# Low-temperature readiness

a comprehensive guide

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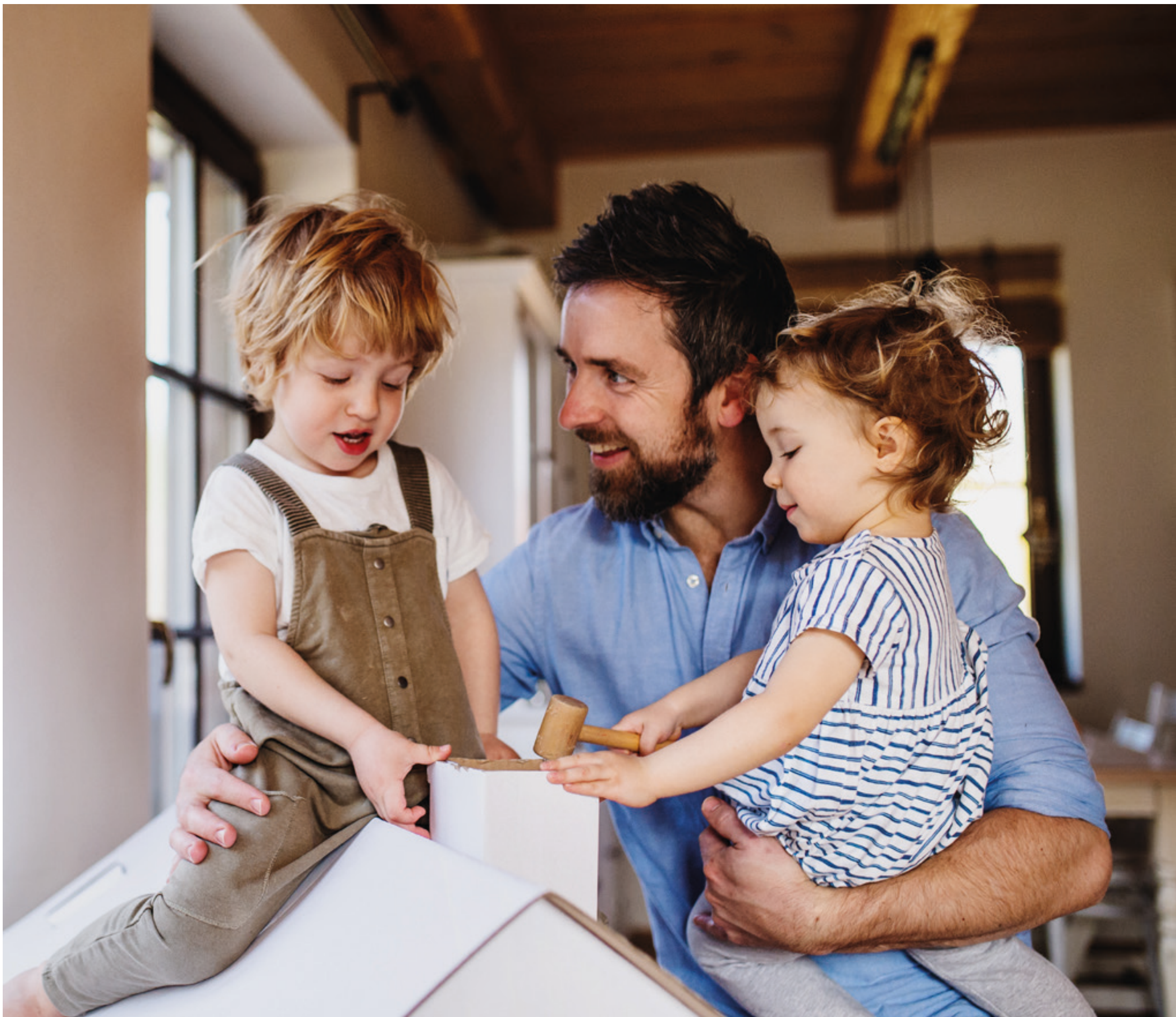
# 1. Executive summary

Decarbonising Europe's building stock is central to achieving climate neutrality by 2050. Heating systems play a pivotal role in this transition: while insulation and other efficiency measures reduce energy demand, the operating temperature of heating systems largely determines whether renewable technologies, such as heat pumps, can perform efficiently. Today, many buildings still rely on high-temperature systems designed for fossil fuels, creating a barrier to electrification and grid stability.

Low-Temperature Readiness (LTR) addresses this challenge by assessing whether a building can operate effectively at lower system temperatures, enabling the shift to clean heating not conditioned by a deep renovation. Unlike traditional approaches that rely on a single flow-temperature threshold, the LTR concept takes a broader, whole-system perspective. It links building performance to energy system goals, considers peak demand impacts, and provides a clear, staged pathway for improvement.

The LTR methodology is designed to be practical and adaptable. It helps policy makers integrate the concept into national strategies and EU frameworks, such as the Energy Performance of Buildings Directive, while giving building owners actionable guidance. By combining energy efficiency, heat pump compatibility, and grid resilience, LTR ensures that investments made today support a future-proof, climate-neutral energy system.



# 2. Introduction to energy efficiency and heating systems in buildings

Decarbonization of heating/cooling systems in buildings is necessary to achieve **EU climate and energy targets** (i.e., European Green Deal, Recovery and Resilience Facility, REPowerEU, etc.).

While **energy efficiency** measures (such as insulation on building envelope) reduce the energy demand of a building, the choice of **heating systems** determine the carbon content of heating.

Currently fossil fuels such as gas and oil are predominant, but **district heating** systems and specifically **heat pumps** are gaining significant market shares.

The combination of both does not only define the overall energy demand and carbon footprint of a building but also has significant influence on the (electricity) **peak demand.**

# 3. Why is low-temperature heating becoming increasingly important?

When it comes to heating and heating-distribution systems in buildings, the **system operation temperature** is a key parameter. While radiators, especially in older buildings, are often operated at temperature levels between 70°C – 90°C, modern floor heating systems or radiators can operate between 30°C – 50°C.

While the heating distribution system temperature has a small impact on the efficiency of boilers (especially the condensing part), it has **significant impact** on the overall **efficiency of heat pumps** – with direct effects on the electricity demand.

With increasing shares of heat pumps and renewable electricity in the energy system, **high-efficient heat pumps,** enabled by **proper efficiency levels of building envelopes**, are of **key importance** to increase the share of renewable heating systems, decarbonize the energy system and reach a climate neutral building stock by 2050.

Furthermore, as we face massive needs in terms of grid transformation, low temperature heating helps to limit **grid-reinforcements needs** and consumers benefit from better **comfort and resilience** levels.

# 4. What national concepts on low-temperature readiness exist already?

The **LTR concept is country-specific**, as it depends on various elements, such as the heating technologies used, a building's characteristics, climate zone, condition of electricity grid, etc. and **determines** when a building is ready for low-temperature heating.

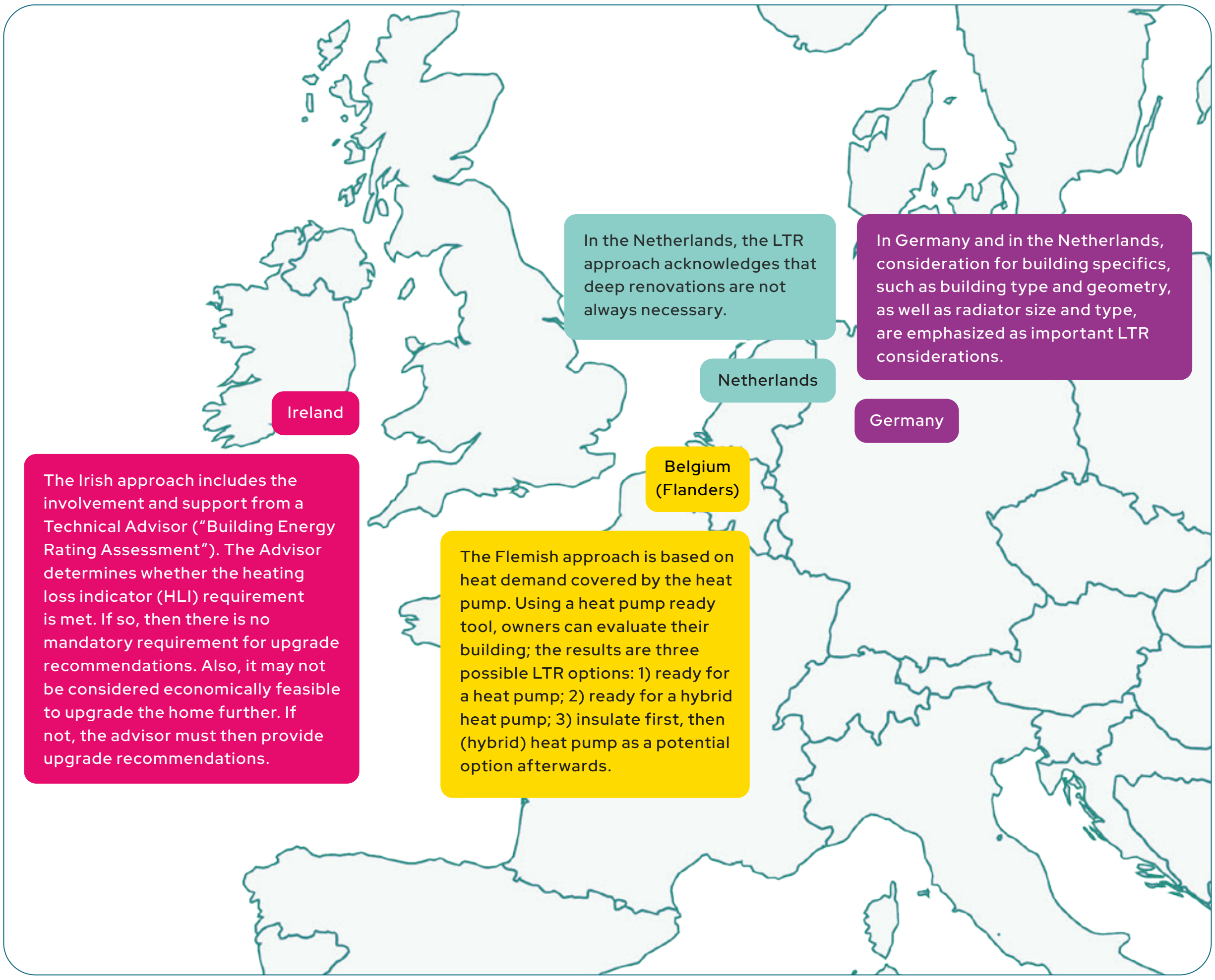
Various Member States provide information on national approaches to the LTR concept including Belgium (Flanders), Czechia, France, Germany, Ireland, Luxembourg, Netherlands, Spain, and Sweden. However, the **quality and quantity of information varies greatly.**

Generally, the **most comprehensive national approaches** for LTR are based on one of the following parameters:

- The share of heat demand covered by the heat pump
- Maximum flow temperature (55°C)
- Coefficient of performance (COP)
- Heat loss indicator related to total fabric

Moreover, there tends to be **general consideration for building energy renovation** among the approaches as a way to prompt LTR.

Below are some highlights extracted from the national approaches:



# 5. What does the Energy Performance of Buildings Directive (EPBD) require?

The current Directive (EU) 2024/1275 (recast EPBD) **does not explicitly mandate an LTR indicator in the renovation journey of a building**; instead, it sets binding frameworks where Member States can embed LTR criteria during transposition and implementation (e.g., targets, indicators, installers guidance, and funding rules).

The LTR concept (and corresponding measures) can be brought into practice by **including it in the design of various EU-level policies**, either as a mandatory or optional.

Below are EPBD Articles identified in which including the LTR concept may be possible and impactful.

- → In **Article 3 (NBRP)**, an LTR indicator can be included as an National Building Renovation Plans (NBRP) element. The NBRP can be linked to fossil phase-out and specify low-temperature systems as an option for financial incentives.
- → **Articles 5 & 6 (Minimum Energy Performance Standards and cost-optimality)** could, for example, set fabric/system requirements that facilitate low-temperature operation and consider decarbonisation-oriented cost-optimality.
- → In **Article 11 (Zero Emission Buildings)**, guidance can explicitly reference LTR readiness in national ZEB definitions.
- → **Article 12 (Renovation passports)** can include an LTR indicator which can be used as a pathway to enhance building roadmaps.
- → **Article 13 (Technical Building Systems)** provides an opportunity to prioritise LTR in terms of requirements and incentives to enable low-temperature operation and accelerate the phase-out of fossil boilers.
- → In **Article 17 (Financial incentives, skills and market barriers)**, LTR can be referenced as a condition for accessing funding for heating systems. However, an exception for deep renovations could be made if the building is already "LTR".
- → **Article 19 (Energy Performance Certificates)** can integrate an LTR indicator on the EPC front page, provide pre-defined measure packs to help buildings achieve LTR status, and adapt EPC templates (including Annex V) to incorporate LTR-related information.
- → **Articles 23 and 24 (Inspections and Reports)** can include low-temperature feasibility testing in the inspection process and provide tailored advice on achieving LTR in reports, thereby linking technical assessments with actionable recommendations.

# 6. Why a new concept – and what is the differentiator to existing concepts?

Many **current LTR definitions are too narrow** because they rely on a single threshold for maximum heating system flow temperature (often 55 °C). This **somewhat arbitrary** proxy does not reliably indicate whether a building can run an efficient, renewables based heating system under real operating conditions.

For assessing readiness, the **average system temperature** across typical operation is more meaningful than a one off maximum. However, since average temperatures are difficult to calculate in practice, the **heating energy need (kWh/m²·a) serves as a robust proxy** for LTR that directly links to heat pump efficiency and energy system outcomes.

Since the concept ideally considers final energy demand and peak demand when buildings adopt heat pumps, overall, it also requires an overall **whole energy system perspective**. This perspective thereby acknowledges heat pump efficiency, grid impacts, renewable electricity availability, and infrastructure needs, which makes the concept future proof.

The updated Guidehouse approach specifies two thresholds, which enables **three practical categories**: **Prepare first, LTR with checks, and LTR**. These clear categories create an actionable pathway so owners and policymakers can prioritise upgrades efficiently, avoid a binary pass/fail approach, and follow a guided transition path rather than defaulting to blanket deep renovation.

**Peak demand** is explicitly built into the concept by adding a heating load check to avoid oversizing, to minimise grid stress, and to ensure future proof deployment at scale.

**Energy efficiency is an integral part** of the updated concept rather than optional. Building envelope performance reduces heat demand, enables lower system temperatures, improves heat pump performance, and flattens electricity and heat peaks, making efficiency a co determinant and prerequisite of LTR rather than an afterthought.

**Country-specific adaptability** is essential because LTR must adapt to the technology mix, building stock characteristics, climate zone, and grid conditions. Moreover, existing national approaches vary widely and thus call for a framework that is consistent in principle but adjustable in parameters.

An **evidence-based proxy** remains useful because while the main indicator is heating energy need, maximum operating temperature can function as a convenient approximation. For example, approximately 45 °C maximum operating temperature is already feasible in about 50% of Germany's stock today, demonstrating that substantial parts of the stock can move to low-temperature operation with limited interventions.

The concept aligns well with **regulation and financing mechanisms** because thresholds are tied to **energy system pathways,** allowing the LTR approach to integrate naturally with EPBD/Energy Efficiency Directive, Renewable Energy Directive instruments, as well as to be supported through targeted subsidies and advisory schemes, mapping well to EPCs, Renovation Passports, minimum energy performance standards, and funding conditions.

The approach is intentionally pragmatic because it focuses on **enabling decarbonisation** now without demanding deep renovation everywhere, using **cost effective measures** at natural renewal points to deliver most of the benefits.

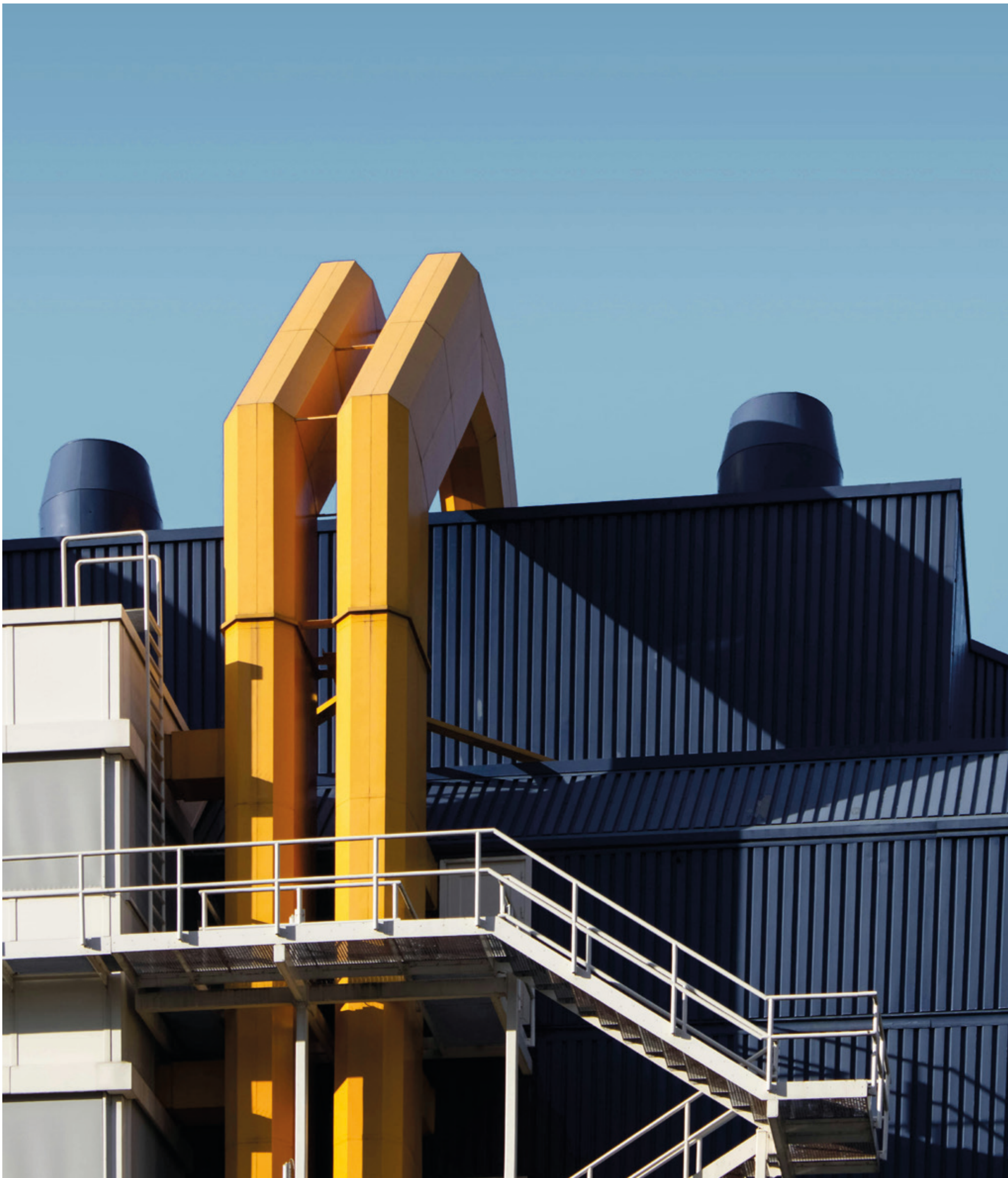
What differentiates this LTR concept:

→ **From 55 °C to system-ready:** moves beyond a single flow-temperature cap to system-relevant indicators (heating energy need + peak load).

→ **From building-only to whole-system:** explicitly links building outcomes to grid and renewables integration, avoiding future peak bottlenecks.

→ **From binary to graduated readiness:** two thresholds and three categories provide nuanced, actionable pathways (including "check-box" measures).

→ **From ad-hoc to pathway-based:** thresholds derived from EU energy system studies (2040/2050 pathways), future-proofing decisions.



# 7. How to use the low-temperature readiness tool?

The LTR tool assesses, in a bottom-up manner, whether and how an individual building is ready for low-temperature heating by **comparing its heating energy need** (kWh/m$^2$·a) **against established EU pathway-based thresholds.**

**Inputs to and conditions of the tool include the following:**

→ The tool requires key building information, including the building type, the country or climate data, and envelope details, such as areas and U-values, ventilation or infiltration rates, and window specifications including shading.

→ The tool records the main systems, capturing the relevant characteristics of the heating system and the ventilation system and uses core parameters, such as internal heat gains, conditioned floor area, set-point temperature, and night set-back to ensure a consistent and realistic calculation basis.

→ The tool includes a measures toggle in the form of "check-box" options for upgrades, such as window replacement, roof insulation, façade or cavity wall insulation, and hydraulic balancing.

## How is the lower threshold set?*

**523** TWh (EU)

Total allocated electricity for heat pumps in building sector

↓

**÷17,3** bln m$^2$

Floor area designated for heating with heat pump systems

→

**=30** kWh/m$^2$a (EU)

Average annual delivered energy for heat pumps (approx.)

→

**x3,5** (SCOP)

On average, heat pumps produce over three times the heat compared to the electricity they consume.

↑

**=105** kWh/m$^2$a (EU)

Average annual energy need in building to ensure safe/stable energy system and enable comfortable indoor temperature

* All assumptions taken frome European Commission 2040 Impact Assessment. All averages are European, final calculation will have to be Member State-specific.

→ Determine **heating energy need** (kWh/m$^2$a) for the building.

→ Compare to **thresholds** derived from EU impact assessment pathways. As the building stock is very heterogeneous, **two thresholds** and **three categories** are defined.

## Guidehouse proposal - The LTR Concept (II)

Heating Energy Need

| | |
|---|---|
| **Prepare first**<br>A building that has improvement potential for almost all components, e.g. only one component is renovated to proper standard, the rest not renovated. | **Upper threshold** (indicative):<br>around 140/150kWh/(m²a) |
| **LTR with checks**<br>Check-box approach (wall (façade, cavity), roof, window, hydraulic). | **Lower threshold** (main threshold):<br>Approx. 105 kWh/(m²·a) |
| **Building is LTR**<br>Average heating energy need for EU countries from energy system studies - in average, lower threshold reflects buildings that are fully renovated except one component (e.g. façade). | |

→ Assess **peak demand:** The tool calculates heating load to size the maximum heat pump power at the lowest outdoor temperature in the climate dataset, critical to avoid future peak stress.

→ **Prioritise measures**: If "LTR with checks", the tool recommends cost effective envelope and system actions (e.g., window replacement; roof, façade/cavity, and cellar ceiling insulation; radiator upgrades; control optimisation; hydraulic balancing).

### Outputs of the tool:

→ **Readiness status**: LTR / LTR witch cheks / Prepare first

→ **Peak load** at design outdoor temperature.

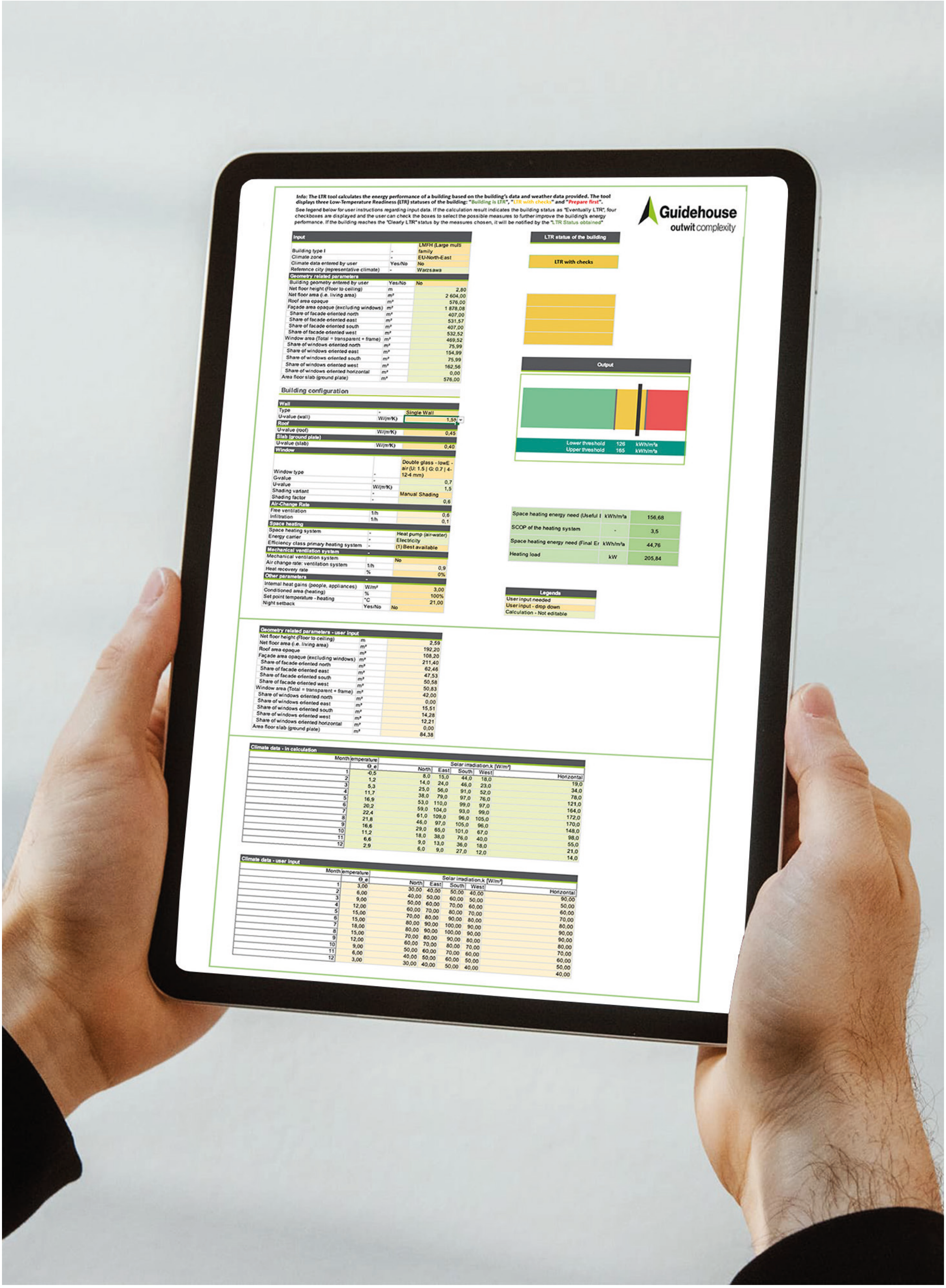
→ Tailored **upgrade list** (the "check box" measures) to cross the threshold(s).

### Why this updated LTR approach works:

→ Anchors decisions in EU energy system pathways (e.g., total allocated electricity for heat pumps (HPs) ≈ 523 TWh, HP delivered energy ≈ 30 kWh/(m²·a), yielding ≈105 kWh/(m²·a) heating need).

→ Directly connects building efficiency, heat pump performance, and peak demand, thereby ensuring readiness that is technically credible and grid compatible.

→ The calculation of heating load implicitly assumes a specific design heat load of approximately 80 W/m², representing typical existing-building conditions. This value can be adjusted for different national datasets or building archetypes.


Guidehouse
outwit complexity
LTR status of the building
LTR with checks
Output
Building configuration
Legends