BEUC The European Consumer Organisation

Introducing the Heat Pump Readiness Indicator:

How to make Energy Performance Certificates fit for heat pumps

BPIE

This study was prepared by BPIE

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Executive summary

Heat pumps may have a crucial role in the decarbonisation of the building stock in the EU, the uptake of renewable heating and the reduction of our dependency on fossil fuel imports for heating. Heat pumps can support EU decarbonisation efforts to phase out fossil fuels and promote low-temperature district heating systems. To realise their full potential, it is important to understand if residential EU buildings, and in particular their building envelopes, are fit for heat pump installation and deployment. Energy performance certificates (EPCs) have an important role in conveying this information, especially to building owners.

For this purpose, this study:

1. Defines an approach to measure the "heat pump readiness" of buildings, tested on 30 target buildings across the EU
2. Assesses how a break in heating supply may affect indoor temperature and comfort period in target buildings
3. Proposes the heat pump readiness indicator (HPRI) and ways to include it in national EPCs, including a list of policy recommendations.

The definition of **heat pump readiness (HPR)** is based on the main characteristics of heat pump technology and how it is used in buildings. The HPRI estimates the extent to which a heat pump can use outside air to cover a building's heating demand, and how this depends on the building envelope and improvements made to it. Heat pump readiness can be assessed relatively easily once the characteristics of the building envelope, climate and the reference heat pump are known. A reference heat pump is introduced to ensure implementation of feasible heat pump solutions, clear comparison of results, and analysis highly relevant for all stakeholders.

Building insulation and the climate zone have a significant impact on a building's heat pump readiness. The better the insulation and warmer the climate, the higher the possible heat pump readiness. Therefore, building renovation that includes the installation of a low temperature heat distribution system can significantly increase heat pump readiness of buildings, but only up to the point when maximum share of heating energy extracted from air is reached.

The share of a building's heating demand covered by electricity also increases its heat pump readiness. The decarbonisation potential of heat pumps therefore depends heavily on efforts to decarbonise the electricity supply.

Figure 1: Building heat load coverage by heat pump, electricity and backup systems

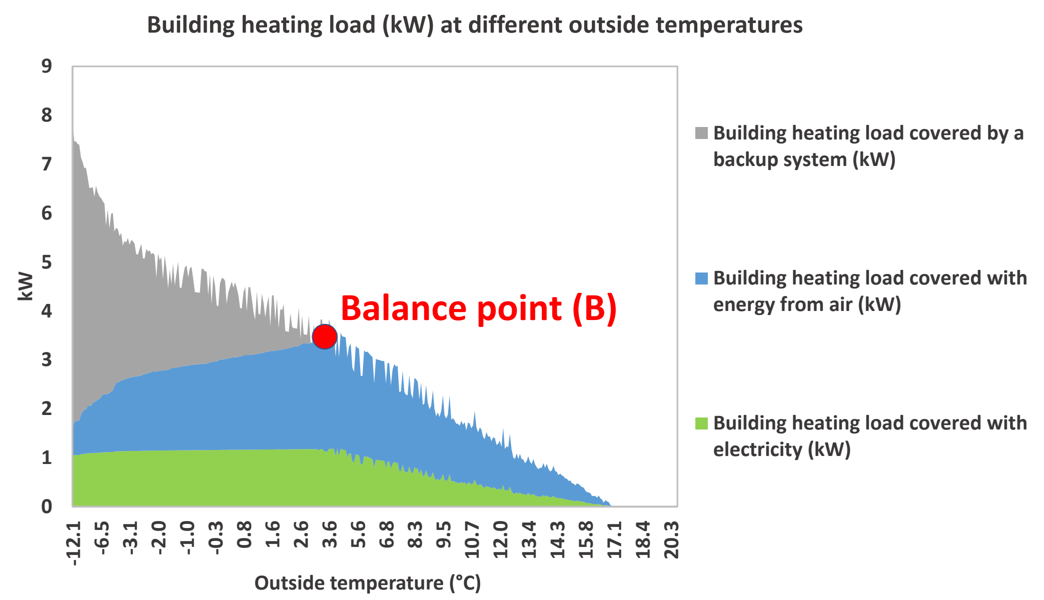
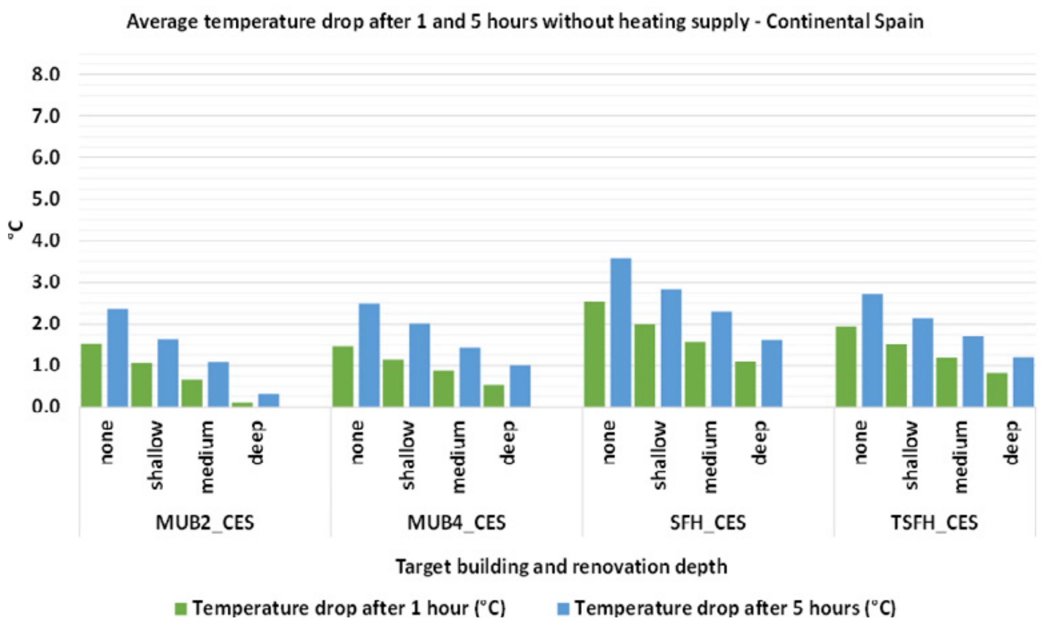


Figure 1 demonstrates that at temperatures below the balance point, the heat pump capacity is not enough to cover the entire building heating load. In this case, a backup heating system such as a gas boiler is needed to cover the difference.

Figure 2: Temperature drops after heating is switched off for non-renovated and renovated buildings (Continental Spain)



Regarding the risk of breaks in gas and heating supply, the study shows that comfort levels in buildings can fall quickly if they are not properly insulated. For example, in Continental Spain (see Figure 2), indoor temperatures can fall by between 1.5°C and 2.5°C within an hour of heating being switched off in non-renovated buildings; heat losses are around 50% lower after deep renovation. Deep renovation may be an efficient way to make homes comfortable in the case of blackouts or energy rationing and has obvious benefits linked to the installation of heat pumps in Boreal, Central Europe and Alpine regions. In Atlantic, Continental Spain and Mediterranean regions, where outdoor temperatures are higher, the costs and benefits would have to be evaluated according to the specific context, considering other possible benefits.

Although heat pump readiness may be highly relevant for making decisions on building envelope renovation and heat pump investments, it will have little value unless it is properly communicated. EPCs can be an important tool to pass this information to building owners and other stakeholders.

Our review of 11 EPC schemes across the EU showed that although many capture significant information on heat pumps, they do not clearly show if the building is heat pump ready. To help inform homeowners about the benefits of heat pumps, this study proposes to include the heat pump readiness indicator in EPCs. This inclusion would provide a common methodology to assess the capacity of a building to use heat pump technologies and adapt its operation to the needs of the occupants and the grid while improving energy efficiency. Including the HPRI in EPCs would be an effective way to pass on useful information (e.g. financial payback, annual electricity costs, indoor comfort) to consumers.

There are various barriers to developing and deploying the HPRI. This report provides a broad range of policy recommendations to realise its full potential. These include recommendations on assessment and communication, consistency between the HPRI and EPC calculation methodologies, and technical specifications for different building types.

Our review of 11 EPC schemes across the EU showed that although many capture significant information on heat pumps, they do not clearly show if the building is heat pump ready.

Key takeaways

- **The heat pump readiness of a building is defined as the share of a building's annual space heating demand that can be covered by energy extracted from outside air using a reference heat pump.**
- **Building renovation can improve the energy efficiency of the building envelope,** and by installing low-temperature heat distribution systems, can help improve the heat pump readiness of target buildings.
- **Deep renovation would in most cases eliminate the need for a backup system**, allowing the reference heat pump to completely cover heating demand.
- **Renovated buildings will have a longer comfort period after the heating cut-off.** Deep renovation can significantly reduce temperature drops when the heating supply is cut off, keeping buildings comfortable for a longer period.
- **National EPCs do not explain heat pump readiness,** although they may capture information on heat pumps.
- **HPRI should be included as a label on a building's EPC,** allowing owners/occupants to easily assess and understand the imminent and future potential of a heat pump, and helping to communicate other potential benefits.
- **The energy that heat pumps can obtain from certain sources, such as outside air, is still not classified as renewable in some national EPC schemes.** To ensure consistency, such energy sources should be classified in the same way across the EU.
- **Introducing the HPRI to EPC schemes should not require additional data collection efforts.** Existing EPC schemes contain most of the data required for assessing a building's heat pump readiness.
- **Installation of heat pumps triggered by the HPRI will increase buildings' demand response and comfort, and could increase the renewable capacity of the energy grid.**
- **An HPRI assessment will enhance the quality of EPCs.** Adding a HPRI will make EPCs more accurate through reliable data.
- Despite the barriers to adding the HPRI to EPC schemes, **EPCs are important tools to evaluate and easily communicate** a building's heat pump readiness.
- Depending on the climate zone and the building type, **a medium range retrofit may be sufficient** to allow the reference heat pump to completely cover heating demand and reduce temperature drops sufficiently to keep buildings comfortable enough.

Acronyms and definitions

- **Building Renovation Passport:** A document outlining a long-term (up to 15 or 20 years) step-by-step renovation roadmap for a specific building, usually based on an on-site energy audit.

- **Coefficient of Performance (COP):** The ratio between the heat delivered by a heat pump, e.g., to a building, and the (electrical) power used by the heat pump.

- **Comfort period:** Ability of a building to remain comfortable, i.e., to keep a satisfactory level of indoor air temperature, after the cut-off in heating supply. Here evaluated with a drop in indoor air temperature after number of hours following the end of heating supply.

- **Energy Performance Certificate (EPC):** A document that assesses the energy efficiency of a building. Its main component is a rating scheme used to communicate the building's energy consumption.

- **Heat pump readiness (HPR):** For the purpose of this study defined as the share of the building's annual space heating demand that the reference heat pump covers with the energy extracted from outside air.

- **Heat pump readiness indicator (HPRI):** For the purpose of this study defined as a sign / symbol on EPCs allowing homeowners and occupants to assess and understand in a simple and meaningful way the present and future potential of a given building to be heated with a heat pump (partially or fully), based on the existing state of the building's envelope and current heating distribution system, or depending on modifications brought to the envelope energy performance.

- **Reference heat pump:** Heat pump used for assessing the heat pump readiness of a building. For the scope of this report defined as an air-water heat pump with a heating capacity of 15 W per m2 of the building floor area supplying hot water at the temperature of 45°C.

- **Return on investment (ROI):** A metric used to assess an investment's profitability by explaining how much benefits the unit of investment can produce. It is usually obtained as a ratio between the investment's net benefits and investment's costs.

- **One Stop Shop (OSS):** A business or organisation that provides a number of different services in one place. Here it implies an organisation providing advice and other services on energy renovation of buildings. As such, it is a common reference point for the majority of building renovation participants.

Introduction

The full decarbonisation of buildings relies on three pillars: reducing operational energy demand, switching supply from fossil fuels to renewables, and decreasing embodied emissions. At EU level, these aspirations have been translated politically in the Renovation Wave strategy (October 2020). The Renovation Wave sets the goal to double the annual renovation rate, to foster deep renovation, and to reduce greenhouse gas emissions in the buildings sector by 60% by 2030 compared to 2015. In its proposal for a recast Energy Performance of Buildings Directive (EPBD; December 2021), the European Commission put forward policy measures to deliver these objectives more concretely and specified that the building stock should reach zero emission building level, equivalent to energy performance certificate (EPC) class A, by 2050.

With the invasion of Ukraine by Russia in early 2022, energy security concerns have made these objectives even more pressing. Improved energy performance and decarbonisation of buildings must be accelerated to deliver concrete results by 2030, while aligning with longer-term energy and climate targets. Faced with an energy price and energy security crisis, the European Commission presented the REPowerEU Communication (March 2022) and action plan (May 2022), outlining pathways to phase out EU imports of Russian fossil fuels well before 2030. Both EU-level strategy and Member States' reactions have focused more on switching energy suppliers and boosting the deployment of renewables than on reducing energy demand through structural measures. European citizens are on the frontline of the crisis, wondering whether they will have access to necessary energy in the coming months, and at what price. Consumers are currently being presented with many solutions, often leaving them unsure of the best option and course of action.

One objective of REPowerEU is to have 30 million additional heat pumps installed in the EU by 2030. Compared to 2022, this represents a doubling of the current installation rate. At national level, several Member States are supporting heat pump deployment through targets, regulations and incentives. In Germany for example, there is an objective to install 500,000 heat pumps annually by 2024, reaching a total of 6 million by 2030. In France, heat pumps now receive a bonus under the subsidy scheme for building renovation, *Ma Prime Rénov*, while since April 2022, gas boilers are no longer eligible.

Heat pumps have experienced tremendous market growth in recent years. According to the International Energy Agency, sales in the EU grew by around 35% in 2021 compared to 2020, twice as fast as in the previous decade. In several Member States, sales growth has been even stronger (+60% in Italy and Poland, and +40% in France). The IEA expects the number of heat pumps in the EU to triple between 2021 and 2030.

As efforts are made across the EU to phase out fossil fuels,[1] there is a need for affordable and efficient technology to replace gas boilers and other fossil fuel equipment. Recent research suggests heat pumps are one of the most affordable solutions for decarbonising heating systems in buildings. Beyond the individual building level, heat pumps can also be used to power district heating systems [1].

The acceleration of building decarbonisation objectives and the recent push for certain technological options makes it even more fundamental to have a clear picture of the relationship between reduction of energy demand and switching to renewables, which measures to undertake and when. This relationship is usually more easily conceptualised and implementable in new construction than in existing buildings that need to be renovated. BPIE **previously** defined deep renovation as *"a process of capturing, in one or, when not possible, a few steps, the full potential of a building to reduce its energy demand, based on its typology and climate zone. It achieves the highest possible energy savings and leads to a very high energy performance, with the remaining minimal energy needs fully covered by renewable energy. [...] Deep renovation considers key building elements to cover, and when it cannot be completed in one step, carefully plans renovation steps – for example by using Building Renovation Passports, which outline the selection of energy-saving measures and renewable energy installations to be executed, avoiding any lock-in. [...]"*.

Deep renovation is thus defined according to the high energy savings it can provide; technically, it can be delivered in one or several steps, and through different packages of 'renovation works'. The push for renewable heating supply (such as heat pumps run by electricity provided from renewable sources) should be coherent and work in synergy with energy demand reduction (building envelope improvements). This clarity between energy demand reduction and switching to renewables is relevant for consumers at building level and will also aid market actors and public authorities at a macro-economic level, breaking silos between policies applying to buildings, grids, and appliances.

This analysis explores this "break-even" point in existing buildings, specifically in the residential segment, which represents 75% of the total floor area in the EU. **For this purpose, three different levels of building envelope and U-values reduction are considered (shallow, medium, and deep renovation) while relative depth of the retrofit varies across climate zones and building types.** In this context, deep renovation corresponds to a significant improvement of the energy performance of the building envelope, achieved only by improving the U-values of walls, windows, floors, and roofs, which reduce heat transmission losses.

This report explores the definition of 'heat pump readiness' (HPR): specifically, how to assess when a building is "ready" to be heated with a heat pump, based on the energy performance of the building envelope. This report also investigates how the HPR information could be communicated to consumers via Energy Performance Certificates (EPCs).

1 Ten EU countries already have plans to ban the installation of new oil and gas boilers in new and/or existing buildings, while 16 countries redirected financial support from new boilers to sustainable alternatives [12].

> ***Deep renovation corresponds to a significant improvement of the energy performance of the building envelope, achieved only by improving the U-values of walls, windows, floors, and roofs, which reduce heat transmission losses.***

The introduction of the heat pump readiness indicator will take place in the wider context of EPCs being reformed in order to increase their reliability.

In order to utilise the full potential of heat pump technology to reduce fossil fuel dependence, it is essential to understand the level of residential building envelope performance required for their proper installation and employment. Homeowners should be provided with reliable information on heat pump technology and should be able to understand the benefits and potential interactions with their specific building insulation improvements.

Large scale introduction of a technology must inevitably first confront an initial lack of detailed understanding. In this case, building owners would benefit from accurate and reliable information on the building and system performance. Although EPCs are widely used for this purpose, they suffer from limited and poorly designed information and can be misleading due to irrelevant content. It is therefore important to understand how the HPRI can be included in the EPC while staying both understandable and relevant for consumers and heat pump installers, building certifiers and renovation workers.

Compared to the systems currently found in most building stock, heat pumps belong to the family of low-temperature systems. The upper temperature limits of these systems have been recently defined by several sources. The Association of Homeowners in the Netherlands [2] foresees that a low-temperature system should stay below 50°C while VDPM[2] in Germany states that a building is «low-temperature-ready» if it can be heated on the coldest days of the year with a maximum heating water flow temperature of 55°C. [3] Analysis of several EU case studies suggest that current low-temperature systems use temperatures between 40 and 60°C [4].

There is a strong debate on whether or not heat pumps can efficiently heat inefficient buildings, which may significantly affect the potential for heat pump technology uptake. It is our conclusion that if properly designed, installed, and connected to adequate heat emitters (e.g., properly sized radiators), heat pumps may be used in any building. However, in an inefficient building this may come at very high investment and operational costs, which may threaten the economic feasibility of the investment. In addition, superfluous installation of heat pumps in inefficient buildings could place excessive strain on the electricity grid.

2 Verband für Dämmsysteme, Putz und Mörtel e.V.

The performance of a heat pump driven heating system will significantly depend on correctly sized emitters. However, some research shows that most of the existing heating systems and emitters may already be well prepared for low-temperature employment. For example, a study on the building stock in the Netherlands shows that supply temperatures can be lowered to 55 °C or more while keeping the existing radiators in most of the analysed buildings [5].

Following these important considerations, and within the context of reaching the EU objective of a Zero Emission Building stock by 2050, the present study analysed several aspects that may additionally support and strengthen the link between the level of renovation depth and the deployment of heat pumps in residential buildings.

Policymakers involved in the revision of the Energy Performance of Buildings Directive (EPBD), should consider the study findings when designing advisory, regulatory, and financial measures, thereby tapping into the full potential of both energy demand reduction and switching to renewable heating options through more comprehensive renovations.

Objective of the study

The present study proposes concrete solutions on how to foster energy efficiency in the Energy Performance Certificates (EPCs) via the introduction of a "heat pump readiness" indicator and through supporting consumers' decisions on building renovation.

In detail, this study aims to:

- **Define the approach and metrics to assess the heat pump readiness of buildings,** depending on location and quality of the building envelope.
- **Apply the heat pump readiness metrics to specific parts of the EU residential building stock,** represented with pre-defined target buildings, to understand their current and post-renovation readiness for heat pump employment.
- **Assess how long target buildings can remain comfortable** after the heating is switched off, for both existing and renovated buildings.
- **Propose how a "heat pump readiness" indicator could be integrated into Energy Performance Certificates.**

Special considerations

Due to the high complexity of the topic, it is important to clarify certain scope limitations and assumptions:

- **This study, and its proposed concept of a building's heat pump readiness, do not answer whether an individual building is heat pump ready.** Instead, the report defines and provides **potential metrics** to measure the heat pump readiness of a building as one of the first necessary steps to establish whether a building/building stock is heat pump ready or not. For this reason, the study does not establish a threshold above which a building can be considered heat-pump ready.

- **The target buildings explained in Table 1 are not selected to represent the EU or national building stocks.** Therefore, the resulting heat pump readiness or comfort period of the target buildings should not be used to derive conclusions on heat pump readiness, comfort period, or the importance of insulation levels for EU or national building stocks.

- **The readiness of largescale heat pump uptake is not analysed.** Instead, the study may support such an assessment by explaining how one of its potential steps can be undertaken.

- **Building insulation or heat pump installation/operation costs are not taken into account.** This means that the economic feasibility of potential heat pump investments is not addressed. This extremely important component cannot be neglected and is therefore resolved with the reference heat pump concept.

- **The study assumes that all physical preconditions of heat distribution in homes and heat pump selection and installation are fulfilled.** For example, it is assumed that heat emitters[3] of proper type and size are installed. It is also assumed that each building provides enough space for installation of the selected heat pump.

3 Such as radiators or fan coil units.

Main inputs and assumptions

Target buildings and climate zones

Heat pump readiness is assessed for target buildings of different use (Table 1) located in several EU climate zones (Table 2). Target buildings represent parts of the building stock (grouped per building use or structure) where quality of building envelopes has an important impact on energy consumption.

Table 1: Target buildings

Target building use	Target building code
Four facades single-family house, used by a family of four	SFH
Two external facades single-family house, used by a family of four (commonly referred to as terraced)	TSFH
4 floor 8 flats multi-unit building, used by single people	MUB1
6 floor 24 flats multi-unit building, used by single people	MUB2
4 floor 8 flats multi-unit building, used by a family of four	MUB3
6 floor 24 flats multi-unit building, used by a family of four	MUB4

Table 2: Climate zones and locations

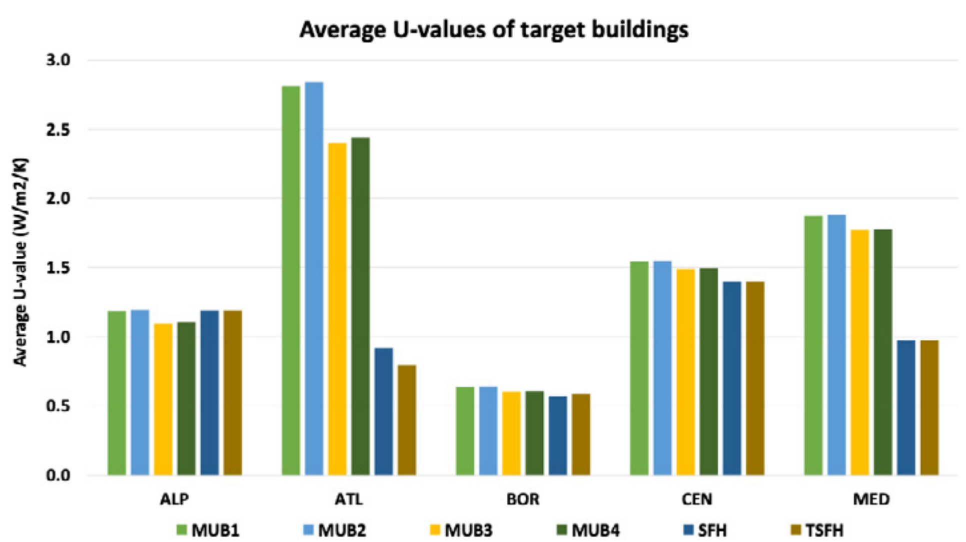
Climate zone	Climate zone code	Representative location
Alpine	ALP	Vienna
Atlantic	ATL	Brussels
Boreal	BOR	Stockholm
Central Europe	CEN	Prague
Continental Spain	CES	Madrid

To cover all locations and building use types, 30 combinations of building type and climate zone, i.e. target buildings, were modelled and analysed. Throughout the report, each target building is assigned with a target building code, combining the building type and the climate zone. For example, building code MUB1_ATL implies a building with 4 floors and 8 flats, used by single people and located in the Atlantic region. Detailed list of the buildings and building codes can be found in Annex 1.

Inputs for defining and modelling each of 30 target buildings were obtained from the BPIE EU building stock database that contains data on reference buildings in 27 EU Member States. For each reference building this dataset provides information on size, materials used, and thermal characteristics, to name a few.

For example, to understand the quality of their building envelopes, the BPIE database provided average U-values for each target building, as shown Figure 3.

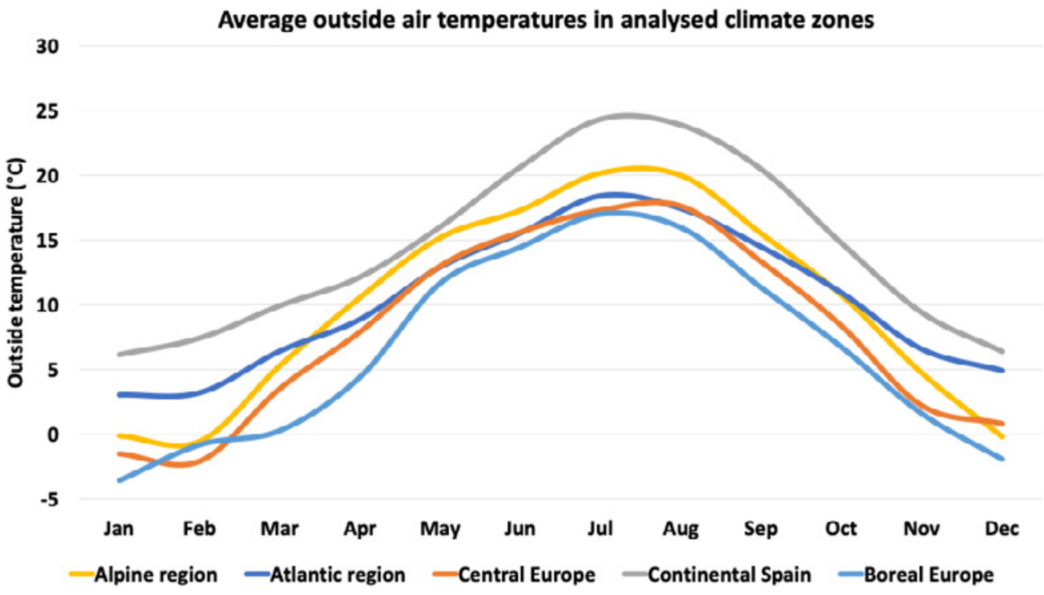
Figure 3: Average U-values of target buildings



It can be noted that target buildings with the highest U-values, i.e., the worst insulation levels and the worst thermal protection, are those located in the Atlantic and Continental Spain regions. The best thermal performance and the lowest U-values can be found among Boreal Europe target buildings.

Average outside air temperatures in five climate zones analysed in this report are shown in Table 3.

Table 3: Average outside air temperatures in analysed climate zones



Building renovation levels

Envelope improvement is achieved only by improving the U-values of walls, windows, and roofs, which reduced their heat transmission losses.[4] Three levels of building envelope and U-values reduction are considered:

- 30% (shallow renovation)
- 50% (medium renovation)
- 70% (deep renovation)

4 Although improved U-values for windows may imply window replacement and therefore reduced infiltration losses, these effects were not analysed.

Heat pump readiness

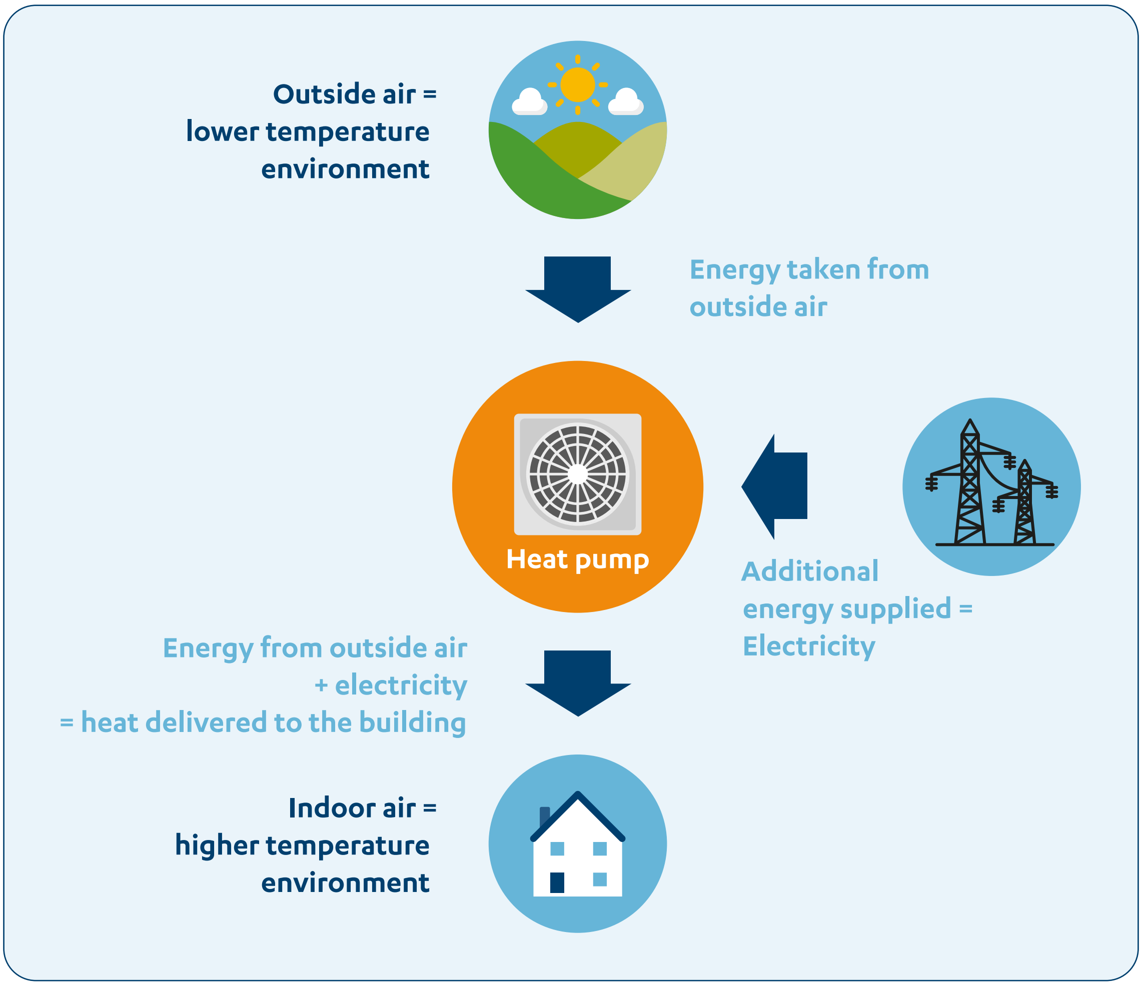
How heat pumps work

The heat pump is a device that extracts heat from a heat source at lower temperature, such as air,[5] and transfers it to higher temperature environments where the heat is needed. For instance, in winter months, the heat pump takes the energy from cold outside air and transfers it to warm rooms inside the building.

To complete this task and "pump" the heat from a cold to a warm environment,[6] the heat pump uses additional energy, usually in the form of electricity.[7] Additional energy and heat from the cold environment together make the heat delivered to the warm environment.

These main working principles of a heat pump are displayed in Figure 4.

Figure 4: Basic scheme of a heat pump



5 But also ground, water or waste heat from a factory.
6 Since the heat does not flow naturally from lower to higher temperatures but vice versa.
7 Heat pumps using the heat, e.g., from combustion of natural gas, are possible as well.

A performance of a heat pump is usually defined with its coefficient of performance, or COP, that shows how much heat is delivered, e.g. to a building, with a unit of additional energy used. As a general rule, higher COP means that per unit of heat delivered, more energy is provided from outside air. The heat pump performance depends on a variety of conditions, but a typical heat pump may have a COP of between 2 and 6 in winter conditions [6].

The following aspects of heat pump operation are especially important for this study:

- **Economic aspect:** When a heat pump is installed, a portion of the heating demand covered by an expensive fuel (e.g., natural gas) is replaced with energy extracted from the low-temperature heat source, such as air. Since this energy obtained from outside air usually comes at no cost, heat pump installation usually reduces energy bills[8] for the building owner.
- **Renewable energy aspect:** Heat sources, such as air, ground, or water are usually renewable energy sources and therefore important for decarbonisation and improved energy security at both local (building) and global (country) levels.

Heat pump readiness definition

The "heat pump readiness of a building" can be defined as the share of the building's annual space heating demand that the reference heat pump covers with energy extracted from outside air.

This definition aims to provide a metric to calculate the heat pump readiness of a building and does not establish a threshold above which a building can be considered heat-pump ready.

Heat pump readiness is heavily influenced by the quality of the building envelope. The intersection of the quality of the building envelope and the heat pump readiness is the cornerstone of this analysis.

The "heat pump readiness of a building" can be defined as the share of the building's annual space heating demand that the reference heat pump covers with energy extracted from outside air.

8 It is the amount of the additional energy (such as electricity in Figure 4) that determines the cost of running the heat pump. Final reduction in energy bill will depend on the relationship between the price of electricity and the price of energy used by the backup system, e.g., natural gas.

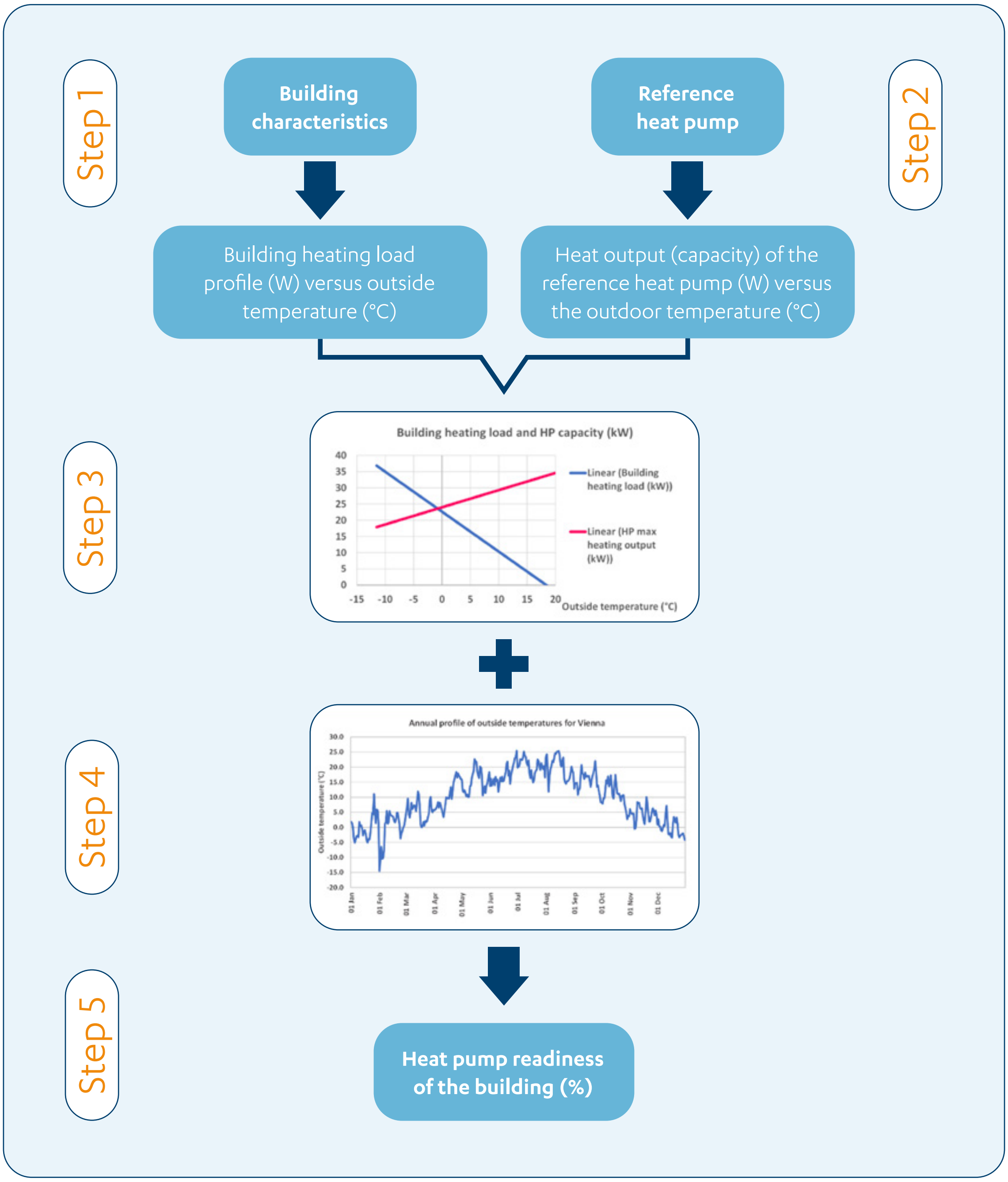
Methodology

The heat pump readiness assessment depends on three main components:

- How the heating load of a building depends on the outside temperature, considering building envelope quality (e.g., U-values), building use and compactness,
- How the heat output of the reference heat pump depends on the outside temperature,
- The series of daily outside temperatures for a given location for a full calendar year.

The steps for obtaining heat pump readiness are visualised and further explained below.

Figure 5: Calculation steps for heat pump readiness of a building[9]



9 Lines in step 3 are not necessarily linear.

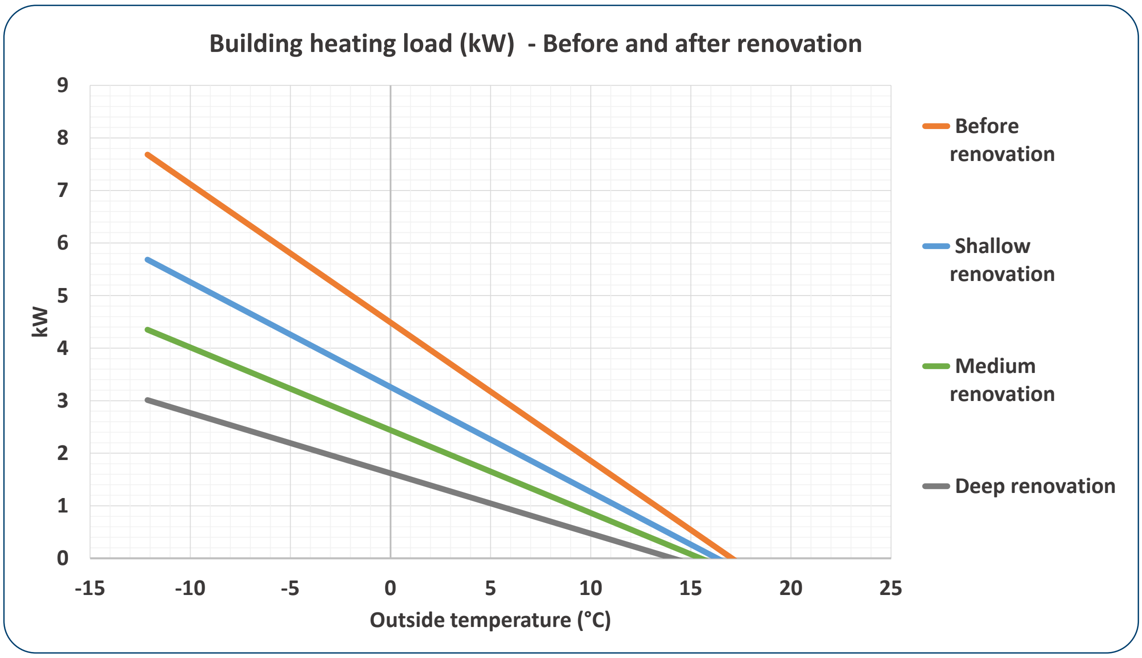
Step 1: Assessing building heating load

Building related information, such as floor area and U-values of the building envelope, are the main inputs for obtaining the building's heating load profile.[10]

This profile can be defined by using standard building heat transfer formulas, such as those used in ISO 52016 or similar standards, and can show how the heating load of a building, expressed in Watts (W), depends on the outside temperature. This dependency is usually approximated with a negatively-sloped linear trendline.

Figure 6 shows the heating load profile for a theoretical building before and after renovation. The building renovation decreases the slope of the heating load curve and therefore the annual heating demand of the building.

Figure 6: Building heating load versus outside temperature



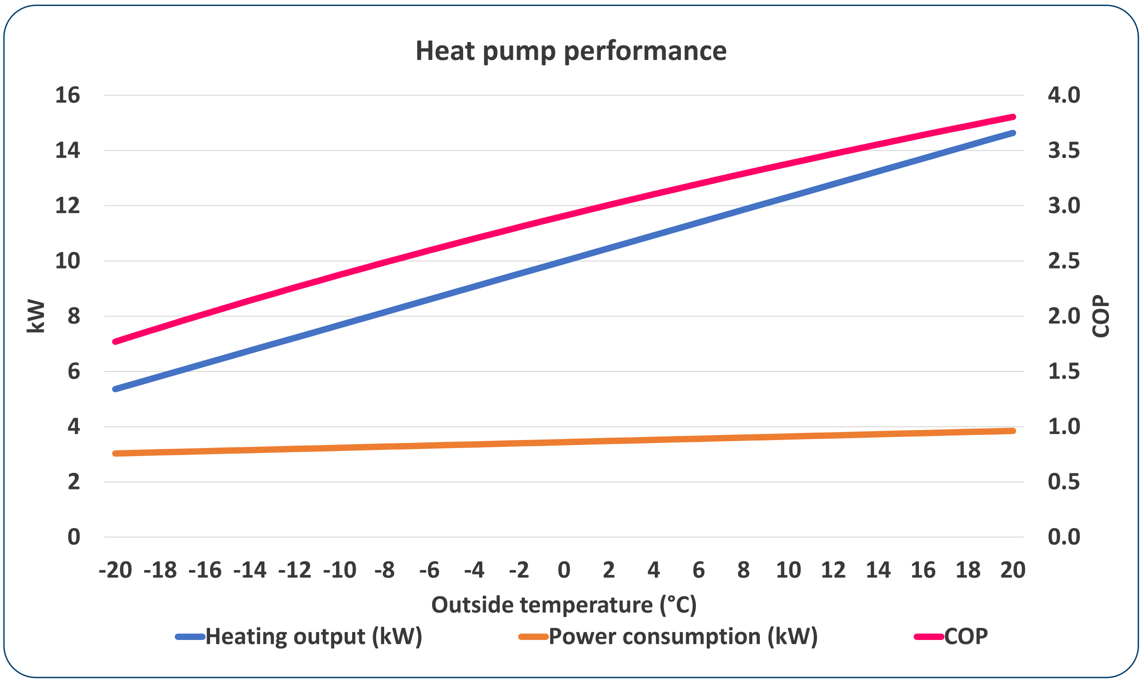
10 U-values of the existing target buildings can be found in the section Target building.

Step 2: Heat pump performance analysis

The next step is to define the heat pump performance, i.e., its heating output and power consumption curves. For different outside temperatures, these curves explain how much heating output (W) the heat pump can deliver to the building, and how much electric power (W) is consumed for this purpose. The ratio between the heating output and the electric power used, at given outside temperature, is referred to as coefficient of performance or COP of the heat pump.[11]

Heating output, electrical power consumption, and COP for a theoretical heat pump used in the analysis can be found in Figure 7.

Figure 7: Typical heat pump performance



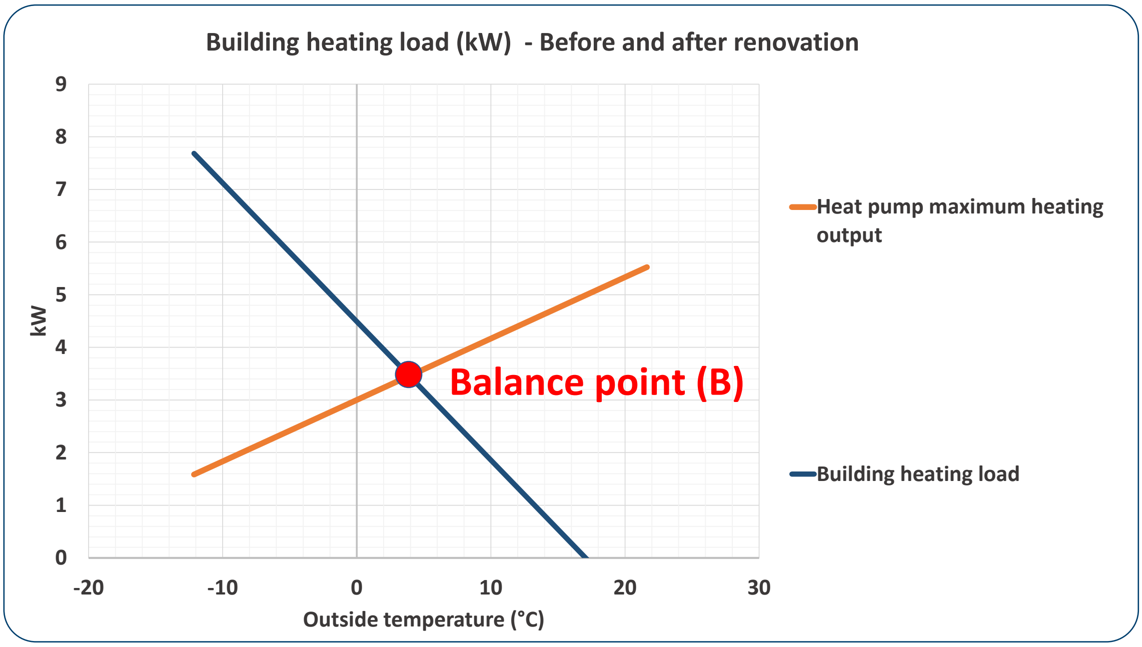
11 More on COP can be found in the section How heat pumps work.

Step 3: Merging building heating load and heat pump output curves

Once defined, the building heating load and heat pump output curves are merged, therefore showing to what extent the heat pump can meet the building energy demand. Figure 8 shows an illustrative example of these two curves in the same graph with their intersection that defines the balance point (B).

At temperatures lower than the balance point (seen on the left of the balance point), the heat pump heating capacity is not enough to cover the entire building heating load and the difference must be covered by a backup system, such as a gas boiler.[12] At temperatures higher than the balance point (seen on the right of the balance point) the heat pump is capable of covering all the building's heating load, without any intervention from the backup heating system.[13]

Figure 8: Heat pump maximum heating output and building heating load versus outside temperature



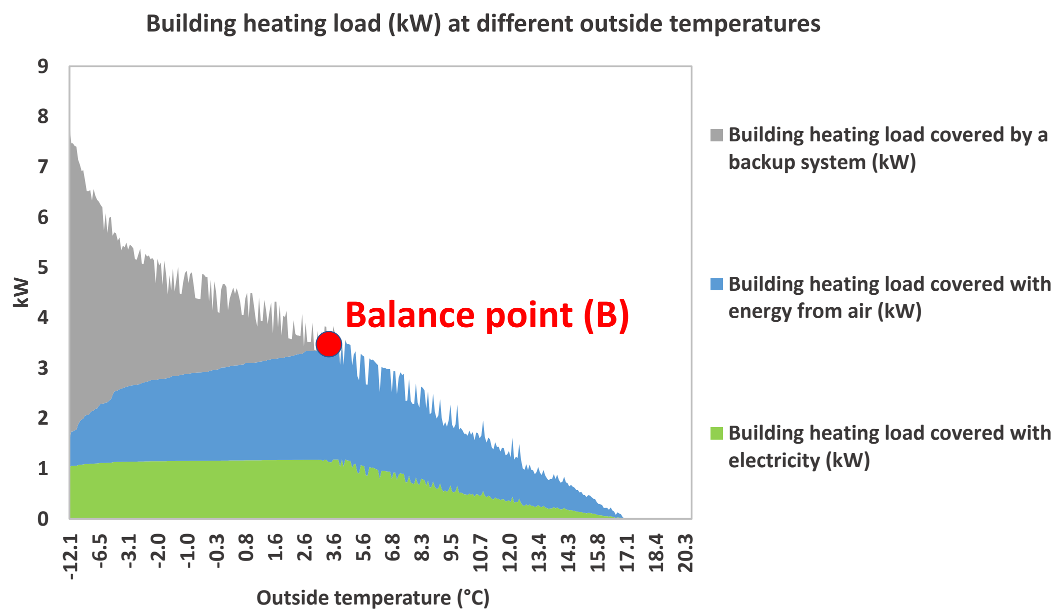
12 Although the backup system can be designed to fully replace the heat pump at temperatures lower than the balance point, this possibility is not analysed.

13 At these temperatures, the heat pump can supply more heating energy than required by the building. The heat pump control system reduces its heating output and brings it down to what is required by the building.

When in operation, the heat pump uses energy from two sources: a) the electricity grid and b) renewable energy source (RES) such as air, ground, or water. The sum of energy taken from these two sources equals the heat supplied to the building (heating load). At outside temperatures below the balance point, the heating load of the building will be covered from three sources – electricity to run the heat pump, RES, and the backup system. At the temperatures above the balance point, the backup system is not used and the building's heating load is covered only from the electricity grid and RES.

This is further explained in Figure 9 where it is displayed how the total amount of heating load of the hypothetical building is covered at different outside temperatures.

Figure 9: Building heating load coverage

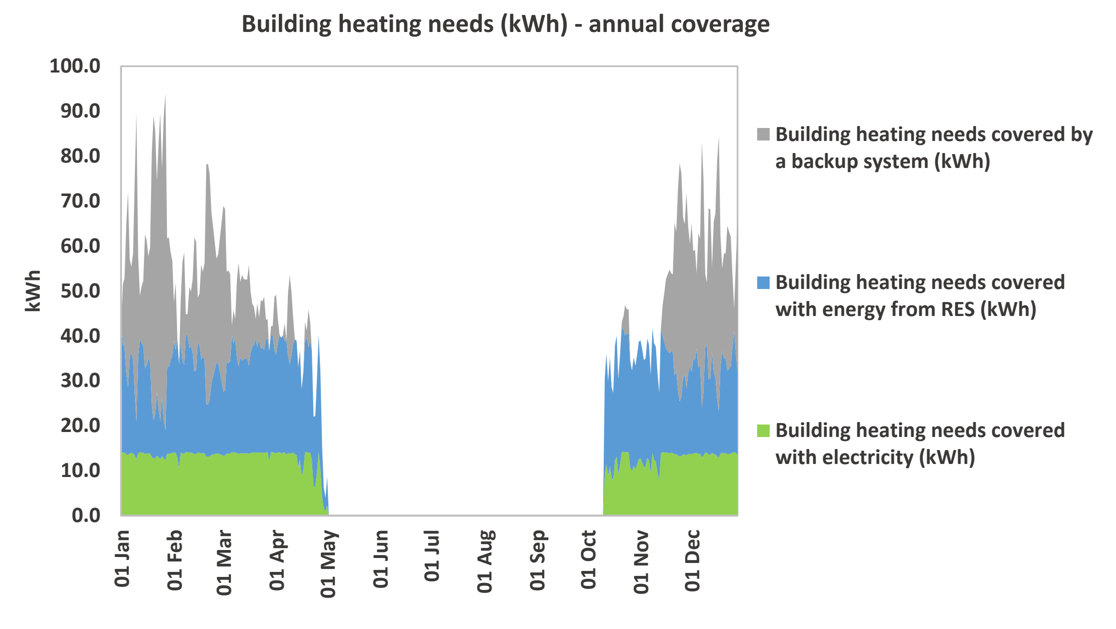


Step 4: Obtaining the heat pump readiness of the building

The results of the previous steps, especially those from Figure 9, are then combined with the annual profile of outside temperatures linked to the building's location. This allows an understanding of how much daily and annual heating needs can be covered by the heat pump once it is installed and running.

This is visible in Figure 10 where, for the hypothetical building, the blue area represents the heating energy supplied from RES throughout the year.

Figure 10: Annual coverage of the hypothetical building's heating needs[14]



Finally, the share of the blue area in the total area (including all three colours, i.e., three different energy sources) is used as a proxy for heat pump readiness of the building. This follows the proposed HPR definition[15] and expresses the share of the building's annual space heating demand that the heat pump covers with energy from a renewable source (outside air).

14 Domestic hot water (DHW) preparation is excluded from the analysis and the graph.
15 The heat pump readiness of a building is the share of the building's annual space heating demand that the reference heat pump covers with the energy extracted from outside air.

Reference heat pump selection

Reference heat pump requirements

Optimal price, capacity, and/or design are key factors that guide a consumer's decision-making when selecting a heat pump..

Contrary to such an approach, in this study, a single reference heat pump was selected to be applied to buildings despite differences in size and heating load. Since the same reference heat pump is expected to provide meaningful results when applied to different buildings, its selection needed to satisfy two main criteria:

- Its application should be technically and economically feasible for most buildings, and
- It should allow a comparison of heat pump readiness between different buildings and within the same building before and after renovation.

In order to satisfy these two criteria, the reference heat pump should:

- **Be easily applicable to most buildings**, implying it has a widely available heat source, low space requirements, the absence of complex construction works and be easily available in different markets.

- **Have a relatively low heating output**, which is important for two reasons:

    - The reference heat pump with high heating output may be oversized when applied to some of the analysed buildings and result in high heat pump readiness close to the maximum values even without building renovation. Such heat pump readiness would not be sensitive to improving the building envelope quality and would therefore prevent a) comparison of the heat pump readiness between different buildings and b) comparison of the heat pump readiness for a single building before and after renovation. To be applicable to a majority of the analysed buildings, the reference heat pump heating output should be kept relatively low.
    - Secondly, the reference heat pump with lower heating output is likely to cost less, making it a more economically feasible solution for homeowners. While higher heating outputs may imply higher heat pump readiness, such high heat pump readiness may easily come with low financial return in most of the analysed buildings, which eventually makes these heat pumps irrelevant for their homeowners and therefore for this analysis. Similar to the above, to be relevant for the majority of homeowners, the reference heat pump should have relatively low heating output.

- **Function at mid-range temperatures of supplied hot water.** While using high water temperatures (typically above 60°C) may match the existing high-temperature heating systems, it may result in lower heat pump performance (lower COP). At the same time, better heat pump performance (higher COP) at lower water temperatures (such as below 40°C) may imply lower compatibility with the existing heating systems. For these reasons, to avoid economically and/or technically unfeasible solutions, mid-range water supply temperatures are suggested.

Reference heat pump used

For the reasons listed above, the reference heat pump selected for this study has the following characteristics:

- **Air-water heat pump**, i.e., a heat pump that transfers heat from the outside air to the hot water that heats the building via its low-temperature heating system,
- **With a space heating capacity[16] of 15 W per m^2** of the building floor area, defined for an outside temperature of 0°C, and
- **Supplying hot water at the temperature of 45°C.**

For this study, we chose a reference heat pump with characteristics similar to models of air-water heat pumps currently available on the European market.

Heat pump readiness of the target buildings

This section shows the heat pump readiness for target buildings in each climate zone **when using the reference heat pump** selected for this analysis (as explained in the section Reference heat pump used). Target buildings are analysed in their current state (not renovated) and after renovation levels, as defined above.[17]

For each climate zone, the results are presented in a graph that, for different renovation levels, shows:

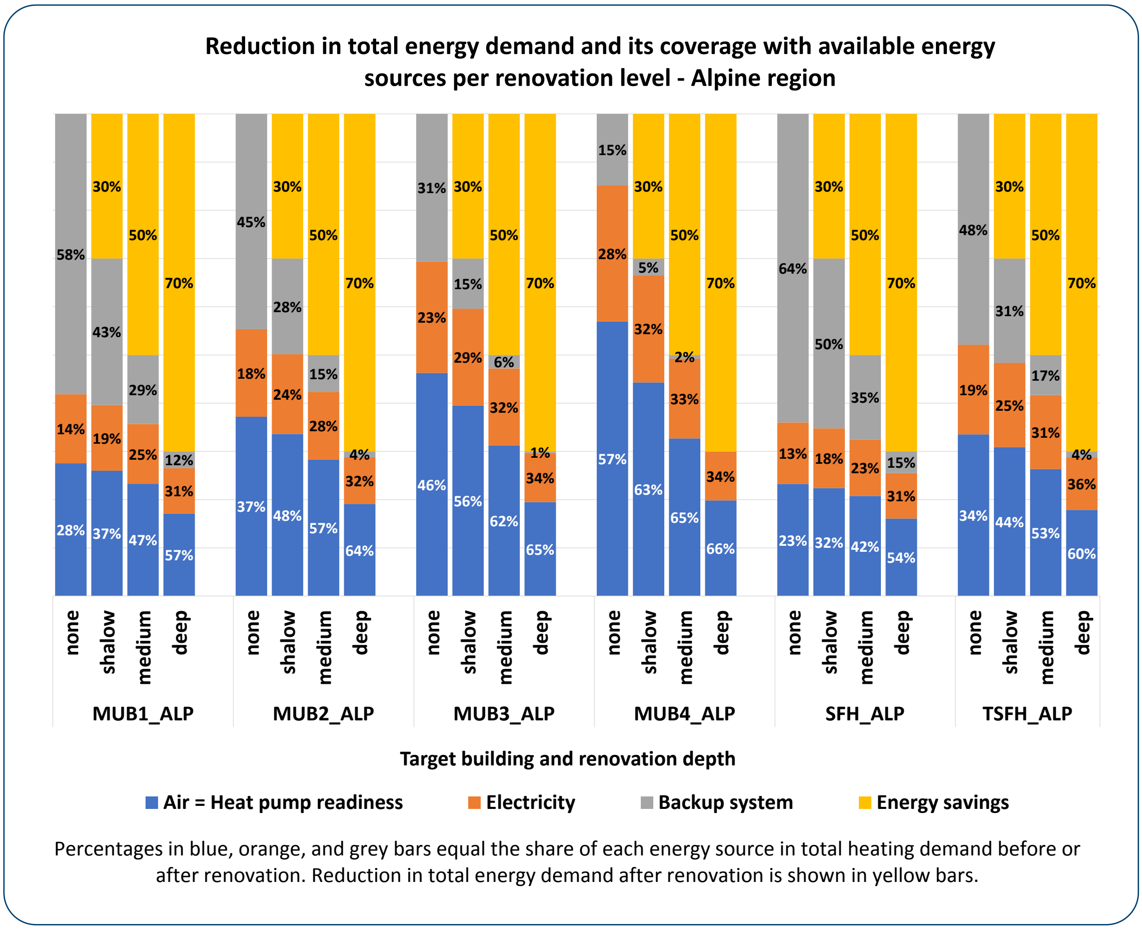
- Reduction of a building's total heating demand, as explained with the yellow bar and the percentages they contain.[18]
- The share of each energy source (blue, orange or grey bar) in total heating demand (the sum of blue, orange, and grey bars) before and after renovation. These values are shown in the bars and their sum equals 100%.

The following sections provide information on individual climate zones and their target buildings. A more detailed comparison is provided in the Conclusions.

16 Heat pump capacity required for providing domestic hot water, or similar, is not taken into account.
17 30% improvements – shallow renovation; 50% improvements – medium renovation; and 70% improvements – deep renovation.
18 It is assumed that relative savings in total energy demand equals relative reduction in U-values, i.e., 30%, 50%, and 70% for shallow, medium, and deep renovation, respectively.

Alpine region

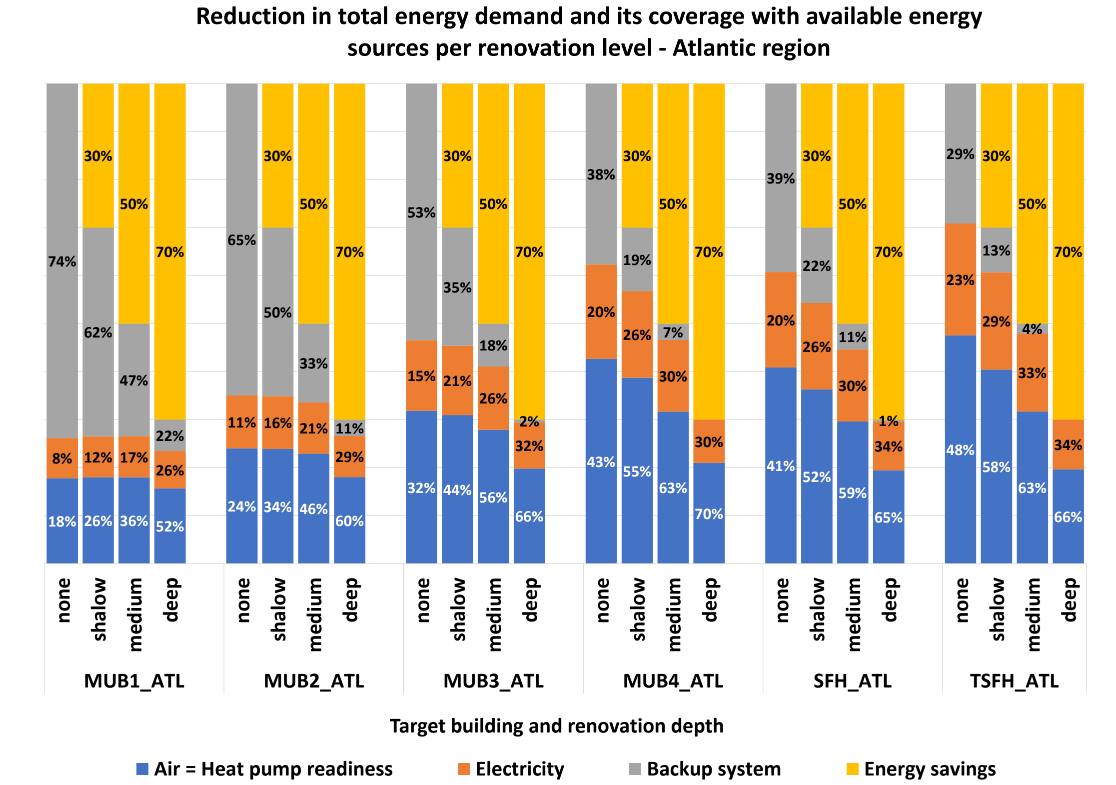
Figure 11: Reduction in total energy demand and its coverage with available energy sources per renovation level – Alpine region



The heat pump readiness of the existing target buildings in the Alpine region is between 23% and 57%. For most of the buildings the increase in HPR is visible at all renovation depths. Maximum HPR achieved with deep renovation is around 66% as visible in case of MUB3 and MUB4.

Atlantic region

Figure 12: Reduction in total energy demand and its coverage with available energy sources per renovation level – Atlantic region



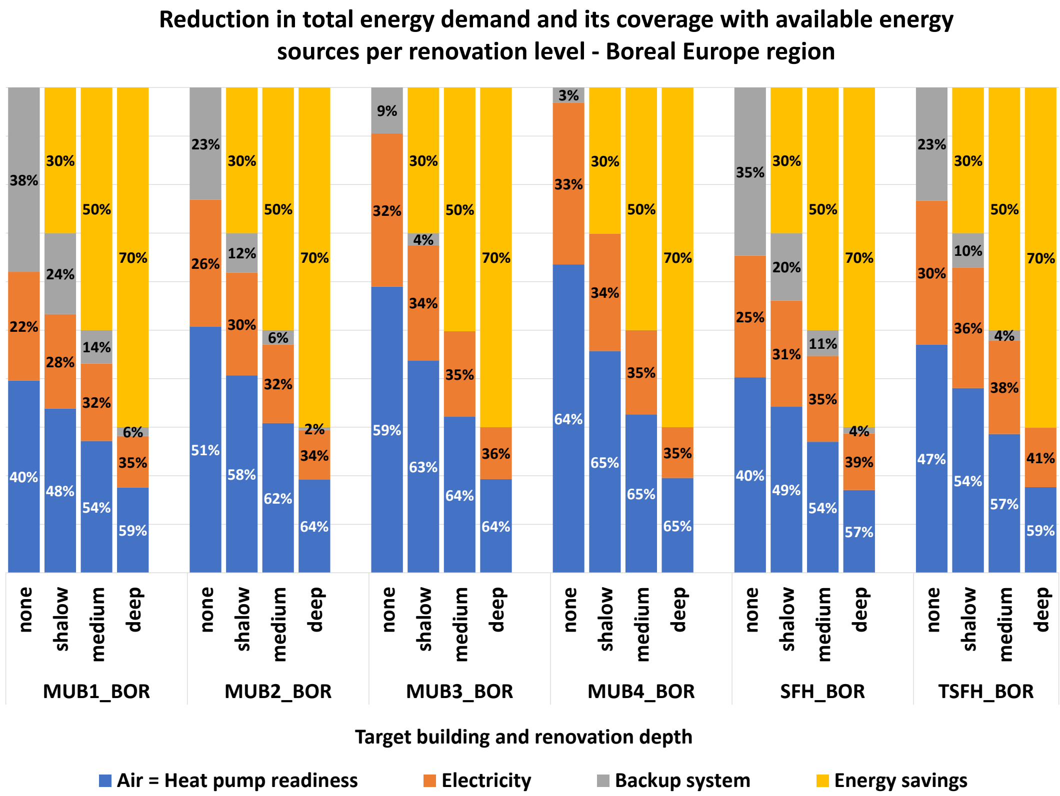
Percentages in blue, orange, and grey bars equal the share of each energy source in total heating demand before or after renovation. Reduction in total energy demand after renovation is shown in yellow bars.

The heat pump readiness in the Atlantic region and for the existing target buildings varies from 18% (MUB1) to 48% (TSFH). Renovation significantly increases heat pump readiness in all buildings apart from TSFH, where any renovation beyond the medium level brings only a minor increase in HPR.

Boreal Europe

Existing target buildings in the Boreal region have a high HPR of between 40% and 64%, mostly due to the lowest U-values noticed among the analysed regions. In buildings with lower HPR, such as MUB1 or SFH, any renovation brings a decent increase in HPR. On the other hand, for buildings such as MUB 3 and MUB 4, where pre-renovation HPR are high, HPR is not affected with middle and deep renovation.

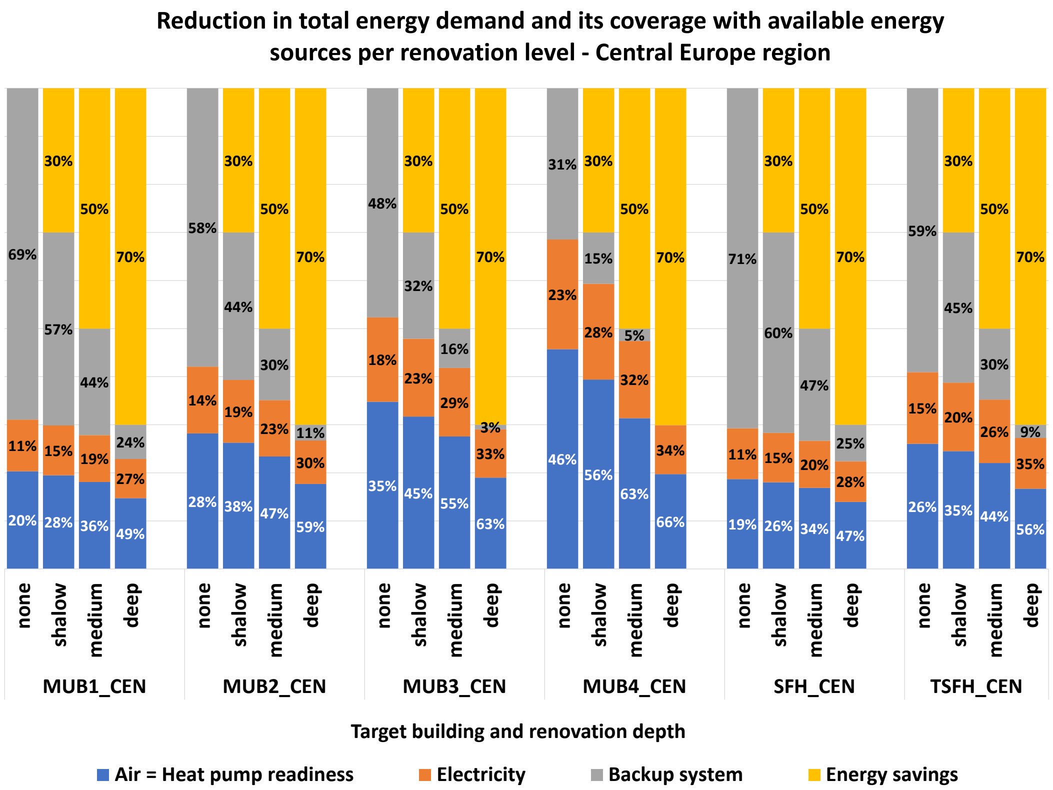
Figure 13: Reduction in total energy demand and its coverage with available energy sources per renovation level – Boreal Europe



Percentages in blue, orange, and grey bars equal the share of each energy source in total heating demand before or after renovation. Reduction in total energy demand after renovation is shown in yellow bars.

Central Europe

Figure 14: Reduction in total energy demand and its coverage with available energy sources per renovation level – Central Europe



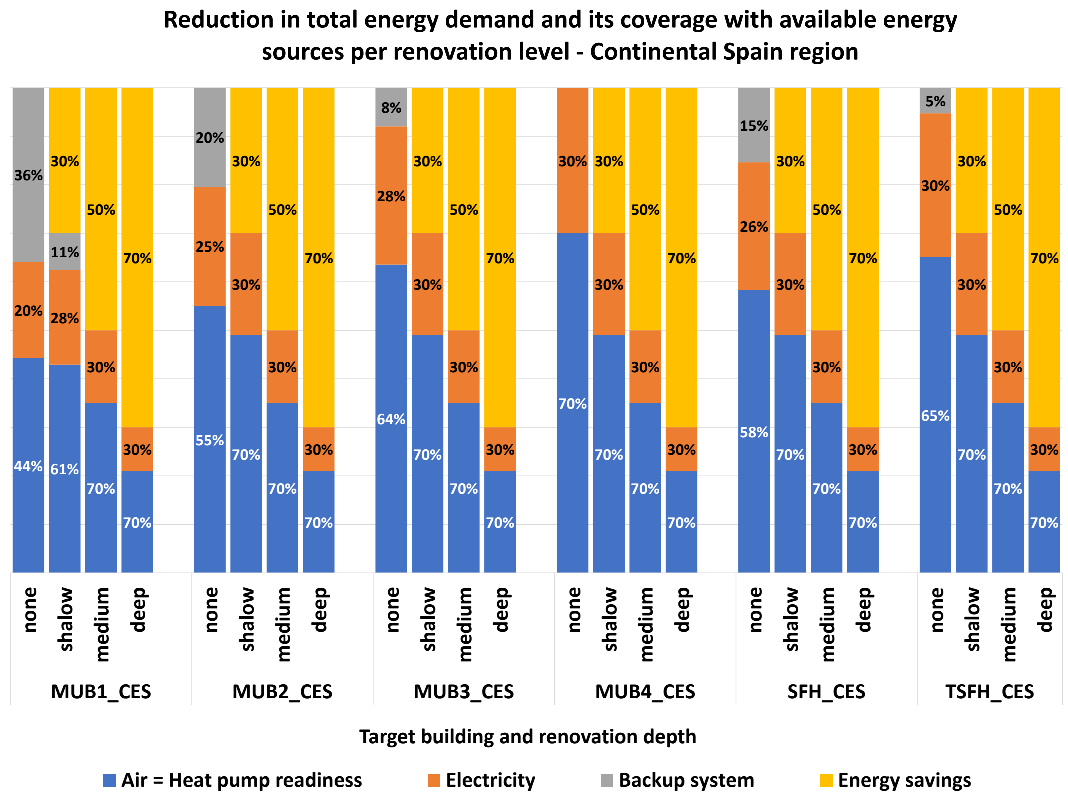
Percentages in blue, orange, and grey bars equal the share of each energy source in total heating demand before or after renovation. Reduction in total energy demand after renovation is shown in yellow bars.

Existing target buildings located in the Central Europe region have generally low HPR values ranging between approximately 19% for SFH to 46% for MUB4. With the exception of MUB4, all target buildings would benefit from renovations: all levels of improvement would bring a visible increase in HPR, with higher values produced after deep renovations.

Continental Spain

Target buildings in Continental Spain region have high heat pump readiness values due to a mild climate. High HPR is reached even in non-renovated buildings, such as MUB4 or TSFH. It is clear that with the proposed levels of renovation, all buildings easily reach maximum possible HPR, sometimes even after shallow renovation, as seen in MUB2 or SFH.

Figure 15: Reduction in total energy demand and its coverage with available energy sources per renovation level – Continental Spain



Percentages in blue, orange, and grey bars equal the share of each energy source in total heating demand before or after renovation. Reduction in total energy demand after renovation is shown in yellow bars.

Conclusions

This section explains heat pump readiness of target buildings in each climate zone, **when using the reference heat pump.** The most important conclusions of the analysis are:

- **Among all the analysed target buildings, heat pump readiness is the highest in Boreal Europe and Continental Spain.** This is due to very good insulation levels in the former and relatively milder outside temperatures in the latter. Target buildings with the lowest heat pump readiness are found in Central Europe, because of modest insulation coupled with low outside temperatures (details can be found in section Target buildings and climate zones).

- **In general, renovation brings an increase in the heat pump readiness of all the buildings analysed, increasing the share of heating energy obtained from air.** However, there is a renovation depth above which increased insulation does not significantly affect a building's heat pump readiness. This effect can be noticed in around 1/3 of the analysed buildings, e.g., in case of medium renovation of MUB1_CES or shallow renovation of MUB4_BOR. In these instances the heat pump readiness does not increase with increased renovation depth.

- Two points related to electricity consumption are especially important and confirm the need to decarbonise electricity supply:
  - **Increased heat pump readiness comes with an increased share of electricity in heat demand coverage.** In other words, reducing the energy supplied by a backup heating system, such as gas boiler, simultaneously increases the energy used from the air and from the electricity grid.
  - **Electricity consumption cannot be completely avoided.** There is a minimum share of electricity required to operate the heat pump when it replaces a backup system.[19]

19 This is a consequence of the maximum heat pump readiness explained above.

Comfort period

In addition to analysing heat pump readiness, this study also addresses the question of how comfortable target buildings may be in case of heating cut offs. For this purpose, indoor comfort is approximated solely by the temperature of the indoor air.[20]

Comfort period in target buildings is evaluated by measuring the drop in indoor air temperature after the first and fifth hour following the cut-off in heating supply.

The comfort period may be important to understand how residential buildings are used and how they interact with the energy supply grids. For example, comfort period could be used to understand more about the flexibility of the building energy demand profiles, as well as about how long a heat pump can be off without sacrificing indoor comfort.

Methodology

To properly assess all the effects of heat supply cut-off, dynamic simulations of 30 target buildings were performed using the OpenStudio building simulation tool. The analysis of each target building included 3 main steps:

- **Step 1:** Modelling the building geometry by considering building size and envelope characteristics,
- **Step 2:** Defining all remaining inputs such as materials used, occupancy, heating schedules and types and details of energy systems,
- **Step 3:** Running simulations and analysing the results.

Important inputs for analysing the comfort time of target buildings are:

- Each target building is preheated to ensure that steady and realistic operational conditions are achieved. It is important that sufficient heat is accumulated in the building structure[21] prior to the heating cut-off. Preheating ensures that indoor temperatures before cut-off equal 20°C.
- At the moment the heating supply is cut-off, the outside temperature equals the winter design temperature increased by 5°C which excludes extreme and unrepresentative weather conditions. The outside temperature is then kept constant for 5 consecutive hours during which time the indoor temperature drop is observed.
- The remaining parameters included in the energy simulations, such as infiltration levels, occupancy, lighting loads, and internal mass, are the same for every target building and follow typical values for residential buildings.
- The analysis and results do not depend on the heating system used.[22] It is assumed that during the pre-heat period all conventional heating systems heat the building in the same way and that the same amount of energy is stored in the building elements.[23]

20 Therefore neglecting other comfort indicators, e.g., relative humidity or radiant temperature.
21 In both external and internal buildings elements, e.g., external and internal walls.
22 The heating system used in this study is an ideal air handling unit that mixes indoor exhaust air with the specified amount of outside air and then adds or removes heat and moisture at 100% efficiency.
23 After the heating supply is switched off, the role and type of heating system becomes irrelevant.

Table 4: Outside temperature at which heating cut-off occurs

Climate zone	Representative location	Outside temperature [°C]
ALP	Vienna	-4.6
ATL	Brussels	-1.1
BOR	Stockholm	-7.6
CEN	Prague	-6.7
CES	Madrid	0.2

Finally, energy simulations were run on the existing and renovated[24] target buildings in five climate zones. The results of these simulations are explained in the following section.

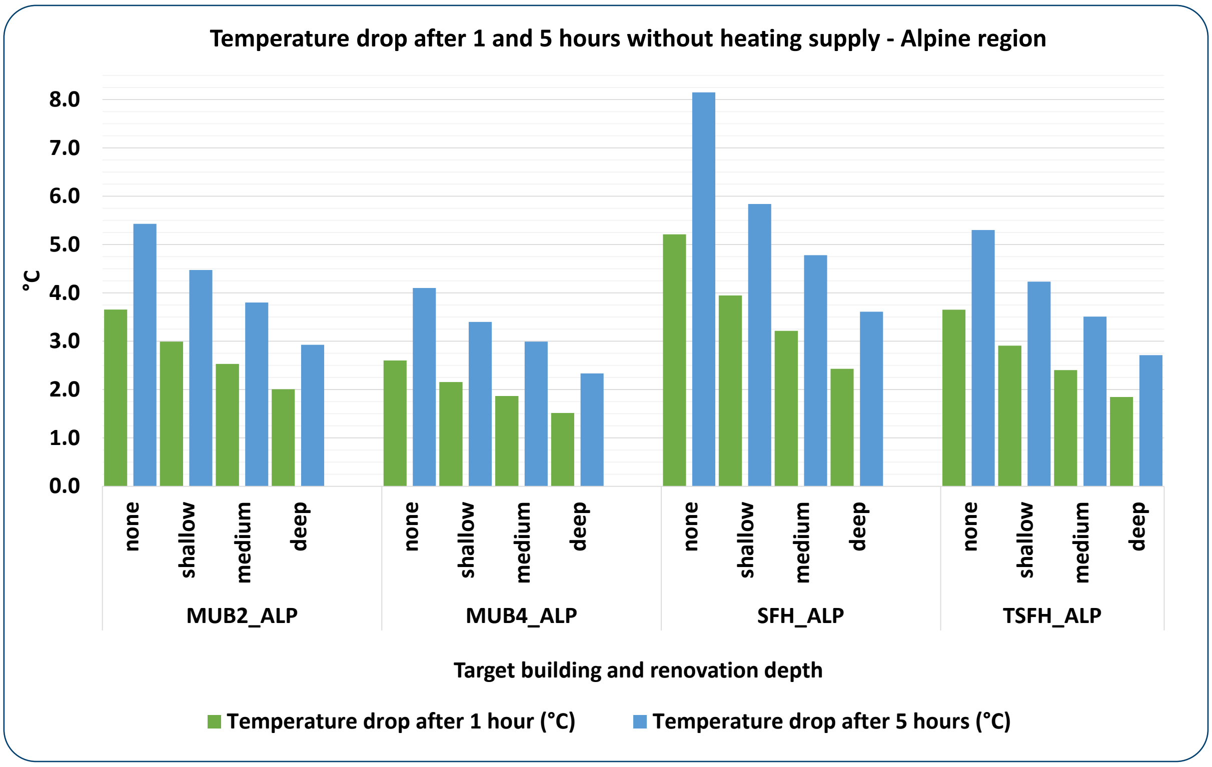
24 30% improvements – shallow renovation, 50% improvements – medium renovation, and 70% improvements – deep renovation

Results for existing and renovated buildings[25]

The results show that there are no significant differences in comfort periods between MUB1 and MUB2, and between MUB3 and MUB4 buildings. For simplicity reasons, MUB1 and MUB3 results are excluded from this section and can be replaced with the results for MUB2 and MUB4, respectively.

Alpine region

Figure 16: Average temperature drop after 1 and 5 hours without heating supply – Alpine region

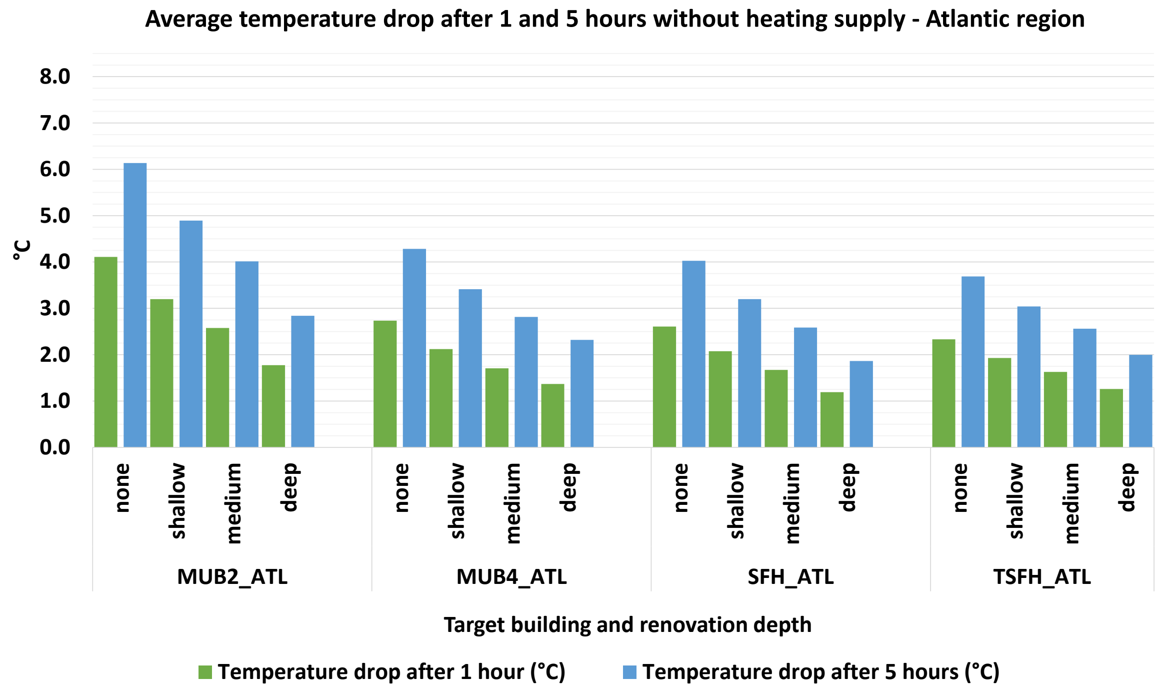


In case of heating supply cut-off, indoor temperature in the existing Alpine buildings will drop between 2.6°C and 5.2°C after one hour and between around 4.1°C and 8.1°C after five hours. Renovation improves the situation significantly. Deep renovation would reduce these drops by more than 40%, bringing the one-hour temperature drop below 2.4°C and five-hour drop to below 3.6°C.

25 Drop in indoor air temperature depends on a variety of factors, such as outside temperature, infiltration heat loss, or the quality of the building envelope. This can lead to significant differences in results provided by different studies. Comparing different studies and their results should therefore include a thorough analysis of the study assumptions.

Atlantic region

Figure 17: Average temperature drop after 1 and 5 hours without heating supply – Atlantic region

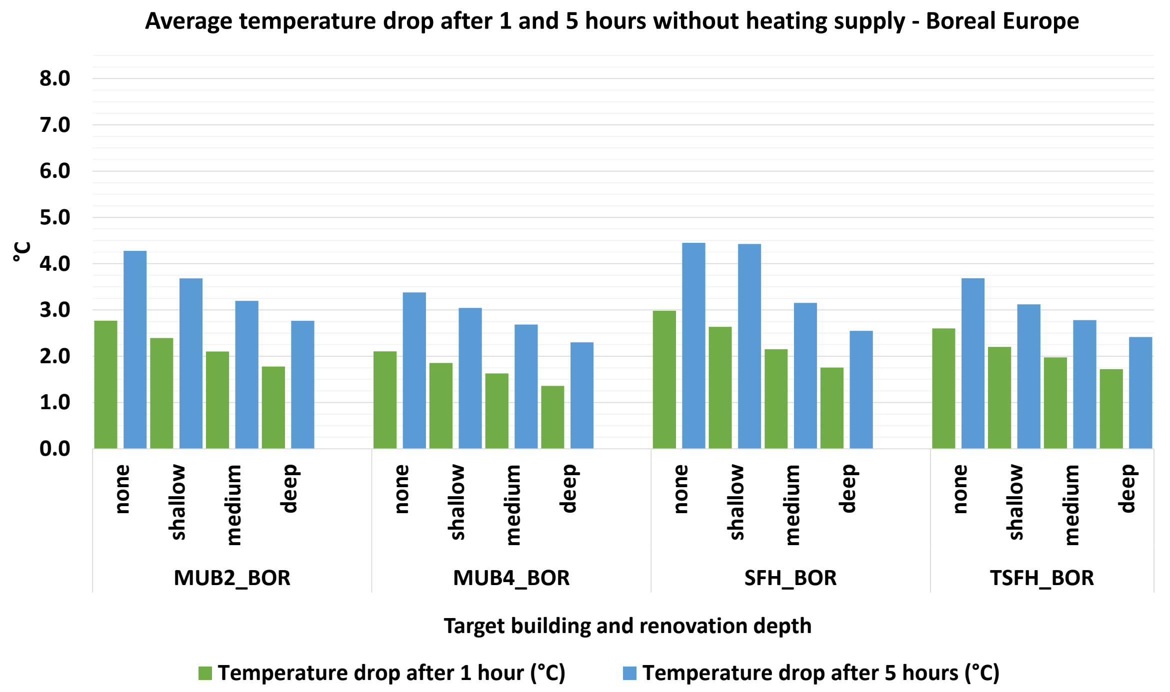


Temperature drop in the existing target buildings located in the Atlantic region is between 2.3°C and 4.1°C after one and between 3.7°C and 6.1°C after five hours. Deep renovation slows down the drop by 46% or more, reducing the temperature drops to less than 1.8°C and less than 2.8°C for one-hour and five-hour periods, respectively.

Boreal Europe

Boreal Europe has one of the lowest temperature drops among all analysed climates, which is linked to high performance of its target buildings. The first hour without heating supply will reduce the temperature in existing buildings between 2.1°C and 3.0°C, while after the fifth hour this drop will be between 3.4°C and 4.5°C.

Figure 18: Average temperature drop after 1 and 5 hours without heating supply – Boreal Europe

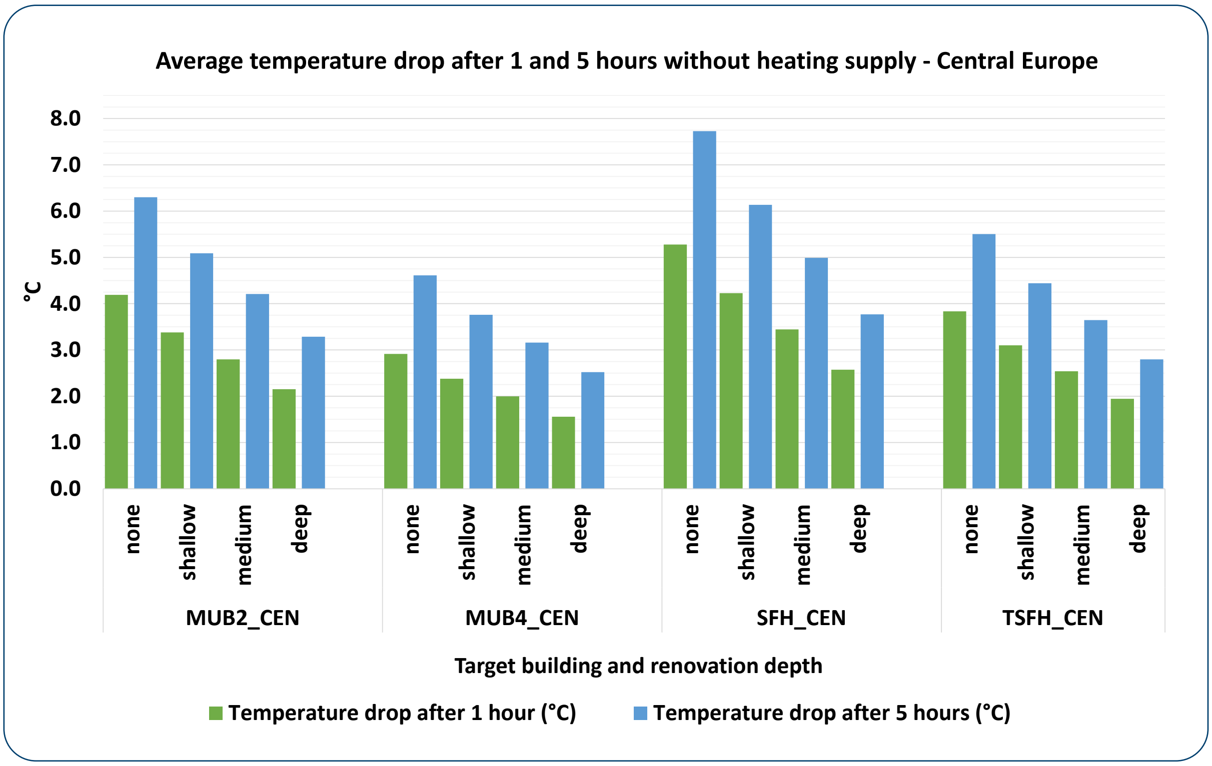


Deep renovation in the Boreal region would reduce the temperature drop by at least 32%, resulting in a maximum temperature drop of 1.8°C after the first hour and of 2.8°C after the fifth hour, respectively.

Central Europe

Central Europe is similar in temperature drop to the Atlantic and Alpine regions, most likely due to similar outside temperature profiles and building insulation levels. Temperatures in the existing target buildings would drop by between 2.9°C and 5.3°C in the first hour and between 4.6°C and 7.7°C after five hours.

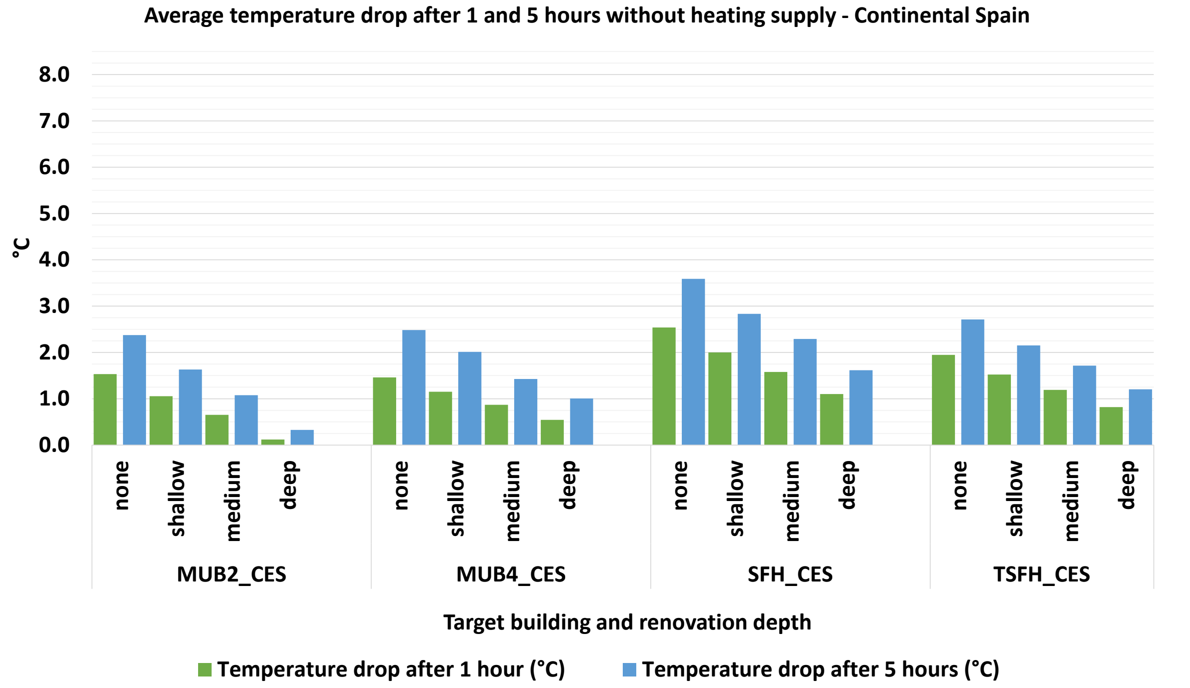
Figure 19: Average temperature drop after 1 and 5 hours without heating supply – Central Europe



Deep renovation would reduce temperature drops to less than 2.6°C and less than 3.8°C, after one and five hours, respectively. The reduction in temperature drops achieved with deep renovation is 45% or more.

Continental Spain

Figure 20: Average temperature drop after 1 and 5 hours without heating supply – Continental Spain



Due to the mildest climate among all analysed regions, Continental Spain is the region with the lowest sensitivity to heating supply cut-offs. Indoor temperature drops in the existing buildings would be between 1.5°C and 2.5°C after the first hour, and between 2.4°C and 3.6°C after the fifth hour.

Renovation makes a significant difference in the post-heating temperature drop. Deep renovation would reduce the temperature drop by at least 55% and result in a 1.1°C drop after the first hour and 1.6°C after the fifth hour.

Conclusions

- Considering the existing target buildings, the fastest drop in indoor temperature after the heating supply is switched off can be found in Alpine and Central Europe regions, regions with low outside temperatures and modest building insulation levels. Drop in indoor temperature in the existing target buildings in these regions can go up to 5.3°C after the first hour and 8.1°C after the fifth hour of the break in heating supply.

- On the other hand, the most resistant existing target buildings are those located in Continental Spain and Boreal Europe, regions characterised by either very good insulation levels (Boreal Europe) or relatively milder outside temperatures (Continental Spain). Once the heating supply is terminated, an average temperature drop in these target buildings is between 1.5°C and 3.0 °C after one hour and between 2.4°C and 4.5°C after five hours.

- Temperature drops are sharp in the first hour and have a tendency to slow down after that. For example, the highest temperature drop speed in the first hour is noticed in SFH_CEN target building and equals 5.3°C/hour. Additional drop in temperature between the second and the fifth hour in the same building equals 2.5°C or 0.6°C/hour implying a significant reduction in the comfort-losing speed.

- Renovation has an important impact on protecting the target buildings and reducing the indoor temperature drop in case of a break in heating supply. As a general rule, the more insulated a building, the slower the temperature drop.

  Renovation can also prevent heating supply breaks by reducing peak electricity demand and can therefore be seen as an insurance policy at both building stock and grid levels.

  Deep renovation of target buildings will bring between 30% and 90% decrease in the post-heating temperature drop. In the worst-performing regions, the Alpine region and Central Europe, deep renovation would reduce the one-hour temperature drop from 5.3°C to 2.6°C and the five-hour temperature drop from 8.1°C to 3.6°C.

  The speed at which buildings are losing their comfort is significantly affected by deep renovation. Taking into account the worst-performing buildings, the average speed at which indoor comfort is lost equals 1.6°C/hour for non-renovated and 0.7°C/hour in a deeply renovated building.

How to communicate heat pump readiness in energy performance certificates?

EPCs have been developed to communicate the energy performance of buildings using metrics such as primary energy consumption, heated floor area or GHG emissions. They present information on multiple aspects of buildings including energy demand, performance of installed energy systems, renewable energy share, energy carrier, building envelope performance, estimation of yearly energy costs, recommendations for improvement or renovation and sometimes cost savings.

In the previous sections we analysed how the heat pump readiness metrics change based on improvements of the building envelope. The installation of heat pumps would also foster green energy use and pave the way for the deployment of renewable energy systems. The HPR could be used to inform building owners about the benefits of using heat pumps in their homes, shifting mindsets towards heat pumps and district heating as more efficient means for space heating needs. Building on these ideas, this part of the study assesses how energy performance certificates can be used to communicate information.

The information generally shown on EPCs can be used to inform heat pump readiness. In some cases, the heat pumps is presented as an energy efficiency improvement measure, while in others it is considered renewable technology. Thus, existing EPCs already show some elements which could enable heat pump readiness integration in EPCs. The adoption of heat pumps has significantly increased in recent years, due to consumers' rising demand for energy efficient solutions and government policies and programmes incentivising the adoption of clean energy technologies.[26]

Despite this recent increase, only a few countries, such as Denmark, Ireland, the Netherlands, and Portugal have adapted their EPC methodologies to show the impact of

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26 The perfect fit: Shaping the Fit for 55 package to drive a climate-compatible heat pump market (raponline.org) heat pumps on a building's energy performance. The current information included in EPCs about heat pumps may not always be relevant for the consumer.

The purpose of this section is to analyse whether information on heat pumps is used in EPCs, to propose how a "heat pump readiness indicator" should be added to Energy Performance Certificates and which specific actions should be taken to make this inclusion effective and easy for different parties involved (e.g. owners, tenants, public authorities, energy agencies, standardisation authorities).

To understand the status quo, an overview of EPCs and how different heat pump aspects are treated across selected Member States is presented in the following sections.

An overview of the existing EPC rating schemes used in the EU

To understand if and how existing EPC rating schemes consider a building's heat pump readiness, a short overview of 11 different EPC rating schemes is presented in this section. The countries included are Belgium (Wallonia), Denmark, the Netherlands, Spain, France, Italy, Ireland, Portugal, Bulgaria, Slovenia and Slovakia. A summary of the total floor area of dwellings covered by these countries in the EU is given in the table below. In this section, we analyse and present existing solutions and/or emerging ideas from the EPC rating schemes that could suggest how to develop and deploy an effective EPC containing heat pump readiness. Further references to each country are provided in Annex 2.

The selected countries represent some of the biggest markets in Europe for heat pumps. France and Italy alone capture more than 1/3 of the total market share,[27] while Ireland, Portugal, the Netherlands and Belgium, and followers such as Slovakia, Bulgaria and Slovenia, comprise the emerging market. Based on the heat pump sales data, air dominates as the main source of energy with a share of air-air heat pumps (38%) and air-water heat pumps (45%).[28] A significant market growth is observed in the air to water heat pumps from 2010–2021.[29] Among the 11 countries reviewed, the share of air/water is highest in Slovakia, France, Ireland, Belgium, the Netherlands followed by Spain, Italy, Denmark and Portugal.

While the 11 countries vary in heat pump uptake, they have certain similarities in their usage and integration of heat pump related information and specific EPC rating schemes. Further details will be defined in the next sections as we examine the approach of each country.

27 EU HP market and statistics 2022
28 Ready for mass deployment? EU HP market and statistics- Report 2022
29 idem

Existing approaches for heat pump evaluation in EPCs

EPCs are regulated under the Energy Performance of Buildings Directive (EPBD) and are mandatory for the transactions of buying, selling, and renting of new and renovated buildings. Table 6 presents an overview of approaches for heat pump uptake and evaluation of EPCs in the 11 countries reviewed.

EPCs in most of the 11 countries (except Bulgaria, Slovakia and Slovenia) capture the existence of heat pumps under the energy systems present in the building, which can be further used to calculate the share of renewable energy used in the building. Ireland, the Netherlands, Belgium and France include heat pumps in the renewable energy calculation only when specific seasonal coefficient of performance (SCOP) or seasonal performance factor (SPF) or a similar metric is met. Most of the EPC schemes consider heat pumps as measures for improving the energy efficiency of the building (Portugal, Denmark, Slovenia). In contrast, Dutch EPCs do not promote any specific renewable energy technology such as heat pumps but have developed a new 'future proof standard'[30] (2021) that provides advice for home insulation and indicates when a building is insulated enough to become natural gas-free and be heated with low-temperature sources, such as electric heat pumps and low-temperature district heating.

Bulgaria, the Netherlands and Slovakia do not consider heat pumps as measures to improve building energy efficiency, whereas in Slovenia heat pumps are listed in EPCs as potential building renovation measures, but the main metric for energy performance is the building's energy demand for heating.

It is observed that in some EU countries such as Ireland, the Netherlands, Denmark and France, heat pumps are assessed either as a part of the EPC, reporting the energy performance of existing heat pumps, or are used separately to assess the eligibility requirements for the installation of a new heat pump under a grant or subsidy. In most cases, EPC assessors or energy consultants in different Member States are not required to conduct a detailed analysis for the installation or replacement heat pump. In Ireland, however, a detailed analysis is conducted for existing heat pumps in the process of issuing an EPC.

Denmark has developed an independent platform which is connected to the central Building and Housing Register that is also used to extract data of buildings for issuing EPCs. This platform is used by owners to identify a suitable heat pump for their dwelling based on parameters such as current heating type and consumption, required space for installation, heating requirements (space heating or water heating), existing radiator system, etc. The platform also provides a comparison of different types of heat pumps available in the Danish market that are tested by an independent laboratory for more performance reliability. Contacts of government approved companies for inspection and installation are provided, as well as a platform for the homeowner to apply for grants/subsidies online.

30 Standaard en streefwaarden voor woningisolatie (rvo.nl)

Table 6: An overview of approaches for heat pump uptake and value for EPCs

Aspects of heat pumps captured in EPCs	BE	BG	DK	ES	FR	IE	IT	NL	PT	SK	SL
Included in the overview of energy systems present in the building	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗
Included in share of renewable energy calculation (based on specific range of SCOP/SPF/SEER)	✓	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗
Heat Pumps considered in EPC as a potential measure to improve energy performance	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	✓
Available independent or integrated assessment methodology for existing or new heat pumps linked with EPCs	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	✗
Minimum requirements for building fabric/ envelope/ insulation performance before obtaining grant for installation of heat pump	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗
Grants and subsidies for heat pump based on EPCs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EPC used to evaluate heat pump penetration in the building stock	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗

For the installation of the heat pump or its upgrade, it is important to evaluate the fabric or envelope heat loss which can be used to assess the appropriate size of the heat pump and its type. This information (fabric or envelope heat loss) can be easily obtained from the data entries that are used in EPCs for calculation of the building energy performance. In Ireland, a Heat Loss Indicator (HLI),[31] based on the total envelope and ventilation loss for the dwelling divided by the total floor area, is used. Similarly, the Netherlands introduced a compactness ratio[32] (ratio of the surface area of home and surface area of facade and roof) to determine the suitability for heating the building without natural gas.

31 https://www.seai.ie/publications/Introduction_to_DEAP_for_Professionals.pdf
32 Standaard en streefwaarden voor woningisolatie (rvo.nl)

Development of EPC certificate and its relationship with heat pump information

Houses can function with a primary (fossil fuel based) heating source or with an additional secondary (renewable) heating source. In buildings with more than one heating source, heat pumps are generally reported in EPCs as a secondary source along with an indication whether it is used for space heating or water heating. There is an opportunity here to adapt the reporting in EPCs to make heat pumps labelled as a primary source of energy. EPCs in different Member States present information in different ways. In most EPCs, information on heat pumps is generally presented either on the first page or subsequent pages giving an indication whether a heat pump is present in the building. In all analysed countries apart from Bulgaria, Slovakia and Slovenia, if used, the heat pump is listed under renewable technologies. The Dutch EPC explicitly mentions heat pumps under the installed systems on the first page (see Annex 4 for examples). A summary of heat pump related information presented on EPCs for consumers is given in Table 7.

It is observed that, apart from Denmark and France, the specific level of renewable energy from heat pump installation is not presented in any of the other analysed EPCs. While the total renewable energy is presented on most EPCs, the specific breakup or energy contribution from heat pumps is not provided in countries like the Netherlands, Portugal, France, and Belgium. EPCs in Belgium, Portugal and France provide details on the performance (e.g., SCOP/SPF/SEER) of the existing renewable technologies such as heat pumps. Other information on heat pumps and their details are presented in the annex or subsequent pages of EPCs, e.g., Ireland, the Netherlands, Belgium, and Spain, while Bulgaria, Slovakia and Slovenia do not have any details provided.

> ***Apart from Denmark and France, the specific level of renewable energy from heat pump installation is not presented in any of the other analysed EPCs.***

Table 7: Heat pump related information presented on EPCs

Heat pump related information presented on EPCs	BE	BG	DK	ES	FR	IE	IT	NL	PT	SK	SL
Indication of heat pump present in the building on the EPC (under renewable technologies present)	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗
Recommended improvement of heat pump	✓	✗	✓	✗	✓	✗	✓	✓	✓	✗	✗
Total renewable energy from all sources including heat pump presented on EPC	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗
Renewable energy contribution/ production presented from heat pump on EPC	✓	✓	✓	✓	✗	✗	✓	✗	✗	✗	✗
Performance/ efficiency of existing renewable technologies (e.g. heat pump) on EPC	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗
Detailed information on heat pumps in the annex	✓	✗	✗	✓	✗	✓	✗	✓	✗	✗	✗
Electrical energy requirement of heat pumps in the EPC	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
Indication of annual energy costs for heat pumps on EPC	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗
Indication of payback (return on investment) for heat pumps	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗

With the exception of the Netherlands, Portugal, Slovakia and Slovenia, most of the Member States provide information on the electricity consumption of the heat pumps on the EPC. However, including additional information on the efficiency of heat pumps could be beneficial. It is also found in the review of EPCs that the indication of potential annual energy savings due to heat pump installation, which is key information for the consumer, were not presented except in Denmark and France. Another important aspect that is missing on most EPCs is the indication of payback or return on investment for heat pumps which is only found on the Italian EPC. This information could significantly influence heat pump uptake.

In summary, no current EPC conveys that a building is heat pump ready.

Conclusions

The review of 11 different EPC schemes allow us to draw several conclusions:

- **Although EPCs contain significant information on heat pumps, there is no direct statement in any EPC that a building is heat pump ready (meaning it has suitable conditions that allow for heat pumps to operate flexibly). EPCs only consider heat pumps broadly for their renewable energy calculation, or report them as an improvement measure for energy performance.**

- **Existing EPC schemes offer opportunities to report heat pumps as general information.** Initial investment-related information and specific recommendations are not available for consumers even though heat pumps are presented as an improvement measure.

- **In some countries, the free energy heat pumps extract from the outside air is still not classified as renewable.** This should be addressed to provide consistency across the EU.

- **Each member state has a political standpoint on the promotion of heat pump technologies. This is reflected in the Dutch EPC**. The Dutch EPC is generally used by experts such as energy or heat pump consultants to provide heat pump related advice to owners. Thus, there is a need to review the existing value chain and supply chain mechanisms to effectively understand how heat pumps can become more mainstream for consumers. **Heat pump technology verification must be centralised in order to have better market control and fair prices for consumers.**

- **The process to receive a heat pump which follows EPCs recommendations must be standardised for consumers.**

In summary, though the existing EPC schemes include a broad range of information related to heat pumps (e.g. energy requirements, annual energy costs, improvement recommendations etc.), it is strongly recommended to present this information as the primary source of heating while indicating the annual energy costs.

These recommendations to EPC schemes would give confidence that evaluation of heat pump readiness is feasible at building level based on the clarity and accessibility of heat pump information in the EPCs.

Development of the "heat pump readiness" indicator for EPCs

Currently no EPC gives a direct indication whether or not a building is heat pump ready. Considering this gap, it is necessary to provide consumers with actionable information that supports them in decision making for renovation. This could be addressed through an innovative indicator on heat pumps on EPCs.

The indicator would explain how renovation makes buildings more heat pump ready, while also specifying the renovation depth required for maximum heat pump readiness. This threshold would prevent the consumer from underinvesting or overinvesting, and reduce the chances of being locked into an underperforming building.

Further sections below highlight the approach for such an indicator and how it could be developed.

Definition of heat pump readiness indicator and its assessment

As previously mentioned, for the purpose of this report, *heat pump readiness of a building is defined as the share of its annual space heating needs that the reference heat pump supplies from outside air as energy source.* Heat pump readiness also refers to how much a building and its envelope are fit to use a heat pump. The heat pump readiness indicator in EPCs has the purpose of informing homeowners and occupants about the usefulness of heat pumps in their homes and the multiple benefits they can bring.

Therefore, its definition can be framed as:

A 'heat pump readiness indicator' is a sign / symbol on EPCs allowing homeowners and occupants to assess and understand in a simple and meaningful way the present and future potential of a given building to be heated with a heat pump (partially or fully), based on the existing state of the building's envelope and current heating distribution system, or depending on modifications brought to the envelope energy performance.

The heat pump readiness indicator (HPRI) would aim to make EPCs more usable with actionable information which could be used by owners as well as public authorities in their decision-making for deployment or improvement of heat pumps in their building units.

Considering the strengths and weaknesses of each EPC scheme, the HPRI would need to be developed by respective member state public authorities further considering the following key criteria:[33]

Quality and reliable data

Data used for the heat pump readiness evaluation must be high quality. The addition of the HPRI would lead to higher reliability and trust in energy assessors since they would need to fill in the parameters correctly for evaluation. It would also enable higher user acceptance of heat pumps, maintain data consistency and allow monitoring of building stock against the national goals.

User-friendly information

The heat pump readiness indicator must be easy to use and have understandable results. Since homeowners often have limited knowledge of energy efficiency and renewable technologies, it is crucial to communicate information efficiently and clearly.

To this end, an EPC could provide the following to accompany HPRI:

- Concise and to-the-point overview of the heat pump principles focusing on essential concepts for understanding the basics of the HPRI.
- Brief explanation of what HPRI means in practice and how it may add value to investment decision-making. For example, the EPC might explain how the HPRI (and HPR as its component) can be used to assess financial performance of the heat pump investment. Including an example of a back-of-the-envelope calculation using HPR as an input may be very useful.

Consistency with national EPC methodology and European standards

Consistency with national EPC methodology means that the calculation procedure for heat pump readiness must align with the current EPC calculation method, hence a detailed analysis of the indicator methodology must be conducted before it can be integrated in EPCs. Additionally, the evaluation of heat pump readiness indicator must follow the recommended EU standards to maintain the comparability of the information on heat pumps at EU level. An update of the EPC methodologies may be needed to include the HPRI into the existing EPC rating schemes.

Economic feasibility in assessment

In the context of EPC schemes, it is essential to study the benefit-cost ratios of introducing a new indicator to EPCs. It is a crucial aspect and must be studied during the early development of the indicator.

33 https://x-tendo.eu/wp-content/uploads/2022/06/X-tendo_D2.5_Cross-cutting-criteria_v6-_RDA.pdf

- It is important to include an analysis of the market, expected impact on consumers, benefits accrued and economic and technological conditions of a member state before implementing the new heat pump readiness indicator.
- The impact on increase in the costs of building assessment by assessors must be studied for heat pumps in conjunction with other building systems (e.g. hydronic heating) and building components (e.g. insulation, windows).

Methodology to calculate the indicator

The methodology for the calculation of the HPRI will be built on the heat pump readiness as well as aspects under the criteria presented in the previous section. The goal of the HPRI would be (i) to provide a common methodology to assess the capacity of a building to use heat pump technologies and adapt its operation to the needs of the occupants and the grid while improving the energy efficiency of the buildings, and (ii) to effectively pass the actionable information to consumers through EPCs.

Since the methodological approach for heat pump readiness in this report is limited in its development, it would need further tailored adjustments according to the certification schemes in different Member States to enhance the comparability and increase harmonisation across the EU.

The HPRI could cover the impacts related to six main aspects of heat pumps in buildings as given below (only first impact has been evaluated in this study while others would need further investigation):

1. **Capacity of heat pumps to cover the share of the annual building heat load with energy from the outside air**
   An estimation of the share of annual heating demand that would be covered by a heat pump and from outside air as energy source.

2. **Capacity of heat pumps to cover the duration of the annual building heat load**
   An estimation of the number of days annually, or alternatively, the heating season share, that would be covered by the heat pump only, i.e., without using the backup system.

3. **Theoretical maximum for heat pump performance based on reference heat pumps**
   This would mean that for the existing building's envelope performance the maximum SCOP/SPF of the heat pump that would be achievable in the building.

4. **Impact on indoor thermal comfort**
   Achievable range of indoor temperatures while using the heat pump for space heating.

5. **Annual energy costs savings achievable**
   An estimation of the energy cost savings that will be made annually through heat pump technology would be useful for homeowners for their decision making.

6. **Information on payback**
   Indication of payback period could provide the homeowners a realistic understanding of the return on investment that would influence decision to install or upgrade their heat pumps.

The following guidelines can be useful for implementing the HPR methodology previously described:

- EPC rating calculations, such as those for annual energy demand of a building, may be accompanied with clear guidelines for obtaining the building's heating load curves. Rather than establishing a completely new approach, these will most likely rely on the components (e.g., formulas) of the calculation methods used in existing EPC schemes.
- The HPR assessment could be either designed as a spreadsheet calculation or could require a specialised software for building and energy system simulation. In both cases, the HPR assessment method should be well explained, for instance with a clear set of guidelines.
- Although this report suggests that the reference heat pump is air sourced, other energy sources[34] can be used. Due to its high importance and potentially strong impact on the results, it may be wise to define the number/type of sources or the methodology to account for them at the EU level supporting a consistent approach and comparability of the results among countries.
- Other characteristics of the reference heat pump, such as heat pump capacity per floor area, medium used for heat transfer[35] and its supply temperature, or heating output curve, may be specified at a country level and based on the specifics of the local market. Although this may reduce comparability of the results across the EU, it would maximise the relevance of HPR and HPRI for the homeowners and other stakeholders as the information would be closer to national market conditions.

The HPRI methodology would require further specification on the applicability and scope for existing or new buildings and development of implementation pathways:

- Since the heat pump readiness methodology has been developed and tested only on single family and multi-unit buildings, there is a possibility to adapt it to other building types as well such as non-residential buildings.
- The HPRI could be developed in two different formats for EPCs such as the detailed format which is more suitable for operational rating of existing buildings (developed under this study) and a simplified format which would be suitable for new construction/ renovation. The HPRI with a simplified approach could be used for asset rating (for new construction/ renovated buildings) while the detailed approach could be used for operational rating (for buildings already in use) in EPCs.
- The visual organisation and presentation of the HPRI is also an essential aspect and important for its success and impact, therefore, further investigation is required to effectively develop the HPRI for EPCs.

The HPRI will unlock the energy savings both by improving the energy efficiency at the building level and by allowing the optimisation of energy flows on an aggregated grid level. In the current method developed in this study the calculation of the heat pump readiness assesses energy performance by taking into account the reference heat pump. With the installation of heat pumps, the buildings will offer (i) demand response services such as self-consumption, self-production or storage services, (ii) capacity to maintain indoor thermal comfort in conjunction with existing heating system and (iii) increase the renewable

34 Water or ground, for instance.
35 e.g., water in air-water heat pumps

capacity of the energy grid as well as the energy efficiency of the system. However, further investments are required to enable harvesting of these benefits at member state level.

Overview of Standard EPC input data

EPC methodology across different Member States require assessors to collect and use certain data to calculate the energy rating of the buildings. These inputs are either standard or default values or recorded by the assessor through an on-site visit when mandatory. The data inputs are entered in an EPC calculation software. The number of data inputs vary for each member state according to the methodology and it can be as high as 180 input parameters. To understand whether the assessment of heat pump readiness of building requires additional input data than what is already collected in EPC, a list of standard EPC inputs is developed based on the 11 countries reviewed in this study. The list of EPC inputs is divided into three levels. The first level are the core categories of input data such as details on the building, envelope, renewable systems etc. The second level is a further sub-division under the first level and subsequently the second level is further subdivided into third level with more details on the inputs. Table 8 below provides an example of the input data categories in different levels.

Table 8: Example of input data categories in three levels in EPCs

Level 1 input data	Level 2 input data	Level 3 input data
Building	General information	Address
		Building ID
		...
	Geometry	Net floor area
		Building orientation
		...
	...	...
Envelope	Door	Surface area
		..
	External wall	Insulation thickness
		...
	...	...

Level 1 input data	Level 2 input data	Level 3 input data
Renewables	PV solar	Solar irradiation on horizontal plane
		...
	Solar thermal	Installed capacity
	...	...
Technical building systems	Cooling system	Cooled area
		...
	DHW system	Fuel type
		...
	Heating system	Primary heating system
		...
	...	...
Reporting functionalities/ information to the occupant	Cooling system	Report information regarding cooling system performance
		...
	Envelope	Reporting information regarding performance
		...
	Heating system	Report information regarding heating system performance
		...
	...	...

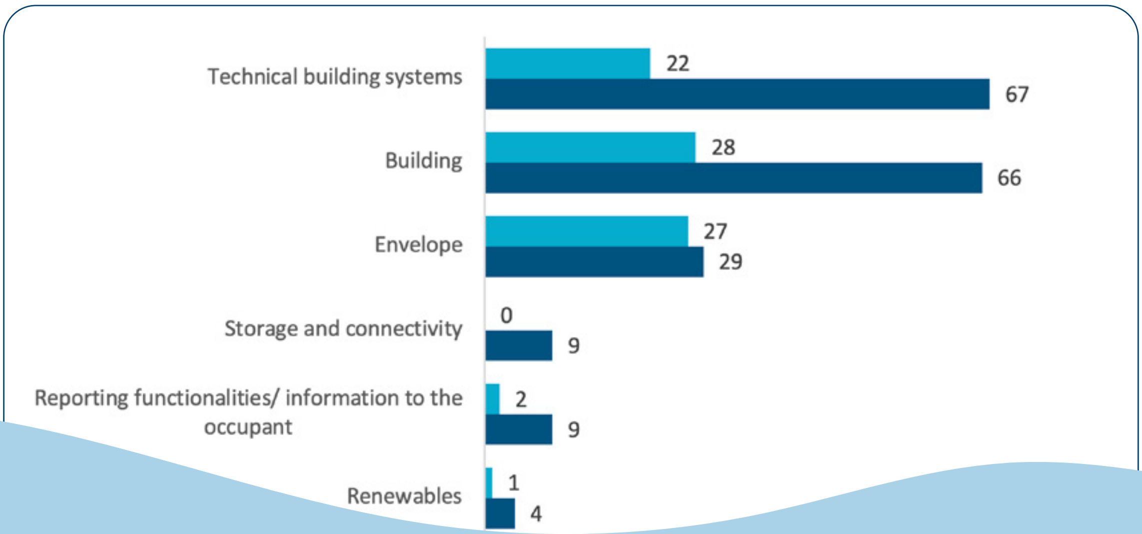
Level 1 input data	Level 2 input data	Level 3 input data
Storage and connectivity	Electrical vehicle charging	EV charging capacity
		...
	Electricity	Storage of locally generated energy
		...
	...	...

Overlap of heat pump readiness input data with standard EPC data inputs

A total of 184 standard EPC data inputs were found in the EPC schemes of the 11 countries and these were analysed for similarities with the input data that is required to calculate the heat pump readiness developed in this study. It is found that about 80 of these standard EPC data inputs are required for the calculation of heat pump readiness which indicates that almost no additional data is required to be collected in the EPCs. However, specific analysis of each scheme would give a more detailed and accurate overview.

An overlap of data required for assessment of heat pump readiness and the data collected in EPCs is presented in Figure 28. These are mainly captured in the following categories (i) Building, (ii) Envelope, (iii) Technical building systems, (iv) Storage and (v) Reporting functionalities (refer to Figure 28).

Figure 21: Overlap of EPC data inputs with heat pump readiness calculation inputs



Presentation of the heat pump readiness indicator (HPRI) to the EPC

Through the analysis of EPC reports produced by different Member States (from the 11 countries), different observations were made on how the information related to heat pumps is presented (see annex 4). It is certainly important to consider the user-friendliness of this information and how HPRI should be presented for the owner of the EPC along with other indicators already presented. In general, most EPC schemes (e.g. Portugal, Denmark, Italy, Bulgaria) preferred to include detailed technical information/ data on heat pump performance or as an improvement measure in subsequent pages (or annex) of the EPCs as they are less relevant for the owner. However, following the examples of the Netherlands and France where an indication is given on the initial pages regarding heat pumps, it could be recommended to include the HPRI indication on the first pages of the EPC in the form of symbols, a colour scale such as a diverging (double-ended scale), gradient (different hues of same colour) or categorical (specific colours with annotated meaning) indicating the readiness of the building for the installation of a heat pump and what level of benefits could be achieved (e.g. cost or energy savings etc.). Further studies and analysis are required from a behavioural and user-experience perspective to understand what aspects are triggered in decision making through the presentation of HPRI on EPCs and how it could be adapted to suit the needs of end-users.

Analysis of potential barriers

The heat pump readiness indicator aims to provide useful information to the consumer through a rating on the energy performance certificate (EPC). Since there is no existing concept or approach to present such information on EPCs, the proposed method for evaluating heat pump readiness and its development into an indicator would require further validation and testing at member state level.

From the overview of different EPC schemes in the EU, some of the identified key barriers related to HPRI are highlighted below:

1. **Most EPCs do not present the SCOP/SPF of heat pumps against any reference heat pumps that could give the homeowner an understanding about its relative performance.** A reference database is required at national level to enable effective use of HPRI and enable its comparability. This is also particularly important to highlight the efficiency of the existing heating system.

2. **Though most EPCs recommend heat pumps as a measure to improve energy performance, the real annual energy savings are not presented in detail.** This does not clearly indicate the benefit to the homeowner, thus HPRI would need to take into account these aspects for EPCs.

3. **Most Member States use EPC methodology and heat pump assessment methodology separately.** This is a major barrier to integrate the HPRI with EPCs. If the assessment is integrated, it would be cost-effective and time-efficient, and the homeowner can receive reliable results through the same energy expert or the assessor.

4. **Heat pump readiness assessment will be simpler if there is a dedicated tool developed at national level** that also provides details on the type of heat pumps suitable for a specific building type. Such tools only exist in a few countries; however, their unavailability may act as a barrier in the HPRI assessment by assessors.

5. **Specific performance of the building envelope is a mandatory pre-requisite in some Member States for the installation of heat pumps.** Since most of the countries do not have minimum standards set for building insulation before a heat pump is installed, it could lead to low outputs from heat pumps, high running costs and consequently low values of HPRI and its acceptability.

6. **The HPRI could be used to provide access to heat pump grants and subsidies to homeowners**, which would require benchmarking to identify what type of heat pumps should qualify for these grants and subsidies through the integration of these measures in national level policies.

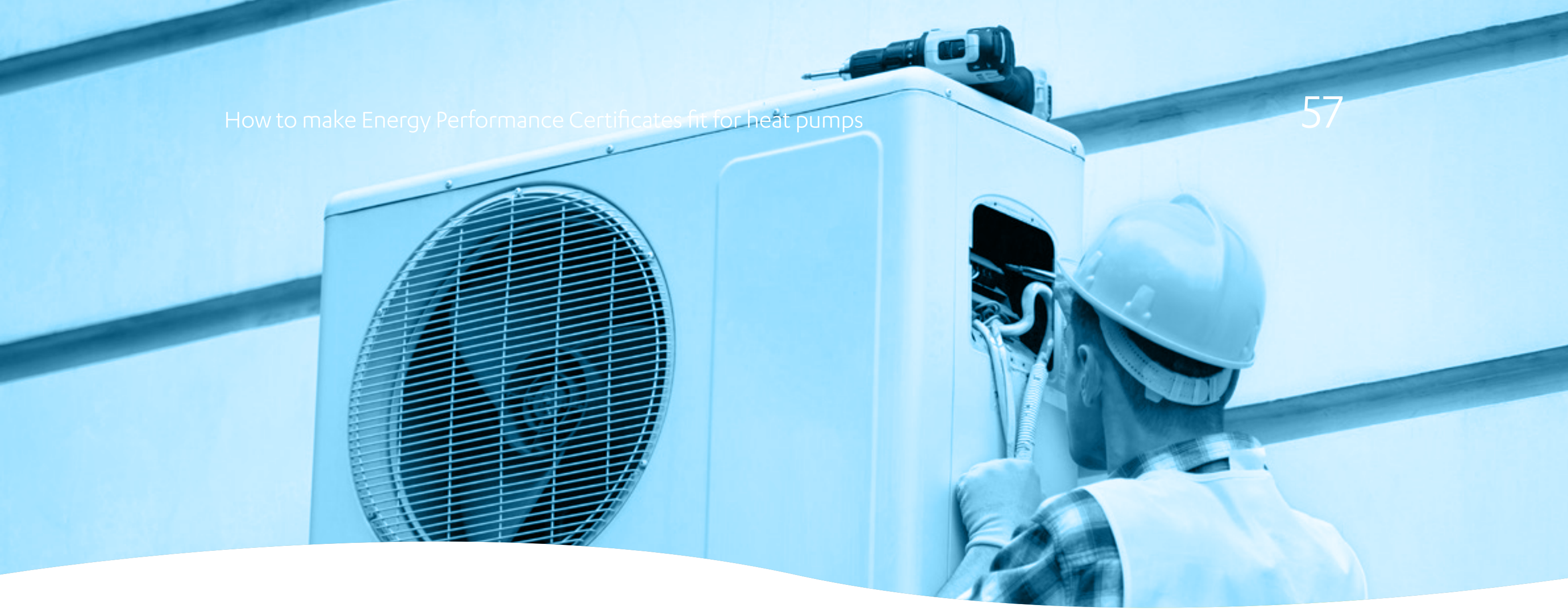
7. **Some member state EPC schemes do not encourage the promotion a specific renewable technology such as heat pump,** therefore, they do not present heat pumps as a choice for homeowners to improve the energy efficiency. In certain cases, Member States (like Ireland) where national programmes prioritised interventions on the building envelope, adequate grants and subsidies for the adoption of HPs could also be considered to allow a holistic approach combining renovation measures and installation of more efficient renewable based heating technologies (like heat pumps).

8. **Most EPCs do not indicate the payback or return on investment (ROI) on renewable technologies like heat pump, which is a crucial information for the homeowner before making an investment decision.** These financial calculations (e.g., payback/ROI) are often dependent on the national market conditions which is in constant fluctuation (e.g., cost of electricity, interest rates etc.); thus, EPCs may not be the right instrument for providing such dynamic information as they have a validity of 10 years and market conditions may vary more frequently. Other options like BRP and OSS could be considered to make sure this essential info is captured and passed onto consumers.

9. **Though the HPRI is a new approach to present heat pump related information on EPCs to inform the homeowner, most EPCs already include data inputs that are necessary for the calculation of the heat pump readiness developed in this study.** However, the assessors would need additional training to evaluate the indicator and assess the readiness of the buildings for heat pump installation or improvement.

10. **The HPRI would provide an opportunity to improve the reliability of EPCs.** However,, the assessment process must be designed to overcome the challenges of capturing quality data.

11. **The assessment of the HPRI would need additional time from the assessor, potentially causing the cost of EPCs to increase.** This delay and subsequent cost increase may act as a barrier towards the willingness of homeowners to get a heat pump installed.



Conclusions

Heat pump readiness and comfort time

The "heat pump readiness of a building" explains how the building envelope makes the building ready for the installation and use of heat pumps. The heat pump readiness metrics can be defined as the share of the building's annual space heating demand that the reference heat pump covers with the energy extracted from outside air.

In brief, heat pump readiness can be obtained after comparing three main inputs:

1. The building's heating load curve
2. Heat output curve of the reference heat pump, and
3. Weather profile of the building's location.

The reference heat pump is an essential component of the HPR assessment and should be:

1. Easily applicable on most of the buildings,
2. With relatively low heating output, and
3. With moderate temperatures of supplied hot water.

The purpose of the study is rather to explain potential metrics to assess the heat pump readiness of a building, and to understand how these metrics, after using the reference heat pump, can be applied to predefined target buildings located in several EU climate regions. The study identifies further area of investigation for the European Commission and Member States for the implementation of the Fit for 55 package. This study does not meant to answer whether an individual building or building stock is heat pump ready.

When analysing 30 target buildings around the EU, the highest heat pump readiness was found in Boreal Europe and Continental Spain, with the lowest in Central Europe. Building renovation focusing on the building envelope and reduced U-values is expected to improve the heat pump readiness of the target buildings when using the reference heat pump. In some cases, above certain renovation levels, the heat pump readiness, as defined here, will remain unchanged while the heat pump alone will be enough to cover the complete building heat load. For those cases, increasing the level of insulation will not further increase the heat pump readiness of that specific individual building, as all heating needs would already be covered with the heat pump. However, increasing the level of insulation of this specific building will bring other additional benefits from a building stock level perspective. Further reducing the energy demand in this specific building means reducing the electricity demand, thereby decreasing the pressure on power grids and potentially lowering energy prices for all other consumers.

Finally, increased heat pump readiness implies an increased share of electricity in the energy supplied to the building, therefore suggesting that while heat pumps can strongly support the decarbonisation of the building stock, *full decarbonisation of the building stock* will heavily depend on decarbonisation of the electricity supply.

To understand the potential for fighting shortages in energy supply, the study analysed temperature drops after the heating is cut-off in 30 target buildings across EU. The results showed that the fastest indoor temperature drop of around 5.3°C and 8.1°C after one and five hours, respectively, can be found in Alpine and Central Europe target buildings. The most resistant target buildings are in Continental Spain and Boreal Europe regions, with average temperature drop of 3°C and 4.5°C after one and five hours, respectively.

Renovated buildings are much more resistant to losing comfort in case of heating supply cut-off. Deep renovation of the target buildings can reduce their post-heating temperature drop between 30% and 90%. In the worst-performing target buildings, deep renovation will reduce the temperature drop from 5.3°C to 2.6°C after one and from 8.1°C to 3.6°C after five hours.

Renovated buildings are much more resistant to losing comfort in case of heating supply cut-off.
Deep renovation of the target buildings can reduce their post-heating temperature drop between 30% and 90%.

Communication of the heat pump readiness via EPC

Existing national EPCs do not include explicit information on a building's heat pump readiness. However, the potential to integrate HPRI into EPCs is there. A number of EU Member States already include information on how heat pumps are used in buildings in their national EPC schemes, capturing a significant amount of evidence on heat pumps.

By using the heat pump readiness metrics, heat pump readiness indicators could be developed to pass additional information to homeowners and stakeholders. This could include: heat pump capacity to cover the duration of the annual building heat load, theoretical maximum for heat pump performance, the impact of heat pumps on indoor thermal comfort, and maximum possible annual savings and information on financial payback.

Introducing a heat pump readiness indicator to EPC schemes should not require additional data collection since almost all data required can be found within the standard EPC data inputs. It is, however, essential to make this information easier to read in EPCs for consumers to grasp it.

The HPRI will unlock the energy savings both by improving energy efficiency at the building level and by allowing the optimisation of energy flows on an aggregated grid level. With the installation of heat pumps triggered by HPRI the buildings will offer (i) demand response services such as self-consumption, self-production or storage services, (ii) capacity to maintain indoor thermal comfort in conjunction with existing heating system and (iii) increase the renewable capacity of the energy grid as well as the energy efficiency of the system. However, further investments are required to enable harvesting of these benefits at member state level. HPRI would also provide an opportunity to improve the reliability of EPCs, however, the assessment process must be designed to overcome the challenges of capturing quality data.

EPCs are important tools for both evaluation and communication of heat pump readiness at building level. However, a number of barriers must be resolved in order to add the HPRI to EPC schemes, such as separate use of EPC and heat pump assessment methodology, and lack of dedicated heat pump assessment tools.

Policy changes required to embed "heat pump ready" buildings into EPC

EPBD policy recommendations on EPCs related to heat pump readiness

At the end of 2022, the European Commission proposed a new Council Regulation, which was adopted for a period of 18 months, to accelerate the deployment of renewable energies. For heat pumps specifically, *"the permit-granting process for the installation of heat pumps below 50 MW shall not exceed one month"*. While this measure would speed up deployment on the ground, it will not support consumers in their renovation journey, for example, to help them choose whether a heat pump is suitable in their building.

According to a study from the Sustainable Energy Authority Ireland (2021), the heat pump adoption customer journey can be structured in five stages: considering, choosing, organising, designing and installing, and finally, operating. The changes brought by the Council Regulation would certainly contribute to the fourth stage, while BPIE's analysis on HPR fills a gap and is relevant for the second phase of "choosing". **This analysis is therefore relevant for the choice to buy a heat pump vs. renovating other building elements, but also for the choice to buy a heat pump vs. other alternative heating solutions.** Decarbonisation of heating in buildings will be mostly driven by low temperature district heating based on renewables, as well as (electric) heat pumps. According to the IEA, current and announced fossil fuel boiler bans in the EU will require around 16 million households to switch to alternative heating options by 2030. Information tools for consumers should consider this trend, so that (heat pump) roll out is done in an optimal way.

Assessing and communicating the HPR of a building should be done through an EPC. In this analysis, HPR is defined as the share of the building's annual space heating demand that the reference heat pump covers with the energy extracted from outside air under the assumption that all physical preconditions of heat distribution in homes are fulfilled.

EPCs are existing information tools about the energy performance of buildings, which have existed for around twenty years and are broadly recognised by consumers. Thus, it is logical to embed HPR into EPCs, rather than to create an additional separate label, which would confuse consumers, and also add unnecessary complexity and administrative burden. Also, the EPBD recast includes many provisions to reform and improve the EPC framework (Articles 16 to 19).

Adding an HPRI to EPCs would contribute to the evolution of EPCs from solely informational tools on building performance, into actionable advisory tools on building renovation that can empower consumer decision making. The EPBD revision also entails measures (Article 17) to increase the coverage of the building stock with EPCs. This is essential if all the suggestions related to HPR and its indicator are to have an impact.

The EPBD Commission proposal added new triggers to issue an EPC, next to selling or renting to a new tenant, i.e., the renewal of a rental contract or a major renovation. In addition, triggers related to the lifetime or replacement of the heating system should also be added.

> ***Adding an HPRI to EPCs would contribute to the evolution of EPCs from solely informational tools on building performance, into actionable advisory tools on building renovation that can empower consumer decision making.***

To increase the coverage of the building stock with EPCs, all buildings should be required to have an EPC by a certain date, if no EPC has been issued in the last 5 years based on the previous triggers. Increasing the coverage of the building stock with EPCs would be useful to identify and map the worst-performing buildings and those that are potentially already heat pump ready. These EPCs can be differentiated between building segments.

How exactly should the EPBD revision improve EPCs to facilitate the rollout and use of an HPRI?

Calculation methodologies must be made fit to assess HPR

This study has shown that most of the data inputs needed to calculate the HPR are already included in the methodology to calculate the energy performance, thereby reducing the time and cost needed to produce a HPRI within the EPC. Consistency must be ensured between the HPR assessment methodology and the EPC calculation methodology, in terms of how the data is collected and processed, to enable the integration of the HPRI into the EPC. Input data that needs to feed into both the HPR assessment and the EPC should be included in the mandatory list of indicators of EPBD Annex V (EPC template) and be reflected in the EPBD Annex I (common general framework for the calculation of energy performance).

The HPRI should be a mandatory indicator in the EPC template

Careful consideration should be given to the design and layout of EPCs in order to effectively communicate the HPR of a building in the form of an indicator. The overview of some examples show how information on heat pumps is presented very differently on EPCs, depending on the Member State (see Annex 4 of this report). Consequently, some information points included on an EPC should be made mandatory, not only indicative, for example, the *"renewable energy produced on site, main energy carrier and type of renewable energy source"* (EPBD Annex V §2b). **Regarding the HPRI specifically, it should be included as a mandatory indicator in the EPC template** (EPBD Annex V), building on the indicator mentioned in §2(n), *"feasibility of adapting the heating system to operate at more efficient temperature settings".*

EPBD ways forward and issues to be further explored, related to HPRI

The specifics of how the HPRI should look, and how exactly it should be developed, should be dealt with through a Commission Delegated Act, stipulated in the EPBD. Including a Commission Delegated Act on HPRI now will ensure the concept is acknowledged in the Directive during this revision of the EPBD, while leaving sufficient time to explore detailed technicalities and interactions with other provisions in the text.

The Delegated Act should set out the technical specifications, according to different building types, for the definition and calculation of HPR, as well as the intended use of the HPRI, in coherence with EPCs and the EU scheme on Renovation Passports.

It should also explore issues which were beyond the scope of this study, but which are particularly relevant for the development of a HPRI, such as:

- **How to make consumers easily understand what HPR means.** In other words, that the HPR of their building consists in the share of annual heating demand covered by the outside air extracted by the heat pump, but that electricity is still needed on top to operate the heat pump (as analysed in this study).
- **How to express and calculate the HPRI based on six parameters**: 1. Capacity of heat pumps to cover the share of the annual building heat load with energy from the outside air, 2. Capacity of heat pumps to cover the duration of the annual building heat load, 3. Theoretical maximum for heat pump performance based on reference heat pumps, 4. Impact on indoor thermal comfort, 5. Annual energy costs savings achievable, and 6. Information on payback.
- **How to express “heat pump readiness” in a way which would be flexible enough to allow political choice about the cut-off concept of “heat pump ready”,** while being based on sound scientific grounds (cf. recent debates on the use of a Heat Loss Indicator in Ireland)
- **How to visualise the HPRI and convey relevant information to consumers:** while it could be visualised through a scale/range if it is solely based on the parameter assessed in this study (which is a share), the HPRI could possibly be represented differently once other parameters are included in the HPR assessment.
- **How to express and calculate the *low-temperature* readiness of a building**, a concept wider than *heat pump* readiness, as it could then also apply to district heating.
- **How to embed a HPRI not only in new EPCs to be issued as of 01/01/2026, but also in existing EPCs already issued** and which will still be valid for at least 5 or 10 years (depending on the energy performance of the building considered).
- **How to link the HPRI with EPC classes?**
- **How to reflect the implications of HPR into the EPC recommendations,** notably the benefits of switching to a heat pump in terms of energy savings and increased renewables share, in coordination with the EU scheme on Renovation Passport.

Regarding the timeline, **requesting the European Commission to adopt a Delegated Act on HPR/HPRI by 31/12/2024** would ensure it can amend the EPBD Annex V (EPC template) in time, considering the EPBD foresees EPCs issued as of 01/01/2026 to follow the new template.

EPBD ecosystem of regulatory and financing measures related to HPRI

What are the policy changes needed now, or to be envisioned in the future, to enable the rollout of an HPRI in EPCs? Put differently, what policy measures could rely on the HPRI to send more appropriate signals to consumers regarding building renovation, and ensure full use of the HPRI is made once it is developed?

The HPRI could further inform the implementation of renovation measures and determine the buildings where deep renovation should be prioritised. As this study shows, renovation contributes to increasing heat pump readiness of all analysed buildings, as there is a positive correlation between the level of insulation and the heat pump readiness.

Two thirds of buildings analysed need to undergo more than a shallow renovation to be made heat pump ready. However, for a few buildings in some climate zones, there is a renovation depth above which further insulation does not significantly increase heat pump readiness for those buildings. This effect can be noticed in around one third of the buildings analysed. In those buildings, going from a medium to a deep renovation does not increase the share of energy demand covered by the heat pump (both from air and electricity).

Therefore, in view of increasing the building's heat pump readiness, going from medium to deep renovation in those individual cases may not be attractive to the consumer from an individual building and microeconomic perspective. However, increasing the level of insulation in those buildings would still make sense from a stock and macroeconomic perspective.

This is for two main reasons. First, deep renovation will decrease the absolute amount of electricity needed to run the heat pump, which has positive collective impacts on how electricity grids can operate. This would also provide an opportunity for consumers to participate in demand flexibility programmes, opening possibilities for more affordable energy prices. Second, deep renovation of those buildings will contribute to the collective reduction of energy consumption, decreasing or even eliminating the need for any (fossil fuel) back up system, thereby contributing to the collective effort of reducing the EU's dependence on fossil fuels.

In both cases, deeper renovations will contribute to shielding consumers from higher energy bills, whether directly (by getting rid of fossil fuels, which means lowering the price of energy paid by the consumer directly) or indirectly (by lowering the need for electricity, which means lowering the transmission and distribution infrastructure costs, paid indirectly by the consumer as taxpayer). Further, the benefits of deeper renovation, even if it does not increase HPR compared to medium renovation, should be highlighted to consumers. For example, when coupled with adequate ventilation and shading, adding insulation can improve (summer) comfort. For buildings reaching heat pump readiness levels, the cost and benefits of deeper renovation would have to be evaluated and programmes promoting deeper renovation would have to be accompanied by an effective system of public financial support.

Using the HPRI in the design of policy measures and financing programmes can help identify and visualise where the biggest potential for direct heat pump rollout lies, versus where the biggest potential and need for building envelope improvements are located.

In that regard, the HPRI could further inform and support policies to phase out fossil fuel heating systems in buildings (EPBD Article 11 and 15, but also Annex II, as well as the planned phase out of standalone fossil fuel boilers by 2029 through Ecodesign). At the same time, it would ensure that this is done while engaging with and convincing consumers, by ensuring that it is done in the most appropriate, comfortable, and affordable way.

Further reflections are needed on how to use the HPR concept and the HPRI in relation to standard-setting when it comes to building performance. While the HPRI reflects a technical tipping point, indicating at which moment a building is deemed “fit for being heated with a heat pump”, using this technical “capacity” point, or rather a range of value, to determine a threshold to be achieved, is a political choice.

In this regard, standard-setting for minimum energy performance levels to be achieved by buildings should look beyond the technical capability of the building to be heated thanks to a heat pump, but should also look at wider benefits of building envelope improvements (notably in terms of summer comfort, when done in coordination with ventilation and shading), as well as economic feasibility considerations (which depend on the financial, subsidy and taxation ecosystem around building renovation). All these aspects were not part of this study but should be further explored and considered in view of a Commission Delegated Act on heat pump readiness.

This work should investigate how the HPRI could inform the setting of Minimum Energy Performance Standards (MEPS) that the European Commission introduced in the EPBD recast proposal (Article 9) to phase out the worst-performing buildings of the stock. A certain HPR level, to be defined, for example as minimum energy performance levels for the building envelope, and/or maximum limits for energy needs for heating, could constitute one intermediary milestone to be achieved between now and 2050, within the MEPS framework. Another area to explore would be how findings on heat pump readiness could inform the setting of energy performance thresholds to be achieved by buildings undergoing a deep renovation and achieving a zero emission building level, notably the differentiation between climate zones (EPBD Annex III).

Finally, developing a HPRI in EPCs should be thoroughly thought through if it is to be used to set conditions for access to finance for building renovation. Both building envelope improvements and the installation of a heat pump represent a high upfront investment for households, as well as renovation works, which are often subsidised, fully or partly. This study has shown, for example, that all 11 Member States analysed use energy performance levels as proxies (and more specifically, 3 use building envelope performance levels) to determine whether a household is eligible for a subsidy to install a heat pump.

In the future, granting subsidies to financially support the installation of a heat pump should be based on and informed by the HPRI. This is key for the optimal use of public money, in the same spirit as granting subsidies to staged deep renovations only if they follow the steps laid out in a Renovation Passport (EPBD Article 15). It ensures that public financial support to the rollout of heat pumps is embedded in a ‘whole building’ approach, rather than looking at ‘single element’ measures. In addition, the EPBD should require Member States to end subsidies to the installation of fossil fuel boilers and require the re-direction of those amounts to the deployment of renewable heating options, including heat pumps. Another key element is to focus the use of public money to support building renovation and decarbonisation measures for low-income households.

The benefits of integrating an HPRI in EPCs

Ensuring money is well spent

Developing a HPRI in EPCs would not only ensure the optimal use of public money, but also of private funds. By installing a heat pump at the right time in a given building, it is ensured that running costs (caused by the amount of electricity needed to run the heat pump) are minimised. That way, a HPRI protects consumers from installing a system which would possibly become oversized, which would result in unnecessarily high electricity bills. Overall, introducing the HPRI would help determine whether subsidies are appropriate to support renovation. Subsidies should in priority fund all renovation measures implemented by low-income households, whether building envelope improvements or heat pump installation. Subsidies should as well fund parts of deeper renovations, complementing private investments, when those deeper renovations bring collective benefits beyond increasing the HPR of a specific building.

Helping consumers plan renovation over the long-term

The HPRI would give consumers the long-term visibility they need to plan renovation of their building, ultimately reaping the benefits of both energy efficiency and switching to renewables, while ensuring comfort. Also, it would give households opportunities in terms of demand-side flexibility (i.e., the capacity to react and adapt their consumption), thereby opening up access to dynamic tariffs where they exist, which is key in terms of energy affordability. Ultimately, it would ensure the Renovation Wave remains attractive and appealing to consumers.

Enabling a more flexible and decarbonised energy system

Using the HPRI to inform the rollout of heat pumps in buildings would have a parallel benefit for the energy system, as it would enable the deployment of such heating systems without increasing the electricity demand too much. It would also enable to plan "brownouts" on the electricity grid (i.e., voluntarily reducing the load in case of emergency), rather than having to face blackouts (i.e., power cuts incurred and uncontrolled), in case of an imbalance between energy demand and supply. All in all, the risks posed to the stability of the grids, as well as investment needs to reinforce those, would be minimised. All this would further boost the role of the building stock, as enabler of a more flexible and decarbonised energy system and should be reflected in the revision of the Electricity Market Design Directive. Therefore, national authorities should design policies that consider both the HPR of individual buildings as much as the HPR of the electricity grids – this holistic approach would ensure a just transition to consumers.

Helping public authorities plan integrated renovation programmes at district level

The development of the HPRI in EPCs would also be useful for public authorities, especially at the local level. This is because it enables a comparison of the HPR of a building before and after renovation, as well as the HPR between different buildings. This is relevant for planning the rollout of integrated renovation programmes at district level, notably through industrial/serial type of renovation processes, as HPRI in EPCs would clearly indicate geographically, which buildings to tackle first and with which measure.

Supporting local heating and cooling plans

The development of the HPRI in EPCs would also contribute to local heating and cooling plans that municipalities over a certain size must undertake in the framework of the Energy Efficiency Directive (Article 23). In that sense, the HPRI data should be made available to public authorities who should have full access to the national EPC databases, to be developed according to the EPBD recast (Article 19). This should also be the case for accredited one-stop-shops, which could base their advice on energy renovation of buildings, on additional relevant information contained in EPCs.

Helping industry efficiently organise the supply chain

The development of an HPRI in EPCs would also be beneficial for the industry. By optimising the rollout of heat pumps within the building stock, it would contribute to better organise supply chains to face this challenge, indicate when and where to intervene, and therefore optimise the use of strained resources. This is particularly relevant at times when objectives of heat pump deployment face issues such as lack of enough trained installers or lack of enough materials/components (such as semiconductors). **In short, the heat pump market could be better organised and spread installations over time and space.**

Monitoring heat pump market penetration

The HPRI in EPCs could ultimately also serve as an indicator for heat pump penetration in the market, which can also be useful in the framework of the Renewables Directive and monitoring of the increase of the share of renewables in heating and cooling in buildings.

The heat pump readiness indicator is a potential tool to safeguard delivery of a consumer-friendly Renovation Wave. It could empower households to play their part in the energy and climate crisis in an affordable and easy way.

While the concept of heat pump readiness holds significant potential to advance building decarbonisation policies and bring many benefits to EU citizens, its exact definition and the development of a corresponding indicator that is integrated into EPCs, should be further investigated before moving to practical implementation. This is essential if the EU intends to implement the Energy Efficiency First principle in the buildings sector and optimise the roll out its REPowerEU objectives, aligning short- and long-term energy security and climate targets, and ensuring that EU citizens take hold of all the potential benefits of deep renovation.

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Annex 1

Dwelling profiles used in the analysis

Dwelling profile code	Dwelling profile	Climate zone code	Building code
MUB1	4 floor 8 flats multi-unit building (MUB) used by single people	ATL	MUB1_ATL
MUB1	4 floor 8 flats multi-unit building (MUB) used by single people	CES	MUB1_CES
MUB1	4 floor 8 flats multi-unit building (MUB) used by single people	CEN	MUB1_CEN
MUB1	4 floor 8 flats multi-unit building (MUB) used by single people	ALP	MUB1_ALP
MUB1	4 floor 8 flats multi-unit building (MUB) used by single people	BOR	MUB1_BOR
MUB2	6 floor 24 flats multi-unit building (MUB) used by single people	ATL	MUB2_ATL
MUB2	6 floor 24 flats multi-unit building (MUB) used by single people	CES	MUB2_CES
MUB2	6 floor 24 flats multi-unit building (MUB) used by single people	CEN	MUB2_CEN
MUB2	6 floor 24 flats multi-unit building (MUB) used by single people	ALP	MUB2_ALP
MUB2	6 floor 24 flats multi-unit building (MUB) used by single people	BOR	MUB2_BOR
MUB3	4 floor 8 flats multi-unit building (MUB) used by a family of four	ATL	MUB3_ATL
MUB3	4 floor 8 flats multi-unit building (MUB) used by a family of four	CES	MUB3_CES
MUB3	4 floor 8 flats multi-unit building (MUB) used by a family of four	CEN	MUB3_CEN
MUB3	4 floor 8 flats multi-unit building (MUB) used by a family of four	ALP	MUB3_ALP
MUB3	4 floor 8 flats multi-unit building (MUB) used by a family of four	BOR	MUB3_BOR
MUB4	6 floor 24 flats multi-unit building (MUB) used by a family of four	ATL	MUB4_ATL
MUB4	6 floor 24 flats multi-unit building (MUB) used by a family of four	CES	MUB4_CES

Dwelling profile code	Dwelling profile	Climate zone code	Building code
MUB4	6 floor 24 flats multi-unit building (MUB) used by a family of four	CEN	MUB4_CEN
MUB4	6 floor 24 flats multi-unit building (MUB) used by a family of four	ALP	MUB4_ALP
MUB4	6 floor 24 flats multi-unit building (MUB) used by a family of four	BOR	MUB4_BOR
SFH	Four facades single-family house (SFH) used by a family of four	ATL	SFH_ATL
SFH	Four facades single-family house (SFH) used by a family of four	CES	SFH_CES
SFH	Four facades single-family house (SFH) used by a family of four	CEN	SFH_CEN
SFH	Four facades single-family house (SFH) used by a family of four	ALP	SFH_ALP
SFH	Four facades single-family house (SFH) used by a family of four	BOR	SFH_BOR
TSFH	Terraced single-family house (TSFH) used by a family of four	ATL	TSFH_ATL
TSFH	Terraced single-family house (TSFH) used by a family of four	CES	TSFH_CES
TSFH	Terraced single-family house (TSFH) used by a family of four	CEN	TSFH_CEN
TSFH	Terraced single-family house (TSFH) used by a family of four	ALP	TSFH_ALP
TSFH	Terraced single-family house (TSFH) used by a family of four	BOR	TSFH_BOR

Annex 2

Links to sources consulted to review EPC schemes for the different countries analysed

Countries	References
Belgium (Wallonia)	https://www.enerconsult.be/pdf/Certificat%20energetique%20PEB/PEB%20-%20exemple%20CPE.pdf https://energie.wallonie.be/servlet/Repository/quelles-informations-dans-le-certificat-peb-depuis-le-3-novembre-2014.pdf?IDR=26529
Spain	https://www.certificadosenergeticos.com/contenido-minimo-del-certificado-energetico https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf
France	https://observatoire-dpe.ademe.fr/impressionDPE https://www.ecologie.gouv.fr/diagnostic-performance-energetique-dpe#scroll-nav__7
Italy	https://www.certificato-energetico.it/Fac-simile-APE.pdf https://www.masterclima.info/post/La-verifica-della-trasmittanza-termica-periodica
Portugal	https://www.sce.pt/wp-content/uploads/2018/06/ADENE_certificado_energ%C3%A9tico_habita%C3%A7%C3%A3o.pdf https://www.sce.pt/wp-content/uploads/2022/03/Manual-SCE-pos-despacho-de-alteracao_v.f..pdf
Ireland	https://www.seai.ie/publications/Introduction_to_DEAP_for_Professionals.pdf https://www.seai.ie/home-energy/building-energy-rating-ber/support-for-ber-assessors/software/deap/DEAP-Manual-Version-4.2.3-Final.pdf
Denmark	Bekendtgørelse om Håndbog for Energikonsulenter (HB2021) (retsinformation.dk) https://www.retsinformation.dk/eli/lta/2021/939#idc1356de2-08c1-4ee2-94aa-3bb3a4516a12 https://sparenergi.dk/forbruger/vaerktoejer/varmepumpelisten
Netherlands	https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/energielabel-woningen https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/standaard-streefwaarden-woningisolatie#future-proof-standard
Bulgaria	https://www.provadia.bg/obspor/123/Сертификат%20за%20енергийни%20характеристики.pdf
Slovakia	https://www.trnava.sk/userfiles/download/attachment/EC_ZpS.pdf
Slovenia	https://ssrs.si/wp-content/uploads/2019/06/Energetska-izkaznica-ID-1083-322-2.pdf

Annex 3

Overlap of standard EPC data inputs required for calculation of heat pump readiness indicator

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
1	Building	Administrative data	Address	0
2	Building	Administrative data	Building ID (cadatral identification)	0
3	Building	Comfort	Metabolic heat rate for activity level i	1
4	Building	Energy performance indicator	Energy delivered for domestic hot water by energy carrier i	0
5	Building	Energy performance indicator	Energy delivered for space heating by energy carrier i	1
6	Building	General data	Emission rates	0
7	Building	General data	Outdoor air quality index	0
8	Building	General data	Type of the building/Function	1
9	Building	General data	Activity level profile per occupant	
10	Building	General data	Air tightness	1
11	Building	General data	Building gross heated volume	1
12	Building	General data	Building inertia	1
13	Building	General data	Climate data	1
14	Building	General data	Climate region	1
15	Building	General data	Specified cold water delivery temperature	1
16	Building	General data	Construction type related to thermal capacity	1
17	Building	General data	Construction year	1
18	Building	General data	Temperature offset for heat gains in heating season (standard year)	
19	Building	General data	Number of occupants	1
20	Building	General data	Outdoor air temperature	1
21	Building	General Data	Sea level	0
22	Building	General data	User profile	0
23	Building	General data	Building structure	0

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
24	Building	General Data	Terrain type	0
25	Building	General Data	Conservatory present	0
26	Building	General data	Outdoor air pollutant concentration	0
27	Building	General data	Building state	1
28	Building	General data	Date and details of last intervention	1
29	Building	Geometry	Net floor area	1
30	Building	Geometry	Room distribution	0
31	Building	Geometry	Building envelope area	1
32	Building	Geometry	Building envelope area (heat loss area)	1
33	Building	Geometry	Building orientation	1
34	Building	Geometry	Compactness (based on heat loss area)	1
35	Building	Geometry	Gross building area	1
36	Building	Geometry	Reference area	
37	Building	Indoor environmental quality	Indoor air temperature	1
38	Building	Recommendations	Measure (1 to n)	
39	Building	Technical Energy System	Space cooling service exists	1
40	Building	Technical Energy System	Space heating service exists	1
41	Building	Ventilation system	Fan power	1
42	Building	Energy performance indicator	Cooling primary energy demand (not renewable)	0
43	Building	Energy performance indicator	Cooling primary energy demand (renewable)	0
44	Building	Energy performance indicator	Global CO2 emission (heating, cooling, dhw, etc.)	0
45	Building	Energy performance indicator	CO2 conversion factor for energy carrier I	0
46	Building	Energy performance indicator	Global primary energy demand (not renewable)	0

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
47	Building	Energy performance indicator	Global primary energy demand (renewable)	0
48	Building	Energy performance indicator	Heating primary energy demand (not renewable)	1
49	Building	Energy performance indicator	Heating primary energy demand (renewable)	0
50	Building	Energy performance indicator	Energy Needs for Cooling	0
51	Building	Energy performance indicator	Energy Needs for Heating	1
52	Building	Energy performance indicator	Primary energy demand for lighting (not renewable)	0
53	Building	Energy performance indicator	Primary energy demand for lighting (renewable)	0
54	Building	Energy performance indicator	Primary energy demand for mechanical ventilation (not renewable)	0
55	Building	Energy performance indicator	Primary energy demand for mechanical ventilation (renewable)	0
56	Building	Energy performance indicator	Transport primary energy demand (not renewable)	0
57	Building	Energy performance indicator	Transport primary energy demand (renewable)	0
58	Building	Energy performance indicator	Transport system efficiency	0
59	Building	Energy performance indicator	Transport systems are considered/exist	0
60	Building	Energy performance indicator	Useful electricity demand	0
61	Building	Energy performance indicator	Useful energy demand for heating	1

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
62	Building	Energy performance indicator	Useful energy demand for DHW	0
63	Building	Energy performance indicator	Useful energy demand for cooling	0
64	Building	Energy performance indicator	Useful energy demand for lighting	0
65	Building	Energy performance indicator	Useful energy demand for mechanical ventilation	0
66	Building	Energy performance indicator	Primary energy conversion factor for energy carrier i	0
67	Envelope	Door	Surface area	1
68	Envelope	Door	U-value	1
69	Envelope	External Wall	Sheltered sides	1
70	Envelope	External Wall	Factor for ambient on back side	
71	Envelope	External Wall	Insulation thermal conductivity	1
72	Envelope	External Wall	Insulation thickness	1
73	Envelope	External Wall	Insulation type	1
74	Envelope	External Wall	Layer material (for n layers)	1
75	Envelope	External Wall	Layer thermal conductivity (for n layers)	1
76	Envelope	External Wall	Layer thickness (for n layers)	1
77	Envelope	External Wall	Overall flat thermal bridge U-value	1
78	Envelope	External Wall	Surface area	1
79	Envelope	External Wall	U-value	1
80	Envelope	Floor against ground	Surface area	1
81	Envelope	Floor against ground	U-value	1
82	Envelope	Roof	Surface area	1
83	Envelope	Roof	U-value	1
84	Envelope	Roof	Insulation thickness	1
85	Envelope	Window	Whole building solar absorption (g.A)	1

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
86	Envelope	Window	g-Value	1
87	Envelope	Window	Sun protection (Shading) – Degree of automation	1
88	Envelope	Window	Surface area	1
89	Envelope	Window	U-value (frame)	1
90	Envelope	Window	U-value (glazing)	1
91	Envelope	Window	Multiple glazed percentage	1
92	Envelope	Window	Windows orientation	1
93	Envelope	Window	yie-value periodic thermal transmittance	
94	Envelope	Window	Frame factor	1
95	Envelope	Window	U-value (global)	1
96	Renewables	PV solar	Solar irradiation o a horizontal plane	1
97	Renewables	PV of electricity generation	Equivalent solar Area/net heated area Ratio	0
98	Renewables	PV of electricity generation	Installed capacity	0
99	Renewables	Solar thermal	Installed capacity	0
100	Reporting functionalities/ Info to occupants	Cooling system	Report information regarding cooling system performance	0
101	Reporting functionalities/ Info to occupants	DHW system	Report information regarding domestic hot water performance	0
102	Reporting functionalities/ Info to occupants	Electricity	Reporting info regarding electricity consuption (smart meters, real-time feedback)	0
103	Reporting functionalities/ Info to occupants	Electricity	Reporting info regarding local electricity generation	0
104	Reporting functionalities/ Info to occupants	Electricity	Reporting info regarding energy storage (electricity)	0
105	Reporting functionalities/ Info to occupants	Envelope	Reporting information regarding performance	1

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
106	Reporting functionalities/ Info to occupants	Heating system	Report information regarding heating system performance	1
107	Reporting functionalities/ Info to occupants	Monitoring and control	Central reporting of TBS performance and energy use	0
108	Reporting functionalities/ Info to occupants	Ventilation system	Reporting information regarding IAQ	0
109	Storage & Connectivity	Electric vehicle charging	EV Charging Grid balancing	0
110	Storage & Connectivity	Electric vehicle charging	EV charging information and connectivity	0
111	Storage & Connectivity	Electric vehicle charging	EV charging capacity	0
112	Storage & Connectivity	Cooling system	Cooling system storage and shifting of thermal energy	0
113	Storage & Connectivity	Electricity	Storage of locally generated energy	0
114	Storage & Connectivity	Monitoring and control	Smart Grid Integration	0
115	Storage & Connectivity	Thermal energy	Heating system storage and shifting of thermal energy	0
116	Storage & Connectivity	Thermal energy	Control of DHW storage charging – HP or electrict	0
117	Storage & Connectivity	Thermal energy	Control of DHW storage charging	0
118	Technical building systems	Appliances	Electricity consumption (excl. space heating)	0
119	Technical Building systems	Cooling system	cooled area	0
120	Technical Building systems	Cooling system	cooled bruto-volume	0
121	Technical Building systems	Cooling system	Cooling emission control	0
122	Technical Building systems	Cooling system	Cooling energy source	0

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
123	Technical Building systems	Cooling system	Cooling system efficiency	0
124	Technical building systems	Cooling system	Energy delivered for space cooling by energy carrier i	0
125	Technical Building systems	Cooling system	Fuel type	0
126	Technical Building systems	Cooling system	Generator control for cooling	0
127	Technical Building systems	Cooling system	Percentage from the total heat generation	0
128	Technical Building systems	Cooling system	Nominal electrical power	0
129	Technical Building systems	Cooling system	Nominal thermal power	0
130	Technical building systems	Cooling system	Cooling degree-days	0
131	Technical Building systems	Cooling system	Number of units installed	0
132	Technical Building systems	DHW system	DHW primary energy demand (not renewable)	0
133	Technical Building systems	DHW system	DHW primary energy demand (renewable)	0
134	Technical Building systems	DHW system	DHW service present	0
135	Technical Building systems	DHW system	DHW system efficiency	0
136	Technical Building systems	DHW system	Fuel type	0
137	Technical Building systems	DHW system	Coefficient x for calculation of residential reference DHW use	0

No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
138	Technical Building systems	DHW system	Primary pipework insulation present	0
139	Technical Building systems	Heating system	Fuel type	1
140	Technical Building systems	Heating system	Heat emission control	1
141	Technical Building systems	Heating system	Heat generation	1
142	Technical Building systems	Heating system	Heat generator control (combustion and district heating)	1
143	Technical Building systems	Heating system	Heat generator control (heat pumps)	1
144	Technical Building systems	Heating system	Heat supply temperature	1
145	Technical Building systems	Heating system	Heated area	1
146	Technical Building systems	Heating system	Heated bruto-volume	1
147	Technical Building systems	Heating system	Heating days	1
148	Technical Building systems	Heating system	Heating energy source	1
149	Technical Building systems	Heating system	Heating system efficiency	1
150	Technical Building systems	Heating system	Indoor temperature	1
151	Technical Building systems	Heating system	Main heat delivery system	1
152	Technical building systems	Heating system	Net energy for space heating	1

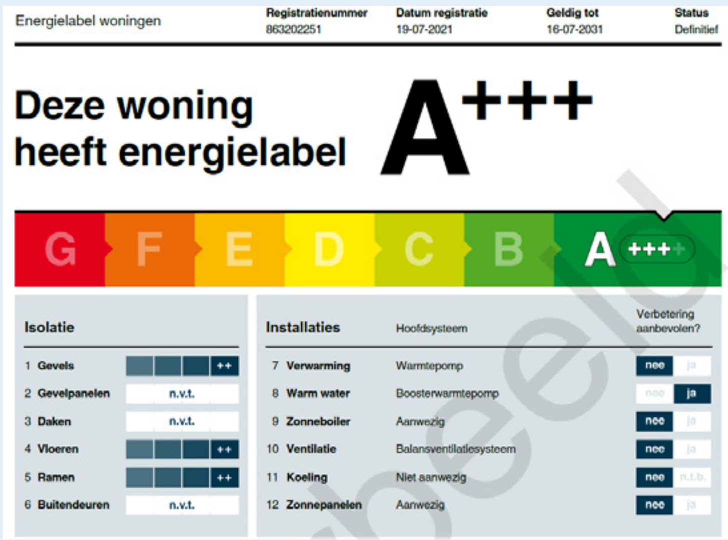
No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
153	Technical Building systems	Heating system	Nominal electrical power	1
154	Technical Building systems	Heating system	Nominal thermal power	1
155	Technical Building systems	Heating system	Norm outdoor temperature	1
156	Technical Building systems	Heating system	Number of units installed	1
157	Technical Building systems	Heating system	Type and dimensions of the units installed	1
158	Technical building systems	Heating system	Operational thermal efficiency of the space heating system	1
159	Technical building systems	Heating system	Central heating pump age	1
160	Technical building systems	Heating system	Heat degree days	1
161	Technical Building systems	Lighting system	Control system: for indoor occupancy	0
162	Technical Building systems	Lighting system	Lamp type	0
163	Technical Building systems	Lighting system	Lighting system efficiency	0
164	Technical Building systems	Lighting system	Lightning is considered	0
165	Technical Building systems	Lighting system	Total power	0
166	Technical Building systems	Monitoring and control	Interaction between TBS and/or BACS	0
167	Technical building systems	Other services system	Energy delivered for other purposes (excl. non-EPC uses) by energy carrier i	0

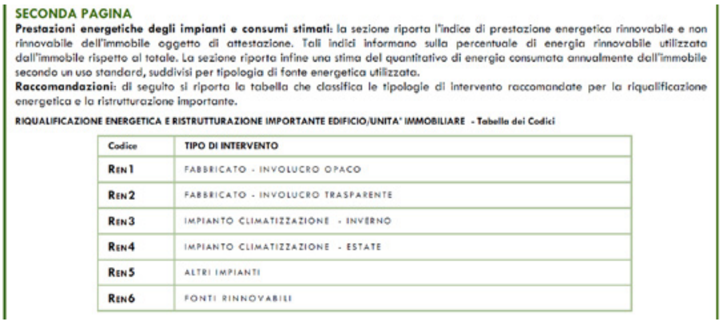
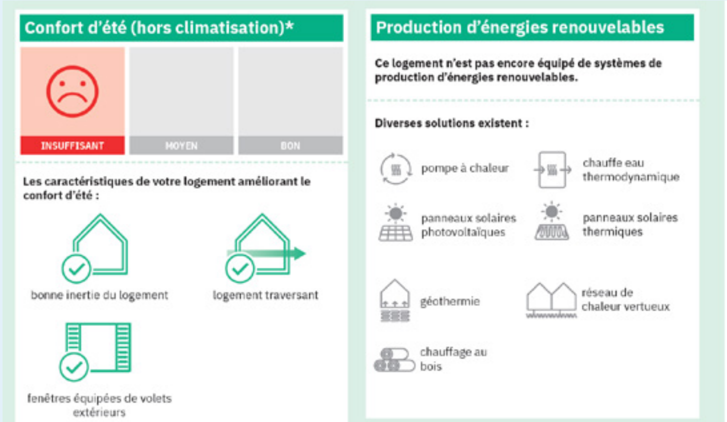
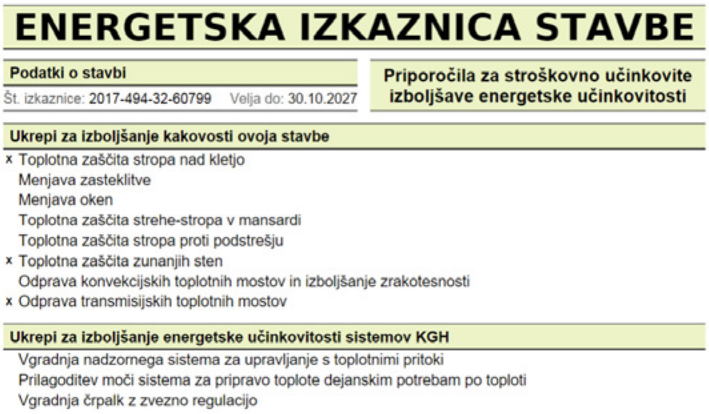
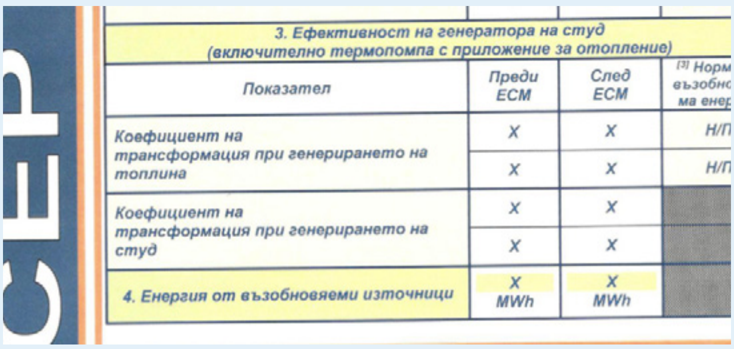
No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
168	Technical Building systems	Ventilation system	Mech Vent system efficiency	0
169	Technical Building systems	Ventilation system	Mech Vent system present	0
170	Technical Building systems	Ventilation system	Air flow control al the room level	0
171	Technical Building systems	Ventilation system	Filter type/class	0
172	Technical Building systems	Ventilation system	Heat recovery efficiency	0
173	Technical building systems	Ventilation system	Operational thermal efficiency of the heat recovery unit	0
174	Technical building systems	Ventilation system	Temperature of ventilation return air	0
175	Technical building systems	Ventilation system	Temperature of ventilation supply air	0
6	Technical building systems	Ventilation system	Ventilation air flow rate	0
177	Technical Building systems	Ventilation system	Ventilation Rate	0
178	Technical Building systems	Ventilation system	Ventilation Type	0
179	Technical building systems	Electrical energy from on-site	Energy delivered for electrical energy production by energy carrier i	0
180	Technical building systems	Electrical energy from on-site	Energy carrier type of energy delivered for electrical energy production	0
181	Technical building systems	Electrical energy from on-site	Technology of electrical energy from on-site	0
182	Technical building systems	Electrical energy exportation	Exported electrical energy	0

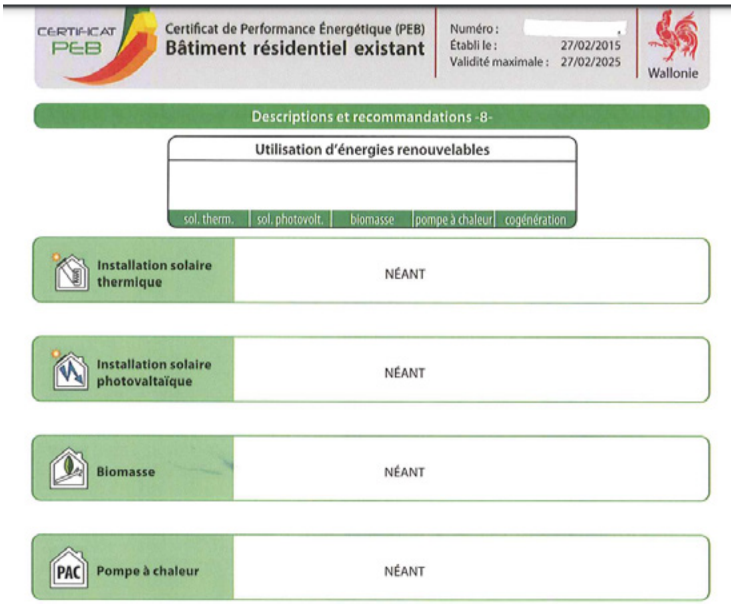
No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Heat Pump readiness indicator calculation inputs (1=required; 0=not required)
183	Technical building systems	Electrical energy from on-site	Factor to control which part of exported energy is included in the EP of the building	0
184	Technical building systems	Other services system	Energy carrier type of energy delivered for other purposes by energy carrier i	0

Annex 4

Presentation of heat pump related information on EPCs

Purpose	Country	Snapshot of EPC
Heat pump installed in the building Recommended improvement of heat pump	NL	
Heat pump related improvement advice	DK	
Energy consumption, power and performance of heat pump captured under technical systems Proposal for improvement with estimated investment, annual energy bill reduction and impact on energy class	PT	

<table>
<tr><th>Purpose</th><th>Country</th><th>Snapshot of EPC</th></tr>
<tr><td>Heat pump captured under renewable energy sources on property</td><td>IT</td><td>
SECONDA PAGINA
Prestazioni energetiche degli impianti e consumi stimati: la sezione riporta l'indice di prestazione energetica rinnovabile e non rinnovabile dell'immobile oggetto di attestazione. Tali indici informano sulla percentuale di energia rinnovabile utilizzata dall'immobile rispetto al totale. La sezione riporta infine una stima del quantitativo di energia consumata annualmente dall'immobile secondo un uso standard, suddivisi per tipologia di fonte energetica utilizzata.
Raccomandazioni: di seguito si riporta la tabella che classifica le tipologie di intervento raccomandate per la riqualificazione energetica e la ristrutturazione importante.
RIQUALIFICAZIONE ENERGETICA E RISTRUTTURAZIONE IMPORTANTE EDIFICIO/UNITA' IMMOBILIARE - Tabella dei Codici
Codice | TIPO DI INTERVENTO
REN1 | FABBRICATO - INVOLUCRO OPACO
REN2 | FABBRICATO - INVOLUCRO TRASPARENTE
REN3 | IMPIANTO CLIMATIZZAZIONE - INVERNO
REN4 | IMPIANTO CLIMATIZZAZIONE - ESTATE
REN5 | ALTRI IMPIANTI
REN6 | FONTI RINNOVABILI</td></tr>
<tr><td>Presence of renewable energy production heat pump on property captured in EPC</td><td>FR</td><td></td></tr>
<tr><td>Installation of Heat Pumps listed among the suggested measures to improve the performance of the building at the EPC</td><td>SI</td><td>
ENERGETSKA IZKAZNICA STAVBE
Podatki o stavbi
Št. izkaznice: 2017-494-32-60799 Velja do: 30.10.2027
Priporočila za stroškovno učinkovite izboljšave energetske učinkovitosti
Ukrepi za izboljšanje kakovosti ovoja stavbe
x Toplotna zaščita stropa nad kletjo
Menjava zasteklitve
Menjava oken
Toplotna zaščita strehe-stropa v mansardi
Toplotna zaščita stropa proti podstrešju
x Toplotna zaščita zunanjih sten
Odprava konvekcijskih toplotnih mostov in izboljšanje zrakotesnosti
x Odprava transmisijskih toplotnih mostov
Ukrepi za izboljšanje energetske učinkovitosti sistemov KGH
Vgradnja nadzornega sistema za upravljanje s toplotnimi pritoki
Prilagoditev moči sistema za pripravo toplote dejanskim potrebam po toploti
Vgradnja črpalk z zvezno regulacijo</td></tr>
<tr><td>Heat Pumps with the capacity of heating are grouped along with cooling systems at EPCs. They aren't considered as RES nor as conventional heating systems</td><td>BG</td><td>
3. Ефективност на генератора на студ (включително термопомпа с приложение за отопление)
Показател | Преди ECM | След ECM | [3] Норм възобно ма енер
Коефициент на трансформация при генерирането на топлина | X | X | Н/П
 | X | X | Н/П
Коефициент на трансформация при генерирането на студ | X | X |
 | X | X |
4. Енергия от възобновяеми източници | X MWh | X MWh |</td></tr>
</table>

Purpose	Country	Snapshot of EPC
Heat Pumps listed among RES at EPCs	BE-WAL	 CERTIFICAT PEB Certificat de Performance Énergétique (PEB) Bâtiment résidentiel existant Numéro : Établi le : 27/02/2015 Validité maximale : 27/02/2025 Wallonie Descriptions et recommandations -8- Utilisation d'énergies renouvelables sol. therm. | sol. photovolt. | biomasse | pompe à chaleur | cogénération Installation solaire thermique: NÉANT Installation solaire photovoltaïque: NÉANT Biomasse: NÉANT PAC Pompe à chaleur: NÉANT

BEUC The European Consumer Organisation

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The European Consumer Organisation
Bureau Européen des Unions de Consommateurs
Europäischer Verbraucherverband

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