment Procedure (SAP) to incorporate the insulating value of green roofs, and acknowledge reflective surfaces to encourage greater take up.

13 The Department for Levelling Up, Housing and Communities (DLUHC) should work with industry to ensure there is sufficient fire testing methodology and testing capacity for roof technologies such as green roofs and solar PV.

14 Each UK City and Local Authority at risk of overheating should develop an Overheating Strategy and utilise cool, blue or green roof technology as part of its solution through planning policy, similar to policies introduced in Philadelphia and Denver.

15 HM Treasury should develop financial incentives for commercial property owners to retrofit their buildings to become more resilient, such as by extending the Super Deduction policy to include buildings and structures.

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0203 940 0072 | NFRCtrust.org.uk

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