Cooling buildings sustainably in Europe: exploring the links between climate change mitigation and adaptation, and their social impacts

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Across Europe, rising temperatures, combined with an ageing population and urbanisation, mean that the population is becoming more vulnerable to heat and that demand for cooling in buildings is rising rapidly. Buildings, as long-lasting structures, can offer protection from heatwaves and high temperatures if appropriately designed, constructed, renovated and maintained. The summer of 2022, with its successive long heatwaves and high energy prices, may have raised the sense of urgency given to the alleviation of heat stress. But there is a gap in knowledge on the extent of overheating in buildings and data and information is scarce regarding the share of EU citizens unable to keep their homes comfortably cool during the summer. This briefing examines key elements of sustainable cooling policy, and its potential impacts on vulnerable groups, by reducing health risks, inequalities and summer energy poverty.

Key messages

- Heatwave events caused 77,000-129,000 deaths in the 32 EEA member countries between 1980 and 2020, representing 86%-91% of fatalities caused by climate-related extreme events. The elderly and those with pre-existing medical conditions, including cardiovascular disease, are among the most vulnerable.
- Rising temperatures across Europe, an ageing population and increasing urbanisation make the population more vulnerable to heat. If no specific action is taken, this will lead to a rapid, uncontrolled increase in the use of inefficient active cooling systems, such as air conditioning, in buildings. This has social and environmental implications, while also

increasing energy use.

- Europeans spend approximately 80%-90% of their time indoors. Buildings, as long-lasting structures, can protect occupants from the impacts of heat at low energy costs, if appropriately designed, constructed, renovated and maintained.

- The deep energy renovation of building envelopes can improve the resilience of buildings, reduce the amount of energy used for cooling and decrease greenhouse gas emissions. Doing so while also targeting vulnerable groups would minimise climate change impacts on health, reduce inequalities and alleviate summer energy poverty.

- If active cooling is necessary (e.g. because of long heatwaves and/or critical health issues), cooling systems should be as efficient as possible and equitably accessible by vulnerable and other groups.

- Key elements of a sustainable cooling strategy include tailoring to local contexts, promoting urban cooling solutions, prioritising investment in passive cooling techniques, using active cooling systems rationally and moderately, and developing low-energy cooling systems that are suited to future warmer climates.

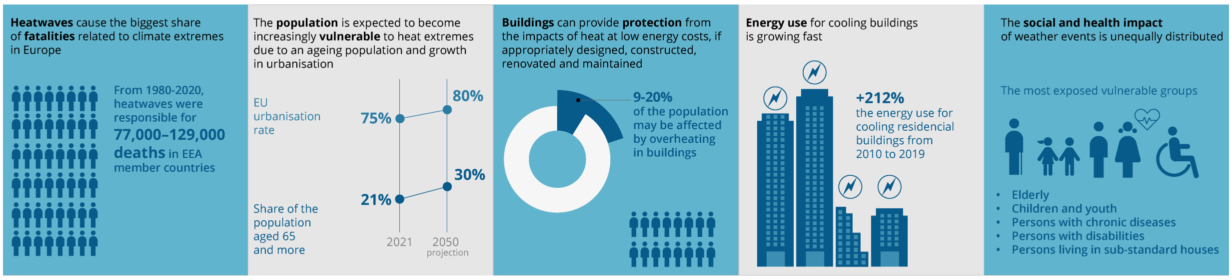
- The current EU policy landscape — including the EU's renovation wave, 'Fit for 55' package of proposals, the EU climate adaptation strategy and the Mission on Adaptation to Climate Change — offers key opportunities to ensure sustainable cooling solutions, social justice and greater resilience. Taking into account future climate and cooling needs, energy efficiency renovation is of central importance to control future summer energy demand.

This briefing explores the nexus between climate change adaptation and mitigation, and the health and social justice aspects of cooling Europe's buildings. It focuses specifically on residential buildings. The briefing is based on a literature review by Ramboll commissioned by the EEA, discussions held with members of the European Environment Information and Observation Network (Eionet), input from individual experts and information from other EEA publications.

Cooling challenges

One of the sustainability challenges facing the EU is how to adapt its building stock to ensure that citizens are protected from the impacts of rising temperatures without compromising the EU's objectives of tackling energy efficiency, energy independency and climate neutrality in a fair and socially just way.

Figure 1. Key facts on vulnerability



Sources: EEA; Zero Carbon Hub, 2015; Kolokotsa, 2015; Eurostat.

Cooling: a social and just transition issue

Heatwaves cause the largest share of fatalities related to climate extremes in Europe. Summer temperature records are broken regularly and heatwaves are currently, and will continue to be, more intense and frequent than before (EEA, 2022a). From 1980 to 2020, for example, heatwaves were responsible for 86%-91% of fatalities caused by weather- and climate-related extreme events in the EEA member countries[1]. This corresponds to 77,000-129,000 deaths over this period (EEA, 2022b).

The combination of higher summer temperatures, an ageing EU population[2] and increasing urbanisation rates[3] tends to increase population vulnerability and exposure to heat. This is because older people are most likely to be victims of heatwaves (EEA, 2018, 2022b) and because buildings in densely populated cities are more likely to overheat as a result of urban heat island (UHI) effects[4].

This increase in vulnerability and exposure to heat is a concern in all European countries. Between 1990 and 2019, central and Mediterranean countries displayed the largest increase in vulnerability within the EU. However, vulnerability to heat exposure associated with ageing, the prevalence of diseases and urbanisation is highest in northern Europe (EEA, 2022c).

As Europeans spend an average of 80%-90% of their time indoors (EEA, 2018; WHO, 2021), improvements to the built environment can help to substantially reduce heat stress. Buildings are long-lasting structures and, if appropriately designed, can help to protect their occupants from the impacts of heatwaves and rising temperatures. On the other hand, when buildings overheat[5], indoor air temperatures can reach levels that negatively affect the health of occupants via heatstroke, dehydration, the aggravation of chronic and respiratory diseases, and even death.

Current studies reveal that 9%-20% of the population might be affected by overheating in buildings in several EU countries (Zero Carbon Hub, 2015; Kolokotsa, 2015). However, further data are needed. Low thermal performance and poor building quality can contribute to overheating risks and uncontrolled increasing energy consumption for cooling. Most of the EU's building stock was constructed before thermal standards were introduced, and nearly 75% of the stock is energy inefficient. In 2020, between 5% and 39% of the population, depending on the Member State, lived in dwellings with leaking roofs, damp walls, floors or foundations, or rot in window frames or floors, according to Eurostat.

Newly constructed or renovated buildings can also overheat, even if they are well insulated. This can occur if building design does not adequately consider the combination of solar gains, internal gains and ventilation strategies. Nearly half of city hospitals and schools are in areas with strong UHI effects, thus exposing their vulnerable users to high temperatures (EEA, 2022c).

Therefore, overheating in European buildings is not only a comfort issue, but also — and increasingly — a climate, health and social justice issue. While all of Europe faces the impact of higher temperatures in summer, people's level of exposure is very unevenly distributed across population subgroups and areas. Moreover, the elderly, the very young, those with pre-existing medical conditions, pregnant women and socially isolated individuals are more vulnerable to heat.

In nearly all European countries, a lower socio-economic status also increases vulnerability to heat stress. This is often related to living in housing that is more prone to overheating and to difficulties in affording cooling solutions (EEA, 2018; WHO, 2018, 2021; Eurofound, 2020). In many European countries, vulnerable communities tend to live in dense, urban environments and, therefore, may be exposed to higher temperatures due to UHI effects (EEA, 2018).

In addition, landlords and tenants face split incentives when it comes to investing in 'cooling-conscious' energy renovations, just as they do in winter. This results in a lack of implementation or partial implementation of strategies for the reduction of "energy need for cooling"[6]. Any renovations undertaken by property owners could result in an increase in rent for tenants (Ástmarsson et al., 2013), thus excluding de facto modest households. At city level, this could potentially lead to gentrification.

Demand for cooling in poor-quality housing occupied by the lowest income households presents a conundrum in the context of the need for a just transition to a carbon-neutral economy. Active cooling solutions, such as air conditioning — even if the equipment is affordable — may lead to extra running and maintenance costs. If electricity prices increase, these costs would push households with the lowest incomes into summer energy poverty.

Cooling EU buildings: an energy and greenhouse gas issue

In the 19 euro-area countries, the amount of final energy used for cooling in residential buildings tripled between 2010 and 2019. In the 27 EU Member States (EU-27), the amount of energy used for cooling in residential buildings represented only 0.4%, on average, of the total final energy consumption in the residential sector in 2019 (Eurostat). However, this percentage was much higher in countries such as Malta, Cyprus and Greece, at 11%, 10% and 5%, respectively. During summer 2022, the need for cooling became a serious issue in Greece, Italy, Spain and other countries as a result of long-lasting and repeated heatwaves (Copernicus, 2022) combined with high energy prices and the war in Ukraine.

Studies that estimate future demand for cooling in EU buildings differ in their results and other parameters (Dittmann et al., 2016). However, all studies agree that energy use for cooling buildings is likely to increase and, as a result, the share of energy used for that purpose will also increase. Kranzl et al. (2018, 2021) conclude that, of total energy used in buildings, the share of energy used for cooling, both in residential and non-residential buildings, could be between 8% and 9% in 2050, compared with only 2% in 2012. Future energy demand for cooling will increase the most in southern EU countries. Jakubcionis and Carlsson (2017) estimate that, in future, Greece, Italy, Portugal and Spain could represent 71% of total average annual energy use for cooling in residential buildings in the EU.

Although energy use for cooling in buildings constitutes a modest percentage of total EU energy use, peak electricity demand for cooling, which is almost exclusively met by electricity, will increase throughout Europe. The largest increases are projected to occur in France, Italy and Spain. An important adaptation challenge is therefore to ensure the stability of electricity networks during heatwaves. An increase in the peak electricity load for cooling may coincide with a limited supply of cooling water for thermal power generation, which could pose risks of power outages (IEA, 2018; EEA, 2019; UNEP DTU, 2021). Since high demand for cooling coincides with high levels of solar irradiation, on-site solar energy systems, such as rooftop photovoltaic systems, could be used to address cooling demand.

Hot summers and heatwaves will inevitably increase energy use for cooling to limit the impact of climate change on health (IPCC, 2022b). Although active cooling systems in residential buildings are used less in the EU than elsewhere in comparable regions of the world, the EU market is growing fast (ENERDATA, 2019). Air conditioning is currently the dominant cooling strategy for companies and individuals who can afford it, despite its drawbacks. The air conditioning household equipment rate in Europe rose from 14% in 2010 to approximately 20% in 2019 (Odyssee database). Hot summers and recurrent heatwaves have accelerated the trend, as exemplified in France in June 2019, when sales of air conditioning equipment and fans suddenly increased by 400% before a heatwave (The Connexion, 2019). The market for active cooling systems is also expanding with the sale of reversible systems, including heat pumps[7], which can be used for both heating and cooling.

The use of air conditioning units and reversible heat pumps contributes to climate change in two ways. First, the generation of electricity emits CO_2, although the level of emissions depends on the degree of decarbonisation of the electricity-generation system. Second, the use of refrigerants emits greenhouse gases (GHGs), primarily hydrofluorocarbons (HFCs), with a global warming potential that is thousands or tens of thousands of times higher than CO_2. HFCs may be emitted when leakages occur or when refrigerants are disposed of improperly (IEA, 2018).

On the positive side, the EU is the only region in the world in which CO_2 emissions resulting from cooling buildings could decrease by 2050, according to the International Energy Agency's baseline scenarios (IEA, 2018). Existing EU policies have already led to positive results on GHG emissions. The EU's HFC emissions started to decrease in 2015, and this can be partly attributed to the EU-wide HFC phase-down laid out in the EU's F-gas Regulation (EEA, 2021a). Electricity generation in the EU is being progressively decarbonised and the share of renewable sources in total energy consumption has been increasing continuously since 2005 (EEA, 2021b).

Technological progress can limit GHG emissions from active cooling systems, but the demand for equipment and electricity might still increase significantly. This poses challenges for meeting the EU's objectives of reducing final and primary energy use[8] and decreasing dependency on foreign fossil fuels, which is central to the REPowerEU initiative. It also has social and environmental implications (see Box 1). Active cooling needs to be accessible for vulnerable groups and those for whom it is vital. Addressing these challenges will require a comprehensive revision of how to provide summer comfort in buildings.

Box 1. The drawbacks of using air conditioning extensively

The extensive use of air conditioning can be seen as a ‘maladaptation’. It gives rise to difficult issues regarding electricity consumption, peak electricity demand, and heat generated by equipment and its subsequent contributions to urban heat island effects. It also offers the prospect of potential CO_2 emissions (EEA, 2020). While air conditioning can be effective at protecting health, studies also stress the social and individual dependence on overusing air conditioning. Overuse can prevent people from becoming accustomed to natural heat, can create psychological dependence, and can cause people to forget traditional know-how and simple good practices for dealing with hot conditions (e.g. using natural ventilation at night and blinds during the hottest hours). Moreover, adequate and safe indoor temperatures in buildings with a poorly insulated envelope may be disrupted in cases of power outages. This can reduce social resilience to heat (UNEP DTU, 2021).

Key elements of a solution for sustainable cooling

No one-size-fits-all solution

A sustainable cooling strategy should be tailored to local conditions and should pursue the following four complementary objectives. First, prioritise all practices that reduce the energy need for cooling in buildings, including approaches that reduce cooling load[9], passive cooling options and nature-based solutions in the surrounding area of buildings. Second, define optimal cooling solution sets at building level, combining passive and/or active solutions and applying behavioural and awareness raising options. Third, tailor actions to the local context, such as current and future climate conditions, building types, urban density, demographic data, environmental conditions (e.g. vegetation, water, etc.), the quality of the electricity grid, and vernacular knowledge, etc. And fourth, identify the most vulnerable groups who need the most cooling from a health perspective and ensure that they benefit from sustainable cooling and preventive measures.

There is no one-size-fits-all solution to reach these objectives. Based on existing knowledge and practice, the following practical priorities for sustainable cooling are highlighted:

- consider effective solutions in the overall urban surroundings of buildings, including nature-based solutions, green infrastructure (e.g. green corridors, parks and trees in cities, wind corridors) and other technical options, such as surfaces with low solar absorption (so-called cool materials and paintings) or urban shadow infrastructures;
- ensure new and renovated buildings are optimally designed to limit energy needs for cooling in summer, for instance by using an appropriate building shape and orientation, active and passive solar shading (including green roofs and walls), insulation, thermal mass, designs that allow natural ventilation and cooling (e.g. patio and atrium designs) and appropriate comfort models[10] as a basis for the optimal design of cooling solutions;
- prioritise passive cooling solutions, such as summer shading, night and day natural ventilation, and very low energy consumption options, such as well-designed ceiling fans;
- respond to residual cooling needs using low-greenhouse gas (GHG), highly energy-efficient active cooling solutions that are fuelled by renewable energy (e.g. on-site photovoltaic systems);
- consider targeted awareness raising, behavioural learning, behavioural changes and climate justice as integral parts of the sustainable cooling approach.

Using a combination of the above approaches reduces the need for adopting active cooling solutions that involve energy dependency, while also reducing financial and environmental costs. The EU-funded Renaissance project in Zaragoza, Spain, illustrates how to implement several of these dimensions in practice (see Box 2).

Box 2. Minimising energy demand in social housing in Zaragoza, Spain

Social housing in Zaragoza, located in the north of Spain, is confronted with energy inefficiencies and can lead to uncomfortable indoor temperatures during cold winters and hot summers. To overcome these problems, the EU-funded Renaissance project has tested a new bioclimatic design, including the use of renewable energy sources, in two neighbourhoods.

A ‘right to the sun’ methodology is key to the project. It comprises a specific relationship with the sun that is used to design buildings, streets and vegetation. The renovation requires double orientation, renovated north-facing facades using double carpentry and added insulation. To make use of heat from the sun in winter, southern-facing facades consist of renewable resources and large glazed areas while overhangs create shade during hot summer months. In addition, west-facing facades incorporate sun protection such as lattice works.

In Zaragoza, average standard airtight windows were installed on the north- and west-facing facades to protect against cierzo, a strong north-westerly wind. Deciduous trees do not block the sun in winter but provide protection from the sun in summer. Street designs that protect the buildings from the wind were also utilised. Finally, solar panels were installed, and plumbing, hot water, heating and sewerage systems were upgraded.

The Implementation of these measures in 616 new buildings in the Valdespartera neighbourhood resulted in a 49% reduction in energy consumption for electricity and heating compared with standard practices. The investment costs were EUR 43.8/m^2 of floor area for the bioclimatic measures and EUR 956.8/m^2 for the solar thermal panels.

In El Picarral, the other neighbourhood involved, 70 buildings were renovated in two districts. Following renovation, final energy consumption was reduced by 37%, compared with standard practices. This was achieved through investments of EUR 49.3/m^2 and EUR 80.9/m^2 for bioclimatic measures and EUR 1,861.6/m^2 and EUR 1,672/m^2 for solar thermal panels in each district, respectively. The improvements are monitored via real-time systems that provide data used to support behavioural change and inform improvements in building construction.

Sources: Saheb et al. (2019); EEA (2020).

Awareness raising affects individual behaviour and climate justice

Building occupants are constrained by building design, quality and access to cooling technologies. Nevertheless, the behaviour and awareness of occupants play a crucial role in limiting the overheating of buildings and protecting occupants' health, in mitigating the use of energy for cooling and in maintaining an indoor environment of good overall quality. Information campaigns should therefore focus both on the risks of overheating and the potentially simple solutions that can be implemented. This is reflected in a study that finds that 'A fully opened window at night-time and the 2-h ventilation in the morning and evening are more sufficient to avoid heat stress than a tilted window at night-time and the 1-h ventilation in the morning and the evening' (Rosenfelder et al., 2015).

The accurate identification and mapping of vulnerable communities and individuals are essential for targeting equitable adaptation measures (EEA, 2022d) and tailoring communication so that it leads to the translation of knowledge and warnings into heat-adaptive behaviours (WHO, 2021). Notably, information targeted at the elderly has been found to improve protective behaviours and prevent adverse health outcomes during extreme heat. Also effective are information campaigns that encourage the creation of solidarity networks to ensure that neighbours look after each other during hot spells (see Box 3).

Comfort (and possibly productivity and health) can also be improved through simple solutions related to behaviour, and can be enabled by good building design and controls. Based on many interviews, Földváry Ličina et al. (2018) show how air velocity provided by well-designed ceiling fans, as well as wearing informal, light clothing, can considerably improve comfort at very low energy cost (ABC 21 Project, 2021). Setting a thermostat at 25°C is associated with the lower level of the comfort range if individuals are dressed heavily, but results in a relatively high level of comfort if individuals are dressed lightly[11]. The current plans of some governments, such as those of Spain and Italy, to limit cooling beyond 25°C-27°C may help to prevent unnecessarily low setting of thermostats in summer.

Setting air conditioning thermostats at a temperature of 27°C instead of 22°C in a room can halve the energy consumption of air conditioning units (ADEME, 2021). Other examples of good practice proven to deliver energy savings include: turning down air conditioning when windows are open, using different cooling temperatures for different rooms, only cooling selected rooms, cooling at only specific times of the day, properly maintaining and using air conditioning equipment, and using active cooling systems only if needed and not more than needed. A study by ADEME (2021) shows that, in a business-as-usual scenario, energy consumption for air conditioning in France is expected to double between 2020 and 2050, whereas in a scenario adopting good practices, such as those listed above, it is expected to halve.

Box 3. Leaving no one behind

Some European cities and regions help vulnerable groups to adapt to climate change. The need for special assistance for some groups has been recognised in the city of Paris, for example. The city maintains a register of people vulnerable to heatwaves and encourages solidarity networks to ensure that neighbours look after each other during heatwaves.

In Bologna, volunteers and non-governmental organisations assist vulnerable individuals during heatwaves via a payment-free call centre that looks after people at risk and accompanies them to cooling centres or hospitals, if needed. The region of Kassel in Germany provides a ‘heatwave telephone’ service, where volunteers call elderly people to warn them about health risks during heatwaves and suggest possible ways to avoid danger. Moreover, whenever alert levels for various extreme weather-related events are recorded in Lisbon, a contingency plan for homeless people is implemented by the municipal social care department to support the most vulnerable populations (EEA, 2020).

The increase in the frequency and intensity of heatwaves can also trigger climate anxiety and eco-anxiety. In Finland, three non-governmental organisations offer various forms of mental health support for people suffering from these types of anxiety. Vulnerable groups, such as young people and rural communities economically dependent on land, are specifically targeted.

Source: EEA (2022d).

Technologies offer new solutions

The advantages and drawbacks of various technologies for reducing cooling load, and passively cooling and actively cooling buildings, are well documented.

The most effective technologies for avoiding high energy demand include those that reduce the cooling load and implement passive cooling methods, such as better insulation, optimal shading of glazed facades and radiative cooling. These options may increase demand for materials and associated embedded CO_2 emissions (EEA, 2022e), but decrease demand for active cooling during building use. The use of green infrastructure and nature-based solutions at the city and building levels provides benefits in terms of well-being, biodiversity support, CO_2 storage, etc. (EEA, 2021c), but in-depth feasibility studies are needed to identify the requirements for their implementation and maintenance. Not all of these options are technically easily accessible and many require up-front investment (compensated for by long-term benefits).

In contrast, natural ventilation is effective, low cost and does not have environmental impacts. For example, in low-cost housing in southern Spain, the appropriate use of natural ventilation at night reduced indoor temperatures by 5°C on average (Escandón et al., 2019). However, keeping windows open may be difficult because of noise pollution during the day and night, and safety issues at night. Hence, it is important to introduce integrated urban planning aimed at lowering noise pollution by reducing the number and weight of cars (Erba and Pagliano, 2021) and/or by using ventilation openings with sound-attenuation features.

Given the growing challenge of providing summer comfort in a warming climate, the development and uptake of innovative, low-energy and low-carbon cooling solutions, which are able to operate efficiently in high and extreme temperatures, should not be neglected. From this perspective, district heating and cooling systems provide promising opportunities in urban areas, in particular when natural sources are used for cooling (see Box 4).

Fifth-generation district heating and cooling networks allow the provision of both space heating and cooling for different building types, both office and residential, with a strong potential for harnessing renewable energy sources (IEA, 2021). These networks have the potential to considerably reduce total energy demand in a district by facilitating direct heat exchange, while incorporating renewable sources, such as solar, thermal or geothermal sources, to cover residual demand. This in turn can contribute to the decarbonisation of the sector (Boesten et al., 2019). Reversible heat pumps using non-GHG refrigerants, coupled with on-site solar photovoltaic systems, are also promising examples.

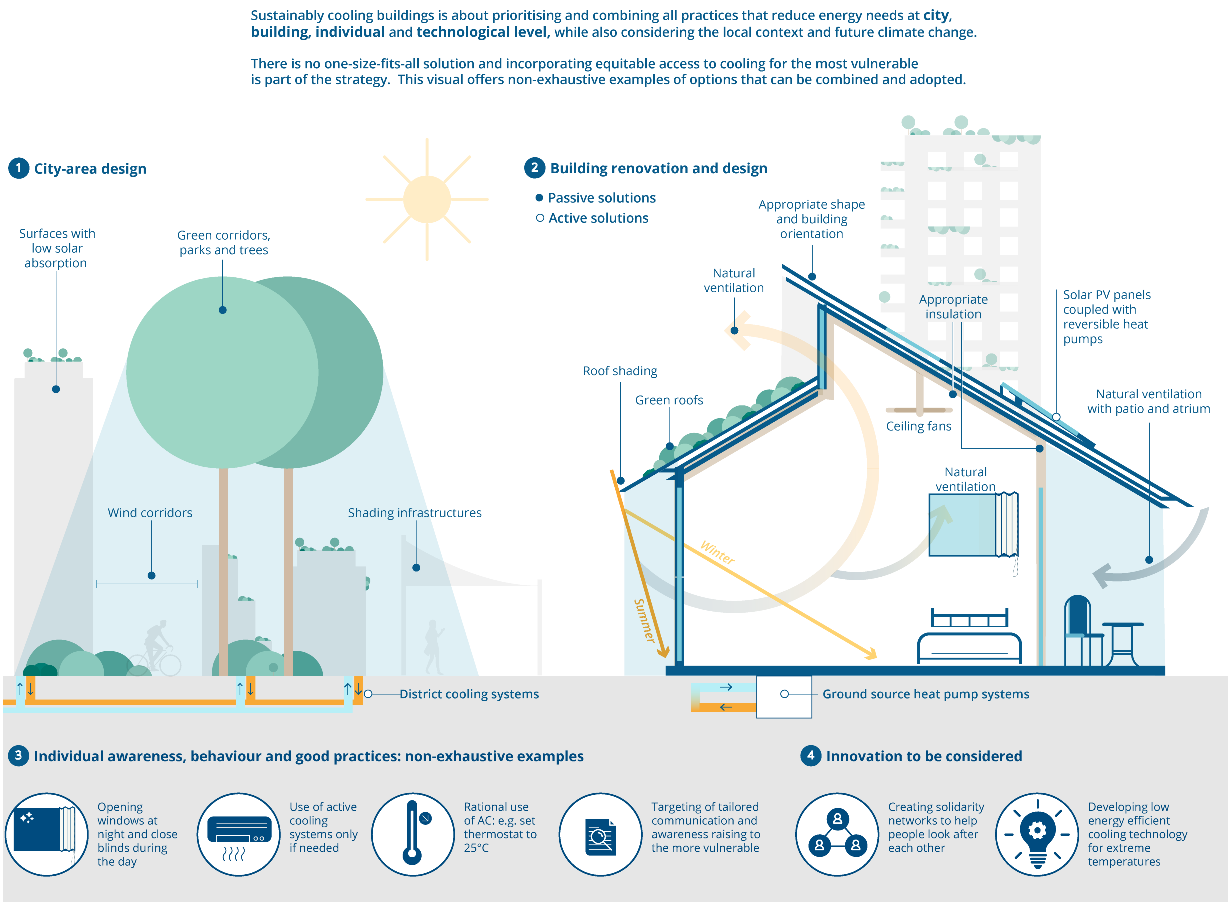
Box 4. Improving indoor thermal comfort with the use of district cooling in Paris

Energy demand for cooling in the city of Paris is increasing and is expected to account for 10% of the city's overall energy demand by 2050. This is due to increasing air temperatures and the growing demand for cooling within information technology installations. City authorities intend to rely increasingly on district cooling systems in tertiary buildings. These systems consist of a central plant where chilled water is produced and conveyed to buildings through a network of insulated pipes. Such plants may be more energy efficient than the usual individual building cooling solutions, which use air as a heat sink.

In Paris, the cooling network currently covers 38% of the city, including many museums and public buildings. Nearly 70% of the chilled water produced annually comes from plants situated along the Seine; these plants use river water in heat exchange systems. This network will be extended to cover the entire city, and at least one other production plant using Seine water, will be built.

Source: EEA (2019).

Figure 2. Sustainably cooling buildings



Sources: EEA.

The EU climate change policy context: an opportunity to anticipate cooling needs

An opportunity to incorporate passive cooling into climate mitigation policies

EU policy discussions regarding the energy renovation of buildings are often dominated by the need to reduce greenhouse gas (GHG) emissions. In that regard, cooling is often seen as secondary to heating because the latter represents a larger share of fossil fuel consumption and GHG emissions. The Renovation Wave Strategy, the ‘Fit for 55’ package — including revisions of the Energy Efficiency Directive — and the revision of the Energy Performance in Buildings Directive could further highlight the importance of providing summer comfort using passive solutions.

At the national level, some countries (e.g. Cyprus, Finland, Latvia, Portugal, Spain) explicitly address the issue of summer indoor temperatures in their long-term renovation strategies and/or address cooling issues as part of considering the thermal regulation of buildings. As for heating and energy efficiency, the development of incentives and legal frameworks that take into account the landlord/tenant split incentive dilemma are needed to encourage the adoption of the most adequate cooling solutions. Other crucial aspects include defining thermal comfort criteria in legislation and giving due consideration to existing relevant standards[12].

An opportunity to integrate the social and climate justice dimension

The EU strategy on adaptation to climate change (EU adaptation strategy) recognises the negative impacts of heatwaves on the economy, and on the health and well-being of Europeans, and promotes the implementation of physical solutions in response. The strategy includes references to buildings (although it does not mention space cooling in particular). It also recognises the need for ‘just resilience’ to ensure that the benefits of climate adaptation are widely and equitably shared.

While good examples of equity aspects of adaptation (e.g. at city level) already exist, an evaluation of the previous EU adaptation strategy (2018) and the new EU adaptation strategy (2021) draws attention to the need to carry out social vulnerability assessments to identify vulnerable groups and to involve them in the design of fair adaptation policies at all governance levels, particularly in cities (EEA, 2020). Little is known about the distribution of the impacts of adaptive actions across various social groups and this is rarely taken into account. Questions on who is disproportionally affected by heat, who benefits from cooling, who finances it and how to design targeted policies to support vulnerable groups are not fully integrated with energy efficiency policies. However, it has been shown that energy efficiency policies for buildings — if well targeted and well designed — can generate positive outcomes by decreasing both monetary and environmental inequalities (EEA, 2021d).

An opportunity to focus on the local level

As with adaptation actions and social considerations, local and municipal governance levels are crucial. However, many local climate adaptation actions focus on technology interventions without taking social characteristics into account (EEA, 2022d). The EU initiative, “Mission on Adaptation to Climate Change”, which is supporting more than one hundred European regions and communities towards climate resilience by 2030, may help in that respect. The initiative will foster the development of innovative solutions to adapt to climate change and will encourage regions, cities, and communities to lead societal transformation.

Robust data are needed for smart policy design, monitoring and evaluation

Key information needs to be improved and continuously collected. For example, the availability of robust data on the health and environmental impacts of overheating in buildings, and on issues such as summer energy poverty, need to be improved and data need to be systematically updated. The lack of data on the costs and benefits of adaptation options for cooling is also a key knowledge gap (EEA, 2019).

Little evidence is available on the cost efficiency of policies and measures for adaptation to heat in the EU context and the evidence that is available is very location specific (EEA, 2020). Policies that enable adjustments to the behaviour of occupants, by promoting simple, yet effective, passive cooling solutions and habits, are the most cost effective and sustainable.

The most well-known, significant costs of non-action include health impacts such as premature deaths, hospitalisations and emergency department visits. In the absence of adaptation measures, heatwaves may also lead to drops in labour productivity of up to 10%-15% for temperature rises greater than 3°C (JRC, 2018). Additional benefits of sustainable cooling include wider social benefits such as the avoidance of (summer) energy poverty, enhanced well-being and greater energy independence.

Conclusion

It is important to harness opportunities in the current policy landscape to anticipate future risks and needs related to heat.

The complexity of sustainable cooling, in the context of climate change and heightened societal challenges, makes it very difficult to solve all elements of climate adaptation, energy consumption reduction, climate mitigation, and social and climate justice at the same time. A nexus approach is useful for understanding the systemic nature of the challenges and their interconnections, and for better defining integrated adaptation and mitigation policies. In most cases, the most effective solution will involve a combination of options. Measures may be implemented at different levels, such as at the building or city level, and by different actors, and implementation may be affected by conflicting demands for space.

Managing this complexity requires coordination among decision-makers at several levels, from the EU level to the national, local and building levels; a common understanding and motivation; and consistent policy messages on priorities and on the importance of fairness in addressing cooling needs. It also calls for the coordinated engagement of public administrations, civil society organisations and the private sector in various fields, including climate data collection, health, social welfare, spatial planning, various industries, energy efficiency in buildings, employment, finance, research and development, and innovation.

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Notes

[1] The EU-27 plus Iceland, Liechtenstein, Norway, Switzerland and Türkiye.

[2] According to Eurostat, The share of the population aged 65 and more is 21% in 2020 and projected to reach 30% in 2050.

[3] The EU urbanisation rate was 75% in 2021 and is projected to be 80% in 2050 (EEA, 2022f).

[4] The term ‘urban heat island’ refers to the relative warmth of a city compared with surrounding

rural areas, associated with changes in run-off, effects on heat retention and changes in surface albedo (IPCC 2021).

[5] Although there is no universally accepted definition of ‘overheating in buildings’, and different measures are used to assess it, it is recognised that the definition of ‘overheating in buildings’ is linked to that of thermal comfort and refers to a situation where air temperature in an indoor environment goes beyond the thermal comfort temperature for a certain period of time, i.e. it becomes uncomfortably or excessively warm.

[6] Tenants may not have any incentive to finance renovations, as they are not the property owners. At the same time, landlords may not want to invest in renovations if these renovations directly benefit the tenants.

[7] Heat pumps are promising technologies for reducing the energy use and GHG emissions of buildings when installed in building envelopes that allow them to run efficiently and when fed with electricity from renewable sources. Under those conditions, they are expected to play a significant role in the energy transition of the EU. The recently published ‘REPowerEU’ initiative aimed at decreasing dependency on Russian fossil fuels intends to accelerate the roll-out of heat pumps, doubling the deployment rate in the next 5 years.

[8] The 2018 Energy Efficiency Directive set a target of an at least 32.5% improvement in energy efficiency by 2030 in the EU-27.

[9] Approaches to reduce cooling load aim to reduce a building’s intake of heat.

[10] The adaptative comfort model is a standard for the design and operation of naturally ventilated buildings. Taking into account the role of air velocity is also important. Comfort models and air velocity’s contribution to summer comfort are described in European Standard BS EN 16798:2017 and in American National Standards Institute Ashrae Standard 55-2020 to assist professional in designing their projects.

[11] For instance, the Cool Biz campaign in Japan encourages workers to dress casually and choose a thermostat setpoint of 28°C.

[12] Such standards include European Standard EN 16798:2017 and Ashrae Standard 55-2020 with provisions for the use of the adaptive comfort model for naturally ventilating buildings and for periods when active cooling systems are off.

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