



HPT Annex 50

Heat Pumps in Multi-Family Buildings

Task: summary of Task 1

Country reports

Edited by  **EDF**

With the participation of:  **AIT** AUSTRIAN INSTITUTE
OF TECHNOLOGY  **TU** Graz
Graz University of Technology  **Fraunhofer**
ISE

 **POLITECNICO
DI TORINO**  **infinitus**
energy solutions group  **CSD INGENIEURS+**

May 2021

Heat Pumps in Multi-family Buildings in some European Countries: market, barriers and opportunities

Abstract

In Europe, the increasingly restricting environmental regulations combined with a growing general awareness of climate change stakes induce a progressive move towards renewables and/or efficient technologies, in all sectors. The building sector is particularly concerned as it plays a significant role for the energy consumption, and then greenhouse gases (GHG) emissions, in every country.

In this way, residential heat pumps (HPs) are a promising technology when attempting to reduce the impact of heating and cooling on the energy consumption in dwellings.

In Europe, the residential HPs market has been steadily increasing for several years in most countries. However, this global figure hides very different situations depending of the type of buildings. Whereas in new individual houses HPs become the most spread solution, their market in multi-family buildings (MFB) remains very low, in new buildings as well as in existing ones.

This study was realized in the framework of the Annex 50 of the IEA Heat Pumping Technologies Program, dedicated to Heat Pumps in MFB. It aims to gather and analyse data from the eight European participating countries (Austria, Denmark, France, Germany, Italy, Netherlands, Switzerland, United Kingdom); in order to identify particular and common characteristics of buildings, technical aspects and regulatory schemes which explain the situation of heat pumps in MFB, determine particular and common barriers to the development of HPs in MFB which are crucial to overcome.

This study shows that the most common heating energy in European MFB is gas. HPs can take benefit from a very favourable regulatory and incentive framework but face some important barriers in MFB. These barriers are technical or economical ones but also concern the lack of awareness and knowledge of these products for an application in MFB. A lot of actors are still convinced that heat pumps are only dedicated to individual houses.

Introduction

The building sector plays a significant role for the energy consumption in every country.

Besides the power generation and the transport sector, it is the most important sector with regard to the emission of greenhouse gases. Therefore, the massive reduction of CO₂ emissions from buildings and the long-term achievement of a climate-neutral building sector can be considered inseparable.

In Europe, heating and domestic hot water (DHW) production represent important parts of energy consumption in residential buildings; with respectively 60 to 70% and 10 to 17% of the total consumption. The figure 1 highlights these shares for Austria, Denmark, France, Germany, Italy, Netherlands, Switzerland and United Kingdom (EHPA 2019, Eurostat 2017).

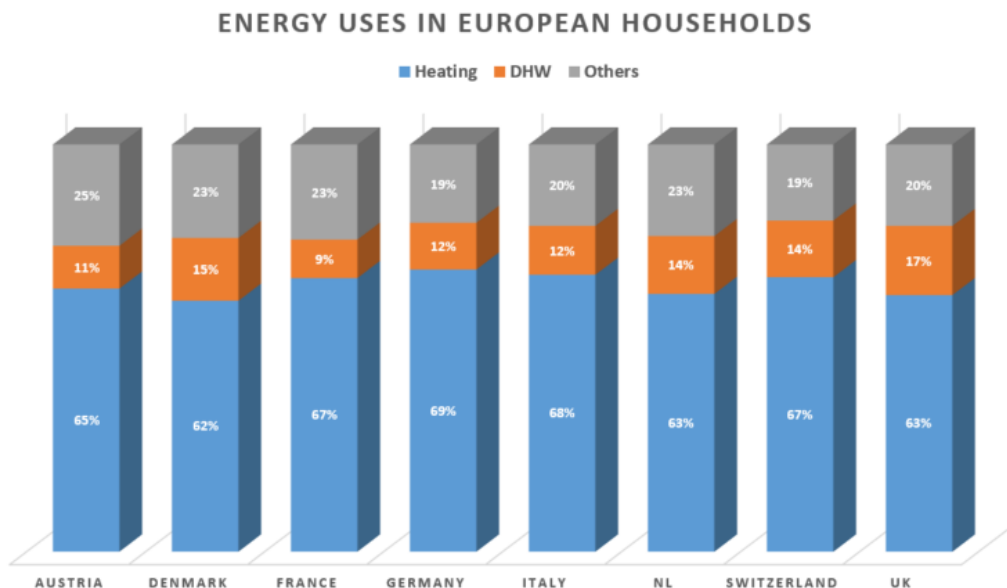


Figure 1: Energy uses in households for 8 European countries

The reduction of energy consumption, and consequently the CO₂ emissions, in buildings has then to be driven by actions on heat demand and production.

New domestic buildings are often built with an envelope and heating system aimed at a low energy usage and with a potential for application of renewable energy technologies, such as heat pumps. For multifamily buildings, the challenge to apply heat pumping technologies and renewable energy is more complex.

This study was realized in the framework of the Annex 50 of the International Energy Agency (IEA) Heat Pumping Technologies Program. The goal of this Annex 50 is to focus on solutions for multi-family houses with the attempt to identify barriers for heat pumps on these markets and how to overcome them.

In this objective, this study, part of the annex 50, consists in gathering information about multi-family buildings (MFB) and heat pumps in all participating countries (Austria, Denmark, France, Germany, Italy, Netherlands, Switzerland and United Kingdom). The collected data permits to:

- Identify particular and common characteristics of buildings, technical aspects and regulatory schemes which explain the situation of heat pumps in MFB,
- Determine particular and common barriers to the development of heat pumps in MFB which are crucial to overcome

1 – Heating and Domestic Hot Water production in Multi-Family Buildings

1.1 Energy for heating and DHW production in the building stock

In the building stock of most participating countries, the main heating energy is natural gas. This domination is particularly significant in some countries like UK, Italy and the Netherlands (see Figure 2, sources EHPA 2019 & Istat 2014). If fossil fuels are considered together, their share is very majority, except in Denmark where district heating (produced with renewables for 60%, gas 20%, waste 10% and coal 10%, Danish Energy Agency 2018) has a majority share.

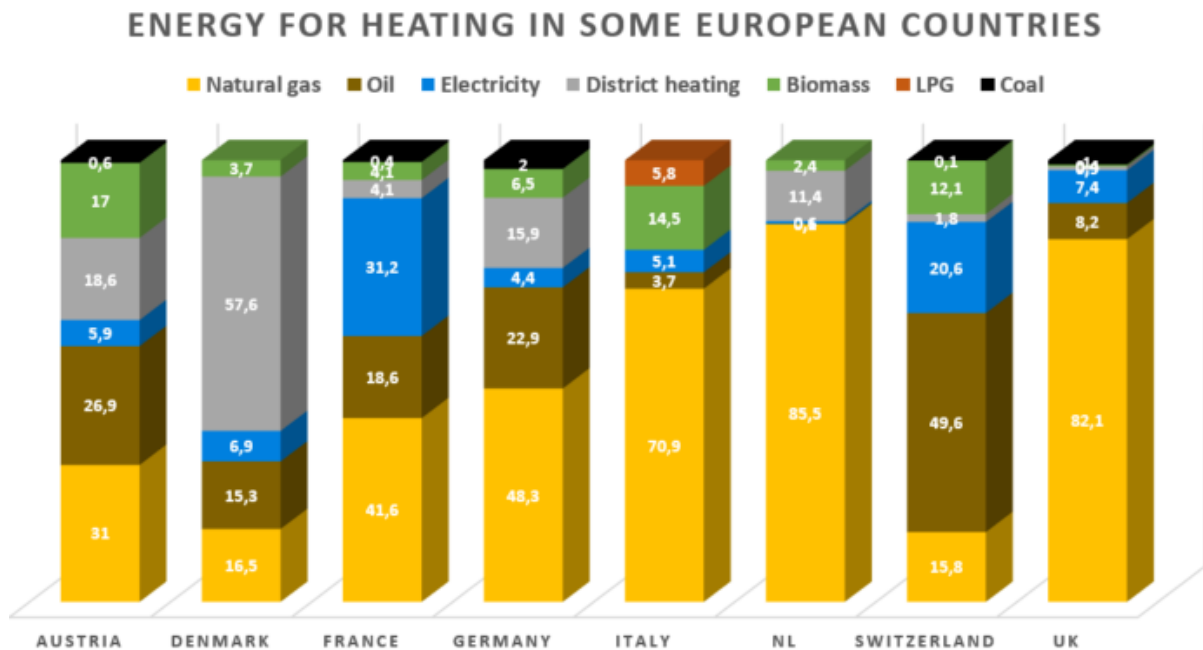


Figure 2: Heating energies for 8 European Countries

In MFB, the global share of fossil fuels is quite similar, but with more gas and less oil. The figure below shows the energies for heating in MFB for several countries where specific data are available (sources).

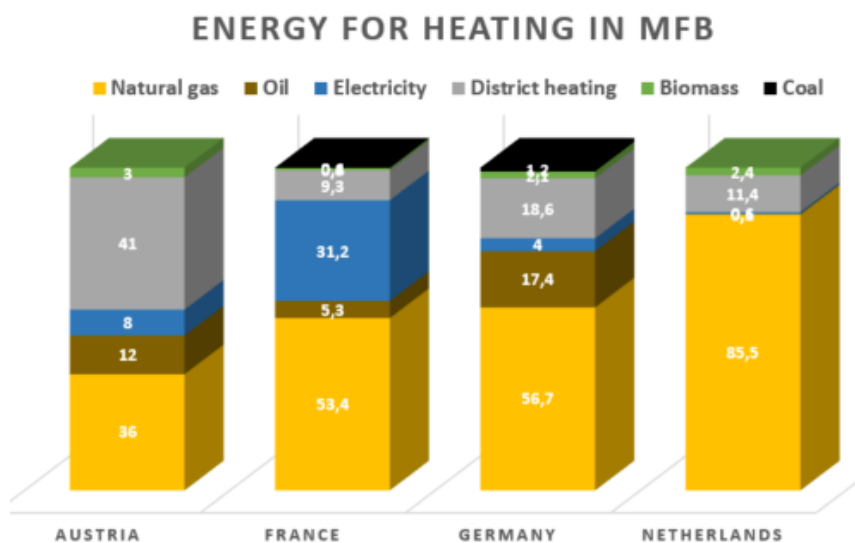


Figure 3: Heating energies in multi-family buildings for 4 countries

1. 2 Place of heat pumps

In all participating countries, residential heat pumps increase their annual sales over the last decade, in particular since 2014 (see figure 4, the growth rate of HP sales in the Netherlands is 5 in 2019 compared to 2009). This overall dynamic of increased sales can be viewed in terms of residential market penetration. Figure 5 thus represents the annual sales of heat pumps reduced to 1000 residential households, for each country. We can thus observe more or less pronounced dynamics, with sometimes still modest heat pump penetration rates despite booming sales, but a clear and increasingly rapid progression.

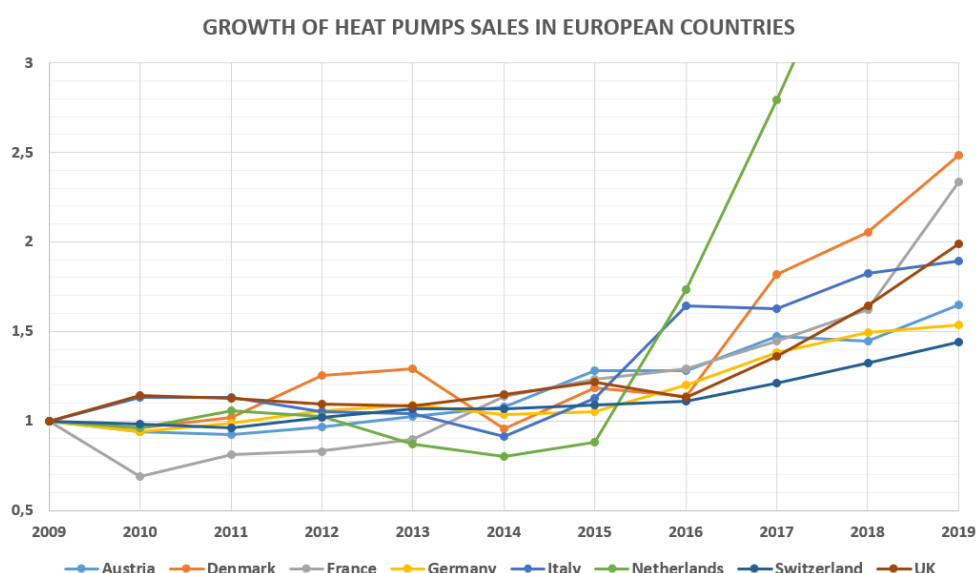


Figure 4: growth rate of HP sales in the 8 participating countries (source EHPA www.stats.ehpa.org)

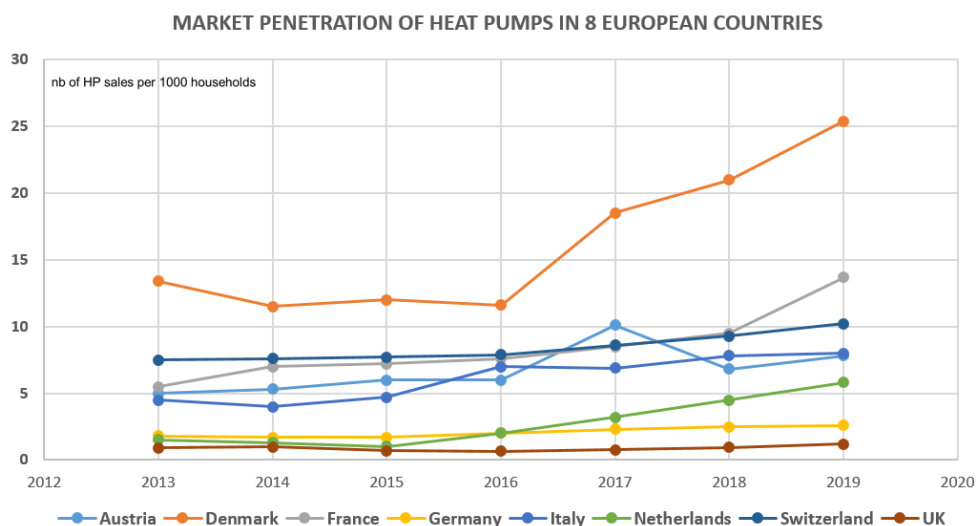


Figure 5: Residential market penetration in the 8 participating countries (sources EHPA www.stats.ehpa.org)

However, this global evolution hides very different situations depending on types of residential buildings.

Indeed, heat pumps still represent a small part of heating systems in the global buildings stock in all participating countries, from few percents to 10%. Except for some countries like Austria, Switzerland

or France where there are significant differences between HPs shares in MFB (1 to 7%) and individual houses (10-15%), differences in the spreading of HPs depending on the building types are not very significant when considering stocks.

However, differences in HPs market development between individual houses and MFB are more obvious in new built buildings. In some countries, like Austria, France and Germany, heat pumps become the first heating system in new built individual houses with a share around 50% or more. But their share increases more or less rapidly in new built MFB in all countries. It remains low in some countries like France (4-5%) and Italy whereas, in Germany and Austria, the share of heat pumps in new built MFB reaches more than 20%.

2 – The driver: policy framework

All participants represent European countries: Germany, Austria, Denmark, Italy, Netherlands, Switzerland, France. Except for Switzerland, the policy background is then common, and the main relevant Directives concern the energy performance of buildings, energy efficiency and performance requirements of energy related products. Moreover, these countries are concerned by 2020 and 2030 objectives in terms of CO2 emission reduction, energy efficiency and renewables use improvement. To address these objectives, each participating country has developed a specific regulatory scheme to encourage renewables and reduce energy consumption in buildings sector.

Among all the regulatory texts into force in each country, two types of rules are particularly important as drivers for heating systems market: buildings regulations for new built buildings and incentive programs for existing ones.

2. 1 Building regulations for new built

Most of countries have set up building regulations based on maximal consumption expressed in primary energy (except for Austria which main regulation is based on energy demand). Almost all these regulations concern only new buildings but some of them include major refurbishments in their scope.

The maximal consumption value and the uses included in the accounting vary from one country to another. Some regulations add a performance requirement on the building structure to minimize the energy needs. It is a stated way to share efforts between building structure and systems efficiency to reduce energy consumption. Other ones are so strict on the energy consumption requirement that it implies to make effort on both aspects even if no requirement on building structure efficiency is imposed. It should be noted that France is the only country where the requirements are different, and less severe, in collective housing than in individual houses. In this country, the upcoming revision of building regulation will include a carbon performance, based on life cycle analysis of the building over 50 years, including construction, operating and dismantling.

In addition, several countries have planned or already implemented a ban on fossil fuels, including natural gas, in newly constructed buildings (Denmark in 2013, Netherlands in 2018, France planned in 2021 for individual houses and later for MFB, and UK announced for 2025). Without being so radical in their stated desire to eliminate fossil fuels, the regulations of other countries are however sufficiently restrictive in terms of energy consumption for heating and domestic hot water uses to promote the development of efficient systems such as heat pumps.

In all countries, these regulations, which last versions entered into force from 2013 to 2016, have a visible impact on HP market, as shown on figure 4. The effect is particularly sensitive for countries with

the heat pump market was hitherto relatively small, such as the Netherlands, Denmark and the United Kingdom.

2.2 Incentive Programs

Incentives schemes can have various logics depending on the countries : promotion of efficient technologies for all markets, contribution of big energy consumers to energy efficiency actions (energy savings or energy efficiency certificates), incentive to existing building and equipments renovation with a wide scope of supported technologies, specific programs to replace fossil fuel boilers in existing buildings, etc. Whatever the incentive logic is, heat pump installation is included in the scheme and even becomes the central part of it. In all countries, heat pumps are supported by grants, tax credit or reduction.

As with building regulations, the effect of some specific subsidy programs is visible on the heat pump market of the corresponding country. In France, the stated objective of replacing the entire residential oil boilers stock by 2028 has resulted in the establishment of significant subsidies in 2019 and a strong development of heat pumps in the individual renovation sector (see figure 4). During summer 2020, the “*Decreto Rilancio*” has been approved in Italy. It includes the “*Ecobonus 110%*” (EB110) aiming to push renovation of existing building stocks. For some specific interventions including HP installation, its principle is to offer a subsidy of 110% of the total spending in the form of a tax credit, spread over 5 years. The EB110 is valid for private single house, multifamily building, and condominium. It is too early to see the effect on the HP market, but it will certainly be important.

2.3 Summary

As a conclusion, the policy framework, increasingly constraining, is more and more favorable to the development of heat pumps in buildings and its influence is notable on the yearly sales for few years. Few differences in regulations can be noted between countries regarding MFB case and can explain slight differences of market development for HPs in these countries. However, these differences noted in the regulations are not enough to explain the far lower development of heat pumps in collective housing compared to single-family homes. Thus, over barriers than regulatory ones have to be overcome to obtain a sustainable development of heat pumps in MFB.

3 – The barriers to overcome

The analysis of MFB stock in participating countries reveals some interesting common features.

The shares of individual and collective housings are quite similar from one country and another: from 45 to 50% of dwellings are located in multi-family buildings. In almost all countries, most of multi-family buildings are composed with less than 10 flats, 6 to 8 in average.

In all countries except Denmark, the multi-family buildings stock is almost equally distributed between owners and tenants, with a slight majority of owners. However, in new built MFB, the share of owner-occupiers is more important.

In all participating countries, the residential building stock is quite old, with an average share of 52-60% of buildings built before 1970, even 80% for Denmark. Then, the majority of MFB stock has been built before the first building regulations. For these multi-family buildings (<1970), the heating demand represent 120-150 kWh/m².an.

All these characteristics of MFB have consequences for the installation of heat pumps.

3.1 Technical Barriers

Heating capacity and supplied temperature

The multi-family buildings stock is quite old in all participating countries. Without any refurbishment, these MFB need high heating temperatures ($> 60^{\circ}\text{C}$), not easily suitable for heat pump application.

Moreover, in most countries, state-of-the-art heat pumps provide heating capacities below 50 kW. It can be seen on the figure below representing the capacity of heat pumps sold in participating countries.

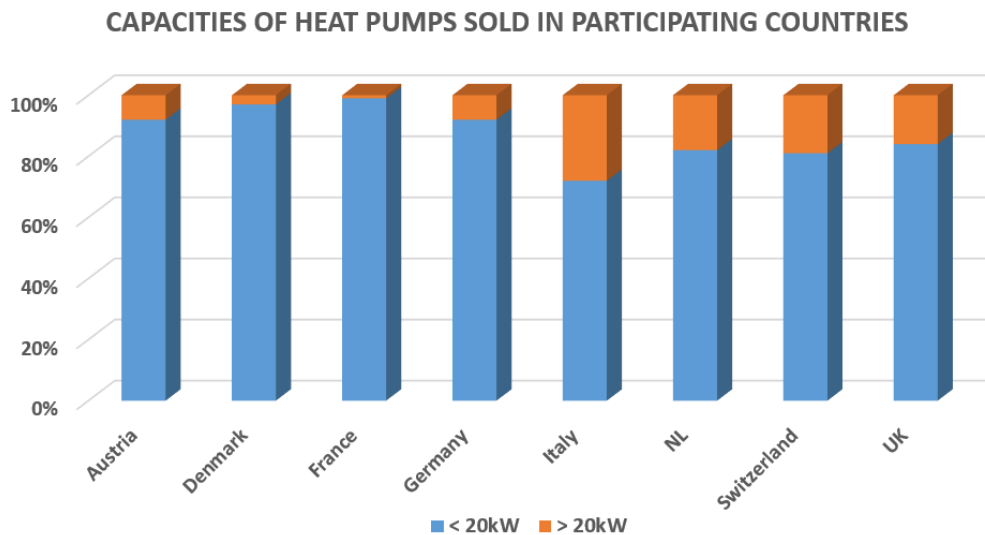


Figure 5: Capacities of heat pumps in participating countries (source Ragwitz 2016)

These type of products are only adapted for efficient buildings, not for collective heating production in old ones.

Access to the heat sources

Most of multi-family buildings are located in cities, with more or less high building density. Therefore, the access to the heat source, in particular geothermal one, is complicated.

For air-source heat pump, the collective heat source is often the only solution to avoid multiple and visible outdoor units, that can be difficult to integrate, even forbidden, in architectural terms.

In the collective case, the unique outdoor unit has to be installed on the roof, which supposes a terrace roof, or in a outside car park or garden near the technical room.



Figure 6: Examples of installed outdoor units or heat sources or HPs (source Suisse Energie and Giordano Industries)

3.2 Economical barriers

Capital costs

In this type of buildings, high capital costs affect the competitive position of heat pumps compared to fossile boilers or direct electric heating.

This criteria is particularly significant in new built operations, often (75% of total cases) managed by private promoters. The main concern of this key type of market players is the cost price of flats, and consequently their selling price.

Indeed, for each new built operation, the promoter estimates a maximum selling price, corresponding to the type of flat, the location of the operation and so on. Among these criteria, a renewable heating system doesn't appear yet.

As promoters are rarely able to value heating by heat pumps in their buildings, this quite expensive heating system directly affects the cost price without any effect on the selling price. For the moment, clients and promoters are not convinced.

Energy prices

The actual prices for oil and natural gas as well biomass have a high influence on the heat pump market.

As the prices for crude oil and other fossil energy sources have been falling during the last years and kept stable at low levels, there is a significant barrier for the investment in new heating technologies, using electricity; which price varies a lot from one participating country to another but is always high compared to gas price.

If an average seasonal performance factor¹ (SPF) around 3 is considered, the figure below shows that in few countries, this SPF doesn't compensate the energy prices ratio. That means that even operating costs can be higher for an heat pump installation than for a gas boiler one.

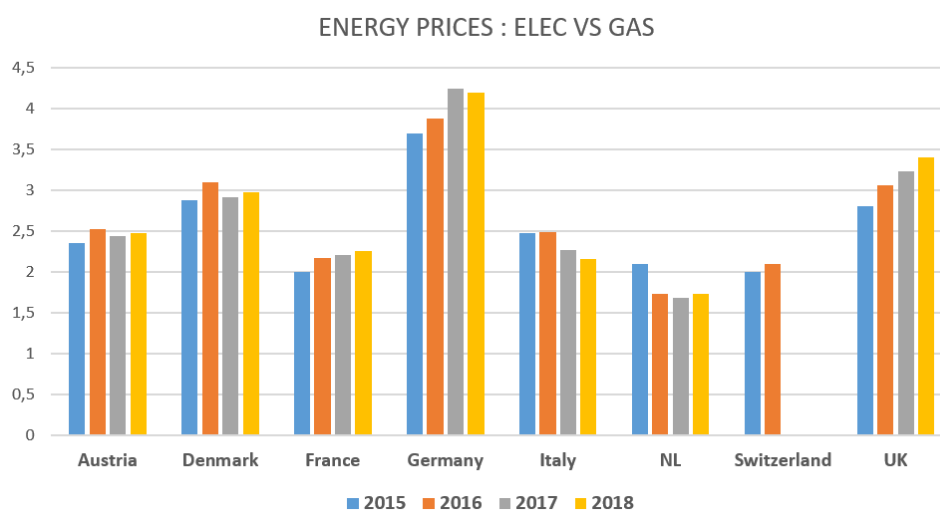


Figure 7: Energy prices ratio for electricity vs gaz (source EHPA www.stats.ehpa.org)

¹ SPF is the seasonal ratio between the thermal energy supplied and the final energy consumed. The SPF can be considered with different boundaries in the installation (Source SEPAMO 2012). A value of 3 for a SPF considering all the consumptions is a common value.

Conclusion

In the 8 European countries participating in Annex 50 of IEA Heat Pumping Technologies Program, the heat pump is expanding rapidly in single-family homes but is still struggling to take its place in collective housing, despite a regulatory context increasingly favorable to their installation in all countries. Common barriers have been identified. They can be technical (access to the cold source, capacity of available products) or economic (investment cost, energy prices).

An essential point, common to all countries, should be added: the lack of knowledge of the sector and of customers. The heat pump is still too often considered as a product only dedicated to the individual house. Significant demonstration work is needed to highlight the possibilities offered by the heat pump in collective housing.

References

EHPA 2019, "European Heat Pump Market and Statistics. Report 2019", November 2019

Eurostat 2017, https://ec.europa.eu/info/departments/eurostat-european-statistics_fr

Istat 2014, Paola Ungaro, L'indagine Istat sui consumi energetici delle famiglie: principali risultati, Rome, 15th December 2014, <http://www.istat.it/it/files/2014/12/Ungaro.pdf>, accessed on March 30, 2018.

DEA 2018, "Energy Statistics 2018", February 2020

Ragwitz 2016, Mapping and analyses of the current and future (2020 - 2030) heating/cooling fuel deployment (fossil/ renewable) – Work package 2: Assessment of the technologies for the year 2012 (Final report March 2016). European Commission (ed.). Brussels.