MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT

Analyzing the Market Potential and Consumer Acceptance of Heat Pump Technology in the Italian Residential Sector: Opportunities and Challenges for Sustainable Energy Transition

Supervisor:

Prof. Anna D'Ambrosio

Candidate:

Faezeh Ghorbankhani

S274950

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Abstract

Italy, like many other nations, is dedicated to achieving its sustainability goals as outlined in various national and international agreements. With the residential sector being a major contributor to energy consumption and greenhouse gas emissions, there is a pressing need for sustainable heating solutions. Heat pump technology presents a promising alternative to traditional heating systems by utilizing renewable energy sources such as air, water, or ground heat to provide efficient heating and cooling. The Italian heat pump market shows significant potential for both qualitative and quantitative improvements.

This study investigates the market potential and consumer acceptance of heat pump technology in the Italian residential sector. The analysis reveals that the market, primarily dominated by reversible air-source heat pumps (ASHPs), is growing, with significant potential for both heating and cooling applications, particularly in central and southern Italy. Key factors influencing consumer acceptance include awareness of heat pump benefits, initial installation costs, perceived reliability, and suitability to the property. Financial incentives and subsidies are crucial in promoting adoption.

While heat pump is a low-emission solution for decarbonizing residential buildings, financial barriers often hamper their diffusion. The study highlights the importance of supportive policies, consumer education, and technological innovation in overcoming these barriers. The transition to heat pump technology offers substantial environmental and economic benefits, contributing to CO2 emissions reduction and energy efficiency.

Future research should focus on adoption studies, integration with other renewable systems, and the social and behavioral aspects of energy consumption to enhance consumer engagement and optimize energy efficiency in residential buildings. This shift represents a critical step in Italy's sustainable energy transition, advancing efforts to reduce greenhouse gas emissions and achieve energy security.

Dedication

"For the ones who believed in me:
my family, my love, and myself."

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Chapter 1

1 Introduction

1.1 Introduction on the topic

The transition towards sustainable energy sources is crucial for combating climate change and ensuring long-term environmental stability. In the residential sector, adopting renewable energy technologies, such as heat pumps, significantly reduces carbon emissions and enhances energy efficiency.

Heat pumps, powered by low-emissions electricity, are a vital technology in the global shift towards secure and sustainable heating solutions. Currently, available heat pumps offer exceptional energy efficiency, surpassing natural gas boilers by three to five times. This not only improves energy conservation but also protects households from the volatility of fossil fuel prices, a concern heightened by the ongoing energy crisis. Notably, heating in buildings accounts for a substantial portion of global natural gas demand, especially in the European Union. Many heat pumps are versatile, providing both heating and cooling capabilities. This dual function eliminates the need for separate air conditioning units, particularly beneficial for the 2.6 billion people expected to live in regions requiring both heating and cooling by 2050. Additionally, replacing fossil-fuel-based boilers with heat pumps presents a significant opportunity for reducing emissions. By lowering CO2 emissions, which currently contribute to 10% of global emissions, heat pumps offer a tangible solution to climate change. This reduction persists across various heating markets, even with the current electricity generation mix, and will intensify with the ongoing decarbonization of electricity systems. [1]

The ongoing invasion of Ukraine by Russia and the resulting energy crises have sparked global concerns about economic and geopolitical stability. In Europe, the war has destabilized and endangered energy cooperation and transition among European countries within and outside the EU. This emergency has highlighted the importance of energy resilience policies to offset the vulnerability of energy systems and address energy insecurity at national and regional levels.

This chapter introduces the analysis of the market potential and consumer acceptance of heat pump technology in the Italian residential sector, addressing the opportunities and challenges for a sustainable energy transition.

1.2 Background and Rationale for the Study

Italy, like many other nations, is dedicated to achieving its sustainability goals as outlined in various national and international agreements. With the residential sector being a major contributor to energy consumption and greenhouse gas emissions, there is a pressing need for sustainable heating solutions. Heat pump technology presents a promising alternative to traditional heating systems by utilizing renewable energy sources, such as air, water, or ground heat, to provide efficient heating and cooling.

The Italian heat pump market shows significant potential for both qualitative and quantitative improvements. Currently, it is predominantly comprised of reversible air-source heat pumps (ASHPs), which are mainly used for cooling during the summer. However, the climate in central to southern Italy is conducive to using ASHPs as the sole heating system for both space heating and domestic hot water production. The potential for this would be even greater with advancements in hybrid heat pumps (e.g., solar HP systems) and low-temperature ASHPs.[2]

Nevertheless, the adoption of heat pumps in Italy's residential sector faces several challenges, including market barriers and consumer uncertainty. Understanding these challenges and opportunities is essential for developing effective strategies to promote a sustainable energy transition.

1.3 Research Objectives and Questions

The primary objective of this study is to analyze the market potential and consumer acceptance of heat pump technology in the Italian residential sector. To achieve this key goal, the following specific objectives will be pursued:

1. To assess the current market landscape of heat pump technology in Italy, including market size, growth trends.
2. To identify the factors influencing consumer acceptance of heat pumps in the Italian residential sector.
3. To provide recommendations to enhance the uptake of heat pump technology in Italy.

The research will address the following key questions:

- What is the status of the market for heat pump technology in the Italian residential sector?
- What are the main factors influencing consumer acceptance of heat pumps in Italy?
- What opportunities exist for promoting the adoption of heat pump technology in the residential sector?
- What are the key challenges hindering the widespread uptake of heat pump technology in Italy, and how can they be addressed?

1.4 Structure of the Thesis

The thesis is structured into several chapters, each focusing on specific aspects related to the analysis of heat pump technology in the Italian residential sector. Chapter 2 provides a comprehensive review of relevant literature and market potential, including theoretical frameworks and previous studies. Chapter 3 outlines the methodology employed in this research, including data collection and analysis procedures. Chapter 4 presents the findings of the consumer acceptance and awareness assessment and discusses the opportunities and challenges for heat pump market in Italy, based on the research findings. Finally, Chapter 5 summarizes the key findings, discusses their implications, and offers recommendations for future research and practice.

Chapter 2

2 Literature Review

2.1 Overview of Sustainable Energy Transition in the Residential Sector

The global imperative for sustainable energy transition underscores the significance of reducing carbon emissions and enhancing energy efficiency within the residential sector. In alignment with international commitments such as the Paris Agreement, countries are increasingly focusing on renewable energy adoption and energy-efficient practices in residential buildings. Literature on this subject provides insights into policy frameworks, technological innovations, and behavioral interventions aimed at promoting sustainable energy practices in residential settings.

The deployment of clean technology has accelerated significantly over the past two years. Approximately one-third of all photovoltaic (PV) solar installations to date occurred in 2021 and 2022, with even higher growth rates observed in other clean energy technologies: around 60% for both electric vehicle sales and the installation of stationary batteries. Emerging technologies like electrolysers for hydrogen production have also advanced, with global installed electrolyser capacity more than doubling in the last two years, has reached around 700 megawatts (MW) in 2022. Electrolysis capacity is growing from a low base and needs a substantial acceleration to align with the Net Zero Emissions by 2050 (NZE) Scenario. This scenario requires installed electrolysis capacity to surpass 550 gigawatts (GW) by 2030.[3]

Manufacturing capacity for clean energy technologies is rapidly expanding, indicating that deployment will continue to grow robustly in the coming years. Despite these impressive advancements, much work remains. The slow turnover of most types of energy-related equipment means there is a significant lag between a technology becoming dominant in new deployments and it is becoming dominant in the overall operating stock. This underscores the urgent need for continued efforts to boost deployment in the near term to stay on track for achieving net zero emissions by 2050.

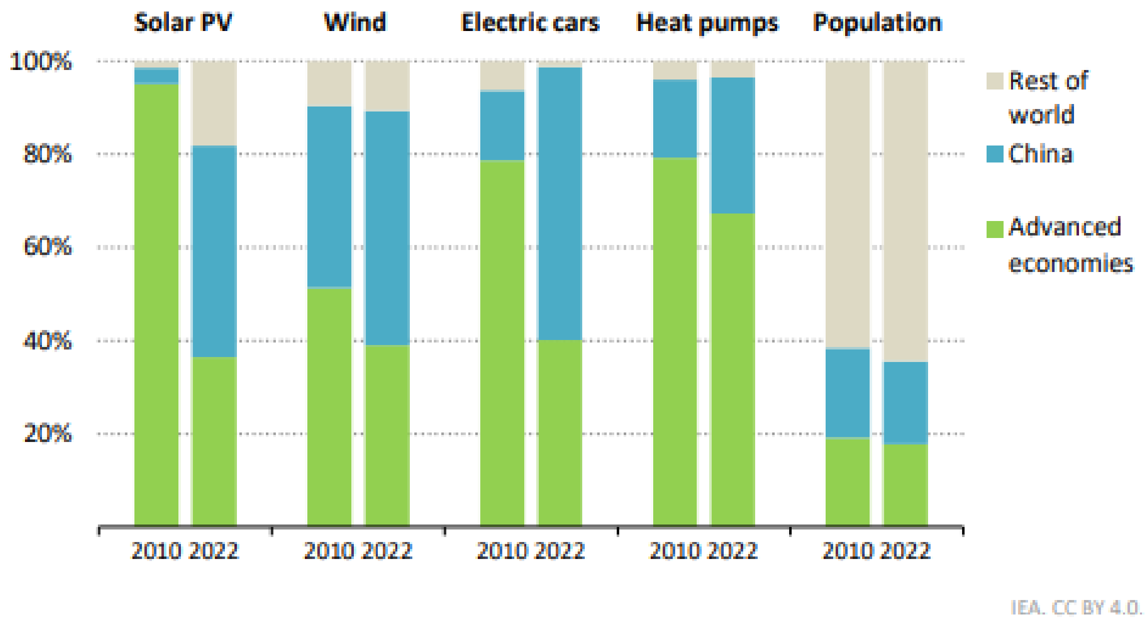

Figure 2-1. Share of global deployment of selected clean energy technologies in advanced economies and China, 2020 and 2022

Increasing access to modern energy plays a pivotal role in expediting the reduction of energy intensity, particularly evident in the NZE Scenario. Presently, approximately 2.3 billion individuals across roughly 130 nations, predominantly in Asia and sub-Saharan Africa, lack access to clean cooking facilities, while close to 780 million people still live without electricity. Beyond its primary advantages, the provision of modern energy fosters enhanced energy efficiency. Despite significant population expansion, achieving universal access to clean cooking results in a nearly 60% reduction in residential fuel demand for cooking in emerging market and developing economies by 2030 in the NZE Scenario compared to current levels.

In the NZE Scenario, the proportion of electricity utilized in the buildings sector globally is anticipated to ascend from the current 35% to nearly 50% by 2030, contrasting with the 40% projected in the STEPS[1] scenario. Particularly noteworthy is the increase in the share of electricity employed for space and water heating, which is expected to rise by approximately 7 percentage points by 2030. This surge primarily stems from the expanded adoption of heat pumps, renowned for their three- to four-fold higher efficiency compared to electric resistance heaters. As of 2022, heat pumps catered to roughly 10% of the global heating demands in buildings, boasting a capacity exceeding 1,000 GW for space and/or water heating. Notably, the sales of heat pumps have been experiencing a rapid ascent, with an 11% increase recorded in 2022, marking the second consecutive year of double-digit growth according to the IEA. The momentum is even more pronounced in the NZE Scenario, where the heat pump stock is projected to nearly triple by 2030, addressing over one-fifth of the heating requirements in the building sector. This translates to an average annual sales growth rate of nearly 20% between 2023 and 2030. The European Union has witnessed an annual surge in heat pump sales exceeding 35% since 2021, indicating that the growth targets outlined in the NZE Scenario are indeed attainable.

In numerous markets, the initial expense associated with acquiring a residential heat pump, inclusive of installation, typically surpasses that of a fossil fuel boiler. However, the magnitude of this cost disparity exhibits considerable variation both within and across countries, even when considering identical technologies. Nevertheless, in select established markets like Norway, Denmark, and Japan, the most economical ductless air-to-air heat pump models have become more cost-effective than natural gas boilers for new installations in small dwellings. This shift is primarily attributed to decreased piping work and installation expenses.

2.1.1 Energy transition

2.1.1.1 Definition

An energy transition denotes the shift from one form of energy production to another, exemplified by historical transitions like the transition from burning wood to burning coal. Past energy transitions often occurred due to a scarcity of one resource

[1] **Stated Policies Scenario (STEPS)**: describes how the global energy system would evolve under the policies already in place today.

prompting the adoption of an alternative resource. However, in these cases, the transition could be seen as a gradual process where different energy sources coexisted rather than a complete replacement of one by another. An energy transition signifies a fundamental shift rather than a slow evolution. [4]

The ongoing energy transition, prompted by concerns regarding climate change, stands apart. Heightened apprehensions regarding global warming and environmental degradation have accelerated an urgent need to supplant fossil fuels with cleaner, renewable energy sources. This transformation is complemented by advancements in efficiency and cleaner transportation options, alongside enhancements in energy storage capabilities.

The stimulus for transitioning to renewable energy escalated notably during the 1990s as the impacts of climate change gained prominence in discussions. The landmark 2015 COP21 Paris Agreement witnessed 196 nations pledging to achieve carbon neutrality by the mid-century mark, with an aim to limit global warming to "well below 2°C, preferably 1.5°C compared to pre-industrial levels." This necessitates a transition away from fossil fuels to mitigate carbon emissions. Unlike past energy shifts driven by resource scarcity, this contemporary transition is propelled by climate change concerns, given that coal, oil, and gas combustion collectively contribute to 89% of all CO2 emissions.

Achieving the objectives outlined in the Paris Agreement mandates a significant departure from previous energy consumption patterns. Specifically, it requires a 95% reduction in coal usage, a 60% reduction in oil consumption, and a 45% reduction in gas usage compared to 2019 levels to attain a 50% likelihood of meeting the Paris Agreement's 1.5°C target.

2.1.1.2 Energy transition importance

Energy transition is crucial for numerous reasons, including decarbonization, job creation, industrial growth, and enhancing competitiveness. There are several key reasons why energy transition is important today: [4]

Decarbonization: Decarbonization is essential to mitigate climate change. Europe has been at the forefront, surpassing China, and the United States in decarbonizing the economy by initiating the process in the early 2000s. By 2018, Europe had achieved a carbon intensity 20% lower than the United States and 70% lower than China.

Empowering Consumers: Consumers can actively participate in the energy transition by adjusting their electricity demands and supplying energy back to the grid. This shift allows customers to become 'prosumers,' who sell their excess electricity, thereby playing a proactive role in energy management.

Financial Security: Over the past two decades, investments in renewable energy have been more resilient to financial crises compared to other investments, offering enhanced financial security.

Improved Competitiveness: Europe has experienced increased competitiveness due to the energy transition, with the energy required to produce one unit of economic output decreasing by 20% between 2005 and 2017. Industries like cement, chemicals, glass, plastics, and steel need further energy efficiency improvements, achievable through digitalization, automation, and increased recycling and material reuse.

Industrial Growth: The cost of renewable energy has significantly decreased, with solar energy costs falling by 75% and wind power costs by 35% between 2010 and 2018. However, subsidized fossil fuels continue to undermine the global competitiveness of renewable energies.

Job Creation: The shift to green energy has the potential to create numerous jobs. In Europe, around 4 million jobs have already been generated through the transition to cleaner energy solutions, with projections indicating that 0.3% to 0.9% more jobs will be created by 2050 as a result of this transition compared to maintaining the status quo.

Reduced Energy Dependency: Reliance on energy imports poses challenges for energy security and pricing. Locally produced renewable energy mitigates these issues and remains competitive with fossil fuels.

2.1.2 Regulations and Policy frameworks

2.1.2.1 Paris agreement

At COP 21 in Paris on December 12, 2015, Parties to the UNFCCC reached a historic agreement to tackle climate change and boost the actions and investments necessary for a sustainable low-carbon future. The Paris Agreement builds on the Convention and, for the first time, unites all nations in a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support for developing countries. This marks a new direction in the global climate effort. [5]

The Paris Agreement's primary goal is to strengthen the global response to the threat of climate change by limiting the global temperature rise this century to well below 2 degrees Celsius above pre-industrial levels and striving to limit the increase to 1.5 degrees Celsius. Additionally, the agreement aims to enhance the ability of countries to cope with the impacts of climate change and to ensure that financial flows align with a low greenhouse gas emissions and climate-resilient pathway. To achieve these ambitious goals, the agreement calls for the mobilization and provision of financial resources, a new technology framework, and enhanced capacity-building, thereby supporting action by developing countries and the most vulnerable nations in line with their national objectives. The Agreement also establishes an enhanced transparency framework for action and support.

In summary, the Paris Agreement sets up a comprehensive framework to combat climate change, requiring coordinated efforts from all Parties to achieve its ambitious targets.

2.1.2.2 REPowerEU

Russia’s unprovoked and unjustified military actions against Ukraine have greatly disrupted the global energy landscape. This aggression has driven up energy prices, causing widespread difficulties, and has intensified concerns about energy security. It has also exposed the EU's heavy reliance on Russian imports of gas, oil, and coal. The high payments for these fossil fuels are indirectly supporting Russia’s war efforts in Ukraine. [6]

In response, EU leaders decided in March 2022 during the European Council meeting to rapidly reduce Europe's dependence on Russian energy imports. They called on the Commission to quickly develop a detailed REPowerEU plan based on prior communications. This plan was initiated amid the backdrop of sanctions being extended to include coal and oil imports from Russia. The recent gas supply cuts to Bulgaria and Poland highlight the immediate need to address the reliability issues with Russian energy supplies.

The REPowerEU initiative focuses on swiftly decreasing reliance on Russian fossil fuels by speeding up the transition to clean energy and fostering collaboration to build a more resilient energy system and a genuine Energy Union. The initiative aims to significantly reduce dependence on Russian fossil fuels within the year and expedite the overall energy transition. Building on the Fit for 55 package and actions addressing energy security of supply and storage, the REPowerEU plan introduces additional actions to:

- Save energy,
- Diversify supplies,
- Quickly substitute fossil fuels by accelerating Europe's clean energy transition,
- Smartly combine investments and reforms.

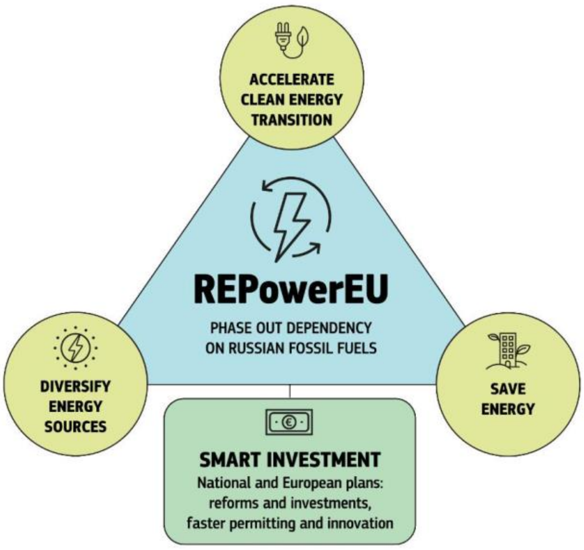

Figure 2-2. REPowerEU Actions (Source: EUR-Lex)

By implementing these strategies, the EU aims to achieve a more stable, secure, and sustainable energy future, reducing its vulnerability to dependence on Russian energy imports. Collectively, these measures will fundamentally transform the EU's energy system. This transformation requires effective coordination between European regulatory and infrastructure initiatives, national investments and reforms, and collaborative energy diplomacy. It also involves synchronizing efforts to reduce energy consumption and transform industrial processes by replacing gas, oil, and coal with renewable electricity and fossil-free hydrogen, with the creation of the capacity and framework to expand and produce renewable energy.

2.2 Conceptual Framework: Heat Pump Technology and Its Role in Sustainable Energy Transition

Heat pump technology emerges as a pivotal component in the transition towards sustainable energy within the residential sector. This section delves into the fundamental principles of heat pump operation, emphasizing its capacity to harness renewable energy sources for heating and cooling purposes.

2.2.1 Heat Pump Technology

A heat pump is a device capable of providing heating, cooling, and hot water for residential, commercial, and industrial applications. It can simultaneously offer both heating and cooling. Depending on its primary function, the device may be referred to as a heat pump, an air-conditioning unit, or a cooling/refrigeration machine. Various thermodynamic principles are used to deliver heating and cooling, so "heat pump" encompasses a range of technologies rather than a single solution.

Heat pump technology offers significant economic, environmental, and energy system benefits for Europe. Utilizing renewable energy, heat pumps may be the most efficient technology for heating and cooling, especially when both services are needed in the same location simultaneously. Although large-scale installations of heat pumps have only become common recently, the underlying concept has existed for over 150 years. Today, heat pumps are becoming a cornerstone of the energy mix for decarbonizing heating and cooling in industry and society. Thus, the energy transition is not a technological challenge but rather an issue of policy and awareness.

2.2.2 How Does a Heat Pump Work?

The operation of a compression heat pump is based on the refrigeration cycle, also known as the thermodynamic cycle. This cycle comprises five main components (Figure 2-3):

- Evaporator: A "liquid-to-gas" heat exchanger
- Compressor
- Condenser: A "gas-to-liquid" heat exchanger
- Expansion valve
- Transfer fluid (refrigerant)

Heat pumps function by utilizing the concept of heat transfer, where heat moves from one location, known as the source, to another, called the sink. This mechanism persists continually, prompted by variations in temperature between the source and the sink. The refrigerant cycle allows the heat pump to provide heating and cooling simultaneously.

Most heat pumps available on the market utilize the electric vapor compression cycle. Besides the electric compression cycle, a heat pump compressor can also be driven by an electric motor or a gas engine. A smaller share of heat pumps uses the vapor compression cycle driven by combustion engines. Depending on the specific process, these can be further categorized into adsorption and absorption processes. Other heating and cooling technologies, some still in experimental stages and a few with market relevance, include cold gas compression as well as thermoelectric, thermomagnetic, thermoacoustic, and thermoelastic processes.

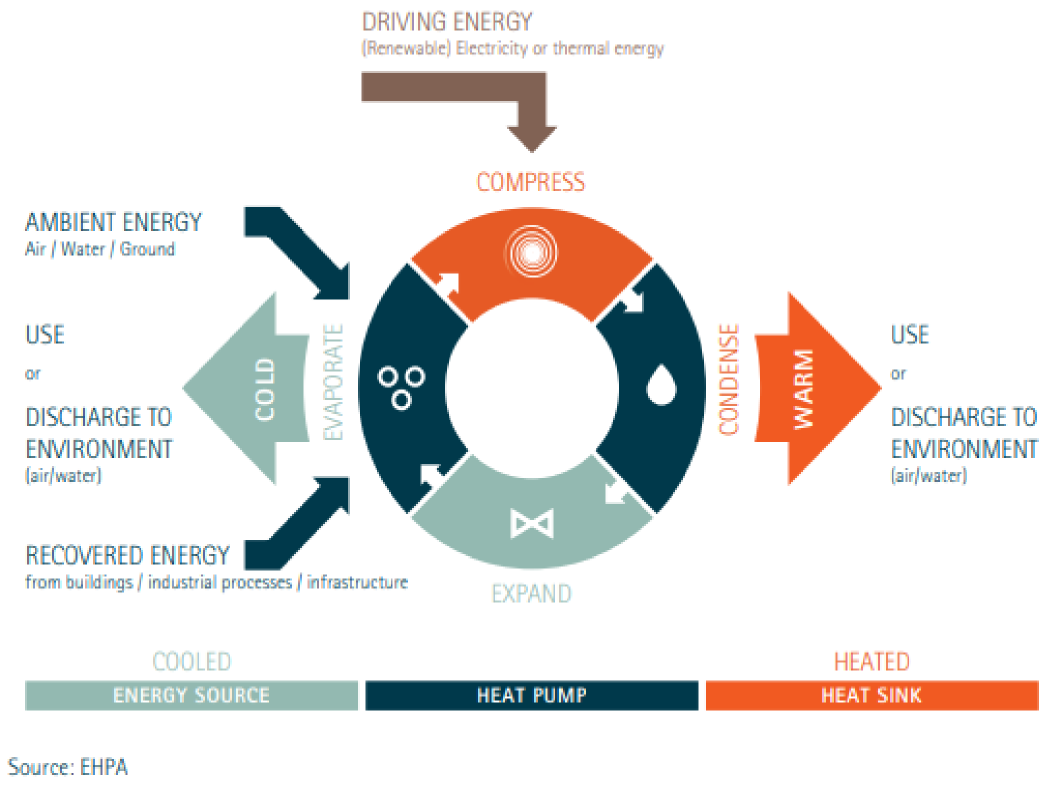

Figure 2-3. Heat pump Vapour Compression Cycle

2.2.3 Energy sources for Heat Pump

An electric compression heat pump utilizes electricity to operate the compressor and pumps, while a sorption heat pump relies on thermal energy to drive the cycle. In the overall energy balance, the amount of energy required to drive the cycle is relatively small. In heating mode, one unit of driving energy can produce approximately 3 to 5 units of useful heat (see Figure 2-4).

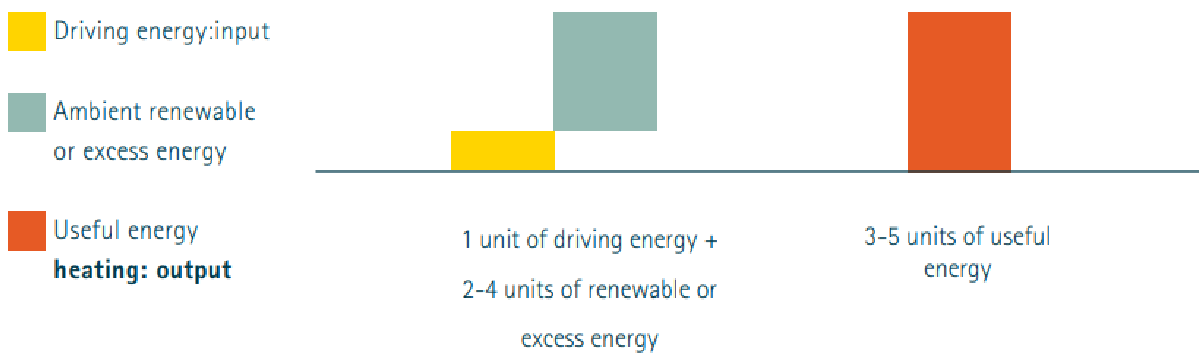

Figure 2-4. Generated Energy by a Heat pump (Source: European Copper Institute)

Most of the energy generated by heat pumps is extracted from the environment, utilizing renewable sources such as air, water, and ground. Heat pumps can also harness excess energy from industrial processes and infrastructure installations (e.g., sewers, subways, underground parking), as well as reuse exhaust air from buildings. Although distinguishing between renewable and excess energy can be challenging, both contribute to a significant reduction in non-renewable energy demand and related emissions. The efficiency of a heat pump, reflected in the ratio between the driving energy and the renewable/excess energy, is determined by the machine's coefficient of performance (COP).

2.2.3.1 Air Source Heat Pumps: [7,8,9,10]

Air source heat pumps (ASHPs) are systems that transfer heat between the interior of a building and the outside air, offering both heating and cooling. Known for their high energy efficiency and environmental benefits, ASHPs are a sustainable choice for buildings. They can be 3 to 4 times more efficient than traditional heating systems, delivering 3 to 4 units of heat per unit of electricity used.

During the heating season, ASHPs absorb heat from the outside air and transfer it indoors. In the cooling season, they reverse the process, extracting heat from the indoor air and expelling it outside.

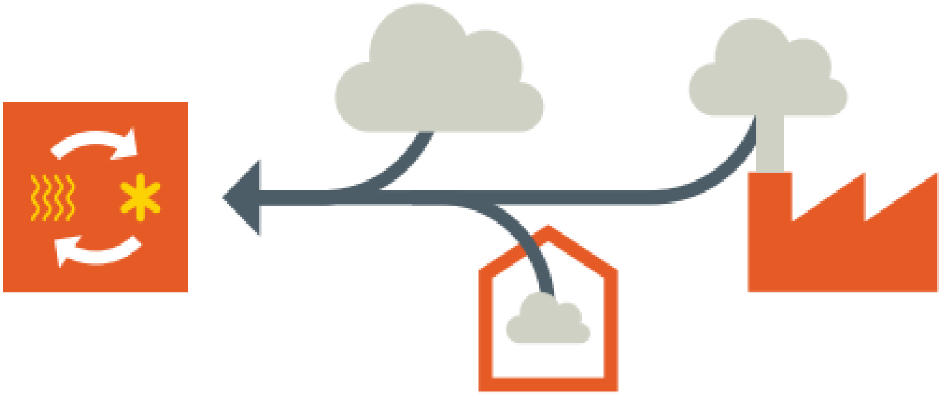

Figure 2-5. Air Source Heat pump (Source: European Copper Institute)

Air Source heat pump types:

- Air-to-Air Heat Pumps: Transfer heat between indoor and outdoor air, suitable for space heating and cooling.
- Air-to-Water Heat Pumps: Transfer heat to a water-based system, used for underfloor heating, radiators, or domestic hot water.
- Exhaust Air Heat Pumps: transfers heat from a ventilation system to warm air that heats your home. It can also be used to heat water stored in a hot water cylinder for hot taps, showers, and baths.

2.2.3.2 Ground Source (Geothermal) Heat Pumps

Ground source heat pumps extract energy from the ground through a closed-loop system, using either horizontal or vertical collectors. This energy is transferred to a fluid, often brine or water, which is then circulated to the heat pump unit. A specialized variant, known as direct expansion heat pumps, bypasses the transfer of fluid by circulating refrigerant directly through the ground pipes. This approach removes the need for an extra pump and increases overall efficiency. [10]

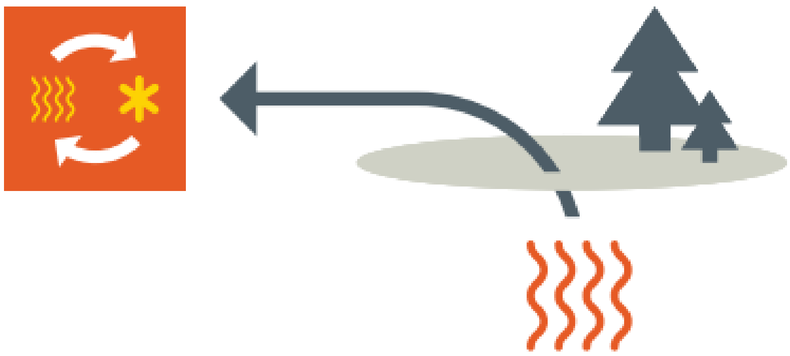

Figure 2-6. Ground Source Heat Pumps (Source: European Copper Institute)

2.2.3.3 Water Source Heat Pumps

Water source heat pumps operate similarly to ground source units but use an open-loop system with direct water intake instead of a closed-loop system with a transfer fluid. These systems can draw water directly from sources like aquifers, rivers, lakes, or the sea, as well as from wastewater, industrial cooling water, or district heating systems. [10]

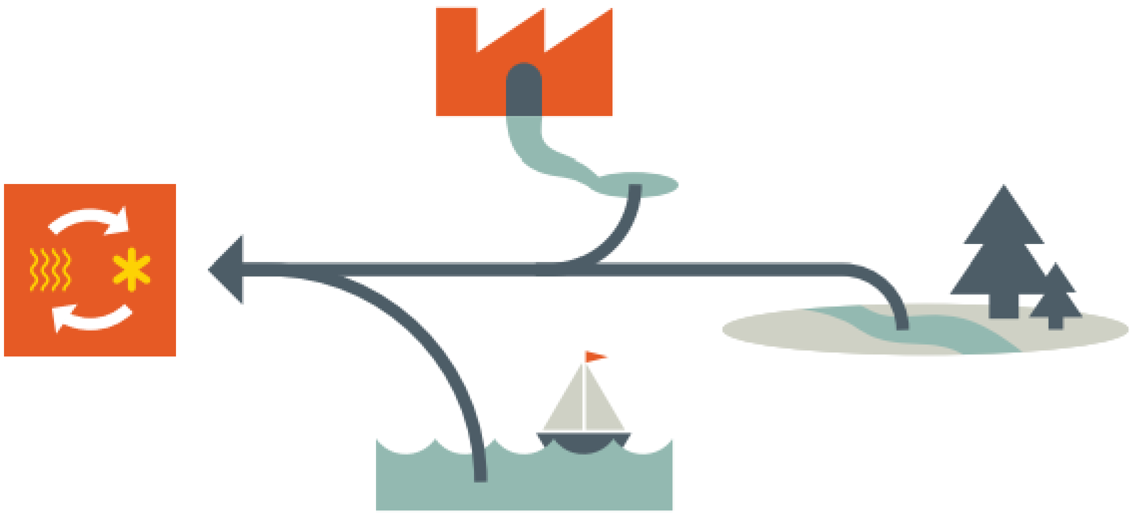

Figure 2-7. Water Source Heat Pumps (Source: European Copper Institute)

2.2.3.4 Hybrid Heat Pumps

Hybrid systems are designed to maximize energy efficiency and reliability, reduce operating costs, and lower environmental impact by combining the strengths of different heating technologies. These systems can also offer greater flexibility and resilience, ensuring a stable heat supply under varying conditions. [10]

When multiple heat generators are used together, a hybrid system is formed. Common combinations include:

- **Air source heat pumps paired with a small gas boiler:** This setup is often used to handle peak heating loads during extremely cold weather, ensuring consistent warmth without overloading the heat pump.
- **Heat pumps combined with solar thermal collectors:** Solar collectors can preheat the water or space heating fluid, reducing the workload on the heat pump, and enhancing overall system efficiency.

- **Heat pumps integrated with biomass boilers:** This combination leverages the renewable energy from biomass, providing a sustainable and efficient heating solution, particularly in areas with ample biomass resources.
- **Heat pumps supplemented by direct electric backup:** Many storage tanks come with built-in electric resistance heaters. These are typically used as a backup to ensure reliable heating during periods of high demand or if the primary heat pump system is underperforming.

2.2.4 Heat pump's impact on Climate change

Heating buildings frequently rely on natural gas or heating oil, which is why the sector accounts for about 10% of global emissions today. Heat pumps are expected to become the central technology for reducing heating's climate impact, according to *Yannick Monschauer*, an energy analyst at the International Energy Agency. [11]

Increasing Enhancing energy renovations and accelerating the adoption of heat pumps could result in a 46% reduction in CO_2 emissions from the EU residential building sector between 2022 and 2030, helping the EU achieve its climate goals. Burning fossil fuels and biomass for heating releases not only CO_2 but also other air pollutants harmful to public health. In contrast, heat pumps do not emit air pollutants directly. Thus, increasing the use of heat pumps could reduce NO_x emissions by nearly 40% by 2030 compared to 2022 levels. [12]

2.2.5 Heat pump's Impacts on Consumers

To meet the EU's REPowerEU objectives, millions of heat pumps need to be installed in buildings across the EU, along with energy renovations to homes. This transition will generate multiple benefits for consumers.

Accelerating the deployment of heat pumps and energy renovations will reduce final energy demand in the building sector by 24% by 2030 compared to 2022, and gas demand by 40%. Consequently, the average heating bill in the EU is expected to decrease by more than 20% by 2030.

While heat pumps offer long-term savings on energy bills, their upfront costs are high. Purchasing a heat pump is more expensive than buying a gas boiler, which can be a barrier, especially for consumers with limited financial resources. However, these initial costs are expected to decrease over time as the market matures and economies of scale are achieved.

The upfront cost of heating technology is a relatively small portion of its total lifetime cost. The largest share of total costs comes from running and maintaining the heating appliance. Over its lifetime, the average total cost of a heat pump is lower than that of a gas boiler because heat pumps are up to four times more efficient and do not rely on expensive gas. This makes heat pumps cost-competitive, as they are on average 30% cheaper to run over their lifetime than gas boilers in the EU.

Overall, the transition to heat pumps and energy renovations will benefit all income groups. With a rapid roll-out of heat pumps, the disposable incomes of all income groups in the EU are expected to grow by around 2% by 2030, thanks to the positive economy-wide effects of heat pump deployment. [12]

2.2.6 Heat pump's impacts on Economic

The shift to more efficient homes powered by heat pumps brings a wide range of economic benefits.

GDP Impacts

The EU's transition to heat pumps is projected to result in a 2.5% net increase in Gross Domestic Product (GDP) by 2030 compared to a business-as-usual scenario. Germany's GDP is expected to perform particularly well, exceeding the EU average with an increase of over 4% in its annual GDP. [12]

Energy Imports

Currently, the EU heavily relies on fossil fuel imports to heat its homes. Recent surges in energy prices have highlighted Europe's vulnerability to volatile fossil fuel markets. In 2022, the EU spent an astounding €400 billion on gas imports, more than three times the amount spent in 2021. Transitioning to heat pumps and enhancing energy efficiency in homes will reduce the need for coal, gas, and oil imports. This shift could save the EU €60 billion in fossil fuel import costs by 2030, including €43 billion on gas imports. If the recovery from the energy price shock is slower, the savings on energy imports could reach as high as €83 billion. Germany, in particular, stands to benefit significantly from these changes, potentially saving €26 billion in energy imports by 2030, with €19 billion in gas import savings. [12]

"Meeting EU Heat Pump Targets Will Save Europe €60 Billion in Energy Imports"

2.2.7 Heat pump's impacts on Employment [12]

The uptake of heat pumps, which are significantly more efficient than fossil fuel boilers, will lower household energy bills, thereby unlocking spending in other areas. This shift will lead to positive multiplier effects such as increased domestic demand for goods and services, higher domestic production to meet this demand, and consequently, increased employment. Aligning with the EU's REPowerEU plan, the increased adoption of heat pumps is projected to create nearly 3 million net additional jobs by 2030.

Most of these new jobs will be in the service sector (1.8 million) and the construction sector (almost 500,000), while approximately 27,000 jobs will be lost in fossil fuel-related industries. The net result is the creation of 3 million additional jobs by 2030. Notably, over 1 million of these new jobs are expected to be in Germany.

The transition to heat pumps thus not only contributes to environmental goals but also significantly boosts the economy by generating millions of jobs across the EU.

"Meeting EU Heat Pump Targets Will Create 3 million Jobs in the EU"

2.3 Market Potential Analysis of Heat Pump Technology

2.3.1 Demand: Heating needs and Energy Consumption

Heating plays a critical role in global energy usage and is a major contributor to CO2 emissions. In 2021, the worldwide demand for energy for space and water heating reached 62 exajoules (EJ). This amount represented around half of the total energy consumption in buildings, leading to 2.5 gigatons (Gt) of direct CO2 emissions, which accounts for approximately 80% of direct emissions from buildings. When considering indirect emissions from electricity and district heating, the total CO2 emissions rise to 4 Gt. [1]

The energy demand per household varies significantly across different countries and regions due to factors such as climate, household size, living space, insulation quality, and the type and efficiency of heating systems (see Figure 2-8).

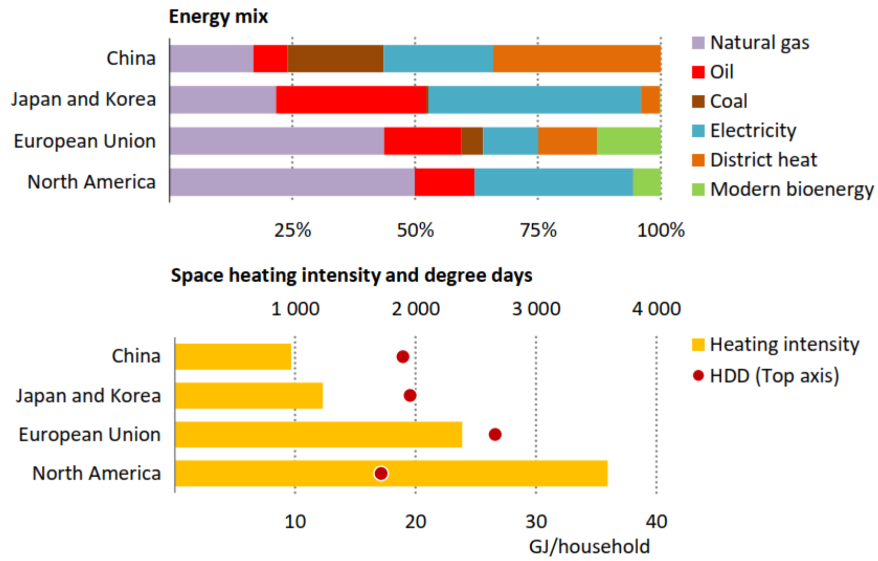

Figure 2-8. Household space heating in selected regions, 2021 (Source: IEA)

Notes: GJ = gigajoules; HDD = heating degree day. HDDs are a standardized measure of heating needs permitting comparisons across regions. They measure how cold a given location is by comparing actual temperatures with a standard base temperature. For this analysis, a base temperature of 18 °C is assumed, while the impact of humidity is also taken into account.

Approximately 70% of the total heating demand is allocated to space heating, with the remaining 30% used for hot water. The energy sources for heating vary globally. Natural gas is the predominant energy source for heating buildings worldwide, accounting for 42% of the heating energy demand. Buildings consume about one-sixth of the global natural gas supply, with this figure increasing to one-third within the European Union. Following natural gas, oil and electricity each contribute 15% to the heating energy mix, while district heating—primarily utilized in China, Northern and Eastern Europe, and Central Asia—comprises 11%. The remaining heating needs are met by biomass and coal. The composition of heating energy sources varies significantly across different regions, although natural gas remains the dominant source in most major regions except East Asia.

Most of the global population that requires space heating already has access to it, making future heating demand relatively predictable. Currently, around 40% of the world's population resides in areas where ambient temperatures necessitate space heating for part of the year. The population in these regions, mainly in the northern hemisphere, is expected to stay relatively stable over the next few decades. However, increasing prosperity is likely to drive up overall heating demand, particularly in emerging markets and developing economies. As people move into newer, larger homes and use more heating services, especially for hot water, the demand will rise, though efficiency improvements are anticipated to mitigate some of this increase. Additionally, growing economic activity will elevate heating needs in commercial buildings.

Between 2021 and 2030, the overall heating demand in buildings within emerging economies is projected to rise substantially in both the STEPS and APS [2]scenarios, primarily due to increased hot water usage (see Figure 2-9). Conversely, in advanced economies, heating demand remains largely stable in the STEPS scenario as efficiency improvements offset the growing number of single-person households. In the APS scenario, enhanced efforts to improve building efficiency, particularly through upgrading building envelopes, lead to a slight reduction in space heating demand.

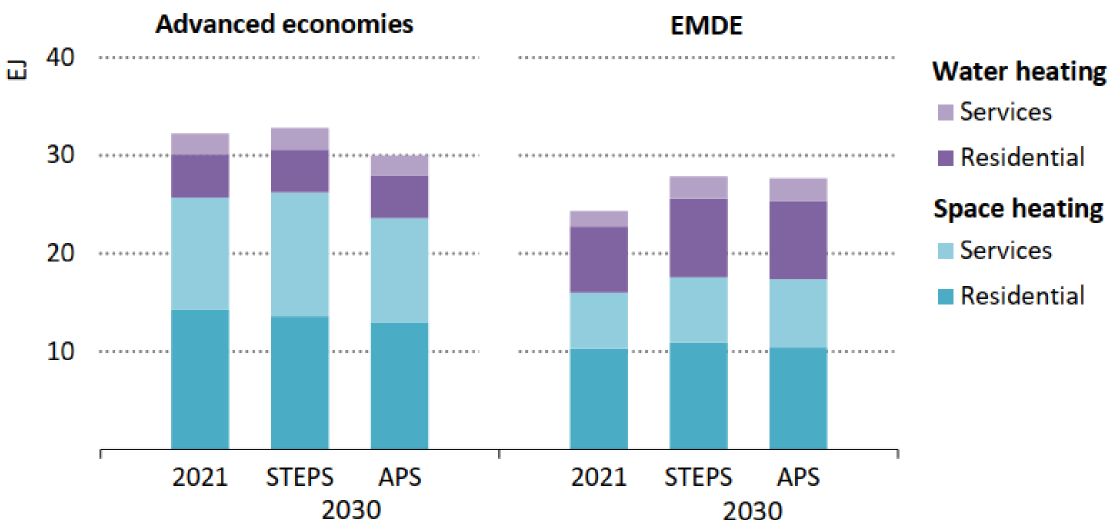

Figure 2-9. Buildings space and water heating service demand (EMDE=emerging market and developing economies)

[2] **Announced Pledges Scenario (APS)**: This scenario assumes that governments around the world meet all announced energy- and climate-related commitments in full and on time.

In the long term, energy consumption for heating in regions with significant space heating needs is anticipated to decline due to climate change. However, this reduction will be partially offset by an increased demand for cooling in these and other regions. By 2050, nearly the entire global population will experience heatwaves that pose public health risks, thereby increasing the use of air conditioning. Heat pumps, which can provide both heating and cooling, are likely to become the preferred choice for new buildings and heating retrofits in areas requiring both at different times of the year.

The population living in regions that need both heating and cooling is projected to grow by about 3%, reaching 2.6 billion people by 2050 in the STEPS scenario (see Figure 2-10). In many regions that currently require heating, most of the buildings constructed today will still be in use by 2050 (see Figure 2-11).

To reduce the use of fossil fuels for heating, it is necessary to implement efficiency retrofits and adopt low-carbon heating technologies. Additionally, stringent building codes ensuring that new constructions are zero-carbon-ready are essential for the decarbonization of heating.

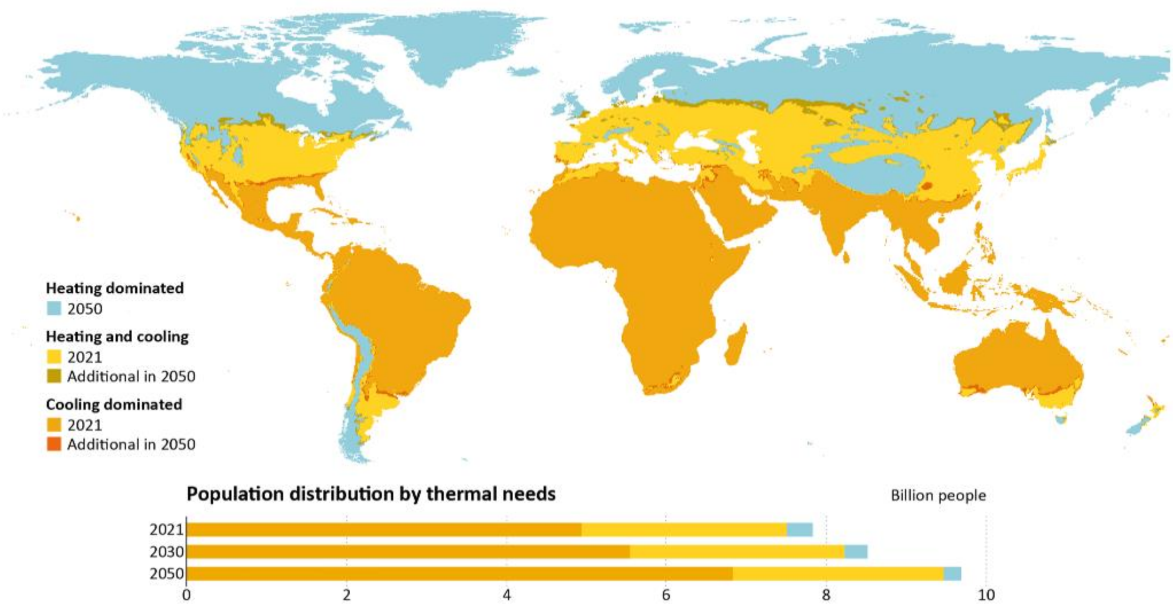

Figure 2-10. Heating and cooling needs by region, 2021 – 2050 (Source: IEA)

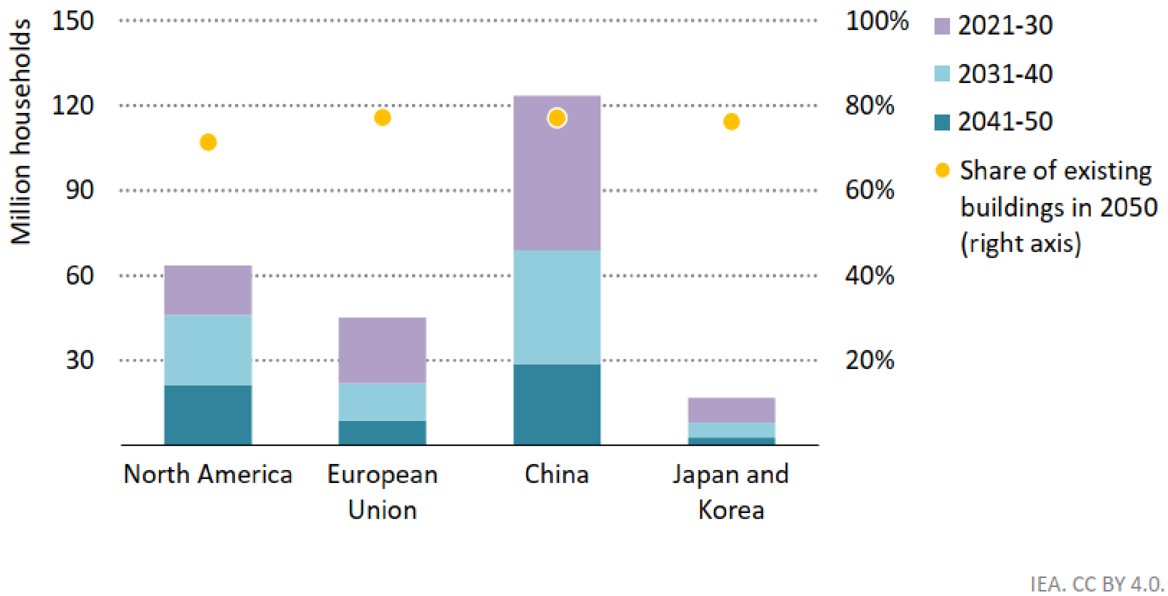

Figure 2-11.Household additions by decade in selected countries/regions 2021-2050.

2.3.2 Market Size & growth

In 2023, the global heat pump market was valued at USD 88.7 billion and is projected to expand at a compound annual growth rate (CAGR) of 9.4% from 2024 to 2030 [16]. The anticipated market growth is largely driven by supportive government policies aimed at promoting energy-efficient solutions and reducing carbon footprints. Many governments are offering subsidies, incentives, tax credits, and rebates for the installation of heat pumps, which is expected to significantly increase the demand for these energy-efficient systems, thereby fostering the growth of the heat pump industry.

The Asia Pacific heat pump market was valued at about USD 38.36 billion in the same year, projected to reach USD 99.40 billion by 2033 with a 10% CAGR. Asia Pacific held 53.14% of the global market share due to strict regulations, environmental awareness, urbanization, and construction growth. In North America, significant market growth is expected, driven by environmental consciousness, government support for renewable energy, technological advancements, and the adaptability of heat pumps to varied weather conditions. For instance, the United States allocated $169 million for heat pump development in 2023, with initiatives like the Defense Production Act boosting investment in clean energy technologies.

2.3.3 Heat Pump Market Growth Factors

Several factors have contributed to the significant growth of the heat pump market. The increasing focus on sustainability and energy efficiency is a crucial driver. Heat pumps offer a more environmentally friendly heating and cooling solution compared to conventional systems, attracting individuals and governments seeking eco-friendly options. Technological advancements have also played a significant role, with ongoing research and development leading to more reliable and efficient heat pump models, thus driving consumer interest.

Government policies and incentives supporting renewable energy sources have further boosted market growth. Financial incentives like tax credits and rebates aim to encourage the adoption of heat pump systems and reduce costs for consumers. Additionally, as consumers become more aware of the environmental impact of traditional HVAC systems, their preferences are shifting towards eco-friendly alternatives like heat pumps. This growing environmental consciousness fuels market expansion.

Moreover, the expanding construction sector, especially in regions with extreme weather conditions, drives the demand for effective heating and cooling solutions, further boosting the heat pump market. Heat pumps' versatility in both cooling and heating applications adds to their appeal.

2.3.4 The Dynamics of the Heat Pump Market

- **Driving Forces**

The heat pump market is experiencing a notable increase in demand driven by a growing emphasis on safety and environmental friendliness. By opting for heat pumps over traditional heating systems, there is a substantial reduction in greenhouse gas emissions. These pumps efficiently extract heat from various sources like the ground, air, or water, resulting in reduced energy consumption, in line with global initiatives to combat climate change. The primary catalyst for adopting heat pumps is their improved safety features. Unlike combustion-based systems, heat pumps operate without open flames, diminishing the risk of gas leaks or fire hazards. This address concerns related to indoor air quality and safety, making them a reliable choice for both residential and commercial use.

Moreover, technological advancements have led to the development of smart and automated control systems for heat pumps, enhancing safety with features like automatic shutdown during malfunctions or irregular operations. This not only ensures prolonged equipment safety but also extends its lifespan. Manufacturers are striving to produce heat pumps with minimal environmental impact to comply with increasingly stringent environmental regulations worldwide. This involves using refrigerants that meet stringent efficiency standards and have lower global warming potential (GWP). As awareness grows about the long-term benefits of environmentally friendly heating solutions, the heat pump market continues to expand.

- **Challenges**

One significant obstacle in the heat pump market is the higher installation costs associated with these systems. Installing heat pumps often requires specialized knowledge, leading to increased labor costs. Moreover, the need for qualified experts to assess the site, make necessary modifications, and ensure proper sizing further escalates installation expenses. Additionally, integrating heat pumps may necessitate infrastructure modifications like ductwork or electrical upgrades, adding to the overall installation cost. The complexity of integrating heat pump technology with existing HVAC systems can also drive-up costs, discouraging potential customers.

Furthermore, compliance with permit regulations and building codes can sometimes result in prolonged installation timelines and increased expenditure. Consumers may be deterred from adopting heat pump solutions due to the requirement for high-quality components and advanced controls, elevating the total cost of ownership. Ultimately, the higher initial installation costs act as a deterrent for both consumers and businesses, impeding the widespread adoption of this energy-efficient innovation.

- **Potential Growth Areas**

An opportunity in the heat pump market lies in the integration of better humidity control features, providing a more comfortable indoor environment by managing moisture levels, especially in regions with varying humidity levels. Effective humidity regulation reduces the workload on heat pumps, thereby enhancing energy efficiency. Users stand to benefit from lower energy consumption and reduced operational costs.

Furthermore, advanced heat pump systems can incorporate ventilation to introduce fresh outdoor air, improving air quality by reducing indoor contaminants. Some heat pump models are equipped with advanced air filtration systems capable of eliminating pollutants, dust, and allergens, thereby creating a healthier living space and enhancing indoor air quality.

2.3.5 Heat pump sales in Europe

Market dynamics are closely linked to the political landscape. In 2022, heat pump sales surged following the energy crisis triggered by Russia's invasion of Ukraine. The European Commission at that time underscored the importance of heat pumps in reducing dependence on Russian fossil fuels and mitigating high gas prices under the REPowerEU Plan, which bolstered market confidence. However, the European Commission's postponement of the Heat Pump Action Plan, along with similar delays at the national level, has created further uncertainty and contributed to the decline in sales.

It is also important to note the drop in gas boiler sales, including both condensing and non-condensing models, by around 12% in 2023. Notably, the installation ratio of gas boilers (standalone) versus hydronic heat pumps (including air-to-water, ground source, and hybrid heat pumps) has shifted significantly, from 14.2 boilers per heat pump in 2017 to 3.2 boilers per heat pump in 2023. This trend illustrates the market's movement towards lower-carbon technologies. [13]

Stable policy support is essential to address this decline and revitalize the market. Measures such as aligning electricity prices with gas prices through carbon pricing and tax breaks can increase the financial attractiveness of heat pumps, drive end-user demand, and accelerate the decarbonization of the heating and cooling sector. By tackling these challenges and providing a supportive policy framework, the EU can promote greater energy independence and drive sustainable growth in the heat pump market.

The European heat pump market experienced a significant downturn in 2023, marking the first reversal in sales trends after a decade of continuous growth. In 16 European countries[3], which represent 90% of the market, heat pump sales declined by approximately 5% compared to the previous year, dropping from 2.77 million units to 2.64 million (Figure 2-12). This decline is particularly concerning as it disrupts the long-standing pattern of annual sales increases and poses challenges to the region's energy transition goals.

[3] The 16 countries include Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, and the UK. However, figures for the UK are not displayed in the graphs as they were not included in the overall calculations.

Figure 2-12. Heat pump sales in Europe, by type, 2013 - 2023

Recently released data from the UK, not yet included in the graphs or overall calculations, show a 4% growth in national sales last year. This decline in sales coincides with delays in the EU's Heat Pump Action Plan, which was initially scheduled for early 2024 but has been postponed by the European Commission. High interest rates and shifting national policies are creating uncertainty among investors and consumers. Government support for heat pump investments, which increased in 2022 following the energy crisis triggered by the Russian invasion of Ukraine, was reduced, or removed in 2023. **Italy**, in particular, experienced one of the largest sales drops between 2022 and 2023 due to these policy changes.

2.3.5.1 Breakdown of Heat Pump Sales Trends in 2023 by Country

Despite the modest growth in some countries, the overall sales trend remained negative. (Figure 2-13) Additionally, even in countries that experienced growth, quarterly sales figures fell towards the end of 2023, suggesting a pervasive downturn across the region (Figure 2-14). This indicates that while some markets showed resilience, the general trend points to a slowdown in heat pump sales across Europe and Market analysts forecast that this downward trend will continue into 2024.

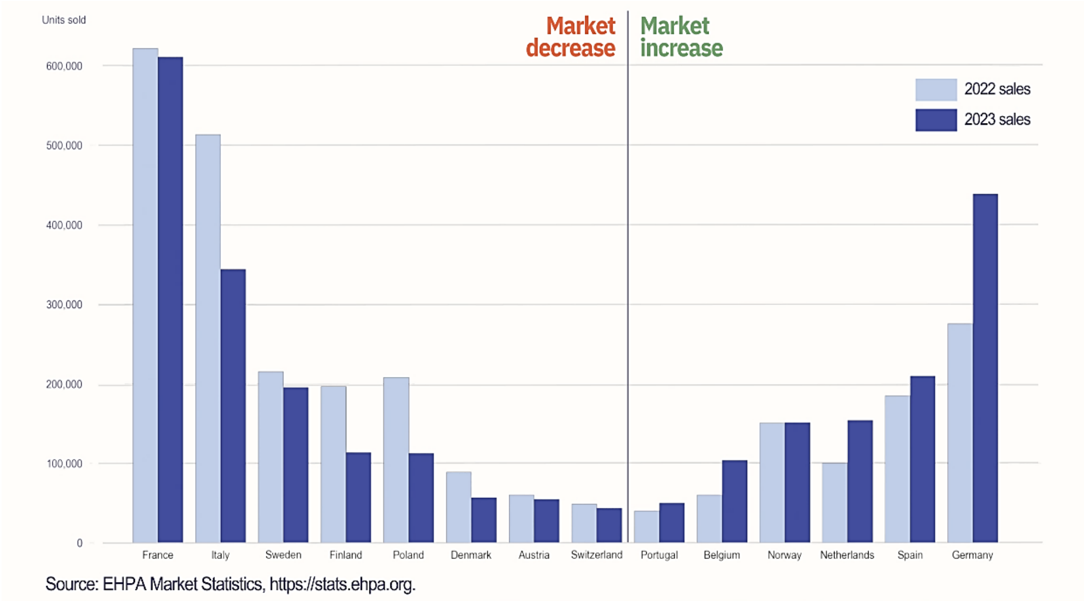

Figure 2-13. Heat Pump sales decline in most European markets, 2023

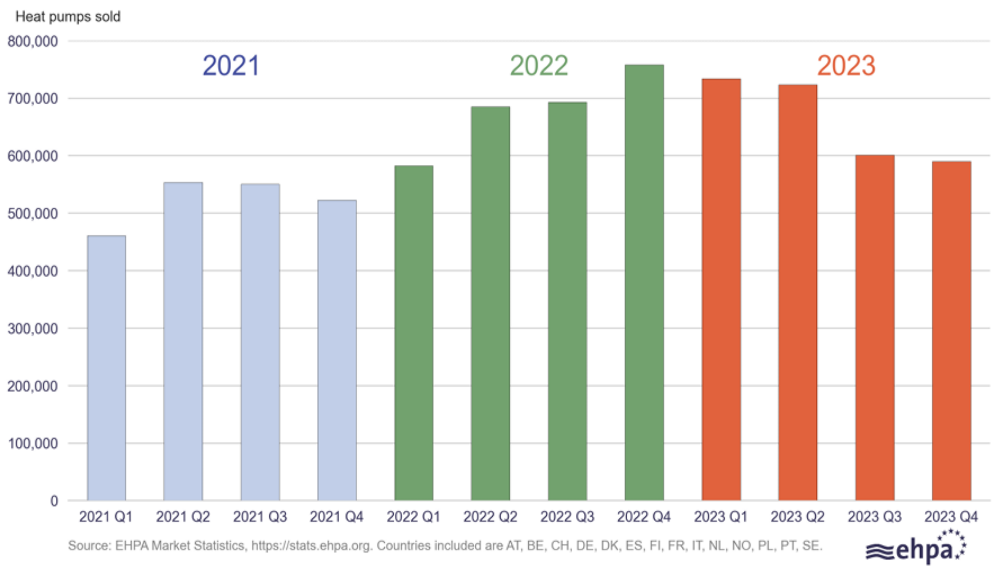

Figure 2-14. European heat pump sales quarterly, 2021-2023

Countries with Declines:

France, Italy, Sweden, Finland, Poland, Denmark, Austria, and Switzerland all saw a decrease in heat pump sales. These declines contributed significantly to the overall negative trend observed in the region.

Both Finland and Denmark experienced significant declines comparing to other countries in heat pump sales in 2023, primarily due to economic and market conditions that made heat pumps less attractive compared to previous years. In Finland, the sharp decline was largely due to a normalization after an exceptional peak, compounded by economic factors such as a slowdown in construction and rising interest rates. In Denmark, the reduction in gas prices and high inflation played crucial roles in deterring consumers from investing in heat pumps.

Despite these setbacks, the underlying factors driving the adoption of heat pumps—such as rising energy prices and the need for more sustainable heating solutions—remain strong. In Finland, the long-term outlook remains optimistic as heat pumps become increasingly profitable and essential for energy security. In Denmark, addressing the perception of high costs and continuing to provide financial incentives could help revive the market.

Countries with Modest Growth:

In contrast, Portugal, Belgium, Norway, the Netherlands, Spain, Germany, Slovakia, and the UK reported modest increases in heat pump sales. However, these gains were not sufficient to offset the overall decline in the region.

Particularly, Belgium, Germany, and the Netherlands each saw significant growth in heat pump sales in 2023, although they faced distinct challenges. Belgium experienced a remarkable 72% increase, spurred by the post-pandemic recovery and high fossil fuel prices, which encouraged investment in sustainable heating solutions. However, by the end of the year, sales began to decline due to rising inflation, higher interest rates, and increasing electricity prices, which dampened demand among builders and homeowners.

Germany's heat pump market grew by 59%, largely influenced by the energy crisis stemming from Russia's war with Ukraine. This crisis made the switch to clean and sustainable heat sources economically appealing. Despite this strong growth, the market faced a substantial drop in sales in the last quarter of 2023 due to uncertainties surrounding the Building Energy Act and funding issues. These challenges reduced consumer confidence, posing a risk to market stability in early 2024.

The Netherlands also saw a 53% increase in heat pump sales, overcoming initial supply chain disruptions caused by material shortages from the Covid-19 pandemic. As manufacturers restocked their inventories, sales rose. However, the market began to cool off towards the end of the year, influenced by rising interest rates and reduced urgency to switch to heat pumps after the energy crisis eased and gas prices fell. Political uncertainties following the fall of *Mark Rutte*'s cabinet also contributed to a cautious market outlook.

2.3.5.2 Europe-wide factors contributing to the decline in heat pump sales

The decline in heat pump sales in Europe in 2023 can be attributed to several factors affecting both investors and consumers, resulting in a notable 5% drop after a decade of continuous growth:

- **Energy Price Fluctuations:** One major factor is **the shift in energy prices**. Following the spike in gas prices due to the Russian invasion of Ukraine in 2022, gas prices fell again in 2023, making electric heat pumps less financially appealing, especially given the persistently high electricity prices. Earlier high gas prices had made electric heat pumps more attractive, but the subsequent drop in gas prices diminished this advantage.

- **Economic Stagnation:** The European economy has stagnated since the summer of 2022, influenced by factors such as high inflation, weak consumer demand, and tightening monetary policy. Despite efforts to boost sectors like tourism and manufacturing, GDP growth has slowed. In this context of **high interest rates, inflation, and overall economic uncertainty**, investment in construction and renovation projects has decreased, impacting the demand for heat pumps.

- **Political and Policy Uncertainty:** Political debates have further contributed to the uncertainty surrounding investment in heat pumps. **A backlash against green policies**, coupled with reduced ambition at both EU and national levels, has dampened market confidence. Additionally, uncertainty about subsidy schemes in some countries has also contributed to the decline in sales.

These factors combined have led to a challenging environment for the heat pump market in Europe, reversing a trend of sustained growth.

The slowdown in heat pump sales has already led manufacturers to implement measures such as job cuts or restrictions, impacting nearly 3,000 employees. This downturn affects not only industry but also poses significant challenges to the EU's climate and energy goals. The decline in sales jeopardizes key targets, including achieving 49% renewables in heating by 2030 and deploying 60 million heat pumps under the REPowerEU initiative (Figure 2-15).

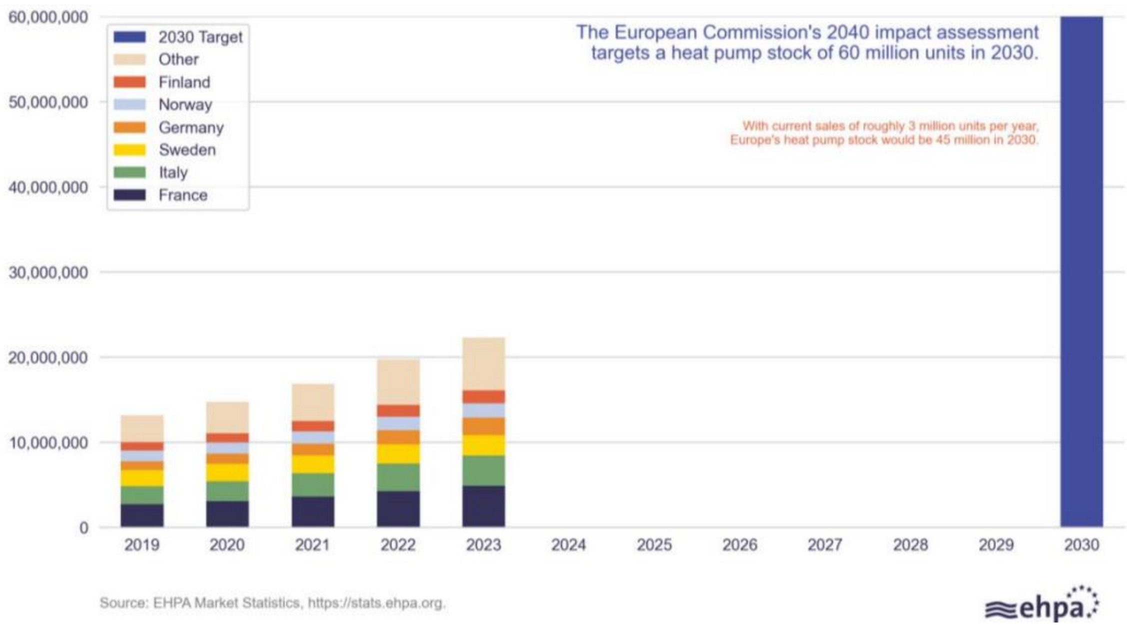

Figure 2-15. Heat Pump stock by countries and target in 2030

2.3.6 Heat pump sales in Italy

In Italy, the heat pump market experienced a significant shift from 2022 to 2023. While 513,540 units were sold in 2022, there was a notable decline in 2023, with only 343,800 units sold, representing a year-on-year decrease of 33%. This result stems from two opposing trends in the air-to-water segments: a significant decline in residential units below 17 kW and strong double-digit growth (+45%) in the commercial segment above 17 kW. Sales of air-to-air heat pumps, both residential and commercial, remained roughly at the same level as in 2022.

The decline in the Italian residential heat pump market in 2023 can be attributed to the end of the free tax credit market, which had previously driven significant demand growth. The introduction of the Superbonus 110% in October 2020, which allowed the free circulation of tax credits and shortened repayment periods, led to a surge in demand as homeowners could renovate their homes essentially for free. However, in February 2023, the government decided to halt the tax credit market due to concerns about the escalating total tax credits being generated and their impact on public accounts. This decision abruptly halted the market's momentum and caused a rapid decline in demand.

Manufacturers were unprepared for the sudden increase in demand, which peaked in the second half of 2021. While they managed to clear the backlog of orders by the end of 2022, wholesalers and installers continued to place orders for fear of product shortages. However, with the government's decision in February 2023, the market began to contract rapidly. As a result, there is now an oversupply of the product in the market, which is further worsening the situation. Looking ahead to 2024, it is expected to be a transitional year as the market awaits the impact of the next generation of incentives currently being developed by the authorities, which are expected to come into effect in the first quarter of 2025.

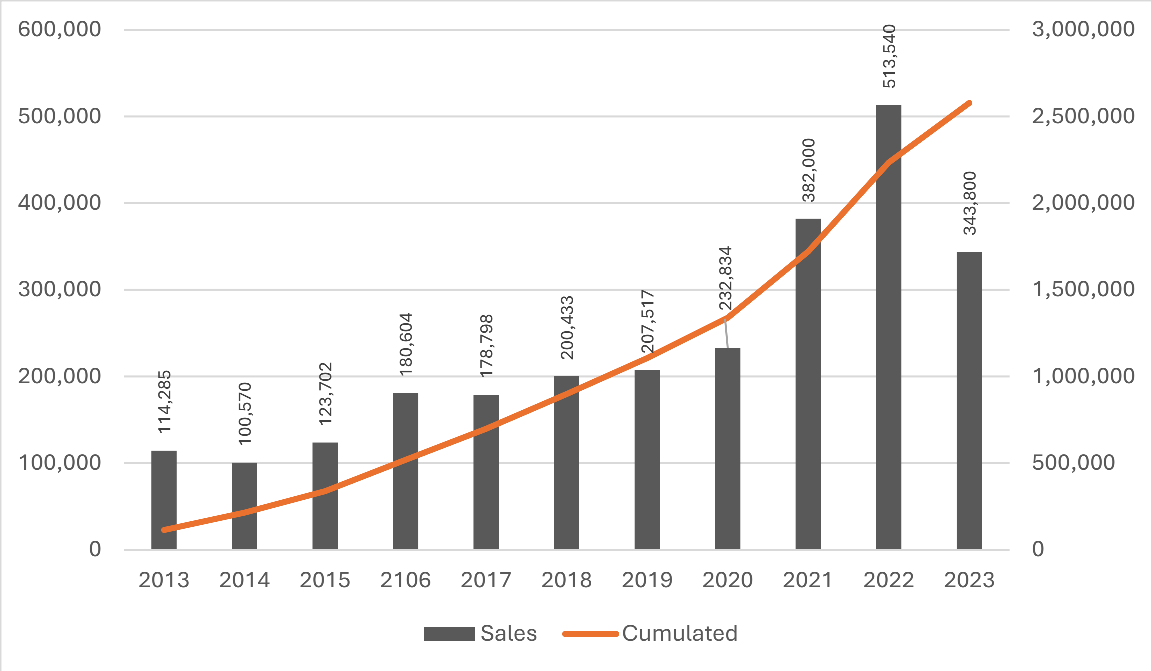

Figure 2-16, Number of Heat pump units sold in Italy, 2013-2023

Despite Italy having one of the top three largest numbers of installed heat pumps in Europe (3.2 million) as of 2022, Norway, with 1.6 million truly green heat pumps, takes first place in the number of installations per 100,000 people (Norway: 29,745; Italy: 5,432). [17]

2.3.7 Barriers and Incentives

Accelerating the deployment of heat pumps to the extent envisioned in the APS hinges on overcoming several barriers, some of which are universal while others are specific to particular countries or regions. The main hurdles for heat pumps in buildings on both the demand side – cost and other market hurdles to customer adoption of heat pumps – and the supply side – practical constraints on expanding manufacturing and the availability of sufficient numbers of trained installers.

2.3.7.1 Cost-Competitiveness of Heat Pumps Compared to Other Heating Technologies

The overall cost-competitiveness of heat pumps relative to other heating technologies is influenced by several factors, including the initial purchase price, operating and maintenance expenses (such as electricity costs), durability, and available financial incentives like grants or tax credits. Generally, heat pumps have higher upfront costs compared to traditional fossil fuel heating systems like oil or gas boilers, even when financial incentives are considered. However, they tend to have lower operating costs over their lifespan due to their superior energy efficiency.

The competitiveness of heat pumps varies significantly by country, depending on these factors. Based on average equipment and fuel prices in 2021 and projected fuel prices in the Announced Pledges Scenario (APS), a new heat pump for an average home in a cold climate is often less expensive than a natural gas condensing boiler in most major heating markets, even without subsidies. However, in some countries, such as the United Kingdom, subsidies are necessary for heat pumps to be cost-competitive. Even in regions where the lifetime cost of a heat pump is the lowest heating option, financial incentives like grants and low-interest loans are often essential to mitigate the initial cost burden, which might otherwise discourage building owners from installing heat pumps.

2.3.7.2 Reducing the Upfront Cost of Heat Pumps

Reducing the initial cost of heat pumps is crucial for increasing their appeal to consumers, especially households. Equipment costs vary based on the type (air-to-air, air-to-water, or ground-source), capacity, quality, and regional market maturity. Installation and ancillary costs, such as electrical and piping work, also vary, influenced by labor costs across different countries.

Typically, residential heat pumps have higher upfront costs compared to fossil fuel boilers. However, in mature markets like Denmark and Japan, the cheapest ductless air-to-air models have become more affordable than gas boilers for small houses due to reduced installation costs. Larger homes may require multiple units, making them more expensive. Air-to-water heat pumps and ground-source heat pumps are generally pricier than gas boilers, with ground-source systems being the most expensive due to the cost of earthworks or drilling.

Despite lower lifetime costs, the higher initial cost of heat pumps can be a barrier. Subsidies in countries like France, the United States, and Poland help make heat pumps more affordable, with higher subsidies available for low-income households and the most efficient models. Upgrading older homes to accommodate heat pumps, such as enhancing electrical systems or replacing radiators, can add to the costs, accounting for up to a third of the total installation expense.

2.3.7.3 Financial Incentive Schemes for Heat Pumps

A wide variety of financial incentives for heat pump installations exist across different countries, influenced by political will, national policy strategies, and local factors. In many regions, financial support is available only if existing fossil fuel boilers are replaced. These countries collectively account for over a third of global heating demand.

Grants are the most common policy tool, available in 30 countries that together represent 70% of global space heating demand. In some places, grants cover most or all the cost for low-income households. Some countries, such as France and the United Kingdom, have reduced or eliminated VAT on alternatives to gas boilers. Income tax credits are also used; for example, Italy's *Superbonus* scheme offers a tax credit worth up to 110% of the cost of substantial building retrofits, including heat pumps. Unlike direct grants, tax credits reach consumers with a delay of up to five years. Additionally, low- or no-interest loans, green mortgages, and specific repayment schemes like pay-as-you-consume are widely available. For medium- and large-scale ground-source heat pump projects, risk-limiting schemes for drilling, such as those in France, are used. Some countries have established "one-stop shops" to help consumers navigate and apply for various types of financial support, with Electric Ireland *Superhomes* being one example.

Other policy measures can also reduce the initial cost of heat pumps. The right regulatory environment can foster new business and financing models that alleviate the upfront financial burden on consumers by allowing costs to be paid back with usage, through models like rental or heat-as-a-service. Regulators should also remove other upfront barriers, such as gas network disconnection charges.

The cost of purchasing and installing heat pumps is expected to decline over the current decade as markets expand and suppliers benefit from economies of scale. The main cost components in manufacturing a heat pump—the compressor, heat exchanger, and electronics—make up about two-thirds of the cost of an air source heat pump. Production costs could be reduced through large-scale automation, provided there are strong and stable policy signals for manufacturers to invest in expanding output capacity. Industry-wide measures like standardizing parts and quality control testing could lower the costs of components, installation, and maintenance. Manufacturers can also develop plug-and-play designs to simplify and reduce the cost of installation. Implementing serial installations across similar buildings in the same neighborhood, as seen in the Dutch-originated *Energiesprong* approach, can help reduce logistical costs. In mature markets, increased competition among installers is also expected to drive costs down.

2.3.7.4 Analysis of the Pros and Cons of Subsidizing Heat Pumps

Subsidizing heat pumps offers several benefits, including the potential to mitigate climate change by promoting the use of more energy-efficient and environmentally friendly heating systems. These subsidies can help lower greenhouse gas emissions, contributing to its climate goals. Additionally, heat pumps can enhance energy efficiency and reduce household heating costs, potentially alleviating fuel poverty. Economic benefits include job creation in the renewable energy and heating sectors and increased demand for installation and related services. Furthermore, subsidies can drive technological innovation, making heat pumps more affordable and accessible over time, and can result in long-term savings on energy bills for consumers.

However, there are also arguments against subsidizing heat pumps. The financial burden on the governments can be significant, especially with extensive programs offering large incentives. Subsidies might also distort the heating systems market, leading to inefficiencies or overuse of the subsidized technology. Equity issues arise as subsidies may mainly benefit wealthier households that can afford the initial installation costs, potentially increasing income inequality. Ultimately, deciding to subsidize heat pumps requires a thorough cost-benefit analysis that accounts for environmental, economic, and social factors.

2.3.7.5 EBRD's Role in Supporting Heat Pump Deployment

The European Bank for Reconstruction and Development (EBRD) promotes the rapid adoption of heat pumps to decarbonize heating systems. Through its Green Economy Financing Facility, the EBRD collaborates with over 170 local financial institutions and 2,300 technology providers to support businesses and homeowners investing in green technologies. The EBRD has invested over EUR 80 million in various projects, primarily in East and South-East Europe, resulting in the installation of 30,000 heat pumps. Additionally, loan funds have facilitated the inclusion of heat pumps in energy efficiency-focused building retrofit programs in Poland and Romania. [1]

To advance heat pump deployment, the EBRD utilizes four main strategies:

- Conducting analyses to optimize the scale-up of heat pump technology in specific markets.
- Collaborating with governments to remove deployment barriers and establish minimum performance standards.
- Assisting municipal infrastructure clients in installing industrial-scale heat pumps for district heating, especially in the Western Balkans, and building-scale heat pumps for deep energy retrofits and new building projects.
- Strengthening green economy finance through the banking sector.

2.3.7.6 Reducing operating costs of Heat Pump

Heat pump operating costs were already lower than those of gas boilers in major heating markets before the current energy crisis. This advantage has increased recently, saving the average European household over USD 900 annually, as electricity tariffs have risen less than gas prices due to government interventions.

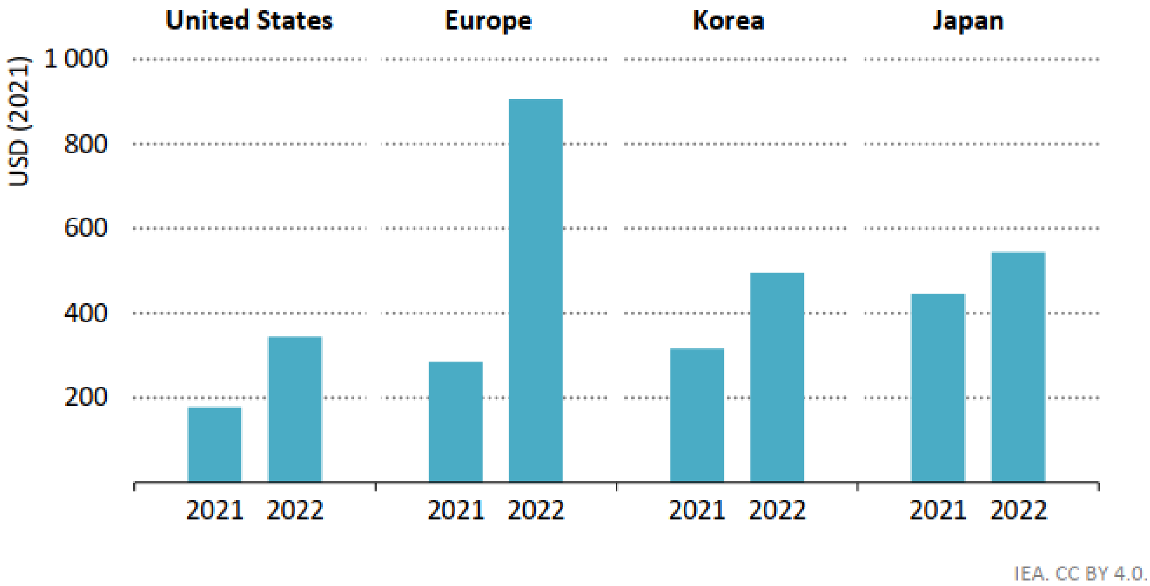

Figure 2-17.Energy bill savings for households switched to heat pump, 2021 and 2022

Fuel tax reforms could further enhance the cost-effectiveness of heat pumps. In some countries, gas is taxed more favorably than electricity, so the operating costs of heat pumps remain higher compared to fossil fuel boilers. Despite heat pumps being three to five times more energy-efficient than boilers, this efficiency doesn't always compensate for the significantly higher cost of electricity. To ensure a quick return on investment and motivate consumers to purchase heat pumps, the price of electricity should be no more than twice that of gas. Italy, Germany and Poland are some of those countries with electricity price between 2.5 to 3.5 times of gas price. For example, the Netherlands reduced electricity taxes while increasing those on gas, making heat pumps cheaper to run. Denmark introduced a lower tax rate for homes heated by heat pumps, and Sweden's high carbon tax has driven a switch from oil boilers to heat pumps. Carbon pricing in over 20 countries also improves heat pump competitiveness, particularly where electricity generation is low-emission. [1,14]

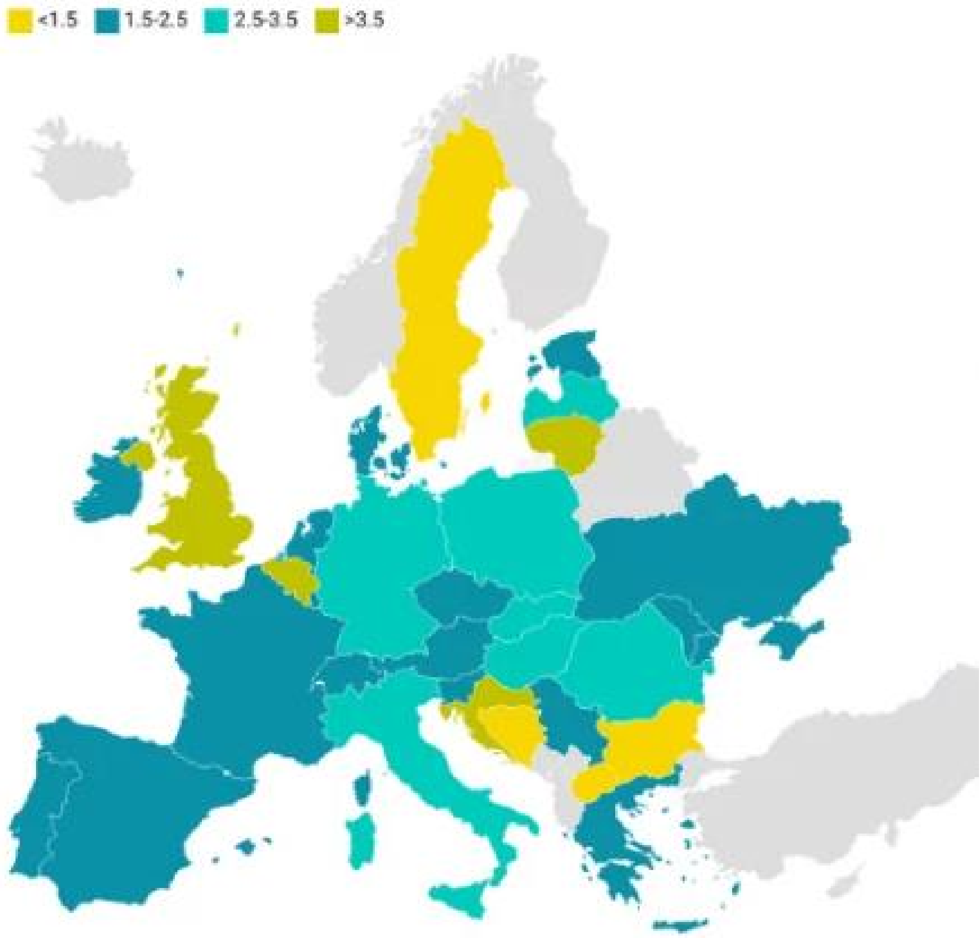

Figure 2-18. Electricity to gas price ratio (Source: EHPA)

Energy taxation and carbon pricing should consider distributional impacts, with measures to protect vulnerable populations funded by higher fuel or carbon tax revenues. Such revenues can also subsidize heat pumps and other clean energy technologies. Electricity tariffs designed to encourage off-peak use, such as dynamic and time-of-use rates, can reduce heat pump running costs. Flexible operation, coupled with rooftop solar PV, can further cut costs, though it requires significant initial investment.

Improved energy efficiency, through well-insulated buildings and efficient heat pumps, reduces both installation and operating costs. Policies like minimum energy performance standards and labelling are crucial for achieving these efficiencies. Proper operation and maintenance are essential for optimal heat pump performance, including regular cleaning and monitoring for refrigerant leaks. Automated control features and integrated metering can enhance efficiency and minimize costs, helping balance the electricity system and mitigate peak demand impacts. Electricity consumption by heat pumps in Denmark is up to 30 times lower in homes with the highest efficiency rating compared with the lowest efficiency rating. (Figure 2-19)

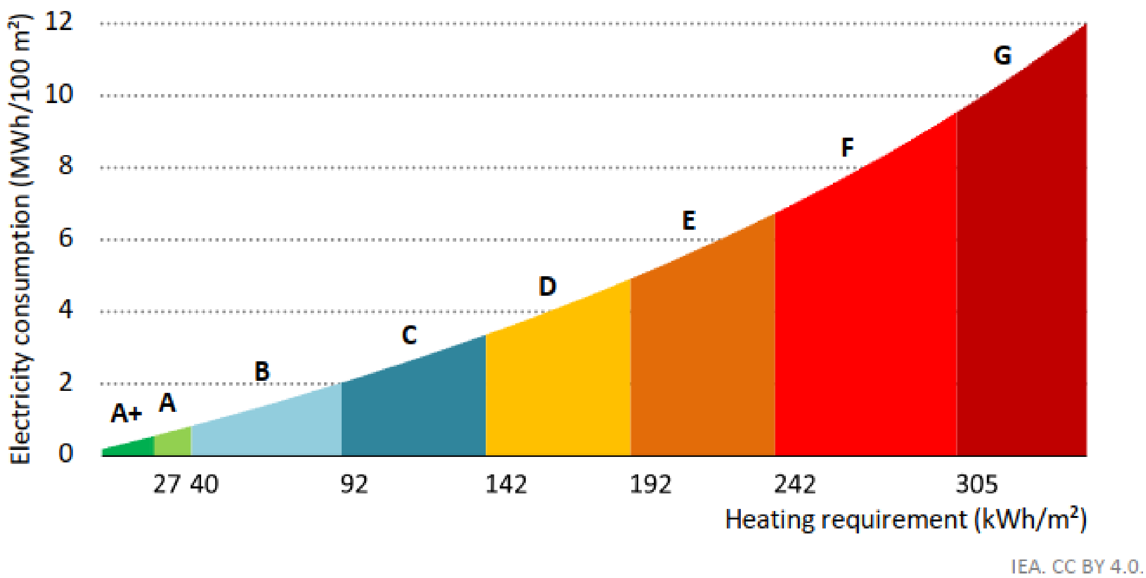

Figure 2-19. Annual Heat pump electricity consumption by building energy efficiency class in Denmark, 2022

2.3.7.7 Non-financial barriers to consumer adoption [1]

Besides cost, several other factors hinder consumer adoption of heat pumps. These include installation restrictions, a lack of information about their benefits, and split incentives between building owners and tenants. While these barriers are less tangible than costs, they significantly contribute to consumer hesitation in choosing heat pumps over other heating systems. If these issues are not addressed, they could deter many consumers and slow the deployment of this technology. Many countries have implemented programs to tackle these barriers, but further efforts are needed to enhance and expand these initiatives.

2.3.7.7.1 Limitations on new installations

Installing a heat pump involves navigating various restrictions, approvals, and practical constraints in most countries. Compliance with building, fire safety, land use, and electrical codes and regulations is typically required. Additionally, approval from homeowners or building associations, concerned about aesthetics and noise, as well as local authorities under planning rules, may be necessary. Limited external space, especially in multifamily buildings, and challenges in attaching external compressor units to building facades pose obstacles. Obtaining approvals and designing systems to avoid constraints can be time-consuming and costly, leading some consumers to abandon the process.

To encourage heat pump deployment, some countries have eased permitting procedures and exempted certain installations from building permits. The European Commission has proposed shorter deadlines for permit-granting processes for heat pumps across the European Union. Despite such efforts, many restrictions persist. A comprehensive review of regulations, codes, and approval processes is necessary to identify redundant or burdensome restrictions. Collaboration among countries can facilitate the sharing of experiences and promote best practices in removing bureaucratic barriers.

2.3.7.7.2 Lack of reliable information

Access to reliable information plays a pivotal role in consumers' decisions to choose heat pumps over alternative heating solutions. The process of evaluating heat pump options, selecting an installer, securing approvals, and qualifying for subsidies can be intricate and time-consuming, dissuading many prospective buyers from proceeding. Surveys reveal that these challenges are often cited by consumers who ultimately decide against purchasing a heat pump.

Energy labeling serves as a vital tool for consumers to identify the most energy-efficient heating options, particularly in regions where minimum energy performance standards are enforced for heating and cooling technologies. These labels should encompass not only energy efficiency but also features like smart readiness, recyclability, and noise reduction to guide consumers effectively.

Information and awareness campaigns are instrumental in dispelling misconceptions surrounding heat pump performance. Many consumers remain unaware of the significant advancements in heat pump efficiency and noise reduction in recent years. Community-level dialogues can foster consumer trust in the technology by sharing insights and addressing concerns. Some countries have adopted one-stop shops to aid consumers in comparing options, evaluating lifetime costs, selecting approved installers, securing financing, and applying for subsidies, particularly beneficial during "distress purchases" prompted by sudden heating system failures. These shops can also facilitate installer-client connections. Alternatively, requiring energy utilities to provide comparison tools or offering free third-party energy audits can empower consumers to make well-informed decisions about replacing their heating systems.

2.3.7.7.3 Split incentives between houseowners and tenants

Challenges arising from split incentives between building owners and tenants often hinder investments in energy-efficient heating systems like heat pumps. Building owners may hesitate to invest in heat pumps if they cannot ensure recovering the costs through higher rents or increased property resale value, despite the potential property value premium associated with heat pump installations. Some governments have enacted laws allowing homeowners to adjust gross rent by a portion of heating cost savings to incentivize landlords to invest in heat pumps. Additionally, minimum energy efficiency standards for rented properties or properties at the point of sale can encourage heat pump investments.

Financial models such as energy performance contracts and heat-as-a-service agreements can mitigate split incentive barriers by minimizing or eliminating upfront costs. These models involve agreements between building owners and tenants, transferring financial, performance, or technical risks to specialized service companies or utilities. The upfront costs are then recouped through regular fees over a specified period, sometimes based on actual energy savings. Many of these models aim to provide alternatives to traditional loans, with the heat pump often remaining the property of the service company, thus reducing financial risks for property owners.

2.3.7.7.4 Manufacturing constraints

Accelerating the global deployment of heat pumps to the levels anticipated in the APS requires a significant expansion of manufacturing capacity. Manufacturers face potential constraints such as material and component availability, business and investment climates, and regulatory hurdles. Policy makers must recognize these challenges and support the private sector in overcoming them. Currently, most heat pumps are produced in China, the United States, Europe, Japan, and Korea. Despite some unused capacity—around 20% of total capacity in 2021—this surplus would only suffice to meet the APS's projected sales increase for two years. Additionally, the supply of essential materials and specialized components like compressors, heat exchangers, and refrigerants needs to scale up rapidly.

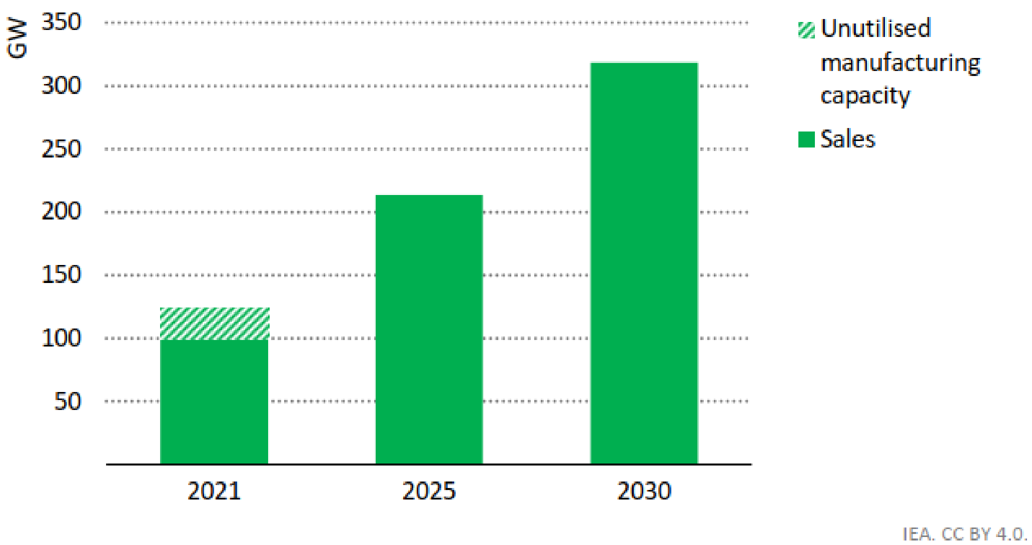

Figure 2-20. Heat pump Sales and unutilized manufacturing capacity in the APS

Governments are increasingly involved in encouraging domestic investment in heat pump manufacturing, addressing supply chain issues, and promoting innovation. Various countries have introduced policies to promote the local production of essential clean energy technologies, including heat pumps. For example, the US Defense Production Act specifically targets heat pumps, while the EU's European Chips Act and Critical Raw Minerals Act focus on semiconductors and critical minerals. Some countries offer research, development, and deployment (RD&D) support for heat pumps, alongside deployment targets, bans on fossil fuel boilers, and consumer incentives, providing market certainty for manufacturers expanding their production. The UK government is planning a rising quota for heat pump sales relative to overall heating system sales by boiler manufacturers. Reducing regulatory uncertainty is crucial for manufacturers' commitment to scaling up production. In the European Union, the revised F-gas Regulation, expected to take effect in 2024, will provide clear guidelines on F-gas usage for heat pump manufacturers. Leading manufacturers have announced plans to invest over EUR 4 billion in expanding heat pump production capacity, with most projects in Europe, though new projects are also emerging in other regions.

2.3.7.7.5 Shortages of skilled installers

The global expansion of heat pumps as envisioned in the APS requires a significant increase in the workforce, particularly in installation. Currently, half of heat pump workers handle installations, with a quarter in maintenance. Demand for installers is expected to quadruple by 2030, reaching over 850,000. This growth necessitates certified training programs for new installers.

A shortage of skilled installers is causing bottlenecks in several countries. Installation requires skills similar to those in construction, with additional specializations like property assessment, heat loss calculation, system updates, and electrical work. Some skills can be acquired on the job, but others, like heat pump sizing and refrigerant handling, require certified training. Ground-source heat pumps need extra qualifications, suitable for skilled drilling engineers from the oil and gas sector.

High standards for installers are crucial to avoid poorly performing systems and frequent maintenance issues, which can breach warranties and insurance terms. Certification schemes vary by region and are not internationally harmonized. Extensive certification requirements can discourage workers from obtaining qualifications. To address this, certifications can be built on existing schemes for electricians, plumbers, and heating technicians. Many manufacturers offer shorter, targeted training programs to speed up certification.

Standardizing credentials across regions could expand the workforce and enhance labor mobility. Policies like boiler bans can provide long-term industry certainty. Governments can promote installer training by updating certifications, offering vocational education incentives, and supporting apprenticeships. Countries like the Netherlands and the UK have launched programs to train installers, particularly since the REPowerEU initiative.

Manufacturers can ease installer shortages by designing robust, standardized, and easy-to-install heat pumps and providing digital tools to aid installation companies. Open data on building characteristics can support business models that facilitate installation assessments and connect customers with installers.

2.3.8 Market Segmentation

2.3.8.1 By Technology

Heat pump technology segmentation includes air source heat pumps (ASHP) for residential and light commercial use, ground source heat pumps (GSHP) for higher efficiency in larger applications, water source heat pumps (WSHP) for properties near water bodies, and hybrid heat pumps that combine conventional and heat pump systems for flexibility and efficiency. This segmentation ensures tailored solutions for various environmental and efficiency needs. The air-source technology segment dominated the heat pump market with an 83% share in 2023.

Numerous advantages are driving the increasing dominance of air-source heat pump technology in the market. Firstly, they are often more cost-effective compared to alternatives like ground source heat pumps. With lower installation and operating costs, air source heat pumps are attractive for both residential and commercial use. Their ease of installation, without the need for extensive drilling or ground excavation, makes them a practical choice, especially for retrofitting heating systems in older buildings.

Another key factor contributing to the popularity of air-source heat pumps is their versatility. They perform well in various weather conditions, including colder climates, thanks to advancements in technology that have enhanced their cold-weather efficiency.

Additionally, air-source heat pumps require less installation space compared to ground-source heat pumps, making them a preferred option, particularly in urban areas with limited space.

For example, in July 2023, Navian UK, a Guildford-based boiler manufacturer, unveiled a monobloc heat pump, marking their entry into the air source heat pump market. This innovative product, along with their latest H2 100% hydrogen boiler, aligns with the growing trend of offering alternative heating solutions as part of the government's goal to achieve net-zero emissions by 2050.

Meanwhile, the water-source technology segment is experiencing significant growth in the heat pump market. This growth is attributed to the sustainability and efficiency of water source technology, leading to a notable increase in its market share within the industry. Water source heat pumps utilize the constant temperature of water bodies such as lakes, rivers, or underground aquifers for heat exchange. The higher thermal conductivity of water compared to air enhances the effectiveness of this technology.

The rising focus on renewable energy solutions and the demand for environmentally friendly alternatives are key drivers behind the expansion of water-source heat pumps. By leveraging the natural heat reservoirs of water bodies, these heat pumps help reduce carbon footprints by decreasing reliance on fossil fuels. Water-source heat pumps offer higher efficiency, lower operational costs, and environmental benefits compared to their air-source counterparts. This affordability has caught the attention of both businesses and consumers, leading to a favorable trend in the market.

2.3.8.2 By Application

Heat pumps are segmented by application into residential heating and cooling, commercial heating and cooling, industrial process heating and cooling, and hot water heating. In residential settings, the demand is driven by energy efficiency improvements and government incentives, despite high initial costs. Commercial applications see growing adoption in offices and public buildings due to operational cost reductions and sustainability goals. Industrial uses focus on precise temperature control and energy efficiency in manufacturing processes, though they require high customization. Lastly, hot water heating is significant across all sectors, propelled by energy savings and incentives, with challenges in retrofitting existing systems.

In 2023, the residential segment captured the largest market share at 86%. Residential applications have emerged as the dominant sector in the heat pump market for several compelling reasons. Firstly, households are increasingly seeking alternative heating and cooling solutions driven by a growing focus on sustainability and energy efficiency, making heat pumps an attractive choice. These systems utilize the Earth's natural temperature or ambient air to provide heating and cooling, resulting in overall energy savings.

Advancements in technology have played a significant role in enhancing the cost-effectiveness, reliability, and efficiency of heat pumps for residential use. Improved designs, variable-speed compressors, and smart controls enable greater efficiency and energy savings, appealing to households seeking both environmentally friendly and economical options.

For example, in November 2023, LG introduced a propane heat pump for residential use that utilizes air-to-water technology. This new product boasts a seasonal coefficient of efficiency (SCOP) exceeding five and utilizes propane refrigerant with a lower global warming potential. LG claims that it can achieve flow temperatures of 75°C and 100% heating output even in -15°C temperatures.

On the other hand, the industrial segment is experiencing significant growth in the heat pump market during the projected period. Several key factors are driving this growth within the industrial sector. The increasing global focus on sustainable and energy-efficient technologies has led industries to adopt heat pumps as environmentally friendly alternatives for heating, ventilation, and air conditioning (HVAC) systems. By harnessing renewable energy sources like air or water for heat transfer, these pumps help in reducing carbon emissions and operating costs.

Furthermore, advancements in heat pump technology have bolstered their efficiency, making them a compelling choice for industries seeking to optimize energy consumption. The versatility of heat pumps in providing heating and cooling solutions caters to the diverse requirements of industrial processes. Government incentives and regulations promoting energy efficiency and environmental stewardship have further encouraged industrial players to invest in heat pump systems. Financial incentives such as tax credits or subsidies for adopting sustainable technologies have motivated industries to make the transition.

Industries are increasingly viewing heat pumps as strategic investments due to a growing recognition of the long-term financial benefits associated with lower operational costs and energy consumption. This shift is particularly significant for sectors like manufacturing and processing facilities with high energy demands.

2.3.8.3 By Rated Capacity

Heat pump capacity segmentation generally includes small-capacity units (up to 20 kW) for residential use, medium-capacity units (20 kW to 100 kW) for commercial applications like offices and retail spaces, and large-capacity systems (above 100 kW) for industrial processes and large commercial buildings. Small-capacity units cater to individual homes and small apartments, medium-capacity units are used in larger residential buildings and small to medium-sized commercial facilities, and large-capacity systems are designed for industrial facilities and extensive commercial applications where higher heating and cooling demands are required. This segmentation ensures that heat pumps are appropriately scaled to meet the specific energy needs and efficiency requirements of different market segments. In 2023, the 10 – 20 kW segment held the largest share of over 23% in the heat pump market.

Several causes are responsible for the rise of the 10-20kW segment in the heat pump market. First, this line fits nicely with the growing need for small-scale commercial and residential applications, where efficiency and capacity must be balanced. As energy efficiency gains traction, consumers choose heat pumps in this power range because they minimize energy use while providing necessary heating and cooling. Technological developments have also been crucial. Higher efficiency levels in the 10–20kW range result from improved compressors, heat exchange systems, and componentry, which appeals to consumers more. Manufacturers also create intelligent and networked products that enable customers to optimize energy using remote control and monitoring.

Enhanced awareness and education are further factors driving the market's expansion. The market for these systems is growing as more people become aware of the advantages of 10–20kW heat pumps, such as decreased energy costs and less of an impact on the environment. This positive feedback loop in the heat pump business drives the 10–20kW category to new heights through awareness, technological breakthroughs, and government backing.

2.3.8.4 Regional Insights

In 2023, the Asia Pacific region led the heat pump market, accounting for 53.14% of global revenue. This region benefits from a large, low-cost skilled labor force. The trend of relocating production bases to emerging economies, particularly China and India, is expected to positively impact market growth over the forecast period. Energy-saving solutions are gaining prominence in countries such as China, Japan, Indonesia, and India.

North America, dominated by the U.S. and Canada, held a significant share of the global heat pump market in 2023. Government initiatives and rebates to promote energy-saving and environmentally friendly technologies are expected to drive demand for advanced heat pumps. Additionally, increasing carbon emissions and fluctuating energy prices are pushing consumers towards renewable heating sources, which is expected to boost regional market growth.

According to a 2020 report by the European Commission, the economic potential of geothermal power in Europe, including enhanced geothermal systems, is projected to be 19 GWe in 2020, 22 GWe in 2030, and 522 GWe in 2050. Geothermal energy has various applications, including district heating, agriculture, and industrial processes. Ground source heat pumps, with two million systems installed, are the most widely adopted geothermal technologies in the EU, especially in Sweden and Germany, driving the growth of the European heat pump sector.

The construction sector in the Middle East & Africa is expected to witness significant growth in the coming years due to strong government support for infrastructure development. The region is seeing new developments in sports facilities, hotels, and restaurants. As the construction industry grows, the demand for sustainable cooling solutions like heat pumps is anticipated to rise, contributing to the growth of the heat pump market in the Middle East & Africa.

Chapter 3

3 Methods and Results

3.1 Methodology

3.1.1 Research Design

This study employed a survey research design to gather quantitative data on the heat pump market, acceptance and perception of it among residents in Italy. The survey was designed to collect data on demographics, current heating systems, awareness and perceptions of heat pumps, and factors influencing the decision to install a heat pump.

3.1.2 Survey Development

The survey instrument was developed based on a comprehensive review of existing literature on renewable energy adoption and heat pump technology. The questions were formulated to answer three main questions of this research and to cover key areas, that are including:

1. **Demographics:** Age, gender, education level, region of residence, income, homeownership, type of dwelling
2. **Current Heating System:** Type of heating system currently used and the satisfaction level.
3. **Awareness and Perception of Heat Pumps:** Familiarity with heat pump technology and types, sources of information, perceptions of heat pumps.
4. **Purchasing Intentions and Preferences:** Likelihood of installing a heat pump or renting a house with heat pump, factors influencing the decision, willingness to pay higher upfront cost, awareness about Bonus.

5. **Additional Concerns and Barriers:** Barriers to adoption (concerns about heat pump).
6. **Adoption and Attitude**: Approaching new technologies, recommending Heat pump.

3.1.3 Data Collection

Data was collected by using an online survey platform, Google Forms to ensure ease of access and wider reach. The survey was distributed through various channels, including social media and community forums in both English and Italian languages, targeting residents across different regions of Italy. However, as the spreading of the survey started from the North of Italy, most of the participants are from this region.

3.1.4 Methods and Analysis tools

Data analysis was conducted using statistical software such as SPSS and Excel. The analysis included:

1. **Descriptive Statistics:** Frequencies, percentages, mean, and standard deviation were calculated to summarize the demographic characteristics and overall responses.
2. **Inferential Statistics:** Independent sample t tests and Chi-square were used to identify significant differences between groups and examine the relationships between variables.
    - **Independent sample t tests**:
      The Independent Samples t-Test results include two main components: (A) Levene's Test for Equality of Variances and (B) the t-test for Equality of Means. These tests are used to determine whether there is a statistically significant difference between the means of two independent groups.

To establish if the observed differences are statistically significant and real, three key criteria are checked:

1. **Levene's Test for Equality of Variances**:

This test checks if the variances of the two groups are equal.
If the p-value (sig.) is less than 0.05, it indicates a significant difference in variances, and the null hypothesis of equal variances is rejected. In this case, the "Equal variances not assumed" row for the t-test results should be referred.
If the Levene's test p-value is greater than 0.05, the equal variances will be assumed, and the "Equal variances assumed" row should be referred.

2. **t-Test for Equality of Means:**

- Confidence Interval of the Difference: This complements the significant test results. If the confidence interval (CI) for the mean difference includes 0 (i.e., the lower boundary is negative and the upper boundary is positive), the results are not statistically significant at the chosen significance level.
- Significance (p-value): The p-value associated with the t-test indicates whether the mean differences are statistically significant. A p-value less than 0.05 typically indicates a significant difference between group means.

3. **Effect Size:**

Effect size measures the magnitude of the difference between groups, which helps determine if the observed difference is meaningful.

Cohen's d is commonly used to assess effect size and it interpret based on the value of effect:

0.2 = small effect

0.5 = moderate effect

0.8 = large effect

3.1.5 Ethical Considerations

Ethical considerations included ensuring informed consent, maintaining participant anonymity, and securely storing data. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time.

3.2 Results and Data Analysis

3.2.1 Descriptive Analysis

3.2.1.1 Demographics

3.2.1.1.1 Gender Distribution

In this survey, there were 45 participants. Among them, 42.2% were female, while 57.8% were male.

Table 1. Gender frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	19	42.2	42.2	42.2
	Male	26	57.8	57.8	100.0
	Total	45	100.0	100.0	

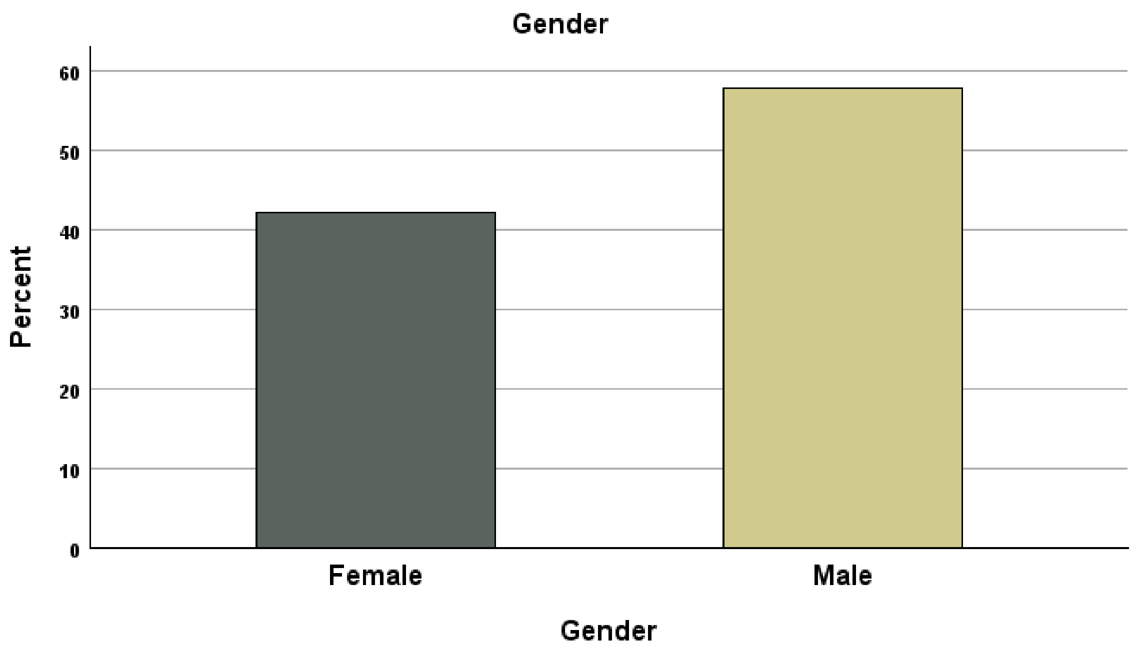

Figure 3-1Gender Percentages

3.2.1.1.2 Age Distribution

The age distribution of the survey participants shows that the majority, 62.2%, were between 25-34 years old. The second largest age group was 35-44 years old, comprising 17.8% of the participants. The remaining age groups were represented as follows: 18-24 years old at 11.1%, 55-64 years old at 6.7%, and 65+ years old at 2.2%. Notably, there were no participants in the 45-54 age range.

Table 2 Age Category Statistic.

Statistics

N	Valid	45
	Missing	0
Mean		2.36
Std. Deviation		1.069

Table 3. Age Categories Percentage

		Frequency	Percent	Valid Percent
Valid	18-24	5	11.1%	11.1
	25-34	28	62.2%	62.2
	35-44	8	17.8%	17.8
	45-54	0	0.0%	0.0
	55-64	3	6.7%	6.7
	65+	1	2.2%	2.2
	Total	45	100.0%	100.0

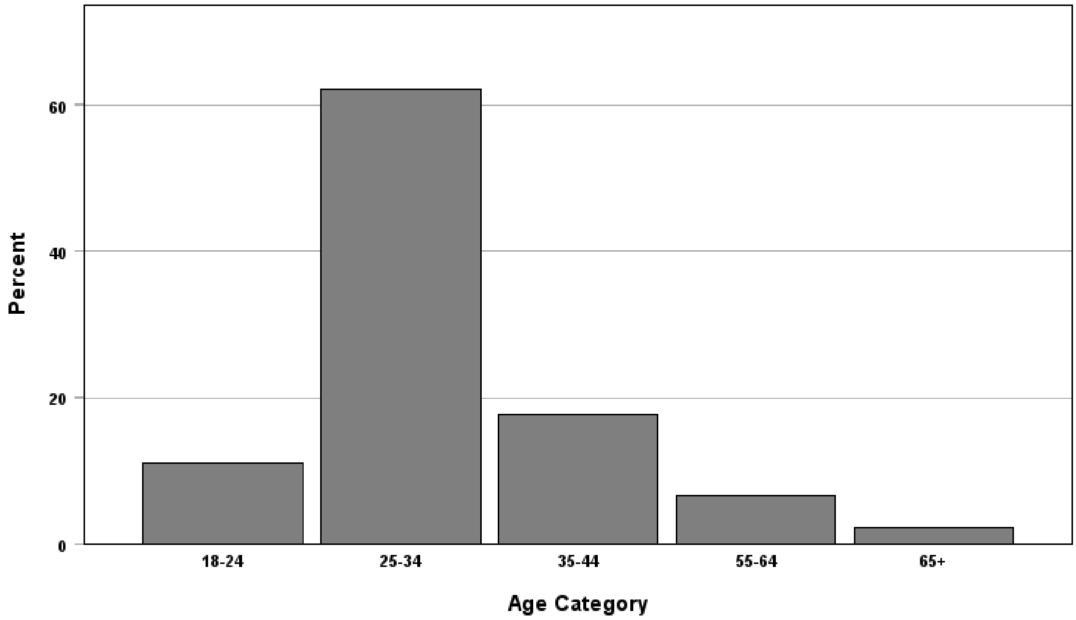

Figure 3-2. Age categories Percentage

3.2.1.1.3 Regional Distribution of Participants

Due to accessibility, the majority of survey participants are from Northern Italy, comprising 73.3% of the total respondents. The next largest group is from Central Italy, accounting for 15.6%. Participants from Southern Italy and the Islands are less represented, with 8.9% and 2.2% respectively. This regional distribution reflects the geographical reach of the survey and may influence the overall findings.

Table 4. Regions Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Islands	4	8.9	8.9	8.9
	South	1	2.2	2.2	11.1
	Center	7	15.6	15.6	26.7
	North	33	73.3	73.3	100.0
	Total	45	100.0	100.0	

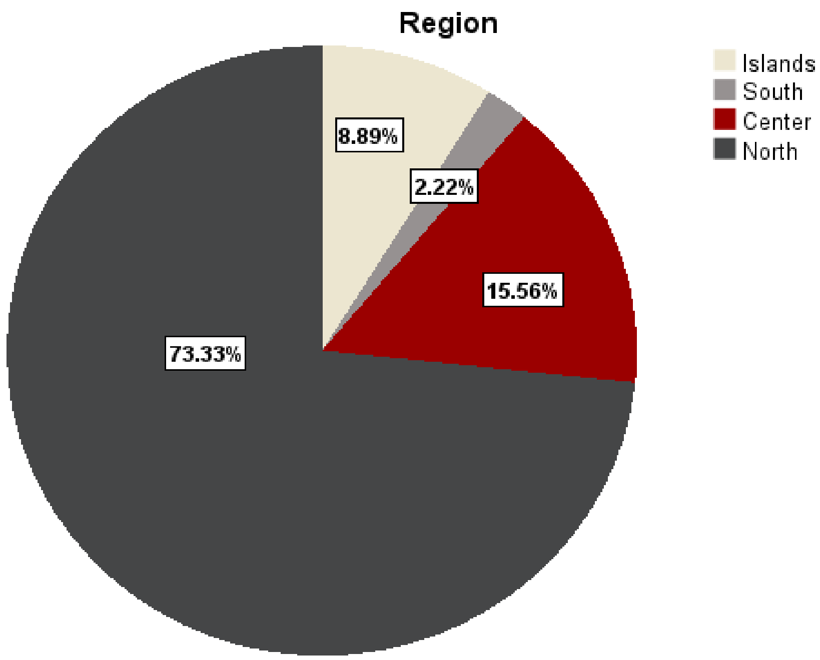

Figure 3-3.Regions distribution pie chart

3.2.1.1.4 Education Level of Participants

The distribution of education levels among participants reveals interesting trends. A notable proportion holds either a high school diploma or equivalent (33.3%) or a master's degree (31.1%), showing a close distribution between these two groups. Participants with a bachelor's degree make up 22.2%, positioning them in third place. The remaining respondents are distributed as follows: 2.2% have less than a high school education, 6.7% have some college or vocational training, and 4.4% hold a doctorate or higher. This varied educational background provides a comprehensive overview of the surveyed population's academic attainment, which may influence their familiarity with and attitudes towards heat pump technology.

Table 5. Education level statistics

Statistics

N	Valid	45
	Missing	0
Mean		3.60
Median		4.00
Std. Deviation		1.405

Table 6. Education Levels frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	1	2.2	2.2	2.2
	High school diploma or equivalent	15	33.3	33.3	35.6
	Some college or vocational training	3	6.7	6.7	42.2
	Bachelor's degree	10	22.2	22.2	64.4
	Master's degree	14	31.1	31.1	95.6
	Doctorate or higher	2	4.4	4.4	100.0

Total	45	100.0	100.0	

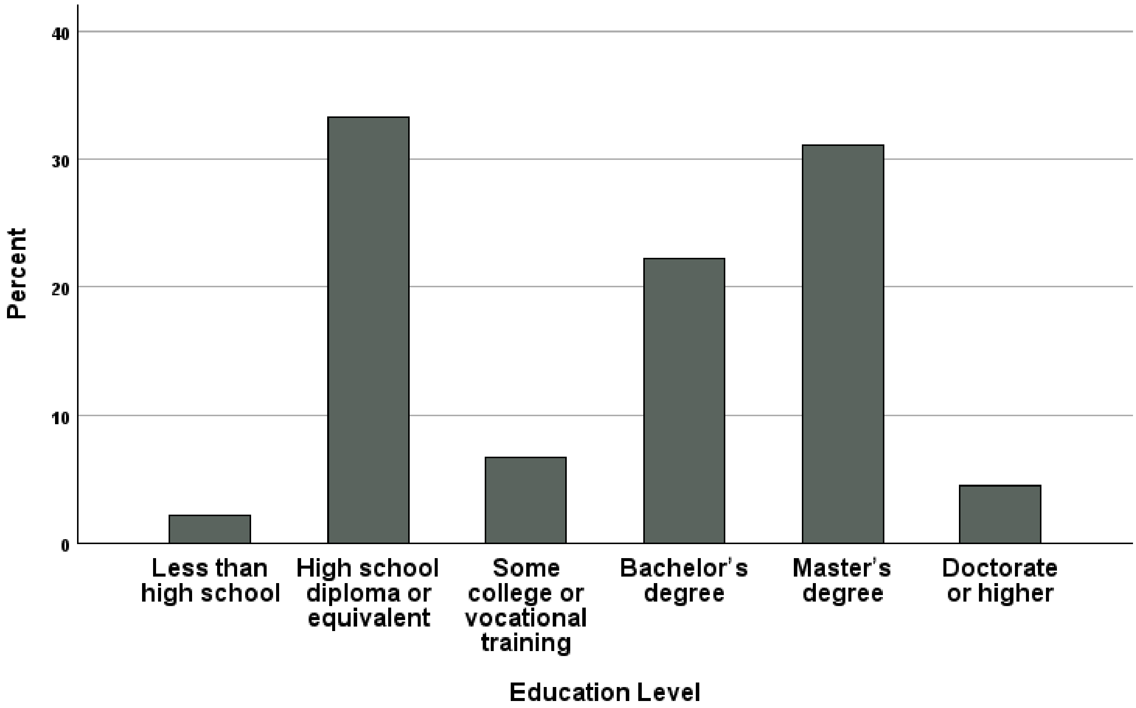

Figure 3-4. Education level bar chart in percent

3.2.1.1.5 Dwelling Types of Participants

The survey results show that the majority of participants (51.1%) reside in apartments with up to 5 floors. The next largest group, comprising 28.9% of respondents, live in houses with 1 to 3 floors. Finally, 20% of the participants live in apartments with up to 10 floors. This distribution highlights the diversity in dwelling types among the surveyed population, which could influence their preferences and feasibility regarding the installation of heat pump systems.

Table 7. Dwelling Types Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single-family house, 1 to 3 floors	13	28.9	28.9	28.9
	Apartment, 3 to 5 floors	23	51.1	51.1	80.0
	Apartment, up to 10 floors	9	20.0	20.0	100.0
	Total	45	100.0	100.0	

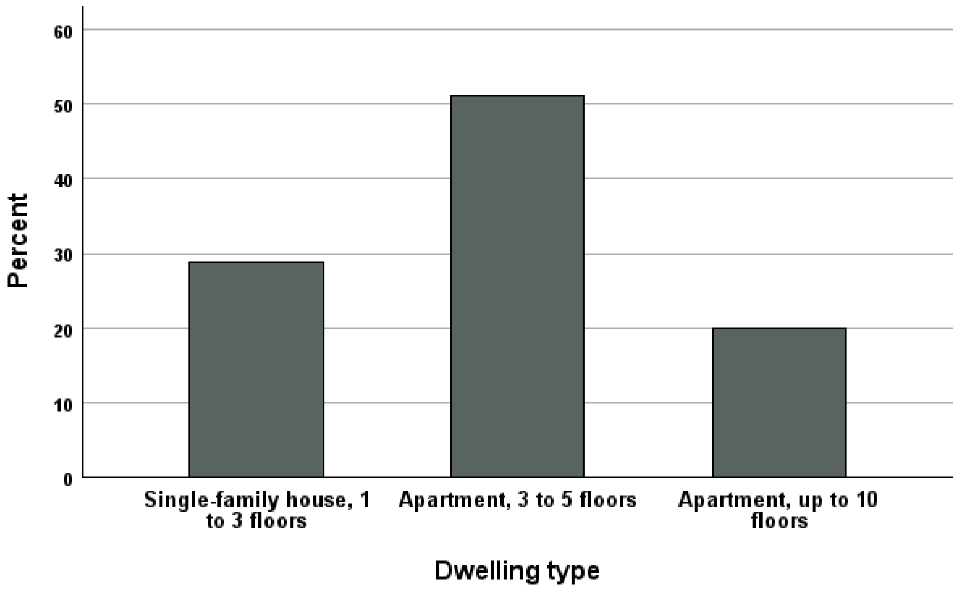

Figure 3-5. Dwelling types bar chart

3.2.1.1.6 Annual Income of Participants

The survey reveals that 55.6% of participants have an annual income before tax of up to 28,000 euros. A further 40% report incomes between 28,000 and 50,000 euros, while only 4.4% have annual incomes exceeding 50,000 euros. However, due to the lack of information on the employment status of the participants, it is unclear what proportion of the first group (up to 28,000 euros) might include individuals with no income. This uncertainty should be considered when interpreting the financial capacity of respondents to invest in heat pump technology.

Table 8. Annual Income Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 28,000€	25	55.6	55.6	55.6
	28,001€ to 50,000€	18	40.0	40.0	95.6
	50,000€+	2	4.4	4.4	100.0
	Total	45	100.0	100.0	

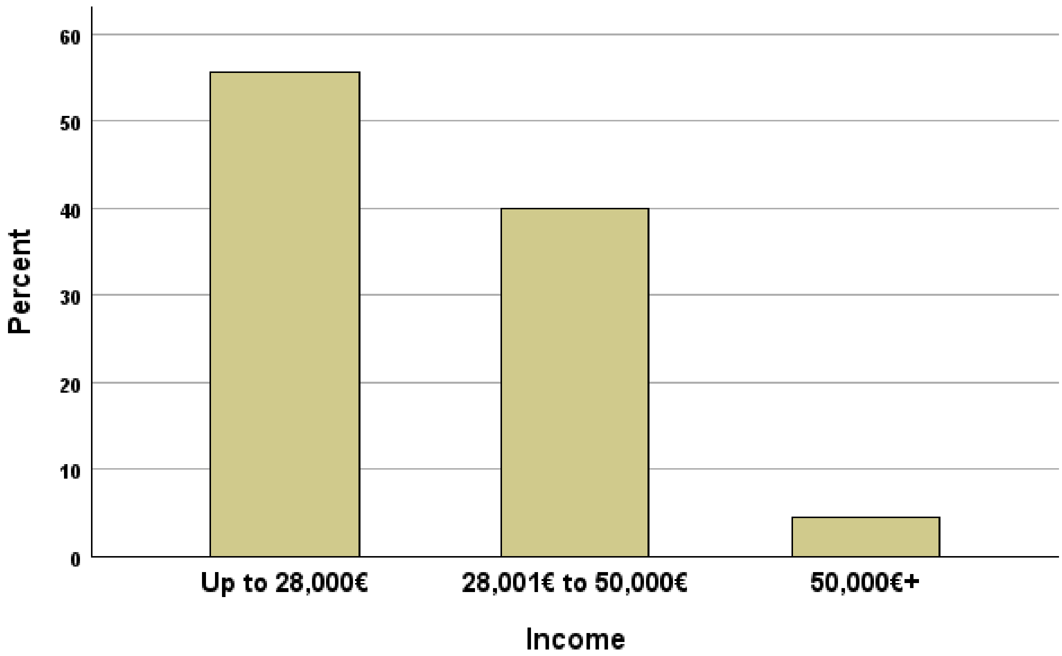

Figure 3-6.Annual Income before tax, bar chart

3.2.1.1.7 House ownership status

53% of respondents are tenants, while 26.7% own their homes. The remaining 20% live with family and don't have decision-making power over the heating and cooling systems. This distribution is crucial when considering heat pump adoption, as factors like ownership and decision-making authority can significantly impact investment in home improvement projects like heat pump installations.

Table 9. House Ownership Status frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner	12	26.7	26.7	26.7
	Tenant	24	53.3	53.3	80.0
	Not Decision makers	9	20.0	20.0	100.0
	Total	45	100.0	100.0	

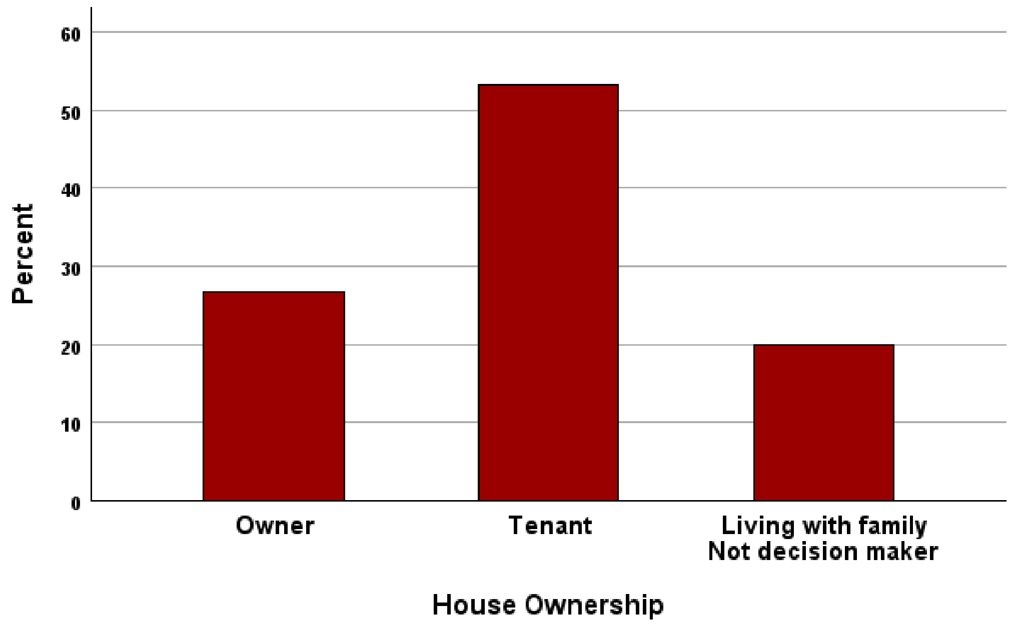

Figure 3-7, House ownership Status, Bar chart

3.2.1.2 Current Heating System

3.2.1.2.1 Current Heating System

The most common heating system among participants are the Central heating systems, including two district heating systems, used by 37.8%. Gas boilers are slightly less, at 35.6%. Additionally, 15.5% use electric boilers. Other types of heating, such as "Stufa a legna," are primarily found in the Islands and Central Italy. One participant uses an air conditioner for both heating and cooling, but this individual has not chosen a heat pump.

Table 10. Current Heating Systems frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Gas boiler	16	35.6	35.6	35.6%
	Electric heater/Boiler	7	15.6	15.6	51.1%
	Central heating	15	33.3	33.3	84.4%
	Other - District heating	2	4.4	4.4	88.9%
	Other - Stufa a legna	4	8.9	8.9	97.8%
	Other - Condizionatori	1	2.2	2.2	100.0%
	Heat Pump	0	0.0	0.0	100.0%
	Total	45	100.0	100.0	100.0%

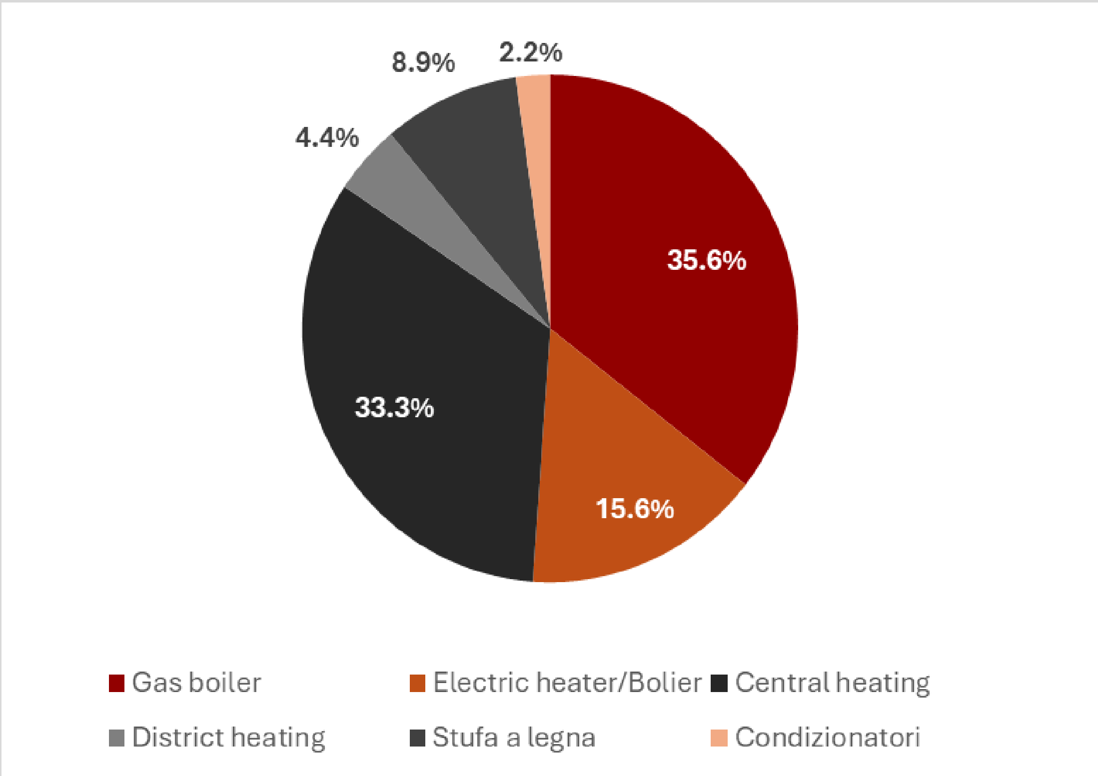

Figure 3-8. Current heating system Pie chart

3.2.1.2.2 Current heating system Satisfaction Level

The frequency distribution of satisfaction with the current heating system among the 45 participants is as follows:

A small number of participants, 4.4% (2 individuals), reported being very dissatisfied with their current heating system. 13.3% (6 individuals) indicated they were dissatisfied. The largest group, 35.6% (16 individuals), expressed a neutral stance regarding their satisfaction. 31.1% (14 individuals) were satisfied with their heating system. Lastly, 15.6% (7 individuals) reported being very satisfied.

Table 11. Satisfaction of Current Heating System frequency

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Very dissatisfied	2	4.4	4.4	4.4
	Dissatisfied	6	13.3	13.3	17.8
	Neutral	16	35.6	35.6	53.3
	Satisfied	14	31.1	31.1	84.4
	Very satisfied	7	15.6	15.6	100.0
	Total	45	100.0	100.0	

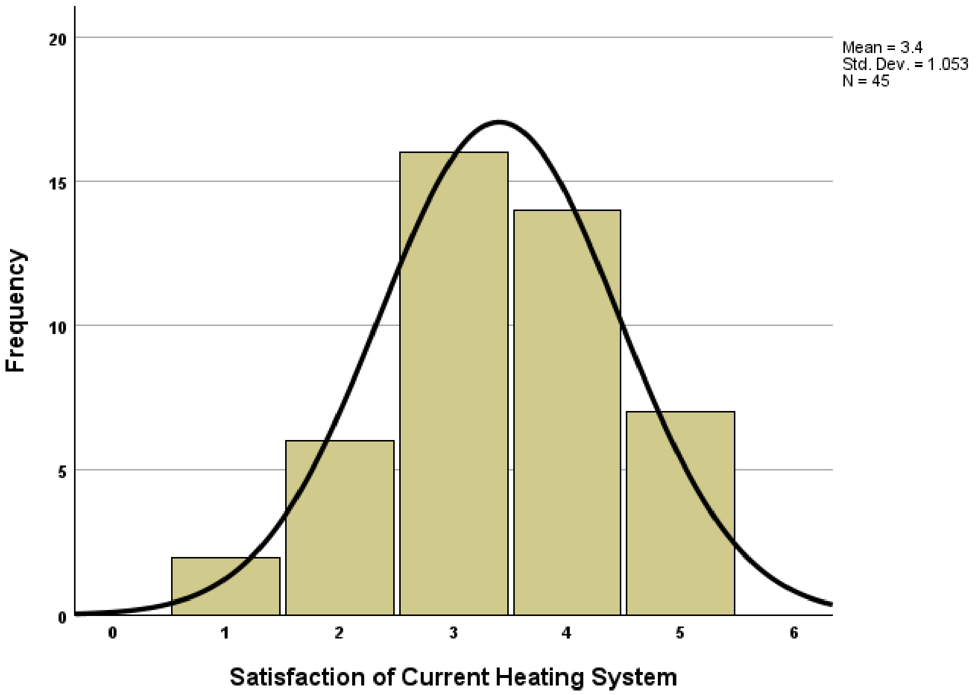

Figure 3-9. Satisfaction of Current Heating System Histogram

Table 12. Satisfaction of Current heating system statistic

Statistics

N	Valid	45
	Missing	0
Mean		3.40
Median		3.00
Std. Deviation		1.053

- **Mean (3.40)**: The average satisfaction score is 3.40, which is slightly above the neutral midpoint (3 on a 5-point scale). This suggests that, on average, participants are moderately satisfied with their current heating systems.
- **Median (3.00)**: The median score of 3.00 indicates that half of the participants rated their satisfaction at 3 or below, and half rated it above 3. This aligns with the mean, showing that the distribution of responses is fairly centered around the midpoint.

- **Standard Deviation (1.053)**: The standard deviation of 1.053 indicates moderate variability in satisfaction scores. This suggests that while most responses cluster around the mean, there is some diversity in how participants feel about their heating systems.

This distribution suggests a range of satisfaction levels, with the highest percentage of participants being neutral, followed by satisfied individuals. The presence of both satisfied and dissatisfied respondents indicates diverse experiences with their current heating systems.

3.2.1.3 Awareness and Perception of Heat Pumps

3.2.1.3.1 Familiarity with Heat Pumps

Among the participants, 40% are somewhat familiar with heat pumps, while 24.4% are not familiar at all. Additionally, 20% are not very familiar, and 15% are very familiar with heat pump technology. After this question, a brief informational section with a picture was provided, explaining how heat pumps work, their efficiency, and the different types available. However, 2 individuals from the 24.4% who were not familiar with heat pumps did not continue with the survey.

Table 13. Heat Pumps Familiarity frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all familiar	11	24.4	24.4	24.4
	Not very familiar	9	20.0	20.0	44.4

	Somewhat familiar	18	40.0	40.0	84.4
	Very familiar	7	15.6	15.6	100.0
	Total	45	100.0	100.0	

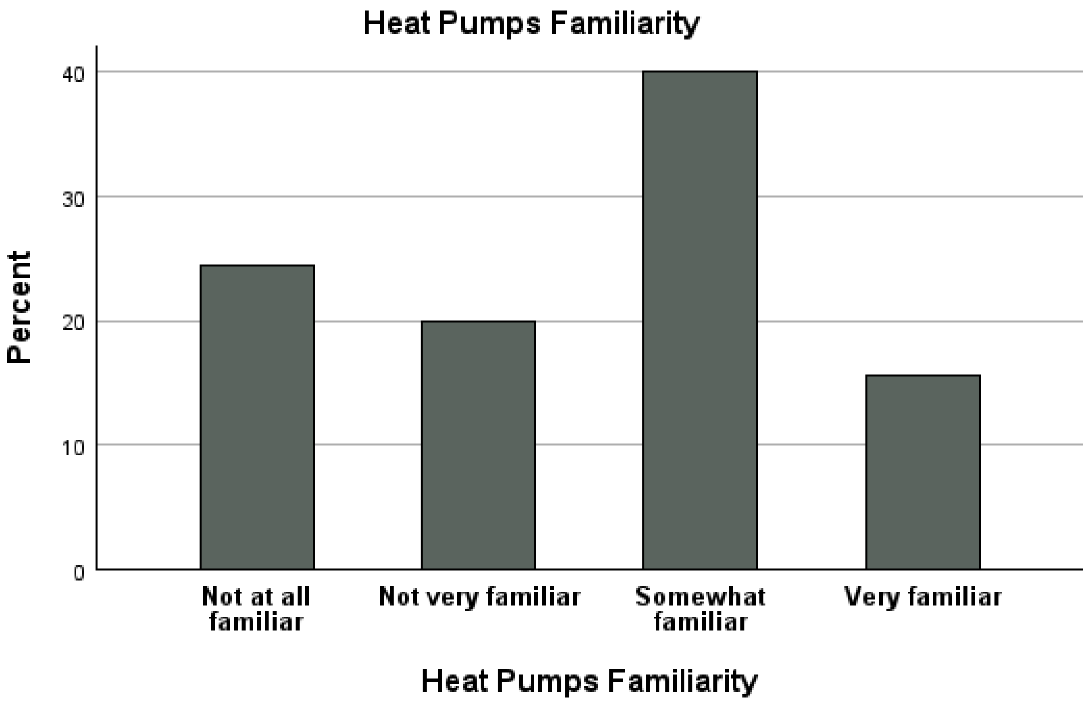

Figure 3-10.Heat Pumps Familiarity In percent

Table 14.Heat Pumps Familiarity statistic

Statistics

Heat Pumps Familiarity

N	Valid	45
	Missing	0
Mean		2.47
Median		3.00
Mode		3

Std. Deviation	1.036

- The **mean** value of 2.47 indicates that, on average, participants have a level of familiarity with heat pump technology that is slightly above "Not very familiar" (which would be a value of 2 on a typical 1-4 scale where 1 is "Not at all familiar" and 4 is "Very familiar"). This suggests that while there is some awareness of heat pump technology among participants, it is not extensive.

- The **median** value of 3.00 shows that the middle point of the data is exactly "Somewhat familiar". This indicates that at least half of the respondents fall into this category or lower, and half have a rating of 3 or higher.
- **Mode**: The most frequently occurring familiarity rating is 3, suggesting that this is the most common level of familiarity among respondents.

- The **standard deviation** of 1.036 suggests there is moderate variability in the participants' familiarity with heat pump technology. This spread indicates that there are also a significant number who are either more or less familiar with heat pumps.

3.2.1.3.2 Sources of Information: First Information source

The majority of people first heard about heat pumps from Family and Friends, accounting for 37.21% of the cases, followed by the Internet, which accounted for 32.56%. TV and radio were the third most common sources at 6.89%, while Print media and Energy consultants or Sales representatives each accounted for 2.3%. Additionally, 18.6% of respondents mentioned other sources, with 8.9% learned about heat pumps through this survey. The remaining respondents were informed through university courses and reference books.

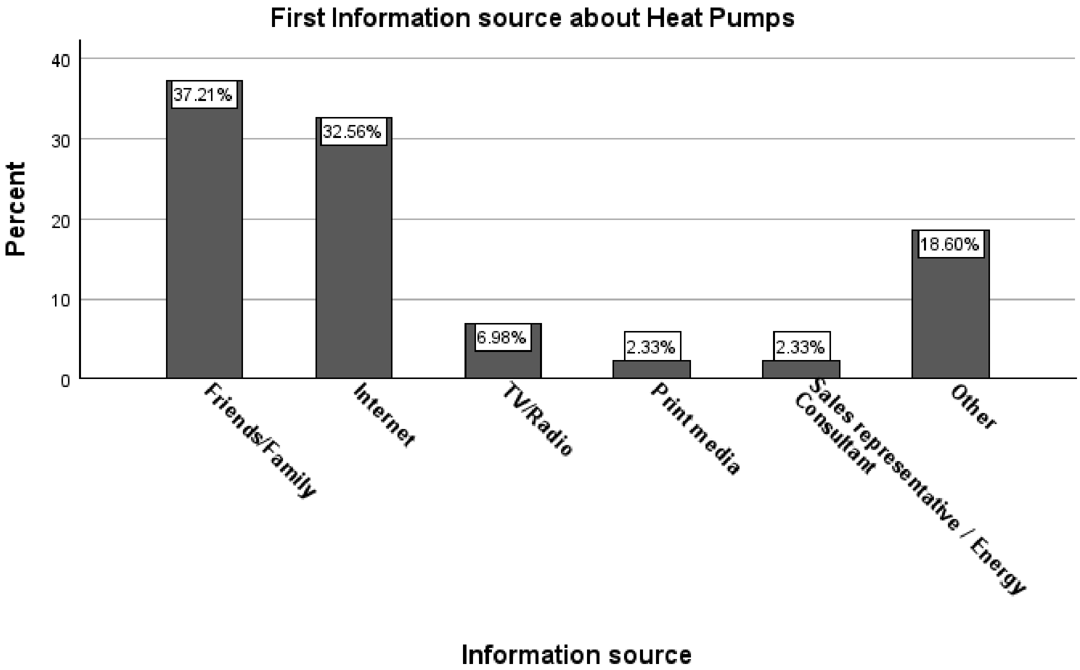

Figure 3-11. First information source about Heat Pumps

3.2.1.3.3 Sources of Information: Main Information source in general

The internet is the main source of information for 58.1% of respondents, indicating its prominent role in informing the public about heat pumps. Family and friends serve as a primary source for 44.2% of participants, highlighting the significant influence of personal networks. TV and radio are used by 27.9% of respondents, demonstrating the ongoing relevance of traditional media. Print media is a main source for 16.3% of participants, while energy consultants or professional advice are key for 11.6%. Lastly, 9.3% of respondents depend on other sources. These percentages reflect that

Respondents could select multiple sources, emphasizing the diverse ways people gather information about heat pumps.

Case Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Main information source	43	95.6%	2	4.4%	45	100.0%

Table 15. Main information source frequencies

		Responses		Percent of Cases
		N	Percent	
Main information source	Family/Friends	19	26.4%	44.2%
	Internet	25	34.7%	58.1%
	TV/Radio	12	16.7%	27.9%
	Print Media	5	6.9%	11.6%
	Energy Consultant and Professional advice	7	9.7%	16.3%
	Other	4	5.6%	9.3%
Total		72	100.0%	167.4%

3.2.1.3.4 Perceptions:

The purpose of this question was to understand common viewpoints of people with or without familiarity with heat pumps.

Case Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Perception	43	95.6%	2	4.4%	45	100.0%

Table 16. Perception about Heat Pumps

		Responses		
		N	Percent	Percent of Cases
Heat pump Perception	Energy efficient	30	29.7%	69.8%
	Expensive to install	12	11.9%	27.9%
	Long-term cost-saving	25	24.8%	58.1%
	Environmentally friendly	18	17.8%	41.9%
	Complex to operate	4	4.0%	9.3%
	Reliable	12	11.9%	27.9%
Total		101	100.0%	234.9%

- **Energy Efficiency Perception (29.7%, 69.8% of Cases)**:

  A significant portion of participants (69.8%) perceive heat pumps as energy efficient. This high percentage indicates a strong awareness of the primary benefit of heat pump technology among respondents.

- **Expensive to Install (11.9%, 27.9% of Cases)**:

  A smaller group (27.9%) views heat pumps as expensive to install. This perception could be a barrier to adoption, suggesting that cost concerns need to be addressed.

- **Long-term Cost-saving (24.8%, 58.1% of Cases)**:

  More than half of the respondents (58.1%) recognize the long-term cost-saving benefits of heat pumps, highlighting a positive perception of the technology's financial benefits over time.

- **Environmental Impact (17.8%, 41.9% of Cases)**:

  Nearly half of the participants (41.9%) see heat pumps as environmentally friendly. This perception aligns with global sustainability goals and indicates a potential driver for adoption based on environmental benefits.

- **Operational Complexity (4.0%, 9.3% of Cases)**:

Only a small fraction (9.3%) finds heat pumps complex to operate, suggesting that operational complexity is not a major concern for most participants.

- **Reliability (11.9%, 27.9% of Cases)**:

A moderate number of participants (27.9%) perceive heat pumps as reliable. This perception indicates a relatively positive view of the technology's dependability but also highlights room for improvement in communicating reliability benefits.

3.2.1.3.5 Types of Heat Pumps:

The question aimed to assess participants' awareness, preferences, ownership, uncertainty, and lack of knowledge regarding different types of heat pumps. The objective was to determine which type of heat pump is most well-known and preferred among the respondents.

- **Air to Air Heat pump:**

The survey data regarding the familiarity and interest in air-to-air heat pumps among respondents can be summarized as follows:

Table 17. Air to Air HP

		N	%
Have HP		6	14.0%
Interested In		9	20.9%
Aware of		16	37.2%
Not sure		7	16.3%
Missing	System	8	18.6%

- **Have HP (14.0%)**: A relatively small percentage of respondents currently have an air-to-air heat pump installed. This suggests that the technology is not yet widely adopted in the surveyed population.
- **Interested In (20.9%)**: A larger percentage of respondents show interest in installing an air-to-air heat pump. This indicates a potential market for future adoption, reflecting curiosity and openness to this technology.
- **Aware of (37.2%)**: The highest percentage among the categories, awareness, signifies that a significant portion of respondents are at least knowledgeable about air-to-air heat pumps. This level of awareness is crucial for market penetration as it reflects the reach of information about this technology.
- **Not sure (16.3%)**: An equal percentage of respondents are unsure about air-to-air heat pumps. This uncertainty may stem from a lack of detailed information or understanding, highlighting the need for more comprehensive education and awareness campaigns.
- **Missing (System) (18.6%)**: A notable portion of the respondents did not answer this question. This could be due to various reasons, including lack of knowledge or interest in the subject matter, or survey fatigue.

- **Air-to-Water Heat pump:**

The survey data regarding the familiarity and interest in air-to-water heat pumps among respondents can be summarized as follows:

Table 18. Air to Water HP

		N	%
Have HP		1	2.3%
Interested In		11	25.6%
Aware of		10	23.3%
Not sure		10	23.3%
Missing	System	15	34.9%

- **Have HP (2.3%)**: Only a small fraction of respondents currently has an air-to-water heat pump installed. This low adoption rate suggests that the technology has not yet achieved widespread use among the surveyed population. Notably, this respondent did not select a heat pump as their current heating system in a different question, indicating a possible error in selection or an incomplete installation process.
- **Interested In (25.6%)**: A quarter of the respondents expressed interest in air-to-water heat pumps. This indicates a significant potential market for this technology, highlighting the need for increased awareness and accessibility to encourage adoption.
- **Aware of (23.3%)**: Nearly a quarter of respondents are aware of air-to-water heat pumps but have not necessarily expressed interest in them. This level of awareness is promising, as it suggests that further information and education could convert awareness into interest and, ultimately, adoption.
- **Not Sure (23.3%)**: A similar proportion of respondents are unsure about air-to-water heat pumps. This uncertainty points to a gap in knowledge that could be addressed through targeted informational campaigns and demonstrations of the technology's benefits.
- **Missing System (34.9%)**: A significant portion of the data is missing regarding the familiarity and interest in air-to-water heat pumps. This could indicate a lack of engagement with the survey question or a lack of knowledge about the technology.

- **Exhaust Air Heat pump:**

The survey data regarding the familiarity and interest in Exhaust Air heat pumps among respondents can be summarized as follows:

Table 19. Exhaust Air Heat pump

	N	%
Have HP	0	0.0%
Interested In	7	16.3%
Aware of	10	23.3%

Not sure	13	30.2%
Missing System	15	34.9%

- **Have HP (0.0%)**: None of the respondents currently have an Exhaust Air HP installed.
- **Interested In (16.3%)**: However, less than one fifth expressed interest in this category.
- **Aware of (23.3%)**: Nearly a quarter of respondents are aware of this type of heat pump.
- **Not Sure (30.2%):** A significant portion of respondents were unsure about their knowledge of Exhaust Air heat pump.
- **Missing System (34.9%)**: A significant portion of the data is missing regarding the familiarity and interest in Exhaust Air heat pumps.

- **Ground Source Heat pump:**

The survey data regarding the familiarity and interest in Ground Source heat pumps among respondents can be summarized as follows:

Table 20. Ground Source Heat pump

	N	%
Have HP	1	2.3%
Interested In	14	32.6%
Aware of	8	18.6%
Not sure	10	23.3%
Missing System	13	30.2%

- **Have HP**: Only 1 participant (2.3%) currently has a Ground Source Heat Pump installed. However, this person has not selected Heat pump as a current heating system in other question.

- **Interested In**: A substantial portion of the participants (32.6%) expressed interest in acquiring a Ground Source Heat Pump.
- **Aware of**: (18.6%) of participants reported being aware of Ground Source Heat Pumps.
- **Not sure**: (23.3%) of respondents were uncertain about their knowledge or understanding of Ground Source Heat Pumps.
- **Missing System**: and large portion of respondents (30.2%), did not provide information regarding their familiarity with or interest in Ground Source Heat Pumps.

- **Water Source Heat pump:**

The survey data regarding the familiarity and interest in Water Source heat pumps among respondents can be summarized as follows:

Table 21. Water Source Heat pump

	N	%
Have HP	1	2.3%
Interested In	12	27.9%
Aware of	8	18.6%
Not sure	12	27.9%
Missing System	13	30.2%

- **Have HP:** Only 2.3% of the respondents currently have a Water Source Heat Pump installed.
- **Interested In:** 27.9% of participants expressed interest in acquiring a Water Source Heat Pump in the future.
- **Aware of:** 18.6% of respondents indicated awareness of Water Source Heat Pumps, suggesting familiarity with the technology.
- **Not sure:** 27.9% of participants were uncertain about their knowledge or understanding of Water Source Heat Pumps.

- **Missing System:** 30.2% of responses did not provide information about whether they have a Water Source Heat Pump installed or their interest in the technology.

3.2.1.4 Purchasing Intentions and Preferences:

3.2.1.4.1 Likelihood of Installation:

This question aimed to understand how likely respondents are to install a heat pump in their current home or rent a property equipped with a heat pump within the next two years.

Table 22. Likelihood of Installation statistic

Statistics

N	Valid	43
	Missing	2
Mean		2.70
Median		3.00
Std. Deviation		1.124

Table 23. How likely to install HP or rent a property equipped with HP in next 2 years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very unlikely	10	22.2	23.3	23.3
	Unlikely	4	8.9	9.3	32.6
	Neutral	19	42.2	44.2	76.7
	Likely	9	20.0	20.9	97.7
	Very likely	1	2.2	2.3	100.0
	Total	43	95.6	100.0	
Missing	System	2	4.4		
Total		45	100.0		

The data suggests a mixed level of interest in installing a heat pump within the next two years among the survey respondents:

- **Neutral Responses**: The largest group (44.2%) is neutral about installing a heat pump, indicating uncertainty or indifference.
- **Low Likelihood:** A combined 32.6% (23.3% very unlikely and 9.3% unlikely) show little to no intention of installing a heat pump.
- **Positive Likelihood**: 23.2% (20.9% likely and 2.3% very likely) are inclined towards installing a heat pump.
- **Mean** and **Median**: The mean (2.70) and median (3.00) are close, suggesting a symmetric distribution around the neutral point.
- **Standard Deviation**: A relatively moderate value (1.124) indicates some variability in responses, but not excessively high.

3.2.1.4.2 Influencing Factors

"Influence Factors" provides insights into the perceived importance of various factors influencing decisions related to heat pumps.

Case Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Influence factors	43	95.6%	2	4.4%	45	100.0%

Table 24. Factors Influencing People's Decision to Install a Heat Pump

Rate / Influence Factors	Extremely Important	Very Important	Moderately Important	Slightly Important	Not at All Important	Missing
Installation cost	13.3% (6)	37.8% (17)	31.1% (14)	13.3% (6)	0.0% (0)	4.4% (2)

Operational cost saving	17.8% (8)	35.6% (16)	15.6% (7)	22.2% (10)	4.4% (2)	4.4% (2)
Environmental impact	15.6% (7)	26.7% (12)	28.9% (13)	17.8% (8)	6.7% (3)	4.4% (2)
GOV. incentives subsidies	11.1% (5)	35.6% (16)	17.8% (8)	26.7% (12)	4.4% (2)	4.4% (2)
Recommendation from others	8.9% (4)	15.6% (7)	28.9% (13)	31.1% (14)	11.1% (5)	4.4% (2)
Reliability and performance	20.0% (9)	33.3% (15)	24.4% (11)	15.6% (7)	2.2% (1)	4.4% (2)
Ease of use	6.7% (3)	33.3% (15)	28.9% (13)	15.6% (7)	11.1% (5)	4.4% (2)
GOV. Regulation	13.3% (6)	24.4% (11)	20.0% (9)	20.0% (9)	17.8% (8)	4.4% (2)
Isolation and Renovation cost	11.1% (5)	40.0% (18)	15.6% (7)	22.2% (10)	6.7% (3)	4.4% (2)
Heat pump price	17.8% (8)	40.0% (18)	22.2% (10)	11.1% (5)	4.4% (2)	4.4% (2)

Percent (Number of respondents)

The factors are categorized based on five levels of importance: 0%: Not at all important, 25%: slightly important, 50%: Moderately important, 75%: Very important and 100%: Extremely important and factors list with the combined percentage of Moderate, high and extreme ratings:

- **Installation Cost**

  A significant number of respondents (**51.1%**) rate installation cost as very or extremely important, making it a crucial factor in their decision-making process.

- **Operational Cost Saving**

  Operational cost saving is also highly influential, with **53.4%** of respondents considering it very or extremely important. This indicates that ongoing costs are a major concern.

- **Environmental Impact**

Environmental impact has a mixed level of importance, with **42.3%** rating it very or extremely important. This shows that while some respondents prioritize it, it is not the most critical factor for many.

- **Government Incentives/Subsidies**

  Government incentives are significant for **46.7%** of respondents, highlighting the importance of financial support in promoting heat pump adoption.

- **Recommendation from Others**

  Recommendations from others are less influential, with the largest groups considering them slightly or moderately important. This suggests that personal endorsements have limited impact compared to other factors.

- **Reliability and Performance**

  Reliability and performance are highly important, with **53.3%** rating them as very or extremely important, underscoring the need for dependable and effective heat pumps.

- **Ease of Use**

  Ease of use is moderately important for **62.2%** of respondents, indicating that while it's not the most critical factor, it still plays a role in decision-making.

- **Government Regulation (e.g. Tax on CO2)**

  Opinions on government regulation are varied, reflecting diverse perspectives on its importance. This suggests that regulatory factors may influence some respondents more than others.

- **Isolation and Renovation Cost**

  A significant proportion (**51.1%**) find isolation and renovation costs very or extremely important, showing that these costs are a major consideration.

- **Heat Pump Price**

  Price is a major concern, with **57.8%** of respondents rating it very or extremely important. This underscores the impact of initial costs on heat pump adoption decisions.

Overall, the data indicates that cost factors both spending and saving (installation, operation, isolation and renovation, and price) are the most influential, followed closely by reliability and performance. Other factors like recommendations and ease of use are less critical, while environmental impact and government incentives hold moderate importance. The influence of government regulation varies among respondents.

The chart "Influence Factors" provides insights into the perceived importance of various factors influencing decisions related to heat pumps. The factors are categorized based on five levels of importance: Not at All Important, Slightly Important, Moderately Important, Very Important, and Extremely Important.

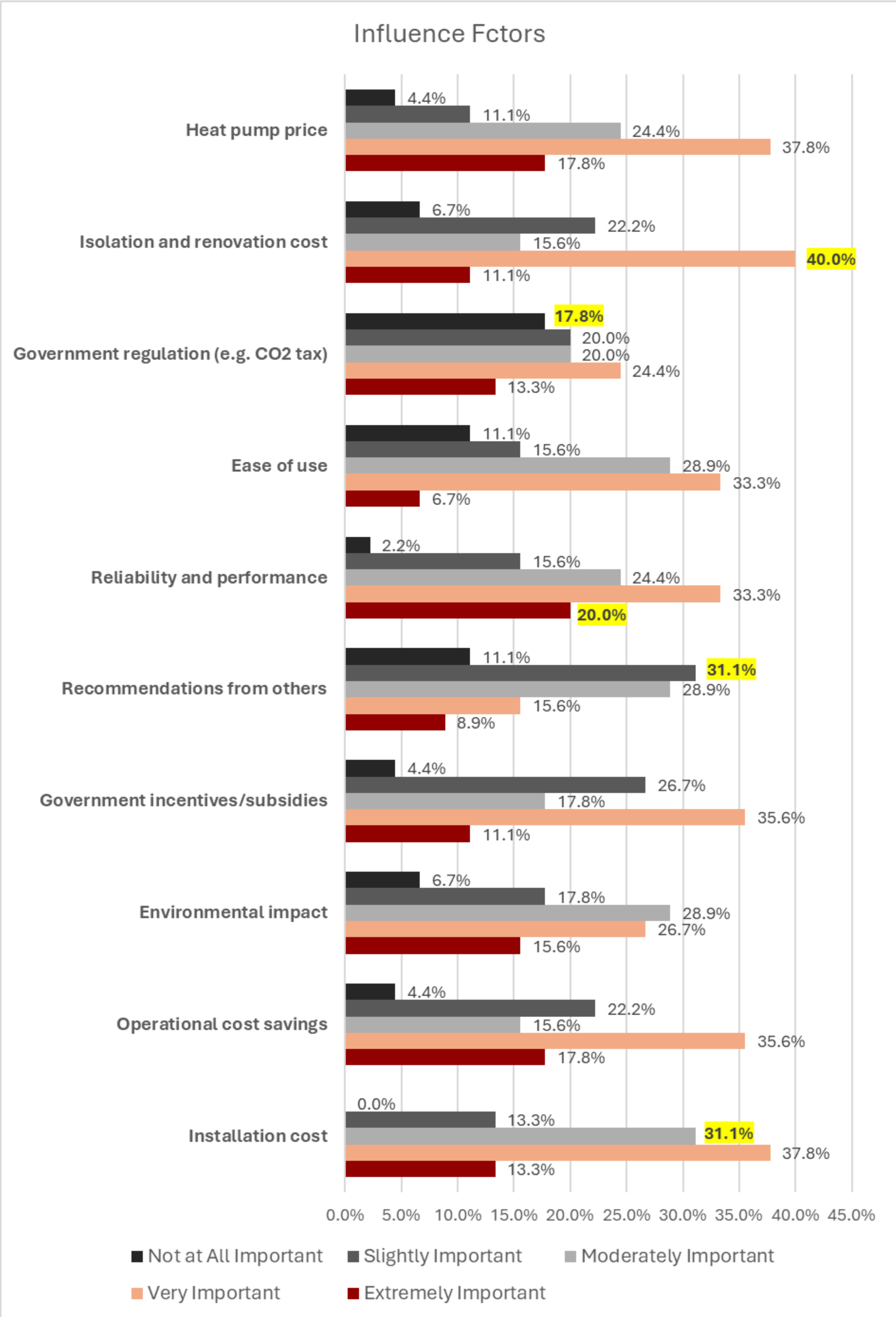

Figure 3-12. Factors Influencing People's Decision to Install a Heat Pump

3.2.1.4.3 Willingness to pay a higher upfront cost

The percentage of respondents willing to pay a higher upfront cost.

Question: Would you be willing to pay a higher upfront cost for a heat pump if it resulted in lower long-term energy costs?

Table 25. Willingness to pay higher cost for less bill

Statistics

N	Valid	43
	Missing	2
Mean		1.53
Median		1.00
Std. Deviation		.855

Table 26. willingness to pay higher cost for less bill

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	30	66.7	69.8	69.8
	No	3	6.7	7.0	76.7
	Maybe	10	22.2	23.3	100.0
	Total	43	95.6	100.0	
Missing	System	2	4.4		
Total		45	100.0		

The survey data on participants' willingness to pay a higher cost for lower utility bills reveals insightful trends. Out of the 45 respondents, 66.7% indicated a willingness to pay more upfront for reduced long-term energy bills, representing the majority stance. Specifically, 30 respondents (69.8% of valid responses) affirmed their willingness, while only 3 respondents (7.0% of valid responses) were against the idea. Additionally, a significant portion, 10 respondents (23.3% of valid responses), remained undecided, expressing a "maybe" response.

Statistically, the mean response was 1.53, with a median of 1.00 and a standard deviation of 0.855, indicating that most participants leaned towards a positive willingness to pay more initially to benefit from lower bills over time. The close mean and median values suggest a relatively consistent agreement towards paying higher initial costs among the participants, with some variation reflected in the standard deviation.

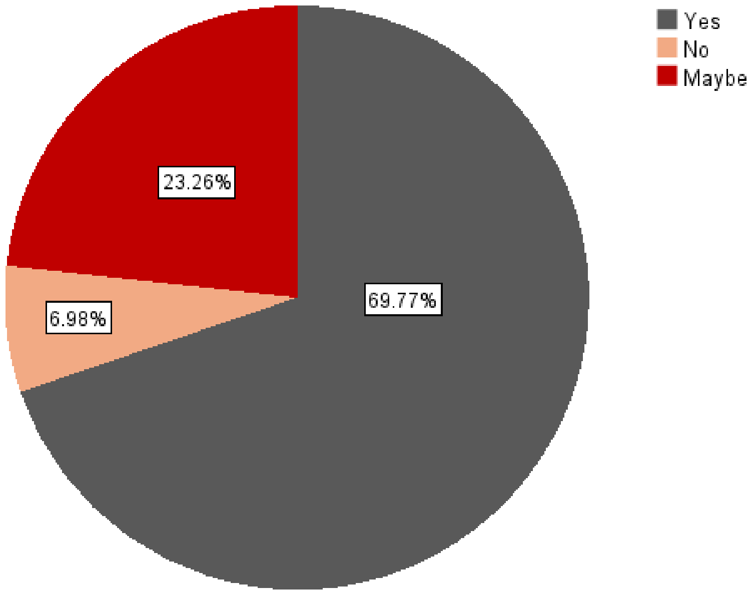

Figure 3-13. Willingness to pay higher cost for less bill

3.2.1.4.4 Encouragement Factors; Governmental Incentives Awareness

This question will help determine the level of awareness and utilization of government incentives among respondents, which is crucial for understanding barriers to adoption and the effectiveness of these incentives.

Question: Are you aware of the different government incentives and bonuses available in Italy for installing heat pumps, such as the Ecobonus or Superbonus 110%?

Table 27. Italy Bonuses awareness statistic

Statistics

Italy Bonus awareness

N	Valid	43
	Missing	2
Mean		2.19
Median		2.00
Std. Deviation		.627

Table 28. Italy Bonus awareness frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, used	5	11.1	11.6	11.6
	Yes, not used	25	55.6	58.1	69.8
	No	13	28.9	30.2	100.0
	Total	43	95.6	100.0	
Missing	System	2	4.4		
Total		45	100.0		

The survey data regarding awareness of the Italy Bonus reveals a mixed level of familiarity among respondents. Out of 45 participants, 43 provided valid responses, while 2 were missing. Among the valid responses, 11.6% of the participants (5 respondents) indicated that they had used the Italy Bonus, suggesting a level of engagement with the program. A larger group, 58.1% (25 respondents), reported being aware of the Italy Bonus but had not utilized it. This group forms the majority of the participants aware of the program. Meanwhile, 30.2% (13 respondents) indicated they were not aware of the Italy Bonus at all.

Statistically, the mean response was 2.19 with a median of 2.00 and a standard deviation of 0.627. This data points to a general awareness of the Italy Bonus among the participants, with a substantial portion having not utilized it despite their awareness. The mean value being closer to 2 indicates that the average response leans towards awareness but non-use of the bonus.

In summary, while there is significant awareness of the Italy Bonus among the respondents, actual utilization of the bonus is relatively low. This highlights a potential area for increasing engagement and participation in such programs.

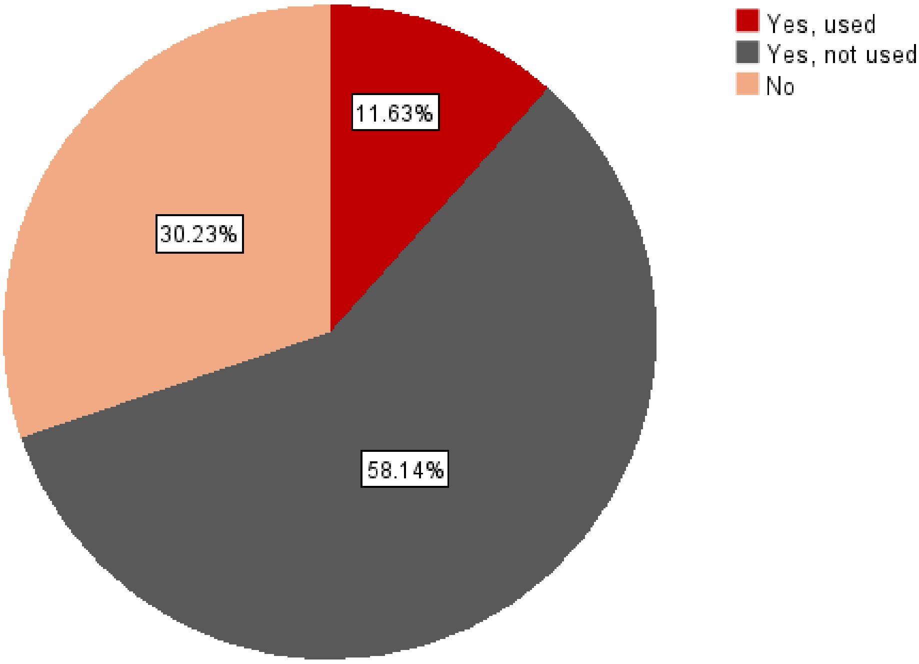

Figure 3-14. Italy Bonus awareness

3.2.1.5 Additional Concerns and Barriers

3.2.1.5.1 Concerns about installing a heat pump

Case Summary

Cases

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Concerns	43	95.6%	2	4.4%	45	100.0%

Table 29. Concerns about Heat Pumps, Frequencies

		Responses		Percent of Cases
		N	Percent	
Concerns about Heat Pumps	High initial costs	28	25.5%	65.1%
	Maintenance and repair cost	17	15.5%	39.5%
	Effectiveness in extreme weather	4	3.6%	9.3%
	Complex installation	11	10.0%	25.6%
	Suitability of building	15	13.6%	34.9%
	Noise level	6	5.5%	14.0%
	Lack of reliable information	3	2.7%	7.0%
	Electricity cost	13	11.8%	30.2%
	Choice of Heat pump	11	10.0%	25.6%
	Other concerns	2	1.8%	4.7%
Total		110	100.0%	255.8%

- **High Initial Costs:**
  - **Frequency**: 28 responses (25.5%)
  - **Percent of Cases**: 65.1%

  High initial costs are the most frequently cited concern, indicating that upfront investment is a significant barrier to heat pump adoption.

- **Maintenance and Repair Cost:**
  - **Frequency**: 17 responses (15.5%)
  - **Percent of Cases**: 39.5%

Ongoing costs for maintenance and repairs are also a major concern, reflecting worries about long-term affordability.

- **Effectiveness in Extreme Weather:**

  - **Frequency**: 4 responses (3.6%)
  - **Percent of Cases**: 9.3%

  Relatively few respondents are concerned about effectiveness in extreme weather, suggesting confidence in heat pump performance under normal conditions.

- **Complex Installation:**

  - **Frequency**: 11 responses (10.0%)
  - **Percent of Cases**: 25.6%

  Complex installation is a moderate concern, indicating that ease of installation could improve adoption rates.

- **Suitability of Building:**

  - **Frequency**: 15 responses (13.6%)
  - **Percent of Cases**: 34.9%

  The suitability of the building for heat pump installation is a notable concern, highlighting the need for compatibility assessments.

- **Noise Level:**

  - **Frequency**: 6 responses (5.5%)
  - **Percent of Cases**: 14.0%

  Noise level is a minor concern for a small proportion of respondents, implying that noise is not a significant barrier for most.

- **Lack of Reliable Information:**

  - **Frequency**: 3 responses (2.7%)
  - **Percent of Cases**: 7.0%

  A lack of reliable information is the least cited concern, suggesting that most respondents feel sufficiently informed.

- **Electricity Cost:**

  - **Frequency**: 13 responses (11.8%)
  - **Percent of Cases**: 30.2%

  Electricity cost is a considerable concern, reflecting worries about the ongoing operational expenses.

- **Choice of Heat Pump:**

  - **Frequency**: 11 responses (10.0%)
  - **Percent of Cases**: 25.6%

  The variety and choice of heat pumps available is a moderate concern, indicating the importance of market options.

- **Other Concerns:**

  - **Frequency**: 2 responses (1.8%)
  - **Percent of Cases**: 4.7%

  Other concerns are minimal, indicating that the primary issues are well captured in the survey options.

3.2.1.6 Adoption and Attitude

3.2.1.6.1 Recommending heat pumps to others

Table 30. Would you recommend HP to others, Statistic

Statistics

N	Valid	43
	Missing	2
Mean		1.40
Median		1.00
Std. Deviation		.660

Table 31. Would you recommend HP to others, frequencies

		N	%
No		4	8.9%
Yes		18	40.0%
Maybe		21	46.7%
Missing	System	2	4.4%

- **General Attitude**: The majority of respondents (86.7%) are at least open to the idea of recommending heat pumps to others, with 40% willing to recommend and 46.7% considering it (Maybe).

- **Positive Recommendation**: 40% of respondents affirmatively recommend heat pumps, indicating a favorable view among a significant portion of the participants.

- **Uncertainty**: A large portion (46.7%) is unsure, indicating that while they see potential benefits, they might have reservations or require more information before fully endorsing heat pumps.

- **Negative Recommendation**: A small percentage (8.9%) would not recommend heat pumps, suggesting that there are some concerns or dissatisfaction within this group.

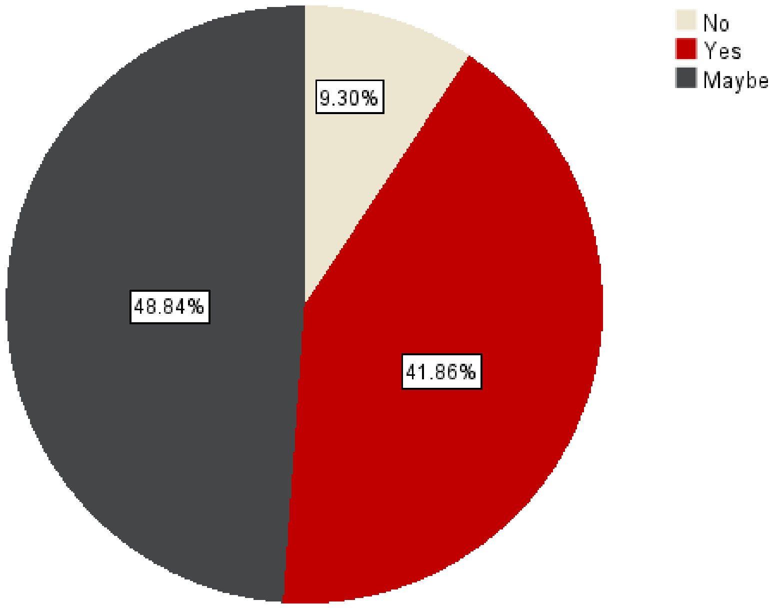

Figure 3-15. Would you recommend HP to others, Pie chart

3.2.1.6.2 Technology Adoption:

From the survey, the distribution of respondents based on their technology adoption category is as follows:

Table 32. Technology Adoption, statistic

Statistics

N	Valid	43
	Missing	2
Mean		2.86
Median		3.00
Std. Deviation		1.082

Table 33. Technology Adoption distribution

Technology adoption

	N	%
Innovators	4	8.9%

Early Adopters	12	26.7%
Early Majority	17	37.8%
Late Majority	6	13.3%
Laggards	4	8.9%
Missing System	2	4.4%

- **Majority Adopters**: The largest group falls within the Early Majority (37.8%), suggesting that a significant portion of respondents are open to adopting new technology but prefer to wait until it has been tested by a few early users.
- **Early Adopters**: 26.7% are Early Adopters, showing a substantial group willing to adopt new technology soon after it becomes available, which is promising for the diffusion of heat pumps.
- **Innovators and Laggards**: Both categories have equal representation at 8.9%, indicating a small group at both ends of the adoption curve—those who are very quick to adopt new technology and those who are very reluctant.
- **Late Majority**: 13.3% of respondents are in the Late Majority, who adopt technology after the average participant, indicating a cautious but eventual acceptance.
- **Overall Trend**: The mean value of 2.86 and median of 3.00 align with the Early Majority category, reinforcing the idea that most respondents are neither the first nor the last to adopt new technology.

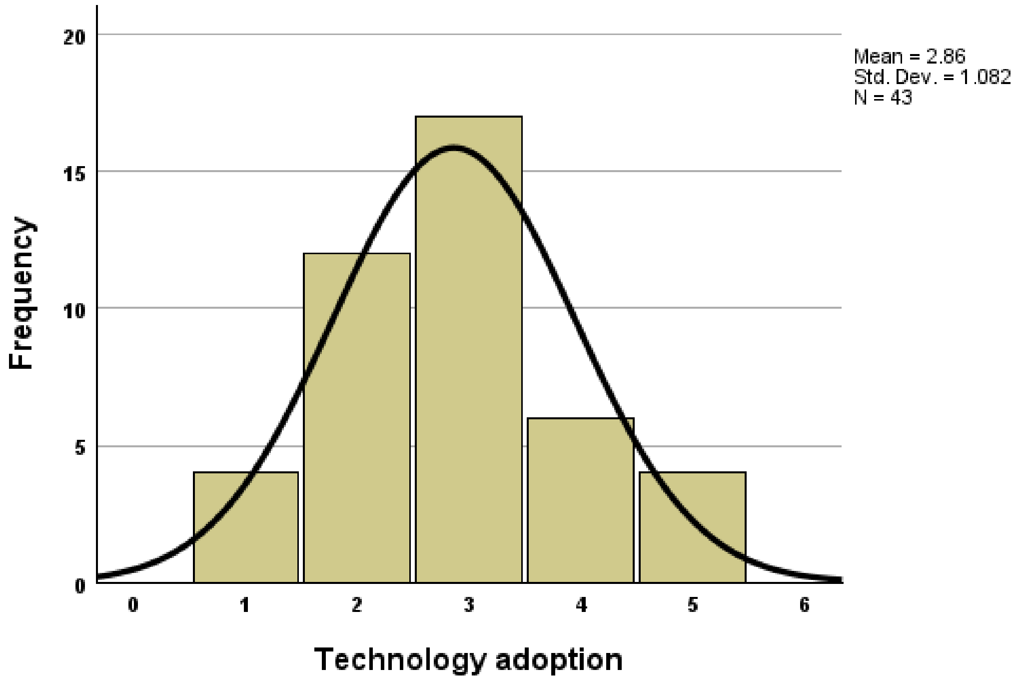

Figure 3-16. Technology Adoption in Heat Pumps, Histogram

3.2.2 Inferential Analysis

3.2.2.1 Satisfaction vs. Likelihood to Install

Satisfaction with Current Heating System vs. Likelihood of Installing a Heat Pump or moving to equipped property with it as a tenant, in the Next 2 Years

*Table 34. Satisfaction of Current Heating System * How likely to install HP in next 2 years Crosstabulation*

		How likely to install HP in next 2 years					
		Very unlikely	Unlikel y	Neutral	Likely	Very likely	Total
Satisfaction of Current Heating System	Very dissatisfied	0	0	2	0	0	2
	Dissatisfied	1	2	1	1	0	5
	Neutral	6	1	6	3	0	16
	Satisfied	1	1	7	3	1	13

	Very satisfied	2	0	3	2	0	7
Total		10	4	19	9	1	43

The crosstabulation table examines the relationship between participants' satisfaction with their current heating system and their likelihood of installing a heat pump (HP) in the next two years.

- **Neutral Satisfaction and Uncertainty**: The majority of participants who are neutral about their current heating system tend to be neutral or very unlikely to install a heat pump, indicating indecision or lack of strong opinion.
- **High Satisfaction and Neutral Likelihood**: Among those satisfied with their current heating system, a significant portion is neutral about installing a heat pump. However, there is a slight increase in those likely to install it, indicating a modest interest.
- **Dissatisfaction and Mixed Responses**: Dissatisfied participants show a mixed response, with some being unlikely and others being neutral or likely to install a heat pump. This suggests that dissatisfaction with the current system does not strongly push participants toward adopting a heat pump.
- **Very Dissatisfied Participants**: Only two participants are very dissatisfied, and both are neutral about installing a heat pump, possibly indicating that even dissatisfaction does not strongly influence the decision to install a heat pump.

Key Points:

1. **No Significant Relationship**: There is no statistically significant relationship between satisfaction with the current heating system and the likelihood of installing a heat pump or renting new house in the next two years.
2. **Indecision Among Neutral and Satisfied Groups**: Neutral and satisfied participants exhibit a tendency towards neutrality regarding the installation of a heat pump, reflecting uncertainty or indecision.
3. **Influence of Dissatisfaction**: While dissatisfaction leads to mixed responses, it does not significantly push participants toward adopting a heat pump.

4. **Overall Neutrality**: The overall trend shows that most participants, regardless of their satisfaction level, tend to remain neutral or unlikely to install a heat pump.

3.2.2.2 House ownership status vs. likelihood to Install/Move:

The comparison between house ownership status and the likelihood to install a heat pump or move into a property equipped with one show that 44% of participants are neutral on the matter. When combining those who are likely and very likely to install or move, the potential market comprises over 67% of participants.

The Chi-square test results indicate no significant relationship between ownership status and the likelihood of installing or moving into a property with a heat pump. This suggests that ownership status does not strongly influence participants' decisions regarding heat pump installation or relocation to properties with such systems.

*Table 35. House Ownership * likelihood to install HP/ Move in next 2 years Crosstabulation*

		How likely to install HP in next 2 years					
		Very unlikely	Unlikely	Neutral	Likely	Very likely	Total
House Ownership	Owner	4	1	6	0	1	12
	Tenant	5	2	8	8	0	23
	Not Decision makers	1	1	5	1	0	8
Total		10	4	19	9	1	43

3.2.3 Comparative Analysis

3.2.3.1 Comparing Owners and Tenant groups

Table 36. Owners and Tenant comparison, independent samples t Test

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Significance		95% Confidence Interval of the Difference	
						Two-Sided p	Mean Difference	Lower	Upper
Italy Bonus awareness	Equal variances assumed	.115	.737	-2.571	33	.015	-.518	-.928	-.108
	Equal variances not assumed			-2.355	17.787	.030	-.518	-.981	-.055
willingness to pay higher cost for less bill	Equal variances assumed	.395	.534	.200	33	.843	.062	-.565	.688
	Equal variances not assumed			.208	25.039	.837	.062	-.547	.671
How likely to install HP in next 2 years	Equal variances assumed	.111	.741	-.971	33	.338	-.409	-1.267	.448
	Equal variances not assumed			-.949	21.040	.353	-.409	-1.306	.488
Heat Pumps Familiarity	Equal variances assumed	.119	.732	1.066	34	.294	.417	-.378	1.211
	Equal variances not assumed			1.050	21.266	.306	.417	-.408	1.241
Influence of Installation cost	Equal variances assumed	.571	.455	-1.716	33	.096	-.525	-1.148	.098
	Equal variances not assumed			-1.589	18.279	.129	-.525	-1.219	.169
Influence of Operational cost saving	Equal variances assumed	.748	.393	-2.845	33	.008	-1.112	-1.908	-.317
	Equal variances not assumed			-2.672	18.948	.015	-1.112	-1.984	-.241
Influence of Reliability and performance	Equal variances assumed	.000	.999	-2.508	33	.017	-.909	-1.647	-.172
	Equal variances not assumed			-2.534	23.084	.019	-.909	-1.652	-.167
Influence of Isolation and Renovation cost	Equal variances assumed	2.302	.139	-.487	33	.630	-.217	-1.126	.691
	Equal variances not assumed			-.511	25.635	.614	-.217	-1.092	.658
Influence of Heat pump price	Equal variances assumed	.717	.403	-1.308	33	.200	-.529	-1.352	.294
	Equal variances not assumed			-1.237	19.264	.231	-.529	-1.423	.366

The result of independent sample t test on:

- Italy Bonus awareness

  There is a significant difference with a large effect size between the groups, indicating that the owners are more aware of incentives and utilize it than the tenant (Equal variances assumed: $p = .015$, Mean Difference = -.518, 95% CI = [-.928, -.108], Effect size (Cohen's d) = -.916).

- **Willingness to pay higher cost for less bill**

  No significant difference was found between groups in willingness to pay higher cost for less bill (Equal variances assumed: $p = .843$, Mean Difference = .062, 95% CI = [-.565, .688], Effect size (Cohen's d) = .071).

- **How likely to install HP in next 2 years**

  No significant difference was found between groups in likelihood to install or move to other property that is equipped with Heat pumps (Equal variances assumed: $p = .338$, Mean Difference = -.409, 95% CI = [-1.267, .448], Effect size (Cohen's d) = -.346).

- **Heat Pumps Familiarity**

  No significant difference was found between groups in their familiarity with Heat Pumps (Equal variances assumed: $p = .294$, Mean Difference = .417, 95% CI = [-.378, 1.211], Effect size (Cohen's d) = .377).

- **Influence of Installation cost**

No significant difference was found between groups in being influenced by Installations cost (Equal variances assumed: $p = .096$, Mean Difference = -.525, 95% CI = [-1.148, .098], Effect size (Cohen's d) = -.611).

- **Influence of Operational cost saving**

  There is a significant difference with a large effect size between the groups, indicating that the tenants are more influenced by operational cost saving than the owners (Equal variances assumed: $p = .008$, Mean Difference = -1.112, 95% CI = [-1.908, -.317], Effect size (Cohen's d) = -1.013).

- **Influence of Reliability and performance**

  There is a significant difference with a large effect size between the groups, indicating that the tenants are more influenced by reliability and performance of heat pump (Equal variances assumed: $p = .017$, Mean Difference = -.909, 95% CI = [-1.647, -.172], Effect size (Cohen's d) = -.893).

- **Influence of Isolation and Renovation cost**

  No significant difference was found between groups in being influenced by isolation and renovation costs (Equal variances assumed: $p = .630$, Mean Difference = -.217, 95% CI = [-1.126, .691], Effect size (Cohen's d) = -.173).

- **Influence of Heat pump price**

  No significant difference was found between groups in being influenced by price of heat pumps (Equal variances assumed: $p = .200$, Mean Difference = -.529, 95% CI = [-1.352, .294], Effect size (Cohen's d) = -.466).

3.2.3.2 Comparing Low Familiarity group with High Familiarity

One of the important questions and its result is about level of familiarity of participants with Heat Pump. In order to compare and determine if there are significant differences in the different aspects based on familiarity with HP, I have used independent samples t-tests and grouped responses into two groups, Low familiarity (Not at all and Not very familiar) and second group High Familiarity (Somewhat and very familiar). In all of following cases, HP familiarity is considered as Grouping Variable and Test variables includes:

Perception of Heat pump, Concerns about Heat pumps, Influence factors, Willingness to pay more for upfront cost, willingness to install, Government Incentives Awareness, Satisfaction with Current system, Recommending to others, and Technology adoption.

3.2.3.2.1 Perception of Heat pump based on Familiarity groups

- Group Statistics and Independent Samples Test Results:

The group statistic indicates number of respondents in each group, 18 people with low or no familiarity and 25 with moderate or highest. There are some possible significant differences between the Mean of two groups such as Energy efficient (.44, .88) and Long term cost-saving (.39, .72), Expensive to install and Reliable with same Mean (.17, .36).

Table 37. Heat pump Perception based on Group familiarity, statistic

Group Statistics

	Grouped Familiarity	N	Mean	Std. Deviation	Std. Error Mean
Energy efficient	Low Familiarity	18	.44	.511	.121
	High Familiarity	25	.88	.332	.066
Expensive to install	Low Familiarity	18	.17	.383	.090
	High Familiarity	25	.36	.490	.098
Long term cost-saving	Low Familiarity	18	.39	.502	.118
	High Familiarity	25	.72	.458	.092
Environmentally friendly	Low Familiarity	18	.50	.514	.121
	High Familiarity	25	.36	.490	.098
Complex to operate	Low Familiarity	18	.06	.236	.056
	High Familiarity	25	.12	.332	.066
Reliable	Low Familiarity	18	.17	.383	.090
	High Familiarity	25	.36	.490	.098

Other	Low Familiarity	18	.00	.000[a]	.000
	High Familiarity	25	.00	.000[a]	.000

a. t cannot be computed because the standard deviations of both groups are 0.

- Independent Samples t Test results

The first criteria to check is significant (sig.) in Levene's Test for equality variance. Those items with this amount under .05 are considered as a significant difference which reject the null of Levene's test. This tells that we should look at the "Equal variances not assumed" row for the t test (and corresponding confidence interval) results. And, if this test result had not been significant then we would have used the "Equal variances assumed" output.

For those items with more or less double difference between Means of two groups, it can be concluded that the variance in perception of respondents about HP as an Energy efficient device, Expensive to install and being Reliable with high familiarity are significantly different than those of with low familiarity. The 2-sided p of each are .004, .171, and .171 respectively which indicates the two latter ones are not significant difference. The Long-term cost-saving's significant is more than .05 with Levene's test (.178), thus the Equal variance assumption is considered to check the 2-sided that is .030 which is significant different.

The second criteria, CI for both Energy efficient (-.718, -.153) and Long-term cost-saving (-.629, -.034) with the intervals that does not contain zero agrees that the significant difference is true.

And the third criteria, Effect size by using Cohen's d says the point estimate that is reported as d is -1.048 for Energy efficient and -.695 for Long-term cost-saving. These large effects approve that the significant difference in these two cases are real.
The rest are not significant different between two groups perception and interpret shortly below:

- **Expensive to Install**:

No significant difference was found between groups in their perception of installation costs (p = 0.155, Mean Difference = -0.193, 95% CI = [-0.463, 0.076]).

- **Environmentally Friendly**:

No significant difference was found between groups in their perception of environmental friendliness (= 0.371, Mean Difference = 0.140, 95% CI = [-0.172, 0.452]).

- **Complex to Operate**:

No significant difference was found between groups in their perception of operational complexity (p = 0.485, Mean Difference = -0.064, 95% CI = [-0.249, 0.120]).

- **Reliable**:

No significant difference was found between groups in their perception of reliability (p = 0.155, Mean Difference = -0.193, 95% CI = [-0.463, 0.076]).

Table 38. Heat Pump Perception Independent samples t test based on Familiarity Groups

	Levene's Test for Equality of Variances		t-test for Equality of Means					
					Significance		95% Confidence Interval of the Difference	
	F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
Equal variances assumed	21.696	<.001	-3.39	41	0.002	-0.436	-0.695	-0.176

Energy efficient	Equal variances not assumed			-3.166	27.099	0.004	-0.436	-0.718	-0.153
Expensive to install	Equal variances assumed	9.197	0.004	-1.393	41	0.171	-0.193	-0.474	0.087
	Equal variances not assumed			-1.45	40.659	0.155	-0.193	-0.463	0.076
Long term cost-saving	Equal variances assumed	1.88	0.178	-2.247	41	0.03	-0.331	-0.629	-0.034
	Equal variances not assumed			-2.213	34.695	0.034	-0.331	-0.635	-0.027
Environmentally friendly	Equal variances assumed	1.46	0.234	0.905	41	0.371	0.14	-0.172	0.452
	Equal variances not assumed			0.898	35.672	0.375	0.14	-0.176	0.456
Complex to operate	Equal variances assumed	2.133	0.152	-0.705	41	0.485	-0.064	-0.249	0.12
	Equal variances not assumed			-0.745	40.999	0.461	-0.064	-0.239	0.11
Reliable	Equal variances assumed	9.197	0.004	-1.393	41	0.171	-0.193	-0.474	0.087
	Equal variances not assumed			-1.45	40.659	0.155	-0.193	-0.463	0.076

3.2.3.2.2 Concern about installing heat pump based on Familiarity groups

The same test has been run for concerns about installation of heat pump based on two groups with high and low familiarity and the results indicated no significant difference between them as all p-values were more than $\alpha = .05$ and no big difference between Means. Additionally, there are not significant differences between extreme options of familiarity and concerns about heat pump. [Appendix, Table 41]

3.2.3.2.3 Influence factors on installation decision based on Familiarity group level:

Table 39. Influence Factors independent samples t test based on Heat pump familiarity groups

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance		95% Confidence Interval of the Difference	
		F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
Influence of Installation cost	Equal variances assumed	1.981	0.167	2.272	41	0.028	0.609	0.068	1.15
	Equal variances not assumed			2.352	40.358	0.024	0.609	0.086	1.132
Influence of Operational cost saving	Equal variances assumed	8.74	0.005	2.652	41	0.011	0.904	0.216	1.593
	Equal variances not assumed			2.85	40.411	0.007	0.904	0.263	1.546
Influence of Environmental impact	Equal variances assumed	0.95	0.336	1.06	41	0.295	0.38	-0.344	1.104
	Equal variances not assumed			1.105	40.717	0.276	0.38	-0.315	1.075
Influence of GOV incentives subsidies	Equal variances assumed	6.375	0.016	1.044	41	0.303	0.364	-0.341	1.069
	Equal variances not assumed			1.114	40.796	0.272	0.364	-0.296	1.025
Influence of Recommendation from others	Equal variances assumed	0.957	0.334	3.599	41	<.001	1.124	0.493	1.755
	Equal variances not assumed			3.511	33.3	0.001	1.124	0.473	1.776
Influence of Reliability and performance	Equal variances assumed	0.572	0.454	2.77	41	0.008	0.856	0.232	1.479
	Equal variances not assumed			2.818	38.873	0.008	0.856	0.241	1.47
Influence of Ease of use	Equal variances assumed	8.163	0.007	1.189	41	0.241	0.413	-0.289	1.115
	Equal variances not assumed			1.272	40.685	0.211	0.413	-0.243	1.07
Influence of GOV. regulation	Equal variances assumed	0.282	0.598	1.115	41	0.271	0.462	-0.375	1.299
	Equal variances not assumed			1.113	36.434	0.273	0.462	-0.38	1.304

Influence of Isolation and Renovation cost	Equal variances assumed	2.097	0.155	1.915	41	0.062	0.667	-0.036	1.37
	Equal variances not assumed			1.989	40.565	0.053	0.667	-0.01	1.344
Influence of Heat pump price	Equal variances assumed	4.879	0.033	1.942	41	0.059	0.624	-0.025	1.274
	Equal variances not assumed			2.064	40.905	0.045	0.624	0.014	1.235

- **Influence of Installation cost:**

  There is a significant difference with a large effect size between the groups, indicating that those with low familiarity are more influenced by the heat pump's installation cost (Equal variances assumed: p = .028, Mean Difference = .609, 95% CI = [.068, 1.150], Effect size (Cohen's d) = .702).

- **Influence of Operational cost saving:**

  There is a significant difference with a large effect size between the groups, indicating that those with low familiarity are more influenced by the heat pump's Operational cost saving (Equal variances not assumed: p = .007, Mean Difference = .904, 95% CI = [.263, 1.546], Effect size (Cohen's d) = .820).

- **Influence of Environmental impact:**

  No significant difference was found between groups in being influenced by Environmental impact (Equal variances assumed: p = .295, Mean Difference = .380, 95% CI = [-.344, 1.104], Effect size (Cohen's d) = .328).

- **Influence of Government incentives subsidies:**

  No significant difference was found between groups in being influenced by Government incentives subsidies (Equal variances not assumed: p = .272, Mean Difference = .364, 95% CI = [-.296, 1.025], Effect size (Cohen's d) = .323).

- **Influence of Recommendation from others:**

  There is a significant difference with a large effect size between the groups, indicating that those with low familiarity are more influenced by Recommendation from others (Equal variances assumed: $p < .001$, Mean Difference = 1.124, 95% CI = [.493, 1.755], Effect size (Cohen's d) = 1.113).

- **Influence of Reliability and performance:**

  There is a significant difference with a large effect size between the groups, indicating that those with low familiarity are more influenced by Reliability and performance (Equal variances assumed: $p = .008$, Mean Difference = .856, 95% CI = [.232, 1.479], Effect size (Cohen's d) = .856).

- **Influence of Ease of use:**

  No significant difference was found between groups in being influenced by Ease of use (Equal variances not assumed: $p = .211$, Mean Difference = .413, 95% CI = [-.243, 1.070], Effect size (Cohen's d) = .368).

- **Influence of Government Regulation:**

  No significant difference was found between groups in being influenced by Government Regulation (Equal variances not assumed: $p = .062$, Mean Difference = .462, 95% CI = [-.375, 1.299], Effect size (Cohen's d) = .345).

- **Influence of Isolation and Renovation cost:**

No significant difference was found between groups in being influenced by Isolation and Renovation cost (Equal variances not assumed: p = .592, Mean Difference = .667, 95% CI = [-.036, 1.370], Effect size (Cohen's d) = .368).

- **Influence of Heat pump price:**

There is a significant difference with an almost large effect size between the groups, indicating that those with low familiarity are more influenced by Heat pump price (Equal variances not assumed: p = .045, Mean Difference = .624, 95% CI = [.014, 1.235], Effect size (Cohen's d) = .600).

The comparative analysis of two groups based on their familiarity with heat pumps reveals that participants with lower familiarity are more influenced by factors such as installation cost, operational cost savings, recommendations from others, reliability and performance, and heat pump price. Among these, the most significant difference is the influence of recommendations from others. This insight is valuable for producers and government entities, suggesting that leveraging recommendations can be an effective strategy for advertising and increasing awareness. Future efforts should focus on enhancing the awareness of heat pumps among the Italian population in a simpler and more targeted manner, including disseminating more reviews from current users to build trust and knowledge about the technology.

3.2.3.2.4 Government Incentives Awareness based on Familiarity groups

The comparison between two groups regarding awareness of the SuperBonus 110% incentive provided by the Italian government indicates a significant difference. The results show a p-value of .001, a mean difference of .636, and a 95% confidence interval of [.278, .993], assuming unequal variances. The effect size (Cohen's d) is 1.161, indicating a large effect. [Appendix, Tables 42,43]

The options for this question were:

"Yes, and I have used it"

"Yes, but I have not used it"

"No, I am not aware of it"

The overall mean of responses is 2.19, indicating that most respondents are aware of the bonus but have not used it, suggesting a tendency towards a lack of awareness. In this comparison, the high familiarity group has a mean of 1.92, which falls between the two "Yes" options, indicating that they are more aware and likely to have used the bonus. In contrast, the low familiarity group has a mean of 2.56, which is closer to the "No" option, indicating less awareness and usage. This significant difference implies that the high familiarity group is more aware of and has utilized the bonus more than the low familiarity group.

3.2.3.2.5 Would They Recommend HP to Others

The analysis indicates no significant difference between the groups in their willingness to recommend heat pumps (HP) to others. With equal variances not assumed, the results show $p = .384$, a mean difference of .180, a 95% confidence interval of [-.233, .593], and an effect size (Cohen's d) of .272. [Appendix, Tables 42,43]

However, the mean recommendation score for the high familiarity group (1.32) is lower than that of the low familiarity group (1.50). This suggests that individuals with higher familiarity are more certain about recommending HP to others compared to those with lower familiarity. The lower mean value for the high familiarity group indicates a stronger inclination towards recommending HP.

3.2.3.2.6 Willingness to Pay Higher Upfront Cost for Lower Bills

The analysis reveals a significant difference with a large effect size between the groups regarding their willingness to pay a higher upfront cost for heat pumps to achieve lower bills throughout the year. Those with low familiarity are more influenced by the price of the heat pump. When equal variances are not assumed, the results show p = .030, a mean difference of -.538, and a 95% confidence interval of [-1.022, -.053]. The effect size (Cohen's d) is -.655, indicating a substantial impact. [Appendix, Tables 42,43]

Interestingly, the low familiarity group is much more certain about paying a higher upfront cost to save on bills compared to the high familiarity group. In contrast, 44% of the high familiarity group members are uncertain or unwilling to pay this upfront cost. This discrepancy suggests that despite their lower familiarity, the first group may be more motivated by the potential long-term financial benefits, whereas the second group may be more cautious or need additional information to justify the initial investment.

3.2.3.2.7 Likelihood to Install a Heat Pump in the Next 2 Years

No significant difference was found between groups in the likelihood to install a heat pump or, as tenants, rent a new property equipped with a heat pump based on their familiarity (Equal variances assumed: p = .880, Mean Difference = -.053, 95% CI = [-.763, .657], Effect size (Cohen's d) = -.047). Both groups had mean scores below neutral (Low Familiarity: 2.72, High Familiarity: 2.63), indicating a general tendency towards being unlikely to install or rent a new house with a heat pump. This suggests that familiarity with heat pumps does not significantly influence the decision to adopt them within the next two years, highlighting the need for targeted efforts to boost interest and adoption rates among both familiar and unfamiliar groups. [Appendix, Table 44]

3.2.3.2.8 Satisfaction with current heating system

No significant difference was found between groups in terms of satisfaction with their current heating system based on familiarity with heat pumps (Equal variances assumed: p = .575, Mean Difference = .180, 95% CI = [-.462, .822], Effect size (Cohen's d) = .170). Both groups reported mean satisfaction scores above neutral (3.50 and 3.32 respectively), indicating a general tendency toward satisfaction with their current systems. This suggests that familiarity with heat pumps does not significantly impact overall satisfaction with existing heating systems. [Appendix, Table 45

3.2.3.2.9 Demographics based on Familiarity groups

No significant difference was found between groups (low and high familiarity) in demographics, including gender, age, region, education, house ownership, and income. Although there are slight differences in means, these differences are not statistically significant. This indicates that familiarity with heat pumps is not strongly influenced by these demographic factors. Therefore, initiatives aimed at increasing awareness and adoption of heat pumps can be broadly targeted across the entire population. [Appendix, Table 45]

Chapter 4

4 Findings and Discussion

Key findings are highlighted in this section, including common barriers to adoption, factors that influence the decision to install a heat pump, and overall awareness and perception trends.

4.1 Survey Overview

The survey had a total of 45 respondents. Two respondents exited the survey after reading the explanation about heat pumps, indicating they had no prior knowledge or interest in the technology.

4.1.1 Analytical Approach

In the analysis section, I conducted descriptive analysis, frequency counts, and statistical tests. I employed cross-tabulation and independent samples t-tests to explore the relationships between various survey aspects, such as participants' familiarity with heat pumps, their perceptions, concerns, and the factors influencing their decision to install or adopt heat pumps.

4.2 Key Findings

4.2.1 Familiarity and Demographics

- **Gender:**
    - Slightly more than half of the respondents (55.55%) have moderate or high familiarity with heat pumps.

- There were slightly more male respondents than female. Females exhibited a higher average familiarity with heat pumps than males, though their responses were more varied. Males had a lower average familiarity score with less variation. Overall, the combined average suggests a moderate level of familiarity with heat pump technology among all respondents. This data can help identify target groups for educational campaigns or further studies on heat pump technology adoption.

- **Age Group Representation:**
  - The majority of participants (62.2%) were in the 25-34 age group, significantly impacting the overall analysis. This age group's familiarity scores heavily influenced the aggregate data. The broad range of familiarity scores within this group introduced more variability into the dataset, which might not be as pronounced with more balanced age group representation.
  - When interpreting familiarity with heat pumps across age groups, it is essential to consider the unequal distribution of participants. This imbalance can limit the generalizability of findings across all age groups.

- **Education:**
  - The distribution of education levels among participants revealed interesting trends. A significant proportion of respondents hold either a high school diploma or equivalent (33.3%) or a master's degree (31.1%), showing a close distribution between these two groups.
  - Cross-tabulation results indicated that more than 66% of participants with high school diplomas have high familiarity with heat pumps, compared to 50% of those with master's degrees. [Appendix, Table 46]

- **House Ownership Status:**

- Regarding house ownership status and heat pump familiarity, no significant difference was found between tenants and homeowners. However, within each group, there is a notable difference: 75% of homeowners are familiar with heat pumps compared to 45% of tenants. [Appendix, Table 47]

In general, no significant differences were found between groups with low and high familiarity in demographics, including gender, age, region, education, house ownership, and income. While there are slight differences in means, these differences are not statistically significant, indicating that familiarity with heat pumps is not strongly influenced by these demographic factors.

Therefore, initiatives aimed at increasing awareness and adoption of heat pumps can be broadly targeted across the entire population. Informational campaigns and educational efforts to improve familiarity with heat pumps should not be confined to specific demographic groups but should instead address the general public.

4.2.2 Familiarity, Current heating system and Heat pump types

Understanding the types of heating systems currently in use helps establish a baseline understanding of the market. The results indicate that the majority of people use gas boilers and central heating systems. Interestingly, no respondents explicitly selected heat pumps as their heating system, although one person mentioned using an air conditioner, likely referring to a unit that provides both heating and cooling. Additionally, eight people indicated in another question that they have air-to-air, air-to-water, and water source heat pumps. This discrepancy suggests possible confusion or misinterpretation among respondents. It seems the first group may have mistaken air conditioners for heat pumps, indicating a lack of understanding about the technology despite claiming familiarity. This highlights a need for clearer information and education about the different types of heating systems, especially heat pumps. Addressing this misunderstanding can improve awareness and adoption of heat pump technology, ensuring that consumers correctly identify and understand their heating systems.

A comparison between ownership and awareness or interest in different types of heat pumps shows that the highest ownership is for air-to-air heat pumps, although respondents may have confused these with non-reversible air conditioners, as they did not select heat pumps in the current heating system question. This confusion also applies to ground source and air-to-water heat pumps.

The results indicate that ground source heat pumps generate the most interest, suggesting a significant potential market for this technology or curiosity about its operation. This highlights the need for increased awareness and accessibility to encourage adoption. By combining the number of respondents "interested in" and "aware of" these technologies, the highest awareness is for air-to-air heat pumps, followed by ground source heat pumps. Conversely, exhaust air heat pumps have the lowest awareness, followed by air-to-water and water source heat pumps, indicating a significant gap in information and familiarity with these types.

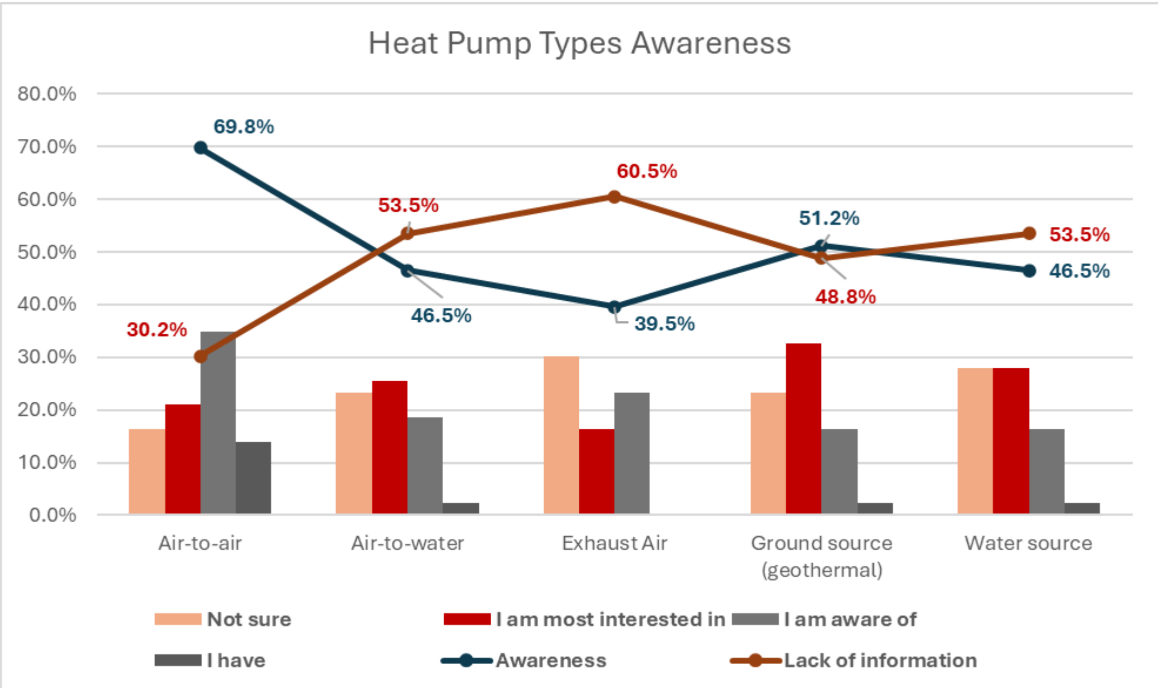

Figure 4-1Heat pump Types Awareness

4.2.3 Familiarity and Perception

The results indicate that participants with low familiarity perceive heat pumps as less energy-efficient and not cost-saving in the long term. This insight is crucial for government bodies and manufacturers aiming to enhance public awareness about heat pumps in Italy. There is a significant difference between the groups, with those having high familiarity viewing heat pumps as more energy-efficient. This suggests that increasing familiarity and knowledge about heat pumps could positively influence their perception and adoption. Thus, targeted educational campaigns and information dissemination about the energy efficiency and long-term cost benefits of heat pumps could be instrumental in shifting public perception and encouraging broader adoption.

4.2.4 Familiarity and Influence Factors

Comparing two groups based on their familiarity level with heat pumps reveals significant insights into the factors influencing their installation decisions. Participants with a lower level of familiarity are more influenced by installation cost, operational cost savings, recommendations from others, reliability and performance, and heat pump price compared to those with a higher familiarity level. One of the most significant differences is the influence of recommendations from others. This finding suggests that producers and government bodies should consider leveraging word-of-mouth and user testimonials as part of their advertising and awareness strategies.

4.2.5 Familiarity and Government incentives

The comparison between two groups regarding awareness of the SuperBonus 110% incentive provided by the Italian government indicates a significant difference. The results show a p-value of .001, a mean difference of .636, and a 95% confidence interval of [.278, .993], assuming unequal variances. The effect size (Cohen's d) is 1.161, indicating a large effect.

The options for this question were:

"Yes, and I have used it" = 1

"Yes, but I have not used it" = 2

"No, I am not aware of it" = 3

The overall mean of responses is 2.19, indicating that most respondents are aware of the bonus but have not used it, suggesting a tendency towards a lack of awareness. In this comparison, the high familiarity group has a mean of 1.92, which falls between the two "Yes" options, indicating that they are more aware and likely to have used the bonus. In contrast, the low familiarity group has a mean of 2.56, which is closer to the "No" option, indicating less awareness and usage. This significant difference implies that the high familiarity group is more aware of and has utilized the bonus more than the low familiarity group.

4.2.6 Influencing factors

"Influence Factors" heatmap provides insights into the perceived importance of various factors influencing decisions related to heat pumps.

Table 40. "Influence Factors" heatmap

Rate / Influence Factors	Extremely Important	Very Important	Moderately Important	Slightly Important	Not at All Important
Installation cost	14.0%	39.5%	32.6%	14.0%	0.0%
Operational cost saving	18.6%	37.2%	16.3%	23.3%	4.7%
Environmental impact	16.3%	27.9%	30.2%	18.6%	7.0%
GOV. incentives subsidies	11.6%	37.2%	18.6%	27.9%	4.7%
Recommendation from others	9.3%	16.3%	30.2%	32.6%	11.6%
Reliability and performance	20.9%	34.9%	25.6%	16.3%	2.3%
Ease of use	7.0%	34.9%	30.2%	16.3%	11.6%
GOV. Regulation (e.g. CO2 tax)	14.0%	25.6%	20.9%	20.9%	18.6%

Isolation and Renovation cost	11.6%	41.9%	16.3%	23.3%	7.0%
Heat pump price	18.6%	39.5%	25.6%	11.6%	4.7%

The key findings from the heat map are interpreted with combination of the “Extremely and very important” ratings:

- **Installation cost:** Initial installation costs can be a barrier to adoption. Participants are likely concerned about the upfront expense required to set up a heat pump system. 86.0% of participants consider this factor from moderate importance to an extreme level.
- **Operational cost savings**: Long-term savings on energy bills are a significant motivator. 72.1% of respondents are moderately to extremely interested in how a heat pump can reduce their monthly heating expenses.

- **Environmental impact:** The ecological benefits of heat pumps are appealing. Participants value reducing their carbon footprint and contributing to environmental sustainability. 74.4% consider the environmental impact of a heat pump when deciding whether to install one.

- **Government incentives/subsidies:** Financial incentives and subsidies from the government make heat pumps more affordable. These incentives can influence the decision of 67.4% of participants from a moderate to extreme level.

- **Recommendations from others:** Personal recommendations provide trust and assurance. This could analyze the power of word of mouth about this technology in Italy. 55.8% believe this factor could be influential in their decision. However, this factor has the lowest rate, with 44.2% considering it of low importance.

- **Reliability and performance:** Consistent and efficient performance of heat pumps is crucial. Participants prioritize systems that are dependable and perform well over time. For 81.4%, the performance and reliability of heat pumps have a moderate to extreme influence on their decisions. This factor has the highest percentage in extreme importance.

- **Ease of use:** Simple and user-friendly operation is important. Participants prefer heating systems that are easy to manage and operate without technical difficulties, and 72.1% believe it is an important factor.

- **Government regulation (e.g. CO2 tax):** Regulations and potential penalties related to CO2 emissions influence decisions. This could analyze the sample thoughts towards solutions such as paying tax for a defined amount of CO2 produced by them. For this factor, the number of people with low and high ratings is completely the same, both 39.5%, and 20.9% rate it as moderately influential.

- **Isolation and renovation cost:** Additional costs for insulation and home renovations affect the total expenditure. Participants consider these costs when evaluating the feasibility of heat pump installation and 69.8% consider this an important factor.

- **Heat pump price:** The purchase price of the heat pump is a major consideration. High costs can deter potential buyers despite long-term savings, and with 83.7%, it has the second-highest rate proving this effect.

Regarding extreme importance the highest is for reliability and performance 20.9%, mainly selected by participants with less than average knowledge and familiarity with heat pumps. The second extreme influences are heat pump price and operational cost savings, both with 18.6%.

Although the majority of participants first heard about heat pumps from family and friends, recommendations from others have the lowest influence on their decision to install a heat pump and have the highest rate of slight importance, which is considered 32.6% of the impact in this research.

For 7.0% of respondents, the environmental impact of heat pumps, whether positive like reducing carbon footprint or negative like refrigerant leakage, has no impact on their decision to install a heat pump. While more than 74.4% of participants declared this factor important to them, with 50% to 100% influence.

I have grouped the scales of this question into three categories: Very Important and Extremely Important as High Ratings, Not at all Important and Slightly Important as Low Ratings, and Moderately Important as Middle Rating. This grouping highlights the most and least important factors based on participants' responses.

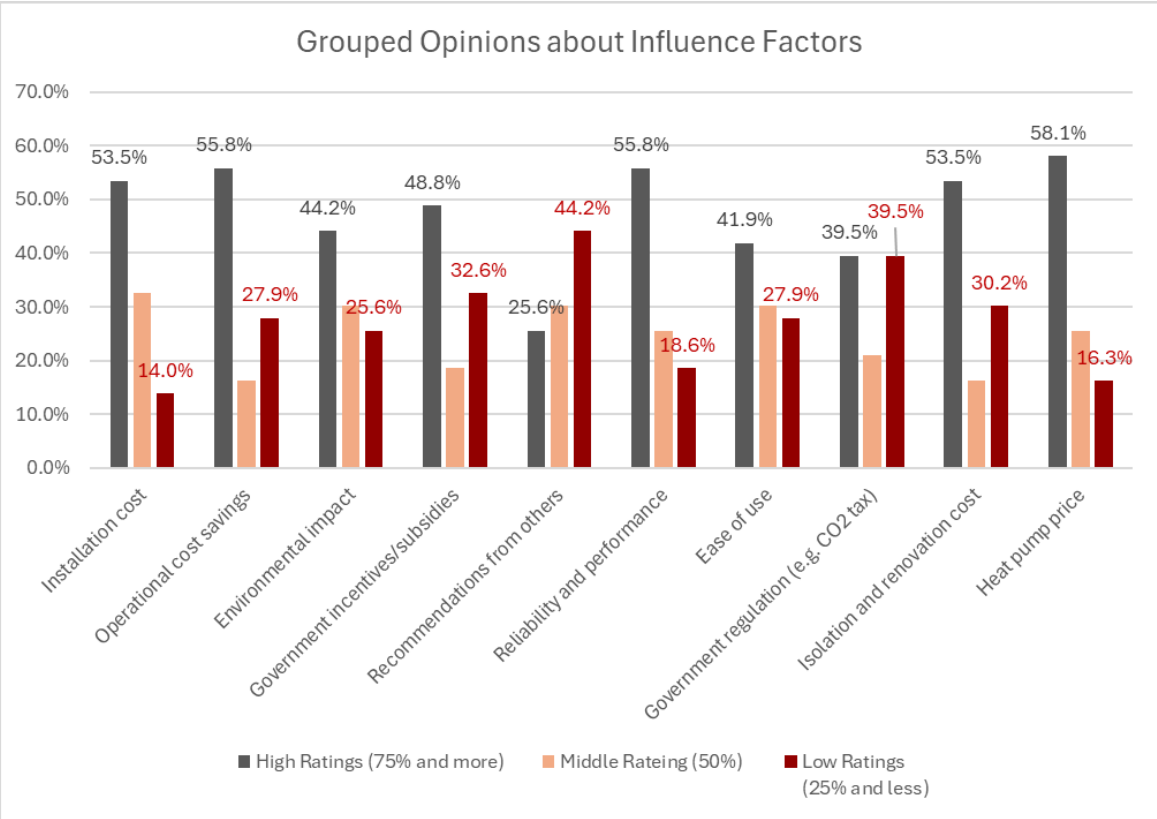

Figure 4-2. Influence factors, Grouped opinions

According to the chart, the highest rating, with 58.1%, belongs to Heat Pump price, indicating that price is the most critical factor and affordability is a significant concern for potential buyers. Solutions to address this issue could include renting out heat pumps by specialized energy companies, reducing production costs by manufacturers, and increasing the availability of lower-capacity models for apartments and smaller houses.

Operational cost savings and Reliability and performance, both with 55.8%, indicate that participants are highly motivated by the potential to save on operational costs, suggesting that long-term financial benefits are crucial in decision-making. Reliability and performance are essential, indicating that participants prioritize efficient and dependable heating systems.

Other factors, with more than 53.5% of respondents' choice for each, include Initial cost and Isolation and Renovation cost, showing that additional costs associated with purchasing a heat pump are a significant concern. Environmental Considerations, while important, are not as highly prioritized as the economic factors of price and installation cost.

Government Incentives show that 48.8% of respondents are influenced by incentives and subsidies provided by the government to install heat pumps. This suggests that future plans should include more targeted incentives for households that are inclined to use heat pumps but cannot fully afford the price.

In conclusion, the chart indicates that economic factors (price, installation cost, operational cost savings, and isolation and renovation cost) are the most critical considerations for respondents when it comes to adopting heat pumps. While environmental impact and government incentives are also important, they are to a slightly lesser degree. Recommendations from others and ease of use are the least influential factors. Therefore, for increased adoption, focusing on reducing costs and providing clear financial benefits could be the most effective strategy.

4.2.7 House ownership status vs. likelihood to Install/Move

The comparison between house ownership status and the likelihood to install a heat pump or move into a property equipped with one show that 44% of participants are neutral on the matter. When combining those who are likely and very likely to install or move, the potential market comprises over 67% of participants.

The Chi-square test results indicate no significant relationship between ownership status and the likelihood of installing or moving into a property with a heat pump. This suggests that ownership status does not strongly influence participants' decisions regarding heat pump installation or relocation to properties with such systems.

Within the neutral group, 18.6% are tenants, which underscores the need for targeted solutions. Recommendations include:

- Encouraging property owners to install heat pumps.
- Supporting policies that ban gas boilers in new buildings.
- Promoting businesses to offer heating systems for rent.
- Defining clear guidelines for cost-sharing between tenants and owners willing to invest in heat pumps.

These measures can help address the concerns of neutral respondents and foster greater adoption of heat pump technology.

No significant difference was found between groups in the likelihood to install a heat pump or, as tenants, rent a new property equipped with a heat pump based on their familiarity (Equal variances assumed: p = .880, Mean Difference = -.053, 95% CI = [-.763, .657], Effect size (Cohen's d) = -.047). Both groups had mean scores below neutral (Low Familiarity: 2.72, High Familiarity: 2.63), indicating a general tendency towards being unlikely to install or rent a new house with a heat pump. This suggests that familiarity with heat pumps does not significantly influence the decision to adopt them within the next two years, highlighting the need for targeted efforts to boost interest and adoption rates among both familiar and unfamiliar groups.

4.2.8 General Findings and Insights about concerns

- **Top Concerns**: High initial costs and maintenance/repair costs are the top concerns, suggesting financial barriers are the primary deterrents for heat pump adoption.
- **Performance Confidence**: The low concern for effectiveness in extreme weather implies that respondents are generally confident in the performance of heat pumps.

- **Installation and Compatibility**: Moderate concerns about complex installation and building suitability indicate a need for better installation solutions and compatibility assessments.
- **Minor Issues**: Noise levels and lack of reliable information are minor concerns, suggesting these are not significant barriers for most respondents.
- **Electricity Costs**: Concerns about electricity costs reflect ongoing operational expense worries, which could influence the adoption decision.
- **Market Variety**: The choice of heat pumps is moderately concerning, indicating the need for a diverse range of options to suit different needs.

These findings highlight that while there is a strong interest in the benefits of heat pumps, financial and practical concerns remain significant barriers that need addressing through incentives, reliable information, and cost-effective solutions.

4.2.9 Attitudes about recommending heat pump to others

The data shows a generally positive but cautious attitude towards recommending heat pumps. While a substantial number of participants see the value in heat pumps, the high percentage of 'Maybe' responses indicates that there are still reservations that need to be addressed. Factors such as cost, installation complexity, and performance reliability are likely to influence these decisions. Addressing these concerns through clear communication, financial incentives, and demonstrating the benefits of heat pumps could potentially convert the 'Maybe' group into advocates.

Additionally, the mean recommendation score for the high familiarity group is lower than that of the low familiarity group. This suggests that individuals with higher familiarity are more certain about recommending HP to others compared to those with lower familiarity. The lower mean value for the high familiarity group indicates a stronger inclination towards recommending HP.

This difference may be attributed to the lack of knowledge and experience with HP among the low familiarity group. They might be hesitant to recommend HP due to insufficient understanding of its performance and benefits. Given that this group is more influenced by recommendations from others, they could be a key target for awareness campaigns. Encouraging current HP users to share their positive experiences could help increase adoption among those with lower familiarity.

4.2.10 Willingness to Pay More for upfront cost and lower in long term

Overall, these findings demonstrate a strong inclination among the surveyed population towards investing in cost-saving measures, such as potentially adopting more efficient technologies or systems, to reduce long-term expenses. This trend underscores the importance of highlighting long-term savings in energy cost reduction strategies when promoting such investments.

Interestingly, the low familiarity group is much more certain about paying a higher upfront cost to save on bills compared to the high familiarity group. In contrast, 44% of the high familiarity group members are uncertain or unwilling to pay this upfront cost. This discrepancy suggests that despite their lower familiarity, the first group may be more motivated by the potential long-term financial benefits, whereas the second group may be more cautious or need additional information to justify the initial investment.

This finding highlights the need for targeted communication strategies to educate potential users about the long-term savings associated with heat pumps, particularly focusing on reducing upfront cost concerns among those with higher familiarity.

4.2.11 Technology adoption

The distribution indicates that while there is a substantial portion of respondents who are quick to adopt new technology (Innovators and Early Adopters), the majority are more cautious and prefer to adopt once a technology is proven (Early and Late Majority). This suggests that with proper information, incentives, and demonstrated reliability, heat pumps can see widespread adoption. Addressing concerns and providing comprehensive data on benefits and savings will be key to convincing the Early and Late Majority groups to invest in heat pumps.

4.3 Research Questions

This research and the survey was conducted to answer 4 main questions of this research on analysing the Market Potential and Consumer Acceptance of Heat Pump Technology in the Italian Residential Sector.

I. What is the status of the market for heat pump technology in the Italian residential sector?

The market for heat pump technology in Italy is growing, but it still faces several challenges. The survey indicates that over half of the respondents (55.55%) have moderate to high familiarity with heat pump technology, suggesting a reasonable level of awareness. However, a substantial portion of the population remains unfamiliar with this technology, highlighting the need for continued education and outreach.

The higher educational background does not influence familiarity with heat pumps. More than 66% of high school graduates report high familiarity with heat pumps, compared to 50% of those with master's degrees. This indicates that educational campaigns might need to be tailored differently depending on the audience's educational background.

The result also indicates that familiarity of heat pumps between homeowners 75% is moderately more than tenants' share in this awareness 45%. This disparity suggests a need for targeted awareness campaigns, particularly among tenants who may have less exposure to or incentive to learn about heat pumps.

Heat pumps are viewed as a viable solution for reducing carbon emissions and enhancing energy efficiency in the residential sector. The market is currently dominated by reversible air-source heat pumps (ASHPs), which are primarily used for cooling during the summer. There is potential for these systems to be utilized year-round for both heating and cooling, especially in the milder climates of central and southern Italy.

The research indicates that the highest ownership of heat pumps is for Air-to-Air models. However, respondents might have confused these with non-reversible air conditioners. This misunderstanding also extends to Ground Source and Air-to-Water heat pumps. Most of these respondents currently use gas boilers and central heating systems, with none explicitly selecting heat pumps as their primary heating system.

This discrepancy underscores a significant gap in understanding and awareness of heat pump technology. Despite a claimed familiarity, many respondents seem unsure about the specific types of heating systems they own. This emphasizes the need for clearer information and education about heat pumps to ensure consumers can correctly identify and understand their heating systems, which is crucial for improving awareness and adoption of this technology.

Awareness data for the SuperBonus 110% shows a significant difference between high and low familiarity groups, with high familiarity groups being more aware and likely to utilize incentives. This suggests that awareness campaigns and incentives could significantly impact market growth.

The market's growth is driven by increasing environmental awareness, government incentives, the push for sustainable energy solutions, and the banning of gas boilers for new buildings. Additionally, the rising cost of traditional energy sources, intensified by the Russia's invasion, has led to a rise in heat pump sales in many European countries, including Italy.

II. What are the main factors influencing consumer acceptance of heat pumps in Italy?

The results of the data analysis indicate that economic factors are the most critical considerations for respondents when adopting heat pumps. Specifically, the highest rate of concern belongs to the heat pump price, with 58.1% of respondents identifying it as crucial. Operational cost savings and reliability and performance are each critical for 55.8% of respondents. Additionally, initial cost and isolation and renovation cost are also significant, with more than 53.5% of respondents considering each of these factors important.

Environmental issues such as decarbonization, lower carbon footprints, and preventing the increase of earth temperature are significant concerns for governments, driving the promotion of green energy and low-carbon emission devices like heat pumps. However, only 44.2% of respondents consider these environmental factors to be very or extremely important, indicating a relatively low level of environmental concern among the Italian public.

Government incentives play a notable role, with 48.8% of respondents indicating they would be highly influenced by government-provided incentives and subsidies to install heat pumps. This suggests that targeted financial support could significantly boost heat pump adoption, particularly among those who are willing but financially constrained.

The analysis also reveals that recommendations from others and ease of use are the least influential factors. This suggests that for increased adoption, efforts should focus on reducing costs and providing clear financial benefits. Moreover, the overall moderate satisfaction with current heating systems indicates room for improvement. The mean satisfaction score is slightly above the midpoint but not significantly higher, showing a general sense of adequacy rather than strong satisfaction.

Additionally, the data shows that most respondents first heard about heat pumps from family and friends, accounting for 37.21% of the cases, followed by the internet at 32.56%. However, the internet is the main source of information for 58.1% of respondents in general, indicating its prominent role in informing the public about heat pumps. Family and friends selected by 44.2% of participants, highlighting the significant influence of personal networks. About 10% of people reported learning about heat pumps through university courses and reference books.

Efforts to promote heat pumps should address other factors beyond current satisfaction levels, such as highlighting additional benefits or addressing misconceptions about heat pump performance and efficiency. The comparison between satisfaction levels and willingness to install or move into a house equipped with a heat pump within the next two years shows no statistically significant relationship. Most participants, regardless of their satisfaction level, tend to remain neutral or unlikely to install a heat pump, indicating that other factors might play a more crucial role in this decision.

III. What opportunities exist for promoting the adoption of heat pump technology in the residential sector?

Current Heating System and Potential for Replacement

The survey results indicate that gas-based heating systems should be the primary target for replacement, as they produce significant CO2 emissions. Educating consumers who purchase air conditioners for cooling about reversible air-to-air heat pumps could help reduce reliance on gas for heating and provide year-round climate control, including hot water.

Additionally, electric boiler users are potential candidates for heat pump adoption. Highlighting the long-term cost savings and energy efficiency of heat pumps can appeal to these consumers. Survey responses show that all participants with electric boilers are open to paying higher upfront costs for long-term energy savings. Although about half of them lack detailed information about heat pumps, they perceive them as energy-efficient and cost-saving. Their common concerns include initial costs, maintenance, repair, complexity, and building suitability.

Targeting Dissatisfaction

Moderate satisfaction levels with current heating systems present an opportunity to target less satisfied consumers. Understanding the specific reasons behind their dissatisfaction can help position heat pumps as a superior alternative.

Financial Incentives

Comparing two groups based on their awareness of the SuperBonus 110% incentive reveals a significant difference. The overall mean response is 2.19, indicating awareness but limited usage of the bonus. The high familiarity group has a mean of 1.92, suggesting greater awareness and usage, while the low familiarity group has a mean of 2.56, indicating less awareness. This implies that familiarity with heat pumps may be linked to knowledge of these incentives. Increasing awareness of existing incentives is crucial before introducing new ones.

The SuperBonus 110%, intended to boost technological innovation during the COVID-19 pandemic, faced criticism for being distortive and inflationary. Despite this, government incentives remain influential, with 48.8% of respondents indicating they would be highly influenced by such incentives to install heat pumps. Additionally, implementing CO2 taxes and using the revenue to fund new incentives, as seen in Sweden, could be effective. Another financial solution is offering low-interest loans, similar to Ireland, to support homeowners in making their properties more energy-efficient.

Public Awareness Campaigns

Educating the public about heat pump benefits and functionalities can increase acceptance and adoption. Targeted campaigns and advertisements are more effective than broad ones. Highlighting the energy efficiency, cost savings, and environmental benefits of heat pumps can persuade those currently indifferent. Moderate satisfaction levels with current heating systems suggest that consumers might be open to new solutions if presented with clear advantages.

Nearly half of respondents with higher educational levels have low familiarity with heat pumps. Universities can play a vital role in educating students through environmental events and conferences on topics like green energy and sustainability. Heat pump producers can also provide clear, concise information on their websites and social media, simplifying the decision-making process for consumers. Additionally, including information about heat pumps and their efficiency compared to current heating systems in gas or electricity bills could be an effective awareness strategy, while respecting data privacy rules.

Technological Advancements

Continuous development of more efficient and user-friendly heat pump systems, including hybrid systems, can make them more appealing. Maintenance and repair costs, a concern for 30% of respondents, can be addressed by offering extended warranties and quality assurance. Simplified online calculators to estimate annual costs and carbon emissions savings from new heating and cooling systems can help consumers make informed decisions. Energy consultants and installers can reduce installation complexity and time, addressing concerns about building suitability and installation complexity. Producing heat pumps in various capacities and sizes suitable for apartments and small flats can also increase affordability.

Energy Price Stability

Promoting the stability of operational costs compared to the volatile prices of fossil fuels can attract more consumers. To meet carbon reduction goals and protect low-income households, Italy must ensure that electricity prices are no more than twice the price of gas. Currently, electricity prices are 2.5 to 3.5 times higher than gas prices (EHPA), highlighting the need for pricing reforms to encourage sustainable energy adoption. Additionally, 16.1% of electricity generation in Italy is from gas, highlighting the need to substitute it with green and renewable energies such as wind and photovoltaic (PV) power.

Professional Training

Increasing the number of trained professionals who can install and maintain heat pumps is essential. Although there are reportedly 73,400 certified installers listed on the official F-Gas website, this may not represent all active installers. As the heat pump market grows, the number of installers will likely need to increase. Providing more training opportunities can address concerns about installation complexity and reliability.

By addressing these opportunities, Italy can significantly promote the adoption of heat pump technology in the residential sector, contributing to environmental goals and energy efficiency.

IV. What are the key challenges hindering the widespread uptake of heat pump technology in Italy, and how can they be addressed?

Barriers for Tenants One of the major barriers to the installation of heat pumps is related to rental properties. Typically, tenants are not allowed to install major appliances or systems like heat pumps without the landlord's permission. Installing a heat pump usually involves significant modifications to the property, which are generally the responsibility and prerogative of the property owner. However, in some cases, tenants may negotiate with landlords for such upgrades, especially if they benefit the property in the long term.

In Italy, there is a rule called the Attestato di Prestazione Energetica (APE), which translates to Energy Performance Certificate. The APE is a mandatory energy efficiency certificate required for the sale, rental, or major renovations of buildings. It assesses a building's energy consumption and provides a rating on a scale (typically A being the most efficient and G the least). There have been proposals and discussions at the national and regional levels to discourage rentals of low-efficiency buildings (F or G) by potentially:

- Limiting rent increases for these buildings.
- Requiring landlords to make energy efficiency improvements before raising rents.

While these discussions are ongoing, there is currently no nationwide legislation that directly prohibits rent increases based solely on the APE class. However, it could be a very effective solution to this barrier. By increasing the energy efficiency of a property, the owner could be allowed to raise the rent, thereby recouping the costs associated with heat pump installation.

Another possible solution to providing houses equipped with heat pumps is to support policies that ban the installation of gas boilers in newly constructed buildings. This would offer tenants housing options with higher energy efficiency.

High Initial Costs and Maintenance Concerns The high initial cost, uncertainty about the best heat pump type, and maintenance and repair expenses are major barriers. Financial incentives, subsidies, and low-interest loans can help address cost concerns. Subsidies in countries like France, the United States, and Poland help make heat pumps more affordable, with higher subsidies available for low-income households and the most efficient models. Another effective solution is leasing heat pumps, a model already available in Germany. Leasing allows homeowners to pay a lower upfront cost and a fixed monthly fee, which includes maintenance and repairs. Contracts typically last 3 to 7 years, with options to renew or transfer ownership at the end.

Variety and Complexity of Heat Pump Choices According to the survey, 25.6% of respondents are concerned about choosing the right heat pump. The wide variety of models and capacities can be confusing. The selection depends on factors like the size and insulation of the home, and regional climate conditions.

Solutions to this challenge include:

- **Online Retailers:** Offering a broad range of models and installation services through certified partners, allowing price comparisons and informed decisions.
- **Direct Sales by Manufacturers:** Providing detailed information and bundled deals, though limited to their own brands and availability.
- **One-stop Shops:** Hosting annual fairs or events where consumers can access all brands, attend workshops, and get expert advice on costs and property suitability.

Chapter 5

5 Conclusion and Recommendations

According to Paris Agreement, in 2015, world leaders pledged to try and prevent global temperatures rising by more than 1.5C. In March 2022, EU leaders decided to rapidly reduce Europe's dependence on Russian energy imports by REPowerEU plan. Heat pumps are recognised as having a crucial role in helping to reach this plan target, which means 60 million additional heat pumps to be installed in Europe by 2030. Additionally, by 2040, global emissions from buildings need to be reduced by 90% from 2015 levels, and by 95-100% by 2050, primarily through increased efficiency, reduced energy demand, and electrification alongside complete decarbonization of the power sector (Climate Action Tracker, 2020; Rogelj et al., 2018). In Italy, the building sector is responsible for 21% of CO2 emissions, and the country's energy mix is still dominated by fossil fuels (79%). Although the share of renewable energy has steadily increased to 17.5% of total primary energy consumption in 2021, the carbon intensity of Italy's energy mix has barely changed. Despite Italy's plan to reduce carbon emissions by 60% by 2030, climate reports indicate that the country is not on track.

Italy's National Recovery and Resilience Plan and the Integrated National Energy and Climate Plan (NECP) emphasize the need for social inclusion and support for regions affected by the economic transition required to reduce greenhouse gas emissions. The country has announced a phase-out of coal-fired electricity generation by 2025 [15]. Italy is significantly affected by heatwaves, with temperatures reaching a record 48.8°C (119.8°F) in August 2021. Addressing increasing temperatures driven by high emissions requires urgent action. However, reducing emissions without social support will be challenging. As people buy air conditioners to cool down during hotter summers, it is crucial to inform potential buyers that reducing global temperatures requires more than just cooling their houses. Promoting reversible air-to-air heat pumps can help reduce carbon footprints by providing a more energy-efficient way to warm homes in winter and cool them in summer, contributing to a broader effort to mitigate climate change.

Heat pumps have emerged as a promising solution for residential heating and cooling, offering significant environmental and economic benefits. This study aimed to explore the market potential and consumer acceptance of heat pumps in Italy, particularly focusing on the factors influencing their adoption and the challenges hindering their widespread use. The research was guided by four key questions: the current market landscape, factors affecting consumer acceptance, opportunities for promoting heat pump adoption, and challenges to overcome.

Market Landscape of Heat Pumps in Italy

The Italian Heat pump market is one of the largest in Europe and is growing while faces several challenges. Over half of the respondents (55.55%) have moderate to high familiarity with heat pumps, indicating a reasonable level of awareness. However, a significant portion of the population remains unfamiliar with this technology, highlighting the need for continued education and outreach. Familiarity is not influenced by higher educational background, as over 66% of high school graduates report high familiarity, compared to 50% of those with master's degrees. The result also indicates that familiarity of heat pumps between homeowners is moderately more than tenants' share in this awareness. This suggests the need for targeted campaigns, particularly among tenants who have less exposure to heat pumps.

Heat pumps are seen as a viable solution for reducing carbon emissions and enhancing energy efficiency in the residential sector. The market is currently dominated by reversible air-source heat pumps (ASHPs), primarily used for cooling during the summer, with potential for year-round use in milder climates. The highest ownership is for Air-to-Air models, though respondents may confuse them with non-reversible air conditioners, as most of these respondents use gas boilers and central heating systems, indicating a gap in understanding and awareness of heat pump technology. Awareness data for the SuperBonus 110% shows significant differences between high and low familiarity groups, suggesting that awareness campaigns and incentives could significantly impact market growth. Driven by increasing environmental awareness, government incentives, and rising traditional energy costs intensified by global events, heat pump sales will rise more in Italy and across Europe.

Factors Influencing Consumer Acceptance

The data analysis reveals that economic factors are the most critical considerations for respondents when adopting heat pumps. More than half of respondents identifying Heat pump's price, Operational cost savings, reliability and performance, initial costs, and renovation expenses are crucial concerns. Although environmental issues like decarbonization and reducing carbon footprints drive governmental promotion of green energy, only 44.2% of respondents consider these factors very important, showing a relatively low level of environmental concern among the Italian public. Government incentives are influential, with 48.8% of respondents indicating they would be highly influenced by subsidies to install heat pumps, suggesting that targeted financial support could significantly boost adoption.

Overall satisfaction with current heating systems is moderate, revealing room for improvement as the mean satisfaction score is just above the midpoint. Despite satisfaction levels, most participants remain neutral or unlikely to install a heat pump within the next two years, suggesting that other factors significantly influence this decision.

The internet is the primary source of information for 58.1% of respondents, followed by family and friends for 44.2%, highlighting the influence of personal networks. Efforts to promote heat pumps should focus on addressing economic concerns, enhancing public awareness, and dispelling misconceptions about heat pump performance and efficiency.

Opportunities for Promoting Heat Pump Adoption

The survey underscores the need to prioritize replacing gas-based heating systems, major contributors to CO_2 emissions. Educating consumers who rely solely on air-conditioners for cooling can unlock the potential of reversible air-to-air heat pumps. These pumps offer year-round climate control while reducing dependence on gas for heating. Electric boiler users are also prime candidates for the long-term cost savings and energy efficiency that heat pumps provide. Despite a lack of detailed information about heat pumps among some respondents, they recognize the long-term efficiency and cost savings these systems offer. However, concerns linger regarding upfront costs and ongoing maintenance needs. Addressing moderate satisfaction levels with current heating systems can position heat pumps as a superior alternative.

Financial incentives play a crucial role in promoting heat pump adoption. Awareness of the SuperBonus 110% incentive correlates with increased usage, indicating that familiarity with incentives is essential. Despite criticism, government incentives significantly influence installation decisions, with nearly half of the respondents indicating they would be highly influenced by such incentives. Implementing CO2 taxes and offering low-interest loans, as seen in Sweden and Ireland, respectively, could further support adoption. Public awareness campaigns, targeted advertising, and educational initiatives at universities can increase acceptance and familiarity. To unlock the full potential of heat pump technology and ensure its energy efficiency and environmental benefits for homes, three key factors are essential: advancements in the technology itself, professional training for installers, and stable energy prices.

Challenges to Overcome

The largest barrier to heat pump adoption and installation is the high initial cost and uncertainty about the best type of heat pump for a house, as well as concerns about maintenance and repair costs. Financial incentives, subsidies, or loans can address these cost barriers. An alternative solution is leasing heat pumps, a practice currently available in Germany. Leasing offers the advantage of lower upfront costs and predictable monthly fees, including maintenance and repairs, under a contract typically lasting 3 to 7 years. This solution requires clear rules and participation from businesses before it can be effectively promoted and awareness increased.

Another major barrier to heat pump installation in rental properties is that tenants usually need landlord permission, as such installations involve significant modifications. The Attestato di Prestazione Energetica (APE) in Italy, an energy efficiency certification, could address this by discouraging rentals of low-efficiency buildings and incentivizing landlords to make improvements. Proposals suggest limiting rent increases for inefficient properties and requiring upgrades before rent hikes, allowing landlords to recover heat pump installation costs. Additionally, banning gas boilers in new buildings could ensure higher energy efficiency options for tenants.

Survey results show that respondents are concerned about suitability of the property and choosing the right heat pump due to the wide variety of models and capacities. Factors such as house size, insulation level, and regional climate significantly impact the required heat pump capacity, which can be confusing even for knowledgeable consumers. Solutions to this barrier include online retailers in Italy that offer a range of heat pump models and installation services through certified installers, providing the ability to compare prices and options. Direct sales from major manufacturers can offer bundled deals and expert advice, though their selection may be limited to their own brands. Additionally, a “one-stop shops” model, similar to annual fairs, could provide access to various brands, types of heat pumps, workshops for increasing awareness, expert consultations, and cost and suitability assessments.

Implications

The transition to heat pump technology in the Italian residential sector offers significant environmental and economic benefits. By reducing CO_2 emissions and enhancing energy efficiency, heat pumps contribute to national and international sustainability goals. The study underscores the importance of supportive policies and financial incentives in accelerating the adoption of heat pumps. Additionally, raising consumer awareness and providing clear information on the benefits and savings associated with heat pumps are critical for increasing market penetration.

In conclusion, this study underscores the potential of heat pumps as a sustainable solution for residential heating and cooling in Italy. The findings highlight the importance of addressing financial, technical, and informational barriers to promote their adoption. By leveraging technological advancements, supportive policies, and consumer education, Italy can significantly advance towards a more sustainable and energy-efficient future. Future research should focus on longitudinal studies to track adoption trends, integration with renewable energy systems, and the social dynamics of energy consumption.

"Our actions matter. Let's unite to cool the planet."

6 Reference

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17. Which Countries Are Winning the European Heat Pump Race, The eco experts, Josh Jackman, 2023.

7 Appendix

Table 41. 3.2.3.2.2 Concern about installing heat pump based on Familiarity groups, Independent sample T test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance		95% Confidence Interval of the Difference	
		F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
High initial costs	Equal variances assumed	7.350	.017	1.276	14	.223	.302	-.205	.809
	Equal variances not assumed			1.332	13.947	.204	.302	-.184	.787
Maintenance and repair cost	Equal variances assumed	4.000	.065	.875	14	.396	.111	-.161	.383
	Equal variances not assumed			1.000	8.000	.347	.111	-.145	.367
Effectiveness in extreme weather	Equal variances assumed	.150	.705	.191	14	.851	.048	-.487	.583
	Equal variances not assumed			.192	13.199	.851	.048	-.489	.584
Complex installation	Equal variances assumed	.441	.518	-.917	14	.375	-.238	-.795	.319
	Equal variances not assumed			-.909	12.577	.380	-.238	-.806	.330
Suitability of building	Equal variances assumed	7.560	.016	-1.146	14	.271	-.143	-.410	.125
	Equal variances not assumed			-1.000	6.000	.356	-.143	-.492	.207
Noise level	Equal variances assumed	2.223	.158	-.847	14	.411	-.206	-.729	.316
	Equal variances not assumed			-.826	11.596	.426	-.206	-.753	.340
Electricity cost	Equal variances assumed	.014	.906	-.059	14	.953	-.016	-.589	.557
	Equal variances not assumed			-.059	12.951	.954	-.016	-.594	.563

Choice of Heat pump	Equal variances assumed	1.396	.257	.617	14	.547	.159	-.393	.711
	Equal variances not assumed			.623	13.495	.544	.159	-.389	.707

Table 42. Independent samples T test, Incentives awareness, recommending HP, Willingness to pay higher upfront cost, based on two familiarity groups

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance		95% Confidence Interval of the Difference	
		F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
Italy Bonus awareness	Equal variances assumed	5.527	.024	3.756	41	<.001	.636	.294	.977
	Equal variances not assumed			3.622	31.569	.001	.636	.278	.993
Would you recommend HP to others	Equal variances assumed	.506	.481	.880	41	.384	.180	-.233	.593
	Equal variances not assumed			.863	33.988	.394	.180	-.244	.604
willingness to pay higher cost for less bill	Equal variances assumed	13.229	<.001	-2.118	41	.040	-.538	-1.051	-.025
	Equal variances not assumed			-2.243	40.981	.030	-.538	-1.022	-.053

Table 43. Independent samples Effect Sizes, Incentives awareness, recommending HP, Willingness to pay higher upfront cost, based on two familiarity groups

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Italy Bonus awareness	Cohen's d	.547	1.161	.499	1.811
Would you recommend HP to others	Cohen's d	.661	.272	-.338	.879

willingness to pay higher cost for less bill	Cohen's d	.822	-.655	-1.273	-.029

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.

Table 44.Likelihood to Instal/ Move, based on familiarity groups, independent samples T test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance		95% Confidence Interval of the Difference	
		F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
How likely to install HP in next 2 years	Equal variances assumed	.162	.689	-.152	41	.880	-.053	-.763	.657
	Equal variances not assumed			-.152	36.779	.880	-.053	-.766	.659

Table 45.Demographics and Current heating system satisfaction based on familiarity groups, Independent samples T test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance		95% Confidence Interval of the Difference	
		F	Sig.	t	df	Two-Sided p	Mean Difference	Lower	Upper
Education Level	Equal variances assumed	1.466	.233	.852	43	.399	.360	-.492	1.212

	Equal variances not assumed			.862	42.394	.393	.360	-.482	1.202
Region	Equal variances assumed	.669	.418	.431	43	.669	.120	-.442	.682
	Equal variances not assumed			.441	42.971	.662	.120	-.429	.669
Gender	Equal variances assumed	1.626	.209	-.933	43	.356	-.140	-.443	.163
	Equal variances not assumed			-.928	39.987	.359	-.140	-.445	.165
House Ownership	Equal variances assumed	2.917	.095	1.019	43	.314	.210	-.206	.626
	Equal variances not assumed			1.043	42.986	.303	.210	-.196	.616
Income	Equal variances assumed	.248	.621	-1.433	43	.159	-.250	-.602	.102
	Equal variances not assumed			-1.430	40.553	.160	-.250	-.603	.103
Satisfaction of Current Heating System Education Level	Equal variances assumed	.006	.938	.565	43	.575	.180	-.462	.822
	Equal variances not assumed			.566	41.149	.574	.180	-.462	.822

*Table 46. Education Level * Grouped Familiarity Crosstabulation*

		Grouped Familiarity		
		Low Familiarity	High Familiarity	Total
Education Level	Less than high school	0	1	1
	High school diploma or equivalent	5	10	15
	Some college or vocational training	3	0	3
	Bachelor’s degree	4	6	10
	Master’s degree	7	7	14
	Doctorate or higher	1	1	2
Total		20	25	45

Table 47. House Ownership and Grouped Familiarity Crosstabulation

		Grouped Familiarity		
		Low Familiarity	High Familiarity	Total
House Ownership	Owner	3	9	12
	Tenant	13	11	24
	Not Decision makers	4	5	9
Total		20	25	45

*Table 48. willingness to pay higher cost for less bill * How likely to install HP in next 2 years Crosstabulation*

willingness to pay higher cost for less bill * How likely to install HP in next 2 years Crosstabulation

Count

		How likely to install HP in next 2 years					
		Very unlikely	Unlikely	Neutral	Likely	Very likely	Total
willingness to pay higher cost for less bill	Yes	6	3	13	7	1	30
	No	3	0	0	0	0	3
	Maybe	1	1	6	2	0	10
Total		10	4	19	9	1	43