HPT Annex 50

Heat Pumps in Multi-Family Buildings

Task 1: Market Overview

Country Report

ITALY

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Key Facts in Italy

Heat pump benefits

	2015	Potential*
Sales	121k	765k
Stock	1.4m	9m
Renewable energy produced	10.6 TWh	70.1 TWh
CO2 emissions saved	2.7 Mt	17.9 Mt
Final energy saved	13.6 TWh	89.7 TWh
Full time jobs provided	6 942 Jobs	45 883 Jobs

Key facts

Capital	Rome	
GDP per capita	26 400 €	
		rank

Housing

Dwelling stock by category		
Total	31 208 161	% of tot:
One	6 126 043	19.6%
Two	5 313 036	17%
Multi	19 699 199	63.1%
Non residential	69 883	0.22%
Average energy consumption per m²	124 kWh/m²	
Space heating	74.4 kWh/m²	60%
Water heating	11 kWh/m²	8.9%
Other	38.6 kWh/m²	31.2%
Growth of new building permits	-11.8%	

Renewable energy

Share of renewable energy of total consumption	17.1%	
EU 2020 target for the share of renewable energy	17%	
National emission factor of electricity	402 g/kWh	

Energy consumption

Dwellings by energy source used for space heating		
Gas	13 202 560	39.8%
Oil	7 921 540	23.9%
Biomass	3 368 000	10.1%
District heating	6 560 060	19.8%
Electricity	1 616 640	4.9%
Coal	538 880	1.6%
Energy prices		
Electricity	0.24 €/kWh	
Gas	0.1 €/kWh	
Heating oil	0.18 €/kWh	
District heating	0.09 €/kWh	
Pellets	0.08 €/kWh	

Figure 1 - Italy: Key statistics. (Source: EHPA 2016).

1. Energy Demand in Italy

This brief introduction aims at presenting the energy framework in which heat pumps are operating in Italy, to highlight the main features of the contexts that may enhance or limit their development.

1.1 Global figures

1.1.1 Total Primary Energy Supply (TPES) by source

The energy consumption in Italy is massively relying on fossil fuels, with a total primary energy consumption of around 140-150 Mtoe in last years. The following plot highlights the historical trend, which has seen a gradual shift of the oil consumption towards natural gas, although oil is still sharing with natural gas the first place when considering energy consumption by type. Last years have seen an increase of the renewable share, especially when considering biofuels and waste. However, it has to be noted that their lower efficiency compared to other renewables suggests that a fairer comparison should be performed on useful energy. Nevertheless, primary energy consumption remains a significant indicator when considering the energy framework of a country.

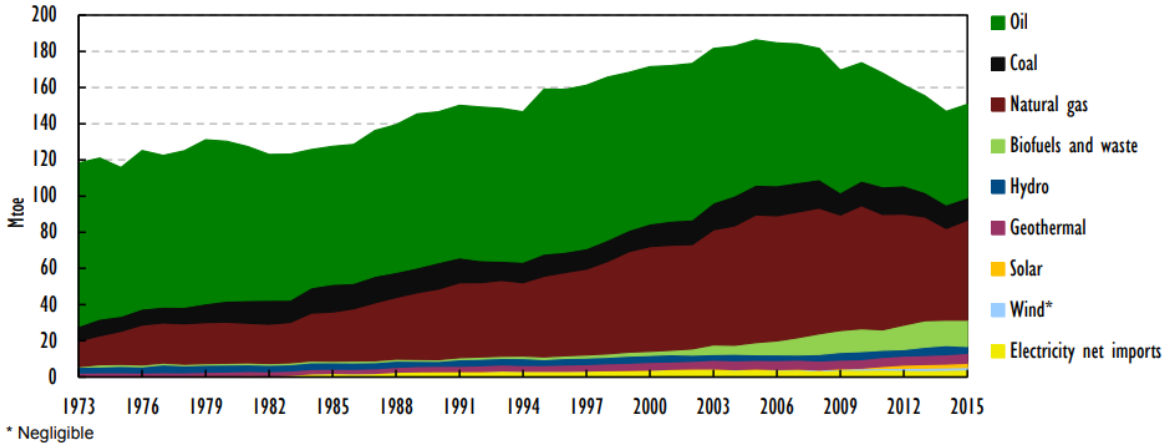
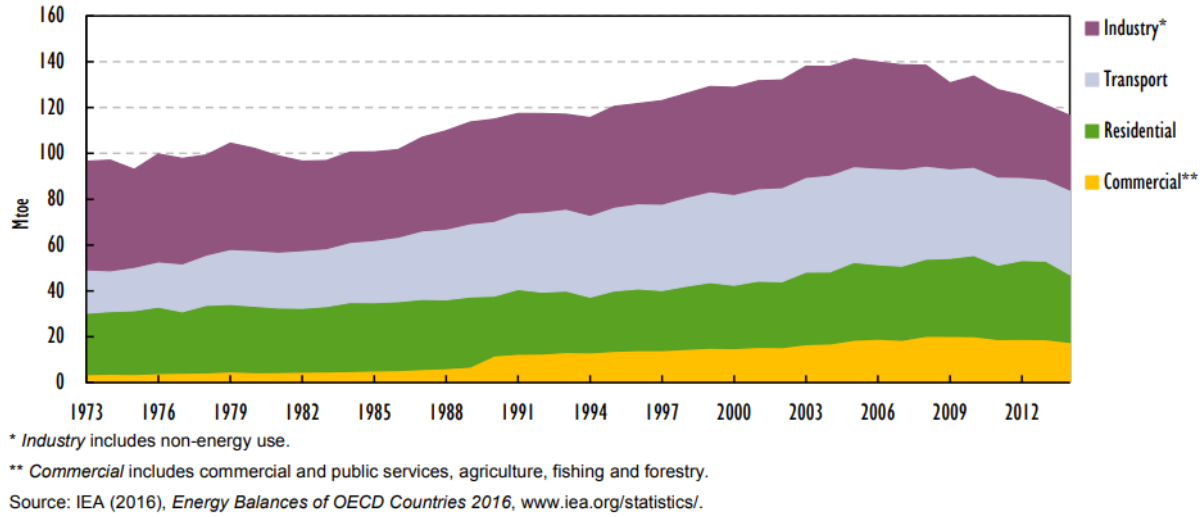


Figure 2 - Total Primary Energy Supply by source.

1.1.1 Total Final Consumption by sector

The total final consumption in Italy is a little less than 120 Mtoe, as reported in the following plot.



* *Industry* includes non-energy use.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

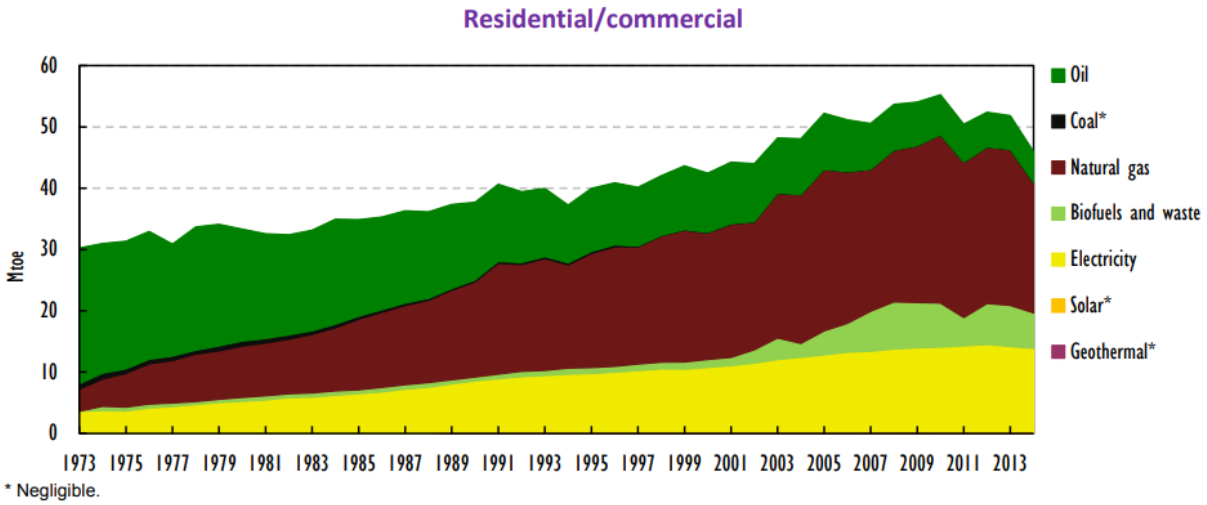
Source: IEA (2016), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 3 - Total Final Energy Consumption by sector

The classical three main sectors (Industry, Transport and Buildings) account roughly for one third each, with a significant decrease of industry consumption in last years, after the economical crisis. On the other hand, the transport has significantly increased since the 70's, both in absolute value and in share. Considering the buildings sector, commercial buildings increased their share starting in the early 90's, but residential buildings currently remain the major consumer.

1.1.2 Total Final Consumption - Buildings sector

The last forty years have seen a shift also in the final energy consumption of buildings. The total Italian energy consumption for buildings is currently around 45 Mtoe, after an historical peak in 2010 of 55 Mtoe. The gradual trend of increasing energy consumption seems to have changed in last years, with a slight decrease since 2010, while the electricity consumption remains stable. Also, in this sector a massive shift from oil to natural gas can be noticed, especially before 1990. After 2000 the use of biomass for heating becomes noticeable, while solar and geothermal remains negligible.



* Negligible.

Source: IEA (2016), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 4 - Building sector. Total Final Energy Consumption.

1.2 Heat Generation by source

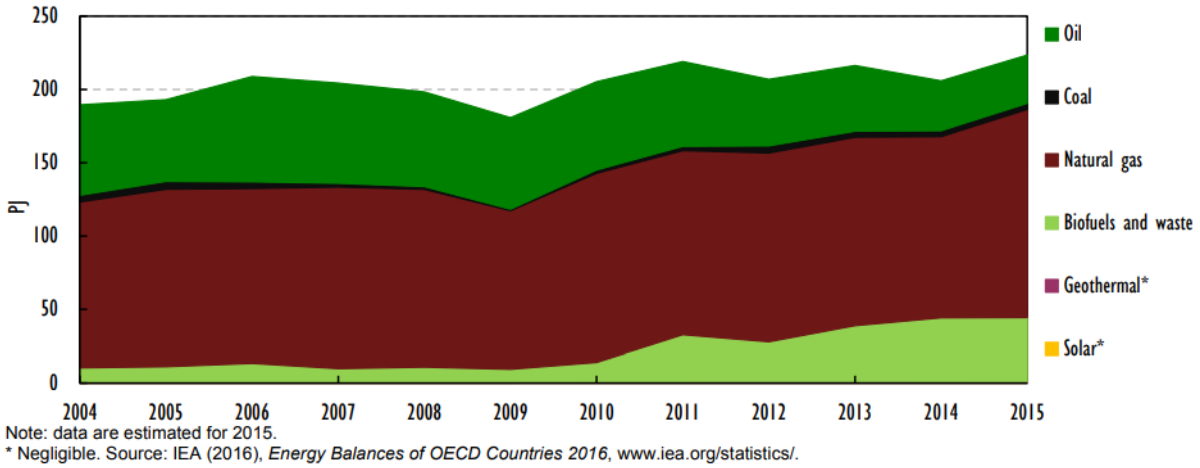


Figure 5 - Heat Generation by soruce.

1.3 Electricity Generation by source

The Italian Power Grid has seen a significant increase of energy production from Renewable Energy Sources in last years, partly due to the incentive schemes that have been defined in the framework of the EU goals by 2020. The electricity sector has been the most significant for RES production. In 2016 the share of electricity production from RES reached 38.2% on the total net production of the country (with 43.8 TWh produced by hydro, 21.8 TWh by solar PV, 18.0 TWh by biomass, 17.5 TWh by wind and 5.9 TWh by geothermal). The numbers for 2017 show a slight decrease, with a total share of 36.8% due to a 14% decrease of hydroelectric production for weather conditions, that has partially been compensated by a 14% increase of solar generation.

The following chart shows the CO_2 specific emissions of the electricity generation in Italy (source: ISPRA, 2017). A generalized decreasing trend can be noticed, related to both an increasing penetration of RES, and to a higher efficiency of the thermoelectric plants, both for refurbishment of exiting units and to the increase of high-efficiency fuels share (i.e. natural gas).

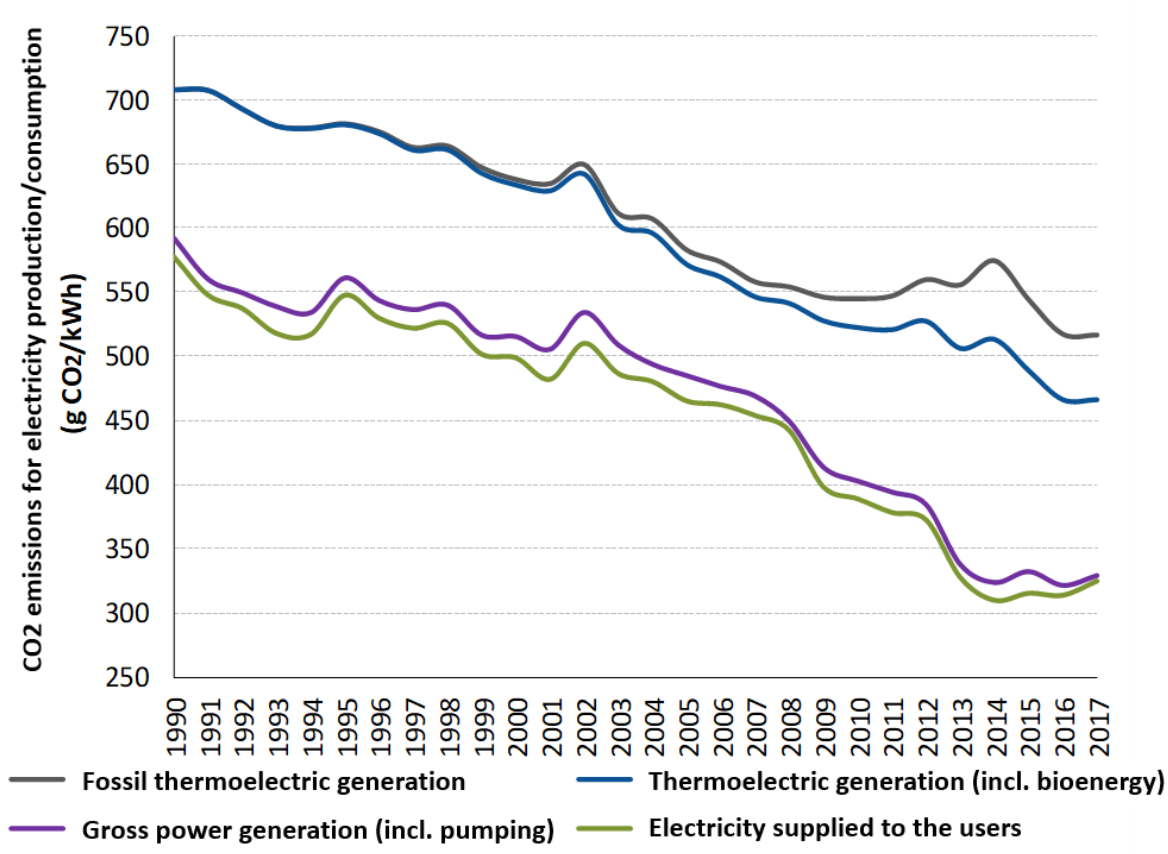


Figure 6 - CO2 specific emission per kWh

2. Policy framework

2.1. Buildings Regulations and Energy efficiency

The Decree-Law D.Lgs.28/2011 introduced significant minimum share of energy demand for new buildings or "relevantly refurbished" to be met by renewable energy sources. The Heat pumps are considered a renewable source and this decree has *de facto* moved the heat pumps from being the second choice in heating generation after condensation boiler to be the first option.

2.2. Incentive Schemes for Heat pumps

The installation of heat pumps for heating in the residential sector are in line with the Italian energy strategy ("SEN Strategia Energetica Nazionale"). They are supported with different incentive schemes, with the aim of reducing the gap in initial investment with respect to traditional heating systems, which are currently less expensive.

Tax deductions

The Italian regulations in last years used tax deductions to support several energy efficiency measures in the residential sector. Considering heat pump, the tax deduction of 65% of the investment has been extended to 2018. The measure applies to all high efficiency heat pumps that are installed in substitution of an existing heating system, up to 35 kW of total heat output.

Factory made hybrid systems, based on the coupling between a heat pump and a natural gas condensing boiler, are included in the deductions. However, only hybrid systems already factory-assembled are accepted, i.e. an on-site combination of a heat pump and a natural gas boiler is not acceptable by this measure.

This measure has supported in 2016 the installation of around 17,500 heat pumps, for an investment of 98 M€ (source: ENEA).

Incentive "Conto Termico"

This incentive scheme, was started in 2016 and supported by GSE (Gestore Servizi Energetici), a company owned by Ministry of Finance, to pursue and achieve environmental sustainability in Italy. The main target of the scheme is the support of energy efficiency and thermal renewable energies in buildings, by providing an annual economic refund to users in the first 2 or 5 years (depending on the design power) of operation of the system. This scheme is financed by a specific cost in the energy bills of the final users, and it has an annual limit of 700 M€ for private citizens and 200 M€ for Public Authorities. Both these limits are currently far from being reached, as in 2017 the "Conto Termico" provided 74 M€ to private citizens and 15 M€ to PA.

The "Conto Termico", as of March 1st, 2018 has supported almost 3,000 heat pumps for space heating in private buildings and 1,000 heat-pump boilers for the generation of domestic hot water. The number of installations for Public Authorities is currently very limited.

Energy Efficiency Certificates

Energy Efficiency Certificates (in Italian "Certificati Bianchi", or "Titoli di Efficienza Energetica") are an incentive for the support of energy efficiency measures in different contexts. This measure has been recently updated, and the current Regulation started on March 4th, 2017. This measure is currently supporting interventions that allow saving more than 5 toe of primary energy consumption per year.

Each Energy Efficiency Certificate allows the user to demonstrate the saving of 1 toe of primary energy, as companies are required to demonstrate a specific amount of primary energy saving each year. These Certificates are then exchanged in a dedicated market. The price of Energy Efficiency Certificates, which has remained between 50 €/toe and 100 €/toe from 2006 to 2015, reached an annual average value in 2017 of 267 €/toe. This increase has been caused by some modifications of the Regulation in last years. The total volume of Primary Energy Savings exchanged in the market reached 6.22 Mtoe in 2017.

Energy Efficiency Certificates support the installation of heat pumps both in the Industry sector and in the Buildings sector (both residential and services). A limit of this measure, in addition to the minimum energy savings of 5 toe per year, lies in the fact that a short-list of entitled users can request it, namely: Energy Service Companies, Energy Managers and Companies that have an Energy System Management compliant with ISO 50001.

There is currently limited statistic on the actual emission of EEC related to heat pumps installations in Italy.

Ecobonus 110%

During summer 2020 the Italian government has approved the "*Decreto Rilancio"* which contain a series of new incentive schemes, laws, and regulations for different economic sectors such as

mobility and building one. Among all the different proposition, one is aiming to push renovation of existing building stocks: the "*Ecobonus 110%"* (EB110). The EB110 states that, for some specific intervention (recapped in the following table), it is possible to receive the 110% of the total expenditures in tax discount within 5 years. The EB110 is valid for private single house, multifamily building, and condominium.

Table 1 - Specific Intervention for which the 110% bonus can be implemented.

INCENTIVIZED INTERVENTION	***REQUIREMENTS***		***BUDGET LIMIT [€/APARTMENT]***	
THERMAL INSULATION OF THE BUILDING	For at least 25% of the external surface	It is needed to improve the energy class by factor 2	Single unit	€ 50,000.00
			2-8 unit	€ 40,000.00
			more than 8 unit	€ 30,000.00
RENOVATION/SUBSTITUTION OF THE THERMAL/AIR CONDITIONING SYSTEM		It is needed to improve the energy class by factor 2	Single unit	€ 30,000.00
			2-8 unit	€ 20,000.00
			more than 8 unit	€ 15,000.00
ANTI-SEISMIC IMPROVEMENT	Live in an high risk area			€ 96,000.00

The tax credit can be directly claimed from the client or can be assigned to a third entity such as banks or the contracting company itself. Moreover, if one of the main interventions is done it is possible to include in the 110% credit also other "secondary" intervention (for example, derived from other incentives scheme) such as photovoltaic installation with/without electrical storages, windows substitution and electrical vehicles charging point.

The EB110 strongly incentivize the use of Heat Pumps system both in stand-alone configuration and with a hybrid solution (HP + fossil peak boiler). Moreover, the possibility to include the installation of storages and photovoltaic system increase the advantage for the client and stimulate the industry to produce "factory-made" systems. Moreover, it is important to emphasize that this bonus is in addition to and does not replace the previous incentives schemes such as "*Conto Termico"* or the energy efficiency certificates. Details about the EB110 are available on the website of the Ministry of Economic Development.

2.3. Electricity tariffs

A significant barrier that limited the development of heat pumps in Italy had been the structure of electricity tariffs for residential users. Historically, the electricity bills show prices increasing with annual consumption, i.e. the users that had high electricity consumption had also high specific costs. While this measure supported the energy efficiency in residential buildings, the use of heat pumps for space heating was strongly discouraged. For this reason, a specific electricity tariff has been introduced from 2014 for the users relying on heat pumps as unique heating system.

This aspect is part of a larger electricity tariffs reform, which will lead by 2019 to a change of all residential users. This change will include a shift towards a unified specific cost of electricity, an increase of fixed costs, more available options for maximum power, and specific supports for families with low income.

The reform of electricity tariffs is expected to trigger the diffusion of heat pumps, by lowering one of the strongest barriers for their diffusion, the operational cost for the final users. Yet, other aspects remain critical, as it will be described in the following.

3. Building stock Characteristics

A precise estimation of the Italian building stock is currently difficult, due to the different sources that provide slightly different numbers. In particular, considering 2011 as reference year (the last revision of the 10-year census survey in Italy by ISTAT), the results of the survey provide 31.21 million residential homes. However, the public cadastre registered 34.06 million homes (based on the relevant categories for the buildings), and the homes served by electricity supply contracts are 29.86 million (source: http://www.cresme.it/it/articoli/15/ma-quante-sono-le-abitazioni-in-italia.aspx).

Therefore, the data provided in the following paragraphs could show some differences with data provided by different sources. In particular, the data provided by the ISTAT Census Survey of 2011 are not the most updated, but their detail is usually higher than more recent data sources.

3.1. Italian Building Stock

The most recent data on the residential building stock comes from ISTAT National Census of 2011. The total number of residential buildings in Italy reaches 12.2 million, with 31 million of dwellings. More than 60% of the building stock has more than 45 years, and 25% of these buildings show energy consumptions higher than 160 kWh/m².

Non-residential buildings represent a wide number of types and no single statistical reference is available. Some information is presented in the STREPIN document (Energy Refurbishment Strategy for the Italian Building Stock). The main types are the following:

- Schools: around 51,000 buildings, with 73.2 million m^2 of surface and a volume of 256.4 m^3.

- Offices: around 65,000 buildings, with a surface of 56.7 million m^2 and a volume of almost 200 million m^3.
- Commercial: around 165 million m^2 of surface, of which 99 million m^2 of shops in 876,300 companies, 44 million m^2 of restaurants and bars in 261,600 companies and 22 million m^2 of supermarkets in 20,100 companies.
- Hotels: around 25,800 buildings, with a surface of 46.8 million m^2 and a volume of more than 140 million m^3.
- Banks: around 33,727 locations, mostly limited to first floor of buildings, with an estimated volume of 11.5 million m^3.

3.2 Energy Consumption in Italian Buildings

Residential buildings in Italy consumed around 25.6 Mtoe in 2014, with a significant decrease with respect to previous years. The distribution of energy sources is shown in the following figure.

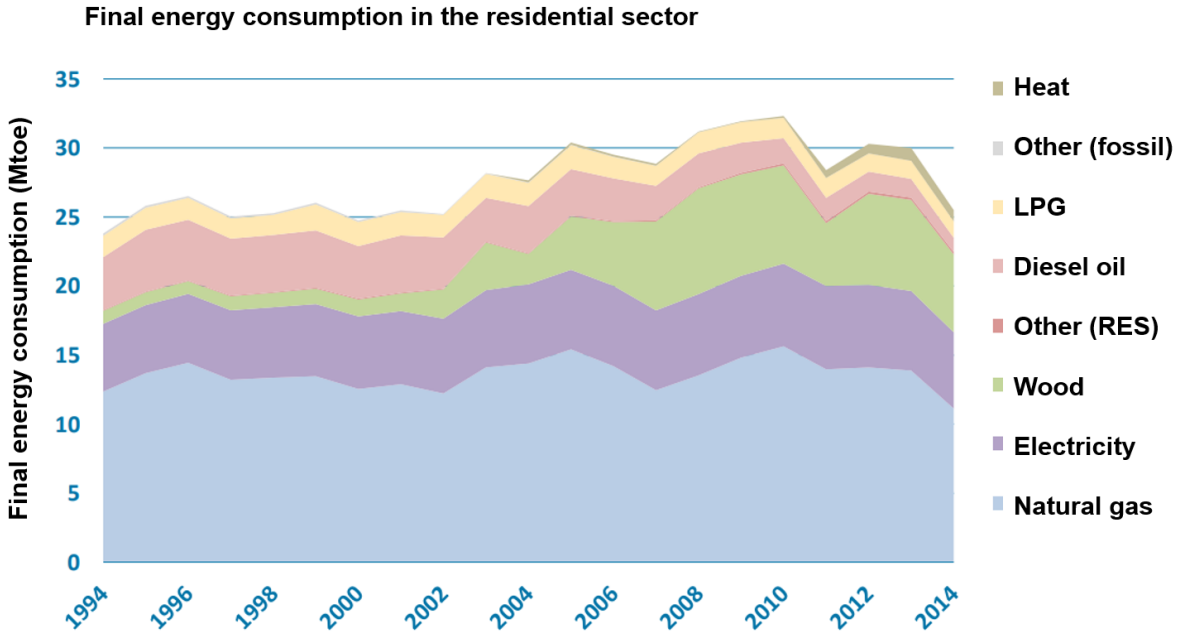


Figure 7 - Final energy consumption in italy, residential sector (2015, Source ENEA).

Non-residential buildings showed an annual consumption in 2014 of 19.2 Mtoe, being natural gas and electricity the most significant energy sources (roughly 50% each).

Consumption indicators for heat and electricity have been calculated by ENEA and are provided in the STREPIN document (Energy Refurbishment Strategy for the Italian Building Stock). The following table reports the average values calculated on the building surface and harmonized considering climate zone, building type and building use.

Table 2 - Average building energy consumption in Italy (2015, source ENEA - STREPIN)

BUILDING USE	ELECTRICITY CONSUMPTION	HEAT CONSUMPTION
	kWh/m²year	*kWh/m²year*
RESIDENTIAL (SINGLE FAMILY)	38	142
RESIDENTIAL (MULTI-FAMILY)	35	125
SCHOOL	20	130
OFFICE	95	170
HOTELS	110	150

3.2.1 Heating and cooling

The vast majority of Italian houses are equipped with a space heating system (98%) or a domestic hot water heating system (99.3%). However, southern regions show a share of houses not equipped with space heating (Sicily 12%, Calabria and Sardinia 5%) due to specific climate. Space cooling is significantly less adopted in residential buildings, as it can be seen in the following plot, showing an average National value of 3 families each 10 equipped with a space cooling system, with significant variations across regions.

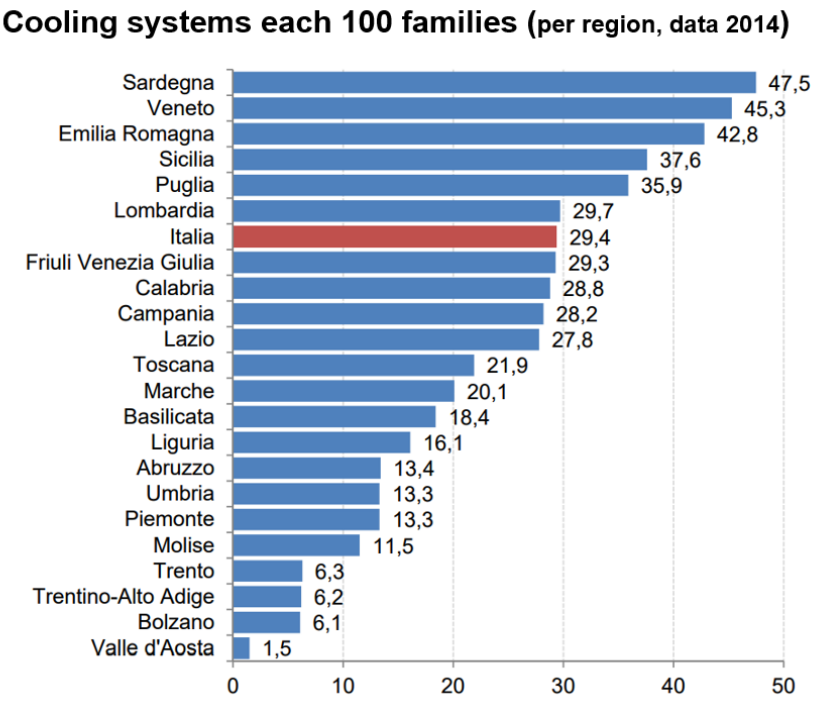


Figure 8 - Cooling system installation each 100 families (source: ISTAT 2014)

The majority of families use an autonomous system both for space heating (66% at National level) and for domestic hot water generation (74%). There are however several differences from North to South: centralized systems have a higher distribution in Northern regions, while remaining a smaller share.

Considering heat sources, natural gas shows the highest share, over 70%, while the remaining part is split amongst Biomass, LPG, Electricity and Gasoline. District Heating is not considered in these results, but its share is around 4% at National level.

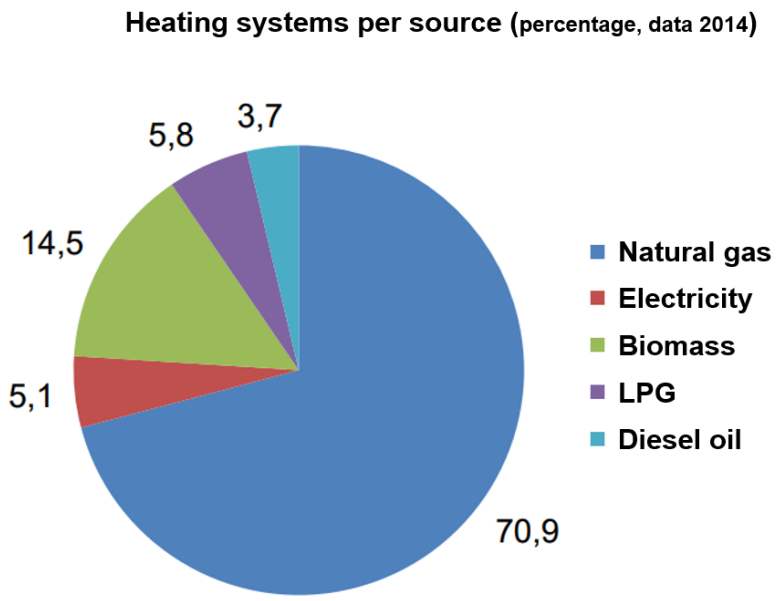


Figure 9 - Heating system per source (source: ISTAT 2014)

3.2.2. Domestic Hot Water

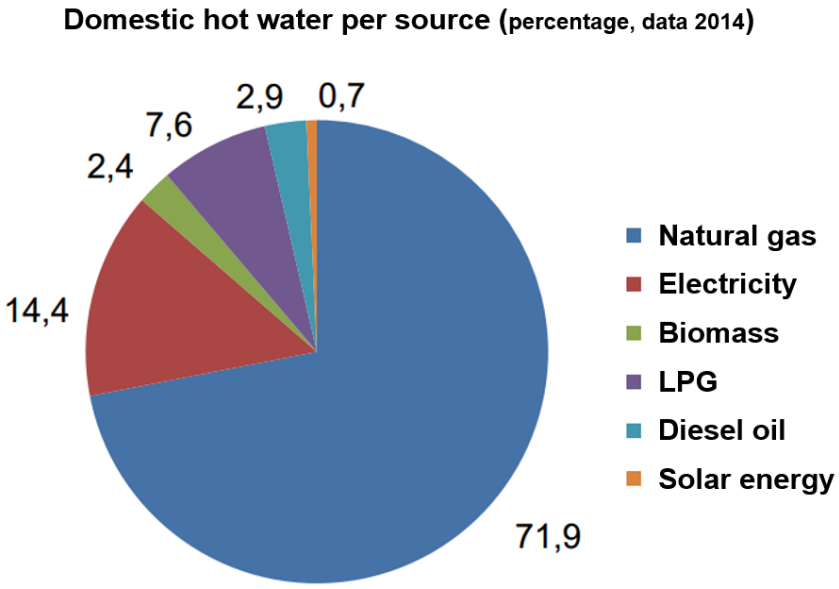


Figure 10 - Domestic hot water per source (source: ISTAT 2014)

4 Market of Heating Systems in Multi-Family Buildings

Some data are available from a web platform developed by GSE that includes the system installed by using the "Conto Termico" incentives (Link). This list may not be complete as it is continuously under development. As of January 31st, 2021, the number of total incentivized project is 35538 with a total number of installed heat pump equal to 58378. The total electrical installed power is 96 MW with a

thermal output of 594 MW (average installed power 2.7 kW, average output thermal power 16.7 kW). The weighted COP is 6.1, while the simple average is 4.2, suggesting that larger unit may have generally a slightly higher COP. Considering the COP distribution, the 70% of the heat pumps in the database have a nominal COP in the range 3.75 to 4.50. However, the actual COP may differ, based on the operation temperatures and the outdoor temperature, as well as the part load operation of the units. Back in March 2018 the number of heat pumps installed and incentivized was 1850, with 26.6 MW of input power and 139.6 MW of output power. Thus, an important increasing trend is highlighted as the number of incentivized projects have been increased by almost 20 times. Moreover, also the average COP slightly increase (+27% for the weighted value).

Another source for market info is Assoclima, the association of the main companies producing and selling climatization system in Italy. Assoclima observation bulletins include records from the following companies:

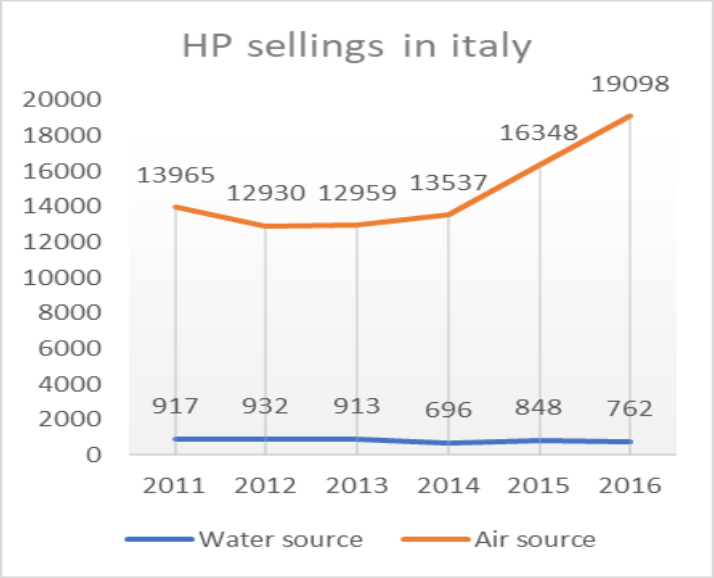
- Ariston Thermo
- ACM Kaelte Klima
- Aermec
- Baltur
- Baxi
- Blue Box Group
- Carrier
- Clivet
- Climaveneta
- Daikin
- Emmeti
- Eurofred Italy
- Ferroli
- Galletti
- G.I. Holding
- Hidros
- Hitachi Europe
- Immergas
- Lamborghini Calor
- Mitsubishi Electric
- Olimpia Splendid
- Panasonic Italia
- Paradigma Italia
- R.C. Group
- Rhoss
- Riello
- Robert Bosch Italia
- Sabiana
- Systemair
- Tecnoclima
- Termal
- Toshiba Italia Multiclima

The list does not cover all of the producers and sellers active in Italy, but it includes the most important players.

In the following table and diagram are reported data of heat-pump units sold, considering the heating/cooling and heating-only (very few) system. The figures refer to air-to-water of water-to-water systems and do not consider neither split systems neither portable units.

Heat pump units sold in Italy by associated to Assoclima (source Assoclima)

	2016		2015		2014		2013		2012		2011	
	Water	Air	Water	Air	Water	Air	Water	Air	Water	Air	Water	Air
<18kW	285	12617	282	10332	251	7197	423	9323	347	8157	420	9186
18-50kW	219	3702	294	3386	183	2685	227	1954	306	2684	312	2780
>50kW	258	2779	272	2630	262	3655	263	1682	279	2089	185	1999
TOT	**762**	**19098**	**848**	**16348**	**696**	**13537**	**913**	**12959**	**932**	**12930**	**917**	**13965**



Heat pump units sold in Italy by associated to Assoclima (source Assoclima)

Italian market is mainly air-source centered. The years from 2014 to 2016 show a strong increasing trend for air-source units, especially in the lower power range <18kW.

If we consider the overall market (including split and portable units) the annual market sales reached 1.4million unit in 2018 (was around 1million in 2011). (source: Assoclima).

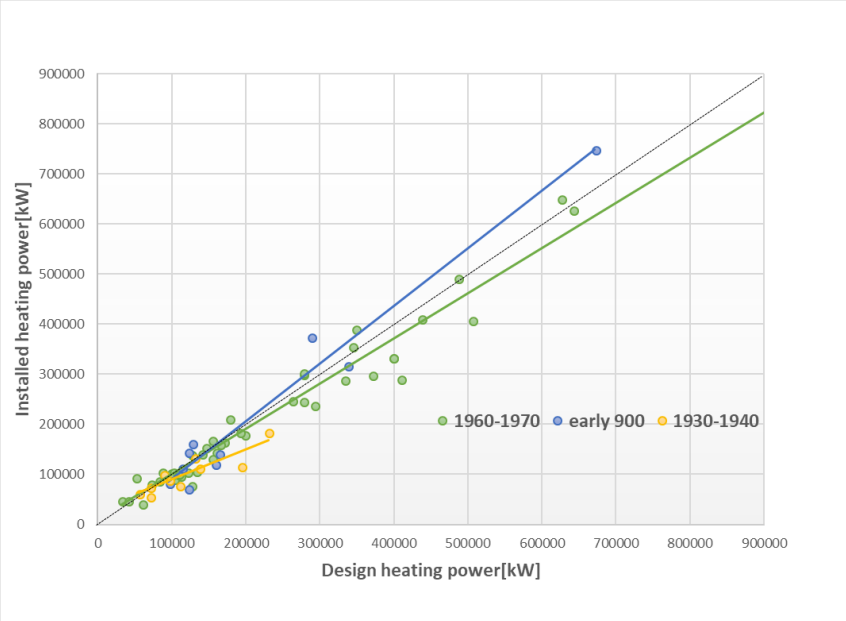
5 Barriers for Heat Pump Market in MFB

Heat pumps application in MFB is becoming more and more common in new buildings, due to the prescription of D.Lgs.28/2011 about renewable energy miminum share. Yet, in existing buildings heat pumps are rarely installed. Many hystorical factors have determined the current state. Some of these factors, and some other news, act as effective barries to market penetration that should be addressed,

and can be classified in 3 main categories: technical barriers, morfological barriers, administrative barriers.

Among the technical barriers are the followings:

- The italian building stock is for the vast majority composed by **poorly insulated buildings fitted with high temperature (>60°C) heating systems**. It is a common opinion among professionals that the elder buildings, aging more than 40 years, have been oversized, which could help in lowering the design supply temperature and improve the potential for the application of heat pumps, as well as of high efficiency condensing gas-boiler. A variable flow control might be also considered in those cases, but the general introduction (mandatory) of thermostatic valves does not suite very well with highly variable flowrates. Moreover, we are collecting data from MFB energy audits and we are verifying that the supposed oversizing is not as intense as generally agreed on among the professionals and scientists community. (figure).
- In general, the feasibility evaluation of heat-pump retrofit in existing MFB depends strongly on the precision of the energy savings prediction. For the heat pumps system, expecially air-source ones, it is clear that hourly dynamic simulation is the minimun granularity needed to catch the transient of COPs and power supplied. This kind of simulation is not every-day skill in the professional sector. There is a **need for specialized dynamic calculation instruments**, which can be used to support the design, with a lower complexity than the one requested by, for example, tools like Energy+.



Installed heating power, derived from room-by-room system survey, as a function of design heating power, calculated a posteriori for energy audit goals, in a set of 150 buildings in Torino (source: Studio Chiabrera, Antonio Passaro)

As for the morfological barriers:

- The typical urban tissue of italian cities is very dense and **hardly fits for finding sufficient and effective spaces to host heat pump system**. As for geothermal systems, it is hard to allocate in a densely and stratified constructed environment either the boreholes either the dwellings. As for air source system, the typical roofing in large-demand regions of Italy is a double slopes with tiles, which does not present favourable caracteristic for hosting air-source heat pumps, unless it is significantly modified.

The main administrative barriers are:

- The new **electricity tariff** for heat pumps, as described, is **under evolution** and its effect should be further investigated.
- The **authorization procedure for drilling dwells and boreholes** is different among regions, and it is **excessively long** (averagely > 1 year). The body that is in charge of authorizing water-taking is different from the one controlling water discharge in the ground and a clear prescription about delta of temperature for water discharge is not currently homogeneously set. The local environmental protection agencies treats the in-ground water discharge for thermal uses following the same national code written for industrial discharges. Some Regions, as Lombardia, recently updated and improved the process. Other large regions, as Piemonte, are still undergoing the process.
- The **incentives scheme** in the form of tax discount **presents some shortcomings**: for 65% and 50% fiscal incentive, if a service is offered by ESCOs under a contract in which the heat pump is not sold to condominium, the fiscal incentive can not be leveraged by the ESCO. If the machine is sold to the condominium and financed by the ESCO, a problem arises in that the houselords had to pay for the works (though receiving a fiscal gains on its turn or deciding to pass the fiscal advantage to the ESCO), while the lenders do enjoy the savings. In this way, the houselords are unlikely to decide for the retrofit intervention.
- In scenarios of evolution of smart metering, that might be important in case of application of the “smart city” concept, it looks hard to design a metering system able to provide a real-time economic value for unit of energy, due to the variable COP.

Finally, a special factor is the **competion with district heating**, that is well developed in the northern large cities Torino (almost 50% of the city served) and Milano, as well as in minor towns. Though the competition in pure economical terms of cost of energy is open, the just described barriers, expecially the morfological and the administrative barriers, play an important role in the decision process by the condominiums. Moreover, the minimum renewable energy share prescribed by D.Lgs.28/2011, does not apply explicity to buildings connected to the district heating, that is considered *a priori* efficient.

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