An Arup Study: Addressing Overheating Risk in Existing UK Homes

Arup used DesignBuilder to help quantify the best ways to reduce overheating risk in existing UK homes. The study forms part of the Climate Change Committee (CCC) research to influence climate change adaptation policies for the UK.

Context

Summertime overheating in homes affects health and productivity, and 2022's record-breaking temperatures in the UK brought this into sharp focus. Higher global temperatures will increase the frequency, severity, and geographic extension of this risk for millions of existing homes in the UK. Part O of the Building Regulations were introduced in 2022 to help minimise the overheating risk in new homes.

The CCC appointed Arup to undertake the study to assess how different parts of the UK's existing housing stock are exposed to overheating risks. It includes current and expected future climate conditions, and how credible retrofit options for existing homes could limit overheating risk.

Approach

The work was split into three broad phases:

1. Phase one assessed the current and future risk posed by summertime overheating to the existing UK housing stock to understand what factors influence overheating risk.

2. In phase two, passive design measures were modelled to adapt or upgrade homes to mitigate overheating severity, with each measure costed.
3. In the final phase, the required mitigation measures were extrapolated across the UK to understand the cost, energy, and carbon implications of eliminating severe overheating.

To understand the likelihood and severity of overheating across the UK, representative samples of UK residential properties were modelled. DesignBuilder's standard features and scripting tools were used to enable an automated parametric energy modelling approach.

Parametric modelling was used to change variables such as building location, current and future weather scenarios, orientation, construction properties, and eventually the mitigation packages. For each individual design option, a range of overheating criteria and energy consumption outcomes were recorded. That led to a total of 2,400 individual dynamic simulations representing a wide sample of the UK housing stock, each including CIBSE TM59 outputs. This ensured more granularity in outcomes and greater confidence in the conclusions and recommendations.

Having understood the key drivers of overheating risk, a set of increasingly sophisticated passive design packages was developed to mitigate the severity of overheating. These mitigation packages were applied to a representative sample of buildings, with the results extrapolated to a UK scale using a housing stock model from Parity Projects.

Key findings

In the current climate scenario, the study demonstrated that the cost of upgrading all UK homes to meet TM59 criteria through passive or low-energy strategies only is circa £275 billion. The average capital cost per home is around £15,000. This cost rises significantly for future climate scenarios, increasing to circa £710 billion at 2°C and £1,145 billion at 4°C of global warming respectively.

In addition to the huge capital cost, a 4°C warming scenario would result in 90% of homes still overheating and therefore requiring active cooling. The significant increase in electrical energy consumption would require an additional £4 billion of electricity (relative to a 'no-intervention' baseline), and an additional 2 million tonnes of carbon emissions annually. The addition of active cooling to homes would also increase heat rejection, contributing to further global warming and urban heat island effects.

The report, publicly available here and here, is an independent study undertaken by Arup with the support of Parity Projects and the University of Loughborough, appointed by the Climate Change Committee.

ARUP

Arup was founded by Ove Arup in 1946. Today, we are 6,000 strong in the UK, working on local, national and international projects. We are a professional services firm with a focus on the built environment and we work closely and collaboratively with our clients to develop the solutions they need today – and tomorrow. We bring deep expertise in strategy, design, planning and engineering, and our project portfolio ranges from the UK Government's heat decarbonisation programme, to the design of new cancer treatment centres and playing a central role in engineering a more resilient rail network.