POLICY BRIEF · SEPTEMBER 2026

# Keeping Europe Cool

*A One-System Response to Rising Summer Heat*

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## EXECUTIVE SUMMARY

Europe is moving from a continent that rarely needed to cool its buildings to one that increasingly must. Heatwaves are already a leading cause of climate-related mortality in Europe, and the economic toll in lost productivity, disrupted sleep, and strained health systems could be running into hundreds of billions of euros. As summers grow hotter, cooling demand will keep rising.

How Europe meets that demand is not yet decided. Letting mechanical cooling grow unchecked would add hundreds of terawatt-hours to electricity demand and tens or even hundreds of gigawatts to the summer peak load, often when the grid is under the most pressure. The solution is to treat cooling as part of a system rather than a problem to be solved in isolation.

The growth in electricity required for cooling could be cut by up to 60% through a combination of efficiency measures — solar shading, insulation, windows, lighting, passive ventilation, smart controls, highly-efficient reversible heat pumps and district energy. On the electricity used for cooling alone, that would avoid roughly €4 to 10 billion a year in costs by 2030, rising to around €7 to 17 billion by 2050, before counting the value of the grid and generation capacity that would otherwise have to be built.

**22.3 TWh**

EU household electricity used for cooling in 2024 — double the amount used just six years earlier

**96–137 TWh**

projected electricity demand for cooling across all EU buildings by 2030, rising to 126–188 TWh by 2050

**Up to 60%**

potential reduction in the growth of future cooling demand through shading, insulation and other efficiency measures

**€4–17bn**

potential annual savings on cooling electricity costs — €4–10bn by 2030, rising to €7–17bn by 2050

## One system, not an afterthought

Efficiency measures could more than halve the growth in future cooling demand, helping Europe stay resilient in the face of extreme heat while safeguarding competitiveness, economic output and living standards.

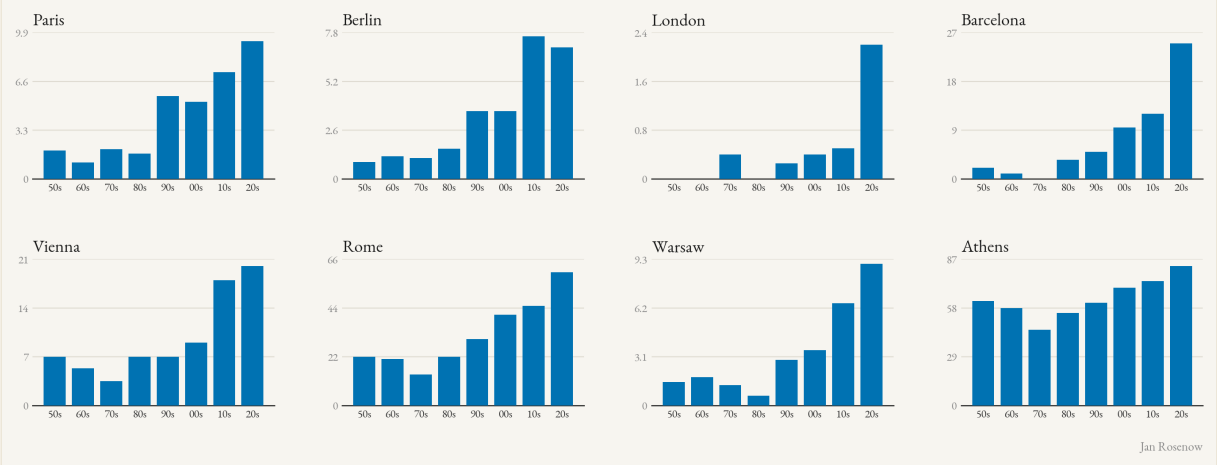
Cooling and heating use the same technologies and address the same challenges. Handled as one system — paired with end-use efficiency, heat pumps, district heating and cooling, and renewables — equipping more of Europe's homes and public buildings to stay cool need not strain the grid unnecessarily. This brief sets out the evidence for why, and what it will take to get there.

## 1. Heatwaves are a health and economic emergency

Much of Europe never had to think about keeping cool. Summers simply didn't get hot enough for extended periods, except in southern regions that have adapted to hot weather over centuries. While in warmer countries such as Spain around 40% of homes have mechanical cooling[1], air conditioning rates in northern Europe are low: only 6% of households in Germany[2] and 4% in the UK[3] have it, versus more than 90% in the US[4], a roughly fifteen-fold gap. That is changing quickly: extreme heat is no longer rare in Europe's cities. The chart below shows the average number of days per year, by decade since the 1950s, when temperatures topped 30°C. In London and Paris, days above 30°C have roughly doubled since 2000. More and more countries now face heat their building stock was never designed for.

FIGURE 1

**Average number of days per year with a daily maximum temperature of at least 30°C in European cities**




*Source: based on data from Copernicus Climate Change Service, Climate Data Store[5] and Carbon Brief[6]*

Hotter summers and heatwaves do not just mean increased discomfort. The impacts can be measured in lives lost, lower economic output, and daily wellbeing. Heatwaves are already a leading cause of climate-related mortality in Europe[7], concentrated among older people[8] and those in poorly cooled buildings[9].

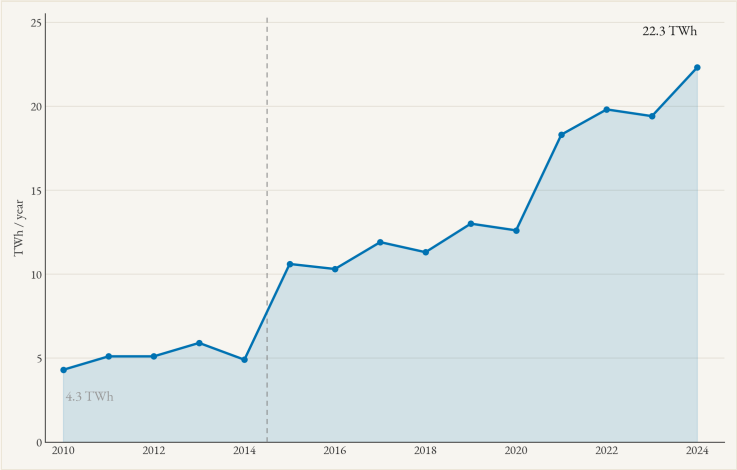
The economic cost is substantial, and growing fast. Allianz Research[10] has estimated that France, Italy, Germany, and Spain alone could see cumulative heat-related GDP losses of €550 billion by 2030, driven primarily by falling labour productivity and rising costs of cooling. Office productivity falls by roughly 2% for every degree above 25°C.[11] Nights that stay too warm also degrade sleep, compounding health and productivity losses the following day.[12] But it is not only homes and offices. Schools[13], care homes[14], and hospitals[15] house the people least able to tolerate heat. Cooling adequacy in these settings is a health priority, not a question of comfort.

## 2. Cooling demand is already rising fast

Hotter summers mean demand for cooling is rising. EU households' cooling energy use doubled in just six years, 2018–2024. It is now at 22.3 TWh[16] which is 3% of residential electricity consumption.[17]

FIGURE 2

**Residential electricity consumption for space cooling**




*Source: based on Eurostat data*[16]

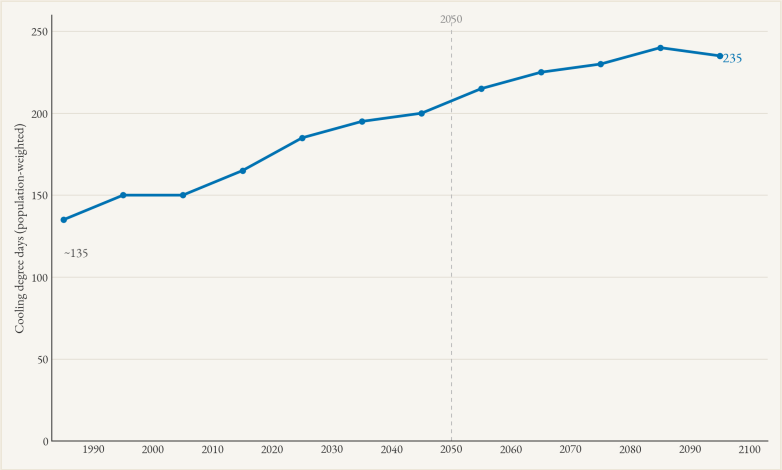
Non-residential buildings already use more electricity for cooling than households (39 TWh in 2022)[18] equivalent to 5% of the sector's total electricity consumption. The combined current all-buildings estimate is 61 TWh of electricity per year.[19] The non-residential sector spans many buildings that matter most for health: schools, care homes, hospitals, alongside offices and retail.

## 3. It will keep on rising

There is no question that climate change is increasing cooling degree days and the frequency and intensity of heatwaves.[20] More and more people will seek to move from a heating-only approach to a dual heating and cooling mode.[21]

FIGURE 3

**Number of cooling degree days averaged across EU**



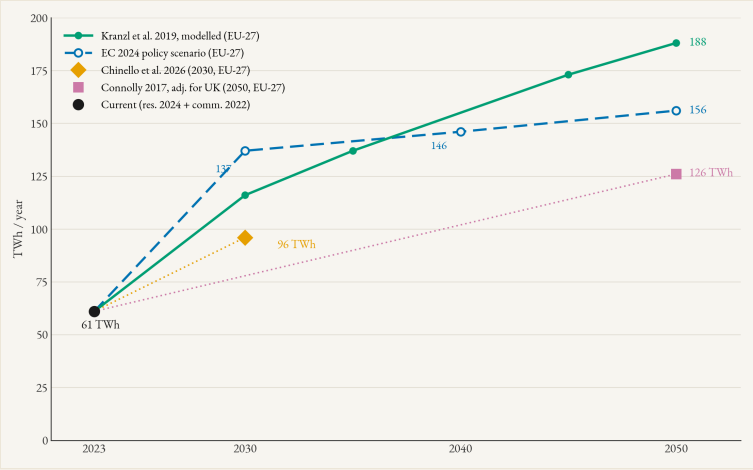

*Source: based on data from Spinoni et al. 2018*[22] *for RCP4.5 scenario*

How future cooling electricity demand will evolve depends on the magnitude and frequency of summer heat, how widely passive cooling measures are adopted, how many households, public buildings and businesses choose to install air conditioning, reversible heat pumps and other options such as district cooling. Projections

all point to a significant increase: between 96 TWh and 137 TWh by 2030, and between 126 TWh and 188 TWh by 2050. Measured against today's electricity demand, that is equivalent to a rise from around 2.5% to as much as 7.5% by 2050.

FIGURE 4

**Potential electricity demand for cooling in all EU buildings**

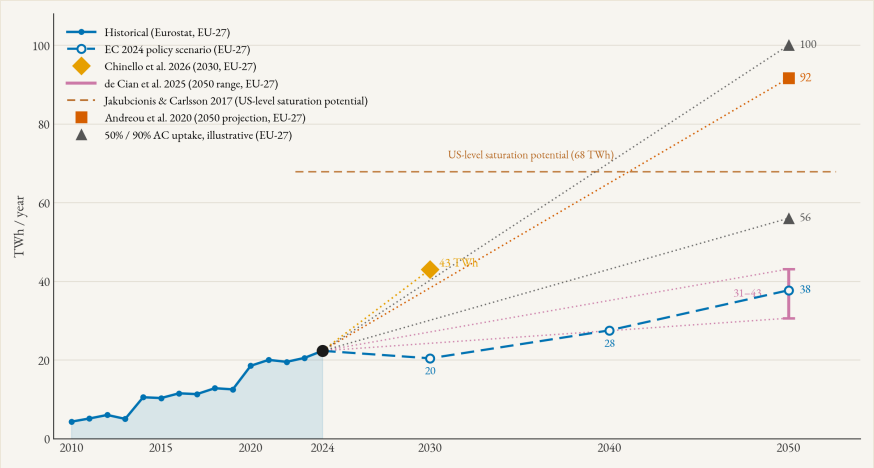



*Source: based on data from Chinello et al. 2026[18], Connolly 2017[23], Eurostat[16], European Commission[24] (EC) and Kranzl et al. 2019[25]. Adjusted for UK using Connolly's EU-28 cooling breakdown*

However, if demand for air conditioning was to rise faster and in line with other major economies, the numbers could be a lot higher. The figure below shows residential sector electricity demand for cooling for existing projections, plus 50% and 90% adoption scenarios.

FIGURE 5

**Potential electricity demand for cooling in residential EU buildings**



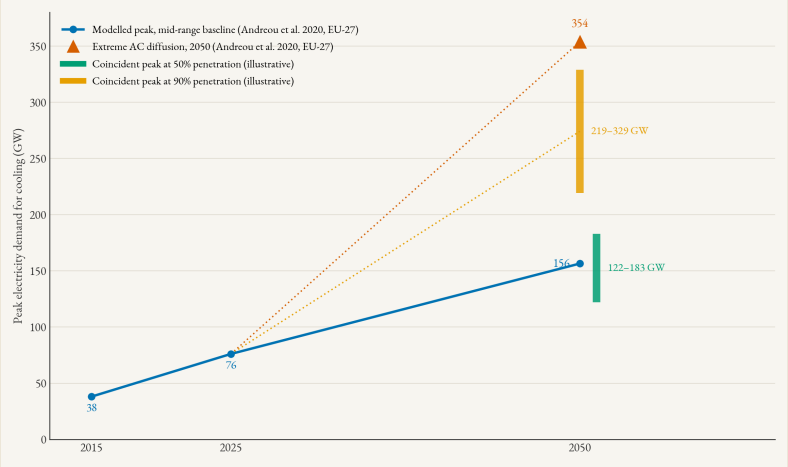

*Source: based on data from Andreou et al. 2020[26], Chinello et al. 2026[18], Connolly 2017[23], de Cian et al. 2025[27], Eurostat[16], European Commission[24] (EC)*

*Note: Illustrative only. Scales EU-27 residential cooling demand (22.3 TWh, 2024) in proportion to AC penetration, using the EU's own current intensity (~550 kWh per AC-equipped household/year, derived from today's ~20% penetration[28] and 202 million EU-27 households[29]). Assumes new adopters use AC at roughly today's average rate. Andreou et al. 2020 figures adjusted for UK based on 12% share of households in EU28. Excluded UK figure from total provided in Jakubcionis and Carlsson 2018.*

Importantly, the share of annual electricity for cooling understates the challenge. This is because cooling needs are concentrated in the hottest afternoons, when the grid is already stretched. How much additional generation and network capacity must be built depends on cooling's contribution to peak load. The figure below provides figures for the potential peak demand for cooling for the residential sector.

FIGURE 6

**Potential peak electricity demand for residential cooling**




*Source: based on Andreou et al. 2020*[26]

*Notes: peak demand at 50% and 90% penetration assumes 203 million EU-27 households with a 3 kW single-split unit each, converted to coincident peak with a 0.4–0.6 diversity factor*[30]*, giving 122–183 GW (50%) and 219–329 GW (90%). A 3 kW nameplate is toward the upper end relative to today's average system size but warmer climate will increase cooling demand in the future*

Today, with about a fifth of EU households cooled, the cooling peak is on the order of 76 GW. At 50% ownership it would reach roughly 122–183 GW. This is also close to the mid-range baseline from modelling studies. But at 90%, close to US or Japanese levels, peak load could reach 219–329 GW. Detailed modelling suggests that under extreme conditions, peak demand for cooling could exceed 350 GW just for residential buildings.

For context, ENTSO-E projects the EU-27 system peak rising to around 850 GW by 2050 as heating and transport electrify. Cooling would account for roughly 15–20% of that system peak at 50% ownership, and a quarter to two-fifths at 90%. Historically, the system has been under less strain in summer. But unmanaged cooling growth would add a large and rapidly growing new summer peak – capacity the grid must be built to serve even though it would be called on for only a handful of hours each year.

## 4. Efficiency measures can offset much of the increase in energy demand for cooling

The projections above assume Europe counters rising heat largely through mechanical cooling. Yet the scope to reduce that load is very substantial. Drawing on the literature, a high-level estimate is that the growth in electricity required for cooling could be roughly halved through a combination of efficiency measures. On the electricity used for cooling alone, cutting the growth in demand by 50-60% would avoid roughly €4 to 10 billion a year in electricity costs by 2030, rising to around €7 to 17 billion by 2050. This is before counting the value of the grid and generation capacity that would otherwise have to be built (see Annex).

Many solutions already exist at scale and range from keeping heat out to minimising internal heat build-up: manufacturers supply external shading and shutters for windows, insulation and efficient glazing that creates a thermal barrier between the hot outside and cooler indoor space, while highly efficient lighting cuts the internal heat gains and electricity use that lighting adds to the cooling load. A key point is that these measures have the biggest impact on the hottest afternoons, precisely when the grid is most stressed, so their effect on peak load is larger still

> **Solar protection should be approached as an integrated solution.** High-performance solar-control glazing, external shading such as shutters, blinds and overhangs, and other façade solutions should be designed to work together to limit unwanted solar gains before they contribute to overheating. An effective combination can substantially reduce cooling demand while preserving daylight and occupant comfort.

> **Insulation and thermal mass work in both directions.** The same fabric improvements – thermal insulation and windows – that keep heat in during winter keep it out during summer, while heavier construction and exposed thermal mass slow the daytime temperature rise and flatten indoor peaks.

> **Passive ventilation and night cooling flush out accumulated heat.** Cross- and night-time ventilation, e.g. ventilative cooling, purge warm air when outdoor temperatures fall, 'resetting' the building before the next day. Cool or green roofs, reflective surfaces, and shading from vegetation reduce the heat load on the structure itself.

> **Smart controls and management tie it together.** Automated shading, thermostats, and building-management systems pre-cool indoor spaces and shift demand away from peak hours — these improvements cost little and can be retrofitted fairly easily.

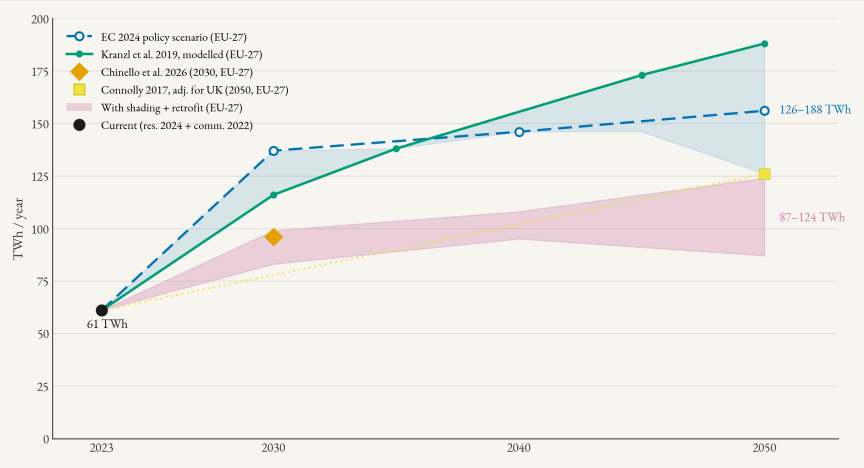
> **Combine with active cooling equipment that does double duty.** Reversible heat pumps provide efficient cooling in summer and replace fossil-fuel heating in winter. In dense urban areas, hospitals and campuses, district heating and cooling networks can meet the same demand with large, centralised plants and thermal storage. Paired with rooftop solar - which generates most on the same hot, sunny afternoons when cooling demand typically peaks – and battery storage, much of the additional load can be met without drawing on the wider grid.

> **Use high-efficiency active cooling technologies.** Every air conditioning, heat pump and district cooling system with top of the market efficiency avoids unnecessary electricity demand increases.

Taken together, these solutions can make the cooling Europe needs affordable, low-carbon, and manageable for the grid.

FIGURE 7

## Potential for reducing EU electricity demand for cooling in buildings (residential + non-residential) through passive cooling




*Source: Baseline: EC 2024 Annex 8, Kranzl et al. 2019, Chinello et al. 2026, Connolly 2017, EU-27. Retrofit: 50-60% reduction (external shading + insulation), the same assumption used for residential buildings, applied here to the growth in demand across the whole building stock based on Todeh Kharman et al. 2026[31] and simulation studies (Vasaturo et al. 2018[32], Perez-Carraminana et al. 2024[33]), not separately validated for non-residential buildings.*

Doing this would have a range of benefits:

| BENEFIT | WHAT IT MEANS |
|---|---|
| **Lower peak consumption** | At 50% air-conditioning ownership, passive measures could shave roughly 25–65 GW off the growth in the summer cooling peak, and well over 100 GW at high ownership. This is capacity that would otherwise have to be built and paid for to cover only a handful of extreme hours each year. |
| **Free up electricity** | Passive measures free up electricity and make cooling capacity faster and more affordable to deliver. With more efficient buildings, the same generation and network can serve about twice as many homes, offices, schools, and care settings — extending relief to those who need it most without a matching expansion of the grid. |
| **Decarbonise heating** | Where reversible heat pumps and thermal insulation are deployed, they also help decarbonise heating. The asset installed for summer cooling displaces fossil-fuel heating in winter, so the same investment cuts emissions year-round. |
| **Allow for pre-cooling** | Efficient buildings allow for pre-cooling and much-needed demand response. Combined with building automated control systems and rooftop solar, they can be cooled ahead of the afternoon peak and flexed around grid conditions, turning cooling from a source of stress on the system into a solution that helps balance it. |
| **Support the wider transition** | Because an efficient approach to cooling frees up grid capacity and holds down peak demand, it makes room for the faster electrification of heating, transport and industry. It also strengthens energy security by cutting the fossil-fuel generation called on during summer peaks, protects living standards and health for those least able to withstand heat, and safeguards economic output that extreme heat would otherwise erode. |

Importantly, the ability to keep cool must not become an equity issue. There is a real risk that higher-income households benefit from cooling technologies, but lower-income households are left behind. If cooling is provided solely with air conditioning, outside temperatures in urban environments could become even higher on the hottest days, affecting those who cannot afford improvements to their buildings. There is an important role for policy to ensure fair access to cooling.

## 5. Conclusions

Europe is moving from a continent that rarely needed to cool its buildings to one that increasingly must. Heatwaves are now the leading cause of climate-related death in Europe, and the economic toll in lost productivity, disrupted sleep, and strained health systems is already running into hundreds of billions of euros. As summers grow hotter, cooling demand will keep rising.

What is less clear is how Europe meets that demand. Letting mechanical cooling grow unchecked would add hundreds of terawatt-hours to electricity demand and tens or even hundreds of gigawatts to the summer peak load, often when the grid is under the most pressure. The solution is to treat cooling as part of a system rather than a problem to be solved in isolation.

Better solar protection, thermal insulation, and building management can roughly halve the growth in the electricity that cooling requires. At a high penetration of air conditioning, that could avoid on the order of 100 GW of cooling capacity that would otherwise have to be built. Where active cooling is used, reversible heat pumps and district level systems can deliver it from the same asset that decarbonises winter heating. Solving the cooling challenge this way also solves much of the heating one. Meanwhile, solar generation peaks at the same time as the demand it serves and can help reduce stress on the grid.

The tools to do this already exist. The recast Energy Performance of Buildings Directive is designed precisely to trigger the renovations that make buildings cooler and more efficient. It will be important to direct efforts to those buildings where the stakes are highest: the schools, hospitals and homes that house those least able to withstand the heat. Just as important is the policy trajectory beyond 2030: the gains described here depend on holding the line on energy-efficiency ambition, implementing the Energy Efficiency and Buildings Directives, and agreeing 2040 targets that give investors and industry a stable long-term signal.[34]

The upcoming Heating and Cooling Strategy will also be key to define the right path forward: Cooling and heating use the same technologies and address the same challenges. Equipping more of Europe's homes and public buildings to stay cool need not strain the grid unnecessarily, provided it is paired with end-use efficiency, heat pumps, district heating and cooling, and renewables. Handled as one system, keeping Europe cool becomes far less a matter of solely installing air conditioning than of integrating cooling demand into an already-changing energy system.

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## Annex: method for the cooling scenarios

All figures are illustrative scenarios, not forecasts, built from one reference point so the energy (TWh) and capacity (GW) estimates describe the same future.

**Reference point.** EU-27 residential cooling uses 22.3 TWh/year today[34], at ~20% household air-conditioning penetration[28] across ~203 million households[29]. This implies 550 kWh per air-conditioned household per year. Scenarios scale this in proportion to ownership, holding usage and climate constant; they isolate ownership, not climate. Because cooling is concentrated in southern Europe, extrapolating to cooler climates overstates per-unit use, while a warmer climate raises use and partly offsets this.

**Energy.** At 50% ownership, ~56 TWh/year; at 90%, ~100 TWh/year (near current US levels).

**Peak.** At a representative 2.7 kW unit (consistent with 550 kWh/year at ~200 full-load hours)[21],[35], installed nameplate reaches ~275 GW (50%) and ~490 GW (90%). Applying a residential coincidence factor of 0.4–0.6 (diversity factor 1.4–3.0)[5] gives a coincident summer cooling peak of ~110–165 GW (50%) and ~195–295 GW (90%). Passive measures cutting cooling load 50–60%[6] remove ~70–100 GW (50%) and ~120–175 GW (90%) of that peak.

**System context.** The EU system peaks at ~400 GW today, in winter (ENTSO-E, 2023).[7] Treating cooling as additive to summer load, the summer peak overtakes the winter peak at ~50% ownership and, by 2050 (winter peak an illustrative 560–640 GW), the summer cooling peak can rival or exceed it at high ownership. Passive measures hold the summer peak at or below the winter peak.

**Main uncertainties.** The coincidence factor (0.4–0.6) drives the peak estimate and is the figure most open to challenge. Unit size affects capacity but not energy. The ~20% penetration anchor underpins the whole chain. The 2050 system-peak values are directional, not sourced forecasts.

**Cost-saving estimate.** The saving quoted in Section 4 is the value of the cooling electricity that passive and efficiency measures avoid. It is deliberately conservative: it counts avoided electricity only, and excludes the avoided network and generation capacity, the health and productivity gains, and the value of the winter heating that reversible heat pumps displace.

**Demand avoided.** Projected all-buildings cooling electricity demand is 96 to 137 TWh by 2030 and 126 to 188 TWh by 2050 (Section 3). Applying a 50-60% reduction to the growth above today's 61 TWh therefore avoids about 18 to 46 TWh a year by 2030 and 32 to 76 TWh a year by 2050.

**Price applied.** Avoided electricity is valued at a blended EU retail price of about €0.22 per kWh. This weights the residential price (€0.29 per kWh, Eurostat, 2025 H2) and the non-household price (€0.19 per kWh) by each sector's current share of cooling electricity use, roughly 36% residential and 64% non-residential (22.3 TWh residential against 39 TWh non-residential today).

**Result.** 18 to 46 TWh at €0.22 per kWh gives roughly €4 to 10 billion a year by 2030; 32 to 76 TWh gives roughly €7 to 17 billion a year by 2050. Figures are rounded and illustrative.

**Main uncertainties.** The retail price is the largest single driver and varies widely across member states (from under €0.11 to over €0.40 per kWh), so a national estimate should use national prices. Valuing avoided demand at wholesale rather than retail prices would lower the figure; including avoided capacity, and the wider health, productivity and heating benefits, would raise it substantially. The saving scales directly with the demand and halving assumptions set out above.


### ACKNOWLEDGEMENTS

This work was enabled through support and input from ABB, Alfa Laval, Danfoss, Knauf Insulation (Knauf Group), ROCKWOOL Group, Saint-Gobain, Schneider Electric, Signify and VELUX Group.