# Heat Pumps: An Appropriate Solution for Decarbonising Existing Apartment Buildings?

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Author: Katalin Varga

INTERVIEWS

Vladimir Machaček, Residential Sales Manager, Daikin Czech Republic, October 14, 2024.

Zoltán Varga, economist-urbanist, October 15, 2024.

Marek Miara, heat pump expert, Fraunhofer ISE, October 17, 2024.

Mihály Czabarka, condominium renovation strategist, Projectdoctor Ltd., November 4, 2024.

Tamás Csoknyai, head of department, associate professor, Budapest University of Technology and Economics, Faculty of Architecture, November 7, 2024.

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Phone: +36-1-482-5153

www.rekk.org , rekk@rekk.hu

# INTRODUCTION

**In 2023, European heat pump sales reached 3 million units annually. Less than 10% of the heat pumps sold are installed in apartment buildings, and only a portion of these are part of renovation projects. Considering that 70% of Europe's population lives in cities and that 90% of the buildings in use today will still be standing in 2050, the question arises whether heat pumps can offer a suitable solution for the decarbonization of our existing apartment buildings, and what obstacles need to be overcome to achieve this.**

Accelerating the deployment of heat pumps is central to the REPowerEU plan, and the European Commission has set an ambitious target for Member States to install 10 million new heat pumps within 5 years. When modernising apartment buildings, the main concerns – in addition to investment costs – are whether the heat pump will work properly in a building whose heating system is designed and dimensioned to operate with a high-temperature fossil-fired boiler, how inconvenient it will be for residents to switch to a new energy source, and how much extra noise it will generate. Heat pumps are known to work most efficiently in well-insulated buildings, with low flow temperatures and large-area floor or wall heating. While these aspects can be easily taken into account when designing new apartment buildings, the goal for existing buildings may be to ensure that the modernization involves as few changes as possible and that residents do not have to permanently leave their apartments. Deep renovations are of course desirable, but they can be particularly complicated in the apartment building segment. At the same time, it will become clear that in order to avoid the spread of individual air-to-air heat pumps in apartment buildings, it will be necessary to build centralized heating systems.

**Karlsruhe-Durlach, Ersinger Straße 2, Germany**
As part of a pilot project in Karlsruhe, several adjacent apartment buildings were converted to heat pump heating. The building at Ersinger Str. 2, constructed in 1963, is a 30-apartment condominium with a central heating system. It was considered to have medium energy efficiency (windows were replaced in 1995, and 60 mm of thermal insulation was installed).

In 2020, a water-to-water heat pump system with a total capacity of 55.4 kWth (maximum temperature 75 °C) was installed, along with 202 m² of PVT (photovoltaic thermal) hybrid solar panels. During the project, the building's facade and windows were left untouched. The system provides heating at 55/45 °C and domestic hot water at 55 °C (the latter using ultrafiltration technology). A backup condensing gas boiler covers peak demand.

During the renovation, only 13 out of the building's 150 radiators needed to be replaced with larger units.

**St-Julien, Geneva, Switzerland**
An eight-story, 53-apartment condominium built in 1972 switched from oil heating to heat pump heating and domestic hot water (DHW) without major renovations. Two 156 kW air-to-water industrial heat pumps were installed. Additionally, an oil backup boiler was kept in operation for two years, but after not being used, it was dismantled. The importance of careful design and system sizing is demonstrated by the fact that, due to poorly adjusted pumps, the first year resulted in a Seasonal Performance Factor (SPF) of only 2.3. Corrections are currently underway, along with ongoing performance monitoring.

**Daru, Geneva, Switzerland**
Another renovation in Genova was carried out on a four-story, 68-apartment condominium built in 1992, equipped with a central gas boiler. Six 30 kW air-to-water heat pumps were installed on the roof, and a 240 kW backup gas boiler was retained to cover winter peak demands. The roof was insulated in advance, but no other energy efficiency upgrades were made. Alongside the heat pumps, the domestic hot water (DHW) system operates at 60°C. Challenges included system sizing as well as addressing noise and vibration issues.

**Daisyfield, Blackburn, United Kingdom**
A 300-meter ground source heat pump replaced gas heating in a 183-apartment condominium in Blackburn. An interesting feature of the project is that the central heat pump is supplemented by 6 kW units (shoebox heat pumps) installed in each apartment. The system provides heating and hot water at 65°C.

The above examples come from case studies prepared by the IEA Heat Pump Working Group's Annex 50 and Annex 62 projects. It should be noted that the IEA collection also contains few examples of apartment building heat pump renovations. Among these, I also looked for investments that involved minimal renovation of old buildings, and there are even fewer examples of these. Additional case studies are available here: https://heatpumpingtechnologies.org/annex62/

Based on the literature and professional interviews, heat pump renovations in apartment buildings face the following limitations (outlined below).

## TECHNICAL LIMITATIONS

**Each apartment building is different**. Condominiums are generally characterized by their age, i.e. the construction styles and technologies around the year of their construction. Region- or country-specific characteristics may be decisive. In Hungary, Tamás Csoknyai typified the building stock, and out of the 23 building types identified, 11 types are condominiums with four or more apartments. (Csoknyai, 2022)

In the case of apartment buildings and gangway buildings built before 1945 in Hungary, renovation is difficult because they are often under local protection, so the street-facing thermal insulation is often a problem, and the doors and windows have to be manufactured individually. High interior heights are typical. The heating system in these buildings is varied: it can be central heating, but in many places individual heating per apartment is typical. The advantage is that a yard or basement is available for placing the machinery.

Post-war buildings, typically built in the 1950s and 1960s, were often equipped with gas convector heating, but they may also have central heating. These buildings already have a rational (lower) interior height.

In panel buildings and apartment buildings built with industrial technology, insulated windows, central boilers (for DHW and heating) or district heating are already appearing. The obstacle to installing a geothermal heat pump is that buildings typically do not have their own land, as the garden or yard next to them is usually public land.

Apartment buildings built after 1990 also need rationalization. Typically, individual central heating provides heating and hot water, but without special investment, their ceiling and facade insulation is weak. It varies whether a garden is available.

Basically, when switching to a heat pump, the applicability of a geothermal heat pump in terms of heat source is determined by whether there is an available and usable green area (larger in the case of a ground collector, smaller in the case of a ground probe). From a technical point of view, an air heat pump (air-to-air or air-to-water) can be considered in almost every building, but the placement of outdoor units often causes problems and can also hinder implementation. Heating reconstruction is always simpler and more economical if the starting point is a central or house central heating.[1]

**Technical solutions vary from centralized to individual solutions**. The IEA Heat Pump Working Group also follows the typification method, and has developed 13 solution types for the application of heat pumps in apartment buildings (see figure below). How heating and domestic hot water (DHW) are produced ranges from a centralized version at the house level to a solution at the apartment or even room level. Typification allows for the standardization of investments, which reduces costs from planning to administration to construction. According to IEA researchers, although standardization may not be a 100 percent solution, it can be applied to 80% of our existing buildings. (Marek Miara interview)

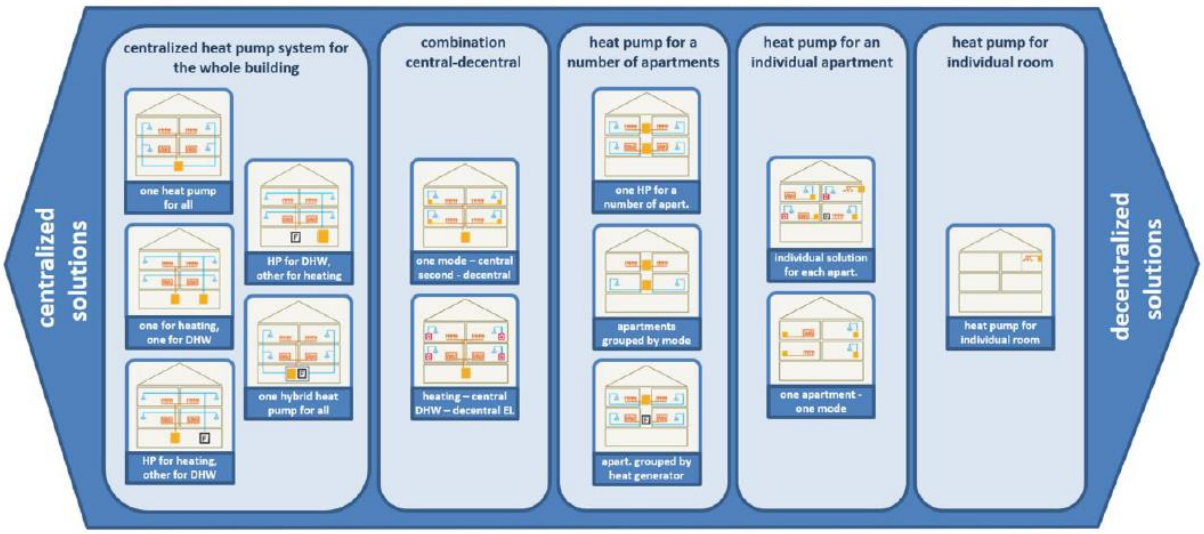



*Figure 7: The overview of the 13 resulting solutions identified is shown in the Figure 3 sorted by families according to their degree of system centralization*

Source: heatpumptechnologies.org

**The better the energy efficiency of the building, the more efficiently and cost-effectively the heat pump can operate.** The above case studies showed that with today's modern equipment, apartment buildings can be converted to heat pump heating (and DHW), even if this does not involve a complex renovation. However, in accordance with the "energy efficiency first principle", the long-term solution is always to reduce the building's

[1]This document does not address the issue of ventilation and cooling.

energy demand - for all energy carriers - and to generate the remaining energy demand as efficiently as possible. If we do not oversize the system, the effects on the electricity grids will also be reduced (see the section on Electricity supply problems).

**There is no need for a flow temperature of 70 °C**. Several studies have shown that the flow temperatures of radiators are too high. In Central Europe, the occurrence of very cold hours around -10°C is limited during the entire operation of the heating system, and systems can usually be operated at a maximum temperature of 50-55°C. This temperature is fully compatible with the operation of conventional heat pumps. (Build-Up , 2024) There are many technical solutions to meet peak demands, e.g. electric heating, booster / shoebox heat pumps (see Daisyfield example above), or e.g. hybrid systems in combination with a gas boiler.

**New refrigerants pose several challenges for the heat pump industry.** Due to the revision of the EU F-Gas Regulation (2024/573) effective from spring 2024, the heat pump industry will have to gradually switch to refrigerants with a global warming potential (GWP) of less than 150. Although the timing varies for each product category, the increasing quota rules are expected to accelerate the spread of propane (R290) or other low GWP refrigerants. Alternatives that comply with the F-Gas Regulation are more flammable and explosive, which means that their installation requires greater caution and may be restricted in some locations.

Although with a lower COP, heat pumps designed especially for cold climates are still in operation today, with 60% of buildings in Norway and more than 40% of buildings in Finland and Sweden heated by heat pumps. This challenges the belief that heat pumps are not applicable in cold climates (IEA, 2022). The use of refrigerants compliant with the F-Gas regulation entails higher costs for manufacturers and ultimately for users, but some refrigerants can provide higher flow temperatures.

**When designing, it is necessary to examine whether there is a nearby heat source that the heat pumps can use.** Air-source heat pumps placed on the roof/facade can be a solution for almost all buildings, if the outdoor unit can be placed. What makes heat pump modernization more complicated than a classic renovation is that, in order to achieve higher efficiency, it is worth examining whether there is a heat source nearby that can provide the heat pump with a higher temperature than the outdoor air, especially in the cold of winter. This could be a ventilation system, residual heat from a data centre, wastewater, or a geothermal heat pump.

**There are times when an air-to-air heat pump is not a solution either.** If all apartment building residents were to install air-to-air heat pumps individually, it would have a serious impact on the appearance of the settlement. In addition to the aesthetic consequences, the resulting noise impact and possible related litigation must also be taken into account. Vollmer et al (2019) state that district heating may be the right answer instead of heat pumps in the most densely populated areas.

## ADMINISTRATIVE CONSTRAINTS

**The ownership of condominiums determines how complicated decision-making is**. In countries where a significant proportion of condominiums operate as municipal or other institutional rental housing, owners are more easily committed to modernizing. In Hungary, 91 % of the housing stock is privately owned (Eurostat, 2024), so residents of different financial and social situations, ages and levels of awareness must jointly decide on condominium investments. This often hinders basic maintenance investments. It is not a coincidence that in foreign examples where successful heat pump renovations were carried out, they typically took place in publicly owned rental apartments. In the case of individual homeowners, community-building solutions are key.

**The licensing process is often complicated and lengthy**. It requires a lot of research not only to find out what the best solution is technically but also to obtain the necessary permits. It often involves significant costs and a procedure that lasts more than a year before all the necessary permits are obtained. In most countries, this involves obtaining a building permit, a mining permit for geothermal systems, and a civil protection/fire safety permit related to the refrigerant of the heat pump. Compliance with the regulations of urban planning and heritage protection when placing outdoor units is a particular challenge. The condominium regulations and the of the given building must also be taken into account. Network connection can be a lengthy and potentially project-stalling issue (this will be discussed separately). There is a great risk that due to the unfamiliarity of the technology and the complexity, or slowness of the procedures, residents will change their minds along the way and decide in favour of the less bureaucratic, known technology (gas boiler). (However, according to EU rules, from 1 January 2025, the replacement of heat generators using fossil energy cannot be supported from community funds.) Based on experience in the Czech Republic, in the case of a heat pump installation in a family house the technical content itself is responsible for 60-70% of the costs , in the case of apartment buildings due to the complicated administration, the situation is reversed, often the technical content accounts for only 30% of the costs, with the rest being other expenses. (Vladimir Machaček interview)

## ELECTRICITY SUPPLY PROBLEMS

**The internal electrical networks of apartment buildings are often outdated and overloaded.** There are more and more large appliances in homes that consume a lot of electricity (air conditioning systems, electric cookers). Before installing a heat pump, not only may it be necessary to upgrade the power supply, but if other maintenance measures have not been carried out earlier, the wiring may also need to be inspected or possibly replaced.

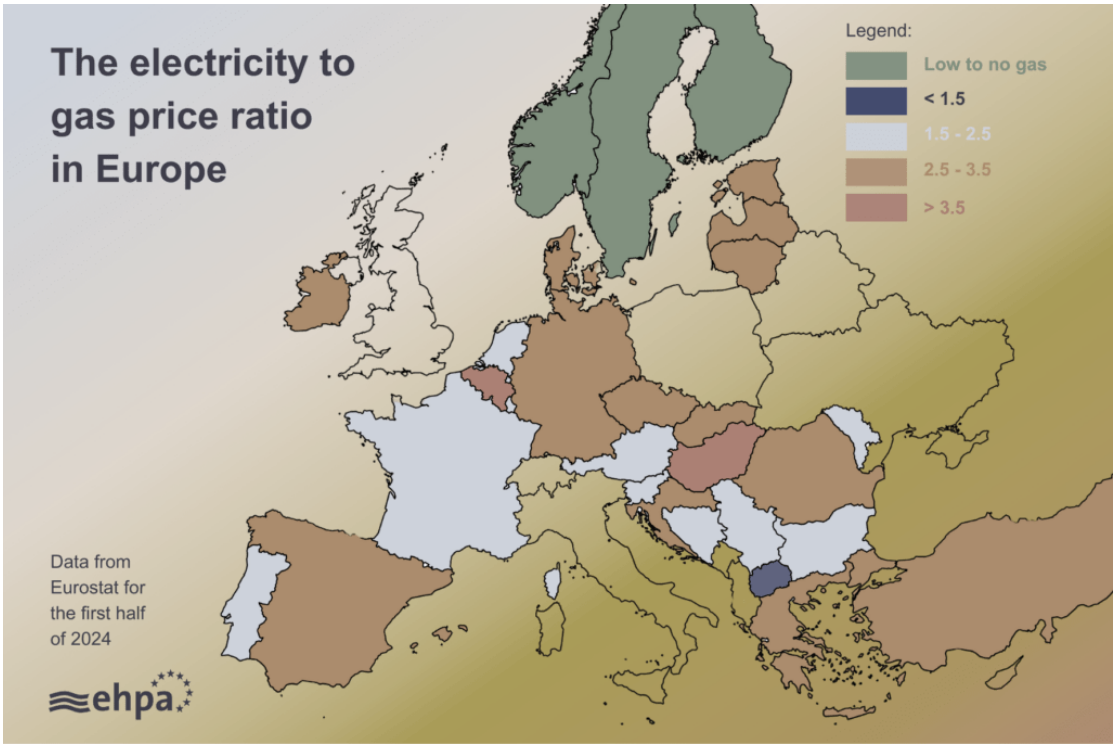
**Restricting the public grid connection can lead to the project's cancellation.** It is possible that the apartment building will transform the electrical network down to the street by expanding the individual and shared capacities, but due to the local grid condition of the given area, the DSO might only undertake the capacity expansion years later. Based on the interviews, coordination with the DSO is crucial in the first phase of the project, as the lack of a proper network connection could make the investment impossible. Due to electrification trends, this is a limitation in almost every country.

## SUGGESTIONS

**The initial cost of heat pump investments must be reduced.** Roughly speaking, compared to replacing a gas boiler, an air-source heat pump is available at twice the price, and a geothermal heat pump at four times the price. To overcome the cost disadvantage, state support sources, tax breaks, preferential loans, preferential connection fees, and ESCO schemes are available in several EU countries. In those countries where stable and predictable support is available, the heat pump industry will also develop faster. The Green Panel Program planned in Budapest, for example, may also provide an opportunity for this.

**It is worth focusing support sources on areas where individual involvement is not enough**. We have seen that central heating systems can be converted to heat pumps more easily. For individually heated flats, when owners are considering customised solutions, the air-to-air heat pump is often the first option. It is advisable to focus the support amounts on the development of centralized heating (and DHW) systems in apartment buildings.

**The electricity to gas price ratio needs to be improved**. In many countries, it costs twice, three times, or even four times as much to produce one kWh of energy from electricity as from natural gas. Taxes and other cost elements on electricity prices can thus nullify the efficiency advantage achieved by heat pumps. Carbon taxes on fossil fuels, preferential electricity tariffs available to heat pumps (e.g. H-tariff, Geo-tariff in Hungary), and time - of- use tariffs can give heat pumps an advantage. According to the EHPA, a maximum ratio of 2 would be necessary for a heat pump to be an economical alternative to a gas boiler. (EHPA, 2024b)




Source: European Heat Pump Association

**With the gradual elimination of regulated residential energy prices, more and more consumers would be interested in modernizing their heating systems** and favouring efficient technologies. In Hungary, it would be important to gradually phase out the price regulation of utility bills and redirect the freed resources to modernizing building energy systems. In parallel, targeted measures should be taken to help vulnerable and energy-poor households.

Many additional proposals can be formulated that do not target the cost side of investments but would simplify the application of heat pumps (not only) in condominiums by improving the policy and regulatory environment.

**The most effective is the ban on fossil fuels.** Several Member States have announced target dates for the ban on fossil fuel combustion in new and existing buildings. In Poland, mainly for air pollution reasons, new residential use of coal-fired combustion appliances is banned in Warsaw from 2023, and in the entire Mazovia region from 2028. Bans on oil and coal-fired appliances have also been implemented or planned in Norway, Austria, Germany, France, Belgium. Bans on natural gas have also been introduced in Denmark, Germany, France, Luxembourg, etc. (EHPA, 2023).

**The rapid implementation of the EPBD directive measures is important**. The revised Energy Performance of Buildings Directive (EPBD - EU/2024/1275) will tighten the requirements for buildings, including renovations. In

countries where support programs for facade insulation and window replacement have been available in recent years, moving on to heat pumps will be easier. Under the new EPBD, Member States must prepare national building renovation plans and introduce a system of renovation passports. The latter is a tailor-made timetable for deep renovation of buildings, which provides guidance for the property on the sequence of individual investments, which can be particularly important for heat pump investments.

**The use of a municipality-level planning and energy experts helps to manage heating (and cooling) issues in a complex manner**. With the help of municipality-level heating strategies, building registers and other tools, local governments get a comprehensive picture of the municipality's energy management, can plan goals and measures, and financing needs. In municipalities where energy experts are employed, the modernisation of heating systems can be carried out in line with long-term planning.

**The issue of monument protection and townscape regulations is critical**. In many countries, it is a problem that national or local regulations prohibit the placement of outdoor units of heat pumps and air conditioners (and sometimes solar panels) on listed buildings. In order to accelerate the decarbonization of buildings, the United Kingdom abolished the expensive and lengthy central licensing process for listed buildings in 2024 and municipalities decide on the license. In many places, outdoor units cannot be placed in a visible location from the street front even in non-listed buildings, which can be a significant obstacle to the transition to heat pumps. If we do not want to relax townscape regulations, targeted support for more complex, house-centered solutions will be necessary.

**Standardization and typification can speed up investments**. In the case of any complex renovation, planning appropriate to the characteristics of the given building is necessary. Developing typical problems and solutions to them (as the IEA Heat Pump Working Group is working on) can simplify planning, construction, licensing and training of professionals.

**Legislation can also encourage the modernization of rental properties**. In France, from 2025, the worst energy-efficient properties will not be allowed to be rented out. The provision will gradually become stricter, and from 2028 it will also apply to properties with energy classes F or worse, and from 2032 to properties with energy classes E or worse. (IEA, 2022; knightfrank.com) In Hungary, an energy certificate is mandatory for the sale of apartments or for renting them out for more than 1 year (even in the advertisement. However, the lack of rental records makes it difficult to enforce such measures.

**Time-of-use tariffs and smart systems can help reduce grid problems**. We have seen above that distribution networks are under particular pressure in the energy transition. In combination with time-of- use tariffs and smart technologies, heat pumps can provide flexibility services. In a pilot program between German heat pump manufacturer Viessmann and the Equigy platform, Viessmann aggregates the flexibility potential of the participant and offers it to the TSO via the Equigy platform. (IEA, 2022)

**Access to information helps dispel misconceptions**. Heat pumps are not a new technology, but due to their high price, they are still a little-used technology, so there is little personal experience with their operation. In order to dispel misconceptions (e.g. that they can only be used in combination with underfloor heating), broad communication campaigns, residential energy consulting offices, and one-shop-stop services are needed. In many countries, there is a shortage of properly trained designers and contractors, which delays and increases the cost of investments.

**Community solutions can help where the number of individual homeowners is high**. Hungary and Romania have the highest share of private ownership in the real estate market. This makes joint decision-making very difficult in condominiums. Good communication, mailing lists, frequent residents' meetings, the use of moderators and appropriate management of authorisations support effective joint decision-making and problem-solving. In addition, targeted community-building activities (e.g. identifying key people in the community, organizing community events, exploring common issues, and community planning) can have an impact not only on

building modernizations, but also on several areas of condominium coexistence. (Szolidáris Gazdasági Központ, 2024)

**Finally, the most important is a high-level political commitment to decarbonize buildings.** It is essential to have well-communicated goals and policies to phase out fossil fuels, withdraw fossil subsidies, and fine-tune existing regulations that provide a good orientation for users and industry players alike. According to CAN Europe's analysis, the United Kingdom, the Netherlands and Germany are on the right track. (CAN Europe, 2023) However, in the case of the latter and France, it appears that the transition can cause serious political tension.

# SUMMARY

The aim of the research was to explore the potential of heat pumps—widely regarded as a key technology in the decarbonization of buildings—for use in existing apartment buildings, and to examine what technical, legal, administrative, etc., measures are necessary for this technology to become a viable alternative to gas heating even in densely populated urban areas.

It can be stated that the technical and technological possibilities are in place; heat pumps can be applied in virtually any building. However, depending on the characteristics of the building, there may be obstacles that are difficult or very costly to overcome. Pilot projects demonstrate that with proper planning and sizing, today's heat pumps can operate with meaningful SCOP (Seasonal Coefficient of Performance) values in apartment buildings with central or block heating systems, requiring only minimal modifications.

Of course, according to the "energy efficiency first" principle and the concept of deep renovation, comprehensive overhauls are the most desirable. However, in apartment buildings, such renovations can affect hundreds of people and are often very time- and cost-intensive. The situation is particularly challenging in buildings where each apartment has its own individual heating system, where the units are under separate ownership, where building regulations are strict, and where the electrical grids are overloaded.

It ultimately comes down to political commitment as to whether governments will assist homeowners in choosing decarbonized heating methods by gradually phasing out fossil-fuel heating systems, offering targeted support programs, setting up advisory offices, and running public awareness campaigns.

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