Delivering Policy CC7: Development that is adaptive and resilient to climate change

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Introduction

1. The Climate Change Committee's (CCC) independent assessment of UK climate risk outlines the conditions we will need to adapt to as a result of climate change. Three trends are predicted across the UK:

- Wamer and wetter winters- rainfall overall will be more intense and there will be more wet days
- Hotter and drier summers- summer days will be an average of 1.5 degrees warmer and 10% drier. However, when rain does fall it will be more intense
- More frequent and intense extremes[1]

2. Consequently, communities will be at higher risk from heatwaves, wildfires, air quality degradation, flooding and coastal erosion.

3. By 2070 Devon's average climate is expected to see a 2.66^{0}C increase in temperature, a decrease in rainfall by 0.16mm/day, a decrease in cloudiness by 17.06 watts/m2 and decrease in windiness by 0.15m/sec. Summer temperatures are expected to increase by 3.28^{0}C whilst rainfall decreases by 0.77mm/ day. These changes mean an increased risk of overheating, reduced indoor and outdoor air quality, reduced water availability and increased occurrence of drought. Winter temperatures are predicted to increase by 1.90 degrees whilst rainfall increases by 0.37 mm/day, increasing flood risk, particularly in urban areas[2].

4. New buildings must be adapted to the shifting climatic conditions to prolong the longevity of the building and protect its occupants. The CCC reports that it is vastly more cost effective for developments to be adapted to the effects of climate change at the new build stage than to retrofit buildings later[1].

Exeter Plan policy response

5. To address the above, Exeter City Council has included a policy in its emerging Exeter Plan. Policy CC7 is presented in Appendix A. The report below represents evidence to support this policy and will be helpful in delivering this policy once the Exeter Plan is adapted. Reference has also been made to the 'Local Climate

[1] Climate Change Committee, Independent Assessment of UK Climate Risk Advice to Govt for CCRA3 CCC, 2021.
[2] CHESS_SCAPE: future projections of meteorological variables at 1 km resolution for the United Kingdom 1980-2080 derived from UK Climate Projections 2018, NERC EDS Centre for Environmental Data Analysis, 2022.

Adaptation Tool' (LCAT) and the 'Devon, Cornwall and Scilly Climate Change Adaptation Plan'.

Reducing overheating in buildings

6. Developments should incorporate methods to maintain a comfortable indoor temperature despite warming outdoor temperatures. In 2018 there were over 4,000 heat related deaths due to high temperatures in homes, care homes and hospitals[1]. 2022 brought the highest recorded temperature in the UK at 40.3^{0}C causing ~2,985 excess deaths[3]. As the UK's climate warms, the frequency and intensity of heat waves is expected to rise. Urban areas like Exeter are likely to experience even greater heatwave intensity, exacerbated by the urban heat island effect.

7. The urban heat island effect describes an increased risk of overheating in urban areas as temperatures are higher than their rural surroundings due to less vegetation and more dry, impermeable land resultant of urbanisation. With less shade and moisture to cool surfaces in summer, urban temperatures can be up to 12^{0}C warmer than surrounding rural areas[4,5].

8. The UK Green Building Council recommend, new developments should follow the 'cooling hierarchy' (below). This means that design should incorporate passive mechanisms, over mechanical or electric, methods of cooling and ventilation where possible. This reduces energy consumption and running costs compared to air conditioning systems that are more energy intensive, thus increasing emissions and emitting heat to the surrounding area, ultimately intensifying the urban heat island effect [6].

[3] UK Health Security Agency, Heat mortality monitoring report, 2022
[4] Environmental Protection Agency's Office of Atmospheric Programs, Reducing Urban Heat Islands: Compendium of Strategies - Urban Heat Island Basics, 2008.
[5] UK Green Building Council, How the urban heat island effect makes cities vulnerable to climate change, 2022.
[6] UK Green Building Council, The nature recovery and climate resilience playbook, 2022.

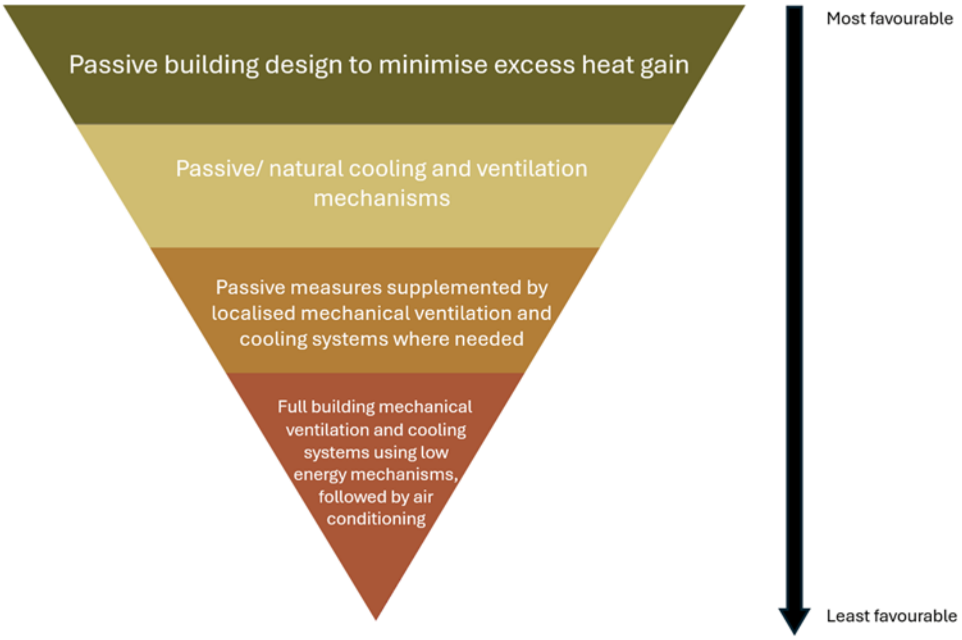

Figure 1: Cooling hierarchy for reduced energy consumption

9. Building Regulations (Part O) include measures to reduce overheating including limiting glazed areas and providing cross ventilation. Policy CC7 requires developers to demonstrate more holistically how development is designed for a warmer, more extreme climate and use cooling through passive mechanisms where possible, following the cooling hierarchy. This includes mechanisms to maintain comfortable temperatures inside buildings and the surrounding urban area. Some measures that may be included are explained below.

Building orientation

10. Passive cooling mechanisms work by managing the building's incoming solar radiation. This starts with the orientation of the building, optimising the amount of sunlight and radiation for passive heating and lighting, reducing the building's energy consumption in winter. This involves south facing windows, with the longest facades facing north and south. The layout of the building can also be designed to follow the sun path (zone planning) to take advantage of natural light and heat. Shading measures can then be used to reduce excess radiation and prevent overheating of the building[7].

Air tightness

11. For efficient use of solar radiation, air leakage through gaps and cracks in building fabric must be minimised through choices in glazing, building materials

[7] PIMES, Guide for bioclimatic design, 2015.

and insulation. This prevents heat loss, reducing energy consumption in winter and improves the thermal comfort for occupants which will be especially important with more frequent winter weather extremes. However, with more frequent heat extremes, air tightness must be paired with proper ventilation for both heat reduction and air quality purposes[8].

Passive ventilation

12. Ventilation is increasingly important when improving the air tightness of buildings, not only to prevent overheating but to reduce the likeliness of mould and damp developing with more intense rainfall. The orientation and placement of buildings is also an important factor for proper ventilation, to ensure there is enough space between buildings to allow wind to circulate.

13. Passive ventilation systems operate along temperature gradients and the natural upward flow of warm air. Examples include wind towers or ventilation shafts that allow warm air to rise through the shaft and be taken away by wind. Shutters can be installed in the shaft so that ventilation can be 'turned on or off' in cooler periods[7].

Shading

14. Shading mechanisms should be used to manage excess solar radiation in summer. Design features such as roof overhangs on the south side of the building, allow low winter sun to warm and light the building, but restrict the radiation gain from high summer sun. Similarly, window shutters, awnings and outdoor shades can be installed to enable manual management of solar radiation. These shading mechanisms also provide ideal areas for PV, which can be installed on overhangs, fins and shades.

15. Vegetation can also be used as a shading mechanism, with additional cooling from the evapotranspiration of water. Use of deciduous trees in particular works well with seasonal demand for light and radiation. When in full bloom in summer, their shading mechanism is at its peak when cooling demand is also at peak. However, in winter, these leaves fall, allowing more sunlight and heat to enter the building.

Reflective surfaces

16. Increasing the albedo of surfaces such as roofs reduces the amount of radiation reaching the building. This can come in the form of white roofs, or special glazing that reflects incoming radiation.

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[8] Impact of climate change on the domestic indoor environment and associated health risks in the UK, Environ Int 85 (2015) 299–313. https://doi.org/10.1016/j.envint.2015.09.010.

Green infrastructure

17. Green infrastructure refers to a network of green, blue and other natural features in urban and rural areas. This includes, but is not restricted to, green roofs, green walls, parks and private gardens, allotments and sustainable urban drainage systems (SuDS). Green roofs reduce indoor temperatures via evaporative cooling, removing excess heat from the building fabric[9]. They work well in in conjunction with solar photovoltaic panels (PV), as operating efficiency decreases as the PV arrays overheat. With the green roofs' cooling mechanism, a more optimal temperature can be maintained, improving the efficiency of solar PV energy generation[10].

Heat refuges

18. Large developments should create shaded areas for people to escape from high outdoor temperatures. These can be natural, with wooded areas that create shade, or shelters with cooling/ ventilation mechanisms.

Reducing flood risk and aiding recovery from flooding

19. In addition to complying with Exeter Plan policy CC8, developments should incorporate design mechanisms to reduce the risks and effects of surface flooding caused by increased rainfall in urbanised and impermeable areas.

20. Place-based and property level interventions should be incorporated into developments to both alleviate and aid recovery from flooding. Developments with large artificial and impermeable surfaces are discouraged, instead plans must incorporate soft landscaping, green infrastructure and permeable surfacing. Developments should also be designed to prevent damage from flooding and, where possible, aid quick recovery. Some potential measures are described below.

Place-based measures

21. Measures can be taken in the wider development area to increase its resistance to flooding.

Green roofs

22. Green roofs and similar green infrastructure can help control stormwater runoff and prevent flash flooding, creating a delay in the runoff of water from the roof [7].

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[9] Natural England, Green Infrastructure Planning and Design Guide, 2023
[10] Living Roofs, Green roofs and solar power- biosolar approach.

Permeable pavements

23. Permeable surfaces such as pavements, roads and driveways allow water to infiltrate into the soil or a reservoir beneath the surface to reduce the risk of flash/ surface flooding. Permeable surfaces may include more porous concrete or asphalt, woodchips, grass and concrete mosaics or paving with uneven edges and gaps to make room for water to infiltrate. Permeable pavements also allow for better surface cooling than traditional pavements which absorb and emit heat[11,12].

Rainwater harvesting

24. Rainwater harvesting and storage systems are encouraged to help reduce surface runoff volumes, storing it for later use such as for irrigation or toilet flushing.

Property level interventions

25. Various measures can be taken, predominantly on the ground floor, to prevent property damage and allow for a quicker recovery from property flooding[13]. Examples include:

- Flood doors and barriers
- Air brick covers
- Waterproofed brickwork
- Water resistant paint
- Replacing carpets with non-porous materials
- Raised electrical sockets
- Raised white goods e.g. on a plinth
- Valuable appliances such as boilers relocated to upper floor
- Separate electrical circuit for upper and lower floors
- Installing non-return valves in plumbing to prevent contamination from sewage water
- Certain flood resistance and resilience measures must be incorporated in areas at flood risk in order to meet the Flood Risk Assessment requirements (see: Guidance on Flood Risk Assessment).

Integrating biodiversity into the built environment

26. Data from the State of Nature report show a 19% decline in UK species since 1970 and that nearly 1 in 6 species are now threatened by extinction. Evidence over the past 50 years indicates that the largest drivers of decline are the effects

[11] Urban flooding mitigation techniques: A systematic review and future studies, Water (Switzerland) 12 (2020)
[12] Simulation study on effect of permeable pavement on reducing flood risk of urban runoff, International Journal of Transportation Science and Technology 8 (2019) 373–382.
[13] Scottish Government, Living with flooding: action plan for delivering property level flood resilience in Scotland.

of climate change and the way we manage land and water for agriculture and fishing. Urbanisation creates an additional pressure, converting land that was once habitat, into urban developments[15].

27. Developments should be designed to reduce the impact of urbanisation on biodiversity by creating space for wildlife in the built environment. The term 'wildlife' includes all living organisms ranging from plants to birds, mammals to lichens, fungi and invertebrates. Proposals must make clear effort to increase the abundance and diversity of wildlife.

28. Whilst the recently introduced biodiversity net gain requirements address the need to create and improve habitats, much can still be done to ensure that all development make space for wildlife.

29. Soft landscaping should be comprised of native species, which provide not only aesthetic value but food, shelter and nesting sites for a range of native species.

30. Other green spaces on the development should be managed to increase biodiversity by including elements like wildflower meadows, native trees and hedgerows, ponds and areas suitable for hibernation.

31. Green roofs and similar infrastructure should incorporate a variety of native grass and flower species, creating a habitat mosaic that encourages pollinators and invertebrates[10].

32. Developments could also include purpose built nesting areas such as bird and bat boxes, nesting space in building fabric and insect 'hotels'.
    See Residential Design SPD for further guidelines on appropriate provisions for biodiversity in new developments.

Adapting to reduced water availability

33. With increased frequency and intensity of drought, households will be more susceptible to water shortages. Part of the 25 Year Environment Plan[16] aims to reduce the risk of drought and increase the resilience of homes and infrastructure to these adverse conditions. Key to this is ensuring that interruptions to water supplies are minimised during drought periods. A review

[15] State of Nature, 2023.

[16] https://assets.publishing.service.gov.uk/media/5ab3a67840f0b65bb584297e/25-year-environment-plan.pdf

by the CCC suggests a broad portfolio of adaption measures are needed including demand level measures to reduce per capita consumption[17].

34. To adapt to reduced water availability and more frequent instances of drought, buildings must be designed to reduce water demand. In addition to installing efficient utilities to meet the requirements of Exeter Plan policy CC9, further innovative measures to reduce water use will be sought. Some examples are outlined below

35. Integration of rainwater harvesting, even at small scales , is encouraged to reduce water used for irrigation on the development. Rainwater could also be harvested for toilet flushing, further reducing mains water consumption.

36. Greywater recycling systems can be used similarly, harvesting wastewater from baths, showers and sinks to be used for flushing toilets or irrigation[18].

37. Drought resistant species can be used in landscaping on the development to reduce the need for irrigation in the maintenance of green spaces.

38. Landscaping features such as rain gardens, irrigated by drainpipe/roof run off water can also be integrated into the property, reducing consumption for irrigation whilst also helping to soak up excess runoff in times of heavy rainfall .[19]

Retrofitting renewable energy technologies

39. Some buildings will be built with renewable energy technologies included but may have opportunities for the installation of additional capacity, others may not have certain technologies installed when built.

40. Building designs that provide for the later installation of building based renewable technologies such as roof mounted solar photovoltaic panels are encouraged where this is feasible and practical.

41. In particular, designs should consider how to optimise the use of solar photovoltaic panels. For example, where a site incorporates buildings with pitched roofs the site layout should maximise the number of buildings with the main roof aspect facing south east to south west. Buildings with pitched roofs should aim for a roof angle in the range of [35-40] degrees and dormer windows

[17] https://www.theccc.org.uk/wp-content/uploads/2019/07/Outcomes-Water-stress-case-study.pdf
[18] Ricardo_Independent-review-of-costs-and-benefits-of-RWH-and-GWR-Final-Report.pdf
[19] https://www.wwt.org.uk/discover-wetlands/gardening-for-wetlands/how-to-make-a-rain-garden/

and other design features that break up roof spaces should be avoided as should over shading of roofs by adjacent buildings. Buildings constructed with the following characteristics are encouraged:

- A static load roof strength where solar equipment can be placed, capable of supporting a minimum of 15 kg/m^2 on pitched roofs and 30 kg/m^2 on flat roofs.
- Placement of non-solar related rooftop equipment that avoids shading of solar equipment and maximization of continuous roof space with the aim of at least 75% continuous roof space, unobstructed by HVAC equipment, vents, or any other objects, with all objects located on the north end of the solar ready roof.
- Sizing and/or provision of extra electrical switchboard capacity in the building to accommodate addition of an appropriately sized future solar energy system. Electrical switchboards in homes having an excess of 30% capacity and space for an additional electric switchboard in non-domestic buildings.
- Provision of space in the building for a solar photovoltaic system DC-AC inverter in the vicinity of the photovoltaic panels or in another suitable location which is identified in the building.
- Conduits in the building to allow the easy running of cables from the photovoltaic panels to the DC-AC inverter and from the DC-AC inverter to the electrical switchboard.

42. Solar ready construction is not encouraged where:
    - Solar resources are too poor at a specific site, for example excessive shading as a result of the building being on the north side of a steep slope or in the shadow of other taller buildings.
    - On north facing pitched roofs.

Appendix A

CC7: Development that is adaptive and resilient to climate change

Development proposals will be required to demonstrate how they will adapt to a changing climate and remain resilient over their lifetimes by:

a) Reducing overheating in buildings;
b) Reducing flood risk and aiding recovery from flooding;
c) Integrating biodiversity into the built environment;
d) Adapting to reduced water availability; and
e) Retrofitting renewable energy technologies.