D4.1. Review and mapping of legislations and regulations on sustainable space cooling at EU and national levels

Cool LIFE

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List of Acronyms

CAs	Comprehensive Assessments
CBA	Cost-Benefit Analysis
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
ESPR	Ecodesign for Sustainable Products Regulation
LTRS	Long-Term Renovation Strategies
MS	Member State
NAS	National Adaptation Strategies
NAP	National Adaptation Plans
NECP	National Energy and Climate Plans
RED	Renewable Energy Directive

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Keywords list

- space cooling
- EU policy
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- summer comfort
- building regulations
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Executive summary

Final energy consumption for space cooling in residential buildings tripled between 2010 and 2019 in the 19 euro-area countries, while households' equipment rate in air conditioning in Europe rose from 14% in 2010 to about 20% in 2019. Cooling alone accounts for around 4% of final energy demand in the EU, with 106 TWh for space cooling and about 110 TWh for process cooling complemented by 0,6 TWh for district cooling. More frequent and intense heat waves accelerate this trend, and contribute to peak loads, and even power cuts. Above all, this represents a major risk for health, with over 70,000 excess deaths in Europe in 2003, and more than 60,000 in 2022. Heatwaves cause about 90% of fatalities related to climate-related extreme events.

Summer comfort is thus a major challenge for both, mitigation and adaptation policies. Policies for space cooling may be too much focused on cooling technologies, overlooking solutions to avoid, or at least minimise, cooling needs while ensuring summer comfort. Cooling demand is indeed influenced by various factors beyond cooling devices' efficiency, including passive architecture building design based on bioclimatic principles, urban environment (e.g. urban heat island) and behaviours.

This report examines how space cooling is addressed in the EU policy framework, including changes brought by the fit-for-55 package, as well as at national level. The review of the national level is focused on national building regulations, comprehensive assessments on heating and cooling, draft updates of National Energy and Climate Plans, and National Adaptation Strategies and Plans. These analyses are crossed with a scouting of solutions for sustainable space cooling (previously done in the CoolLIFE project), to discuss their coverage in the current EU policy framework. We conclude that a shift may be needed in the policy framework to prioritise first measures that can minimise cooling needs, acknowledging that their implementation implies a coordination between EU, national and local policies, as the local level can best take into account local climate conditions and adapt urban planning.

1. Introduction

1.1. Space cooling is an increasingly important topic for energy and climate policies, with major differences among countries

The European Environment Agency (Quefelec 2023) stressed that final energy consumption for space cooling in residential buildings tripled between 2010 and 2019 in the 19 euro-area countries (based Eurostat data), while households' equipment rate in air conditioning in Europe rose from 14% in 2010 to about 20% in 2019 (based on ODYSSEE data). This shows a **strong increasing trend**.

Cooling was previously estimated to account for around 4% of EU final energy consumption in 2016, with 106 TWh/year for space cooling (i.e. 1.9% of EU final energy consumption) and about 110 TWh/year for process cooling complemented by 0.6 TWh/year for district cooling (Gerard et al. 2021). As space cooling is mostly generated from electricity, its share is primary energy consumption is larger. But it remains **much less than space heating** in most Member States. This explains the focus on space heating in most policies dealing with energy consumption in buildings.

Giussani et al. (2024) provides a complementary assessment of the useful energy demand[1] for space cooling in buildings as of 2021, showing that (1) **tertiary buildings** would represent **about 78% of the useful energy demand** for space cooling in EU27. And that **four countries** would represent **79% of the useful energy demand** for space cooling in EU27 (Spain: 33.4%; Italy: 24.1%; France: 15.8%; Greece: 5.7%). Moreover, some countries may represent a small share of energy demand in EU27 due to their size, whereas space cooling represents a significant share of their useful energy demand and final energy consumption (e.g. Cyprus and Malta). This explains why space cooling is addressed to **various extents among Member States**. This not only reflects differences in needs for space cooling (e.g. in terms of cooling degree days), but also in terms of equipment rates.

Giussani et al. also highlights difficulties encountered when assessing energy demand for space cooling, especially in terms of **data availability**. Complementary assessments at national level are thus useful to improve the evidence base for policymaking.

More frequent and intense heat waves accelerate the trend towards increasing energy demand for space cooling, and contribute to **peak loads** in summertime, and even power cuts such as in Italy in summer 2023. Likewise, warmer summers and heat waves represent a **major risk for health**, with over 70,000 excess deaths in Europe in 2003, and more than 60,000 in 2022 (Ballester et al. 2023). Heatwaves would cause about 90% of fatalities related to climate-related extreme events (Quefelec 2023). Summer comfort is thus a **major challenge for both mitigation and adaptation policies**.

[1] Useful energy demand for space cooling represents the net heat extracted from the space area that is cooled. This is different from the final energy consumption that represents the energy input to the cooling generators. The conversion factor between useful energy demand and final energy consumption depends on the cooling technology. Most space cooling is delivered by electrically driven cooling equipment that have an energy efficiency ratio greater than 1. Therefore, final energy consumption for space cooling is significantly lower than its useful energy demand.

1.2. Going beyond the focus on technologies

Lizana et al. (2022) highlighted that policies for space cooling tend to be too focused on cooling technologies, overlooking solutions to avoid, or at least minimize, cooling needs while ensuring summer comfort. Cooling demand is indeed influenced by various factors beyond cooling devices' efficiency, including bioclimatic architecture principles in buildings' design, urban environment (e.g. urban heat island) and behaviours.

Lizana et al. pointed out five main factors of the dominance of air-conditioners to meet cooling needs:

- building energy policies based only on energy efficiency
- air-conditioning considering only temperature rather than other thermal comfort parameters
- building-centric design instead of occupant-centric design
- businesses guided exclusively by product sales
- lack of innovation beyond the standard operational phase of incumbent technology

Based on a survey of requirements related to summer comfort in national buildings codes, the recommendations of the Keep Cool II project in 2009 (Gonçalves and Camelo 2009) were already promoting passive measures (e.g. solar heat attenuation, heat dissipation, natural ventilation) to avoid as much as possible the need for mechanical cooling systems (i.e. air conditioners).This was the approach that was already used in the Austrian regulations. In line with the requirements of the first Energy Performance of Buildings Directive, the Keep Cool II recommendations were calling for calculations of cooling energy needs and summer comfort to be included systematically in all regulations for new buildings. This was proposed as a way to ensure the adoption and use of passive measures to counter the already increasing use of air conditioning systems in Europe. As a complement, the recommendations called for informative campaigns on passive cooling, for households and for building managers and users. While the analyses of the requirements in building regulations covered various aspects (e.g. U-values for walls, roofs and windows, sun shading, natural ventilation), summer comfort was indeed mostly considered in terms of maximum indoor temperature not to exceed.

Similarly, the main recommendations of the ASIEPI project on summer comfort and efficient cooling in buildings stressed three main points (Laskari and Santamouris, 2010):

1. Protect the building against overheating and against the need to install active cooling in the future;
2. Make alternative cooling techniques a top priority in national regulations and practical applications rather than conventional cooling systems[2].
3. Improve the current national energy performance procedures and thus enhance energy savings from cooling[3]

2 Proposed measures included: "establishment of financial incentives for alternative cooling systems; inclusion of more alternative cooling techniques along with their performance calculation methods in national regulations; but also mandatory requirements for using alternative cooling techniques, such as solar and heat protection and modulation and dissipation cooling techniques before using conventional systems."
3 Proposed measures included: "reduction of the oversizing capacity of the A/C installations during the design phase; minimum COP requirements and consideration of the COP of cooling systems during the peak and part load conditions instead of only under the nominal conditions; restrictions on the use of cooling during the peak periods; application of modular pricing policy for big cooling consumers (…) attention to proper setting of default values, integration

Following the input provided in a previous CoolLIFE reports (Gelesz et al. 2023, Hurtado-Verazaín et al. 2023), it is important to highlight the socially structured concept of thermal comfort and the occupants' behavioral patterns when assessing summer comfort and cooling needs. To begin with, the word "comfort" itself is extremely complex and difficult to define and measure. Scientists and engineers have continuously tried to introduce indicators and parameters that would provide specific quantitative insight to this "state of mind" in order to design indoor environments that would prove to be tolerable, satisfactory, and "comfortable" for everybody, at any time. The ambition to attain a neutral environment in which people do not report to be "uncomfortable" led to the artificial manipulation of indoor conditions, mainly driven by engineers and the construction industry, which triggered the increased adoption of air conditioning systems for the standardization of space cooling.

1.3. Objectives of the report and target audience

This report aims at providing an overview of the current EU policy framework relevant to sustainable space cooling, reviewing how it is implemented by Member States, and more generally how Member States are addressing space cooling in their energy and climate policies.

It is primarily meant for policy makers, officers and analysts, as well as experts and researchers dealing with space cooling and related policies and regulations. Especially these involved in the preparation of National Energy and Climate Plans, comprehensive assessments, building regulations and national building renovation plans (formerly long-term renovation strategies).

The work behind this report was also used to prepare the data for the 'policy' module of the CoolLIFE tool. A template was developed to collect data from Member States' reporting in a systematic way, as well as about building regulations for the ten countries analysed more in-depth. The resulting country files are available in the CoolLIFE tool (as attachment to the policy layer). Their contents are explained in the wiki of the tool. Therefore, this is not included in this report that is focused on cross-country analysis.

1.4. Methodology

The **overview of the EU policy framework** was done by screening the following pieces of legislation, considering the latest version after the adoption of the fit-for-55 package:

- EED – Energy Efficiency Directive (EU)2023/1791
- RED – Renewable Energy Directive, as amended by Directive (EU) 2023/2413
- EPBD – Energy Performance of Buildings Directive (EU)2024/1275
- ESPR – Ecodesign for Sustainable Products Regulation, and more specifically the energy labelling and ecodesign regulations applicable to cooling products

of all aspects that have an impact on the cooling energy consumption in the procedures, avoidance of complex input data, make alternative cooling techniques part of the thermal balance equations but also integrate them in the global calculation method."

This screening also covered European Commission's communications, including the 2016 heating and cooling strategy (COM(2016) 51 final), and the Renovation Wave (COM(2020) 662 final).

For each piece of legislation, we looked for the provisions relevant to space cooling, and whether analyses about their implementation were available in the literature. The results of this are summarized in **chapter 2**.

The **review of Member States' policies and regulations** covered the following sources:

- National Energy and Climate Plans (NECPs), considering their draft updates (due by 30 June 2023);
- Comprehensive Assessments for heating and cooling (required by the EED, now in Article 25(1)), considering the 2020 reporting;
- Long-Term Renovation Strategies (LTRS) (required by the EPBD, previously Article 2a), considering the 2020 reporting;
- National Adaptation Strategies (NAS) and National Adaptation Plans (NAP) for all 27 MS (the updated NAS and NAP reports were taken into account and the work was finalized in May 2024).
- National building regulations, for the ten countries analysed more in-depth (Austria, Croatia, France, Italy, Germany, Greece, Hungary, Portugal, Spain and Sweden)

The mandatory template for **NECPs** does not include any section specific to cooling, therefore their review was made using a list of keywords to identify information relevant to space cooling: # add list of keywords #. The analysis was done on draft NECP updates, as by the end of November 2024, only 15 final NECP updates were available. Moreover, it was found that NECPs provide little information specific to space cooling. The review of the NECPs was also used to find information about governance of policies relevant to space cooling (e.g. about the respective roles of national, regional and local authorities, when relevant).

The review of the Comprehensive Assessments followed the structure of the assessment, as set in the European Commission's Delegated Regulation 2019/826/EU, and now in Annex X of the EED recast. The analysis was done on the comprehensive assessments due by Member States in 2020. Comprehensive assessments were initially updated every five year. The EED recast has aligned the timing of updating comprehensive assessments with the timeline of the NECPs. Therefore in theory, Member States had to submit their new comprehensive assessment together with their final NECP update due by 30 June 2024 (instead of 2025, as planned in the previous EED). However, no new comprehensive assessment was available by the end of November 2024. When reviewing the 2020 comprehensive assessments, we focused on the information dealing specifically with space cooling.

Like for the NECPs, the requirements about **LTRS** do not include any provision specific to space cooling. In practice, LTRS are usually focused on space heating, that is by far the main end-use in buildings in most countries. Moreover, one of the major objectives of the LTRS is to decarbonize the building stock. As space cooling is mostly supplied from electricity, this also explains the low coverage of space cooling in LTRS. A review of LTRS was already available from the literature (Castellazzi et al. 2022). This review already showed that little information on space cooling was available in the LTRS, which was confirmed by a screening using the same keywords as for the NECPs.

The methodology in analysing the NAS and the NAP consists of two-stepped manner. Firstly, the latest information available for each NAS and NAP are collected from the Climate-ADAPT database considering the original links, latest

updates and keywords such as "space cooling" or "cool"; "air-conditioning"; "comfort"; "summer"; "heat pump"; "green areas"; "shading"; "sun protection", "thermal", and "passive". The scope of the NAS and NAP analysis contains a total of 158 policy documents that were translated in English and assessed based on the keywords. Secondly, the assessment process entails several general categories such as climate hazard/ key topic of measures, adaptation priorities, objectives, main key measures related to the keywords, and good practices (essential communication campaigns on heating and cooling in different sectors). After the assessment process was finalised and added to the respective file for each Member State, the content was reviewed by an internal reviewer which then revised according to the remarks and proceeded with the completion.

Going further in the policy review, ten countries were analysed in-depth. They were selected first to include the countries with the largest energy consumption for space cooling (Spain, France, Italy, Germany, Greece, Portugal), and second to cover countries with different climate conditions: Central Europe (Austria), Eastern Europe (Hungary), Southeastern Europe (Croatia) and Northern Europe (Sweden). For this later group of countries, the selection was also based on the national languages spoken within the consortium, as the review of building regulations requires to analyse regulations most often available in national language only.

When reviewing the **building regulations**, we looked at the following points: how space cooling or summer comfort is addressed in the regulations (i.e. in the definitions, calculation methodology, energy performance requirements), provisions about the use of space cooling or related comfort parameters (i.e. about indoor temperature and cooling season, when relevant). This analysis also aimed at identifying differences in the provisions for new and existing buildings, and for residential and non-residential buildings.

The review of national policies was complemented by a targeted search in the literature and the MURE database of energy efficiency policies.

The results of the review of Member States' policies and regulations are presented in **chapter 3**.

The policy review was then crossed with the review of space cooling solutions done in previous CoolLIFE reports (Duplessis et al. 2024, Gelesz et al. 2023) (see **chapter 4**).

2. Space cooling in the EU policy framework

In this report, we focus the analysis of the EU policy framework on its parts that include provisions specific to space cooling. Our starting point is the 2016 heating and cooling strategy, a communication by the European Commission, setting the scene about how the EU policy framework could address heating and cooling. Then we review to what extent and how the EU legislation covers the different part of the space cooling chain, from the end-use side (cooling equipment and buildings) to the supply-side, as summarized in the figures below.

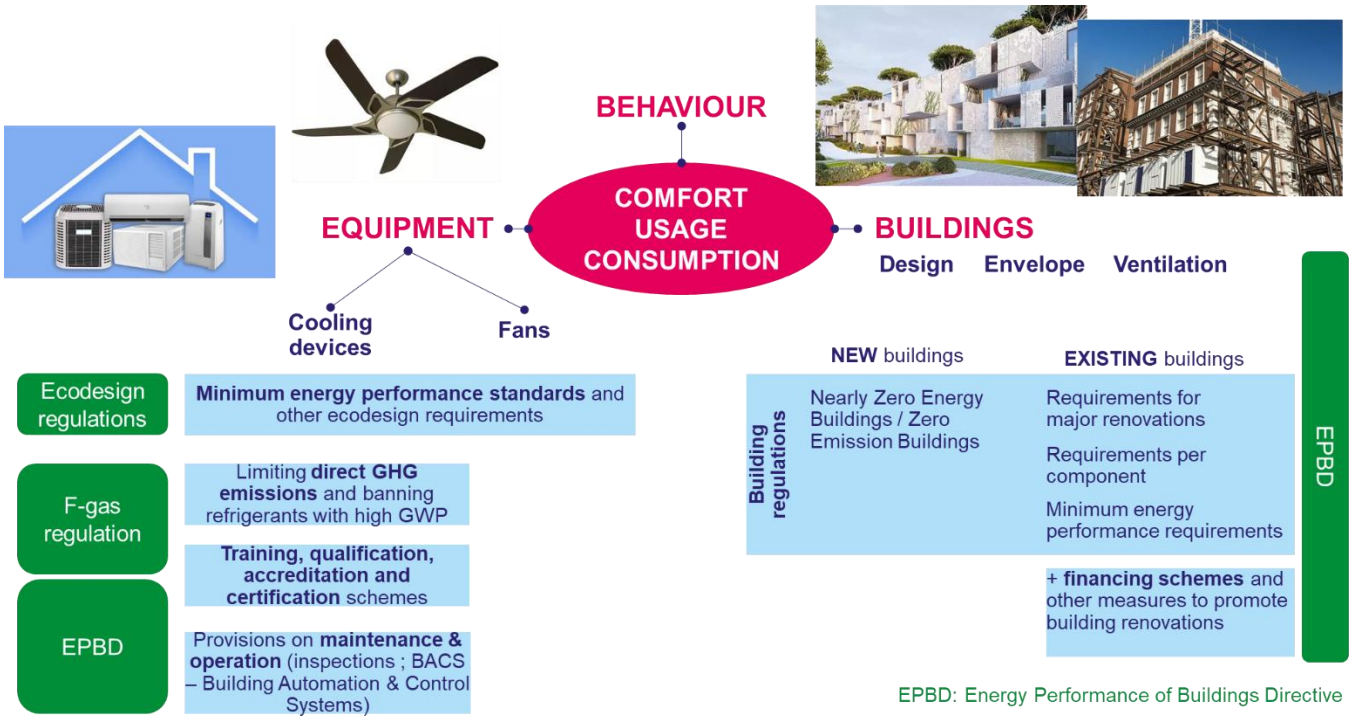

Figure 1. Coverage of the equipment and building level in the EU policy framework.

Figure 2. Coverage of cooling supply in the EU policy framework.

The review of the EU policy framework also includes a discussion about the expected planning processes at national and local level, summarized in the figure below.

Figure 3. National and local planning processes for heating and cooling, as expected in the EU policy framework.

This is complemented by a discussion about the link with the adaptation policy framework.

2.1. The 2016 heating and cooling strategy

The European Commission published in February 2016 an EU strategy on heating and cooling (COM(2016) 51 final), with the aim to better integrate efficient heating and cooling into EU energy policies, especially in the Clean Energy for all Europeans' package[4]. The strategy is not limited to space heating and cooling. It also covers industrial use of heating and cooling, and refrigeration systems in services. Still, buildings represent a large part of its scope.

The main axes highlighted about space heating and cooling include the renovation of buildings (especially improving the building envelope), increasing and decarbonising heating and cooling systems, and increasing the share of RES (Renewable Energy Sources) in the heating and cooling supply.

The analyses and recommendations are mostly focused on space heating, as it is by far the largest energy use in buildings in EU27. The strategy mentions a few solutions for space cooling (well-designed street vegetation, green roofs and walls, shading, innovative low energy cooling technologies).

In terms of EU policies in place at that time, the only ones that were specific (or strongly related) to space cooling were about cooling systems: the Regulation (EU) 517/2014 on fluorinated greenhouse gases, and the ecodesign

[4] Legislative proposals published by the Commission in 2016, and adopted in 2018-2019

regulations for air conditioners and comfort fans (Regulation (EU) 206/2012) and for cooling products (Regulation (EU) 2016/2281).

The strategy included a few recommendations to Member States (e.g. about addressing split incentives or energy poverty). Most of the actions suggested at EU level were related to the legislative proposals made in the Clean Energy for all Europeans' package. Some could contribute to reducing energy consumption for space cooling, mostly through boosting building renovations. Only few provisions were specific to space cooling.

In terms of planning and implementation at national level, the strategy made the link with the upcoming National Energy and Climate Plans (NECPs) that were part of the proposal for the Governance Regulation of the Energy Union ((EU) 2018/1999). The strategy mentioned that the NECPs should integrate the heating and cooling sector.

The strategy was complemented with an accompanying document in two parts. The first part provided a detailed analysis of energy consumption for heating and cooling, and an overview of heating and cooling technologies. It estimated the energy consumption for space cooling in EU buildings at that time: 18.6 TWh/year for the residential sector and 100.6 TWh/year for the services sector. It discussed a possible exponential growth based on recent trends, also pointing to the large uncertainty about future cooling demand. The second part included a focus on cooling technologies, pointing out the expected increase in the sales of residential air conditioning units from about 3 million units per year in 2010, to 4.5 million by 2030. Italy, Spain, Greece and France together accounted for the majority of sales in the EU. However, this growth in the equipment rate was expected to be compensated by energy efficiency improvements from the ecodesign requirements and energy labels.

The accompanying document raised the issue that improved building insulation may lead to higher indoor temperatures in summer, generating higher cooling demands. Which can be mitigated by a building design or renovation taking into account local climate conditions (e.g. with a better integration of natural ventilation).

The document also pointed out the development of summer peak load, with the examples of Spain in July 2015 where very high temperatures created a surge of 8% in electrical demand due to air conditioning, and Italy where since 2006 the summer daily peaks in electricity demand were higher than winter peaks. Examples of measures to address these summer peaks were mentioned from Australia that required the inclusion of a demand-response enabling device in all household air-conditioners sold since 2011, and the development of a standard for demand-response interface for air-conditioners, facilitating the reception and response to energy utilities' signals that provide an incentive to consumers who accept the remote control of their air conditioner in case of peaks.

The document mentioned a few examples of national plans or strategies for heating and cooling. It is noticeable that all were heat plans or strategies, with only minor aspects related to space cooling (if any). When data or provisions about space cooling were included, this was often due to the comprehensive assessment required by the Energy Efficiency Directive (EED) (see section 2.2.3).

The EU strategy on heating and cooling has not been revised. But the Commission has published several studies providing updates about developments and possible future pathways. The following ones deal with cooling (most often together with heating):

- (Kranzl et al. 2021): study on renewable cooling providing a comprehensive background analysis in support of the Delegated Act on a methodology to calculate renewable energy used in cooling under the Renewable Energy Directive.

- (Gerard et al. 2021): study on policy support for heating and cooling decarbonization, but in practice mostly focused on heating (cf. heat decarbonisation roadmap and recommendations for policies covering space heating in buildings and the process heating industry)

- (Bacquet et al. 2021): study on district heating and cooling providing an overview on market and regulatory frameworks and presenting 10 case studies on best practice to illustrate successful models to integrate renewable energy and waste heat sources into thermal networks.

- (Lettenbichler et al. 2023): 2023 update of the review of advancing district heating & cooling solutions and uptake in European cities, providing an overview of the Commission's district heating and cooling support activities and projects.

- (Braungardt et al. 2023): study to support the analytical basis for the development and implementation of policies towards the full decarbonisation of heating and cooling by 2050 in buildings and industry, assessing potentials for the deployment of renewables and the suitability of various transition pathways for EU countries and outlines possible policy sets.

2.2. From the equipment to the building level and supply efficiency

2.2.1. Two key issues at the equipment level: their energy efficiency and the refrigerants they use

About energy efficiency, the EU legislation ensures the information of consumers through the Energy Labelling Directive, that established the first energy labels for room air conditioners in 2003, with minimum requirements on energy labelling of air conditioners coming into force in 2011 (cf. Regulation (EU) No 626/2011). Minimum energy performance requirements for small air conditioners and comfort fans were first introduced in 2012 by the ecodesign regulation (EU) No 206/2012, further updated in 2014 and 2018. This regulation was expected to save 11 TWh/year by 2020. Larger air conditioners (capacity larger than 12 kW) are covered by the ecodesign regulation on air-heating and cooling products ((EU) 2016/2281). A joint revision of the energy labelling and ecodesign regulations for air conditioners and comfort fans was on-going in 2023, with an adoption of the new regulations planned for 2024[5]. This revision aims, among other objectives, at increasing consistency between both regulations and making it easier for consumers to compare products, improving the method to calculate products' energy efficiency and remove the least efficient products from the market (Huang et al. 2018).

The Energy Performance of Buildings Directive (EPBD) also includes requirements for cooling systems, once in use, with mandatory regular inspections for large air-conditioning systems, and provisions for the installation of building automation and control systems and devices that regulate temperature at room level.

[5] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13358-Energy-efficiency-ecodesign-rules-for-air-to-air-conditioners-air-to-air-heat-pumps-and-comfort-fans-review-_en

About refrigerants, the major concern is due to their very high Global Warming Potential (GWP), that can be from 1,000 to 10,000 times the one of CO_2. The EU Regulation 842/2006 thus introduced requirements to reduce leakages of HFCs from refrigeration and air-conditioning systems, for example with mandatory training of technicians and mandatory leak testing of large systems. This regulation was repealed by the EU Regulation 517/2014 (F-gas regulation) setting the ground for an overall phase-down of the quantity of HFC refrigerant that can be sold in the EU (79% decrease by 2030) and bans on certain refrigerants in specific applications. The new regulation was meant to stimulate a progressive shift to low GWP alternatives.

The energy labelling, ecodesign and F-gas regulations are directly imposed in the Member States. According to the review of the energy labelling and ecodesign regulations for air conditioners and comfort fans done in 2018 (Huang et al. 2018), there is therefore no other major legislation at national level about energy requirements for air conditioners. This review mentions that some countries have previously implemented alternative ecolabels and different taxes to limit the use of fluorinated greenhouse gases.

2.2.2. Space cooling not very visible in the energy performance requirements and renovation of buildings

The EPBD is the key European legislative framework for boosting the energy performance of buildings, considering five main end-uses that include space cooling and ventilation, through a broad range of policies and support measures aiming to the decarbonisation of the EU building stock by 2050. The EPBD requires that Member States set cost-optimal minimum energy performance requirements for new buildings (that must be nearly zero-energy buildings), for existing buildings undergoing major renovation and for the replacement or retrofit of building elements, including for heating and cooling systems, roofs and walls. The EPBD does not set requirements specific to space cooling. Each Member State is free to set such requirements in its building regulations. The new recast of the EPBD keeps this flexibility but highlights more explicitly the need to consider summer comfort (see more details below about space cooling in national regulations).

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.

The EPBD includes provisions for long-term renovation strategies (LTRS), now Building Renovation Plans (BRP), for the transformation of existing buildings into nearly zero-energy buildings, which implicitly covers the same end-uses as for building regulations (i.e. including space cooling). The LTRS or BRP provisions do not include specific requirements for renovation schemes to address space cooling or summer comfort, nor to consider future climates (despite a short reference to health). Similarly, the Commission's communication on the Renovation Wave (COM(2020) 662 final) has one of its three focus areas about decarbonising heating and cooling. But it is in practice mostly about decarbonising heating, as cooling is mostly supplied from electricity. The impact thus mostly depends on how electricity is produced in each country. The communication includes "high health and environmental standards" among its key principles for building renovations, dealing among others with protection against climate-related hazards. The actions listed in the annex to the communication indeed include "supporting the development of climate-resilient building standards". The conclusion of the communication mentions that roofs and walls can contribute to improve the urban climate, for example by increasing their green surface. However, nor the EPBD as

amended in 2018 nor the Renovation Wave's documents discuss the risk that renovation may worsen summer (dis)comfort, and thereby increase cooling needs, if it is not planned with both winter and summer comfort in mind.

More information and analysis about financing schemes for building renovation can be found in (Conforto 2024). More information about behavioural measures can be found in (Gelesz et al. 2023).

2.2.3. Energy efficiency in the cooling supply and decarbonisation of cooling

The EED addresses efficiency in heating and cooling supply, especially by requiring Member States to prepare comprehensive assessments about heating and cooling. These assessments have been more detailed about heating than cooling. But it may contribute to identify the potential for district cooling. Member States are required to implement measures to support the development of district heating and cooling, where relevant.

The EED recast adopted in 2023 reinforced slightly only the link between the comprehensive assessments and the LTRS, by referring to the LTRS as inputs to be considered when assessing future energy demand. In parallel, the EED recast introduced new requirements for regional and local authorities to prepare local heating and cooling plans. This could be an opportunity for more integrated approach and a better consideration of local conditions, also thanks to a participatory process encouraged by the EED recast.

The EED recast strengthened the links between the EED comprehensive assessments and the assessments about potentials for renewable energy sources (required by the Renewable Energy Directive, RED), as both are now due as part of the NECP. In line with the Renovation Wave, there is also an obligation for Member States to design policies and measures for the decarbonisation of heating and cooling, including through district heating and cooling. But unlike heating, cooling typically does not involve the direct use of fossil fuels and currently 99% of cooling is electricity-driven. The key drivers for the decarbonisation of space cooling include first the reduction of space cooling demand, then the transformation of the electricity sector, increasing the share of cooling technologies using renewable heat or waste heat or cold, and thermal energy storage.

The definition and calculation methodology of renewable cooling has not yet been established due to so far relatively low statistical weight of cooling in overall EU energy consumption (even if in specific countries this share can be significant). The RED sets requirements and targets for increasing the share of renewable energy in cooling. This part of the policy framework goes beyond the scope of this paper.

2.3. The emerging link with adaptation

2.3.1. The EU framework on adaptation stressed the importance of considering climate resilience for buildings

As part of a larger plan to lessen and prepare for climate change effects, the European Union has created a thorough policy framework that addresses climate adaptation. The relationship between cooling adaptation and the EU policy framework is varied, with a number of directives, initiatives, and papers, including the European Green Deal, 2030 Climate Target Plan, and EU Climate Law. Despite the efforts to mitigate climate change, the latest publications by the Intergovernmental Panel on Climate Change (see e.g., IPCC 2023) confirm that climate change effects are inescapable, including rising temperatures, increasing frequency and intensity of heat waves.

The European Commission adopted a new EU strategy on adaptation to climate change on 24 February 2021, reminding among other aspects that heatwaves are the “deadliest” of climate disasters, and that creating more green spaces can reduce their impacts. But this type of solution is “lagging behind”. Therefore, one of the key objectives of the strategy is to accelerate the rollout of adaptation solutions and to reduce climate-related risks. More specifically about buildings, the Commission pointed out the need to “prepare Europe’s building stock to withstand the impacts of climate change”, making the link with the Renovation Wave. Examples include the use of green roofs and walls to reduce the effects of Urban Heat Islands (UHI), integrating climate resilience considerations in the revision of the EPBD and in procurement criteria for public buildings.

The European Climate Law (Regulation (EU) 2021/1119, Article 5(4)) requires Member States to adopt and implement National Adaptation Strategies and Plans (NAS/NAP), and to report about their implementation every two years. But there is no mandatory template for these NAS/NAP, and the list of information on adaptation actions set in Annex VIII of the Governance Regulation of the Energy Union remains very general.

Likewise, the mandatory template for the NECPs (see Annex I of the Governance Regulation) includes only a very short reference for Member States to include adaptation goals “if available”. In practice, Member States’ reporting on mitigation and adaptation is usually done separately: the NECPs are mostly focused on mitigation, while adaptation is addressed in the NAS/NAP. On the other hand, the Long-Term Strategies (LTS) about achieving carbon neutrality are supposed to include information on policies and measures for both mitigation and adaptation (see Annex IV of the Governance Regulation). But the template for the LTS is indicative, and the first LTS reported by Member States vary significantly in terms of levels of details and quality.

Overall, the importance of considering climate resilience and developing actions to reduce the effects of heat waves is well acknowledged in the EU framework for adaptation. But in practice, the linkage between mitigation and adaptation policies and measures relevant to space cooling and summer comfort is still to be done.

2.3.2. Points relevant to space cooling and summer comfort in the National Adaptation Strategies and Plans

A review of Member States’ NAS/NAP (Lionggo et al. 2023) showed that climate hazards and key topics of adaptation measures can be summarised in seven clusters, one being ‘temperature variability’ that includes heat waves. Each country has been analysed according to whether they include or exclude references to measures and actions for each cluster. All but one (Germany) of the countries analysed in this paper reported measures or actions to address heatwaves. Typical examples of linkage between adaptation measures and measures to reduce space cooling demand include adding provisions about green walls in building regulations, or introducing requirements that a minimum share of the building areas should be converted to green areas.

Another example from the review of national adaptation actions in 2023 is Austria’s reporting that climate change and climate vulnerability, along with a decrease in heating energy consumption and an increase in cooling energy demand, are likely the causes of fluctuations in its energy demand. Austria also anticipated changes in the number of degree days for heating and cooling. France emphasised that uncontrolled air conditioning development may lead to new summer demand peaks. Portugal stated that in choosing mitigation strategies, the effects of climate change must be considered.

An indirect link with sustainable space cooling is that it is anticipated that there may be variations in the availability of RES (wind, solar, biomass, and hydropower) as a result of extreme weather events including floods, storms, and heavy precipitation, as well as decreased water availability, particularly during the summer (as stressed in the

reporting of Austria, Greece, Spain and Sweden). As electricity is the main energy source for space cooling technologies, this may be an issue to ensure that space cooling consumption can be met with RES.

2.4. The EU framework mostly addresses space cooling as a technical or technological issue

Some of the barriers and issues raised by Lizana et al. are addressed by the EU framework, such as the GWP of F-gases or removing the least efficient devices from the market. However, the EU framework does not really address other barriers or issues that are either not related to technology (e.g. user behaviour, other thermal comfort parameters than temperature), or about prioritising passive measures (usually related to adaptation) and complementing with actives measures (usually related to mitigation) when needed only. More generally, the EU framework is focused on regulating markets for products (e.g. air-conditioners) or buildings: it does not address conditions for the development of the market of cooling as a service (or thermal comfort as a service).

3. Space cooling in EU Member States' energy and climate policies

3.1. Space cooling in the national building regulations

Maldonado (2005) described that winter heating needs and thermal comfort have always been the priority within the EU regulatory frameworks that were first introduced in the 1970s. Follow-up efforts to improve the air-tightness of the building's envelope to reduce heating bills led to unhealthy interiors and the need for sufficient ventilation via mechanical means. In the following decades, only France and Portugal, in the 1980s, introduced a 'summer comfort' requirement in building design processes, while constantly increasing equipment rates of air-conditioning systems were recorded, especially in Southern Europe.

The first EU Directive on the Energy Performance of Buildings (EPBD) was adopted in 2002, requiring Member States to revise their building energy regulations. The EPBD was accompanied by methodologies for calculating the energy performance of buildings, with space cooling among the five main end-uses[6] to be included in these calculations. This was meant for a better consideration of cooling needs, especially for new buildings, and thereby promoting actions connected to summer comfort, such as passive solar systems and solar protection, and natural ventilation. The EPBD set a general framework. The Member States keep a large flexibility to define their national building regulations and related methodologies, according to national specificities (including local climates) and practices.

Maldonado analysed that, about space cooling, the first EPBD focused on the need for cooling regulations for residential and non-residential buildings, and concentrated on the implementation of practical cooling strategies and energy performance goals. However, the author argued that the regulations should emphasize more on centralized efforts and low-energy cooling strategies and the promotion of passive cooling techniques with free-cooling ventilation, instead of opting for minimal cost systems and individual units, that could essentially weaken the long-term goals set by the EPBD regulation.

Camelo et al. (2009) further discussed the introduction of sustainable summer comfort in national building regulations, following the first EPBD, within the framework of the KeepCool II Project. The author refers to the results deriving from the data analysis of a survey that aimed at assessing energy efficiency criteria in various European countries. The three-part analysis included general questions about building regulations on summer comfort, requirements on solar heat prevention, regulations of thermal comfort calculation procedures, and recommendations for sustainable practices in national building codes. The findings highlighted the countries' unanimous agreement that thermal comfort during the summer months should be considered within the national building regulations, without however managing to form a common approach on the introduction of the regulation in the building construction process.

Overall, the author argued that summer comfort must receive an independent position within the national building regulations, by its introduction and adaptation to the needs of existing and future residential and non-residential building capacity. Furthermore, it was suggested that the employment of mechanical ventilation and cooling systems should be the last option in summer thermal comfort strategies, or to be preferred only after passive measures have

[6] space heating, space cooling, domestic hot water, ventilation, lighting and other technical building systems.

already been implemented. Lastly, Camelo concluded that the efforts for more sustainable summer comfort, especially in the European south, should be further enhanced by tackling cooling energy demands.

Laskari & Santamouris (2010), within the ASIEPI project, discussed the challenges that occur during the evaluation of energy consumption for cooling systems within the national building and energy performance regulations. Referring to the results deriving from the analysis of a survey conducted in different non-Mediterranean countries, the authors highlighted the extensive lack of adequate methodology and experience available to perform thermal comfort calculations, as well as the demand for improved assessments of the existing cooling methods, as well as the need for exploring low-cost options. Furthermore, they underpinned that certain assumptions pertaining to thermal calculation methods might impede the adoption of passive cooling techniques.

The authors made recommendations to the various stakeholders engaged with (or making use of) the building regulations in each country, aiming to render these regulations more effective.

Instructions to policy makers included strategies for reducing energy consumption for cooling, promotion of passive cooling concepts, climate mitigation practices and emission reductions, but also practices about financial incentives considering energy savings, emissions reductions, and life-cycle cost-effectiveness.

For developers of calculation methods, their recommendations included, among others, the need for improving evaluation of the employed cooling means with emphasis on the low-energy systems, setting appropriate default values for summer and winter seasons, integrating variables for cost-effective energy consumption and structuring a multi-zone approach for the calculations taking place in varying contexts.

Towards building practitioners, the recommendations suggested a holistic approach during the design phases of a building, during which the internal heat gains should be minimized, while priority should be given to passive cooling techniques. Meanwhile, the associations of architects and building practitioners were advised to develop and distribute guidelines on sustainable cooling techniques and summer comfort evaluation methods, while they were encouraged to further investigate building design principles that abide optimally by the local vernacular architecture and building techniques.

Finally, building owning companies were advised to further invest in sustainable cooling principles, and better incorporate EPBD-oriented practices in their future developments.

Our review of the current building regulations of EU Member States has identified that, when looking a provisions related to space cooling and/or summer comfort, national regulations may include:

- **Specific definitions about space cooling or summer comfort**: this is for example the case for Austria, France, Italy and Germany. Then countries such as Greece and Spain refer instead to thermal comfort in general.

- **Space cooling considerations in the calculation methodology, and minimum energy performance requirements in terms of maximum allowed cooling demand or related to space cooling or summer comfort, for new and existing buildings**: in line with the EPBD, space cooling is always included in the methodology for energy performance calculation for both residential and non-residential buildings, in terms of global energy performance, without specific requirements on space cooling alone. Likewise, the minimum energy performance requirements are usually set in total energy demand, which includes cooling. The national regulations may include more specific provisions:

- Austria's regulation sets a maximum limit on cooling energy (in kWh/m².year), with the explicit objective to avoid or limit the need for mechanical cooling. In a similar way, Croatia sets a maximum limit in terms of heat to be removed from the buildings to maintain indoor comfort during cooling season.

- Greece's regulation includes minimum efficiency requirements for cooling systems for new buildings and major renovations.

- Estonia's, France's and Germany's regulations for new buildings set requirements to avoid overheating (Estonia, Germany) and limit summer discomfort (France), both defined by the number of degree-hours above a base temperature that should not be exceeded (per year). Moreover, in France's latest regulation (RE 2020), the reference scenario for weather conditions was revised to include a period of heat wave,

- Hungary's regulation also include requirements to prevent overheating in buildings during summer months without mechanical cooling, i.e. requiring protection with architectural means (e.g. external shading) and vegetation. Finland's regulation requires an overheating risk assessment, also defining maximum acceptable indoor temperature for summer time, promoting passive strategies to reduce the need or reliance on mechanical cooling.

- Croatia's regulation includes specific provisions about solar protection for buildings with a high share of glazing surface, also with the objective of reducing the risks of overheating.

- France's regulation for major renovations also includes cooling-related provisions (e.g. about sun shading).

- **Standard values about the use of space cooling** (e.g. indoor temperature setpoint): most countries set (mandatory or indicative) minimum temperature setpoints not to exceed (see table below). For non-residential buildings, provisions about indoor temperatures may be related to the labour code or similar legislation protecting workers (as in Cyprus).

National regulations may be complemented with local codes that can better take into account local specificities. For example, local codes may include the limitation of the urban heat island effect in case of new urban developments (case of Budapest's local code).

We investigated more in detail a set of countries including the countries with the largest space cooling demand, as well as other countries with different sizes and climate conditions. A summary of this review per country can be found in the table below. While our review looked primarily at provisions related to indoor temperature when considering comfort parameters, it should be noted that the national regulations increasingly consider a broad range of comfort parameters (e.g. air renewal, humidity rate or thermo-hygrometric well-being).

Table 1. Overview of how space cooling is addressed in national building regulations.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
Austria	Space cooling and summer comfort are addressed in the building regulations with an official and clear definition. However, specifics on the measures or actions related to space cooling are not well defined within the regulations. The focus appears to be on acknowledging the importance of cooling, but detailed implementation guidelines or strategies are not outlined in the regulations.	The building regulations set specific provisions to minimize cooling demand. For new buildings, the cooling energy limit is set at 1 kWh/m² per year, while for major renovations, the limit is 2 kWh/m² per year. These provisions aim to reduce the need for externally induced cooling and promote energy efficiency in both new constructions and renovated buildings.	No specific provision relevant to the use of space cooling was found (likely because the general approach is to avoid as much as possible the need for cooling devices).
Croatia	The Technical regulation on the heating and cooling systems of buildings includes a definition of ‘cooling system’. The Rulebook on the system for monitoring, measuring and verifying energy savings includes a definition of ‘energy consumption for space cooling’. Moreover, in the Technical regulation on energy economy and heat retention in buildings includes an article related to indoor comfort, considering many variables. In the regulation about the assessment of energy performance of buildings, the annual	Residential and non-residential buildings for offices, educational purposes, hospitals, hotels and restaurants, shall be designed so that the annual heat energy related to cooling per unit of useful surface of the building, QC, is not greater than 50 kWh/(m²·.a). Non-residential buildings (i.e. offices, educational buildings, hospitals, hotels, and restaurants) with a total window surface rate of f > 30 % must be designed so that the annual heat energy related to cooling per unit of useful area of the building, QC, is not greater than 70 kWh/(m².a).	Indicative value for temperature setpoint is an indoor temperature of 27°C if outdoor temperature is 35°C. Under Construction act, there is an obligation to regularly inspect heating and cooling or air conditioning systems in buildings.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	heat energy related to cooling, QC (kWh/a), is the calculated amount of heat that should be removed from the building by the cooling system during one year to maintain the internal design temperature in the building during the building's cooling period.	For buildings whose space, having regard to its purpose, should be protected against solar overheating, the outer opaque parts of the building shell exposed to sunlight must have the appropriate dynamic thermal characteristics to reduce their contribution to the heating of the air in the building during the summer months.	
Cyprus	Cyprus' building regulations emphasize overall energy performance rather than setting explicit maximum limits for cooling demand. The focus is on ensuring that a significant portion of a building's primary energy consumption, including that used for cooling, is derived from renewable energy sources: Ministerial Decree 121/2020 mandates that new or renovated buildings source at least 25% of their primary energy consumption for heating and cooling from renewable energy sources. For hotels, this requirement is set at 9%.	New buildings and major renovations of existing buildings must align with energy performance standards to enhance overall efficiency and comfort. The solutions used to meet the requirements of the regulations often focus on measures that improve summer comfort, such as enhanced insulation to reduce heat gain, installation of shading devices like awnings or shutters to minimize solar heat exposure, and replacing outdated cooling systems with energy-efficient models that ensure better indoor thermal regulation. These improvements contribute to reduced energy consumption and increased comfort during warmer months.	Specific indoor temperature requirements are established for workplaces to ensure thermal comfort and protect workers from heat stress. The Safety and Health at Work (Code of Practice for the Protection of Workers from Heat Stress) Orders of 2014 and 2020 (P.I. 291/2014 and P.I. 206/2020) mandates that workplace temperatures must accommodate the human body's needs during working hours, considering the nature of work and physical exertion involved. Employers are required to implement appropriate organizational and technical measures to maintain temperature and relative humidity within defined comfort limits. For residential buildings, there are no explicit indoor temperature requirements specified in national legislation. However, Cyprus adheres to European standards, such as EN 15251:2007,

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
			which recommends indoor temperature ranges for thermal comfort. These guidelines suggest maintaining indoor temperatures between 20°C and 26°C, depending on seasonal and climatic conditions.
Estonia	The regulation titled "Methodology for Calculating the Energy Performance of Buildings" encompasses energy use for indoor climate control, which involves maintaining or adjusting indoor temperatures to meet specified standards. This includes energy consumption for both heating and cooling systems. More specifically, the building regulations address summer thermal comfort by setting specific criteria to prevent overheating in buildings. Compliance is assessed through dynamic simulations of typical living spaces, such as living rooms and bedrooms, under standardized conditions. These measures aim to ensure indoor environments remain comfortable during warmer months without relying solely on mechanical cooling systems.	According to the regulation ‘Minimum Requirements for Energy Performance’, the indoor temperature in residential buildings should not exceed +27°C by more than 150 degree-hours (°C·h) during the period from June 1 to August 31. For non-residential buildings, the allowable exceedance is 100°C·h. In the case of educational and research buildings (excepting pre-school institutions for children, buildings of research institutions and methodology institutions and other educational and research buildings), the time period concerned extends from 1 May to 30 September, and the buildings are presumed to be closed from 15 June to 15 August.	In the case of a simplified calculation which treats indoor temperature as a constant, the indoor temperature set-points are used as the indoor temperature value (e.g., in residential buildings 21 °C for heating and 27 °C for cooling). In the case of a dynamic calculation, the relevant values are used as the heating and cooling set-points of a thermostat. Where the building lacks a cooling system, the difference between the summertime indoor temperatures and the cooling set-point must be calculated. The cooling period may in some buildings be longer than the period defined in the regulation (June 1 to August 31), but this is not considered when verifying compliance with the summertime indoor temperature requirement. The energy need for cooling and the energy use of the cooling system are calculated in respect of the entire cooling period.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
Finland	Space cooling is addressed through energy performance regulations and indoor climate standards within the National Building Code. Cooling is included in the E-value calculation, which evaluates total building energy consumption. Finland's building regulations address space cooling needs and summer comfort primarily through energy performance requirements and indoor climate standards that specify maximum allowable indoor temperatures. Overheating risk assessments are required for new buildings, while renovations must meet updated energy performance standards, to ensure comfortable indoor conditions during warmer months.	The indoor climate standards, part of the National Building Code, set maximum summer temperatures to 27°C for residential buildings and 25°C for other categories (Office buildings, health centres, commercial buildings, educational buildings, hospitals, hotels, sport centres, and others). The National Building Code also promote passive cooling strategies like shading, ventilation and insulation to minimize the need or reliance on mechanical cooling systems.	The standard design temperature for occupied zones during the summer season is 23°C. Adjustments can be made based on the specific use of the space. Large non-residential buildings must implement Building Automation and Control Systems (BACS) to optimize energy use, including the use of energy for cooling.
France	About space cooling, the regulation for new buildings aims at limiting the risk of summer discomfort, which is defined by the number of degree-hours (DH) above a base temperature. For buildings equipped with air conditioning, this indicator is calculated with the system turned off.	The base temperature (limit with discomfort) is set to 26°C at night and between 26°C and 28°C during the day, considering adaptative comfort. Adaptive comfort takes into account that, in case of successive warm days, the human body can adapt and accommodate for a higher indoor temperature, within certain limit. This limit is set in the regulation to +2°C,	The regulatory assessment of the building energy performance considers a constant setpoint temperature for cooling devices (26°C for all buildings, except for housing used for medical care, for the elderly or young children). In theory, the regulations forbid to use lower setpoint temperature for cooling. However, in practice, this is not controlled.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	The method to assess summer discomfort has been updated in the latest version of the regulation (RE 2020), with this new indicator (DH of incomfort), as well as taking into account climate changes (i.e. considering a heat wave event in the reference weather conditions). The new regulation (RE 2020) also considers new options to improve summer comfort.	hence the range 26 to 28°C. Adaptative comfort is considered for daytime only. The difference between residential and non-residential buildings is mainly considered in the building occupancy scenarios. The regulation for new buildings (RE 2020) specifies two thresholds of DH: if DH < 350 per year (i.e. 1 week of discomfort), the building complies with the requirement without the need to consider the use of air conditioning when assessing the building's energy performance. If DH > 1250 per year (i.e. 25 days of incomfort), then the building is not compliant. In-between, a cooling surcharge (i.e. due to the use of cooling system) is added to the calculated building's overall energy consumption. This is a clear incentive to consider passive cooling in the building design. For existing buildings, there are only requirements in case of major renovation (e.g. about solar protection of the glazing surfaces).	For existing buildings, the requirements in case of major renovation include minimum performance requirements for air conditioning systems with a capacity higher than 12kW, devices for stopping the systems (including BACS-Building Automation and Control Systems), and pre-heating of the treated air.
Germany	In the building regulations, space cooling is addressed mainly through global energy performance requirements for both new and existing buildings. Cooling demand is included in overall energy calculations. There	The standard DIN 4108-2 specifies that the maximum allowed cumulated time of excess temperature is 1200 degree-hours in residential buildings and 500 degree-hours in non-residential buildings. Excess temperature is assessed against target indoor	Regular inspections of large air-conditioning systems are mandatory for non-residential buildings.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	is no specific requirement related to the cooling demand. Nevertheless, for new buildings, there are specific requirements on summer thermal protection. These requirements also stipulate that structural measures for summer thermal insulation shall be provided to the extent that the related investment can be recovered within their normal service life through the energy savings related to cooling.	summer temperature between 25 and 27°C according to the location (considering operative temperature). The requirements on summer thermal protection shall limit the solar energy inputs, and thereby excess temperature degree hours, in line with these limits.	
Greece	There is not a specific definition regarding space cooling or summer comfort in Greece's building regulations (KENAK). 'Thermal comfort' is mentioned as a relatively subjective situtation, affected by a number of parameters and circumstances, including air and indoor wall (radiation) temperatures, relative air humidity, user clothing, user activity and velocity of interior air currents. Space cooling is considered in the assessment of the overall energy performance of buildings. The calculation methodology specifies indicative values for comfort indoor temperature.	There is no specific requirement for the maximum allowed cooling demand. The building requirements specific to space cooling are about the seasonal energy efficiency ratio (SEER) of the cooling system, and defined per type of cooling system and building usage (residential / non-residential). This applies to new buildings and existing buildings undergoing major renovation.	The climate zone, in which the building is based, defines the standard duration and period of the cooling season. In addition setpoints used for the calculation of the energy performance are determined according to the usage of the building: 26°C for residential buildings, and between 20 to 26°C for non-residential buildings (depending on the building usage). The energy performance calculation provided in the Technical Instructions of Technical Chamber of Greece compares the primary energy consumption of the studied building with a reference building. As a part of this process the energy demand of the cooling system is taken into consideration among a variety of other

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	The assessment of energy performance takes into account differences according to the use of the building (i.e., residential or non-residential).		parameters, including climate zone, building usage, building envelope, HVAC systems, Building Energy Management Systems, renewables, domestic hot water, etc.
Hungary	In the EPBD implementation, there is no separate requirement for limiting space cooling energy use, it is only considered as part of the total energy demand. However, there is a mandatory calculation of the methodology for 'Summer heat protection', which is relevant to buildings where the total surface area of the transparent structures of the building envelope that differ from the north orientation by at least 45°, or have an inclination angle lower than 45° exceeds 8% of the useful floor area of the building, the solar heat gain coefficient calculated over these surfaces may not exceed the give limit.	There are several parameters for the calculation that need to be followed when calculating relevant to cooling system. Such parameters are, SEER, latent cooling demand, occupancy parameters, requirement for using free cooling, passive cooling options when it is possible in architectural or other reasons, etc As per 3.1.1 point of the Decree, when planning the building technical systems of new buildings and major renovations, it is recommended to take into account the MSZ EN 16798-1 standard or an equivalent technical specification with regard to the indoor environmental parameters to be ensured in conditioned spaces. 253/1997. (XII. 20.) Government decree on the national settlement planning and construction requirements states that during the planning and development of new buildings, protection against excessive summer warming must be ensured with architectural means (e.g. external shading) and vegetation.	Values are specified withtin the calculations for the reference case: Residential: Mandatory 26ºC in the calculations, 0,5 air change/hour, which value can be increased by 3 (one facade) or 6 (cross ventilation) during night time in case of natural ventilation is possible. Non-residential buildings/premises: Indicative 26ºC in the calculations, indicative values in m3/(m2h) from 4 (small office premise) to 90 (cooking kitchen) which value can be increased by 3 airchange/hour (one facade) or 6 air change/hour (cross ventilation) during night time in case of natural ventilation is possible

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
		Local codes may include the limitation of the urban heat island effect for new developments. For example: the § 10 of the district building regulation of the 11th distric in Budapest requires that in the case of construction of offices and residential apartment block, the magnitude of the heat island effect caused by the development must be investigated, and the planned development may not cause an increase of the heat island effect.	
Italy	The building regulations in Italy, based on the EPBD (Energy Performance of Buildings Directive), require the calculation of energy performance, including space cooling. Legislative Decree No. 48 of 2020, which transposes Directive (EU) 2018/844, updates criteria related to summer air conditioning, including provisions on energy efficiency checks for air conditioning systems. Presidential Decree No. 74/2013 also mandates inspections of thermal installations for both winter and summer conditioning with specific energy efficiency control requirements.	The key provisions regarding summer comfort and space cooling are included in updates to the operation, maintenance, and inspection criteria for air-conditioning systems, with specific focus on minimizing energy consumption and optimizing thermal comfort. Regulations also address the need for thermo-hygrometric well-being, especially in relation to maintaining appropriate indoor climate control. Further, measures to control the periods and limits of system operation based on climatic conditions are outlined to ensure comfort while reducing unnecessary energy use .	Italy's building regulations define the periodic inspections and operational criteria for cooling systems. These include guidelines for monitoring energy efficiency, the operation of air-conditioning systems, and limits on their use based on power capacity (systems over 12 kW). There are also considerations for controlling the use of these systems by setting minimum temperature thresholds and operational times to conserve energy while ensuring comfort. The regulation also emphasizes the adoption of efficient technologies like heat pumps for space cooling .

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
Malta	National policies on space cooling within building regulations are designed to increase efficiency and reduce energy consumption through multiple approaches. Malta, for example, emphasizes the use of high-efficiency air-to-air heat pumps to address cooling demands in residential and commercial sectors, highlighting the policy shift toward efficient and reversible cooling systems that also serve heating purposes. Additionally, policies discourage district heating and cooling networks due to low demand and cost-ineffectiveness, instead supporting individual cooling systems that are more practical for Malta's mild winter heating and high summer cooling needs. Furthermore, the country promotes renewable sources like solar water heaters and heat pumps, with policies encouraging their integration into buildings to further improve energy efficiency in cooling applications.	National policies in Malta emphasize the importance of heat pump technology to address high summer cooling demands, largely met by air-to-air units in both residential and commercial sectors. Heat pumps provide energy-efficient cooling solutions, particularly in areas with limited options for traditional cooling infrastructure. With Malta’s predominantly warm climate, national energy policies target the reduction of summer cooling demands through incentives for energy-efficient cooling technologies, such as heat pumps and solar water heaters. These measures also align with the country’s goals for increased renewable energy consumption and reduced dependence on traditional cooling methods. Government incentives aim to support widespread adoption of renewable energy systems and energy-efficient cooling technologies in residential and commercial buildings, thus enhancing summer comfort while meeting energy-saving targets. This includes the encouragement of solar water heaters and advanced air-to-air heat pump systems.	Point not examined for this country.
Poland	Space cooling in building regulations is increasingly integrated into national policies	Polish policies emphasize reducing space cooling needs and enhancing summer comfort as part of	Point not examined for this country.

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	addressing energy efficiency and climate adaptation. The Polish National Energy and Climate Plan (NECP) emphasizes the need for decarbonizing building operations, which includes both heating and cooling, aiming to improve building energy performance and adapt structures to climate resilience goals by 2030. Specific targets within the NECP encourage the increased use of renewable energy sources for both heating and cooling, with annual incremental targets set for renewable energy shares in these sectors. Additionally, national adaptation strategies like NAS 2020 promote sectoral adaptation, focusing on sustainable building practices that incorporate both heating and cooling solutions as part of climate change preparedness.	their national energy and climate strategies. The NECP update highlights the importance of building design and renovation measures that improve thermal efficiency and reduce overheating, especially by increasing insulation, shading, and utilizing natural ventilation where feasible. Additionally, Poland aims to adapt its energy systems to accommodate climate-induced cooling demands while maintaining energy efficiency standards, reducing emissions, and promoting renewable energy use in cooling systems.	
Spain	The Technical Building Code (Código Técnico de la Edificación, CTE) specifies all technical buildings regulations. The part related to energy efficiency requirements is the CTE-HE for energy savings, which covers six criteria including:	The main objective of the regulation is to ensure that the thermal well-being of the building occupants is achieved with a "rational use of energy". "Thermal well-being" is defined in the terminology (Annex A) of the regulation CTE-HE as "indoor conditions of temperature, humidity and air speed established by regulations that are considered to	For residential buildings, these conditions are specified in Annex D of the regulation CTE-HE (standard setpoint cooling temperatures of 25-27°C). For certain tertiary buildings, the complementary regulation for thermal systems (RITE) specifies that the setpoint cooling temperature shall not be

Member State	How space cooling is addressed in the building regulations	Main provisions relevant to space cooling needs or summer comfort	Main provisions relevant to the use of space cooling
	- one about the maximum (upper) limit of primary energy consumption in kWh/m².year (including cooling), according to the regulatory climate zones: this has been aligned with the nZEB (nearly Zero Energy Buildings) and also includes maximum limits for non-renewable primary energy consumption (also in kWh/m².year). As the calculation methodology gives first the final energy consumption, the regulation provides conversion factors (final to primary). The conversion factor for electricity has a strong influence on how energy consumption due to cooling weights in the total primary energy consumption. - one about the conditions for the control of energy demand (include thermal insulation) - one about the conditions for thermal systems (including cooling systems). Space cooling is thus considered when assessing the overall energy performance of the building. No specific requirement applies to the cooling demand.	produce an adequate and sufficient sense of well-being for the occupants." It is put in practice through operational conditions (indoor temperature, humidity, airflow), and distinguishing winter (October to May) and summer (June to September) periods.	lower than 26°C (requirement temporarily increased to 27°C during the energy crisis 2022-2023). The Regulation on Thermal Installations in Buildings (RITE) complements the Technical Building Code (CTE) with specific requirements about the thermal systems (including cooling systems). These requirements cover the sizing and minimum energy performance standards that are aligned with the EU Ecodesing regulations.

The recast of the EPBD states in a new recital[7] that "*priority should be given to strategies which enhance the thermal performance of buildings during the summer period, through measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques, primarily those that improve indoor environmental quality, the micro-climate around buildings and the urban heat island effect*". Such provisions are already included in most of the regulations reviewed (see table above), but to various extents, and primarily for new buildings. The upcoming revision of the national building regulations to align with the EPBD recast will be an important opportunity to ensure that cooling needs are thoroughly addressed for both, new buildings and renovation of existing buildings.

3.2. Space cooling in the comprehensive assessments of national heating and cooling potentials

The review of the first comprehensive assessments (CAs) due by Member States in 2015 highlighted that the level of detail in describing the cooling demand was much lower than for heating demand. Nine reports even contained no description of cooling demand and three contained partial descriptions only. Nine countries only included cooling demand into the Cost-Benefit Analysis (CBA) (Jakubcionis et al. 2018). This review also stressed that information provided about policies and measures was mostly related with CHP and district heating. The amending EED adopted in 2018 and the complementary Commission's Recommendation (EU) 2019/1659 provided a clearer basis for the CAs due by Member States in 2020. The contents partly overlap with the requirements for NECP, first due in 2019 (e.g. about targets and policies and measures). Hence some Member States referring to the NECP in their CA. From 2024, the CAs should be part of the NECP which may solve this. The EED recast (Article 25(1)) also requires the CA to be jointly provided with the assessment of potentials for renewable energy sources (now mapping for RES deployment, still in Article 15 of the Renewable Energy Directive).

Cooling demand is more frequently assessed in the second CAs than in the first CAs. But the focus is still on heating, especially when describing policies and measures, and even for the five countries with the largest cooling demand. This may be explained by the prominent weight of space heating compared to space cooling in the final energy consumption. Another explanation may be that cooling is not a direct challenge for decarbonisation (as mostly supplied from electricity), whereas heating remains a major source of direct CO_2 emissions. Data scarcity about cooling can also be an issue for estimating the demand but should not be an argument for neglecting cooling in the policies and measures.

The table below provides an overview of Member States' planning approach and processes relevant to addressing cooling, based on the review of the CAs reported by Member States in 2020, as well as information available in draft NECP updates (see more about the draft NECP updates in the next section).

It can be noted that the approach and processes related to heating and cooling plans or assessments (such as the Cas) are often focused on the supply of heat and cooling (e.g. promoting district heating and cooling). Likely because the improvement of the building stock is addressed in the national LTRS – long-term renovation strategies (becoming national building renovation plans with the EPBD recast of 2024). The reviews of LTRS have found that these

[7] Recital 52 of the public version from the provisional agreement between the Council and Parliament: https://data.consilium.europa.eu/doc/document/ST-16655-2023-INIT/en/pdf

strategies are most often focused on reducing energy consumption due to space heating, similarly to the conclusions from the review of the CAs.

Table 2. Overview of planning approach and processes in EU Member States.

Country	Planning approach and processes
Austria	The NECP and related assessments are aligned with Austria's broader energy and climate goals, such as the Renewable Energy Expansion Act, which targets climate neutrality by 2040. While specific cooling data may still be limited, these assessments form the basis for future policy adjustments. At the regional level, local authorities, particularly in cities like Vienna and Graz, have been developing district heating systems, but there is no legal obligation for municipalities to create specific heating and cooling plans. Consultations with regional and local governments are ongoing, with increasing efforts to make spatial energy planning more consistent across Austria, especially regarding the integration of renewable energy into heating and cooling systems.
Belgium	In Belgium, the Regions have a major role in energy planning and policies and measures related to space cooling, including to specify building regulations. For example, Belgium's NECP and comprehensive assessment are the aggregation of the contributions from the three Regions (Flanders, Wallonia and Brussels' region) together with the Federal contribution.
Bulgaria	The Bulgarian National Energy and Climate Plan (NECP) outlines strategies to enhance the efficiency and integration of space cooling systems within building regulations. It emphasizes the need to adopt high-efficiency cooling technologies, integrating them with renewable energy sources such as geothermal and solar energy, especially in the buildings sector. Additionally, the plan prioritizes modernizing district cooling networks, with advanced management and monitoring systems that optimize cooling flows, aiming to reduce overall energy demand and losses in heat transmission networks.
Croatia	Croatia's Comprehensive Assessment 2020 includes data specific to energy delivered and useful energy for space cooling, per main sector (residential, services and industry), and with further disaggregated data (e.g. individual houses / multifamily buildings ; sub-sector in services ; data and map per county). This shows that space cooling is and will remain a small end-use (1.2% in 2019) in residential buildings, whereas much more significant (16%) in services. The BAU scenario estimated a moderate increase of energy delivered for space cooling by 2030 (+8%) and larger (+18.5%) by 2050 (all vs. 2019). The scenario with integrated measures would compensate most of this increase, even with a decrease (-7%) by 2030 and slight increase (+3%) by 2050 (all vs. 2019).

Country	Planning approach and processes
	The main action type considered to reduce energy consumption from / improve efficiency in space cooling is the replacement of split systems with heat pumps. No financial incentive is planned for this action type, as it was estimated to be cost-effective already (positive Net Present Value). The development of district cooling is not foreseen. However, the use of heat from district heating system in the summer to power central absorption chillers for cooling spaces in larger non-residential buildings (e.g. hospitals, hotels, shops, etc.) which are already connected to the district heating system is considered as an option to replace compression chillers using refrigerants with high environmental impacts.
Cyprus	Cyprus's planning process for energy and climate policy is structured to align with the EU directives, particularly the National Energy and Climate Plan (NECP) for 2021-2030. The Ministry of Energy, Commerce, and Industry leads this process, coordinating with other governmental bodies to set objectives such as reducing greenhouse gas emissions, increasing renewable energy usage, and enhancing energy efficiency. The collaborative approach to prepare the NECP aims at ensuring that national policies are comprehensive and reflect the input of various sectors and the public. More specifically about heating and cooling, the latest comprehensive assessment for heating and cooling was published in 2021. According to this assessment, the useful energy consumption for space cooling would be about 1.9 TWh/y for residential buildings, and 2.8 TWh/y in services. One of the main results from the economic analysis is that heat pumps combined with photovoltaic panels was found to be the solution identified with the greatest economic potential to meet the heating and cooling requirement in the residential and tertiary sectors. At the opposite, the assessment found that district heating and cooling would not be economically feasible in Cyprus for the moment. The 2021 assessment was prepared by a consultancy (Ricardo), following a study in 2017 about the “development of a heating and cooling strategy at a local level” where an Excel-based model was first developed to assess potentials for high efficiency solutions for heating and cooling in selected areas.
Estonia	Promoting energy-efficient building renovations is a key part of Estonia's energy and climate planning, which includes incorporating advanced cooling systems powered by renewables, alongside fostering innovation in passive cooling and renewable-based technologies, and modernizing and developing district cooling networks. The first district cooling plant is in operation since autumn 2019, firstly to supply two office buildings. Considering that the need for space cooling in Estonia remains small so far (especially compared to space heating), the comprehensive assessment for heating and cooling is mostly focused on the development of low-temperature district heating areas. As Estonia already have district heating systems that should be modernized and/or expanded, more focus is given on that than dealing with district cooling network that were not found at the moment to be cost-effective or economically viable.

Country	Planning approach and processes
Finland	The planning process for Finland's National Energy and Climate Plan (NECP) and the Comprehensive Assessment of Heating and Cooling is guided by the country's commitment to EU energy and climate directives. Both processes involve a structured timeline, with the NECP draft update submitted in mid-2023 and ongoing updates planned until 2025. The Ministry of the Environment and the Ministry of Economic Affairs and Employment lead these efforts, integrating stakeholder consultations, including municipalities, industry representatives, and the public, to ensure inclusivity and alignment with national and EU goals. District cooling production in 2023 was 340 GWh (mainly heat pump and free cooling) (vs. 281 GWh in 2019). In 2030, sales of district cooling are projected to be 490 GWh. Approximately 20% of the current generation comes in the form of free cooling (e.g. cool enough lake water) which does not require additional heat pumps. District cooling utilises ambient energy from the sea, lakes and rivers as well as outdoor air and ground, when possible. District cooling is usually developed together with district heating, and district heating already covers a large part of Finland's space heating needs.
France	While France's comprehensive assessments have been complemented with an online mapping of heating and cooling needs (covering cooling needs), the 2020 comprehensive assessment does not include any assessment or data specific to cooling (it is fully focused on heating). Both, the NECP and comprehensive assessment refer to the national energy planning, and especially the reference scenarios of the medium-term planning (PPE). However, these scenarios do not provide data specific to cooling. This is probably because cooling consumption are negligible compared to heating consumption. In terms of planning, the issue of summer comfort is mostly addressed as part of climate adaptation and health policy, through the National Heat Waves Plan that promotes measures to anticipate and manage heat waves (including promoting sun shading, identifying urban heat islands, etc.)
Germany	At national level, municipalities with over 100,000 inhabitants must develop heating & cooling plans by 2028. Some Länder anticipate this deadline. For example, in Baden-Württemberg, municipalities with over 20,000 inhabitants are required to develop heating and cooling plans by the end of 2023. Currently, there are no specific obligations in Germany for companies to provide data for waste cold. The primary focus is on waste heat reporting, as mandated by the Energy Efficiency Act (EnEfG), which requires companies with annual energy consumption over 2.5 GWh to report waste heat potential to the Federal Office for Energy Efficiency (BfEE) by March 31 each year. This includes details on the annual heat quantity, maximum thermal output, and temporal availability of waste heat. Data centers have additional specific reporting requirements.
Greece	Greece's comprehensive assessment reported in 2020 does not include any target specific to space cooling. It provides an assessment of the current demand for space cooling in the residential (final energy consumption of 835 GWh in 2018; useful energy demand of 1.5 TWh) and services sector (6.9 TWh of final energy consumption, 12.3 TWh of useful energy demand). It also estimated that the energy demand will increase over the next 30 years to reach 2.1 TWh in the residential sector

Country	Planning approach and processes
	and 19.9 TWh in the services sector (by 2050). However, the difficulty in finding data regarding the cooling sector, including district cooling (not implemented in Greece yet), made it hard to identify the cooling and district cooling potential and limited the ability to identify and implement additional policy measures. Furthermore, the need for cooling and district cooling in Greece remains relatively small compared to the need for heating and district heating. While the comprehensive assessment does not explicitly referred to the Long Term Renovation Strategy, it mentioned several renovation programmes (for family houses, multi-apartment buildings and public buildings).
Hungary	The CA (Table IV.7) includes estimated energy consumption of public and commercial building: Primary energy demand of cooling 1.90 kWh/m2/year, 0.7%.
Italy	The Comprehensive Assessment 2020 incorporates results into the energy scenario of the National Energy and Climate Plan (NECP) prepared in 2019, aiming for the progressive decarbonization of the thermal sector. This includes detailed analyses of heating and cooling consumption and demand, and the evaluation of the potential for efficient district heating. The space cooling demand is assessed in terms of useful energy (e.g. energy to remove heat from the buildings). The assessment acknowledged a “relatively new” increase in the demand for comfort, and thereby in the cooling demand. Likewise, it was mentioned that in recent years (before 2020), district cooling services have gradually become more widespread, in parallel to district heating. The comprehensive assessment mentions the objective of expanding the use of efficient district heating and cooling. However, most of the further analyses and support measures presented deal with district heating. The same applies for the information about RES for heating and cooling. The Comprehensive Assessment 2020 reported that new limits on the use of cooling systems were being evaluated, with restrictions (e.g., days of use, hours, minimum temperatures) set in relation to the climate zones. Additionally, other planned provisions were to replace high-emission systems with low-emission, high-efficiency technologies in the heating and cooling sector.
Spain	Spain does not have a specific cooling plan (or heating and cooling) plan. The overall energy and climate planning is done following the process of the NECP, under the Climate Change and Energy Transition Law, and aligning the trajectory with the Long Term Strategy (to achieve carbon neutrality by 2050). More specifically about buildings, the Long Term Building Renovation Strategy (ERESEE) is the main roadmap. The current version was published in 2020. It should be soon revised, according to the new EPBD adopted in May 2024. The Comprehensive Assessment for heating and cooling (2020 version) provides a detailed estimation of the cooling demand (useful energy) and related final energy (mostly electricity) consumption, that would have represented 4% in housing and 29.5% in services of the final energy consumption for heating and cooling (i.e. space heating, space cooling and domestic hot water).

Country	Planning approach and processes
	However, this does not include electricity consumption for fans/ventilators (and likely not for mobile air-conditioning systems either). The projection foresaw a large increase in the cooling demand (useful energy) in housing (+40% in 2030 vs. 2018), and a moderate increase in services (+ 8% in 2030 vs. 2018). The revised projections (in line with the updated targets) in the draft NECP update 2023 show that the reduction final energy consumption of the residential and service sectors would represent about 23% of the total reduction in Spain's final energy consumption. More specifically, the expected cumulative savings over 2021-2030 in the residential and service sectors would represent 21% of Spain's energy savings obligation (Art.8 EED), behind savings in transport (36%) and industry (25%). Moreover, it is likely that most expected savings in buildings be related to space heating, not to space cooling. The technologies considered for space cooling in the Comprehensive Assessment 2020 include, by decreasing order of technical potential for cooling in housing and services: air-source heat pumps, ground-source heat pumps, district heating and cooling (with various technologies), concentrated solar thermal (with absorption systems) and high-efficiency cogeneration (with absorption systems). The draft NECP update promotes the development of district cooling as the most sustainable option to supply space cooling (while the Comprehensive Assessment showed that individual heat pumps would be more cost-effective). District cooling is still rare in Spain, and further studies and R&D seem to be needed to support the development of district cooling.

About policies and measures, most of the CAs analysed cover a broad scope, for example including measures for energy efficiency in buildings (building codes and schemes for building renovation), promotion of RES (mostly for heating) and development of district heating (sometimes also district cooling).

The link with space cooling is rarely explicit, except for some references to energy labelling and regulations for air conditioners or cooling products, measures to promote district heating and cooling (when district cooling is clearly mentioned), and measures for RES for cooling (mostly about geothermal).

When discussing measures for building renovation, the focus is usually on reducing the heating demand, the possible impact on the cooling demand being rarely mentioned (the same for shading for example). The description of the renovation schemes mentions that actions related to space cooling are eligible only for one Spanish programme (National Housing Plan 2018-2021), where efficient air conditioners and connection to district cooling can be eligible. Spain’s CA also mention a specific tax on fluorinated gases.

It should be reminded that the information reported in the CAs do not necessarily reflect the whole policies and measures in place nor their details. For example, France mentioned its white certificates scheme, but without pointing that the catalogue of standardised actions eligible to this scheme includes action types about space cooling. Similarly for Italy and its tax credit where sun shading is eligible.

Looking mor specifically at the five countries with the largest space cooling demand in the EU27 (France, Germany, Greece, Italy and Spain), their targets mentioned in the CAs are most often the general ones from the NECP, sometimes with an assessment of what share of the targets is expected to come from improvements in heating and

cooling, but never setting targets specific to space cooling (nor even cooling[8]). About overall strategies, none of the CAs analysed refers to a national heating and/or cooling strategy. Instead, they refer to the NECP (or other national overall planning or climate law), sometimes also making the link with the long-term renovation strategy, previous National Renewable Energy Action Plan and/or National Energy Efficiency Action Plan (or similar national plans for RES and energy efficiency). This shows that the measures relevant to heating and cooling are integrated in the overall energy and climate planning and strategy. This may also be due to the absence of formal targets specific to heating and cooling.

Most of the CAs reported in 2020 did not include an explicit reference or link to adaptation strategy, plan or measures. Likewise, issues related to heat waves or urban heat islands are rarely mentioned. These points were not included in the Commission's Recommendation (EU) 2019/1659 on comprehensive assessments.

Looking forward, only a few of the announced new or planned measures had an explicit link with space cooling: update of the national regulation for thermal energy systems for buildings (Spain), measures to develop district cooling (France, Greece and Italy), specific consideration about the possible introduction of new limits on the use of cooling systems to be evaluated by defining restrictions related to the climate zone of reference (Italy).

3.3. Space cooling in the National Energy and Climate Plans

The mandatory NECP template includes a few points about cooling, and always jointly dealing with heating, except for the data of number of Cooling Degree Days. The other points are: target, trajectory and measures for RES for heating and cooling, possible energy efficiency objectives for heating and cooling, assessment of the necessity to build new infrastructure for district heating and cooling produced from renewable sources, and current potential for the application of high-efficiency cogeneration and efficient district heating and cooling (both related to the comprehensive assessments, see previous section). The Commission's guidance (2022/C 495/02) for the update of the NECP due in June 2023 (draft) and June 2024 (final) does not include further elements about space cooling, except clarifying that the final NECP update should include the updated comprehensive assessment[9].

Consequently, the draft NECP updates do not include specific sections on cooling. Overall, they include little information about space cooling and related objectives and measures, apart from the RES target for heating and cooling and possible measures to develop district heating and cooling. These are also the few points on cooling in the Commission's EU-wide assessment of the draft NECP updates (COM(2023) 796 final).

The table below provides a summary of the national background, strategy and governance in the EU Member States, mostly based on the review of the draft NECP updates.

[8] In the scope of the CAs, cooling is broader than space cooling and includes cooling processes in industry, refrigeration for wholesale and retail, etc.

[9] However, by the time of writing this report, no new comprehensive assessment was available on Commission's website.

Table 3. Overview of national background, strategy and governance in the EU Member States.

Country	National background and strategy	Governance
Austria	The draft NECP update emphasizes the importance of cooling within its national energy strategy. Cooling is repeatedly addressed in the country's energy objectives, including specific targets related to energy efficiency and the share of renewable energy in the cooling sector. While cooling is not the primary focus, it is integrated into broader energy planning and decarbonization strategies. Additionally, the NECP mentions adaptation measures for cooling, highlighting the importance of addressing the increasing demand for cooling in the context of climate change and energy efficiency improvements in buildings.	The framework for addressing cooling is integrated within the broader energy strategy, led primarily by the national government. Cooling is considered alongside energy efficiency and renewable energy goals outlined in national plans like the draft NECP update. While there is no dedicated cooling strategy, it is addressed through energy efficiency measures, particularly in building regulations. These regulations, set at the national level, ensure that cooling solutions are aligned with the country's overall energy transition. Local authorities and stakeholders are engaged in discussions to promote efficient cooling technologies, while incentive schemes help encourage energy-efficient cooling practices.
Belgium	Belgium being a federal state in which heating and cooling is a regional competence, the country does not have a cooling strategy. Each region has its own Air-Energy-Climate strategy, in which cooling is mostly included as part of the "heating & cooling" couple. Although Belgian regions have not developed a clear strategy for cooling, their reporting and assessments comprise sections in which existing cooling solutions are described. Yet, cooling demand is not deemed significant enough to dedicate resources to forecast its evolution, apart from the adaptation efforts to reduce heat islands effect in urban areas.	Energy-related decision-making lies in the hands of regional governments. Yet, several organs have been establish to coordinate energy and climate action at federal level, such as the National Climate Council or the Regional-Federal Energy Dialogue (CONCERE/ENOVER) or the Stuurgroep. Some public consultation took place in the NECP drafting process, following Governance Regulation's article 10. Each region has its own building code, its own Air-Climate-Energy plan: the Belgian NECP is a compilation of the three plans following the template given in the Governance Regulation's annex.
Bulgaria	Bulgaria's strategy for space heating and cooling aligns with national decarbonization goals by prioritizing energy efficiency and renewable energy use in buildings. Policies support the integration of high-efficiency heating and cooling systems, leveraging technologies like geothermal, hydrothermal, and solar energy, and the promotion of district heating with	National policies for space heating and cooling in Bulgaria emphasize the integration of energy efficiency and renewable sources to meet EU energy targets. Priority is given to implementing high-efficiency heating and cooling systems and innovative technologies, such as geothermal, hydrothermal, and solar energy, as well as the utilization of waste heat. Governance frameworks

Country	National background and strategy	Governance
	renewable sources. Additionally, there are efforts to modernize existing heating systems to reduce heat losses and integrate smart control technologies for optimized heat distribution.	support the modernization of district heating and cooling infrastructures, encouraging the adoption of smart grids, advanced monitoring systems, and efficient heat transmission networks. These measures aim to reduce heat loss, enhance energy efficiency, and integrate more renewable energy sources into the heating sector. Bulgaria's national plan also includes the gradual transformation of district heating systems into smart heat grids, capable of handling variable renewable energy inputs. Policies support this through incentives, regulatory adjustments, and investments, aligning with the EU's long-term sustainability goals
Croatia	No strategy or plan specific to cooling (or heating and cooling). Croatia's National Energy and Climate Plan (NECP) builds on national laws and related strategies. Croatia' Energy Act of 2012 transposed the EU acquis in the field of energy into the national legislation. This law, regularly revised, sets the process for the Energy Development Strategy until 2030 with an outlook to 2050, umbrella document for national energy planning. This strategy defines the national targets (e.g. for energy efficiency and RES) and was submitted to public consultation at the end of 2018. The 2019 Act on Climate Change and Protection of the Ozon layer complements this with the Low-Carbon Development Strategy until 2030 with an outlook to 2050, and the related Action Plan to implement this strategy over 5-year periods. The low-carbon strategy was drafted in 2017 and then aligned with the energy strategy in 2021. In parallel, the Climate Change Adaptation Strategy was adopted in 2020. More specifically about energy efficiency, the Energy Efficiency Act maintains the previous process of a National Energy Efficiency Action Plan (NEEAP) revised every three years with measures to be implemented under the NECP. More specifically about buildings, the key document is the Long-Term Strategy to encourage investment in the renovation of the national building stock until 2050, revised in 2020, with the objective to gradually increase the annual renovation rate from 0.7% in 2020 to 3% in 2030, with a 10-year average of 1.6%/year. Moreover, the Construction Act sets an obligation to regularly inspect large heating and	The energy and climate fields mostly fall within the competence of two ministries, the Ministry of the Economy and Sustainable Development and the Ministry of Physical Planning, Construction and State Assets. The Committee for intersectoral coordination for policy and measures of mitigation of and adaptation to climate change was established in 2018, and includes a Coordination Group and a Technical Working Group, to coordinate mitigation and adaptation policies and measures.

Country	National background and strategy	Governance
	cooling or air conditioning systems in buildings (in line with the EU Energy Performance of Buildings Directive - EPBD). About RES for heating and cooling, the measures are clearly focused on heating (and district heating). Similarly, while in theory some of the main energy efficiency policies (Energy Efficiency Obligation Scheme, energy renovation programmes for buildings, energy management systems) could address space cooling, they are mostly focused on heating, as heating remains the dominant share of buildings' energy consumption.	
Cyprus	Cyprus's strategies for heating and cooling, outlined in the National Energy and Climate Plan (NECP) and related assessments, emphasize increasing renewable energy integration and enhancing energy efficiency. The draft NECP update targets a 48.2% renewable energy share in heating and cooling by 2030, promoting solar thermal systems and other sustainable technologies. In 2021, the share of RES in the power sector stood at 14.8%, while it was 41.3% in the heating and cooling sector (mostly thanks to a widespread use of solar thermal systems for water heating, then heat pumps and biomass). One challenge for decarbonising cooling may then be to increase the share of RES in the power sector (cooling being mostly supplied with electricity, even if heat pumps already help with the share of RES for cooling). Local-level planning and energy-efficient practices are prioritized to optimize systems and reduce emissions. Comprehensive initiatives like the "Energy Efficiency Strategy" and guidance for local heating and cooling strategies support these goals, aligning with Cyprus's broader adaptation measures to address climate change impacts and achieve sustainability objectives. More specifically about cooling, the draft NECP update outlines strategies to enhance the energy performance of buildings, aiming to reduce energy consumption for cooling purposes. The plan also highlights the promotion of renewable energy sources for cooling, such as solar cooling technologies, to decrease reliance on conventional energy sources.	In Cyprus, energy and climate responsibilities are centralized under the Ministry of Energy, Commerce, and Industry, which develops policies, implements EU directives, and oversees national plans like the NECP. The Energy Service manages programs, subsidies, and compliance with energy goals. Without a formal regional governance structure, functions at this level are managed nationally. At the municipal level, local authorities implement specific measures, such as energy efficiency projects, permitting for renewable energy installations, and awareness campaigns, acting as facilitators of national strategies in their communities. The Heating and Cooling Strategy at the Local Level further supports these efforts by promoting tailored solutions for energy efficiency and renewable energy integration, including the adoption of solar thermal systems and energy-efficient building designs. This centralized framework ensures consistent policy application across the country.
Estonia	Estonia's strategic documents, including the National Energy and Climate Plan (NECP) 2030, the Estonia 2035 strategy, and the Climate Change Adaptation Development Plan until 2030, collectively address the nation's approach to energy efficiency and climate resilience. While	In Estonia, the distribution of responsibilities for implementing energy and climate policies, including those related to cooling and building energy performance, is structured across three levels:

Country	National background and strategy	Governance
	there isn't a dedicated national cooling strategy, these plans emphasize the importance of enhancing energy efficiency in buildings, which encompasses both heating and cooling systems. The NECP 2030 outlines measures to improve building energy performance, thereby reducing the need for active cooling. The Estonia 2035 strategy assesses global megatrends influencing energy demand, including the impact of new dependencies such as air-conditioning and ventilation systems. Additionally, the Climate Change Adaptation Development Plan focuses on increasing resilience to climate impacts, which includes considerations for maintaining indoor comfort during warmer periods. Collectively, these documents aim to integrate energy efficiency and climate adaptation measures, ensuring that cooling needs are met sustainably and in alignment with Estonia's broader energy and climate objectives.	National/federal level: The Ministry of Economic Affairs and Communications oversees energy policies, including compliance with the Energy Performance of Buildings Directive (EPBD) and the National Energy and Climate Plan (NECP). Regional level: Estonia operates as a unitary state with limited formal regional governance. However, regional development centers and local offices of national authorities provide support for implementing national policies, such as public awareness campaigns or regional energy efficiency projects. Municipal level: Municipal governments are responsible for the local implementation of energy efficiency measures and building regulations.
Finland	Finland's national strategy on space cooling is shaped by its climate policies and commitments to energy efficiency. Here's an overview based on key national documents: 1. National Energy and Climate Plan (NECP) Update 2023: The draft update, submitted on 30 June 2023, outlines Finland's energy and climate objectives. While it emphasizes renewable energy and emission reductions, specific measures for space cooling are not detailed. The plan focuses on overall energy efficiency, which indirectly impacts cooling strategies. 2. Comprehensive Assessment 2020: This assessment evaluates Finland's heating and cooling sector. It highlights the importance of energy-efficient cooling solutions, especially in the context of rising temperatures due to climate change. The assessment suggests integrating passive cooling techniques and enhancing building insulation to reduce cooling energy demand. 3. National Climate Change Adaptation Plan: Finland's adaptation strategy acknowledges the increasing frequency of heatwaves and the consequent demand for cooling. It promotes adaptive measures such as urban planning that incorporates green spaces, which can mitigate urban heat islands, and encourages the use of energy-efficient cooling systems to ensure resilience against climate impacts.	In Finland, the governance of space cooling falls under the broader framework of energy efficiency and building regulations. Key authorities involved include: Ministry of the Environment (YM): Oversees the National Building Code of Finland, which sets energy performance and indoor climate requirements for buildings, including cooling. Ensures compliance with EU directives like the Energy Performance of Buildings Directive (EPBD). Energy Authority (Energiavirasto): Monitors the implementation of national energy and climate policies, including efficiency in heating and cooling sectors. Responsible for ensuring adherence to energy-related EU directives and goals. Local Authorities: Enforce building regulations at the municipal level, ensuring new and renovated buildings meet cooling efficiency and performance standards. Motiva Oy: Provides guidance and tools for improving energy efficiency in buildings, including cooling strategies. Promotes awareness and best practices for sustainable cooling solutions. Municipal Governments: Play a role in urban planning and green

Country	National background and strategy	Governance
		infrastructure development, which impacts cooling needs and urban heat island effects.
France	France does not have a specific cooling strategy, nor a heating & cooling strategy. The national energy strategy is defined in two main planning documents: PPE (Multi-annual Energy Planning, with objectives for 5-year periods) and SNBC (National Low Carbon Strategy, long-term strategy to achieve carbon neutrality by 2050). However, the reference scenarios used for this national energy planning do not provide data nor objectives specific to space cooling. Similarly, while France implements various policy measures to promote building renovations, these schemes are primarily meant to reduce space heating consumption and do not explicitly address summer comfort or space cooling. Likewise, France's 2020 Comprehensive Assessment is focused on heating only (no data on cooling). This might be because space cooling is still a negligible share of the final energy consumption compared to space heating. From an energy efficiency viewpoint, space cooling is therefore mostly addressed through the regulations for buildings and cooling products. Summer comfort is also addressed from an adaptation perspective, with a close link with health policies, especially with the National Heat Wave Plan published in 2023 and updated in 2024. The main actions of this plan about summer comfort in buildings are to inform owners about improvements they can do to their buildings (homes and offices), and to inform building occupants about efficient behaviours.	Consultation processes are in place, but the main decision-making about the national energy policy lies within the national government. Similarly, the building regulations are set at the national level by the Ministry of Ecological Transition, and the main incentive schemes are also national (e.g. MaPrimeRenov', white certificates scheme). Since 2009, a national committee ('Plan Bâtiment Durable', Sustainable Buildings Plan) has been established by the government to gather the stakeholders of the construction, renovation and real estate sectors, with the mission to help achieve the energy efficiency and environmental objectives for buildings. It includes various working groups that prepare reports and proposals. Due to the white certificates scheme, energy suppliers are also involved in supporting end-users to save energy, including about space cooling. Local authorities of more than 20 000 inhabitants shall prepare and implement a Local Energy Climate and Air Plan (PCAET), while regional authorities are coordinating local energy planning with regional scheme for planning, sustainable development and egality (SRADDET).
Germany	Germany does not have a distinct space cooling policy, however it addresses space cooling through broader energy efficiency and climate policies that improve overall building performance, thus enhancing also summer comfort. These policies address: - energy efficiency standards: the Energy Saving Ordinance (EnEG, EnEV), the Building Energy Act (GEG) and the use of heat from renewable energies (EEWärmeG) set stringent energy efficiency requirements for buildings (including cooling systems); - renewable energy integration: the Renewable Energy Sources Act (EEG) encourages the use of renewable energy for cooling, such as solar thermal systems;	In Germany, the national government sets overarching policies for space cooling, while regions (Bundesländer) implement these policies. Local administrations handle specific regulations and enforcement. Utilities play a role in incentivize energy efficiency improvements, including cooling, thanks to white certificates. In Baden-Württemberg, municipalities with over 20,000 inhabitants are required to develop H&C plans by the end of 2023. At national level, municipalities with over 100,000 inhabitants must develop H&C plans by 2028.

Country	National background and strategy	Governance
	- climate protection: the Climate Protection Act (Klimaschutzgesetz) outlines Germany's commitment to reducing greenhouse gas emissions, which includes measures to improve the energy efficiency of cooling systems; and - sustainable development: the Sustainable Development Strategy includes goals for sustainable urban development and energy-efficient buildings, promoting passive cooling techniques and low-energy cooling systems. Germany also adheres to EU directives on energy performance of buildings and eco-design requirements for energy-related products, which impact cooling systems.	The German Energy Agency (dena) and the Federal Ministry for Economic Affairs and Climate Action (BMWK) often host consultations and workshops on energy efficiency, renewables and H&C strategies. The German government periodically opens public consultations on draft policies and regulations related to H&C. These consultations allow stakeholders, including municipalities, businesses, and citizens, to provide input and feedback. Besides, platforms like the German Association of Cities (Deutscher Städtetag) and the Association of German Cities and Municipalities (Deutscher Städte- und Gemeindebund) frequently organize forums and conferences where H&C policies are discussed. Also the Municipal Heat Transition Competence Centre (KWW) supports municipalities in developing and implementing their heat plans.
Greece	Greece did not develop yet a specific cooling or cooling and heating strategy. Overall, Greece's energy and climate planning primarily revolves around the NECP (National Energy and Climate Plan) and the Long-Term Strategy, both of which are periodically revised to reflect new developments and commitments, in line with the EU governance regulation of the Energy Union. The NECP outlines a comprehensive roadmap for achieving specific energy and climate targets by 2030, and serves as the key reference point for national planning. Initially adopted in 2019, the NECP is currently undergoing a revision to align with the latest EU climate targets (cf. draft update of NECP submitted in 2023). This revision is anticipated to significantly shape future energy strategies and policies in the country. Complementing the NECP, Greece has also developed a Long-Term Strategy for 2050, which presents an overarching plan for climate and energy issues. The Long-Term Strategy is based on the 2030 targets established in the NECP, ensuring that progress toward these objectives is consistently monitored and achieved. In this context, the National Air Pollution Control Programme (NAPCP) and the National Climate Law 4936/2022 are aligned with the NECP and also refer to it. While the NECP is not solely a product of these frameworks, it plays a crucial role in their implementation and serves as the primary vehicle for reporting and integrating national energy planning efforts.	In the period from 2020 to date, the EU has set itself more ambitious targets for 2030 and incorporated the 2050 climate neutrality target in all Member States' NECPs. With regard to this objective, the Greek Government has submitted a long-term energy and climate strategy, as a separate study in the context of the NECP. Previously, the objectives were formulated in the context of the EU's 'Clean Energy for All Europeans' Package adopted in 2018-2019, including the Governance Regulation of the Energy Union, as well as revisions or amendments to the Renewable Energy Directive (RED),the Energy Efficiency Directive (EED), and the Energy Performance of Buildings Directive (EPBD). The National Air Pollution Control Programme (NAPCP) (Joint Ministerial Decision No ΥΠΕΝ/ΔΚΑΠΑ/5615/121/2021, Government Gazette, Series II, No 812) has been established with national policies and measures to comply with the required national commitments on emission reductions. The NAPCP in accordance with an obligation under the above legislation is due to be updated by early 2025.

Country	National background and strategy	Governance
	In most cases, there is no specific objective connected directly with space cooling exclusively, while the majority of the references and targets are referred in regards to "heating and cooling". The following relevant targets are indirectly connected to space coolling: - GHG emissions and removals: e.g., "Existing EU F-gas regulations, including the new Regulation (2022/0099 (COD)) adopted by the European Commission, are expected to almost completely eliminate the use of hydrofluorocarbons (HFCs) in heat pumps and air conditioning (AC) for heating and cooling as early as 2025". The comprehensive assessment also mentions several measures to reduce fluorinated gas emissions (e.g., forbidding fluorinated gases with GWP>150; training and certification for professionals handling fluorinated gases). - Renewables: e.g., "The binding RES development target specifically for heating and cooling is set at 46% for 2030, higher than 43% of the previous NECP. Heat pumps will contribute mainly to this objective, as they use electricity and ambient heat, together with solar thermal systems." In practice, this mostly deals with heating. - Energy Efficiency: e.g., "The use of RES systems for heating and cooling (mainly heat pumps and solar thermal systems) will be enhanced by combining different policy measures in full compliance with the projections of the comprehensive assessment to promote efficient heating and cooling. In order to promote RES systems, initiatives were launched and programmes were implemented to replace energy-intensive appliances with new, more energy-efficient appliances." For example, one programme of Greece's Recovery and Resilience Plan was focused on the replacement of inefficient air-conditioning systems.	Most importantly, following the European Climate Law 2021/1119 establishing a framework to achieve climate neutrality by 2050, Greece adopted for the first time a National Climate Law 4936/2022 (Government Gazette, Series I, No 105), which sets specific targets, including reducing greenhouse gas emissions by 55 % by 2030 and 80 % by 2040 (compared to 1990 levels), and achieving climate neutrality (i.e. zero total greenhouse gas emissions) by 2050. Therefore, the current NECP incorporates the objectives of the National Climate Law, the objectives of the European Union policy (RE-PowerEU and Fit-for-55 under the Green Deal) and the European directives on renewable energy sources, energy efficiency and others, which are being finalised. The Ministry of Energy and Environment oversees the NECP process, and defines and manages most policy measures and strategies relevant so space cooling (e.g. TOTEE 20701-1/2017 (KENAK), Saving at home, Saving business, ELEKTRA, Energy efficiency obligation scheme, etc.) . Regional and local authorities are involved several ways: (i) they contribute to the development of the national strategy and planning, for example by participating in the consultation process for the updated NECP; (ii) they formulate and implement policies and plans based on national guidelines, like in the case of Municipal plans for the reduction of net greenhouse gas emissions (see: http://www.opengov.gr/minenv/?p=12272) or Regional Plans for Climate Change adaptation; and (iii) they act as beneficiaries of relevant programmes, such as ELEKTRA (see: https://hlektra.gov.gr/home).

Country	National background and strategy	Governance
Hungary	Hungary does not have a specific cooling strategy, nor a heating & cooling strategy. The national energy strategy is defined in the NEKT (Nemzeti Energia és Klímaterv - National Energy and Climate Plan), updated last as a draft in 2023. However, the reference scenarios used for this national energy planning do not provide data nor objectives specific to space cooling. National energy policy does not specifically address space cooling, but space heating and cooling is considered together. Targets consider the reduction of final energy use for space heating and cooling, for disitrct heating and cooling, inlcuding the increas of the renewable energy ratio in the energy mix. Decarbonization targets focus on electricity, heat pumps for heating are promoted. Targets in the latest update of the draft NECP are not yet aligned with the requirements of the RED Renewable Energy Directive, or the EED recast. Similarly, while Hungary implements various policy measures to promote building renovations, these schemes are primarily meant to reduce space heating consumption and do not explicitly address summer comfort or space cooling. Likewise, Hungary's 2020 Comprehensive Assessment is focused on heating only (no data on cooling), while the renewable energy target is included only in the context of electrification. This might be because space cooling is still a negligible share of the final energy consumption compared to space heating. From an energy efficiency viewpoint, space cooling is therefore mostly addressed through the regulations for buildings and cooling products. In the energy performance certificate calculation methodology, the latest implementation of EPDB from 2023, requires the assessment of the "summer heat protection" of buildings, based on the glazing area and related solar exposure.	
Italy	The Italian National Energy and Climate Plan (NECP) update highlights the country’s strategic approach towards addressing climate change and energy efficiency. Italy fully aligns with the EU's overarching goal of decarbonization, aiming to lead the world in achieving net-zero emissions. Key legislative frameworks guide this transition, including:	The distribution of main responsibilities between the national, regional, and municipal levels as described in the NECP (National Energy and Climate Plan) is as follows: - National/Federal Level: The national government, through the Ministry of the Environment and Energy Security (MASE), is primarily responsible for

Country	National background and strategy	Governance
	- Fit for 55 (FF55): A package of EU legislative measures that tightens emission caps under the Emissions Trading Scheme (ETS), aiming for a 62% reduction in emissions by 2030 compared to 2005 levels. - Effort Sharing Regulation (ESR): Focuses on reducing emissions in transport, residential, agriculture, and waste sectors by 43.7% by 2030, based on 2005 levels. - LULUCF Regulation: Targets net CO2 removals in the land use, land-use change, and forestry sector, with Italy aiming to absorb more than 35 million tonnes of CO2 by 2030. Italy's cooling strategy is intertwined with these national energy efficiency goals, emphasizing the deployment of renewables, energy-efficient technologies, and circular economy measures. In particular, the REPowerEU and NRRP (National Recovery and Resilience Plan) programs are crucial for improving energy security by accelerating the adoption of renewables and reducing reliance on Russian fuels. This includes enhancing LNG infrastructures and fostering renewable energy technologies like biomethane, hydrogen, and energy storage.	setting and coordinating national energy and climate policies. This includes managing relations with the European Union, protecting competition, safeguarding environmental standards, and ensuring energy security. Additionally, the national level is responsible for the development and regulation of energy production, transportation, and distribution infrastructure on a broader scale, as well as implementing policies that align with national and EU targets. - Regional Level: The regional governments have shared competencies with the national level concerning energy matters. Their responsibilities include formulating regional energy policy objectives, promoting renewable energy sources, managing local energy resources, and handling the certification of buildings for energy efficiency. Regions also play a role in the location and development of district heating systems and grant concessions for hydroelectric power projects. They are integral in ensuring the consistency of national objectives with local realities. - Municipal Level: Municipalities and local authorities, while not as directly involved in energy policy formation, play an important role in implementing energy transition measures on the ground. They contribute through sustainable energy action plans (SEAPs) and local climate action strategies (PAESC), especially within the framework of the Covenant of Mayors. Municipal authorities help manage energy usage at the community level, especially for projects like renewable energy communities and decentralized renewable energy generation. This hierarchical distribution ensures that energy and climate policy integrates national objectives while being tailored to regional and local contexts.
Malta	Malta's strategy for space heating and cooling emphasizes high-efficiency systems tailored to the country's unique demand profile, with cooling being predominant due to the mild winters and hot summers. National policy discourages district heating and cooling networks, as well	National policies regarding governance in space heating and cooling prioritize enhancing energy efficiency while addressing limitations unique to each country's climate and infrastructure. In Malta, for instance, the national

Country	National background and strategy	Governance
	as cogeneration, due to high costs and limited energy demands in winter. Instead, Malta's plan encourages the use of efficient, reversible air-to-air heat pumps in residential and commercial buildings, with policies focusing on increasing the use of renewables for heating and cooling, including solar thermal systems where feasible. Additionally, Malta's NECP sets incremental targets to achieve annual growth in renewable energy use for heating and cooling by 1.1% until 2030, aligning with EU directives	approach integrates high-efficiency air-to-air heat pumps and promotes energy efficiency in both residential and service sectors due to the limited feasibility of district heating and cooling solutions. Additionally, national regulations support renewable energy adoption for heating, such as solar water heaters, and leverage tax incentives to stimulate high-efficiency technologies across commercial and residential applications.
Poland	Poland's strategy for space heating and cooling aligns with its broader climate and energy goals by aiming to phase out coal in household heating by 2040, replacing it with renewable energy sources (RES) such as biomass, geothermal, and heat pumps. National policies emphasize the decarbonization of district heating systems, focusing on expanding low- and zero-emission technologies, alongside RES, within urban and rural areas. The transition is supported by various EU and national funds, regulatory adjustments, and targets to raise the share of RES in heating and cooling, reaching an expected 32.1% by 2030.	National governance regarding space heating and cooling in Poland emphasizes the shift towards renewable energy sources, particularly in district heating and individual heating systems, aiming to reduce dependency on fossil fuels and improve energy efficiency by 2030. Poland's updated National Energy and Climate Plan (NECP) outlines ambitious decarbonization goals within heating sectors, incorporating targets for renewable energy adoption and emissions reduction to align with EU directives on sustainability. To support these goals, national policies provide funding instruments, incentives for renewable energy integration, and progressive targets to phase out coal, thereby fostering a transition to low-emission and energy-efficient systems in alignment with the EU's climate objectives.
Spain	Spain is already strongly impacted by climate changes, notably warmer summers (e.g. several thousand deaths attributed to the heat wave in 2022). Sustainable space cooling is thus one of the key issues related to climate adaptation, with major implications for health and the electricity system (cf. summer peak loads). These concerns can also be found in the recommendations from the Citizens' Climate Assembly, and more specifically the one about adapting housing to climate change for people in vulnerable situations or in need of specific care, and the one about reducing the sensitivity of workplaces to the potential impacts of climate change. Spain does not have a strategy or roadmap specific to cooling (or heating and cooling). The broader umbrella strategy has been established from 2019 with its Strategic Energy and	The major public authorities for policies relevant to sustainable space cooling are MITECO (Ministry for the Ecological Transition and the Demographic Challenge) and MIVAU (Ministry for Housing and Urban Agenda). MITECO coordinates the umbrella Strategic Energy and Climate Framework, and MIVAU leads the building regulations (together with MITECO). They jointly define the renovation programmes that are co-managed with the Regions (Autonomous Communities). The Autonomous Communities and local authorities play a major role in the implementation of the energy efficiency policies and programmes (including for the building regulations and the renovation programmes), according to

Country	National background and strategy	Governance
	Climate Framework (Marco Estratégico de Energía y Clima) gathering the key planning processes (including the National Energy and Climate Plan - NECP), and complemented with specific roadmap (including the Long Term Building Renovation Strategy - ERESEE). Major policy instruments for energy efficiency in buildings include regulations (Technical Building Code - CTE and Regulation on Thermal Installations in Buildings - RITE) and renovation programmes (e.g. PREE, PREE 5000, PREE Terciario + PIREP schemes for public buildings) with financial incentives partly funded by the National Energy Efficiency Fund and boosted by the Recovery, Transformation and Resilience Plan (PRTR), and more specifically its Housing Rehabilitation and Urban Regeneration Plan. The action types eligible to these programmes include actions relevant to sustainable space cooling such as sun shading, free cooling, efficient air conditioning and ventilation systems, building automation and control systems, connection of the building to district heating and/or cooling. Spain also implements an Energy Efficiency Obligation Scheme, including white certificates (CAE) since 2023, that could support building renovations or space cooling actions. The draft NECP update (2023) clearly mentions the objective to significantly develop district heating and cooling (while stressing that district cooling was still rare in Spain). More specifically to cooling systems, Spain already implements a set of measures to reduce GHG emissions related to fluorinated gases, including the Regulation (EU) No 517/2014 and complementary measures (e.g. tax on fluorinated gases). The Sectoral Plan for Market Surveillance of Energy Labelling aims at ensuring good information for the purchase of cooling equipment, in line with the related EU regulations. Spain has already a high share of RES in its electricity mix (43% in 2020), and aims at reaching 81% RES by 2030. As space cooling is mostly supplied with electricity, this means that indirect CO2 emissions related to space cooling should significantly decrease. This also means that flexibiliy in electricy end-use (including cooling) will be increasingly important. This should be partly ensured with the development of self-consumption that has known an exponential growth in Spain in recent years (from 0.4 GW in 2018 to 5.2 GW in 2022).	Spain's distribution of legal competences. Moreover, the Spanish Urban Agenda (Agenda Urbana Española - AUE) provides a voluntary framework for municipalities to develop action plans covering various objectives. Strategic objective 2 includes among others 'improving the quality and sustainbility of buildings'. Strategic objective 3 includes among others 'adapting the territorial and urban planning to the effects of climate change and achieve progress in preventing climate change'. IDAE (national agency to diversify and save energy, related to MITECO) provides technical support to the design, implementation and monitoring of the energy efficiency policies and programmes. It is in charge of the National Energy Efficiency Fund, and coordinates the implementation of the renovation programmes. Energy suppliers are the obligated parties of the Energy Efficiency Obligation Scheme now including white certificates (CAE). However, it is not known yet if their programmes will include incentives for actions related to sustainable space cooling (and to what extent this would play a significant role in this field).

We focus here our findings from the targeted review of the draft NECP updates of France, Germany, Greece, Italy and Spain, on other examples of analysis or measures dealing with space cooling or summer comfort. The first one is common to the five countries, about the role that heat pumps could play to meet the cooling needs while contributing to the RES target. Most of the countries also refer to the F-gas regulation. France mentions a new tax to reduce the use of HFCs (but postponed to 2025). The analysis and details about the schemes for building renovation sometimes remind that they can contribute to reducing the space heating and cooling needs, and thereby the achievement of the RES target. But this analysis is likely more about space heating than space cooling (e.g. Italy's report). Then the draft NECP updates rarely include the actions related to space cooling and that could be eligible (case for the two main renovation schemes of Germany where ventilation systems and the replacement of windows and external doors to improve summer thermal insulation are eligible).

Another group of analysis or measures is about behaviours. France's energy sufficiency plan has been updated in June 2023 to take better account of summer comfort and promote 26°C as minimum temperature setpoint for air-conditioning. Interestingly, this is also the minimum setpoint mentioned in the building regulation. This communication thus implicitly acknowledges that usual behaviours are not in line with the assumptions of the building regulations. Italy's report briefly highlights the importance to raise consumer awareness and active role using, for example, home automation, network digitalisation and smart metering technologies.

Except Germany, the four other draft NECP updates include some discussions related to adaptation. France mentions that its new building regulation (RE2020) considers the need to adapt living and working spaces to future climatic conditions, especially for summer comfort (cf. update of the reference scenario for weather conditions to include a period of heat wave). Italy's requirements for nearly zero energy buildings include a criterion on "summer equivalent solar area per useful floor area", and the next revision of the building regulations may consider introducing new limits on the use of cooling systems according to the climate zones (e.g. about days of use, times, temperature setpoints). Similarly, Greece mentions the need to revise the building regulations and to adapt urban planning considering the already occurring impacts of climate change, speaking of the thermal environment in cities. Greece refers to sound urban and architectural bioclimate planning and the use of sustainable materials in bioclimate planning (cool materials, shading structures, vegetation), mentioning examples such as urban green areas (e.g. green routes and urban green canyons). The issue of higher summer energy needs is also raised due to the importance of the tourism sector in the Greek economy. More generally, the analysis of the risk to the electricity system due to increasing summer peak loads is highlighted in Italy's report, mentioning the risks of black-out. A link can then be found between the expected increase in summer peak load and the development of measures for demand-side management that covers space cooling (often among other end-uses). A measure under consideration in France is for example economic incentives or regulatory obligations for the piloting of new equipment (including air-conditioning systems).

The draft NECP updates are not comprehensive about all measures or initiatives relevant to space cooling. First because they cover all dimensions of the Energy Union and cannot therefore provide details about all issues: they focus on the main measures to meet the EU obligations and targets. Second, because they tend to focus on government-led and national measures. They rarely inventory measures of local authorities, or accompanying measures developed by public agencies or other stakeholders. One example of good practice not included in the draft NECP updates is the online platform 'Cooler my city' developed by ADEME in France.

3.4. Actions and measures relevant to summer comfort in the National Adaptation Strategies (NAS) and National Adaptation Plans (NAP)

Following the identification of priority areas, Member States incorporate their adaptation methods into more comprehensive national policies. NAS/NAP consists of specific actions and adaptation strategies, such as climate-resilient infrastructure in the building sector and sustainable land-use planning techniques.

In France, special attention is given to collective buildings to prevent the penetration of solar radiation, mostly from glass window facades. Potential tax incentives, such as tax credits, have been considered for contributing to enhancing summer thermal comfort in residential and commercial buildings through the use of energy-efficient devices such as blinds, green rooftops, and vertical gardens. France's heat wave action plan ("Plan Canicule") is a comprehensive approach designed to protect vulnerable populations during hot periods. It has a four-level colour-coded alarm system based on temperature thresholds. The measures include campaigns for public awareness, house calls, public cooling centres, healthcare readiness, and data tracking. Several cities in Italy, Germany and Portugal are following France's step to keep track of citizens vulnerable to heatwaves and promote solidarity networks to ensure no one is left behind. Greek cities are adapting urban planning to improve the thermal environment by updating the building regulations (K.Ev.A.K.). The plan includes appropriate architectural redesign of spaces and the integration of greenery into existing structures (ceilings, vertical surfaces, etc.) as a priority.

Spatial cooling measures have also been implemented in Spain, where Northern Spain utilises the 'right to the sun' methodology, employing specific relationships with the sun to design buildings, streets, and vegetation. The transformation towards the integral improvement of buildings and the establishment and maintenance of adequate habitability conditions requires diverse resources and solutions to make buildings more climate-proof.

Beyond the five countries with the largest cooling needs, another interesting example is Austria, which aims to implement structural measures to ensure thermal comfort by utilising alternative cooling technologies to improve thermal efficiency. Anticipating a rise in demand for cooling, the Austrian government implemented the so-called passive cooling strategies as one of the construction measures, as well as optimising building orientation to enable natural ventilation. Austria put in place numerous support schemes to encourage the construction and restoration of environmentally efficient and climate-friendly buildings. Efficient energy use, building cooling, thermal rehabilitation (including shade systems), and information and awareness-raising campaigns, including health aspects and guidance for individuals at higher risk of heatstroke, are all important aspects of adaptation.

The table below provides a short summary per country as regards the link between space cooling (or summer comfort) and adaptation.

Table 4. Overview of links between space cooling and national adaptation plans or strategies in EU Member States.

Country	Links between space cooling and national adaptation plans or strategies
Austria	Austria's adaptation strategies related to cooling focus heavily on addressing the increasing risk of heatwaves, which are expected to become more frequent and intense due to climate change. The National Heat Protection Plan, updated regularly, involves coordinated efforts at federal, state, and

Country	Links between space cooling and national adaptation plans or strategies
	local levels to protect public health during extreme heat events. The plan emphasizes the importance of public awareness campaigns, the preparation of cooling centers, and specific measures to safeguard vulnerable populations such as the elderly and those in urban areas prone to heat island effects. In addition, Austria is developing a heat early warning system to help healthcare facilities, local authorities, and the general public better prepare for and manage the health risks associated with heatwaves. The system will prioritize measures based on detailed climate scenarios, evaluating the effectiveness of interventions like urban greening and adaptation in buildings. This comprehensive approach ensures that cooling measures are integrated into Austria's broader adaptation and public health strategies, helping mitigate the risks posed by rising temperatures.
Belgium	Belgium's cooling related adaptation measures mostly relates to heat waves; information plan, alert systems (e.g. tested in Antwerp), further consideration in urban plans.
Bulgaria	Adaptation measures aim to reduce reliance on fossil fuels and mitigate emissions, incorporating innovative technologies like geothermal and solar energy, alongside efficient district heating systems to optimize energy use. Policies also emphasize the modernization of heating infrastructure, aiming for high-efficiency solutions and the use of waste heat to meet adaptation targets, aligning with the 2030 Action Plan for climate resilience.
Croatia	Croatia's Climate Change Adaptation Strategy was adopted in 2020 aims to to raise awareness about the importance and threats of climate change for society and the necessity of integrating the concept of adaptation to climate change into existing and new policies. This strategy includes the following measures relevant to sustainable space cooling, ensuring summer comfort or mitigating the impacts of heat waves: - Ensuring sustainable regional and urban development by introducing a new model of green urban renewal strategies and implementation of a pilot project for the development of green infrastructure and circular management of space and buildings. - Ensuring sustainable energy development by creating preconditions for improving the resilience of existing production capacities (thermal power plants, hydro power plants and thermal power plants –heating plants) to the effects of climate change. Initiatives are also developing at local level, for example with the Heat Stress of the City of Zagreb, or after the earthquake in 2020 that provided an opportunity for the comprehensive study of heat stress and the subsequent implementation of green infrastructure and nature-based solutions in city blocks. This has for example been investigated in pilot projects, like Greening the City (which involves the architectural design and planting of 1500 trees throughout the city, especially at educational facilities) and GreenscapeCE2 (a project which aims to develop technical and financial prerequisites for the deployment of green infrastructures and nature-based solutions) also provided solutions.
Cyprus	Cyprus is experiencing increased temperatures and more frequent heatwaves due to climate change, leading to health risks such as heat-related illnesses and respiratory issues from worsened air quality. The National Adaptation Strategy and Action Plan addresses these challenges by promoting energy-efficient cooling systems, enhancing building designs for better thermal performance, and implementing early warning systems for heatwaves. These measures aim to

Country	Links between space cooling and national adaptation plans or strategies
	reduce vulnerability to heat-related health risks and ensure sustainable cooling solutions. The strategy also emphasizes public awareness campaigns to educate citizens on coping mechanisms during extreme heat events, aligning with broader efforts to mitigate climate change impacts and protect public health.
Estonia	The Climate Change Adaptation Development Plan focuses on increasing resilience to climate impacts, which includes considerations for maintaining indoor comfort during warmer periods. In relation to extraordinary weather situations (including heat waves), guidelines for behaviour in these crisis situations have been provided. In the autumn 2018, project plans for the implementation of a nationwide crisis hotline and the development of a location-based rapid threat notification system were prepared under the leadership of the Emergency Centre.
Finland	Finland's National Climate Change Adaptation Strategy positions cooling as part of the broader adaptation framework, focusing on reducing vulnerability to heat while ensuring cooling demand is met sustainably. It highlights the importance of integrating cooling solutions into urban design and energy policies to enhance resilience to a warming climate. Adaptation Measures Related to Cooling: Energy Efficiency: Encourages energy-efficient building designs to minimize cooling needs. Passive Cooling: Promotes natural cooling methods, such as enhanced insulation, shading, and ventilation, to reduce reliance on mechanical cooling. Urban Planning: Supports integrating green spaces and water bodies in cities to counteract urban heat island effects. Cooling Systems: Recommends the use of sustainable and low-energy cooling technologies.
France	The latest National Adaptation Plan was published in 2018, the update has been delayed. The objective is to anticipate climate changes and extreme weather events, considering regional differences. The plan highlights the major role of local authorities. One of the main principles is to give priority to nature-based solutions wherever relevant. An emphasis is also put on overseas territories particularly vulnerable to climate changes. More specifically about cooling/summer comfort, the Ministry of Ecological Transition has developed a National Heat Wave Plan. This plan includes a set of actions to anticipate and manage heat waves, for example with: - national awareness campaign to inform about improving buildings, both dwellings and offices (e.g. sun shading) and behaviours - inventory of "cooling spots" where people can go during heat waves - online platform Cooler My City ("Plus fraîche ma ville") developed by the French agency (ADEME) to help local authorities identify solutions to their local conditions, with practical examples from front-runners - a special plan for schools
Germany	Germany's adaptation policies link space cooling to climate resilience through measures like summer thermal insulation, shading, and evaporative cooling in buildings. Green infrastructure initiatives, such as ventilation corridors and green roofs, combat the urban heat island effect, while heat warning systems address rising temperatures and heat-related risks.
Greece	In the National Climate Change Adaptation Strategy (NACCS) of 2016, of the Ministry of Environment & Energy, there is no direct reference to space cooling. Generally, it aims to contribute

Country	Links between space cooling and national adaptation plans or strategies
	to the country's resilience against climate change impacts. The NACCS forms the basis for the specification of adaptation policies and actions for each of the 13 administrative regions of Greece. The NACCS preliminary concludes that agriculture is the sector expected to be most severely affected by climate change in Greece, while the impacts on tourism and coastal systems should have major consequences on household incomes and the economy as a whole. Of particular significance is also the water reserves sector, given its implications for agriculture and water supply. The NACCS does not provide any concrete suggestion in regards to space cooling. The draft NECP update of 2023 highlights about climate change issues that the increase in the average temperature is expected to reduce energy needs for heating in winter and increase cooling needs in the summer. It also stressed that these changes in energy demand will lead to greater variability of loads, and especially to very high peak loads during heatwaves, possibly putting the electricity system at risk. There is not yet a national plan to address heat waves impacts. Nevertheless, in recent years, during periods of extreme heat, various ministries—such as the Ministry of Health, the Ministry of Labour and Social Security, and the Ministry of the Interior— have issued governmental circulars. These circulars outline guidelines and measures to protect the public from the effects of heat waves, including regulations for workplace conditions. For example, relevant circulars were issued during the extreme heat wave from July 15 to July 19, 2024 (see for example: https://www.ypes.gr/metra-prostasias-ypallilon-gia-logous-ygeias-leitourgia-dimosion-ypiresion-sto-plaisio-tou-kafsona/).
Italy	The document provides information on adaptation issues related to cooling, particularly in the context of increasing heat waves and rising temperatures due to climate change. Here are the key points: -Increased Heat Waves and Cooling Demand: The document highlights the increase in the frequency and intensity of heat waves, particularly in flat and coastal areas. This is expected to lead to a higher demand for cooling and an increase in electricity consumption during the summer months . This rise in cooling needs, especially during heat waves, can exacerbate grid stress, leading to the risk of blackouts . -Cooling Strategy: The strategy for cooling includes promoting technologies such as electric and gas heat pumps, which can serve heating, air-conditioning, and domestic hot water needs. These systems are viewed as integral to addressing the increased demand for cooling . In particular, heat pumps are expected to contribute significantly to renewable heat and cooling needs . Italy is also promoting efficient district cooling systems to manage increased energy needs effectively. -Adaptation Actions: The plan includes measures like the renovation of existing buildings to improve energy efficiency and reduce the cooling demand. There is also an emphasis on adapting new buildings to better handle the cooling demand by integrating renewable energy technologies and energy-efficient solutions. The use of reflective materials, natural ventilation systems, and reforestation in urban areas are also part of adaptation efforts. In summary, the action plans outlined focus on increasing the resilience of the energy system to handle rising cooling demands, implementing energy-efficient technologies like heat pumps and district cooling, and upgrading infrastructure to reduce vulnerability to the impacts of heat waves.

Country	Links between space cooling and national adaptation plans or strategies
	These measures are aligned with Italy's broader climate adaptation strategies to address the increasing risks posed by climate change.
Malta	National policies and regulations on space heating and cooling in Malta are increasingly focused on adaptation to climate requirements, particularly through the deployment of heat pumps, which address both heating and cooling needs while reducing fossil fuel dependency. Adaptation strategies have emphasized efficient technologies, with national incentives for air-to-air heat pumps and solar water heaters in the residential sector, aiming to replace less sustainable systems gradually. Additionally, the lack of natural gas distribution and high efficiency requirements for space heating systems underscore the reliance on electrically powered technologies as the primary means for adaptive space heating and cooling
Poland	National policies in Poland link adaptation measures for space heating and cooling with broader climate objectives, aligning with strategies that emphasize increased use of renewable energy and gradual decarbonization in these sectors. The National Strategy for Adaptation to Climate Change by 2020, extended with perspectives up to 2030, includes measures to support resilient heating and cooling systems, integrating renewable sources to reduce dependency on fossil fuels . Poland's NECP (National Energy and Climate Plan) also encourages the adoption of efficient technologies for space heating and cooling within urban and district-level frameworks to align with EU adaptation targets.
Spain	Spain is among the front-runner countries in developing a national adaptation plan (Plan Nacional de Adaptación al Cambio Climático - PNACC), adopting its first one in 2006. The new plan was adopted in 2020 for the period 2021-2030. As stressed in the background section above, Spain is already significantly impacted by climate changes, notably warmer summers and more frequent and intense heatwaves, as well as more frequent and severe droughts. Clear links are made between the PNACC and the NECP. For example, among the various action lines of the PNACC, action line I.8 is about cities, urban planning and buildings (e.g. to address urban heat islands, and with action 8.3 focused on integrating adaptation in the buildings sector), and I.10 is about climate change impacts on the energy sector (e.g. action 10.4 to improve knowledge about the impacts of climate change on energy demand and identify measures to prevent or limit peaks in demand, especially those associated with heat waves). In the other way, measures of the NECP, such as ‘Low-Emission Areas’ or ‘Energy efficiency in existing buildings in the residential sector’ are also meant to contribute to adaptation purposes as they reduce the impact of heat waves on the population. The draft NECP update also highlights that it is essential that these measures are developed with adaptive criteria to ensure their feasibility and functionality in a climate change context. Since 2004, the Health Ministry prepares an annual National Plan for Preventive Actions for the Effects of Excess Temperatures on Health (Plan Nacional de Actuaciones Preventivas de los Efectos del Exceso de Temperaturas sobre la Salud), including an alert system (4 levels of risk) to inform citizen and coordinate the actions of local governments.

4. Current policy framework's coverage and gaps for promoting sustainable cooling solutions

4.1. Overview of sustainable cooling solutions

Air-conditioning systems relying on vapour compression technology represent almost the only cost-efficient systems on the current market. Only a very small part of the market (about 1%) is made of thermally-driven heat pumps (Elnagar et al. 2023). Elnagar et al. also provide a comprehensive understanding of the most promising solutions to supply space cooling. Although there are many alternative technologies with a large range of capacities and promising higher (even very higher) energy efficiency, their work shows that these technologies still have either technological scalability or cost-efficiency barriers to unlock before challenging the current technologies. Nevertheless, over the next decade, vapour compression technologies could undergo profound changes as a result of developments in European regulations on fluorinated gases (European Parliament, 2024).

Among active measures that aim at mitigating space cooling demand, advanced technological measures, such as smart-glazing, active shading devices and adaptive façades, have investment costs that prevent them from being widely used, particularly in existing buildings (Duplessis et al. 2024). In contrast, as long as cooling demand is not excessive, ceiling or room fans demonstrate superior adaptability and suitability for supplying cost-effective thermal comfort in summer, especially when passive measures like (manual) shading devices and/or natural ventilation strategies are implemented by the room occupants (Hurtado-Verazaín et al. 2023). Other passive measures are still under development or require significant structural changes to be implemented in existing buildings.

Duplessis et al. (2024) have also assessed the costs and benefits of a set of measures and technologies supplying space cooling. Their work highlights that the relevant solution for space cooling supply strongly depends on the building environment and the urban context, as well as the occupants' sensitivity to discomfort. In this way, defining an optimal cooling strategy is definitively a challenge that requires further research, taking greater account of the diversity of occupants, building types and their environment.

4.2. Crossing the set of solutions and the set of policies

The table below summarises the current coverage of the main solutions or issues relevant to space cooling, by the EU policy framework.

Table 5. Current coverage of the space cooling solutions by the EU policy framework.

Solutions or issues	EU legislation and initiatives
Vapour compression systems and heat pumps	Energy labelling and ecodesign regulations aim at removing most inefficient systems from the market and promoting the most efficient ones. Updated regulations to be adopted in 2024. EU Heat Pump Action Plan to be adopted in 2024
Fluorinated gases	F-gas regulation (EU 517/2014) aims at overall phase-down of the quantity of HFC refrigerant.Revision of the F-gas regulation now adopted and to be published soon.
Alternatives to F-gas systems	Alternatives to the use of fluorinated gases encouraged by the F-gas regulations. EU research and innovation programmes may be used to develop them. But no flagship initiative in this field.
Ceiling or room fans	Energy labelling and ecodesign regulations aim at removing most inefficient systems from the market and promoting the most efficient ones. Updated regulations to be adopted in 2024.
Active measures to mitigate cooling demand and other passive measures.	For new buildings, in theory encouraged by energy requirements, but in practice often no specific requirement on space cooling. Further support measures may be needed.Rarely considered in renovation schemes. Further analyses could be helpful to identify when additional costs can be reduced, according to the type of renovation projects.
Risk of renovations worsening summer comfort	Issue raised in the 2016 EU strategy on heating and cooling. But it is not explicitly covered in the EPBD provisions nor in the Renovation Wave's communication. The former mentions the issues of 'inadequate ventilation' and 'healthy indoor climate conditions' (about energy performance requirements). The latter considered the development of climate-resilient building standards.
Behavioural measures	The EED and EPBD include general provisions on consumer information. Measures specific to space cooling and summer comfort may be implemented at national or local level.
Solutions to reduce urban heat islands	Briefly mentioned in the 2016 EU strategy on heating and cooling, in the Renovation Wave's communication and now in the EPBD recast, but no measure or provision at EU level to promote them. These solutions may however be part of national adaptation strategies and plans, required by the EU Climate Law.
District cooling	The provisions of the EED about efficiency in cooling supply specify a definition for efficient district heating and cooling, and require Member States to assess potential for district cooling and adopt supporting measures when relevant.

Solutions or issues	EU legislation and initiatives
RES for cooling	The RED set a target and requirements to increase the share of RES in heating and cooling. In practice, this mostly applies to heating (due to space cooling being mostly electrified).

5. Conclusion and discussion

The shift to an integrated reporting of all the dimensions of the Energy Union means that the main national planning document reported in the EU context (NECP) does not enter into the details of each and every topic, and particularly of topics such as space cooling that, despite its growth, represents a small share of most Member States' final energy consumption, and is already almost fully electrified (so not a major direct challenge for decarbonisation, apart from that of electricity production itself). Still, space cooling is already an important issue for security of electricity supply in a few countries (e.g. Greece, Italy and Spain) already facing significant increases in summer peak loads. National adaptation strategies and plans also often raise increasing summer temperatures and heat waves as major changes to anticipate, emphasising the impacts on health as well as economic activity (e.g. tourism). More integrated approaches for summer comfort would therefore be needed.

The EU framework covers the dominant space cooling technologies (vapour compression systems) with regulations to remove the least efficient devices from the market, inform consumers about the efficiency and consumption of the devices, and plan the phase out from fluorinated gases (due to their very high GWP). Updates of these regulations should soon be adopted to strengthen the requirements and stimulate the developments of more efficient and climate-friendly alternatives. A recent review of space cooling technologies however showed that these alternatives are rarely ready to be massively deployed. Policy measures to complement the regulations may therefore be needed.

At building level, while space cooling is assumed to be included in the energy performance calculations and requirements due to the EPBD, the way it is addressed in national building regulations may vary among countries. The EPBD recast emphasises the need to consider summer comfort. Its transposition could be an opportunity to enhance the requirements to minimise cooling needs in new buildings, and to ensure that major renovations do not worsen the conditions for summer comfort. The development of climate-resilient building regulations could help to address these issues.

At urban level, the EED promotes the development of district cooling which remains rare so far. But going beyond the building level is above all relevant to address urban heat islands, and more generally to adapt urban planning and make use of nature-based solutions. Ensuring summer comfort and other cooling needs in a sustainable way indeed implies the consideration of current and future changes in local climate conditions, and therefore an integrated approach from both the mitigation and adaptation sides. This should start with minimising cooling needs through urban planning and building design or renovation, and enabling occupants to meet their comfort expectations in simple and efficient ways.

In the EU framework, the main requirements applicable to space cooling have mostly been focused on cooling devices, district cooling and developing the share of RES in heating and cooling. This technical focus did not favour the development of integrated approaches. The changes from the fit-for-55 package may improve this, for example with the EPBD recast emphasising more the importance of summer comfort, and the EED recast introducing an official EU definition of energy poverty, clarifying that adequate cooling is part of the basic levels and decent standards of living and health.

Member States may implement measures to address urban heat islands, promote efficient behaviours in case of heat waves or include passive measures in construction or renovation schemes. But due to the focus of the EU requirements, these types of measures are rarely described in Member States' reporting to the EU obligations (e.g. comprehensive assessments, draft NECP updates). This makes experience sharing in this field more difficult. The

CoolLIFE tool contributes to fill this gap by making data about cooling needs, sustainable space cooling solutions and related policies easily available. The analysis of the EU framework presented in this report shows that space cooling is a topic that illustrates well the need to consider more integrated approaches, beyond siloed technical solutions, and addressing jointly mitigation and adaptation. This work will continue in CoolLIFE with gathering good practices of national measures, to show how it can be done.

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