



PLAN4COLD

**DEFINING SUSTAINABLE LOCAL
HEATING AND COOLING PLANS:
A PRACTICAL HANDBOOK**

A N N E X E S

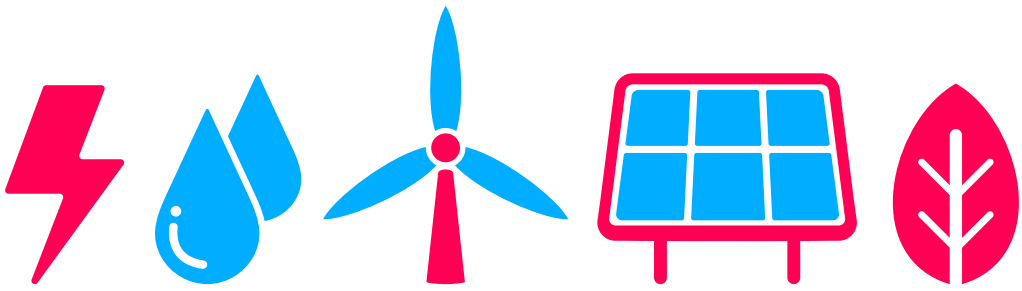


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ABBREVIATION AND ACRONYMS

Plan4COLD

Supporting South Europe municipalities in the definition of Sustainable Local Heating and Cooling Plans

EE: Energy Efficiency

EED: Energy Efficiency Directive

EPBD: Energy Performance of Buildings Directive

DHC: District Heating and Cooling

DHW: Domestic Hot Water

GHG: Greenhouse Gases

H&C: Heating and Cooling

KPI: Key Performance Indicator

RED: Renewable Energy Directive

RES: Renewable Energy Sources

RH&C: Renewable Heating and Cooling

SLHCP: Sustainable Local Heating and Cooling Plan

ANNEX 1

The policy and strategic framework

In the context of the objective of this document, it is useful to briefly outline the regulatory framework of policies and strategies at the EU and national level, so that it can be carried out in a manner consistent with those policies and with commitments made at the local level.

The EU level

The main reference is the Energy Efficiency Directive II (EED II, EU Directive 2023/1791- [Directive \(EU\) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation \(EU\) 2023/955 \(recast\)](#)), which requires Member States to increase the previous energy savings obligations in their National Energy and Climate Plans (NECPs), and, among other measures of energy efficiency implementation, to collect and report data on primary and final energy consumption in the main sectors. Member States are required to integrate in the NECPs a focused initiative for the reduction of the thermal energy needs, based on a comprehensive assessment of heating and cooling, including a cost-benefit analysis that considers various factors, e.g. local climate conditions, and leading to the definition of a heating and cooling plan (art. 25). The plan shall be developed in at least in municipalities having a total population higher than 45,000. A key focus is on opportunities for improving energy efficiency through low-temperature district heating, high-efficiency cogeneration, waste heat recovery, and renewable energy sources (art. 26). The EED also pushes the definition of a pace in the improvement for public authorities and an increase in the share of renewable energy.

Tight connected to EED is the Energy

Performance of Buildings Directive IV (EPBD IV, entered into force on May 28, 2024 -[Energy Performance of Buildings Directive](#)). This directive aims to decarbonize European buildings by 2050. To this end, Member States must prepare a National Renovation Plan by December 31, 2026, and the trajectory to reach those significant targets.

It focuses on increasing the rate of renovation in the EU, particularly for the worst-performing buildings in each country, and covers 4 focus areas: renovation, decarbonization, modernization and digitalization and financing a technical assistance. It also sets a series of obligations for both the public and private sectors, pushing the use of energy performance certificates (EPCs) and building passports as tool for the increase of the renovation pace and making the integration of renewables in buildings equally important. Specifically, starting in 2030, all new buildings must be zero-emission, while public buildings must meet this standard starting in 2028.

The Renewable Energy Directive III (RED III, Directive 2023/2413 -[Renewable Energy Directive](#) <https://eur-lex.europa.eu/eli/dir/2023/2413/oj/eng>) provides the EU legal framework for the development of renewable energy in all sectors. It introduces a binding renewable energy target of at least 42.5 % of gross final energy consumption by 2030, with an aspirational target of 45 %, and includes specific targets for the heating and cooling, transport, industry, buildings, and district heating and cooling sectors. The directive also aims to simplify administrative procedures by reducing barriers that previously discouraged investment. Monitoring and building efficiency are also important in this directive. Therefore, the directive highlights common ground in encouraging the development of efficient district heating and cooling infrastructure using renewable energy. The goal is for each Member State to increase the share of renewable energy in heating and cooling by at least 0.8 % per year (2021–2025) and 1.1 % per year (2026–2030) compared to 2020 levels.

An EU Heating and Cooling Strate-

gy, expected in early 2026, has the specific goal to accelerate decarbonization and improve efficiency through district heating and waste heat recovery systems, promoting clean technologies in buildings and industry. In line with Article 25 of the Energy Efficiency Directive, EU countries are required to conduct a comprehensive heating and cooling assessment and notify the Commission once completed. These assessments should be carried out every five years, together with the National Integrated Energy and Climate Plans.

ANNEX 2

Action and enabling technologies

A holistic understanding of key interventions and technological options that can be available at the local level is necessary to support municipalities and local authorities in designing the SLHCP strategy and selecting the most suitable tools and measure for its implementation towards the H&C system decarbonisation. For this reason, this section of the guideline's deep dives into key actions with the aim of providing guidance towards potential application areas.

Urban regeneration

Aside from the geographic location and climate conditions, several variables influence how urban areas experience and accumulate excess heat. These include, among others, the existing land cover (distribution of urban surfaces, green spaces and tree canopy), the building density, construction practices, and commonly used materials. Proven and demonstrated strategies exist that apply to these variables and can contribute significantly to keeping urban areas cooler while reducing the mechanical cooling needs of buildings. They include a wide range of physical interventions, ranging from optimizing the shape of the built environment, to changing the composition and co-

lours of streets, sidewalks and other surfaces, to increasing the quantity and quality of green spaces. While some of these may require policy, regulatory changes and significant planning, many are “quick wins” in most climate zones.

What remains clear, however, is that all these interventions do mitigate the urban heat island effect, and many of them increase indoor and outdoor thermal comfort. Details on the magnitude of impact will have to be modelled and tested on a case-by-case basis.

Strategies and interventions can be broadly grouped in three inter-related categories:

- Heat-resilient urban form and planning
- Cool surfaces
- Nature-based solutions (NBS)

Urban form and planning

Land-use planning and design control is generally the biggest lever for mitigating future challenges related to the urban heat island effect. Appropriate changes to land use and design controls that prioritize green space and green infrastructure, and promote water-sensitive urban design, will help change the way that buildings and communities are constructed and designed. Land use and building design controls must be adjusted at several different scales – at the city, district and neighbourhood level – in order to maximize effectiveness and ensure that the density and form of new development is appropriate for future climate conditions.

Cool surfaces

In an urban environment, the surfaces that contribute to the urban heat island effect (roads, sidewalks, parking lots, building walls and roofs, even car exteriors) far outnumber the surfaces that reduce the effect (parks, lawns, trees, gardens, water). Conventional paving materials, which typically cover around 40% of a city, reach peak summertime temperatures of up to 65°C and heat the air above them.

Many of these built surfaces can however be replaced with or modified to be surfaces that reflect heat instead of absorbing it. There are two main strategies to make surfaces more re-

flective: Use lighter-coloured materials or apply a coating or overlay.

Replacing or retrofitting existing low solar-reflectivity surfaces with high solar-reflectivity surfaces can drastically reduce the urban heat island effect. And by reducing the need for mechanical cooling, they can also help reduce waste heat and urban heat islands.

Cool roofs are globally applicable to nearly all building types; there are a wide variety of highly reflective products available in nearly every roof surface type and they are generally cost-effective. Roofs can be painted white or with other highly reflective paint, or covered with sheet, highly reflective tiles or shingles, to reflect more sunlight and absorb less heat than a standard roof, cutting building energy use by up to 20%.

It is easiest to design for and choose a cool option when a new roof or a replacement roof is installed, but there are also options to use coatings to increase the solar reflectance of an existing roof. Currently, materials for cool low-slope roofs are more reflective and cheaper per square meter than materials for cool steep-slope roofs, but technology for both continues to improve.

Cool walls use the same principles as cool roofs and provide the same benefits. Nevertheless, they present some costs compared to traditional surfaces. Most materials are more expensive, installation and maintenance are required, and winter heating needs may increase. Upfront costs vary widely in different markets and can represent a challenge in markets where fewer options are available. But cool surfaces present a wide array of benefits as well, including direct and indirect cooling energy reduction, peak energy load reduction, lower energy bills, in some cases longer surface life.

Nature-based solutions (NBS): green and blue spaces

Natural features provide cooling benefits through evapotranspiration and direct shade in the case of trees and other vegetation, and by acting

as heat sinks in the case of bodies of water. As a result, integrating vegetation and water bodies (also referred to as nature-based solutions- NBS) at the urban level can reduce local and ambient temperature

NBS can include forests, wetlands, green belts and parks in and around cities as well as green infrastructure such as natural wastewater plants, green roofs, green wall, ecosystem corridors and other green, blue and hybrid infrastructure.

While native species will usually be best adapted to the city’s climate, there may be a need to integrate species from climate zones comparable to those expected in the future, and to prioritise species that are resilient to drought, wildfire or other climate impacts. Diversifying species can also strengthen the resilience of the local ecosystem.

Nature-based solutions are some of the most powerful tools to both reduce cooling demand and improve outdoor thermal comfort. They can also provide a range of physical and mental health benefits, are cost-effective, and have few trade-offs or downsides compared to other cooling interventions.

Green roofs and walls combine the benefits of vegetation and green spaces with the benefits of cool roofs and walls: they prevent solar gain on buildings thus improving the thermal, and acoustic, properties, cool the surrounding air through evapotranspiration, retain, collect, and use stormwater and provide for more local biodiversity. They range from a thin layer of vegetation (extensive green roofs) to trees and shrubs (intensive green roofs) and are most suitable in cities with sufficient precipitation and require buildings that can support their weight.

Green roofs are more expensive than cool surfaces and require ongoing maintenance, but if properly sized and maintained they can extend the life of the underlying roof.

Green walls are vertical systems of plants attached to an internal or external wall or are freestanding. Typically used on or in buildings, they can also be part of streetscapes, for example on columns or fences lining busy roadways. A major benefit of



outdoor green walls is that they are highly visible to the public and can provide a best practice that might otherwise be less visible. Green walls are less common than other measures, so markets are less developed and prices are often high.

The building sector - Residential and tertiary

The building sector is a critical component of urban infrastructure, accounting for more than half of the share of energy consumption and approximately half of the total GHG emissions in EU municipalities.

- Buildings account for approximately 40% of the EU's energy consumption, while 75% of buildings' heating and cooling is produced from fossil fuels.
- Nearly 35% of the buildings in Europe are more than 50 years old, and almost 75% of the building stock is considered inefficient¹.

Buildings have a long lifespan covering many decades, and therefore efficiency measures embedded into them can have significant benefits that last far into the future.

At date, the building renovation rate is still rather low and increasing it can contribute to the more efficient use of

energy and the reduction of GHG emissions while improving indoor comfort. With a wide range of building types, residential, tertiary, public, the sector can reduce its GHG emissions due to H&C needs through various energy retrofit measures, targeting the building envelope on the one hand and the building's H&C technological components, such as plants and devices, on the other hand.

The building envelope acts as the 'skin' of the building, regulating contact and energy exchange with the outside and interventions to improve its thermal performance and minimize the mechanical heating or cooling loads (passive measures) must be the first step in the process of energy upgrading a building. Passive measures could reduce cooling loads by 24%, with savings in investment costs, energy costs and GHG emissions. Key principles of passive measures may include appropriate materials and design features in the building envelope (insulation, windows and shading to minimize heat/cold gain due to thermal transmittance) and natural ventilation where temperature, humidity and air quality allow. Passive measures could reduce cool-

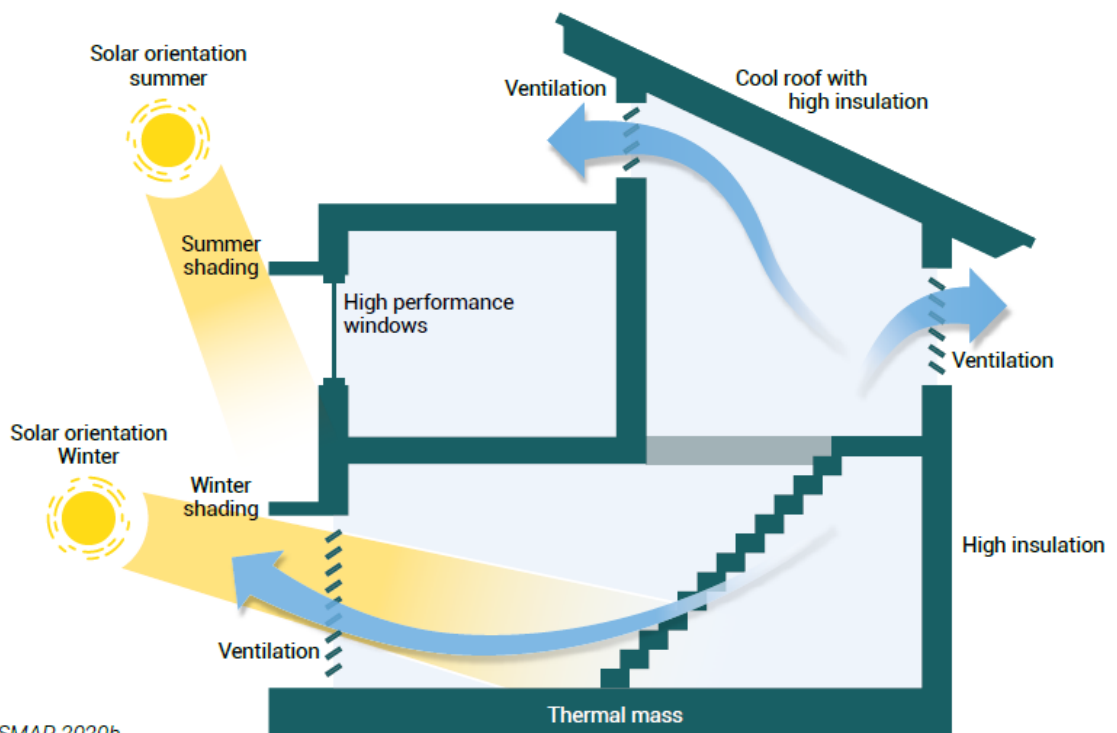
ing loads by 24%, with savings in investment costs, energy costs and GHG emissions.

Once the H&C loads are reduced, efficient and best-fit technologies, plants and building management and operation systems should be introduced to deliver the required amount of H&C with the least amount of energy. Reducing loads in the H&C chain is important because the replacement cycle for plants and equipment is typically around 10 to 15 years, which is much shorter than for buildings (50 years).

The integration of local RES to meet the reduced energy demand can then strongly contribute to further lowering the environmental impact of H&C final uses and the energy costs as well.

Passive measures

The building envelope consists of roofs, walls, floors, windows and doors. Different retrofit measures can be carried out on both opaque and transparent components of the building and can be realised at the component level, dwelling level, building level and even at an up-scaled district level.



Source: Adapted from ESMAP 2020b

Adding **insulation material** is the most common measure for improving the thermal resistance of the building envelope, thus reducing the number of thermal losses. Insulation acts as a barrier to heat flow, reducing heat loss in winter to keep the interior of a building warm and reducing heat gain in summer to keep the interior of a building cool. The exact insulation measures depend on the type of structure, the type of insulation material, and the location of the insulation material within the structure.

For **façades**, the insulation layer can be placed externally, internally or in the wall cavity. From a building physics perspective, external insulation is the preferred option because it provides the most guarantees for realising a continuous insulation coat around the building without ‘thermal bridges’ and it completely ‘packs’ the thermal mass of the building structure so that the latter can work as heat (or cold) storage within the protected volume, reducing the temperature fluctuations and hence improving the thermal comfort.

Roof insulation is generally more critical than wall insulation and will most often be the first measure to apply when prioritizing retrofit interventions. At the same time, the payback time for roof insulation is generally (much) shorter than for wall insulation. How the roof is insulated depends on the roof type; the appropriate techniques for flat roofs are substantially different from those for pitched roofs.

Attic insulation. In the cold attic, insulation is placed on the attic floor rather than in the roof structure, keeping the loft cold. In the warm attic, thermal insulation is placed in the roof structure. In this way, the attic can be used as a living space rather than as a storage space solely.

Windows are typically a significant source of heat and cold gain in a building and therefore the use of appropriate materials in windows is a critical issue. Common strategies include using double- or triple-paned windows and using high performance glass that controls thermal conductance and solar heat gain. Indoor

comfort will increase as well, as the cold radiation from windows in winter will substantially decrease. There may however be a limit to set on the thermal performance of the windows, depending on the thermal characteristics of the other parts of the building envelope. Installing triple – or even double-glazing windows in poorly insulated walls may provoke condensation problems on the walls.

External/Internal shading devices can limit the amount of undesired solar radiation entering the building. They can be either external or internal, either fixed or dynamic. External shading is more efficient than internal shading as solar radiation is prevented from entering the interior space where it will be absorbed and turned from light into heat. Fixed shading can be smartly designed so that with low solar altitudes in winter, the sunlight enters the building and provides free heat gains, while with high solar altitudes in summer, the radiation is blocked off.

Ventilation. Air movement cools people by increasing evaporation, and ventilation cools the building naturally at lower ambient temperatures by removing heat. When outdoor temperature, humidity, and air quality allow, free cooling through open windows (also referred to as “natural ventilation”) may be all that is required to improve temperature and humidity in closed indoor spaces.

H&C technologies

According to an integrated approach, passive measures shall have to be complemented with the renovation and refurbishment of installed plants and devices and the application of new and more efficient technologies, distribution and operations systems, to deliver the required H&C needs with the least possible amount of energy and emissions.

With a wide range of technologies available, the choice of the most suitable and efficient solution will depend on several factors, but particularly on the type (residential, tertiary, etc.) and scale of the built environment being addressed – that is, whether H&C is to be provided, for example, for a room, a single build-

ing, or more buildings.

Mechanical H&C ranges from the use of single heating boilers, heat pumps, fans, air coolers and air conditioners to complex HVAC or centralized systems. Furthermore, it can entail measures to ensure efficient operations – including maintenance and demand-side management practices also including building automation.

As for more traditional heating systems, if renewables are not locally available, **condensing boilers** should be considered, also foreseeing fuel shift from oil to natural gas.

Individual renewable heating technologies such as **biomass** and **solar thermal** plants can also play an important role in a local low-carbon building renovation strategy and will remain important for replacing fossil-based technologies. Both can be used to generate heat and hot water, can be employed in various applications and can also be **combined** to create **hybrid systems**.

The use of wooden biomass for heating is quite diffused all over Europe particularly in the domestic sector, mainly in small-scale manually loading systems (often integrating main heating traditional systems) with usually limited energy and environmental performances (dust emissions can be quite significant in case of bad maintenance or bad combustion). Nonetheless trustable technologies are already available on the market, ensuring high efficiency levels, modest investments and a low level of emissions in full compliance with regulatory limits.

Solar thermal plants can be integrated on building structures or placed on the ground. Therefore, a key aspect to be considered is the availability of suitable surfaces for installation (as for slope and azimuth to maximize solar radiation, as well as for architectural and structural possible constraints).

Solar-biomass integration, combining solar thermal panels and a biomass boiler for space heating and hot water production, can be a real-



ly efficient and sustainable solution, reducing biomass consumption and maximising emission reduction. In fact, solar thermal can cover most of the energy requirements during summer and the warmer months, while the biomass boiler can be used only in winter or when the sunlight is not sufficient.

Heat pumps are a versatile technology crucial in decarbonising the EU's heating and cooling sector. They can be used in various settings, from residential buildings to industrial structures, and can be integrated with other low-carbon technologies.

- They are from 3 to 5 times more energy-efficient than fuel-based or electric resistance systems, because they
- move heat in and out of buildings instead of generating it.

They can be particularly suitable as an alternative to independent LPG or heating oil systems serving buildings not connected to the gas network. To ensure adequate levels of efficiency, their application requires low-temperature emission systems (radiant panels or fan coils) and, in all cases, a good performance of the building envelope.

Heat pumps are usually connected to a tank for hot water, heat distribution systems, bathrooms and kitchens and some models also provide space cooling and can be efficiently **combined with solar thermal plants**. In fact, solar thermal can cover a significant portion of hot water requirements, thus lightning the workload of the heat pump and reduce electricity consumption.

There are 3 main types of heat pumps, as described in the following and the one to be selected will depend on the H&C demand, the space available and availability of nearby renewable ambient energy.

Air-to-water heat pumps use heat from outside air to heat water for radiators or underfloor heating. Some models also provide space cooling. Their average lifespan before replacement is 15-18 years.

Ground source heat pumps use heat from the outside ground to heat water for radiators or underfloor

heating. Ground source heat pumps, as well as water source ones that absorb heat energy from a nearby river, lake or pond, or from groundwater, are also more energy-efficient than air-source heat pumps as ground and water temperatures stay relatively stable compared with outdoor air temperatures. Their average lifespan before replacement is 20-25 years but the loops that absorb heat from the ground can last for more than 50 years.

Air-to-air heat pumps use heat from the outside air to heat home through in-room blowers or vents. They are ideal for homes without radiators or underfloor heating, and they can also provide space cooling. Some models can be combined with water tanks to provide hot water for bathrooms and kitchens. Their average lifespan before replacement is 12-15 years.

Heat pumps generally operate at high efficiency and will reduce greenhouse gas emissions for most municipalities, except those relying significantly on fossil fuels for their power production.

A crucial point should thus concern the sustainability of such solutions, since electrification doesn't automatically imply decarbonization. For heat pumps to be truly sustainable, the electricity powering them must come from RES.

Heat pumps, if powered by low-emissions electricity, can be one of the central technologies in the global transition to secure and sustainable H&C.

Active cooling measures involve the use of mechanical means to remove or transfer heat from an indoor space. Multiple mechanical cooling options are prevalent to provide cooling and ventilation in buildings, such as vapour compression systems, fans and air coolers.

Vapour compression-based air-conditioning systems are the most dominant space cooling approach today and include several technologies of

varying complexity, such as room air conditioners, central unit air-conditioner systems, variable refrigerant flow systems and chillers.

While each category of cooling equipment encompasses a range of efficiencies, the most efficient equipment types are often fans, fan derivatives and evaporative cooling. But these approaches do not provide the full utility that vapour compression cooling provides across all climatic conditions today.

Within the vapour compression equipment types, those that can use heat sinks (typically water or geo-exchange) to increase the efficiency of the condensing cycle, would be the most efficient – starting with district cooling followed by water-cooled chillers.

Among air-cooled cooling equipment, the distinctions in efficiency between available solutions as opposed to fixed-speed compressors and fans, are less pronounced.

Cooling equipment such as fans, air coolers and room air conditioners are operated across all levels; however, these are most widely used at the room, residential and small commercial scales.

As the building scale moves towards offices and large commercial and industrial scales, cooling equipment such as multi-split air conditioners, variable refrigerant flow air conditioners and chillers become a more common choice, due primarily to better control, ease of maintenance and the improved overall efficiency of centralized systems over individual units.

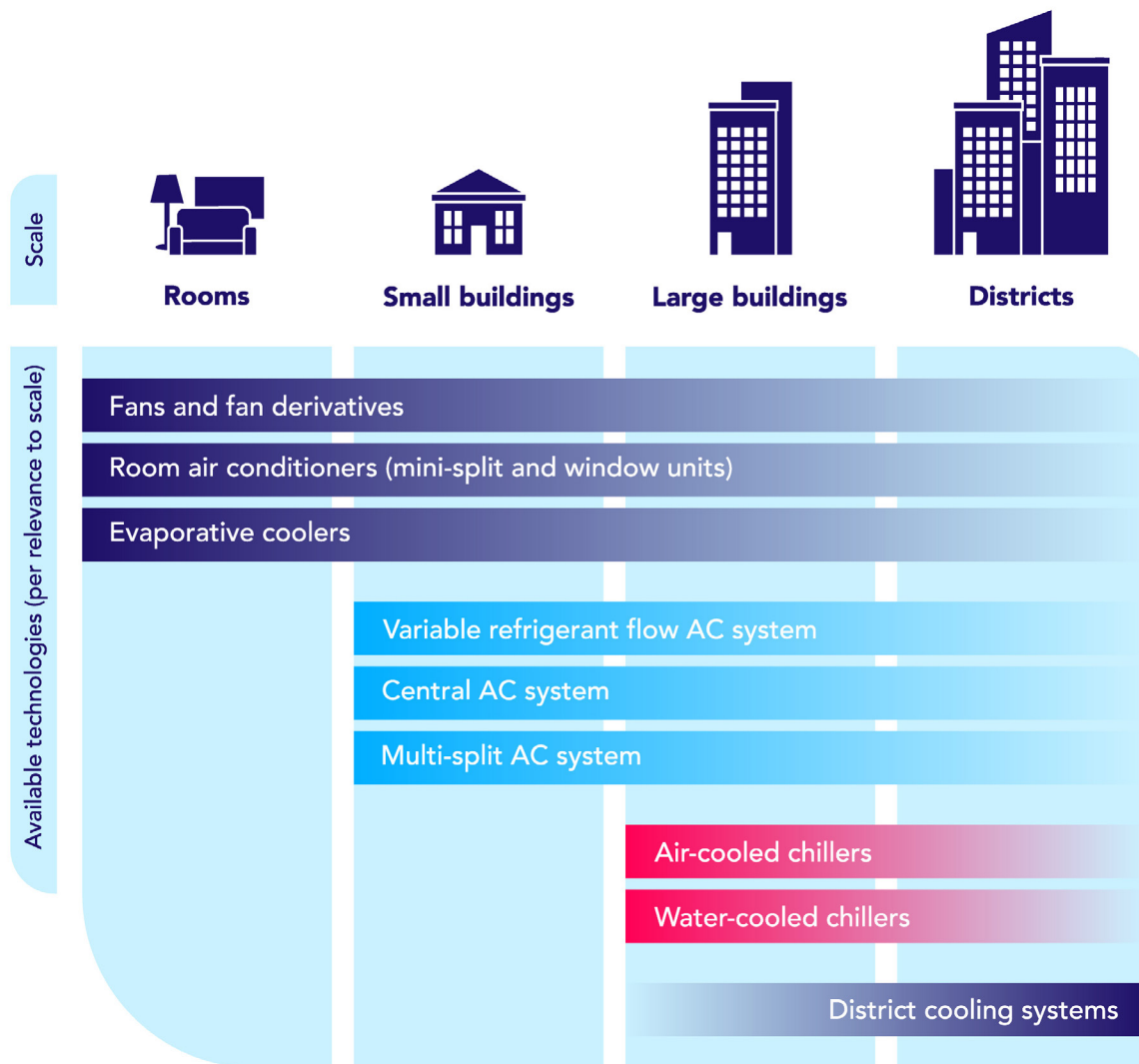
As the building scale expands to include multiple buildings systems, district system approaches can become a viable choice subject to sufficient scale and density.

H&C final uses may also concern **refrigeration and cold chains**² for storing food or specific products in tertiary facilities such as supermarkets and food warehouses, but also public services such as hospitals, health centres, pharmacy, etc.

A variety of technology innovations exist, concerning both equipment efficiency improvement and load reduction through the entire cold chain, to ensure that this is being done in an environmentally and economically sustainable manner while

minimizing energy consumption. Relevant measures can include the use of advanced insulation materials, energy-efficient refrigeration systems and smart temperature monitoring, as well as low-GWP refrigerants.

2 The cold chain can be best defined as: “The series of actions and equipment applied to maintain a product within a specified low-temperature range from harvest/production to consumption, including farming/fishing, food processing, cold storage, transportation, food services, and domestic uses, as well as specialized products like medicinal products and vaccines” (UNEP OzonAction 2020a).



Cool Coalition “Beating the heat. A Sustainable Cooling handbook for Cities” <https://coolcoalition.org/>

The manufacturing sector - Industry and agriculture

The industry sector is one of the largest energy consumers in the EU, accounting for 25,1% of final energy consumption. In EU municipalities, industry accounts for 12,5% of energy consumption and 13% of total GHG emissions. Process heating is the most important energy use in the EU industrial sector, corresponding to more than half of accounted energy demand, and mainly dependent on fossil fuels. Among the most ener-

gy-intensive sectors are the iron and steel, the chemical and the non-metallic mineral products, with mainly high temperature process (>500°C).

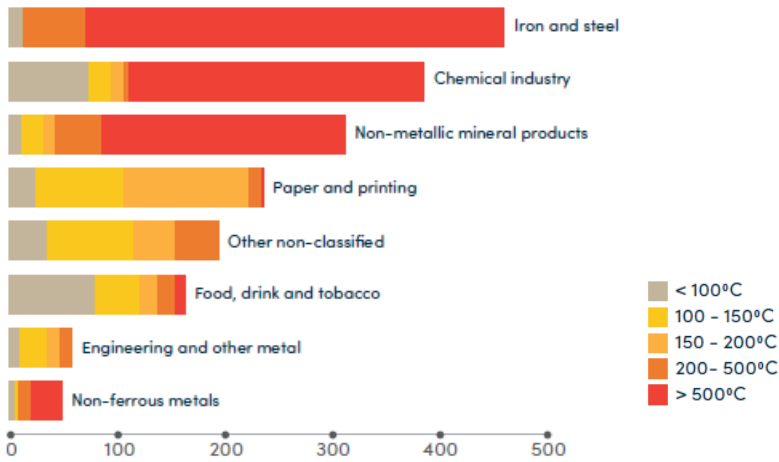
Also in the agriculture sector, process heating is often the most relevant energy use, generally connected to farm and livestock products processing. In both sectors, other relevant H&C final uses can also include space heating and cooling, refrigeration and cold chains.

Energy is an important component of production costs in many indus-

trial sectors, although its share can strongly vary. These differences are influenced by the dimension of firms, the type and complexity of production processes, the technologies, operational practices and management approaches.

Energy efficiency offers a way to structurally lower yearly energy costs, while providing the same or, in many cases, improved output. Investing in efficiency can also help firms to create or safeguard jobs, lower emissions, and achieve a more durable competitive advantage.

Estimated total final energy demand for process heating in 2019 by temperature & energy carrier in EU-27 (Source: Fraunhofer-Ise)



For highly energy-intensive industries, managing energy costs can be a question of survival. These heavier industries (such as chemicals, metals, pulp and paper, refining and cement) are characterised by high fixed costs and capital-intensive processes, where efficiency improvements often require substantial upfront investment. For less energy-intensive sectors (such as electronics, machinery, automobiles, textiles, and food and drink processing), energy generally plays a smaller role in overall costs. However, these lighter industries have significant potential to achieve cost-effective energy savings in the short term, with lower capital costs. Managing costs in lighter industries is also crucial, not only to improve firm competitiveness but also to achieve broader economic objectives. The industry sector has a significant potential for reducing H&C energy demand and improving energy efficiency, that can be deployed at the local level: The adoption of energy-efficient equipment, process improvement, RES and low-carbon technologies and digital tools, management procedures.

Electrification is an essential part of industrial decarbonisation. High-temperature heat pumps and electric boilers/furnaces could meet up to 45% of industrial heat demand for temperatures between 200 and 500 °C. Furthermore, almost 40% of the heat required by industries is needed at temperatures below 150-200 °C, which can be easily achieved using industrial heat pumps.

In industrial applications, heat pumps are designed to meet more complex and higher-temperature demands than in the building sector. Common configurations include:

- Liquid/water-to-liquid/water heat pumps
- Air/gas-to-liquid/water heat pumps
- Liquid/water-to-air/gas heat pumps
- Air/gas-to-air/gas heat pumps

For higher temperatures, resistance heating, electric arc furnaces and induction technologies can reach up to 1,800 °C and 3,000 °C respectively, making them suitable for melting metals and plastics. Existing technologies, which are already promising, are likely to improve further in the coming years. Electrified processes are more efficient than those based on fossil fuels, reducing overall consumption and emissions, however they are not always the ideal or the only possible solution. A crucial point should concern the sustainability of such solutions, since electrification doesn't automatically imply decarbonization. To be truly sustainable, the electricity powering them must come from RES.

Several alternative or supplementary technological solutions already exist, able to increase final uses efficiency, reduce consumption and GHG emissions. Some are easy-to-implement measures (quick-win), that typically have low upfront costs and re-

quire limited intervention, which can translate into short payback periods, reduced risks and more easily perceived benefits:

- Regulation of heating, ventilation and air conditioning (HVAC)
- Reduction of losses in compressed air systems
- Repair and maintenance of insulation materials
- Right-sizing and linking assets to match load
- Replacement of aged motors with high-efficiency models

Deeper upgrades entail more significant, longer-term changes to equipment or processes and deliver more substantial improvements to energy and process efficiency. While quick wins can be enabled through easy-to-implement changes, deeper upgrades generally require investment in newer equipment and adjustments to production processes. Examples include:

- Recovery of waste heat from operations (well-designed exchangers, recuperators on furnaces/dryers and absorption heat pumps)
- RES plants installation and/or energy recovery from processing waste
- Redesigning processes to reduce energy use and/or production line bottlenecks
- Advanced automation and controls to optimise energy use
- Building insulation and fabric improvements
- Thermal energy storage systems installation.

Among renewables, solar thermal can be particularly suitable for industrial processes, farm facilities and agriculture activities with temperatures up to 500 °C, like pre-heating of raw materials, provision of hot water or steam generation:

- Greenhouse heating, washing, heat treatment and drying (<75°C)
- Boiling, pasteurising, sterilising, bleaching and dyeing (75°C to 150°C)
- Distilling, nitrate melting, pulp-ling and drying of paint (150°C to 400°C)

The local H&C energy supply – Renewable energy sources

This section and the following, are intended to provide a collection of key measures to promote the uptake of renewable sources, enabling technologies and integrated urban energy systems for a sustainable local H&C supply chain.

Photovoltaic

Solar energy is the fastest-growing RES, largely due to an 82% drop in costs between 2010 and 2020 and one of the most promising approaches to electricity production.

Solar energy can be harnessed using photovoltaic (PV) systems, which convert sunlight into electricity. Most photovoltaic modules are used to generate power connected to an electricity grid while there is also a smaller market for off-grid power, particularly in remote areas and developing countries.

PV systems can be installed on rooftops, in solar parks and in areas such as roads and roundabouts, railways and water bodies to optimise the use of land dedicated to PV systems.

The integration of renewable energies in cities, in particular building integrated photovoltaics (BIPV), where solar panels double as architectural elements, represents significant opportunities in combination with increased energy efficiency. The integration of solar modules has been improved by manufacturers. In addition to roofs and bricks, modules can be integrated to external building walls, semi-transparent façades, skylights and shading systems.

Solar energy integration in buildings offers several benefits: it contributes to reducing energy bills, improves energy efficiency and enhances environmental performance. Widespread adoption also protects consumers from energy price fluctuations and helps combat energy poverty.

The Energy Performance of Buildings Directive in Article 10, mandates increased deployment of suitable solar energy installations on new buildings and certain existing non-residential buildings where technically and economically feasible. It ensures that

new buildings are solar-ready, fitted to host solar installations based on site-specific solar irradiance, thus facilitating future installation of solar technologies without expensive modifications.

However, challenges remain: Solar energy's variable supply, low conversion efficiency, and the complexity of integrating systems into existing buildings represent technical hurdles. Economically, despite cost reductions and low operational costs, upfront investment remains relatively high compared to other energy sources. For instance, while BIPV is not new, it remains a niche market in the EU, with a limited and specialised demand and just a handful of producers, largely due to different legal requirements and certification needs for such products and market fragmentation. Lastly, more skilled workers are needed to meet the EU renewable energy deployment targets, including in the solar sector.

Agrivoltaics

Agrivoltaics combines farming and photovoltaic electricity production. This innovative approach allows for the simultaneous production of food and energy, mitigating concerns about land competition between solar panels and farming activities. Additionally, agrivoltaics systems can provide shading for crops, protecting them from heat stress and severe weather, while also offering opportunities for greenhouses made of semi-transparent PV panels. The implementation of agrivoltaics at the local level requires careful consideration of various factors. Identifying suitable areas for agrivoltaics systems, such as agricultural lands, brownfields, or other underutilised areas, is a crucial step as well as the impact on agricultural land practices.

Solar thermal systems

Solar thermal energy, together with biomass and geothermal energy can be a major source of heating and cooling in Europe.

Solar thermal systems convert sunlight directly into heat and make this heat available for various applications. Main market segments may

include: residential and tertiary buildings, industry, agriculture & farming, district heating.

Currently, solar thermal applications are mainly used for domestic hot water (DHW) and space heating in single and multi-family homes, although large-scale uses have experienced a strong growth over recent years. They can provide heat for industrial applications (Solar Heat for Industrial Processes- SHIP) like preheating of raw materials, provision of hot water, or generation of steam for various manufacturing processes. Solar thermal can also be used in agriculture and farming, e.g. to dry crops, to warm food/drinks for animals, to warm greenhouses etc.

Solar district heating systems, with and without large seasonal heat storages, are relevant for district energy systems. Large solar heating systems can also be integrated into an existing district heating system. Collective systems that are used in multi-family homes, hospitals, hotels and retirement homes are other options.

In terms of efficiency, solar thermal panels require three times less roof space than PV panels to generate the same amount of energy.

Solar Thermal panels can work in synergy with a range of technologies and can be effectively combined with other renewables such as biomass, heat pumps, and biogas, improving overall system efficiency and furthering decarbonisation.

Combining solar thermal and heat pump technologies offers a particularly powerful and increasingly relevant heating solution. Together, these high-efficiency, low-carbon systems are already in use in many European buildings. Solar collectors, capable of converting up to 80% of the sun's radiation into usable heat, can preheat domestic hot water or provide space heating. In addition, solar thermal heat can be used to drive a thermal cooling machine and so be used as an energy source for cooling. This reduces the load on the heat pump, enabling it to operate more efficiently. As a result, the combined system consumes less electricity, leading to lower energy bills and greater protection against fluctuations in energy prices. Moreover, these hybrid systems are designed



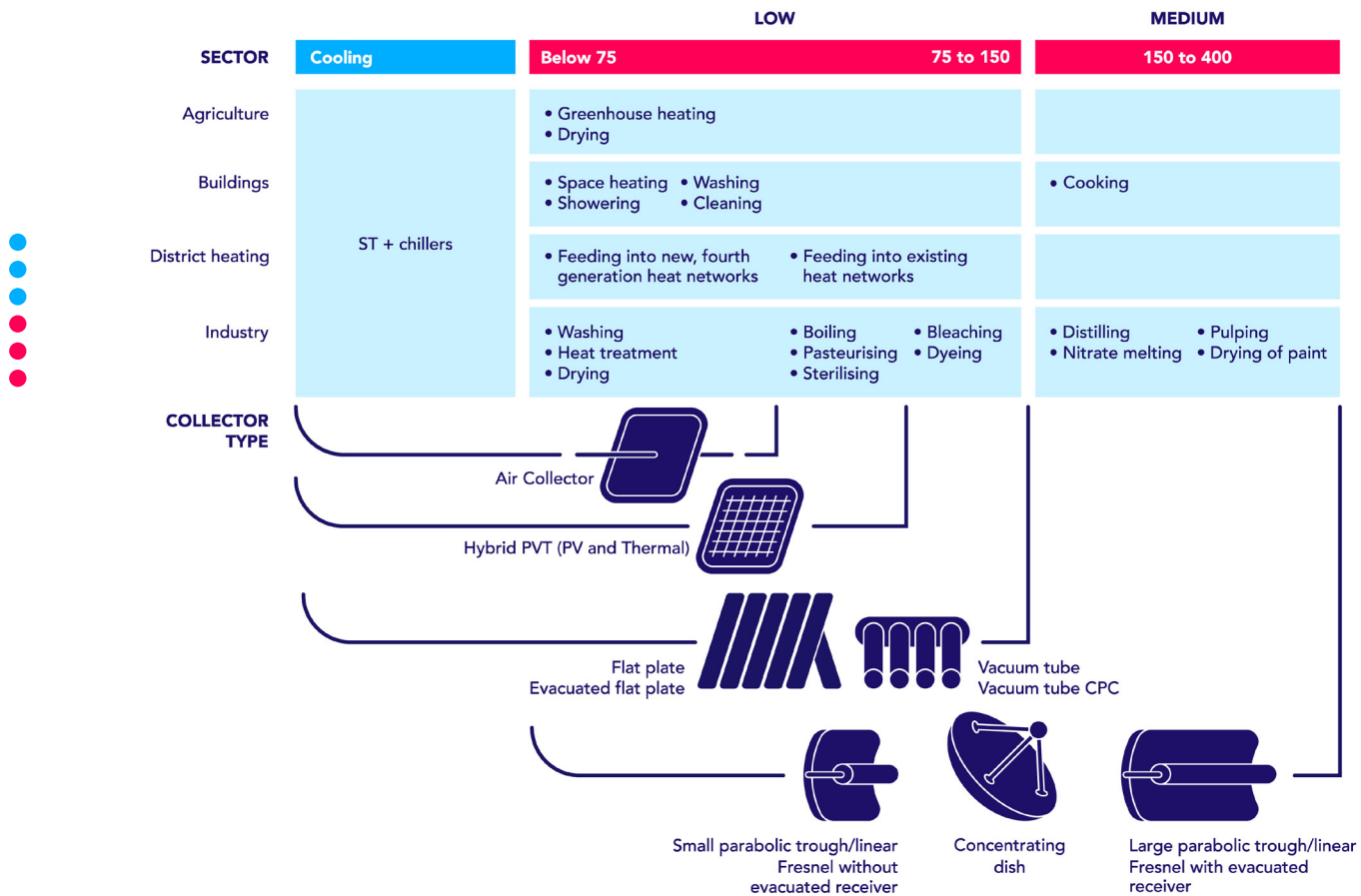
for longevity: solar thermal systems can operate reliably for 25–30 years, while heat pumps, when not overloaded, maintain high performance for 15 – 20 years. By reducing stress on individual components, this configuration enhances durability and lowers maintenance requirements,

making the system more cost-effective over its lifetime.

Against the backdrop of the recast EPBD and the drive to decarbonise Europe's building stock, solar thermal and heat pump hybrids offer a scalable, reliable, and future-proof

solution that warrants far greater attention in renovation strategies.

In addition to solar thermal systems, photovoltaic/thermal (PV/T) systems are an option for the utilization of solar energy to produce both electricity and thermal energy.



Source: Solar heat Europe "Market Outlook 2024/2025" - www.solarheateurope.eu

Geothermal

Geothermal energy is a renewable energy source harnessed from the thermal energy stored in rocks and fluids deep within the earth's crust. Drilled wells connect the fluid to the earth's surface, allowing it to be used for a range of purposes such as to generate electricity or provide direct heat for district heating, water heating or industrial processes.

Geothermal can also present a significant opportunity to increase the uptake of renewables and decarbonisation of the energy sector, not only through electricity production, but also of heating and cooling (e.g. water heating or industrial processes, among other).

A major advantage of geothermal en-

ergy, compared to other renewable energy sources, is that it is not dependent on the weather conditions and can help to offset the risks associated to an energy system based on variable supplies of other energy sources. When used for heating, geothermal offers efficiency gains by supplying heat directly.

Several geothermal technologies exist, with different levels of maturity. So far, the share of geothermal energy in the EU's renewable energy mix is small compared to other sources, such as wind and PV, due to several challenges and obstacles associated with technical and economic risks: High upfront costs, the lack of knowledge and of geological data, the availability of skilled labour.

But it has potential to grow in the context of the European Green Deal and the EU's ambition to achieve carbon neutrality by 2050.

Biomass

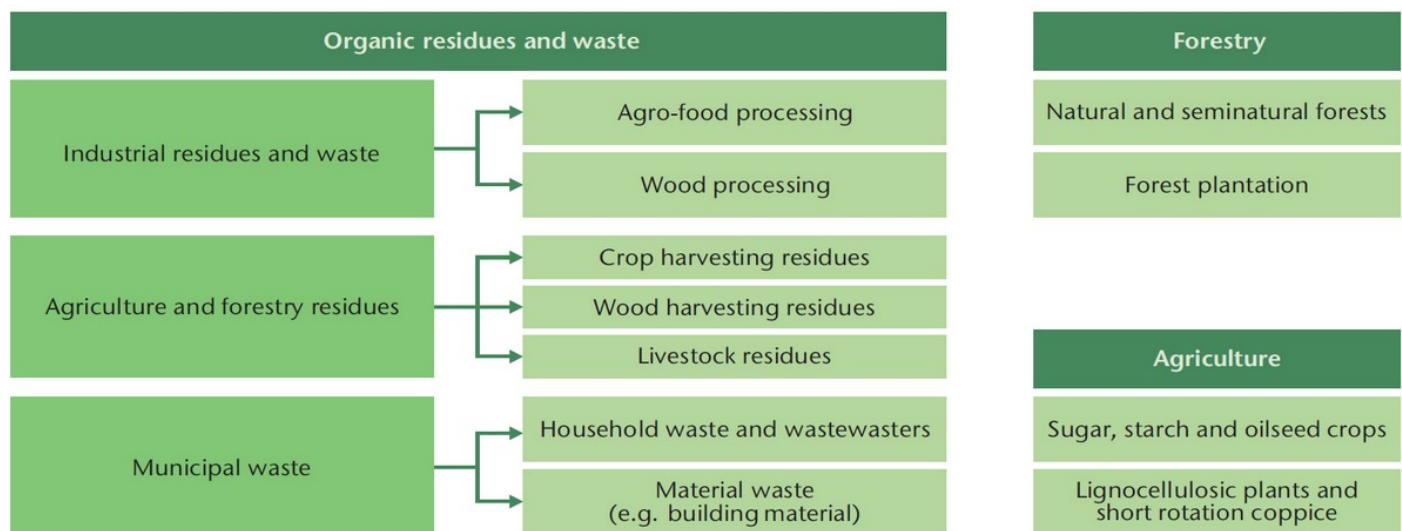
Biomass is defined as biological material which is directly or indirectly produced by photosynthesis. Examples are wood and wood residues, energy crops, crop residues, and organic waste/residues from industry, agriculture, landscape management and households.

The biomass is converted to solid, liquid or gaseous fuel and is the main source of renewable energy today, contributing to energy used in power generation, heat for industry and buildings, and for transport.

International Energy Agency (IEA) modelling indicates that modern bioenergy is an essential component of the future low carbon global energy system if global climate change commitments are to be met. Some key features of bioenergy:

- Available now
- Applicable in all energy sectors (electricity, direct heat, transport)
- Readily integrated with existing infrastructure
- Storable – it can support expansion of intermittent renewables

Bioenergy encompasses many potential feedstocks, conversion processes and energy applications. It interacts strongly with the agriculture, forestry and waste management sectors, and its prospects are linked to the growth of a broader bioeconomy.



Source: IEA Bioenergy - www.ieabioenergy.com

Technologies for producing heat and power from biomass are already well developed and competitive in many applications. A wide range of other conversion technologies are under development, offering prospects of improved efficiencies, environmental performances and lower costs.

The use of biomass for collective heating could be a good choice once some requirements are met. First of all, a local short supply chain should be ensured, thus avoiding unsustainable energy production and stimulating the territorial economy. Secondly, the best available boiler technologies, in terms of conversion efficiency and emission filtering and reduction, should always be used. The use of modern and efficient collective boilers that run on biomass is cheaper and more sustainable than having many individual systems. Lastly, the energy production by biomass can be combined in a synergic way with other sources, to reduce the fuel consumption and the related emissions, for example, by coupling these systems with a solar thermal plant.

Bioenergy can only expand if supplied and used in a sustainable man-

ner. It contributes to climate change mitigation when:

- Biomass is based on waste/residues or is produced in line with sustainable resource management, forestry and agricultural practice
- Biomass is produced with minimized impacts on land use change emissions by co-production with food, use of under-productive land, improved production
- Converted to energy products efficiently
- Used to displace GHG-intensive fuels

While biomass is attractive as a renewable fuel, utilization of biomass as an energy resource is not without potential environmental impacts. Competition for arable lands required for food and fiber production is the major issue concerning biomass production. Soil disturbance, nutrient depletion and impaired water quality are also potential environmental effects from biomass feedstock production and utilization of agricultural and forest residues for energy. The importance of these impacts is highly site-depen-

dent and must be assessed locally. Biochemical processes for converting biomass materials to fuel produce air pollutants, solid waste and wastewater, which may adversely impact the environment.

Thermochemical conversion of biomass to fuels produces air pollutants including particulates, carbon monoxide, hydrogen sulphide and polycyclic organic matter. Other environmental considerations arise from the production and handling of wastewater and solid waste.

The environmental impacts from biomass production and conversion can be minimized by implementing careful planning and conservation practices, employing appropriate environmental control technology and utilizing any by-products and residue produced.

Waste heat

Excess heat or waste heat includes all the heat flows resulting from any process that cannot be recovered for the process itself but can be reutilized for other purposes. This definition would include the excess heat resulting from electricity production in a power plant.

Waste heat recovery can be used in a variety of ways, including feeding it into district heating networks, providing direct heat to buildings, and powering industrial processes. Other potential uses of waste heat include heating greenhouses and aquaculture facilities, powering desalination and water treatment processes. Additionally, waste heat can be used to produce fuels such as methanol and biodiesel, and to power hydrogen production through electrolysis. To complement these approaches, waste heat recovery can be integrated with energy storage technologies, to optimise its use, enhance flexibility and provide a stable and reliable energy supply.

- There is a myriad of industrial processes that release heat to the environment and can be utilized. Conventional sources include refineries, cement production and steel mills. The sources provide temperatures that are high enough and can be used directly by a district heating network by means of a simple heat exchanger. Furthermore, they may also be employed for producing cooling thanks to absorption chillers, which convert heat to cooling with very limited electricity consumption

Other types of non-conventional lower-temperature (below 70 °C) waste heat sources are data centres, supermarkets, sewage treatment facilities or metro ventilation.

By harnessing waste heat from industrial processes, power generation, and other sources, municipalities can reduce their energy consumption and GHG emissions. Effective implementation requires a thorough understanding of the local potential waste heat sources and the development of a comprehensive plan to recover and utilise this energy.

The local H&C energy supply – Enabling technologies and integrated systems

Heat pumps

Heat pumps combine high energy conversion with the capability of using aerothermal, geothermal or hydrothermal heat at useful temperature levels. Heat pumps present a

versatile energy technology that can provide both heating and cooling in a great variety of building contexts and applications, which can be combined with smart technologies and storage. Heat pumps can also provide for flexibility in the electricity system and contribute to the management of the variability of heating and cooling demand. For these reasons, heat pumps have the potential to become a mainstream technology in the heating and cooling sector, including at the building level. Heat pumps use electricity (compression heat pumps) or thermal energy (absorption heat pumps) as their primary energy source. Heat pumps can upgrade low temperature heat sources to higher temperature levels or to produce cold.

Compression heat pumps use electricity to upgrade a low-temperature heat source, using a mechanical compressor working on a refrigerant. These refrigerants can be natural, such as CO₂ or ammonia, or synthetic, such as hydrofluorocarbons. There is a tendency towards natural refrigerants use as they are ozone friendly and do not have significant global-warming potential.

Electric heat pumps in a district energy system provide a crucial conversion technology between the electricity and the heating sectors. Heat pumps provide flexibility for the integration of variable renewable-based electricity sources when combined with adequate heat storage.

The installation of large heat pumps connected to district heating and cooling systems can also prevent the high losses in the distribution grid that would occur if heat pumps were deployed individually as stand-alone installations at a large scale in urban areas. An electric heat pump's efficiency is measured by a ratio called the coefficient of performance (CoP) and is the ratio between the thermal output and the electricity input for the heat pump.

Regardless of the heat source, heat pumps perform at a higher efficiency when they are used to deliver heat at a lower temperature instead of at a higher temperature. This is a key motivation for moving away from first to third generations of DHC and

transitioning towards fourth generation. Apart from the efficiency, lower operating temperatures open up a broader range of heat pump technologies to be used since many refrigerants have an upper bound of working temperatures.

Absorption heat pumps, on the other hand, are driven by thermal energy. Their electricity consumption is minimal and, in some cases, null. These machines take advantage of the phenomenon in which heat is released when one substance is absorbed into another. Their efficiency is not as high as the efficiency of compression heat pumps and usually around 1.7.

A variation of absorption heat pumps are absorption chillers, which can produce cold using heat at high temperatures. In this sense, there is a lower bound for the temperature of the heat source, which lies around 80°C. Absorption machines offer the possibility of taking advantage of an inexpensive source of thermal energy either to upgrade a low-temperature heat source, and hence increase the total thermal output, or to produce cooling. Potential heat sources for absorption machines include bio-energy (biogas or biomass boilers), solar thermal (in concentrating arrays and in flat-plate collectors), direct geothermal heat, waste heat from industrial processes or power generation through thermal cycles or waste incineration.

Energy storage

Storing energy so it can be used later, when and where it's most needed, is key to supporting increased renewable energy production, energy efficiency and energy security.

The rapid deployment of a hugely increased share of variable renewable energy sources will require more flexibility, allowing the energy system to adapt to the changing needs of the grid and manage the variability and uncertainty of energy supply and demand. At any moment in time, the consumption of electricity has to be perfectly matched with the generation of electricity. This balance is necessary in all electricity grids to maintain a stable and safe supply. Flexibility solutions can adjust de-

mand and supply by allowing excess electricity to be saved in large quantities over different time periods.

Besides being an important flexibility solution, energy storage can reduce price fluctuations, lower electricity prices during peak times and empower consumers to adapt their energy consumption to prices and their needs. It can also facilitate the electrification of different economic sectors, notably buildings and transport.

Thermal storage

To accelerate the decarbonisation of heating and cooling, thermal energy storage (TES) has an important role to play, particularly in cities where the population density is high enough to adopt district systems. TES enables the decoupling of heat/cold generation from consumption, facilitating more flexibility in energy systems. These technologies can accommodate a range of timescales from short (hourly) to seasonal storage, link better supply with demand, reduce curtailment and avoid the need for costly electricity network reinforcement. Thermal storage consists of a system able to accumulate thermal energy and put it aside for later use. TES usually makes use of water as storing fluid, due to its large heat capacity and low price, but the ground can also be used. TES can be utilised not only for storing the heat produced in thermal renewables such as solar or geothermal, but also for capturing excess wind or photovoltaic electricity production once it is converted to heat thanks to a heat pump or an electric boiler. This latter option has the benefit of coupling the electricity and heat sectors. Furthermore, thermal energy storage is considerably cheaper than electricity storage such as batteries or pumped hydro.

The size of thermal storage has a wide range, spanning from a few hundreds of cubic meters to hundreds of thousands of cubic meters. Larger storage sizes would make it possible to remove a key barrier to integrating significant shares of different renewables heat sources in district heating networks. This barrier is the seasonal discrepancy between the demand and supply profiles, and the competition between each other in summer.

District heating and cooling

District heating, or heat networks, is a heat distributing system. Heat is generated in one or several central (or decentralised) location(s) and transported through a network of insulated transmission and distribution pipes and auxiliary equipment. This system meets the requirements of space heating and domestic hot water (DHW) for residential and tertiary buildings using multiple energy sources and technologies: solar thermal, moderate geothermal resources, industrial waste heat, back-up boiler and seasonal storage. Other technologies could be used such as cogeneration, heat pumps and waste heat from the service sector. District cooling can be seen as a reverse heat network that functions on largely similar principles to those of district heating. District cooling distributes chilled water to residential and commercial buildings, offices, and factories. In district cooling systems, chilled water is produced at a central chiller plant, which typically comprises multiple electric water-cooled chillers, although sometimes absorption chillers powered by locally available heat sources can be utilized. The chilled water is then distributed through insulated pipe networks to customer buildings. Heat exchangers in these buildings distribute the chilled water to air-handling or fan coil units, which in turn deliver the cooling demanded by the building. The supplied water, having absorbed heat from the customer's building, flows back to the central plant through a separate return pipeline, where it is again chilled and re-distributed.

A key advantage of district energy networks is that they can provide a proven solution for the efficient use of multiple renewable energy sources on a large scale, that would be unsuitable for use in stand-alone systems, including: biomass, geothermal and solar thermal, waste heat from electricity production, incineration, industrial processes, data centres, wastewater, etc.

The development of subsequent DHC technologies has resulted in improved efficiency and the use of lower supply temperature

1st generation district heating systems (1880-1930) were characterized by high temperature supply from steam, while 2nd generation systems (1930-1980) used hot water under pressure, operating with maximum supply temperatures of more than 100 °C.

3rd and 4th (from 1980) generation systems operate with lower distribution temperatures, paving the way for better utilisation of renewable and recycled low-temperature heat. "Low-temperature" does not refer to a specific temperature range in absolute terms but depends on the energy source considered or the set of temperature in the district energy network.

3rd generation, operating between 100 °C and 70 °C, deliver heat primarily from fossil fuels or centralised biomass sources, are effective but less energy-efficient and require robust insulation to minimise losses. 4th generation are modern systems using temperatures below 70 °C, often leveraging renewable energy sources and waste heat and aligning better with energy-saving building standards.

For district cooling systems the first generation used refrigerant as the distribution fluid, and from the second generation onward, water is used as distribution fluid, leading to potentially higher supply temperatures and more available energy sources. This trend even makes it possible to share the distribution network of district heating and district cooling for those countries with separated heating/cooling supply seasons.

The latest approach, 5th generation, emphasises ultra-low temperatures (10–30°C) combined with localised heat pumps. These systems operate very efficiently and allow for bidirectional energy flows, enabling heat sharing and integration with decentralised renewable sources. They are highly adaptable and ideal for new urban developments.

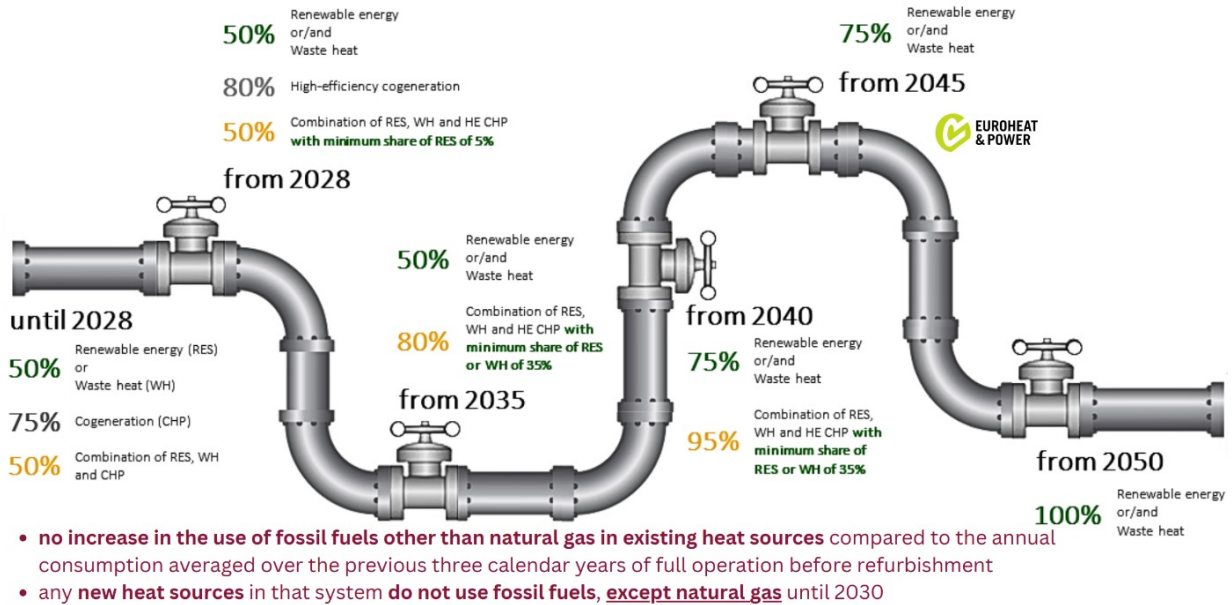
By leveraging biomass, geothermal, solar thermal, and waste heat, DHC networks are expected to become the backbone of urban heating and cooling and the transition to 4th and 5th generation will be crucial, because it



operates at lower temperatures and maximizes the efficiency of RES. The transition path is defined in art. 26 of the Energy Efficiency Directive revision, setting the criteria and objectives for reaching “efficient DHC”.

These goals foresee the use of increasing shares of RES, waste heat, and high-efficiency cogeneration, to meet intermediate targets, starting in 2027, and then reaching the final objective in 2050, when DHC networks

must be operated using RES only, or waste heat only, or a combination of RES and waste heat.



Source: Euroheat & Power

ANNEX 3

Supporting measures and tools

3.1 Assembling a Local Community of Practice

Purpose: To establish a multi-stakeholder Local Community of Practice (LCoP) that supports the development, implementation, and continuous improvement of local heating and cooling plans in line with EU Energy Efficiency Directive requirements.

1. Background and Rationale

Local heating and cooling plans are now mandatory under Article 25 of the Energy Efficiency Directive (EED 2023) for municipalities and regions across the EU[1][2]. These plans must assess current and future heating

and cooling demand, map available renewable and waste heat sources, identify priority zones for district networks, and define concrete measures to decarbonise the sector[2][3]. Developing robust, implementable plans requires sustained collaboration among diverse stakeholders who hold different pieces of the puzzle: municipalities control spatial planning and own public buildings, utilities manage networks and supply, housing providers influence renovation decisions, industry holds waste heat potential, and communities and citizens determine social acceptance[3][4]. A Community of Practice provides the structured dialogue space where these actors can co-create evidence-based strategies and build the relationships necessary for implementation[5].

2. Objectives

The Local Heating and Cooling Community of Practice aims to:

- Co-develop the content of local heating and cooling plans through participatory analysis of data, scenarios, and priority measures
- Ensure alignment between local

H&C plans and other strategic documents (Sustainable Energy and Climate Action Plans, spatial plans, social inclusion strategies)

- Build shared ownership and acceptance among stakeholders for network expansion, building renovation, zoning decisions, and community-led projects
- Provide practice-based input into regional and national policy processes on heating and cooling
- Facilitate continuous learning and plan updates as technologies, policies, and local conditions evolve

3. Scope and Focus Areas

The CoP will support all phases of heating and cooling planning:

- **Initialisation and mobilisation:** Stakeholder mapping, mandate clarification, governance setup
- **Data gathering and mapping:** Validation of building stock, demand, supply infrastructure, renewable and waste heat sources, social vulnerabilities
- **Options appraisal and scenario development:** Joint analysis of district heating/cooling, building-level solutions, energy communities, and social measures

- **Plan drafting and consultation:**

Co-design of objectives, priority zones, project pipelines, governance and financing mechanisms

- **Implementation monitoring and review:**

Tracking progress, adaptive management, and preparation of periodic plan updates

4. Target Stakeholder Groups

Membership should ensure representation from all relevant constituencies:

Stakeholder Group	Representative Organisations
Public authorities	Municipal energy, planning, buildings, social departments; regional government; local/regional energy agencies
Energy infrastructure	Distribution system operators (DSO), district heating/cooling operators, energy service companies (ESCOs)
Industry and commerce	Major energy users, industrial sites with waste heat potential, technology suppliers
Housing sector	Social housing providers, building owner associations, property managers
Community and citizens	Energy communities, consumer groups, neighbourhood associations, vulnerable user representatives
Knowledge providers	Universities, research institutes, technical consultancies, mapping and modelling experts

Table 1: Core stakeholder groups for the Local Heating and Cooling CoP

To support the identification and prioritization of the stakeholders to invite to the LoCP its recommended the use of the stakeholder mapping tool made available by Plan4COLD. (upload this tool in the resources section)

5. Governance and Operating Model

- **Mandate and authority:** The CoP operates under a clear mandate to „support the preparation, implementation, and updating of the local heating and cooling plan“ with formal linkage to municipal deci-

sion-making processes (council committees, technical working groups)

- **Membership:** Open to all relevant stakeholder organisations; participants commit to regular engagement and collaborative problem-solving
- **Coordination:** A small secretariat (typically hosted by the municipality or local energy agency) provides logistical support, meeting facilitation, and documentation
- **Decision-making:** The CoP works by consensus-seeking; outputs are recommendations and jointly developed documents that feed into formal planning procedures

- **Meeting rhythm:** Plenary meetings 3-4 times per year aligned with planning phases; thematic working groups (data, scenarios, financing, community engagement) meet as needed between plenaries
- **Communication:** Shared online workspace for document exchange, asynchronous collaboration, and member communication

6. Key Activities and Outputs

The CoP will organise its work around concrete, usable outputs that directly support the planning process:

Planning Phase	CoP Activities	Outputs
Initialisation	Stakeholder mapping workshop; governance setup	Terms of reference; stakeholder register; work plan
Data & mapping	Data validation sessions; review of heat mapping studies	Validated datasets; heat maps; gap analysis
Options appraisal	Scenario workshops; site visits; technology deep-dives	Criteria and indicators; scenario assessments; priority areas list
Plan drafting	Co-design workshops; review and comment rounds	Draft measures and objectives; project pipeline; governance models
Consultation	Public engagement events; feedback synthesis	Consolidated stakeholder input; revised plan sections
Implementation	Monitoring review meetings; learning exchanges	Progress reports; lessons learned; update recommendations

Table 2: CoP activities and outputs aligned with planning phases

7. Links to Policy and Funding Frameworks

The CoP will actively connect local planning to broader policy and financial support:

- **EU frameworks:** Align with Covenant of Mayors guidance, ActIon-Heat and Plan4Cold project tools, JRC Communities of Practice Playbook[1][4][5]

- **National and regional support:** Engage national energy agencies, ministries, and regional bodies to ensure consistency with national heating and cooling strategies
- **Funding opportunities:** Collectively identify and pursue EU (Horizon Europe, LIFE, Interreg, CEF, cohesion funds), national, and municipal financing for studies, pilots, and infrastructure

- **Knowledge exchange:** Participate in transnational CoP networks and city-to-city learning platforms to import best practices and share local innovations

8. Success Factors and Risks

Success Factors	Risks and Mitigation
Clear mandate linking CoP to formal planning process	Risk: CoP seen as consultative only, outputs ignored. Mitigation: Formalise role in municipal procedures and council decisions
Balanced representation and active participation from all key stakeholders	Risk: Dominance by one actor or low engagement. Mitigation: Rotating chair, clear participation commitments, visible value from early outputs
Dedicated secretariat with facilitation capacity	Risk: Administrative overload or poor meeting design. Mitigation: Secure stable resourcing and professional facilitation support
Concrete, timely outputs aligned with planning deadlines	Risk: Outputs too generic or too late. Mitigation: Co-design detailed work plan with municipal planning team
Trust and open communication among diverse actors	Risk: Conflicts of interest or information hoarding. Mitigation: Ground rules on transparency, confidentiality, and collaborative problem-solving

Table 3: Key success factors and risk mitigation strategies

9. Timeline and Next Steps

1. **Month 1-2:** Stakeholder mapping and initial outreach; draft terms of reference
2. **Month 3:** Kick-off meeting to agree mandate, governance, and work plan; establish secretariat and online workspace
3. **Month 4-6:** Data validation working group meetings; review existing studies and maps
4. **Month 7-9:** Scenario development workshops; priority area identification
5. **Month 10-12:** Co-drafting sessions for plan measures and governance models
6. **Month 13-15:** Public consultation support; plan revision
7. **Month 16+:** Plan adoption; transition to implementation monitoring mode; regular review meetings

10. Conclusion

A Local Community of Practice for heating and cooling planning transforms the mandatory planning exer-

cise into an opportunity for genuine multi-stakeholder collaboration and collective learning. By systematically involving those who will implement and benefit from the plan, the CoP builds the technical quality, political legitimacy, and social acceptance necessary for successful decarbonisation of local heating and cooling systems[3][4][5].

This model can be replicated across municipalities and regions, with coordination and knowledge exchange among local CoPs at national and EU level to accelerate the transition to sustainable heating and cooling throughout Europe.

References

- [1] European Commission. (2023). Energy Efficiency Directive (EU) 2023/1791, Article 25. Official Journal of the European Union. <https://eur-lex.europa.eu/eli/dir/2023/1791>
- [2] ActIonHeat. (2024). Local heating and cooling plans in line with EED 2023: Checklist and guidance.

https://actionheat.eu/sites/default/files/media/LRR_EED_checklist_FINAL.pdf

- [3] Energy Cities. (2023). Local heating and cooling planning in EU Member States: Overall analysis. <https://energy-cities.eu/wp-content/uploads/2023/10/Overall-Analysis-Local-Heating-and-Cooling-plans.pdf>

- [4] Plan4Cold. (2023). Plan4Cold project: Supporting local and regional authorities in heating and cooling planning. Climate Alliance. <https://www.climatealliance.org/plan4cold.html>

- [5] European Commission Joint Research Centre. (2024). The Communities of Practice Playbook: Methodology for setting up and running effective Communities of Practice. Publications Office of the European Union. <https://op.europa.eu/webpub/jrc/communities-of-practice-playbook/en/methodology.html>

3.2 Supporting measures at the Municipality level

This section of the guidelines deep dives into the necessary additional measures a municipality can promote and activate for the development of actions and interventions on territory and the concrete implementation of the SLHCP strategy towards the H&C system decarbonisation.

Measures can be grouped in 3 main categories:

- Management, control and regulation measures
- Financial and incentive measures
- Enhancing and empowering measures

Management, control and regulation measures

Governance and institutional measures are essential for supporting the transition to a low-carbon H&C. Building codes and standards, such as those related to energy efficiency, RES and green building, can be developed and implemented. Certification programs and initiatives can provide a framework for evaluating and recognising low-carbon buildings. Additionally, policies and regulations, such as zoning laws and building permitting requirements, can be used to encourage the development of low-carbon buildings and retrofitting of existing buildings to improve their energy efficiency.

More stringent codes adoption for a city or development zone or district within a city.

Working within the broader framework of national or state-wide codes, cities can, in some cases, choose to adopt more stringent requirements to accelerate the transition towards efficient buildings. Often referred to as “stretch code”, the stricter codes introduce a more ambitious code to be applied to new buildings of a certain size or through positive covenants as a requirement for new buildings in development or eco-zones. Stretch codes can also be voluntary, with some incentives attached to meeting them. Voluntary stretch codes can gradually become stan-

dard practice, at which point the next stretch code is introduced. Cities can establish regular updated cycles, such as every three years, as steps towards a final near or net zero carbon goal for buildings.

By-law to mandate better building energy performance

Where cities do not have the regulatory power to develop their own codes, or to strengthen codes set by higher levels of government, by-laws, or ordinances, are a useful option. By-laws can be narrow in scope, targeting specific building elements, such as green or cool roofs, or can incorporate a broader range of mandatory and voluntary standards.

Building performance standards for existing buildings stock

While building codes apply to both new and existing buildings, their application and benefits can be skewed towards new buildings and the major renovation of existing buildings because of the ease and cost effectiveness of broader integration of code into the (re)construction project.

In cities with a substantial stock of existing buildings, significant advancement in their energy performance can remain a weak link. Given the urgency to achieve emission reduction targets at scale, new and more aggressive approaches that target energy efficiency in existing buildings are needed. A mandatory “building performance standard” (BPS) can be one such approach. It is a forward-thinking policy commitment for existing buildings in which a city establishes a long-term, high-performance standard, with interim targets that increase over time. BPS requires greater changes but allows building owners broad flexibility to use whatever technologies and operational strategies they decide are most effective and economical to meet the target. A BPS allows cities to leverage synergies and pursue deeper commitments by encompassing multiple city priorities at once, including carbon reductions, building electrification, energy efficiency, peak demand reductions etc.

Green Building rating and certification schemes to set minimum per-

formance standards

Many national and international green building rating and certification schemes have been in practice, generally administered at the federal or regional level (LEED, BREAM). These schemes can be voluntary or mandatory, can be used in addition to, or as a replacement for, building energy codes and can have a transformative impact on the local market. They are especially useful for cities with limited regulatory powers to issue their own building energy codes. The minimum required certification level can be strengthened over time to further improve building performance.

Energy audit policies

The term energy audit is commonly used to describe a broad spectrum of energy studies which may include analysis of building and utility data, study of the installed equipment and analysis of energy bills and understanding the building operating conditions with the objective of identifying cost-effective energy measures. Well-designed audits can provide richer information than benchmarking, by enabling a view into system-level information thus enabling more informed and accurate targeting of energy saving opportunities. Audits can be conducted on a voluntary basis. However, to maximize their uptake and effectiveness they should be made a mandatory requirement for priority building types. Mandatory audits usually follow 5- or 10-year cycles and target buildings over a certain size or age. Many cities mandate building energy audits for large non-residential buildings. Cities can also provide free or subsidized voluntary audits to target groups to encourage uptake.

Municipal sustainable procurement and contracting practices

Cities can establish procurement specifications, as well as contracting practices, that promote sustainable urban H&C by integrating heat considerations into regular maintenance, replacement schedules and capital budgets for municipally controlled buildings and assets.

Some examples include: establishing energy-efficient design and materials



specifications for all new construction; requests for information for skilled suppliers that signal a market demand for sustainable urban cooling solutions; hiring only trained/licensed HVAC technicians for city buildings

These procurement strategies are also a way for cities to potentially create pilot projects to demonstrate the local efficacy of H&C strategies. Adjusting internal rules and policies is often a foundational step to cities establishing a sustainable public procurement policy. This may involve, for instance:

- Ensuring that the procurement policies enable and encourage third-party ownership, such as energy services company (ESCO) and public-private partnership models. Cities are often limited in their ability to pursue these models because

of internal rules and the incentive to spend their annual capital budgets.

- Requiring lowest life-cycle cost procurement (instead of selecting the lowest first-cost option, which typically is the least energy efficient)
- Ensuring transparency in procedures to facilitate better understanding between the public and private sectors, such that the requirements are well aligned with the possible technical solutions and business models.
- Encouraging aggregated procurement within city government (as well as within a group of cities). Often, different city departments handle their procurement on their own, missing the opportunity to leverage the city's overall buying power.

A logical next question may be how to define the buildings or products that meet the procurement aims.

Several approaches can be followed, such as:

- Labels, standards and codes: When existing labels (or codes) are available, require H&C equipment (or buildings) to reach a certain level,
- Catalogue of technical specifications: Maintain a document with technical specifications or energy efficiency standards for equipment that is frequently purchased,
- Energy-efficient preferences: Award extra points or price preferences for more energy-efficient products,
- Qualifying product list: Maintain a database of specific products, such as H&C equipment and building materials, that meet government energy efficiency specifications.

Local H&C energy supply

municipalities can implement ordinances mandating the use of renewable energy and require households to purchase green electricity. These ordinances can be connected to national or regional energy laws and implemented through municipal building codes. By doing so, municipalities can promote the adoption of renewable energy technologies and reduce their reliance on non-renewable energy sources.

In addition to ordinances, municipalities can also adapt their urban planning regulations to support the development of distributed energy systems. This can include reviewing and revising building codes and zoning laws to allow for the installation of renewable energy systems, such as photovoltaic panels and wind turbines.

Municipalities can also establish integrated urban planning processes to identify possible sites for local energy generation installations and ensure the availability and compatibility of space for these projects.

Municipalities can also take steps to facilitate the development of distributed energy systems by streamlining administrative procedures. This can include reducing local taxes for electricity production.

Heat and cold production strategies can be supported from the governance and institutional level by removing obligations to connect buildings to natural gas networks and enforce obligations to connect buildings to district heating.

Administrative procedures can be adapted to shorten the time required to obtain permits and reduce local taxes when energy efficiency improvements or renewable energy sources are included in the proposals.

Land use planning should be considered for large-scale solar plants and wind turbines. These aspects call for integrated urban planning processes to support local energy generation decisions as the basis for additional action.

Nature-based solutions

Nature-based solutions offer value for money and a strong return on investment. They are typically cheaper than many hard infrastructure approaches for managing climate risk, and offer significant economic benefits associated with better physical and mental health, and growth for sectors like leisure and tourism. The value of urban nature for communities, investors and climate offers quantified estimates of nature's cost-saving potential for buildings, stormwater management and transportation in six cities, and a replicable methodology. Nevertheless, long-term governance and financing of NbS is a significant challenge for many cities and it is often easier to secure financing for on-off or initial planting projects than for their ongoing maintenance.

To begin implementing NbS at scale, and to lay the foundation for ongoing expansion, restoration, conservation and maintenance, the biggest opportunities are the following

- Masterplans for urban nature, or integration of NbS into the city's existing masterplan. This is important for long-term continuity, as nature takes years or even decades to develop, and must be institutionalised within the city's governance.
- Encourage or require green roofs through incentives and building codes. As green roofs help to reduce building energy consumption for heating and cooling, requirements for green roofs can be incorporated in building energy efficiency standards for new and existing buildings.
- Land use policies and regulations, including community benefits ordinances. Use landuse zoning and other development codes to require a certain proportion of natural or unpaved areas in each development. These can be delivered in the form of incentives, allowing greater development rights for plans that provide more space for nature, or mandates requiring a certain lot coverage.
- Dedicate city budget and explore opportunities to raise revenue for nature-based solutions. Seek routes to fund NbS through relevant sectoral city budgets, especially those for health, emergency preparedness, transport and urban planning. Consider partnering with local non-profits to build community support and advocate for greater budget allocations. Build pipelines of viable green projects that can attract private investment.
- Invest in capacity building for the design and maintenance of nature-based solutions. Key skills to foster include arboriculture, landscaping and forestry, emphasising the need to develop knowledge of species that are native, and those that are resilient to climate change and other stresses.
- Consider engaging the insurance sector. The insurance industry is increasingly interested in supporting the adoption of NbS for reducing climate risk.

Financial and incentive measures

In the following, a short but comprehensive framework is provided of possible financing mechanisms and tools, grouped in three main categories: traditional, innovative and alternative.

Traditional tools and mechanisms

Public funding mechanisms, such as grants, tax incentives, and soft loans, play a key role in supporting energy retrofitting projects and the development of renewable-energy infrastructure. Grants help alleviate the initial financial burden, making proj-

ects more accessible and attractive to private investors. Tax incentives provide targeted economic benefits to promote efficient technologies and sustainable practices, while soft loans offer favourable conditions that enable municipalities to plan larger-scale projects. The private sector also contributes with flexible tools like leasing and traditional bonds, tailored to meet the capital-intensive requirements of major projects. These mechanisms allow municipalities to access additional financial resources, balancing risk and optimising investment opportunities. Finally, mixed financing models combine public and private resources to address the limitations of stand-alone approaches.

Instruments such as revolving funds and project financing not only reduce perceived risks for investors but also enable scaling up of more complex and innovative initiatives, enhancing the overall efficiency of investments.

Scheme	Source of funding	Contractual typology	Description
Grant programmes	Public	Non-repayable	Organised programmes that allocate grant funding to various eligible projects or sectors.
Leasing	Private	Debt	Financing for equipment or infrastructure where the lessor retains ownership.
Project financing	Mixed	Debt	Financing for a project based on its future cash flows, often used for large infrastructure projects.
Public grants	Public	Non-repayable	Specific grants provided by public institutions to support targeted initiatives that benefit the public.
Revolving funds	Mixed	Debt	Funds that are replenished as loans are repaid, allowing for continued lending.
Soft loans	Mixed	Debt	Loans provided at below-market interest rates to support sustainable projects.
Tax incentives	Public	Incentive-based	Fiscal measures, such as credits or allowances, designed to encourage investments in specific sectors or technologies.
Tax increment financing (TIF)	Public	Incentive-based	A public financing method that uses future tax revenue from a specific area to finance infrastructure.
Traditional bonds	Mixed	Debt	Fixed-income securities issued by governments or corporations to raise capital.
Vendor financing	Private	Equity/Debt	Financing offered by the supplier for the purchase of goods or services

Source: Joint Research Center - Covenant of Mayors Guidebook, Complementary document 5 "Financial instruments for mitigation, adaptation and energy poverty actions"

Innovative instruments³

In the context of limited financial resources, innovative financing models offer flexible solutions for municipalities seeking to implement energy efficiency, sustainability and energy poverty projects. These models draw on private capital, stakeholder en-

gagement, and performance-based returns to overcome financial barriers, reduce risks, and accelerate the implementation of projects that might otherwise be hindered by budget constraints. While offering numerous benefits, these models require a well-planned approach, as they often

involve increased complexity in managing and measuring results, as well as greater interaction with private partners and investors.

³ The Prospect+ Learning Handbooks provide cases and current findings about the implementation of innovative financing schemes - <https://h2020prospect.eu/learning-handbooks>

Scheme	Source of funding	Contractual typology	Description
Blended finance	Mixed	Hybrid	Combining public and private-sector funding to achieve greater impact in financing sustainability projects.
Blue bonds	Mixed	Debt	Bonds issued to support ocean and waterway conservation and sustainable maritime activities.
Carbon pricing (ETS, green and white certificates, taxes)	Public	Market-based	Systems where carbon emissions are taxed or traded, providing incentives for reducing emissions.

Scheme	Source of funding	Contractual typology	Description
Climate bonds	Mixed	Debt	Bonds aligned with climate goals, financing projects like renewable energy, mitigation and adaptation.
Climate resilience bonds	Mixed	Debt	Bonds dedicated to financing projects aimed at increasing climate resilience in vulnerable areas.
Energy-efficient mortgages	Private	Debt	Mortgages that offer better terms for purchasing energy-efficient homes or making energy upgrades.
Energy performance contracts	Private	Performance-based contracts	Agreements where energy efficiency upgrades are paid for through future energy savings
Energy services companies (ESCOs)	Private	Performance-based contracts	Companies that finance energy efficiency projects and receive payments based on energy savings.
ESCO 'intraacting' model	Public	Performance-based contracts	Internal financing model for energy efficiency projects within public entities.
Forfeiting	Private	Debt	A financial transaction where a business sells its receivables at a discount to raise immediate cash.
Green bonds	Mixed	Debt	Bonds issued to fund projects with environmental benefits, such as renewable-energy infrastructure.
Green loans	Private	Debt	Loans with favourable terms to support environmental projects, such as renewable-energy installations.
Insurance mechanisms for climate adaptation	Mixed	Risk transfer tools	Insurance products that mitigate financial risks from climate disasters, such as parametric insurance or catastrophe bonds.
Land value capture (LVC)	Public	Revenue-based	A method where increases in land value due to public investment (e.g. infrastructure) are captured and reinvested in additional sustainable projects.
Mini-bonds	Mixed	Debt	Small-scale bonds issued by SMEs or municipalities to raise capital for infrastructure, energy efficiency or sustainability projects.
On-bill financing	Private	Debt	Financing where the cost of energy efficiency up-grades is paid back through utility bills.
Pay-for-performance (P4P)	Mixed	Outcome-based	Payment models where compensation is based on the achievement of specific energy or environmental outcomes.
Public-private partnerships (PPPs)	Mixed	Hybrid	Collaborative arrangements between the public and private sectors to finance and manage public infrastructure projects.
Risk-sharing tools and guarantees	Private	Debt	Instruments designed to mitigate risk for investors, often through partial guarantees or insurance.
Social bonds	Mixed	Debt	Bonds used to fund projects with social outcomes, such as affordable housing or health-care.

Scheme	Source of funding	Contractual typology	Description
Sustainability bonds	Mixed	Debt	Bonds that combine funding for both environmental and social projects, aligning with the Sustainable Development Goals (SDGs).
Third party financing models	Private	Debt	Financing arrangements where a third party provides upfront capital for projects, typically in energy efficiency.
Crowdfunding	Private	Equity/debt	Raising small amounts of capital from a large number of people, often through online platforms.
Energy cooperatives	Private/ citizen-based	Equity	Community-based organisations that pool funds to finance renewable energy projects and energy efficiency.
Pooled procurement	Mixed	Procurement	A group of organisations collaborate to procure goods or services collectively, often to save money.
Carbon finance	Private/ mixed	Market-based	Monetisation of GHG emission reductions through carbon credits in voluntary or regulated markets (e.g. Paris Agreement Article 6). Provides additional funding for mitigation projects.

Source: Joint Research Center - Covenant of Mayors Guidebook, Complementary document 5 "Financial instruments for mitigation, adaptation and energy poverty actions"

Alternative instruments

Alternative financing models offer solutions for funding sustainable energy projects, enhancing community engagement and strengthening the link between investments and local benefits. While these models can significantly expand financing sources, they require careful management and a well-structured engagement strategy to ensure their success and sustainability.

ANNEX 4

Proposed table of contents for Sustainable Local Heating and Cooling Plan

Executive Summary

1. Introduction

- a. Characterization of the local context
- b. Energy and Climate Policy Framework
- c. Process and objectives of local heating and cooling planning
- d. Municipal objectives and objectives of this plan
- e. Governance structure of the plan

2. Stakeholder Participation

- a. Mapping relevant stakeholders
- b. Stakeholder engagement and participation
- c. Citizen participation

3. Baseline assessment

- a. Energy demand
- b. Energy supply
- c. GHG inventory

4. Intervention scenarios

- a. Business as usual
- b. Vision
 - i. Interventions measures per dimension**
 - 1. Urban planning
 - 2. Buildings and Infrastructure per sector
 - 3. Citizen behaviour
 - ii. Supporting measures**

5. Priorities and Roadmap

- a. Characterization of the selected measures in detail (responsible, timeline, investment costs, stakeholders, operationalization)
- b. Finance
- c. Timeline
- d. Implementation process organization

6. Monitoring and update

- a. KPIs definition
- b. Monitoring methodology and periodicity (every two years)
- c. Plan update (every 5 years)

7. Conclusions

Annexes



ANNEX 5

The SLHCP toolbox - Learn and get inspired

Inspiring best practices of H&C planning

Best practices from Baden-Württemberg

<https://publica-rest.fraunhofer.de/server/api/core/bitstreams/6dba8ea6-7f53-45a1-a633-d207ac486554/content>

Best practices from Upper Austria

https://managenergy.ec.europa.eu/publications/watch-now-empowering-regions-heating-cooling_en
https://www.energiesparverband.at/fileadmin/esv/Broschueren/Videos/Solar_576_web.mp4

Best practices from the Decarb City Pipes 2050 project

Bilbao - <https://decarbcitypipes2050.eu/bilbao/>
Bratislava - <https://decarbcitypipes2050.eu/bratislava/>
Dublin - <https://decarbcitypipes2050.eu/dublin/>
Munich - <https://decarbcitypipes2050.eu/munich/>
Rotterdam - <https://decarbcitypipes2050.eu/rotterdam/>
Vienna - <https://decarbcitypipes2050.eu/vienna/>
Winterthur - <https://decarbcitypipes2050.eu/winterthur/>

Best practices from the Act!onHeat project

https://actionheat.eu/sites/default/files/media/Act%21onHeat%20D6.6_case%20study%20collection.pdf

LEA – Energy Agency in Hessen (DE)
 Veka – Flemish Energy and Climate Agency (BE)
 SOL - Le Syndicat de l'Ouest Lyonnais (FR)
 MANU - Macedonian Academy of Sciences and Arts (NM)
 REGEA - North West Croatia Energy Agency (HR)
 Energieinstitut Vorarlberg - Energy Agency of the Vorarlberg region (AT)
 Zelzate Municipality (BE)
 Poznań Municipality (PL)
 Sint-Niklaas Municipality (BE)

Best practices from the Energie Cities EU Tracker

<https://energy-cities.eu/local-heating-and-cooling-plan/>

Best practices from the Covenant of Mayors

„The Cities Heat Detox“ Campaign

<https://eu-mayors.ec.europa.eu/en/The-Cities-Heat-Detox>

Best practices from the Covenant of Mayors „Cities Refresh“ Campaign

<https://eu-mayors.ec.europa.eu/en/Cities-Refresh>

International and EU thematic platforms & portals

NASA – Earth Data - <https://www.earthdata.nasa.gov/topics/land-surface/land-surface-temperature>

EESA Climate Office - <https://climate.esa.int/en/#/>

- **Essential Climate Variable (ECV) projects**

<https://climate.esa.int/en/projects/>

- **Climate data records at a glance**

<https://climate.esa.int/en/climate-data-records-at-a-glance/>

- **Data**

<https://climate.esa.int/en/data/>

ECMWF is the European Centre for Medium-Range Weather Forecasts

<https://www.ecmwf.int/>

The United Nations Environment Programme (UNEP)

<https://www.unep.org/>

- **Global Cooling Watch 2025**

<https://www.unep.org/resources/global-cooling-watch-2025>

- **Global Alliance for buildings and construction**

<https://globalabc.org/>

- **Climate Action Roadmaps for Buildings and Construction**

<https://globalabc.org/climate-action-roadmaps-buildings-and-construction>

World Bank Group

<https://www.worldbank.org/ext/en/home>

- **Handbook on Urban Heat Management in the Global South**

https://www.worldbank.org/en/topic/urbandevelopment/publication/handbook-on-urban-heat-management-in-the-global-south?cid=ECR_LI_worldbank_EN_EXT

IRENA – International Renewable Energy Agency

<https://www.irena.org/Publications>

- **Integrating low-temperature renewables in district energy systems: Guidelines for policy makers**

<https://www.irena.org/%20%20%20publications/2021/March/Integrating-low-temperature-renewables-in-district-energy-systems>

- **Participatory processes for strategic energy planning: A toolkit for national energy planners**

<https://www.irena.org/Publications/2025/Sep/Participatory-processes-for-strategic-energy-planning-A-toolkit-for-national-energy-planners>

C40 Knowledge Hub

https://www.c40knowledgehub.org/s/?language=en_US

- **How to adapt your city to extreme heat**

https://www.c40knowledgehub.org/s/topic/0TO1Q0000001IR5WAI/adapting-to-climate-change?language=en_US

- **Urban Cooling Toolbox**

https://www.c40knowledgehub.org/s/article/Nature-based-solutions-How-cities-can-use-nature-to-manage-climate-risks?language=en_US

- **Nature-based Solutions**

https://www.c40knowledgehub.org/s/topic/0TO1Q000000x1ZXWAY/naturebased-solutions?language=en_US



Nature-Based Solution platform

<https://www.nature-basedsolutions.com/about>

IEA, International Energy Agency – Energy System

<https://www.iea.org/energy-system>

- Cities TCP

<https://cities-tcp.org/tasks-tcp-cities/>

- Renewables

<https://www.iea.org/energy-system/renewables>

- Buildings

<https://www.iea.org/energy-system/buildings>

- The Solar Heating and Cooling Technology Collaboration Programme (SHC TCP)

<https://www.iea-shc.org/>

- The BioenergyTechnology Collaboration Programme (TCP)

<https://www.ieabioenergy.com/>

- Social sustainability of District Heating & Cooling

https://dbdh.org/wp-content/uploads/2026/02/IEA_DHC_XIV-07_Social_Sustainability_Final_Report.pdf

Smart Cities Marketplace

<https://smart-cities-marketplace.ec.europa.eu/>

Energy efficiency

https://energy.ec.europa.eu/topics/energy-efficiency_en

- Energy performance of buildings

https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings_en

- Heating and cooling

https://energy.ec.europa.eu/topics/energy-efficiency/heating-and-cooling_en

- Heat pumps

https://energy.ec.europa.eu/topics/energy-efficiency/heat-pumps_en

- Financing

https://energy.ec.europa.eu/topics/energy-efficiency/financing_en

BUILD UP - The European portal for energy efficiency and renewable energy in buildings

<https://build-up.ec.europa.eu/en/home>

- Healthy Buildings Barometer 2024

<https://build-up.ec.europa.eu/system/files/2024-04/Healthy-Buildings-Barometer-2024-final-for-screen-single-pages-20240404-1.pdf>

Clean Energy Technology Observatory

https://setis.ec.europa.eu/publications-and-documents/clean-energy-technology-observatory_en

JRC Publications Repository

<https://publications.jrc.ec.europa.eu/repository/>

- EU-level technical guidance on adapting buildings to climate change

<https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2023-04/Technical%20Guidance%20adapting%20buildings.pdf>

The Coalition for Energy Saving

<https://energycoalition.eu/>

BPIE - Buildings Performance Institute Europe

<https://www.bpie.eu/>

- Policy packages for a socially just renovation of residential buildings

<https://www.bpie.eu/publication/policy-packages-socially-just-renovation-epbd/>

Efficient Buildings Europe

<https://efficientbuildings.eu/>

Cool Heating Coalition

<https://coolheatingcoalition.eu/>

RHC - European Technology and Innovation Platform on Renewable Heating and Cooling

<https://www.rhc-platform.org/>

IEECP - Institute for European Energy and Climate Policy

<https://ieecp.org/>

European Urban Initiative - The European Hub for sustainable urban development

<https://www.urban-initiative.eu/#>

Climate Action Network (CAN) Europe

<https://caneurope.org/>

CoM - The Cities Heat Detox Kit

<https://eu-mayors.ec.europa.eu/en/The-Cities-Heat-Detox>

CoM – City Refresh Kit

<https://eu-mayors.ec.europa.eu/en/Cities-Refresh>

European Commission Publications

- Renewable heating and cooling pathways

<https://op.europa.eu/en/publication-detail/-/publication/0f8e4ae2-8e77-11ee-8aa6-01aa75ed71a1/language-en>

- Policy support for heating and cooling decarbonisation

<https://op.europa.eu/en/publication-detail/-/publication/f5118ffc-eabd-11ec-a534-01aa75ed71a1/language-en>

- The European Affordable Housing Plan

https://housing.ec.europa.eu/european-affordable-housing-plan_en

Sector associations

Euroheat & Power - International network for district energy

<https://www.euroheat.org/>

- Knowledge hub

<https://www.euroheat.org/dhc/knowledge-hub>

- DHC+ platform

<https://www.euroheat.org/dhc/about-dhc>



EHPA – European Heat Pump Association

<https://ehpa.org/>

EGEC - European Geothermal Energy Council

<https://www.egec.org/>

Bioenergy Europe

<https://bioenergyeurope.org/>

SolarThermalWorld

<https://solarthermalworld.org/>

SolarPower Europe

<https://www.solarpowereurope.org/>

Solar Heat Europe

<https://solarheateurope.eu/>

ESIA - European Solar PV Industry Alliance

<https://solaralliance.eu/>

Hot|Cool magazine

<https://dbdh.org/hot-cool-magazine/>



