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HRSC0025

Submission to Environmental Audit Committee call for evidence on heat resilience and sustainable cooling from Flexibility from Cooling and Storage Project

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Introduction

We are pleased to make this submission to the EAC on behalf of the Flexibility from Cooling and Storage (Flex-Cool-Store) project.

Flex-Cool-Store is a research collaboration project between Cardiff, Exeter and Bath universities funded by EPSRC (EP/V042505/1). We are investigating the potential impacts of a growth in UK cooling demand and how this might be managed through the flexible operation of the energy system and energy storage, including how an increasingly decarbonised electricity system can serve the new demand. Emphasis is placed on residential buildings to define prospective cooling demands and cooling infrastructure required. Through the research, we aim to provide strategic recommendations on the role of cooling in a sustainable, low-carbon and net-zero transition.

Whilst our focus is on cooling, much of our work with the public and policy makers in this space has been framed in terms of overheating, given this is a key driver of possible cooling demand in some of the housing stock. This includes interviews with stakeholders working in and around policy for cooling and overheating as well as interviews and workshops with the public. The research is ongoing and therefore our submission contains emerging insights from our work. Flex-Cool-Store is expected to finish in Autumn 2024, at which point our full findings will be published.

Summary

We have submitted evidence on eight questions within this inquiry.

1. In terms of relationships between heat and human health, we highlight the wealth of information published in this space in respect to physical and mental health. We also include insights from our work with the public, including the impact of heat on existing health conditions, anxiety, and isolation; and flag some of the social inequalities that exist. We need more comprehensive analysis of the issues to support more nuanced, effective interventions.
2. On sustainable cooling and adaptation, we highlight the value of taking an approach to avoid the need for cooling, and then reduce its impact, in respect to policies and standards for technologies and their management and operation within the energy system. This cuts across policies on buildings, places, products, f-gases, energy and climate, as well as public engagement around strategies and behaviour to manage and adapt to heat risk. There are knowledge gaps around what passive or active solutions people

might take, and whilst total electricity demand to meet cooling needs is not expected to be an issue for the energy system, locational peak demand could be. We discuss some of the socio-cultural issues in this space such as issues for vulnerable populations and then opportunities for managing peak, including energy network innovation.

3. To protect the most vulnerable from extreme heat, we highlight the risk factors and wider social determinates of health. Tenure, quality, and size of housing are important indicators of potential risk and the importance of perceptions to heat risk are also highlighted. More work is needed to raise awareness with the public on adaptation and mitigation measures and behaviours.
4. Much is happening within government on overheating and cooling, but there is a lack of urgency and a tendency towards information and monitoring. Heat risk and cooling does appear across many policy documents, but rarely is front and centre, with the NAP 3 being a recent example of lack of thorough consideration. Current approaches do not feel comprehensive or particularly joined up.
5. Part O of Building Regulations is welcome, but we do not think the wider planning framework, or its direction of reform, is particularly fit for purpose on climate adaptation or mitigation. The existing housing stock will be challenging to address and the role of local authorities across these issues will be important to support. There are good examples of action, particularly from the GLA.
6. To protect the existing housing stock from temperature extremes, we suggest an approach based on thermal comfort and wellbeing could deliver several wins. Existing work takes us a long way towards understanding where some of the biggest risks in the built stock will be, but more granular data would help with targeting and prioritising resources to tackle the issues. Air conditioning could reduce health impacts but comes with wider risks for adaptation and mitigation and a strong equity challenge. A few policies will be important in this space, with the biggest challenge being with retrofit. A more holistic approach is needed.
7. Reversible heat pumps could play a role, although it is not necessarily straightforward with wet-based heating systems. Whilst the market may develop in this space, air to air heat pumps could play a significant role, particularly for smaller properties and those without wet heating.
8. We do think there is a need for a heat resilience strategy and highlight the importance of it focussing on delivering solutions, from a building, spatial, energy system, and people perspective. Some regional insights could be important in any national strategy to take account of current and future levels of risk. We are not sure if a standalone strategy will be the best approach and wonder if that could be explored as part of the inquiry, for example we flag the need for a cooling strategy, which could be linked to heat resilience, or more widely aligned to work in decarbonising the heat and buildings space. Understanding which approach will have the most impact would be important to explore; regardless, it is clear a joined-up, integrated approach, across government is needed. Agreed definitions of key terms is needed.

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What evidence exists on the relationship between heat and human health (mortality and morbidity), and which communities are worst affected?

9. It is too early to know the full health impacts and number of deaths resulting from the extreme heat seen so far in 2023 across Europe, the US and China, but temperature records have been repeatedly broken and the impacts are expected to be significant (Carbon Brief, 2023; Copernicus, 2023; Hancock et al, 2023). The impact of extreme heat on human health is well documented (IPCC, 2022; CCC 2022; Vicedo-Cabrera et al. 2021; Drury et al. 2021; Sanchez et al. 2017). Some 70,000 excess deaths across Europe have been attributed to the 2003 European heatwave (Murage, 2020), with 2000 excess deaths recorded in the England. Following the summer of 2022 over 60,000 were recorded across Europe (Ballister, 2023) while the UK Health Security Agency (UKHSA) reported 2985 excess deaths in England, the highest heat-related mortality since the inception of the English Heatwave Plan in 2004 (UKHSA, 2023). Serious health impacts related to extreme heat include heat stress, heat exhaustion, heat stroke, dehydration, mental health impacts, exacerbation and increased risk of death from chronic illness (for example cardiovascular disease), as well as an increased risk of accidents and violence (WHO, 2018; McLoughlin et al. 2023). Heat-related deaths are projected to increase to 7000 annually by 2050 (House of Commons, 2018), emphasising the urgent need for policy to address and mitigate heat-related health impacts and making this second inquiry by the EAC timely and welcome.

10. Whilst a significant body of literature exists relating to heat-related physical health, the impacts of extreme heat related to mental health have become more widely recognised and reported in academic literature in recent years (Hass and Ellis, 2019; Sampson et al., 2018). Heat events may have impacts for mental health disorders, for example increased anxiety as well low mood associated with heat-related lethargy, and difficulty sleeping.

11. Preliminary findings from our research suggest both mental and physical impacts were experienced by participants during the heatwave of July 2022. Participants with existing health conditions such as diabetes or kidney disease, experienced a worsening of their conditions during heatwave events and increased engagement with clinical services. Some participants reported concern regarding efficacy and storage of medications during heat events. Initial findings also suggest a loss of social networks and connection to the natural world contributed to low mood and increased anxiety in some participants. Low motivation and lethargy related to heat events was reported across diverse age groups with a decrease in physical and social activities due to low energy or inhospitable outdoor settings. Moreover, strategies to cope with extreme heat, such as closing windows and curtains were found to increase feelings of isolation and loneliness in some participants.

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12. Social determinants of health were found to be an important influencing factor in experiencing heat event health impacts, aligning with existing evidence of increased vulnerability to extreme heat events for certain sub-groups including socially isolated people, economically disadvantaged or marginalized communities (WHO, 2018). Vulnerable populations worst affected by heat events are well documented in academic literature including older people, young children, outdoor workers and those living with long-term health conditions (Watts et al. 2019).

13. A comprehensive analysis of heat-related human health impacts would provide the basis for a more nuanced design of interventions and communication strategies to mitigate heat-related mortality and morbidity, particularly within vulnerable communities.

How can sustainable cooling solutions and adaptation strategies be implemented in such a way as to minimise overheating, reduce energy consumption and prevent overloading of the electricity grid during peak demand?

14. An avoid-reduce-shift framework underpins our research to consider sustainable cooling (Khosravi et al. 2023). To help reduce the risks of overheating and support sustainable cooling solutions, this framework, starts with avoiding the need for cooling through passive measures which largely relate to planning policies, and occupant behaviour within homes. It then considers how to reduce the impact of any active cooling used, linked to policies on product standards and f-gas use. Finally, in terms of shift, the framework considers how to manage cooling demand in the energy system, to ensure loads can be met through low carbon supply, as well as the use of storage and wider flexibility to shift loads and help avoid potential peaks. It is apparent when looking at overheating and cooling from this perspective, that issues cut across different government departments and agencies, highlighting the importance of cross-departmental working and the need for clear responsibilities and leadership.

15. Sustainable cooling needs to start with passive approaches at the building level and through wider spatial considerations. The options for, and importance of, passive first measures is well documented across academic literature, and wider research including work for the Government (BEIS 2021) and the CCC (ARUP 2022). Passive measures make buildings more comfortable, reduce overheating risk, and help to lessen the need for active cooling or the potential cooling load for any active technology that is used. Passive measures can be at the building level and wider spatial level, such as building orientation, green and blue infrastructure, trees and shrubs, reflective surfaces in streets and shading for openings. Passive measures also extend to occupant behaviour to mitigate internal heat gains, for example through human activities such as appliance use (Lizana et al. 2022; Taylor et al 2023).

16. How passive-first measures can best be supported within homes is less clear, particularly in the retro-fit space. However, a number of important considerations have been highlighted within academic research. The role and perceptions of design professionals is important in delivering effective passive design strategies, rather than technological solutions, with a focus on low carbon passive design within building codes and best practice guidance (Oliveira et al. 2023; Lizana et al. 2022). A shift in measurement metrics from air temperature to wider thermal comfort parameters is also proposed to increase upper thermal comfort ranges, reducing reliance on active cooling (Lovins, 2018). Such parameters could include humidity, air velocity, clothing, insulation and metabolic rate (Lizana et al. 2022). Initial findings from our research noted a broad divergence in personal thermal comfort during heat events, aligning with wider academic research on thermal comfort. As such, there is scope to develop a more nuanced approach to cooling through an occupant-centric approach.

17. Research on occupant strategies and behaviours in response to extreme heat is limited (O'Brien et al. 2020), with a focus on elderly and vulnerable groups (Valois et al. 2020; Kondo et al. 2021). Whilst air conditioning may be culturally embedded in hot climates, this ubiquity has not yet been experienced in temperate climates such as the UK (Murtagh et al. 2022). However, it is critical that responses to extreme heat are understood and shaped within policy to minimise a future which locks-in air conditioning dependence as the frequency and intensity of heat events increases. Our current research contributes to this area and initial findings from our interviews and workshops suggest there is support from the public to engage with passive cooling measures, although knowledge of passive strategies was found to be diverse and unsettled. Respondents relied on a range of information sources, including mainstream and social media, lived experience and word of mouth recommendations. Many of the coping solutions reported by respondents in our research would likely prove insufficient in the face of sustained heatwaves. There is a risk that without trusted sources of information to clearly communicate passive cooling strategies in a targeted manner, active cooling solutions may be sought out to minimise overheating, potentially triggering distress purchasing during heat events. This is well evidenced in the connection between periods of peak temperature and sales of air conditioning units (Cuff, 2020; He et al. 2022). Active cooling solutions will likely vary from the purchase of simple, low-cost solution such as electric fans, to higher-cost solutions such as portable air conditioners, which are relatively cheap and increasingly available online, in supermarkets and DIY retail outlets, through to full air conditioning installations. Respondents in our study reported burgeoning knowledge of the relative affordability and accessibility of mobile air conditioning units. It is important to note that such low-cost devices are likely to be energy intensive and significant adoption may lead to a high electricity peak demand.

18. It will also be important to consider broader socio-cultural contexts when shaping sustainable cooling policy. Our initial findings suggest that daily routines and practices will influence cooling demand, for example, the rise in hybrid and remote working led to increased cooling demand for many participants. Such home working and changes in lifestyle should be taken into account within cooling demand projections (Ugalde-Loo, 2021) and for any emerging work on heat resilience. There are also wider implications relating to employment policy and health and safety regulation which are important to consider within this sphere.

19. Our research also indicates that vulnerable populations, for example those with chronic health conditions, required more significant and urgent responses to heat events, with some purchase of active cooling already reported. Initial findings also suggest housing tenure and quality is significant in the effectiveness of passive cooling solutions. What is termed passive survivability, the "ability to maintain a safe thermal environment in the absence of a functional air conditioning system" (Lizana et al. 2022) is important in this context, as there is evidence that poor quality housing is likely to suffer overheating issues and tenure will impact ability to undertake passive measures. More research into these issues and the crossovers between fuel poverty and cooling poverty should be integral to any heat resilience strategy.

20. In respect of the impact of cooling on the energy system, in addition to the BEIS 2021 study, further work has been commissioned by Government to better estimate the level of demand and emissions from cooling across different sectors of the UK. A general view from some of the stakeholders we have interviewed is that cooling demand and associated emissions from the domestic sector is expected to be small, in comparison to other sectors. This may make overheating more of a health driven concern, rather than an issue for the energy system. However, as highlighted above, whilst there are emerging insights into some of the strategies households are adopting to keep cool, data remains limited. In addition, many of the active cooling technologies that could be chosen will be behind the meter in terms of visibility on networks, meaning there are potential risks in assuming domestic cooling loads will not be an issue.

21. Whilst assumptions are included in the Energy System Operator Future Energy Scenario's and within many of the Distribution Network Operator's (DNO) Distributed Future Energy Scenario's (DFES) for the number of domestic air conditioners under different scenarios, it is unclear how some of those numbers are integrated into peak demand estimates. For some DFES it would appear that peak demand across seasons, including summer, is still driven by cold days i.e. heat loads, rather than air conditioning. That may change as extreme temperatures become more common and depending on the decisions made by householders, it will also vary across and within DNOs. When undertaking our background research, we noted that cooling demand has not yet featured in the various innovation funding for network companies, most recently those supported by the Strategic Innovation Fund. We would suggest it might be prudent

for Ofgem and Innovate UK to consider an Innovation Challenge in this space in the near future, when they begin discussions with stakeholders on future challenges.

22. A final consideration in this space will be how overall energy system governance develops. Work on the role, scope and legislation to establish a Future System Operator (FSO) is ongoing. That includes some decisions on how national, regional, and local area energy planning (LAEP) might evolve. For issues like cooling and the wider uptake of low carbon technologies, it will be important to understand more about how the work of the FSO, regional energy planning, DNOs and local authorities, through LAEPs and wider climate/planning policy, might align to better give sight of how supply and demand might develop at the local level, including options to help avoid peak demand. LAEPs could also play an important role in providing more granular data on the housing stock and the potential risks of overheating.

What actions can be taken to protect those most vulnerable to the impacts of extreme heat?

23. The vulnerability of certain populations to the impacts of extreme heat is well documented, with older people, children, those living with chronic health conditions and in economic deprivation at greater risk (Watts et al., 2019; Williams et al. 2019; WHO, 2018). Further risk factors include living conditions such as housing quality, type and tenure, household composition, social isolation, homelessness and levels of urbanisation all of which, may contribute to increased health risks in relation to heat events (Bai et al., 2013; Liu et al., 2013; Reischl et al., 2018; Vu et al., 2019). Actions to protect the most vulnerable must consider not only the above risk factors, but also wider social determinants of health and perceptions of risk to heat exposure and health.

24. Overheating in UK housing has increased as a result of climate change and will continue to do so (DEFRA, 2017; Wright et al., 2018; CCC 2023a; CCC 2023b). Initial findings from our research suggest that the tenure and quality of housing is of key importance with participants in social housing and private rented accommodation reporting overheating in the July 2022 heatwaves. Further research is needed to better understand links between tenure and overheating. Such issues may also be addressed through the extension of passive cooling measures in Part O of UK Building Regulations, for example insulation improvements which will address both heating and cooling issues (Khosravi et al. 2023).

25. The importance of health risk perceptions related to adaptive behaviours is widely evidenced in academic literature (McCloughlin et al. 2023; Hass et al. 2021; Williams et al. 2019; Wolf et al. 2010). Such perceptions may be heightened within vulnerable groups where passive cooling measures and resources may be inaccessible due to high costs, housing tenure limitations or local infrastructure provision, for example populations living in highly urbanised areas with little or no access to green space (Cutler et al.

2018; Li et al., 2019). Conversely some vulnerable groups may not perceive themselves as at risk of exposure to extreme heat. Our research suggests that participants aged 65+ often did not identify themselves as vulnerable to heat risks. As is well established in literature, vulnerable elderly populations may not perceive themselves as being at risk or consider heat waves as having health implications, preventing or delaying adaptive behaviour (Valois et al. 2020, Hass et al. 2021). This is particularly important within communication of heat-related warnings and public health interventions. Targeted messaging should be underpinned by risk perception, for example addressing perceived risk invisibility through intergenerational or community messaging to foster both collective and individual adaptive behaviours (Sampson et al. 2018, Hass et al., 2021). A comprehensive review of antecedents and behavioural responses to heat risks is provided by McCloughlin et al. (2023) and emphasises the need for further research to test and evaluate heat risk communication.

26. Our initial findings also suggest a lack of awareness of the implications related to rising temperatures. It is important to ensure that such public awareness is raised through education in order to promote adaptive and mitigative measures and behaviours.

To what extent do the Government's Climate Change Risk Assessment and National Adaptation Programme (as well as other related strategies such as the Net Zero Strategy and Heat and Buildings Strategy) identify and address the risks from extreme heat?

27. There is no doubt more attention is being given within Government to some of the risks around overheating, but policy to address those risks, beyond new build and improved heat guidance and monitoring, is lagging and there is little evidence to suggest much sense of urgency. The focus is still largely on responding to extreme heat, rather than working more effectively to prevent it (Ward 2023).

28. We discuss this issue in respect to the planning framework in the next section. For the Net Zero Strategy, there is limited reference to overheating or cooling, although many of the wider ambitions it sets out would assist with efforts to address extreme heat, such as improved energy efficiency, options for decarbonising heat and policies around land/green space. Whilst the Heat and Buildings Strategy acknowledges the risks of overheating and the need for future proofing buildings and considers cooling in more depth, its main focus is on reducing emissions from heating.

29. We would argue a better focus for policy around heat resilience, across departments, would be to consider thermal comfort and wellbeing within buildings. This would help move away from a focus on a need to keep warm or cool, and help ensure issues around noise, air quality, mould, damp, etc are considered holistically, including the health implications associated with these. Taking a whole house

approach, to ensure thermal efficiency, ventilation, overheating are considered concomitantly will lead to better outcomes and help reduce overall costs of dealing with our poor housing stock.

30. It is helpful that the National Risk Register considers high temperatures and heatwaves as a risk, although their assessment of the likelihood of their worst-case scenario happening is relatively low. It might increasingly be necessary for national strategies like this, to include more regional nuance for issues such as heat risk. The risks in the North of England are likely to be very different from the South East for example, this may result in national strategies and supporting policies underestimating the level of risk and missing opportunities for more targeted responses.

31. On the NAP3, we would agree with others that the latest version is a missed opportunity that lacks ambition and urgency (SMC 2023). It feels like many issues, including those related to heat risk have been pushed out for another five years whilst more evidence is gathered. This is a poor outcome given the impacts of extreme heat, which are already being experienced within the UK. Whilst more research and evidence on identifying homes and buildings that are most at risk of overheating is of value, it delays action. The work already done in some national studies (BEIS 2021; ARUP 2022) provide significant contributions towards understanding the type of buildings, tenures, locations that are likely to be most at risk. The challenge is to take those high-level insights down to a more granular level, it is about the last mile, the neighbourhoods and streets where action should be prioritised. Again, there is work happening in this space such as the climate risk mapping in London and Manchester (GLA 2022; MO 2023); as well as studies that assess some of the neighbourhoods most at risk (FOE 2022). It is this much more local level detail that will be vital, so any additional national work, as suggested in the NAP, should take an increasingly granular approach. This is in turn, suggests that identifying risks and taking action to reduce such risks, will require a much broader role for local authorities and those agencies working at local levels than national policy currently seems to acknowledge or support.

Does the current planning framework do enough to encourage heat resilience measures such as cooling shelters, water bodies, green infrastructure and shading to be integrated into urban planning? Where such measures are incorporated, how accessible and successful are they?

32. Our buildings, neighbourhoods, towns and cities have not been designed for the climate change we are already seeing. National and local planning needs reform to tackle these issues, including for heat resilience. The national planning framework is inconsistent and messy for both climate mitigation and adaptation. The issues are well documented, including recent work commissioned for the CCC (CSE & TPCA 2023) and wider work from UK100 (Fenna & Evans 2023). The nature of the risks and principles for effective adaptation are clearly set out by the CCC in its work on the CCRA3 (CCC 2021) and detailed

policy recommendations relating to the planning framework are included in the progress reports to parliament on mitigation and adaptation (CCC 2023a; CCC 2023b).

33. In the interviews we have undertaken, building and spatial planning has been a central focus of our discussions, mainly in respect to passive measures to reduce overheating risks. We have heard how overheating often reads like an afterthought in many national planning policies and is often not included within local plans, with a view that it needs the same sort of attention afforded to flood risk. This extends to perceptions on NAP3 in this space, with stakeholders highlighting that it has narrowly focussed on overheating in buildings. There are concerns that ongoing reforms to planning via the Levelling-up and Regeneration Bill (LURB) looks to be largely about speeding up planning with little on adaptation or mitigation. The CSE & TCPA (2023) have similar findings, also flagging how the National Planning Policy Framework is not appropriate in respect to adaptation or mitigation.

34. Another concern emerging from our interviews was a view that some recent developments like the national design guide and local design guides and a focus on 'beauty' in the LURB may hinder efforts to improve heat resilience at the building and community level. This is because some solutions, for example external shutters or shading, green walls, white or green roofs, cool pavements, and street furniture, which are widely used in hotter countries, are not common in the UK and will therefore be out of character and might fall foul of what is considered at a local level as 'good quality design'. This view may well be reinforced by developers, with some of the interviewees flagging that that housebuilders have developed products that buyers like, in terms of their design and appearance, and as such there is a resistance to add elements like external shading.

35. Other issues raised, include the ongoing challenges of making changes to homes in conservation areas to make them fit for the future. Issues with permitted development, such as the conversion of unsuitable properties into homes, particularly offices with lots of glazing. And wider inconsistencies such as being able to dig up a garden to park a car, but not paint a roof white.

36. More generally, given overheating risks will vary to some degree geographically and partly reflect somewhat local circumstances, such as built stock, density, types of tenure, age of population; the importance of local authorities in this space consistently came through in our interviews. This includes the central role held within urban planning, albeit largely shaped by the national framework. However, the ongoing financial constraints for local government and the well documented issues around the skills and capacity in local planning authorities (CSE&TCPA 2013; Fenna & Evans 2023) continue to make action on heat resilience and wider climate adaptation and mitigation harder than it needs to be. There is some excellent work happening in London around heat resilience, set out in the London Plan and range of

supporting policies, with the GLA and its partners clearly showing what can be achieved. This ability to go further than national policy, enabled through devolving of spatial planning powers can be an important enabler of change on issues around adaptation, something that is more difficult in other local authority areas. Again, these opportunities and barriers are well documented in the literature above.

What can be done to protect the UK's existing public and private sector housing stock from the impacts of extreme heat while ensuring that homes are sufficiently warm in the winter months?

37. It is not news that our existing built stock is old and ill-equipped for both heat and cold (House of Commons 2022). Ongoing information, support and policies will be needed to make it fit for net zero and to deal with the climate impacts that are now unavoidable. As noted above, a policy shift towards thermal comfort and wellbeing could enable a range of issues to be considered more holistically. There is also an important role for the provision of more targeted and nuanced public information regarding the risks associated with extreme heat and strategies to manage heat within buildings.

38. The range of passive measures that might be suitable for different types of housing are reasonably well understood at a high level in the work carried out for BEIS and the CCC, albeit such modelling tends to look at buildings in isolation, meaning some solutions might not work in practice. The GLA's new research on cool roofs is an example of how adaptation from other countries might be applied in the UK (GLA 2013), as there is much existing work on the importance of green and blue space within towns and cities to help reduce extreme heat. There is also an extensive academic and built environment literature on passive cooling and useful high-level summaries that flag the need to consider heat at the citywide scale, within neighbourhoods, and at the building level (Taylor et al 2023). Whilst more granular data will help with effective targeting and prioritisation of resources, a general perception from our stakeholders is that a lack of effective joined up policy and support for preventative measures is holding up efforts to address extreme heat, rather than a lack of knowledge.

39. The importance of a passive first approach and the key role that planning can play in this space is discussed above. Whilst there is a growing body of work happening within Government on cooling, in respect to housing, the main focus has and continues to be on heat and buildings. The need to bring cooling into these policy areas will grow in importance. Even if emissions and energy demand from cooling homes is expected to be low, the health implications of overheating require action.

40. Air conditioning (AC) could play an important and effective role in helping reduce extreme heat risks and given it not widely used in the domestic sector, it is area where there could be considerable market growth. However, there will be strong equity issues around affordability for its purchase and use, as well as significant wider climate and energy considerations associated with any widescale uptake of AC. Efforts

should be made to encourage a passive first approach, including behaviour change to help manage heat, and the promotion of low energy solutions like electric fans, rather than just leaving it to the market.

41. Policy attention on both product standards and f-gases, linked to AC will become increasingly important as demand grows. A perception that has emerged in our research is the window of cooling is currently quite narrow, so people may not seek a particularly efficient, cleaner AC unit, if this comes with a price premium. There were also concerns, mirrored in the BEIS research, that once people have AC, expectations of thermal comfort will change, leading to prolonged use; as well as concerns that smaller systems fall outside of some f-gas regulations, such as a requirement for a logbook and maintenance checks (BEIS 2021).

42. If the demand for AC becomes significant in housing and other parts of the stock where their use may currently be limited, e.g. care settings, schools, prisons, wider policy implications could emerge. Cooling demand is expected to be significantly lower than the electricity that will be needed for low carbon heating and transport (BEIS 2021; Samson 2020), suggesting that system capacity should not be an issue. Although, this should not simply be assumed, given that cooling demand can coincide with times when the wider energy infrastructure is under stress. For instance, there was a recent reported example of fossil fuel plant coming onto the system to help meet cooling demands (Lawson 2023) although this was at a time that some gas generation plant was down for summer. To reduce risks, wider policy areas linked to low carbon generation, flexibility, half-hourly pricing for consumers, and energy storage will increasingly need to consider what might happen with cooling loads. As will wider policy efforts around energy efficiency given that thermally efficient buildings, if designed well will both help reduce heat losses in winter and help avoid risks of overheating. The situation is more nuanced than this, but it is clear that if efforts to improve energy efficiency are done well, they do not directly lead to increased risks of overheating (Taylor et al 2023; ARUP 2022; CCC 2023b). Thermally efficient homes will be important for wider net zero, but also, they will help to reduce cooling loads and better enable load shifting. Health and social equity sit across all of this discussion, driving home the need for joined up action across government.

43. Given the recent improvements in policy for new build, it is clear more attention will have to be paid to the existing stock. Retrofits have always been difficult, and we have repeatedly heard across our interviews of the challenges of improving the existing stock in respect to the fragmented nature of policy, skills, supply chains, costs and the diversity of building types, tenures, and actors working in this space. We have been told a stronger framework for retrofits is needed and that this should bring in overheating risks, to avoid lock-in that might emerge from considering energy efficiency or low carbon heating in isolation. The risk of carrying out a retrofit now, to then have to go back to a property to later deal with

overheating, came up several times in the interviews we have done, and has been flagged by the CCC (CCC 2013b).

What role might reversible heat pumps (which can act as both heating and cooling systems) and other emerging technological solutions, such as the development of smart materials, play in meeting future cooling demands?

44. Heat pumps are devices which move heat from one place to another. For heating, heat is moved from the outside to the inside and cooling it is the reverse process. Many heat pumps installed, ground source and air source, can be used for cooling (as well as heating) if used in reversible mode. However, the use of them for cooling is not straightforward, particularly in the UK, where most people have wet central heating systems i.e. radiators and pipes with water circulating in them. Wet central heating systems pose two issues when it comes to cooling. Firstly, cooling brings with it a risk of condensation and could result in pipework, radiators and floors with underfloor heating getting wet and dripping/pooling. Secondly, while underfloor may be more suitable than radiators for cooling (since they would not need to be as cold to be useful for cooling and therefore condensation risk is lower), radiators would need an additional boost, via fans, to be an effective route to provide cooling. This is possible but adding fan units would come with additional costs. Consideration may also need to be given to the skills needed to size and design systems for both heating and cooling. As such, if a building wants cooling and heating from one appliance, air blown heat distribution might be more appropriate. This is not widely used in houses in the UK but is installed in many commercial buildings such as offices and hotels.

45. Most cooling (or air conditioning) systems installed today will be air to air, that is, an external air conditioning unit and internal blower units. These systems nearly always offer cooling and heating. There is an opportunity for the heating market in the UK to shift more towards air blown systems and these might be particularly suitable for flats and smaller buildings without wet central heating. But in buildings already with wet systems, it will be more complicated. There could be a role for reversible heat pumps and a policy shift towards thermal comfort rather than heating and cooling might help drive that as manufactures and installers see the opportunity and more people seek a cooling solution in a hotter UK. However, depending on the level of cooling required, and given some of complications above, a more straightforward option in a low carbon world for a building that needs cooling might be a heat pump for heating and separate system for cooling.

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Does the UK need a dedicated Heat Resilience Strategy? What lessons can be learned from other nations when it comes to national strategies for heat resilience?

46. A dedicated UK heat resilience strategy is needed. This must move beyond reporting and monitoring into implementation to address the risks of extreme heat in buildings and on wider infrastructure. Importantly risks should be evaluated from both building-centric and occupant-centric perspectives, leveraging increased opportunities to understand cooling demand. It would be sensible to include some regional perspectives within any national strategy, to reflect the current reality of greater heat risks experienced in London, the South East and other large cities/urban areas.

47. A policy for sustainable cooling is also needed. It may make sense to embed this into a heat resilience strategy, given it will be part of the solution for reducing risks. However, there could also be considerable benefit for aligning any cooling strategy with the wider heat and buildings portfolios within DESNZ, albeit cooling is bigger than just buildings. There might also be value in this inquiry considering if heat resilience should also come into that space, rather than being a standalone strategy – it might be useful to canvas wider opinion on which approach would have the most impact in terms of effective delivery.

48. Whatever the approach, a joined-up integrated strategy is needed, and this will require some thought on the wider governance for its development and delivery. Given the issue of heat resilience cuts across multiple departments and wider agencies, ensuring political and departmental buy-in, effective policy alignment and sufficient resources will be essential. The possible mechanisms to best enable this should be explored.

49. A final consideration, any strategy needs to clearly set out what is meant by heat resilience, overheating, sustainable cooling, and related concepts. From the interviews we have carried out, there are clearly different views regarding definitions and implications for different sectors.

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References

ARUP (2022). Addressing overheating risk in existing UK homes. https://www.theccc.org.uk/wp-content/uploads/2022/10/Addressing-overheating-risk-in-existing-UK-homes-Arup.pdf

Bai, L., Cirendunzhu, Pengcuociren, Dawa Woodward, A., Liu, X., Baimaciwang, Dazhen, Sang, S., Wan, F., Zhou, L., Xu, J., Li, X., Wu, H., Yu, B., Xiraoruodeng Liu, Q. (2013). Rapid warming in Tibet, China: public perception, response and coping resources in urban Lhasa. Environ. Heal. A Glob. Access Sci. Source 12, 1–11. https://doi.org/ 10.1186/1476-069X-12-71.

BEIS (2021). Cooling in the UK. https://www.gov.uk/government/publications/cooling-in-the-uk

Carbon Brief. (2023). Heatwaves are new normal as 50C hits US and China – UN. Daily Briefing – July 19 https://www.carbonbrief.org/daily-brief/heatwaves-are-new-normal-as-50c-hits-us-and-china-un/

CCC (2021) Independent-Assessment-of-UK-Climate-Risk-Advice-to-Govt-for-CCRA3. Climate Change Committee. https://www.theccc.org.uk/wp-content/uploads/2021/07/Independent-Assessment-of-UK-Climate-Risk-Advice-to-Govt-for-CCRA3-CCC.pdf

CCC (2023a) Progress in reducing emissions - 2023 Report to Parliament. Climate Change Committee. https://www.theccc.org.uk/wp-content/uploads/2023/06/Progress-in-reducing-UK-emissions-2023-Report-to-Parliament-1.pdf

CCC (2023b) Progress in adapting to climate change 2023 Report to Parliament. Climate Change Committee. https://www.theccc.org.uk/wp-content/uploads/2023/03/WEB-Progress-in-adapting-to-climate-change-2023-Report-to-Parliament.pdf

Climate Change Committee (2022) Risks to health, wellbeing and productivity from overheating in buildings; Briefing paper, July 2022. Available from: https://www.theccc.org.uk/publication/risks-to-health-wellbeing-and-productivity-from-overheating-in-buildings/

Copernicus. (2023, August 8). July 2023 sees multiple global temperature records broken. https://climate.copernicus.eu/july-2023-sees-multiple-global-temperature-records-broken#:~:text=The%20month%20started%20with%20the,hottest%2029%20days%20on%20record

CSE & TCPA (2023) Spatial Planning for Climate Resilence and Net Zero. Centre for Sustainable Energy and Town and Country Planning Association. (2023). https://www.theccc.org.uk/wp-content/uploads/2023/07/Spatial-planning-for-climate-resilience-and-net-zero-CSE-TCPA.pdf

Cuff, M. (2020, August 20). Air conditioning sales soar as climate change pushes summer temperatures up. inews. https://inews.co.uk/news/environment/air-conditioning-sales-soar-climate-change-583987

Cutler, M.J., Marlon, J.R., Howe, P.D., Leiserowitz, A., (2018) The influence of political ideology and socioeconomic vulnerability on perceived health risks of heat waves in the context of climate change. Weather. Clim. Soc. 10, 731–746. https://doi.org/ 10.1175/WCAS-D-17-0105.1.

Drury, P., Watson, S., & Lomas, K. J. (2021). Summertime overheating in UK homes: is there a safe haven? Buildings and Cities, 2(1), pp. 970–990. DOI: https://doi.org/10.5334/bc.152

Fenna, G. and Evans, L. M. (2023) Powers in Place: The handbook of local authority Net Zero powers. https://zcl.gn.apc.org/sites/default/files/publications/UK100_Powers%20in%20Place_FINAL%202.1%20web-compressed.pdf

FOE (2022) Who suffers most from heatwaves in the UK? Friends of the Earth. https://policy.friendsoftheearth.uk/insight/who-suffers-most-heatwaves-uk

GLA. (2023) GLA Roofs Designed to Cool. Greater London Authority. https://www.london.gov.uk/sites/default/files/2023-06/230906_GLA%20Roofs%20Designed%20to%20Cool_High%20ResFINAL.pdf

GLA & Bloomberg Associates (2022) Climate Risk Mapping. Greater London Authority. https://data.london.gov.uk/dataset/climate-risk-mapping

Hancock, A., Kazmin, A., and Varvitsioti, E. (2023, July 18). Scorching Europe struggles to adapt to near-record temperatures. Financial Times, July 2023 https://www.ft.com/content/c5882156-cd08-46b8-be8f-cb14f45b8f77

Hass, A.L., Runkle, J.D. and Sugg, M.M., (2021). The driving influences of human perception to extreme heat: A scoping review. Environmental Research, 197, p.111173.

Hass, A. L., & Ellis, K. N. (2019). Using wearable sensors to assess how a heatwave affects individual heat exposure, perceptions, and adaptation methods. International Journal of Biometeorology, 63(12), 1585–1595.

He, P., Liu, P., Qiu, Y. and Liu, L., (2022). The weather affects air conditioner purchases to fill the energy efficiency gap. nature communications, 13(1), p.5772.

House of Commons (2022). Decarbonising heat in homes. (Seventh Report of Session 2021–22, HC 1038). Business, Energy and Industrial Strategy Committee. https://committees.parliament.uk/publications/8742/documents/88647/default/

House of Commons (2018) Heatwaves: Adapting to Climate Change (Ninth Report of Session. 2017–19, HC 826). Environmental Audit Committee, House of Commons. https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf.

IPCC. (2022). Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. DOI: https://doi.org/10.1017/9781009325844.001

Kondo, K., Mabon, L., Bi, Y., Chen, Y. and Hayabuchi, Y., (2021). Balancing conflicting mitigation and adaptation behaviours of urban residents under climate change and the urban heat island effect. Sustainable Cities and Society, 65, p.102585.

Khosravi, F., Lowes, R. and Ugalde-Loo, C.E., (2023). Cooling is hotting up in the UK. Energy Policy, 174, p.113456.

Lawson, A. (2023). UK heatwave prompts National Grid to fire up coal plant to meet aircon demand. The Guardian. https://www.theguardian.com/environment/2023/jun/12/uk-heatwave-prompts-order-to-fire-up-coal-plant-to-meet-aircon-demand

Li, H., Guan, J., Ye, H., Yang, H., (2019). A survey of rural residents' perception and response to health risks from hot weather in ethnic minority areas in southwest China. Int. J. Environ. Res. Publ. Health 16. https://doi.org/10.3390/ ijerph16122190.

Lizana, J., Miranda, N. D., Gross, L., Mazzone, A., Cohen, F., Palafox-Alcantar, G., Fahr, P., Jani, A., Renaldi, R., Mcculloch, M., & Khosla, R. (2022). Overcoming the incumbency and barriers to sustainable cooling. Buildings and Cities, 3(1), pp. 1075–1097. DOI: https://doi.org/10.5334/bc.255

Lovins, A. B. (2018). How big is the energy efficiency resource? Environmental Research Letters, 13(9), 090401. DOI: https://doi.org/10.1088/1748-9326/aad965

McLoughlin, N., Howarth, C. and Shreedhar, G. (2023) Changing behavioral responses to heat risk in a warming world: How can communication approaches be improved? Wiley Interdisciplinary Reviews: Climate Change, 14(2), p.e819.

MO (2013). Urban Heat Risk in Manchester. Met Office in partnership with Manchester City Council & Manchester Climate Change Agency https://storymaps.arcgis.com/stories/05808279555f42df99aad9a1cc180257

Murage, P., Kovats, S., Sarran, C., Taylor, J., McInnes, R. and Hajat, S., (2020). What individual and neighbourhood-level factors increase the risk of heat-related mortality? A case-crossover study of over 185,000 deaths in London using high-resolution climate datasets. Environment international, 134, p.105292.

Murtagh, N., Badi, S., Shi, Y., Wei, S., & Yu, W. (2022). Living with air-conditioning: Experiences in Dubai, Chongqing and London. Buildings & Cities, 3(1), 10–27. DOI: https://doi.org/10.5334/bc.147

O'Brien, D.T., Gridley, B., Trlica, A., Wang, J.A. and Shrivastava, A., (2020). Urban heat islets: Street segments, land surface temperatures, and medical emergencies during heat advisories. American Journal of Public Health, 110(7), pp.994-1001.

Oliveira, S., Shortt, H. and King, L., (2023). From data to strata? How design professionals "see" energy use in buildings. Energy Research & Social Science, 101, p.103117.

Reischl, C., Rauter, R., Posch, A., (2018). Urban vulnerability and adaptation to heatwaves: a case study of Graz (Austria). Clim. Pol. 18, 63–75. https://doi.org/ 10.1080/14693062.2016.1227953

Sampson, N.R., Gronlund, C.J., Buxton, M.A., Catalano, L., White-Newsome, J.L., Conlon, K.C., O'Neill, M.S., McCormick, S. and Parker, E.A., (2013). Staying cool in a changing climate: Reaching vulnerable populations during heat events. Global Environmental Change, 23(2), pp.475-484.

Sansom, R. (2020). Domestic heat demand study (Rev2). https://esc-production-2021.s3.eu-west-2.amazonaws.com/2021/07/Domestic-Heat-Demand-Study.pdf

Sanchez, S., Peiro, ´ MN., Gonzalez, ´ JN., (2017). Urban Heat Island and Vulnerable Population. The Case of Madrid. Urbanism and Engineering. https://doi.org/10.1007/978-3-319-51442-0_1

SMC (2023). Expert reaction to the government's climate change impacts adaptation plan, NAP3. Science Media Centre. https://www.sciencemediacentre.org/expert-reaction-to-governments-climate-change-impacts-adaptation-plan-nap3/

Taylor, J., McLeod, R., Petrou, G., Hopfe, C., Mavrogianni, A., Castaño-Rosa, R., Pelsmakers, S., & Lomas, K. (2023). Ten questions concerning residential overheating in Central and Northern Europe. Building and Environment, 234, 110154. https://doi.org/10.1016/j.buildenv.2023.110154

Ugalde-Loo, C. (2021) Could Working from Home Put a Strain on UK's Climate Change Targets? Accessed: July 2023. Available from: https://www.cardiff.ac.uk/news/view/2523229-could-working-from-home-put-a-strain-on-uks-climate-change-targets

Valois, P., Talbot, D., Bouchard, D., Renaud, J.-S., Caron, M., Canuel, M., & Arrambourg, N. (2020). Using the theory of planned behavior to identify key beliefs underlying heat adaptation behaviors in elderly populations. Population and Environment, 41(4), 480–506.

Valois, P., Talbot, D., Caron, M., Carrier, M.P., Morin, A.J.S., Renaud, J.S., Jacob, J., Gosselin, P., (2017). Development and validation of a behavioural index for adaptation to high summer temperatures among urban dwellers. Int. J. Environ. Res. Publ. Health 14. https://doi.org/10.3390/ijerph14070820.

Vicedo-Cabrera, A.M., Scovronick, N., Sera, F. et al. (2021) The burden of heat-related mortality attributable to recent human-induced climate change. Nat. Clim. Chang. 11, 492–500 https://doi.org/10.1038/s41558-021-01058-x

Vu, A., Rutherford, S., Phung, D., (2019) Heat health prevention measures and adaptation in older populations—a systematic review. Int. J. Environ. Res. Publ. Health 16. https://doi.org/10.3390/ijerph16224370

Ward, B. (2023). Policymakers must be much better prepared for heatwaves in London. https://www.lse.ac.uk/granthaminstitute/news/policymakers-must-be-much-better-prepared-for-heatwaves-in-london/

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D., Capstick, S., Chambers, J., Dalin, C., Daly, M., Dasandi, N., Davies, M., Drummond, P., Dubrow, R., Ebi, K. L., Eckelman, M.,Montgomery, H. (2019). The 2019 report of the Lancet Countdown on health and climate change: Ensuring that the health of a child born today is not defined by a changing climate. The Lancet, 394(10211), 1836–1878.

WHO (2018). Heat and health. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

Williams, S., Hanson-Easey, S., Nitschke, M., Howell, S., Nairn, J., Beattie, C., Wynwood, G., Bi, P., (2019). Heat-health warnings in regional Australia: examining public perceptions and responses. Environ. Hazards 18, 287–310. https://doi.org/ 10.1080/17477891.2018.1538867

Wolf, J., Adger, W.N., Lorenzoni, I., (2010). Heat waves and cold spells: an analysis of policy response and perceptions of vulnerable populations in the UK. Environ. Plann. 42, 2721–2734. https://doi.org/10.1068/a42503.