Corso di Laurea in Strategic Management

Cattedra di Economics and Management of Energy Business

“Cost-Benefit Analysis of the Impact of the Superbonus 110% on Energy Efficiency in Buildings”

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ANNO ACCADEMICO 2023-2024

ἐχθαίρω τὸ ποίημα τὸ κυκλικόν, οὐδὲ κελεύθῳ
χαίρω τίς πολλοὺς ὧδε καὶ ὧδε φέρει

Callimaco, epigramma 28

"...And therefore never send to know for whom the bell tolls.
It tolls for thee."

John Donne

Cost-Benefit Analysis of the Impact of the Superbonus 110% on Energy Efficiency in Buildings

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Introduction

Finding myself once again writing a thesis, I decided for the second time to explore the impact of government actions on a specific issue. For my bachelor's thesis, I examined on a macro level the impact of economic policies that had helped Italy recover from the Great Recession and had brought the country to the onset of the COVID-19 pandemic, focusing on the historical events that most influenced the nation during years that were particularly significant for someone born in 2000.

And just as the onset of the pandemic had similarly significant effects during equally important years, it was only natural for me to ask again, "What did the government do, and was it effective?" However, while the Great Recession was primarily an economic crisis, and its consequences and responses were mainly economic, the COVID-19 pandemic extended beyond this scope, bringing unprecedented attention—at least in Western countries—to the issue of ecological transition. In this context, it was almost immediate for me to integrate the environmental issue into the question of government actions.

Observing the political debate, but also the economic one, the 110% Superbonus quickly stood out—a measure introduced during the pandemic to promote the energy transition and revive the construction sector. Many criticisms have been leveled against this measure, despite its initial multilateral support, and of course, many arguments in its defense have emerged, often presenting data and insights in favor of it that starkly contrasted with the critical ones, fueling the political debate even further.

With these premises, the desire to shed light and clarity on this debate quickly emerges, and to attempt to provide a clear and definitive answer, as much as possible, on the impact of this measure. This is precisely what has been carried out in this analysis, situating the measure within the broader context of energy efficiency in buildings and attempting to conduct a cost-benefit analysis of the impact the Superbonus has had on the country, primarily in terms of energy, but also economically.

CHAPTER 1. The context of energy efficiency in buildings between the European Union and Italy

1.1 Introduction to energy efficiency in buildings

Energy efficiency in buildings is a crucial aspect of modern sustainable development, reflecting the need to reduce energy consumption and mitigate environmental impacts. This concept involves optimising energy use within buildings to maintain comfort and functionality while minimizing waste.

Modern architecture and environmental sustainability depend on energy efficiency in buildings since it addresses the need of lowering energy consumption and hence environmental impact. Energy efficiency is essentially about best using resources to deliver required services including heating, cooling, lighting, and operational needs while reducing waste. Building have long been significant energy consumers. With the residential and commercial sectors consuming a significant share of total energy consumption, they explain most of the energy use in Europe[1]. Growing awareness of the need of energy efficient technologies and practices to minimize environmental effects and lower energy costs has resulted from this great consumption. Energy efficiency in buildings has straightforward reasoning but great impact. Energy efficiency measures can greatly lower energy bills, lower greenhouse gas emissions and lessen reliance on non-renewable energy sources by lowering the amount of energy needed to sustain comfortable living and working conditions. Simple actions like bettering insulation and installing energy-efficient windows to more sophisticated systems including advanced heating, ventilation and air conditioning (HVAC) technologies and smart building management systems range in scope[2].

Energy efficiency in buildings has evolved from the oil crisis of the 1970s, which underlined the fragility of economies to energy supply interruptions and spurred the growth of energy-saving technologies and practices. First, the emphasis was on lowering energy use by means of improved insulation and more effective heating systems. With time, the field of energy efficiency grew to encompass a broad spectrum of technologies and approaches including passive solar design, energy-efficient lighting, and the integration of renewable energy sources[3]. Growing awareness of climate change and the part buildings play in greenhouse gas emissions gave the drive toward energy

[1] "In Focus: Energy Efficient Buildings - Delivering Energy and Cost Savings for EU Citizens." Energy.ec.europa.eu, energy.ec.europa.eu/news/focus-energy-efficient-buildings-2024-04-16_en.

[2] Elstad, Simon. "Energy Efficient Buildings Explained." Greener Ideal, 29 Mar. 2022, greenerideal.com/news/building/energy-efficient-buildings-explained/.

[3] Ionescu, Constantin, et al. "The Historical Evolution of the Energy Efficient Buildings." Renewable and Sustainable Energy Reviews, vol. 49, Sept. 2015, pp. 243–253, https://doi.org/10.1016/j.rser.2015.04.062.

efficiency fresh impetus at the start of the 21st century. About 40% of world energy consumption and 33% of greenhouse gas emissions come from buildings, thus they are a major target for projects aimed at energy savings. Not only have building codes and standards like the Energy Performance of Buildings Directive (EPBD) in the European Union helped to open the path for notable increases in the energy performance of buildings. The EPBD aims to achieve a fully decarbonized building stock by 2050, emphasizing the importance of nearly zero-energy buildings (NZEBs) and the integration of renewable energy sources into building systems (Energy Performance of Buildings Directive, 2024)[4].

Buildings energy efficiency has been much improved by technological developments. Digital tools, high-performance materials and smart meters have transformed building energy consumption and management. For instance, smart meters give real-time energy consumption data, which helps building managers and occupants to spot inefficiencies and change their behaviour[5]. Energy-efficient windows and advanced insulation are among high-performance materials that help to sustain indoor temperatures with low energy input, so lowering heating and cooling demand[6]. The role of digital tools in energy efficiency cannot be overstated. Significant energy savings follow from the automation and optimization of building operations made possible by building management systems (BMS) and other digital platforms. Based on occupancy patterns, weather, and energy prices, these systems can manage HVAC, lighting, and other building services so that energy is used just where and when it is needed[7].

Apart from technological developments, financial incentives and legislative actions have supported energy economy in buildings. To promote the acceptance of energy-efficient technologies and practices, governments and companies all around have carried out different policies and projects. These comprise rules enforcing minimum energy performance criteria for buildings as well as tax incentives, rebates and subsidies for energy-efficient renovations and new building[8]. Energy efficiency boasts rather significant financial advantages. Because their energy consumption is lower, energy-efficient buildings usually have lower running costs, which translates into lower energy taxes for their occupants. Furthermore appealing investments are energy-efficient buildings since they usually have better rental income and property values.

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[4] "In Focus: Energy Efficient Buildings - Delivering Energy and Cost Savings for EU Citizens.", Op. cit.
[5] "In Focus: Energy Efficient Buildings - Delivering Energy and Cost Savings for EU Citizens.", Op. cit.
[6] "How to Improve Energy Efficiency in Your Building." BDC.ca, 12 Sept. 2020, www.bdc.ca/en/articles-tools/sustainability/climate-action-centre/articles/how-aim-net-zero-energy-efficiency.
[7] "Energy Efficiency Policy Toolkit 2024 – Analysis." IEA, 21 May 2024, http://www.iea.org/reports/energy-efficiency-policy-toolkit-2024. Accessed 8 July 2024.
[8] "Special Report 11/2020 Energy Efficiency in Buildings: Greater Focus on Cost-Effectiveness Still Needed." Op.europa.eu, op.europa.eu/webpub/eca/special-reports/energy-efficiency-11-2020/en/.

From a social standpoint, energy efficiency lowers the demand for imported energy and so lessens the risk related to erratic energy prices, so promoting energy security. The advantages for the surroundings also appeal greatly. Energy-efficient buildings improve air quality and help to slow down climate change by lowering related greenhouse gas emissions and energy consumption. In cities, where buildings are a main cause of air pollution, this is especially crucial. Better health results for residents resulting from improved air quality will help to lower healthcare costs and raise general quality of living.

Along with policy and technology, the road to energy efficiency in buildings also requires building occupants' behaviour and perspective. Encouragement of people to implement energy-saving habits in their daily life depends mostly on education and awareness-raising campaigns. Little deeds like turning off lights when not in use, running energy-efficient appliances, and adjusting thermostats to ideal temperatures taken together can result in major energy savings[9]. Getting over the upfront cost barrier connected with energy-efficient technologies and renovations is one of the main difficulties in encouraging energy efficiency. Though these steps usually result in long-term savings, the initial outlay can be rather large. Low-interest loans, grants and tax credits are among the financial incentives that help remove this obstacle so homeowners and companies may more easily make investments in energy-efficient improvements[10]. Moreover, the idea of energy efficiency is closely related with the more general objectives of resilience and sustainability. Designed not only to lower energy consumption but also to increase the general sustainability of the constructed environment are energy-efficient buildings. This covers the whole life cycle of a building, from construction methods and material procurement to maintenance and ultimate decommissioning[11]. Further lowering their environmental impact are sustainable buildings' inclusion of green roofs, rainwater collecting systems and recycled materials usage.

Another essential quality is resilience, particularly considering climate change. While maintaining steady indoor temperatures with low energy input, energy-efficient buildings are better suited to resist extreme weather events including heat waves and cold spells. This guarantees not only occupants' comfort and safety but also less strain on the energy infrastructure during periods of maximum demand[12]. Further lowering their environmental impact are sustainable buildings' inclusion

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[9] "Buildings – Energy Efficiency 2020 – Analysis." IEA, www.iea.org/reports/energy-efficiency-2020/buildings.

[10] "Special Report 11/2020 Energy Efficiency in Buildings: Greater Focus on Cost-Effectiveness Still Needed." Op.europa.eu, Op. cit.

[11] Belussi, L., Barozzi, B., Bellazzi, A., Danza, L., Devitofrancesco, A., Fanciulli, C., Ghellere, M., Guazzi, G., Meroni, I., Salamone, F., Scamoni, F., & Scrosati, C. (2019). A review of performance of zero energy buildings and energy efficiency solutions. Journal of Building Engineering, 25, 100772. https://doi.org/10.1016/j.jobe.2019.100772

[12] Diakaki, C., Grigoroudis, E., & Kolokotsa, D. (2008). Towards a multi-objective optimization approach for improving energy efficiency in buildings. Energy and Buildings, 40(9), 1747–1754. https://doi.org/10.1016/j.enbuild.2008.03.002

of green roofs, rainwater collecting systems and recycled materials usage. Buildings created from this mix not only use less energy but also generate a good amount of their own needs. Often referred to as net-zero energy buildings, these constructions epitomize sustainable architecture in which buildings positively contribute to the energy network instead of merely exploiting it[13]. Encouragement of energy efficiency in buildings depends on international cooperation and knowledge sharing. Countries all around have similar possibilities and problems in this regard; hence, sharing best practices helps to speed development. This knowledge and experience flow is greatly facilitated by several international agencies including the United Nations Environment Program (UNEP) and the International Energy Agency (IEA). Conferences, seminars, and group research projects give stakeholders venues to grow creatively by learning from one another[14].

Moving forward, it is impossible to overestimate the importance of innovation in advancing energy economy. Emerging technologies provide fresh chances to maximize building performance: artificial intelligence (AI), the Internet of Things (IoT), and sophisticated sensors all help. IoT-enabled devices, for instance, can gather and evaluate real-time data on occupancy patterns, indoor air quality and energy consumption, so allowing more exact control of building systems. By then, AI systems can use this information to forecast energy demand and maximize operations, so increasing efficiency[15].

These problems will be more closely discussed in the following parts of this section, so offering a thorough study of technologies for raising building energy efficiency as well as the environmental advantages of well-designed buildings. Energy efficiency in buildings is achieved through a comprehensive set of methodologies, techniques and tools designed to reduce energy consumption while maintaining or improving occupant comfort and productivity. Among the most effective techniques are the use of heat pumps, induction cooking, advanced insulation materials, mechanical ventilation with heat recovery and LED lighting. Each of these technologies contributes significantly to energy savings, as demonstrated by various studies and industry reports.

Heat pump

Key technology for energy-efficient heating and cooling are heat pumps. Using renewable energy sources such air, water or ground heat, these systems operate by moving heat from a cooler space to a warmer one. Heat pumps can supply up to three times more heating energy to a house than

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[13] Da Cunha, S. R. L., & De Aguiar, J. L. B. (2020). Phase change materials and energy efficiency of buildings: A review of knowledge. Journal of Energy Storage, 27, 101083. https://doi.org/10.1016/j.est.2019.101083

[14] Henryson, J., Håkansson, T., & Pyrko, J. (2000). Energy efficiency in buildings through information – Swedish perspective. Energy Policy, 28(3), 169–180. https://doi.org/10.1016/s0301-4215(00)00004-5

[15] Kumar, A., Sharma, S., Goyal, N., Singh, A., Cheng, X., & Singh, P. (2021). Secure and energy-efficient smart building architecture with emerging technology IoT. Computer Communications, 176, 207–217. https://doi.org/10.1016/j.comcom.2021.06.003

the electricity they consume, the US Department of Energy (2021) notes[16]. Moving heat instead of creating it from scratch—which is far more efficient—helps to achieve this. Studies have shown that a heat pump system can save up to 50% of the energy used from conventional electric heating. Moreover, a study by the International Energy Agency (IEA) shows that by 2025 the extensive acceptance of heat pumps could lower world CO_2 emissions by 8%[17].

Heat pumps have great versatility among other benefits. One can heat, cool, and use hot water among other things. For instance, whereas ground source heat pumps (GSHPs), sometimes referred to as geothermal pumps, provide better efficiencies by using the stable temperature of the ground, air source heat pumps (ASHPs) are effective in a wide range of climates. The Environmental Protection Agency (EPA) claims that, when compared to electric resistance heating with conventional air conditioning equipment, GSHPs can cut energy consumption and related emissions by up to 72%[18].

Induction cooking

Another method enhancing energy economy in buildings is induction cooking. Induction tables heat pots and pans directly using electromagnetic fields, unlike conventional gas or electric tables, so speeding heating and lowering energy waste. A Lawrence Berkeley National Laboratory study indicates that induction cookers are roughly 84% more efficient than conventional electric coils at 74% and 40% respectively[19]. Especially in homes and businesses, this higher efficiency results in notable energy savings.

Induction cooking's precision and control add even more to energy economy. Induction pads virtually instantly heat the utensils, so saving time and effort in cooking. In warmer climates, less residual heat in the kitchen results from the cooking deck not heating up (only the utensil does), so helping to lower cooling loads. Induction cooking is actually 90–95% more efficient than gas, which releases up to two-thirds of the energy consumed and heats the kitchen, since energy is delivered directly to the appliance rather than to the oven burners[20].

Advanced insulation

Reducing energy loss in buildings mostly depends on advanced insulation. Modern insulating materials have better thermal resistance than conventional materials: spray foam, rigid foams, advanced fibreglass. By acting as a barrier to heat flow, insulation keeps warm air indoors in winter and outside in summer. By sealing the air in their homes and adding insulation in ceilings, floor over

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[16] Heat pump systems. (n.d.). Energy.gov. https://www.energy.gov/energysaver/heat-pump-systems

[17] The Future of Cooling – Analysis - IEA. (2018, May 1). IEA. https://www.iea.org/reports/the-future-of-cooling

[18] Geothermal Heat Pumps | AHRI. (n.d.). https://www.ahrinet.org/scholarships-education/education/contractors-and-specifiers/hvacr-equipmentcomponents/geothermal-heat-pumps

[19] Sweeney, Micah, et al. Induction Cooking Technology Design and Assessment. 2014.

[20] Eco-Kitchens: induction cooktops for cleaner, greener cooking. (2024, May 31). EcoBlock. https://ecoblock.berkeley.edu/blog/eco-kitchens-induction-cooktops-for-cleaner-greener-cooking/

crawl spaces, and accessible basement crawl spaces, the Environmental Protection Agency (EPA) projects that homeowners can save an average of 15% on heating and cooling costs (11 per% on total energy costs)[21]. Furthermore, in some climates the use of high-performance insulation can cut the heating and cooling energy demand by up to 50%[22].

Each of the several forms of insulation has benefits of its own. In hard-to-reach areas especially, spray foam insulation expands upon application to fill gaps and offer a waterproof seal. Rigid foam boards are good for areas where depth is a factor since they have great insulating value with low thickness. Higher density and improved fibres combined in advanced glass fibre insulation give better thermal resistance than conventional fibre batts. The US Department of Energy claims that appropriate insulation and air sealing can cut heating and cooling demand by thirty%[23].

Mechanical Ventilation with Heat Recovery

Increasingly used mechanical ventilation systems with heat recovery (MVHR) are meant to enhance indoor air quality and reduce energy loss. Being able to recover up to 95% of the heat that would otherwise have been lost through ventilation, these systems pre-heat the arriving fresh air by recovering heat from the exiting stagnant air[24]. Effective DC motors allow up to 15 times more heating energy to be recovered for every kWh of electrical energy; hence, in a 150 m2 living space, this results in savings of almost 600 litres of fuel oil annually[25].

MVHR systems constantly provide fresh air while extracting pollutants and moisture, so improving indoor air quality in addition to saving energy. In well-sealed, energy-efficient buildings where natural ventilation might be inadequate, this is especially helpful. The heat exchanger used determines the efficiency of MVHR systems; rotary heat exchangers, for instance, can reach more efficiency rates than plate heat exchangers. Achieving the guidelines set by building certification programs such Passive House and LEED (Leadership in Energy and Environmental Design) depends on including MVHR systems into architectural design.

LED lightning

One big advance in energy-efficient building technology is LED lighting. LEDs last 25 times longer and use up to 90% less energy than traditional incandescent bulbs[26]. The Energy Information

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21 Methodology for estimated energy savings. (n.d.). ENERGY STAR. https://www.energystar.gov/saveathome/seal_insulate/methodology

22 Energy Saving Trust. (2024, February 7). Home insulation - Energy Saving Trust. https://energysavingtrust.org.uk/charity-energy-advice-resource/home-insulation/

23 Weatherization. (n.d.). Energy.gov. https://www.energy.gov/energysaver/weatherize

24 Rogers, S. (2023, October 10). MVHR PLUS | What is MVHR? MVHR PLUS. https://www.mvhrplus.com/resources/what-is-mvhr

25 Mechanical ventilation with heat recovery | Viessmann SG. (2023, June 20). https://www.viessmann.sg/en/knowledge/technology-and-systems/housing-ventilation/heat-recovery-ventilation.html

26 LED Lighting. (n.d.). Energy.gov. https://www.energy.gov/energysaver/led-lighting

Administration (EIA) estimates that by 2030, the broad acceptance of LED lighting in the United States could lower lighting energy consumption by almost 40% thus generating annual savings of almost 1.8 quadrillion British thermal units[27].

Beyond only energy efficiency, LEDs—Light Emitting Diodes—have a number of benefits. They can readily be dimmed for additional energy savings and offer high quality light with improved color rendition. LEDs also produce very little heat, which lessens building's cooling demand. From household to commercial and industrial environments, LED lighting's adaptability qualifies for a great spectrum of uses. Their efficiency and simplicity are even more improved by the fast development of intelligent LED lighting systems, which can be controlled via smartphones and connected with integrated building management systems.

Wall insulation

Building energy design depends critically on wall insulation. Insulating materials are added to building walls to lower heat transfer, so maintaining the interior cooler in summer and warmer in winter.

Among the several forms of wall insulation available are batt and roller insulation, loose-fill insulation and spray foam. Every kind has certain special uses and benefits. Usually constructed of fibreglass, roller insulation is used in flooring, ceilings and open walls. Made from materials like cellulose or fibreglass, free-fill insulation is blown into cavities and perfect for remodelling old walls. Expanding to cover cracks and gaps, spray foam insulation offers better air seal and a higher R-value—a gauge of thermal resistance.

By air sealing their homes and adding insulation in ceilings, floors over crawl spaces, and accessible basement siding, homeowners can save an average of 15% on heating and cooling costs—or an average of 11% on total energy costs—according to the EPA, and the US government[28].

Upgrading building insulation results in notable energy savings and carbon emissions reductions, according to an independent study done by ICF, an international consulting firm with experience in energy and energy efficiency. The study found that air sealed existing homes with insulation added to ceilings and floors could save between 10 and 45% of their energy.[29] Moreover, the same study evaluating energy, emissions, and economic effects over a 20-year period revealed

[27] U.S. Energy Information Administration. "EIA - Annual Energy Outlook 2023." Eia.gov, 2023, www.eia.gov/outlooks/aeo/.

[28] Methodology for estimated energy savings. (n.d.-c). ENERGY STAR. https://www.energystar.gov/saveathome/seal_insulate/methodology

[29] National Insulation Association. (2023, December 11). Independent study confirms insulation upgrades save energy and emissions in existing buildings - Insulation Outlook magazine. Insulation Outlook Magazine. https://insulation.org/io/articles/independent-study-confirms-insulation-upgrades-save-energy-and-emissions-in-existing-buildings/

that the installation of code-compliant vapour pipe insulation in a few chosen manufacturing sectors could save almost $126 billion in energy costs. For eight main sectors of industry, this study emphasizes the great advantages of better mechanical insulation and pipework for industrial plants.

Thermal insulation (thermal coat)

Another great way to increase building energy efficiency is with thermal insulation, sometimes known as thermal coat or thermal cladding. This approach creates an unbroken thermal barrier by continuously coating the interior or exterior surfaces of a building with insulating material. Thermal cladding serves mostly to minimise heat loss in winter and heat gain in summer, so lowering the energy needed for heating and cooling.

Commonly used in both new building and renovation, external thermal insulation composite systems (ETICS), sometimes referred to as thermal cladding, usually comprising an insulation layer, a reinforcing mesh, and a protective finish, these systems

By reducing heat loss across outside walls, thermal insulation greatly saves energy for buildings. ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, claims that because of lower fuel consumption for heating and lower use of air conditioning for cooling, thermal cladding can result in annual energy savings of roughly 20% on heating and cooling bills[30, 31]. Furthermore, a study conducted by Cortexa found that thermal cladding can save between 30-33% energy in a two-storey villa and 40-45% in an eight-storey building and pointed out that optimal insulation can lower energy consumption and carbon emissions by up to 42.5%, so saving 33% over 30 years[32].

Furthermore enhancing the architectural attractiveness and shielding the construction from weather damage is thermal cladding. Thermal performance and durability are shown by studies of buildings with thermal cladding to be better. For instance, a study by the European Insulation Manufacturers Association (Eurima) shows that thermal coatings shield building facades from temperature swings and moisture intrusion so extending their lifetime[33].

PVC Window Frames

Another significant advance in building energy design is PVC (polyvinyl chloride) window frames. Excellent thermal insulating qualities and durability and low maintenance character define

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[30] Cappotto Termico: cos' è e quali sono i benefici? | Enel X. (n.d.). Enel X. https://www.enelx.com/it/it/faq/cos-e-il-cappotto-termico-intervento-benefici

[31] Ciancio, L., & Ciancio, L. (2024, January 9). Cappotto termico esterno: pro e contro, durata, costi (2024). Voglia Di Ristrutturare. https://www.vogliadiristrutturare.it/cappotto-termico-esterno/

[32] Alyami, M. (2023). The impact of the composition and location of thermal insulation in the building envelope on energy consumption in Low-Rise residential buildings in hot climate regions. Arabian Journal for Science and Engineering. https://link.springer.com/article/10.1007/s13369-023-08366-8

[33] Thermal coat for greater energy efficiency | COIMEC. (n.d.). https://www.coimec.net/en/service/6/energy-efficiency-buildings.html

PVC as a material PVC frames give a great degree of insulation, so lowering the heat loss through windows compared to conventional wood or aluminium frames.

Particularly when coupled with double or triple glazing and low-emissivity (low-E) coatings, PVC frame windows can greatly increase the energy efficiency of a building, according to the US Department of Energ[34]. These characteristics lower heat loss in winter and heat gain in summer, so lowering energy use for heating and cooling. Apart from their thermal efficiency, PVC window frames provide many more benefits. Their wide spectrum of colours and designs lets one have aesthetic freedom. Additionally low maintenance and easy cleanability of PVC frames help to explain their general cost-effectiveness over time.

Smart thermostats

Precision control of heating and cooling systems is made possible by smart thermostats including the Nest Learning Thermostate. These devices maximize energy use by learning occupants' preferences and schedules. A Nest study claims that their smart thermostat can save consumers 15% on cooling costs and 10 to 12% on heating bills[35].

Energy-efficient windows

Double or triple glazing, low-emissivity (low-E) coatings and gas fillings between panels all help to greatly lower heat transfer in energy-efficient windows. According to the US Department of Energy, changing to energy-efficient windows can cut heating and cooling costs by 12–33%[36]. By cutting stretches and condensation, these windows also increase comfort.

Solar panels

Direct sunlight is directly converted by solar panels, also known as photovoltaic (PV) systems, into electricity, so offering buildings a renewable energy supply. According to the National Renewable Energy Laboratory (NREL) of the US government, depending on system size and local solar resources, the installation of solar panels can offset a notable amount of the electricity consumption of a building, so possibly lowering utility bills by 50–75%[37].

Building automation systems

Integrating several building systems—including HVAC, lighting, security and other technologies—into a centralized control platform, building automation systems (BAS) create Real-time monitoring and control made possible by these systems optimizes energy use depending on

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[34] Windows, doors, and skylights. (n.d.). Energy.gov. https://www.energy.gov/energysaver/windows-doors-and-skylights

[35] Nest. “Real Savings.” Nest, 2017, https://nest.com/thermostats/real-savings/

[36] Windows, doors, and skylights. (n.d.-b). Energy.gov. https://www.energy.gov/energysaver/windows-doors-and-skylights

[37] Waechter, Katy, et al. Technical Potential and Meaningful Benefits of Community Solar in the United States. 2024. 87524.pdf (nrel.gov)

occupancy and other criteria. The American Council for an Energy-Efficient Economy (ACEEE) claims that using BAS might save 10–25% of energy in commercial buildings[38].

Once completed the review of the main techniques that allow buildings to improve their energy efficiency, in the following pages the main energy and environmental benefits of these tools will be illustrated with a broader lens.

Modern building and renovation techniques depend much on energy efficiency in buildings since it provides major advantages in terms of environmental impact and energy savings. Adoption of energy-efficient technologies and practices becomes crucial as urbanization speeds forward and energy needs rise. To fully appreciate the whole advantage of these technologies, the great energy savings and environmental benefits of energy efficiency in buildings will be presented on the next pages. Using energy-efficient technologies and methods can help to drastically lower building energy consumption. Along with integrating smart building technologies, energy efficiency measures encompass a broad spectrum of improvements including upgrading insulation, using sophisticated heating and cooling systems, and choosing energy-efficient lighting. Studies repeatedly show that these steps can cut household building energy consumption by 20–30%[39]. Commercial buildings upgrading to LED lighting and high-efficiency HVAC systems, for instance, can cut energy consumption by 25–35%[40]. Residential buildings rebuilt with better insulation and energy-efficient windows also show yearly energy savings between 15 and 25%[41].

To show the effects of measures, it can be examined LED lighting. With the rest of the energy they consume wasted as heat, traditional incandescent bulbs convert only roughly 10% of it into light. By converting almost all of the energy into light with minimum heat loss, LED bulbs are approximately 90% more efficient[42]. Applied on a big scale in commercial and residential buildings, this efficiency results in notable energy savings. Energy economy also depends much on advanced HVAC systems. These systems adapt to real-time conditions and occupancy levels, so optimizing heating and cooling using modern technologies and so lowering energy consumption. Variable

[38] Smart Buildings: Using smart technology to save energy in existing BUI. (2022, March 1). https://www.aceee.org/research-report/a1701

[39] Baniassadi, A., Heusinger, J., Gonzalez, P. I., Weber, S., & Samuelson, H. W. (2022). Co-benefits of energy efficiency in residential buildings. Energy, 238, 121768. https://doi.org/10.1016/j.energy.2021.121768

[40] Krarti, M., & Dubey, K. (2018). Review analysis of economic and environmental benefits of improving energy efficiency for UAE building stock. Renewable & Sustainable Energy Reviews, 82, 14–24. https://doi.org/10.1016/j.rser.2017.09.013

[41] Baniassadi, A., Heusinger, J., Gonzalez, P. I., Weber, S., & Samuelson, H. W. (2022). Op. cit.

[42] Krarti, M., & Dubey, K. (2018). Op. cit.

refrigerant flow (VRF) systems, for instance, can minimize energy waste by varying the refrigerant flow to various areas of a building depending on the particular cooling needs of every area[43].

By allowing better monitoring and control of energy use, smart building technologies help to increase energy efficiency even more. For instance, smart thermostats learn household preferences and habits and automatically change temperatures to maximize comfort and reduce energy use. Integrating many building systems, building automation systems (BAS) enable coordinated operation that increases efficiency and lowers energy consumption[44].

These energy savings have rather important financial implications. For homeowners and businesses, lower energy consumption directly results in lower utility bills. Economically speaking, these savings could be rather large annual cost reductions. For instance, one study revealed that measures of energy efficiency in a standard commercial building might annually save up to $1.50 per square foot in energy expenses[45]. These savings mount over time, offering a significant financial incentive to make investments in energy-efficient technologies[46].

Apart from direct savings, energy-efficient constructions sometimes have better property value. Because of their lower running costs and more comfort, properties featuring advanced energy efficiency systems are seen as more worth. Buildings with energy efficiency certifications may see up to 10% increase in property values, according to a methodical study[47]. Reduced utility costs and more comfort connected with energy-efficient buildings help to explain this rise in appeal to possible tenants and buyers of such buildings. Furthermore, because of their use of durable and advanced technologies, energy-efficient buildings usually have reduced maintenance expenses. LED lighting, for instance, has a longer lifetime than conventional lighting sources, so lowering the frequency and replacement costs. Advanced HVAC systems are made to run more effectively and with less wear and tear, so reducing breakdowns and over time lowering maintenance costs. These maintenance savings provide still another degree of financial advantage, thus energy efficiency becomes even more appealing as a purchase[48].

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[43] Hafez, F. S., Sa'di, B., Safa-Gamal, M., Taufiq-Yap, Y., Alrifaey, M., Seyedmahmoudian, M., Stojcevski, A., Horan, B., & Mekhilef, S. (2023). Energy Efficiency in Sustainable Buildings: A Systematic Review with Taxonomy, Challenges, Motivations, Methodological Aspects, Recommendations, and Pathways for Future Research. Energy Strategy Reviews, 45, 101013. https://doi.org/10.1016/j.esr.2022.101013

[44] Ryan, Lisa, and Nina Campbell. SPREADING the NET the Multiple Benefits of Energy Efficiency Improvements. International Energy Agency, 2012. https://www.oecd-ilibrary.org/docserver/5k9crzjbpkkc-en.pdf?expires=1720546247&id=id&accname=guest&checksum=AE35496FB4415AED67E2C75C5740834D.

[45] Popescu, D., Bienert, S., Schützenhofer, C., & Boazu, R. (2012). Impact of energy efficiency measures on the economic value of buildings. Applied Energy, 89(1), 454–463. https://doi.org/10.1016/j.apenergy.2011.08.015

[46] Krarti, M., & Dubey, K. (2018). Op. cit.

[47] Kamal, A., Al-Ghamdi, S. G., & Koc, M. (2019). Revaluing the costs and benefits of energy efficiency: A systematic review. Energy Research & Social Science, 54, 68–84. https://doi.org/10.1016/j.erss.2019.03.012

[48] Hafez, F. S., Sa'di, B., Safa-Gamal, M., Taufiq-Yap, Y., Alrifaey, M., Seyedmahmoudian, M., Stojcevski, A., Horan, B., & Mekhilef, S. (2023). Op cit.

Likewise striking are the environmental advantages of building energy efficiency. With roughly 40% and 33% respectively, buildings account for a major share of total energy consumption and greenhouse gas emissions[49]. Building carbon footprint can be greatly lowered by raising energy efficiency. By 2030, for instance, raising energy efficiency could cut CO2 emissions by up to 1.5 gigatons, annually equivalent to removing almost 300 million vehicles[50]. Further lowering reliance on fossil fuels, energy-efficient buildings frequently incorporate renewable energy sources including solar panels, wind turbines and geothermal systems. Residential buildings with solar panels, for instance, can produce up to 50–75% of their required energy, so drastically lowering the fossil fuel consumption[51]. Along with lowering greenhouse gas emissions, this integration encourages the use of clean, sustainable energy sources, so helping to lower environmental pollution levels generally[52].

Furthermore, a 2021 study of the energy performance of historical buildings revealed that buildings contribute roughly 30% of world CO2 emissions and account for almost 40% of final energy consumption in industrialized nations. From building construction and operation to maintenance, this energy use spans the building's whole life cycle. Of a building's total energy consumption, the energy needed for heating, cooling, ventilation, and lighting makes between 40% and 70%; heating and cooling alone accounts for 55%. The study contends that by implementing energy efficiency policies, savings of up to 60% in main energy consumption and 40% in total costs can be attained[53].

Furthermore, energy efficiency affects the surroundings by lowering waste generation and resource consumption during building and running of buildings. Advanced materials and building techniques used in energy-efficient buildings sometimes minimize their environmental impact by requiring less resources and producing less waste[54]. By encouraging resource efficiency and so lowering the total environmental effects of building operations, these techniques help to create a more sustainable built environment. Using high-performance insulation materials, for instance, lowers the energy needed for heating and cooling while also using less raw materials during manufacture.

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[49] Kerr, N., Gouldson, A., & Barrett, J. (2017). The rationale for energy efficiency policy: Assessing the recognition of the multiple benefits of energy efficiency retrofit policy. Energy Policy, 106, 212–221. https://doi.org/10.1016/j.enpol.2017.03.053

[50] Gillingham, K. T., Huang, P., Buehler, C., Peccia, J., & Gentner, D. R. (2021). The climate and health benefits from intensive building energy efficiency improvements. Science Advances, 7(34). https://doi.org/10.1126/sciadv.abg0947

[51] Hafez, F. S., Sa'di, B., Safa-Gamal, M., Taufiq-Yap, Y., Alrifaey, M., Seyedmahmoudian, M., Stojcevski, A., Horan, B., & Mekhilef, S. (2023). Op cit.

[52] Ryan, Lisa, and Nina Campbell, 2012. Op. cit.

[53] Ozbalta, T. G., Yildiz, Y., Bayram, I., & Yilmaz, O. C. (2021). Energy performance analysis of a historical building using cost-optimal assessment. Energy and Buildings, 250, 111301. https://doi.org/10.1016/j.enbuild.2021.111301

[54] Ringel, G., & Capeluto, I. G. (2020). An energetic profile for greener buildings. Sustainable Cities and Society, 61, 102171. https://doi.org/10.1016/j.scs.2020.102171

Furthermore, energy-efficient windows and doors minimise heat loss and gain, so enhancing building thermal performance generally and so lowering the demand for artificial heating and cooling[55].

Major national organizations and international agencies have also underlined the several advantages building energy efficiency can bring about. For instance, the International Energy Agency (IEA) projects that by 2040 almost half of the emission cuts required to reach global climate targets could be attributable to increases in energy efficiency[56]. This emphasizes the vital part energy-efficient buildings play in worldwide attempts to slow down climate change. Furthermore underlined by the American Council for an Energy-Efficient Economy (ACEEE) are the financial advantages of energy economy. Energy efficiency initiatives, according to their research, pay for themselves $2.20 for every dollar spent[57]. These advantages consist not only in energy savings but also in lower emissions and better public health[58].

Trying to join to a conclusion, it is clear that implementing energy-efficient building techniques results in appreciable environmental advantages and energy savings. By lowering greenhouse gas emissions and encouraging the use of renewable energy sources, these steps not only lower running expenses but also raise property values and significantly help to solve world climate problems. The need of energy efficiency in buildings cannot be emphasized as the world keeps confronting the two challenges of rising energy demand and climate change. In the next paragraph, an analysis of the European scenario of energy efficiency in buildings will be carried out, in order to understand how far the technologies discussed here are actually implemented and what benefits they allow to be achieved.

1.2 The European scenario of buildings energy efficiency

In order to better understand how energy efficiency of buildings is a crucial factor nowadays, and how initiatives are needed to improve the energy performance of buildings, it is useful to have a clear and more precise idea of the current scenario. Therefore, in this paragraph an overview of the European performance of energy efficiency in buildings will be presented. It is very important, for the purposes of this thesis, a comparison between Italy and the countries of the European Union, given the great level of integration, including legislation, which has a great impact on this area, and

[55] Hafez, F. S., Sa'di, B., Safa-Gamal, M., Taufiq-Yap, Y., Alrifaey, M., Seyedmahmoudian, M., Stojcevski, A., Horan, B., & Mekhilef, S. (2023). Op cit.

[56] Buildings – Energy Efficiency 2020 – Analysis - IEA. (n.d.). IEA. https://www.iea.org/reports/energy-efficiency-2020/buildings

[57] Tonn, B., & Peretz, J. H. (2007). State-level benefits of energy efficiency. Energy Policy, 35(7), 3665–3674. https://doi.org/10.1016/j.enpol.2007.01.009

[58] Ryan, Lisa, and Nina Campbell, 2012. Op. cit.

on which much, in recent years, has been legislated, including the measures that will be analysed later, which are very important for the purposes of this analysis.

A very important fact to start with is the energy consumption of buildings and the impact it has. In fact, according to a 2019 study by Clara Camarasa and others., residential buildings in Europe are responsible for about 40 per cent of energy consumption and 36 per cent of CO2 emissions[59], so certainly a significant part of overall energy consumption.

To understand what these data represent and imply, it is useful to look at them in a little more detail. A study published in 2010 presents data referring to 2006, which, although not very current, is nevertheless very useful to understand how the energy consumption of buildings in the countries of the European Union is composed. The gross inland consumption in the 27 EU states in 2006 was 1825.2 million tonnes of oil equivalent (Mtoe), of which 7.1% came from renewable energy sources, mostly biomass (69%), and the remainder from hydroelectric (20.5%), wind (5.5%), geothermal (4.3%) and only 0.8% from solar energy[60]. According to this study, the building sector consumes about 39% (455.2 Mtoe) of the total final energy consumption and emits about 35% of the total CO2 emissions in Europe.

However, moving on to more current data, an Enerdata article from 2021[61] proves very useful in understanding how these levels have varied over time. Given that buildings accounted for 43% of Europe's final energy consumption in 2021, two-thirds of this consumption is attributable to residential buildings alone, associated with a high untapped energy saving potential.

Also according to Enerdata, during the first two decades of the 21st century, the consumption of residential buildings decreased, however, this decrease cannot be entirely attributed to an improvement in efficiency, rather to exogenous factors of a mainly economic nature, such as energy prices, employment levels. The graph below shows the final energy consumption of residential buildings in the European Union between 2000 and 2019, nominal, and adjusted for large inter-annual variations due to climate variability.

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[59] Camarasa, C., Nägeli, C., Ostermeyer, Y., Klippel, M., & Botzler, S. (2019). Diffusion of energy efficiency technologies in European residential buildings: A bibliometric analysis. Energy and Buildings, 202, 109339. https://doi.org/10.1016/j.enbuild.2019.109339

[60] Dascalaki, E. G., Droutsa, K., Gaglia, A. G., Kontoyiannidis, S., & Balaras, C. A. (2010). Data collection and analysis of the building stock and its energy performance—An example for Hellenic buildings. Energy and Buildings, 42(8), 1231–1237. https://doi.org/10.1016/j.enbuild.2010.02.014

[61] Evolution of households energy consumption patterns across the EU. (2021, December 16). Enerdata. https://www.enerdata.net/publications/executive-briefing/households-energy-efficiency.html#:~:text=Energy%20efficiency%20trends%20for%20households,in%202019%2C%20Figure%206

Figure 1: Final energy consumption of residential buildings in the EU
Source: Enerdata, op. cit

It can be seen very clearly from the graph how there was a slowdown in consumption, until the year 2014, when the level of consumption rose again, most likely due to the rebound and recovery of production and economic activity after the hardest phase of the great recession. In detail, the slowdown in the trend in energy consumption per dwelling was 1.3% per year for the period 2000-2014 and -0.2% per year for the period 2014-2019, thus a clear difference between the two periods.

A further very useful and interesting source to get a clearer idea of the European scenario of the energy efficiency of buildings is the EU Building Stock Observatory, or EU BSO database[62], managed by the European Commission, which aims to provide transparent and reliable data on the European building stock. Containing historical data for the last 35 years, since 1990, on all EU countries and on the EU level itself, it represents a great source of data and insights, which will be mentioned several times throughout this analysis.

Confirming Enerdata's findings, by analysing the data the BSO makes available, the level of final energy consumption of buildings in the 27 EU countries went from 63,139,346 GWh in 2010 to 55,730,360 GWh in 2020, i.e. a reduction of 11.73%. Undoubtedly, the impact of the Covid-19 pandemic was significant, and the quarantine months reduced energy consumption, especially of industrial buildings, but the trend is still downward during that decade. In fact, between 2010 and 2019, the year before the pandemic, the reduction was around 10%.

The BSO also confirms the importance of buildings in energy consumption. The graph below illustrates the role of buildings in final energy consumption in 2020, compared to other factors.

[62] EU Building Stock Observatory. (n.d.). Energy. https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en

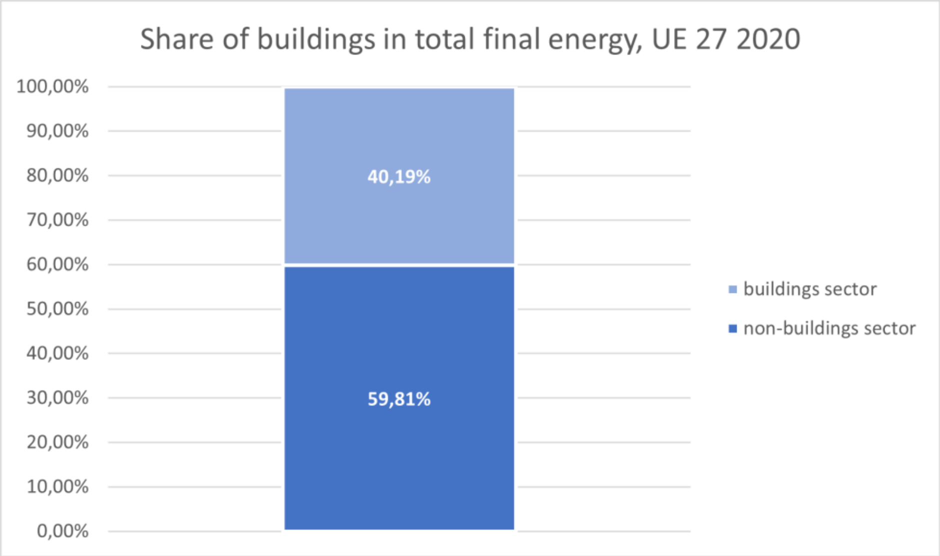

Figure 2: Share of buildings in total final energy, UE (27) 2020
Source: EU BSO data elaboration, op. cit

These data provide a rather clear idea of the overall situation on a European level, however, it would be wrong to consider European countries homogeneous with each other, and a more in-depth analysis illustrating the differences between the various member states is necessary. In this respect, the BSO data, but also the aforementioned analysis by Enerdata, are of great help to get a more detailed overview of the differences between the various European countries.

The following graph shows, based on BSO data, the average level of energy consumption per building in 2020.

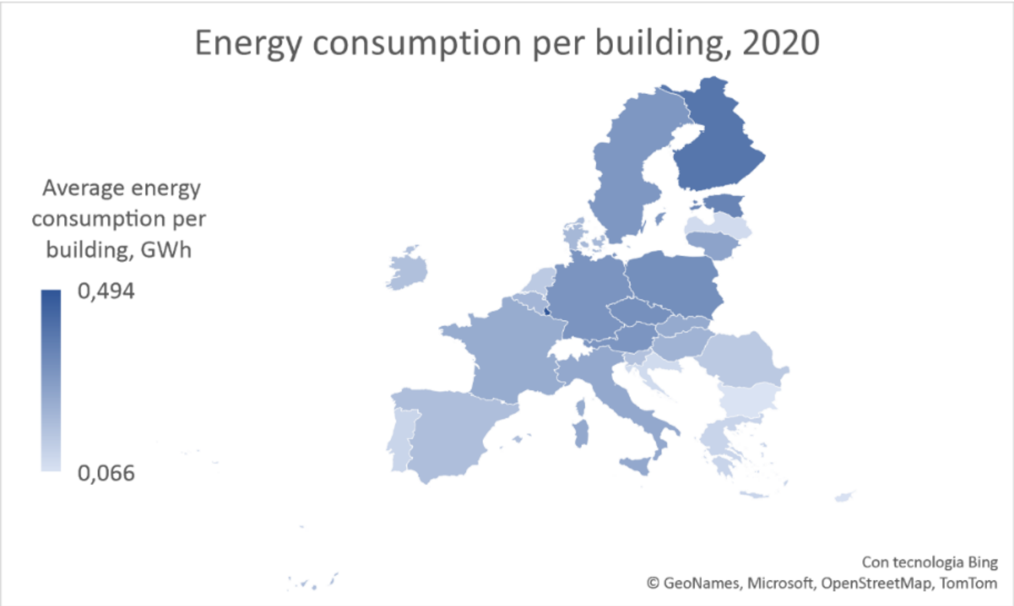

Figure 3: Energy consumption per building, 2020
Source: EU BSO data elaboration, op. cit

As can be seen from the graph, there are many disparities between countries, with consumption levels that, in the case of countries such as Luxembourg, can be up to eight times higher than in countries such as Bulgaria. However, the least performing countries, if one wants to try to group them into a cluster, turn out to be the Nordic and Eastern European countries, followed by some Mediterranean countries.

The disparities between the various countries, shown here in a first graph, have different causes and explanations. Certainly, the Nordic countries, subject to colder temperatures, require greater heating efforts, especially in the winter months, while the eastern countries are most likely characterised by buildings constructed during the cold war, when those areas were subject to the Warsaw Pact and less performing economies. A similar, but not analogous, argument can be made for Mediterranean countries, or those characterised by a territory that does not facilitate large-scale construction or renovation, or by a high presence of historic buildings, built when energy consumption was certainly not the priority.

In order to understand how important the effect of these factors is, and thus to understand how much exogenous factors (e.g. climate) count and how much endogenous ones, i.e. the actual level of energy efficiency of buildings, it is useful to try to separate the two. For this purpose, the database of Odyssee-Mure, the project coordinated by ADEME (French Agency for Ecological Transition), with the technical support of Enerdata and Fraunhofer, which aims to provide a comprehensive monitoring of energy consumption and efficiency trends, as well as an evaluation of the energy efficiency policies implemented by the countries of the European Union, Switzerland and some energy communities63, is very useful. In particular, the project makes available the Odysse database, managed by Enerdata, which contains detailed indicators on energy efficiency and CO2 emissions.

Using the data from the database, it is possible to observe the level of energy consumption per dwelling in each European country, scaled to the average climate level of the European Union, so as to balance everyone on the same level, and to understand, for the same heating or cooling energy needs, how much the dwellings consume, and consequently their level of efficiency. The result of this analysis is proposed in the graph below, where it can be seen that the depuration of climate impact significantly affects performance.

[63] Introduction to the Odyssee-Mure Project | ODYSSEE-MURE. (n.d.). https://www.odyssee-mure.eu/project.html

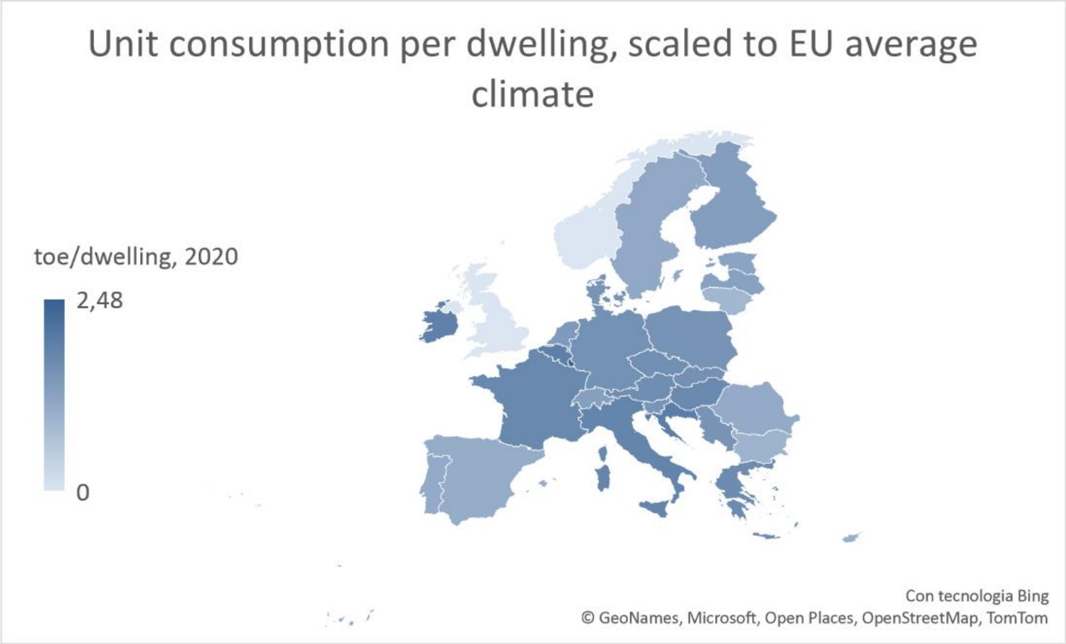

Figure 4: Unit consumption per dwelling scaled to EU average climate, 2020
Source: Odyssee data elaboration, op. cit

It is clear from the graph that the consumption levels of dwellings shown above conceal a particularly important climatic impact. In fact, the Nordic countries, characterised by warmer climates, see their consumption levels reduce substantially in the absence of this factor, unlike the Mediterranean countries which, normally characterised by warmer climates, show a much lower level of energy efficiency of dwellings. It can be assumed both that countries with higher consumption levels here also have a building stock that is on average older, and therefore less efficient, but also at the same time that there is a trend whereby countries in warmer climates have made less effort over time to consume efficiently, and vice versa.

In order to understand which of these two hypotheses can best explain the phenomenon, if not both, it is easy to check the average age of European buildings using BSO data. The graph below shows the % of buildings constructed before 1990 for each country in order to understand which ones have an older and therefore, one assumes, less energy efficient stock of buildings.

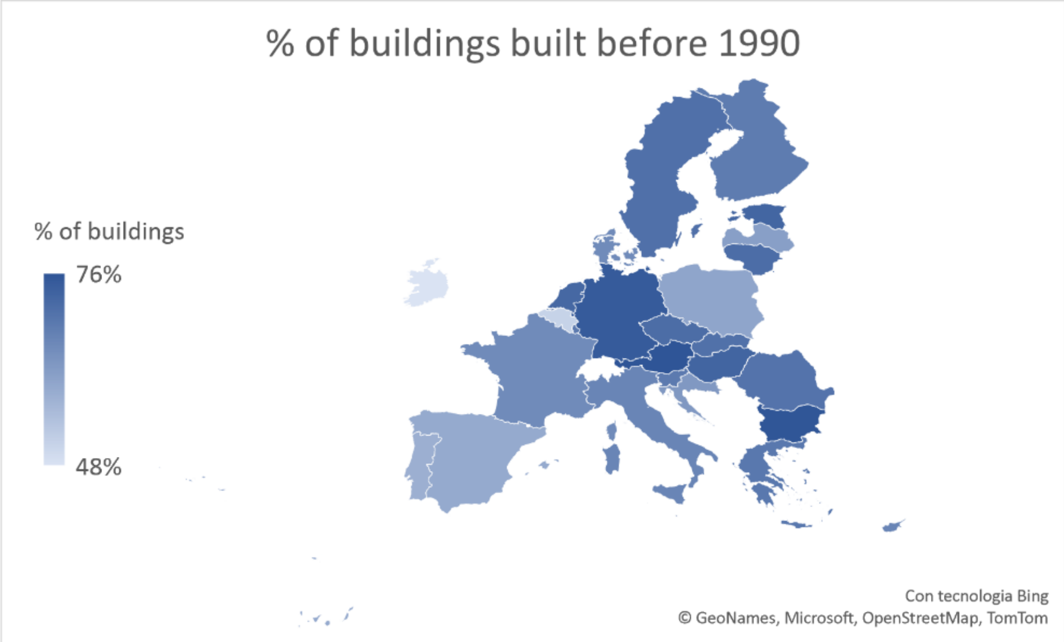

Figure 4: share of buildings built before 1990 per country
Source: EU BSO data elaboration, op. cit

As can be seen, countries with an older, and therefore less energy efficient, stock of buildings is mainly concentrated in Eastern Europe, as well as in Germany, and not in the Mediterranean countries, or those with higher energy consumption, according to Odyssee data compared to the average climate. Therefore, the hypothesis that appears most credible from these data is that there is a trend whereby countries with milder climates have less need to pay attention to the energy efficiency of their buildings.

Further confirmation of this theory could be obtained by carrying out correlation or regression analyses with data on the average climate level in the various countries, however, this is not exactly the right place for this, as this analysis is aimed at illustrating a general overview of the energy efficiency of buildings in Europe, and of the differences between the various countries in order to get a general idea and understanding of the problem.

A more in-depth look at the period of construction of buildings in the various European countries may however be of interest, which is why the graph below shows the breakdown of buildings in each European country by period of construction, taken from the same BSO data.

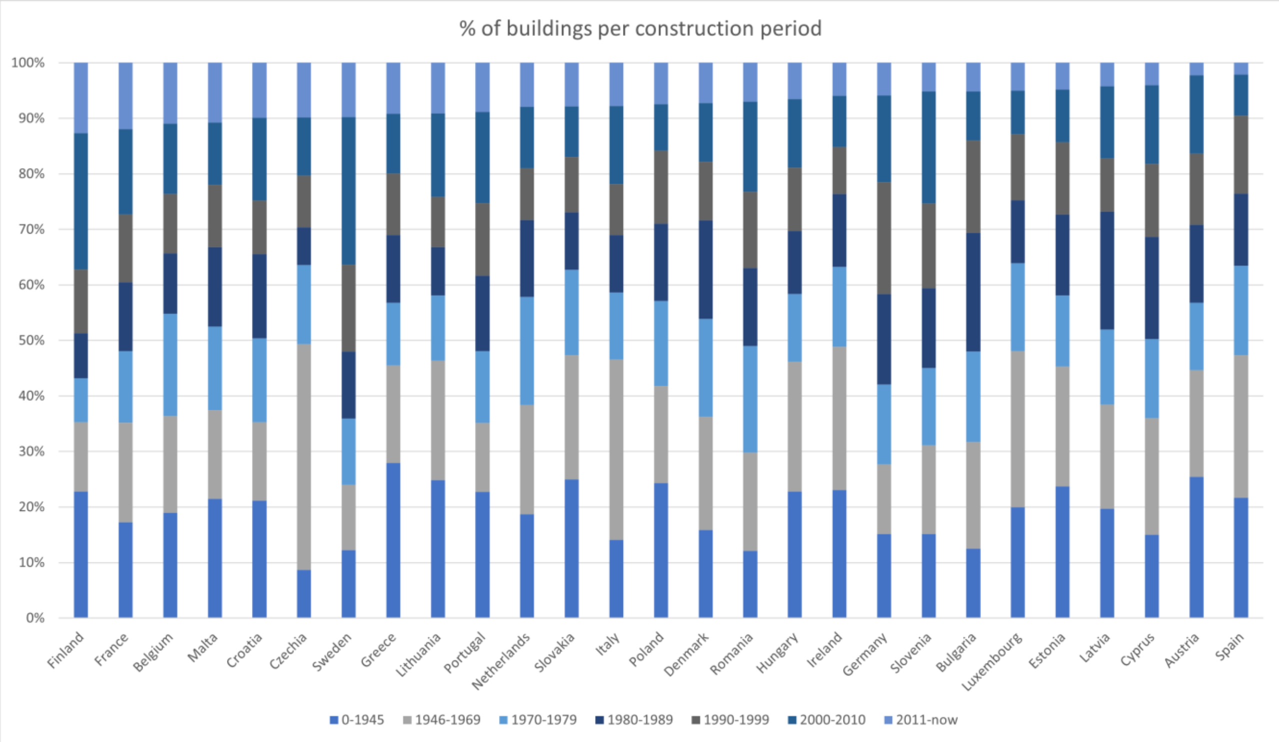

Figure 5: % of buildings per costruction period across EU countries
Source: EU BSO data elaboration, op. cit

From this graph, which cannot for obvious reasons be analysed in too much detail, some main observations can be made, such as the fact that Scandinavian countries such as Finland and Sweden are characterised by a higher proportion of buildings constructed after 2000, while Eastern European countries show a combination of buildings constructed between the post-war period and the end of the cold war, a period when those countries were subject to the Warsaw bloc and the Soviet Union, and at the same time maintain a significant proportion of older buildings. A wider distribution of buildings among all periods can be found among Western European countries, such as Italy and Germany, although Italy has a large percentage of buildings constructed between 1946 and 1969, during the years of post-war reconstruction, building booms and housing policies, such as the INA-Casa plan of labour minister Fanfani, which promoted the construction of numerous residential buildings throughout the country between 1949 and 196364.

However, to give an overall idea of the building situation in Europe, according to the already mentioned 2019 study of Camarasa, around 35 per cent of residential buildings are more than 50 years old and more than 75 per cent of them are considered energy inefficient. To understand how important residential buildings are in this respect, and why they are often mentioned in comparison to buildings in general, one only has to consider that, according to Enerdata, residential buildings account for two-

[64] INA-Casa. (2024, July 5). Wikipedia. https://it.wikipedia.org/wiki/INA-Casa

thirds of final building consumption and are associated with a high untapped energy saving potential compared to business buildings. They therefore represent a major challenge for achieving the EU's climate and environmental targets.

However, while the analyses presented so far provide a snapshot of the situation today, or rather, in 2020, it is equally important to understand how it has changed over the years, so as to understand which countries have been most able to reduce their consumption over time and identify trends. Therefore, in the graph below, based on BSO data, the reduction in energy consumption of buildings in each European country between 2010 and 2020 is presented.

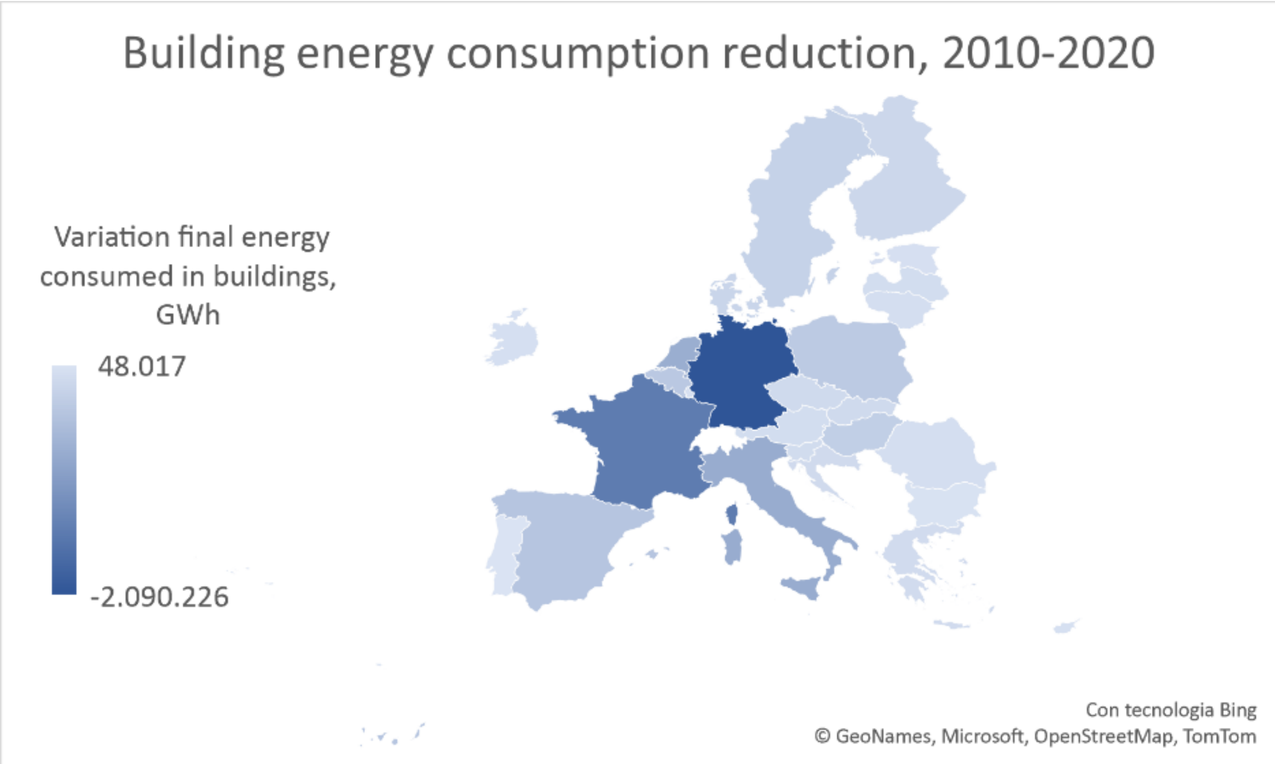

Figure 6: Buildings energy consumption reduction, 2010-2020
Source: EU BSO data elaboration, op. cit

As can be seen from the graph, there are many disparities between countries, with the best-performing countries, such as Germany, having reduced their consumption by more than two million GWh, and the worst-performing countries, such as Portugal or Romania, having instead experienced an increase in consumption, up to almost 50000 GWh. The clusters highlighted above with the countries with the highest levels of energy consumption, are broadly the same as those that have experienced smaller reductions in energy consumption, such as the Scandinavian and Eastern European countries, probably highlighting structural problems such as those already presented, which require very demanding and extensive interventions.

To go into more detail, a graph is shown below, based on Odyssee data processing, also quoted by Enerdata, showing the historical trend between 2000, 2014 and 2019 of the average consumption per dwelling, adjusted for the same climate level, in order to eliminate exogenous differences between countries caused by climate.

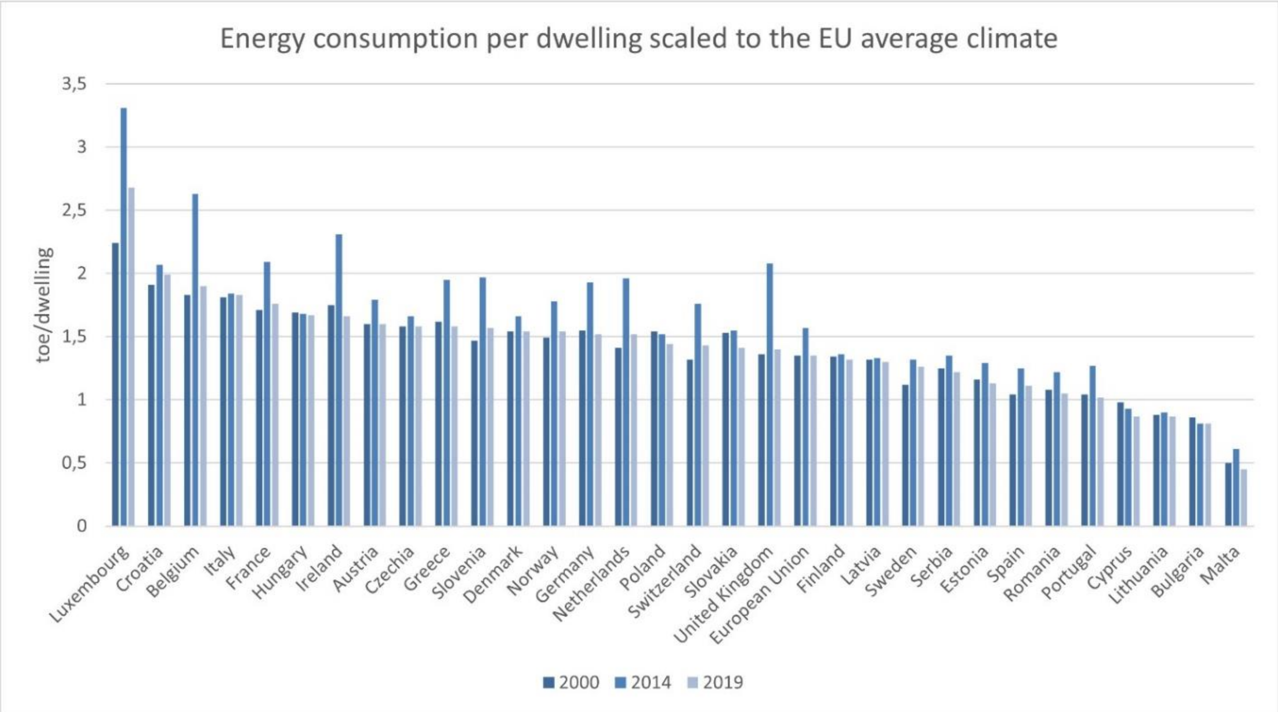

Figure 7: Energy consumption per dwelling, scaled to the EU average climate
Source: Odyssee data elaboration, op. cit

Even after adjusting the data for climate, there are still many disparities between countries, which persist over the years, ranging from 0.5 toe per building in Malta to 2.3 in Luxembourg. In spite of this, it can be seen that the level of consumption between 2000 and 2014 generally decreased, even significantly, in all countries, albeit with differences. However, 2014 and 2019, although we are talking about a period of about one third of the previous one, the reduction is much smaller, certainly much more than one third. In fact, at the European level, unit consumption for heating decreased by 2.1 per cent per year in the first period, and by 0.6 per cent per year in the second period, indicating a clear slowdown. Overall, Enerdata reports, energy efficiency at the European level improved by 29% between 2000 and 2019, but the slowdown after 2014 was remarkable. In fact, the downward trend in energy efficiency, observed especially for end uses, has not been compensated for by greater improvements in the efficiency of large household appliances, or lighting.

In any case, in this post-2019 period, three main contrasting trends between countries can be noted. The first identifies a downward trend accelerating after 2014, manifested in eight countries including Italy and Spain, but also Nordic countries such as Sweden, Denmark and Finland, but also

Poland and Croatia. The second, which tends towards a slowdown or stabilisation, is mainly manifested in Central Europe, such as France, Austria, the Netherlands, the United Kingdom and others, a total of 11 countries. Finally, another group of countries saw a reverse trend, with an increase in consumption after 2014, and although they too are 11 countries, they cannot be grouped into a single cluster. We find Mediterranean countries such as Greece, Atlantic countries such as Portugal and Ireland, and continental European countries such as Germany, Hungary, and Romania.

Trying to understand the reasons for this slowdown is not easy, and several hypotheses can be made, but all of them mainly share a common basic element, the economic one, which, in the years following the great recession, is evident how it may have impacted the habits of families and businesses. In fact, firstly, the rate of construction fell by 35% during the crisis years, leading to fewer new buildings, which are usually more efficient, and a similar argument can be made for investment in renovations. At the same time, the rebound effect of the crisis has led to a drop in energy prices, which has meant that for many households, there has been less need to make their consumption more efficient. While, for those households that have continued to struggle with energy costs, they have often turned to cheaper, but certainly much less efficient alternatives, such as wood-burning fireplaces, for example.

An in-depth look at renovations and energy performance improvements, which is the overall heart of this thesis, in relation to energy saving trends over the years, is therefore very useful. The aforementioned 2019 Camarasa study provides us with some very useful insights. According to the study, in terms of retrofit activities, i.e. a systematic approach taken to improve the likely performance of any structure, between 0.4 per cent and 1.2 per cent of residential buildings in the European Union are renovated each year on average, and of these, only less than 5 per cent reach the standards to be considered nZEB, i.e. nearly zero-energy buildings. Suffice it to say that these do not even reach one third of what would be required to meet EU carbon emission targets. But what does this mean? The main inference that can be drawn is that although technologies that enable high levels of energy efficiency are now highly available and cost-effective, they are not widespread, nor are they spreading at the rate needed to meet EU targets. This phenomenon is referred to as the 'energy paradox', and suggests that the economic feasibility of these technologies, especially the potential energy cost savings, is not sufficiently recognised or attractive to justify the necessary investments.

Returning, however, to the EU overview, these data and trends, although not covering many areas in depth, provide a general idea of the situation and the main trends in terms of energy efficiency in European buildings. But in order to understand the extent to which this phenomenon is not only an energy cost saving problem, but also an environmental one, it is good to take a further look at the issue of emissions from buildings. For this purpose, a study by the European Environment Agency on greenhouse gas emissions caused by buildings in the EU is very useful65. According to this study, there has been a 31% decrease in greenhouse gas emissions from European buildings between 2005 and 2021.

This improvement has been driven by higher energy efficiency standards for new buildings, energy efficiency improvements in existing buildings, decarbonisation of the electricity and heating sectors, and milder temperatures. These emissions are partly caused by the use of fossil fuels in buildings (mainly for heating), and partly by the production of electricity and heat for various uses in buildings (mainly for appliances, lighting, and cooling). This trend, driven in large part by the European Union's decarbonisation strategy, can also be partly attributed to the increasing frequency in recent years of higher temperatures in winter, and thus less need for heating. A useful figure in this respect can be provided by the BSO, with the so-called HDD, heating deegree day, a measure to quantify the energy demand needed to heat a building, derived from the measurement of the outside air temperature. The heating demand for a certain building in a certain location is considered to be directly proportional to the number of HDDs in that location. As hypothesised, between 2010 and 2020, on an average European level, the number of HDDs fell from 3497 to 2759, i.e. a reduction of 21%, which is certainly a significant impact on energy consumption during the winter months. Of course, this measurement can also be done in reverse, with CDDs, cooling degree days, a measure to quantify the energy demand needed to cool a building based on the outside temperature. Indeed, between 2010 and 2020 we see an increase, albeit a much smaller one. In fact, from 96.73 CDD in 2010, we go to 98.53 CDD in 2020, i.e. an increase of 1.86%. This is certainly a reassuring trend, but one that raises interesting questions about the future because of the increasingly hot summers ahead.

Having provided a fairly clear and comprehensive overview with the right level of detail for the purposes of this analysis, it is now possible to proceed to a presentation of the main measures that the European Union has taken in recent years to address this problem.

1.3 European Union policies: the Energy Efficiency Directives

As has become clear from the analysis presented above, the issue of energy efficiency in buildings is a key factor when talking of energy and, naturally, environment; this implies significant consequences at the regulatory level, especially as far as the more developed nations are concerned,

[65] Greenhouse gas emissions from energy use in buildings in Europe. (2023, October 24). European Environment Agency’s Home Page. https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-energy

and in particular, European countries. In fact, the European Union is quite important in advancing environmental and energy policies in order to guarantee a sustainable and safe future for its people.

Beginning in the 1970s, the European Union started coordinating environmental policies after the 1972 Paris European Council declared the need of a community environmental policy. Following many worldwide declarations including the United Nations Conference on the Human Environment in Stockholm in 1972 and the Earth Summit in Rio de Janeiro in 1992, this was a pivotal action[66]. Since then, the EU has created a set of rules and directives covering a broad spectrum of environmental concerns, including air and water pollution, waste management, biodiversity protection and climate change. Aiming to maintain the quality of the environment and safeguard human health, the Single European Act unveiled the 'Environment Title,' the first legal basis for a common environmental policy, in 1987.

The strategy was first disjointed and constrained, but over time it developed into a sophisticated and coordinated legislative framework that resulted in the Maastricht Treaty of 1992, so formalizing the integration of environmental policies into the EU founding treaties. The Treaty made the environment an official policy area of the Union by so strengthening the EU's dedication to environmental protection.

These developments resulted in the acceptance of more than 200 pieces of EU environmental legislation covering several spheres including the control of chemicals, water protection and pollution monitoring. Environmental protection's inclusion into EU sectoral policies has become a top concern, leading to the European Green Deal of 2019, which seeks to make Europe the first continent to be climate-neutral by 2025 by encouraging the use of renewable energy, energy efficiency, and the decrease of greenhouse gas emissions.

With an eye toward an integrated energy market and lower reliance on energy imports, EU energy policies are based on the ideas of decarbonization, competitiveness, security of supply and sustainability[67]. Additionally, part of these initiatives are the encouragement of modern infrastructure and creative technologies to assist renewable energy sources and raise energy efficiency[68].

Among the several nations that exist nowadays, the EU is definitely one of the leaders worldwide in advocating ambitious and advanced environmental policies. Environmental policies of the EU have a major influence not only in Europe but also internationally. They affect environmental

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[66] Politica ambientale: principi generali e quadro di riferimento | Note tematiche sull'Unione europea | Parlamento Europeo. (n.d.). https://www.europarl.europa.eu/factsheets/it/sheet/71/politica-ambientale-principi-generali-e-quadro-di-riferimento

[67] Energy policy: general principles | Fact Sheets on the European Union | European Parliament. (n.d.). https://www.europarl.europa.eu/factsheets/en/sheet/68/energy-policy-general-principles

[68] Energy and the Green Deal. (2022, April 8). European Commission. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/energy-and-green-deal_en

policies of other nations and assist to define global environmental standards. Moreover, EU energy and climate projects are generating economic possibilities and technological innovation, so helping to bring about the change to a low-carbon economy.

One cannot undervalue the relevance of EU environmental policies. They not only assist to fight climate change and preserve the environment but also enable a sustainable future for next generations. Based on cooperation and innovation, the EU's strategy offers other areas looking to tackle environmental issues a coordinated and sustainable model.

More specifically on the most important EU environmental and energy projects and policies of recent years, the main action carried out in this field cannot fail to be presented: the reform package known as the European Green Deal.

Announced by the European Commission in December 2019[69], the European Green Deal offers a combined and ambitious response to environmental and climate issues. Its evolution is against the backdrop of mounting global concerns about environmental sustainability and climate change, which culminate in a set of policies meant to turn the European Union into a modern, resource-efficient and competitive economy[70].

The package's primary objective is to reach climate neutrality by 2025, so producing no more net greenhouse gas emissions. This aim is to be reached by means of a mix of strategies including the encouragement of sustainable mobility and the circular economy, the change to renewable energy sources, and raising energy efficiency.

With an eye toward renewable energy, the European Green Deal's sectoral goals call for major energy efficiency gains and the encouragement of sustainable mobility, so transforming the energy system. Reducing emissions and supporting zero-emission cars takes front stage in the transportation industry. Targets for the sector include the circular economy's promotion and clean technology adoption. While agriculture concentrates on sustainable practices and the preservation of biodiversity, construction is more on remodelling buildings to increase their energy efficiency.

Apart from the already mentioned objectives, one of the main ones is the lowering of greenhouse gas emissions; hence, by at least 55% by 2030 against the levels in 1990[71]. A comprehensive vision that considers the integrity of society makes it a crucial point that no person or place is neglected; indeed, the package aims to ensure that all sectors of society help to ensure the

[69] Green Deal europeo. (2024, August 2). Wikipedia. https://it.wikipedia.org/wiki/Green_Deal_europeo

[70] Il Green Deal Europeo: come i 27 Paesi UE si preparano all'appuntamento con il 2050. (2023, April 17). https://www.enel.com/it/azienda/storie/articles/2023/04/green-deal-europeo

[71] Il Green Deal europeo. (n.d.). Commissione Europea. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_it

green transition. Another approach defining the package is economic growth decoupled from resource use, meaning that economic development should not result in higher resource consumption.

Important steps for the preservation of the natural surroundings also comprise part of the package. Among these, the 'Farm to Fork' approach supports more sustainable farming methods and better, environmentally friendly food; the biodiversity plan seeks to protect and restore ecosystems and habitats. Moreover, the European Green Deal covers sectors closely related to each other and will all help to reach the ultimate climate target: climate, environment, energy, transportation, industry, agriculture, sustainable finance[72].

The Just Transition Mechanism was created as a necessary component of the Green Deal to help this shift and guarantee that every Member State can satisfy the related social and economic issues. This system comprises a fund meant to support the sectors and areas most impacted by the change so making sure nobody is left behind. First, a third of the €1.8 trillion investment from the NextGenerationEU recovery plan and the EU's seven-year budget are earmarked to finance the European Green Deal [9]. Second, the InvestEU investment plan forecasts funds of at least €1.8 trillion, so financing the policies outlined in the Green Deal. Also projected for the accomplishment of the targets set in this agreement is roughly €260 billion annually, from 2020 to 2030.

Of course, the Green Deal contains many policies, but of all of them, one that is particularly relevant for the issue of energy efficiency - the Fit for 55 - should be especially examined here.

Part of the European Green Deal, the Fit for 55 is an ambitious EU plan for sustainable development unveiled in July 2021. Fit for 55 is the name for the aim of lowering greenhouse gas emissions by 55% by 2030 against 1990 levels. An essential component of the European Green Deal, this strategy marks a significant first towards the EU's long-term target of climate neutrality by 2050[73].

The Fit for 55 offers a comprehensive package of policies spanning several important sectors. These comprise buildings, the energy sector, industry, cars and commercial vehicles. The Fit for 55 package has as its main goals raising the share of renewable energy and improving energy efficiency.

Key measures include the revision of the EU Emissions Trading Scheme (ETS), which aims to lower emissions in the energy and industrial sectors by increasing the cost of carbon emissions, with a system whereby businesses buy allowances for the CO2 emissions they produce, and the introduction of a Carbon Border Adjustment Mechanism (CBAM), meant to prevent carbon leakage

[72] Green Deal europeo. Consiglio Europeo. https://www.consilium.europa.eu/it/policies/green-deal/
[73] Fit for 55. (2024, April 28). Wikipedia. https://it.wikipedia.org/wiki/Fit_for_55

to countries with less stringent regulations[74]. Moreover, the strategy promotes the use of low - and zero - emission vehicles by regulations to progressively lower CO_2 emissions for new cars by 55% by 2030 and 100% by 2035, compared to 2021 levels[75]. With the intention of setting charging stations along significant European transport networks every 60 kilometres [12], this also includes the implementation of charging infrastructures for electric vehicles.

Turning now to energy efficiency, the package intends to raise the EU energy mix's share of renewable energy to 40% by 2030 and boost energy efficiency by 36–39%. Among specific actions there are requirements for Member States to annually renovate at least 3% of the total floor area of public buildings in order to increase energy efficiency and lower emissions[76].

The Fit for 55, but more generally the Green Deal of which it is a part, are of course only the main and most recent policies of the many, much more specific ones implemented by the EU for environmental purposes. It is clear that it is not feasible here to examine every current measure; instead, following this hint, we will concentrate in the following paragraphs on the European directives on energy efficiency, which reflect the policies most inherent to the area examined here.

In any case, it would be helpful to summarise generally what the main energy targets in the Green Deal and Fit for 55 are before proceeding to the next analysis. Thus, the EU seeks to raise the share of renewable energy to 40% of total EU energy consumption in 2030 and to improve energy efficiency by 36% (final energy consumption) and 39% (primary energy consumption) compared to expected 2007 consumption levels without energy efficiency measures[77].

Having now a clearer overall awareness of the actions and objectives of the European Union for sustainability, the environment, and especially energy, this section will examine the most significant European policies that influence the sector of building energy efficiency.

The European Union has issued three directives on energy efficiency, also with reference to buildings, starting in 2010.

The first directive is the European Union Directive No. 31 of 2010[78], on the energy performance of buildings, which was revised by Directive 844 of 2018. Considering different climatic and local

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[74] Fit for 55. Consiglio Europeo. https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/#:~:text=The%20European%20climate%20law%20makes,EU%20climate%2Dneutral%20by%202050.

[75] Content/enel-Com/It/Authors/simone-Mori. (n.d.). “Fit for 55”: l’UE verso la riduzione delle emissioni e la crescita sostenibile. https://www.enel.com/it/azienda/storie/articles/2021/08/fit-for-55-obiettivi-transizione-energetica-europa

[76] ‘Fit for 55’: a quick overview. (n.d.). Global Law Firm | Norton Rose Fulbright. https://www.nortonrosefulbright.com/en/knowledge/publications/1ab5016b/fit-for-55-a-quick-overview

[77] Energia. (n.d.). Commissione Europea. https://commission.europa.eu/topics/energy_it

[78] Prestazione energetica nell’edilizia | EUR-Lex. (n.d.). https://eur-lex.europa.eu/IT/legal-content/summary/energy-performance-of-buildings.html#:~:text=A%20seguito%20di%20una%20revisione,delle%20tecnologie%20intelligenti%20negli%20stessi.

conditions, it sought to raise the energy performance of European buildings. In particular, it set minimum criteria and a shared methodology for computing energy performance; originally, the directive contained six main points.

The first point mandated Member States to set minimum energy performance criteria for buildings, their components, and energy used for specific purposes, to be revised every five years to reflect technical advancement. The second point is the introduction of Nearly Zero Energy Buildings (NZEB), i.e. constructions with very high energy performance, using low amounts of energy, mostly renewable. This measure is aimed at new buildings which, from 31 December 2020, must be almost zero energy; in the case of new public buildings, this obligation is brought forward to 31 December 2018.

Thirdly, the directive mandates that existing buildings greatly enhance their energy performance during major renovations involving more than 25% of the surface area or value of the building, so aiming to be achieved with incentive-based policies and support measures supported by Member States. Apart from this, the directive regularly checks air conditioning systems of more than 12 kW and heating systems with boilers of more than 20 kW, so evaluating the size and efficiency of the systems in relation to the demands of the building.

The next point is the commitment by Member States to clearly show in public buildings and buildings for sale or rent as well as to use a system of energy performance certification including information on energy class and recommendations for improvement. At last, a comparative methodological framework developed by the European Commission is incorporated to estimate ideal cost levels to satisfy energy performance criteria.

Aiming at achieving energy-efficient and decarbonised buildings by 2050, the 2018 revision adds to the original points by requiring Member States to adopt long-term renovation strategies to help the renovation of residential and non-residential buildings. These plans should incorporate financial support policies to encourage renovations and intermediate quantitative targets, e.g. 20% energy efficiency increase by 2030. Furthermore, the update encourages the acceptance of smart technologies meant to increase energy efficiency, including control systems and building automation. Furthermore, it is encouraged the installation of electric vehicle charging stations in newly constructed and remodelled buildings. In particular, non-residential buildings with more than 10 parking spaces have to have at least one charging point and plans for their installation for at least 10% of the parking spaces by 2025.

This directive is expected to significantly lower energy consumption in buildings, so helping to lower CO_2 emissions and meet EU climate targets.

The second directive immediately follows the first, but is more far-reaching, and is Directive 27 of 2012, on energy efficiency[79]. It too underwent a rather significant overhaul in 2018 under Directive No. 2002 of 2018, and forms one of the main foundations of the EU's approach to lower CO2 emissions and energy consumption.

The directive's primary objective was to raise energy efficiency by 20% by 2020 from 1990 levels, thus national energy efficiency targets were set by every member state to help to reach this. Covering all level of the energy chain, it also sought to encourage energy efficiency using a shared framework of policies throughout the EU. More specifically, the main actions are a 1.5% annual decrease in energy sales by distributors, public building renovation to increase their efficiency, required energy audits for big corporations, and encouragement of smart meter use to better control energy consumption[80].

The 2018 revision changed many elements, including the target of achieving the energy efficiency target of 32.5% by 2030, the removal of obstacles in the energy market that impede efficiency in the supply and use of energy, and clearer rules on energy metering and billing, so strengthening consumer rights, particularly those of apartment block residents.

Member States will also have to set their national contributions for 2020 and 2030, mandate utility companies to help consumers by enabling them to use 0.8% less energy annually, and have open, publicly available national rules on the cost allocation of heating, cooling and hot water services in apartment buildings and multi-purpose buildings. Finally, it is envisaged in the revision to strengthen the social aspects of energy efficiency by taking energy poverty into account when designing energy efficiency schemes and alternative measures.

Starting in December 2012, these policies, with their requirement to become law in the member states by 5 June 2014, are expected to significantly lower the EU's energy consumption, so helping to reduce CO2 emissions, same as Directive n. 31 of 2010.

The third directive, net of the 2018 revisions, comes more than a decade after the first ones, and in the wake of the Covid-19 pandemic, as well as the changed sensitivity on environmental issues compared to previous years. But the most likely reason behind this directive is the Russian invasion of Ukraine starting in 2022, which significantly affected energy prices and consequently consumption. In fact, the directive is an integral part of the RepowerEU plan to reduce dependence

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[79] Efficienza energetica | EUR-Lex. (n.d.). https://eur-lex.europa.eu/IT/legal-content/summary/energy-efficiency.html

[80] The EU Energy Efficiency Directive (2012/27/EU) – Policies - IEA. (n.d.). IEA. https://www.iea.org/policies/1118-the-eu-energy-efficiency-directive-201227eu

on fossil fuels imported from Russia. It also fits the European Green Deal, and more especially the Fit for 55 already covered here.

It is Directive No 1791 of 2023, on energy efficiency, and it amends, and in fact replaces, the 2012 directive, setting new targets for 2030[81]. The main goal becomes to reduce energy consumption by 11.7 % by 2030, compared to 2020 projections, for energy efficiency targets of -40.5 % and -38 % for primary and final energy consumption, respectively. Also by 2030, a target limits maximum energy consumption of 992.5 million tonnes of oil equivalent for primary energy and 763 million for final energy.

Among the main actions, the directive mandates member states to reach cumulative energy savings over the period of 2021 to 2030 with yearly increases in final energy consumption. Starting at 0.8 per cent in 2021–2023, minimum targets rise to 1.9 per cent in 2028–2030. Target for the public sector is 1.9% annual energy consumption reduction as well as extending the obligation to renovate 3% of buildings annually to it as well.

Member States will also have to set national indicative contributions based on a mix of objective criteria reflecting national circumstances and should they lag in their contributions, an additional mechanism to close the gap is seen.

At last, the directive tackles energy poverty by mandating Member States to increase awareness of and offer data on energy efficiency. This last point definitely reveals a very significant aspect and is surely influenced by the European Commission's Recommendation 1563 of 2020, which addresses energy poverty, recommends member states to create integrated and participative policies for the liberalisation of energy markets, tackling energy poverty and promoting energy efficiency, with particular attention to vulnerable households and the use of EU funds[82].

Though some clauses have different implementation dates, member states will have until 11 October 2025 to translate these rules into national law.

The review and description of these directives concludes this chapter, which focuses on the framework of the energy efficiency of buildings, especially at the European level, so as to understand the context that influences and relates to Italy in this sector. And it is precisely Italy that will be the subject of the next chapter, going to analyse the scenario and thus be able to discuss the actions taken by governments in this area, including the policy that is the subject of this research.

[81] Energy efficiency (from 2025) | EUR-Lex. (n.d.). https://eur-lex.europa.eu/EN/legal-content/summary/energy-efficiency-from-2025.html

[82] Commission Recommendation (EU) 2020/1563 of 14 October 2020 on energy poverty - EUR-Lex. (n.d.). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32020H1563

CHAPTER 2. The Superbonus 110% as an incentive for energy efficiency in Italian buildings

2.1 The Italian scenario of energy efficiency in buildings

The introductory part of this chapter, as anticipated, is focused on the Italian scenario of energy efficiency in buildings, following the same approach as the analysis already carried out at the European level. The goal is to understand the situation in Italy, the trends in recent years, the objectives, and the challenges, so as to grasp the rationale and the reasons behind the policies adopted to promote energy efficiency in buildings, particularly those under analysis.

Following the same path as before, we will move from a more macro perspective of energy consumption to understand the role of buildings in it and the ways energy is used. We will then examine buildings and living conditions to begin understanding the foundations of Italian citizens' behavior in this area, which significantly influences governmental actions. Connected to this, an analysis of renovations and energy upgrades will be conducted to highlight the energy savings achieved over time and the related environmental consequences.

The first step of this analysis is to observe how total energy consumption in Italy has changed over the years, to then identify the determinants, with particular attention to the consumption caused by buildings.

As shown in the graph below, based on ISTAT data processing, the trend of energy consumption in millions of tonnes of oil equivalent (toe) over the last 30 years, from the late 1980s to 2019, is presented before the introduction of the 110% Superbonus, which is the subject of this analysis. It is important to specify that most of the data presented in this section, depending on their availability, will refer to periods culminating in 2019 or 2020 to avoid contamination with the early effects of the Superbonus and to provide a clear and comprehensive overview at the time of the introduction of this measure.

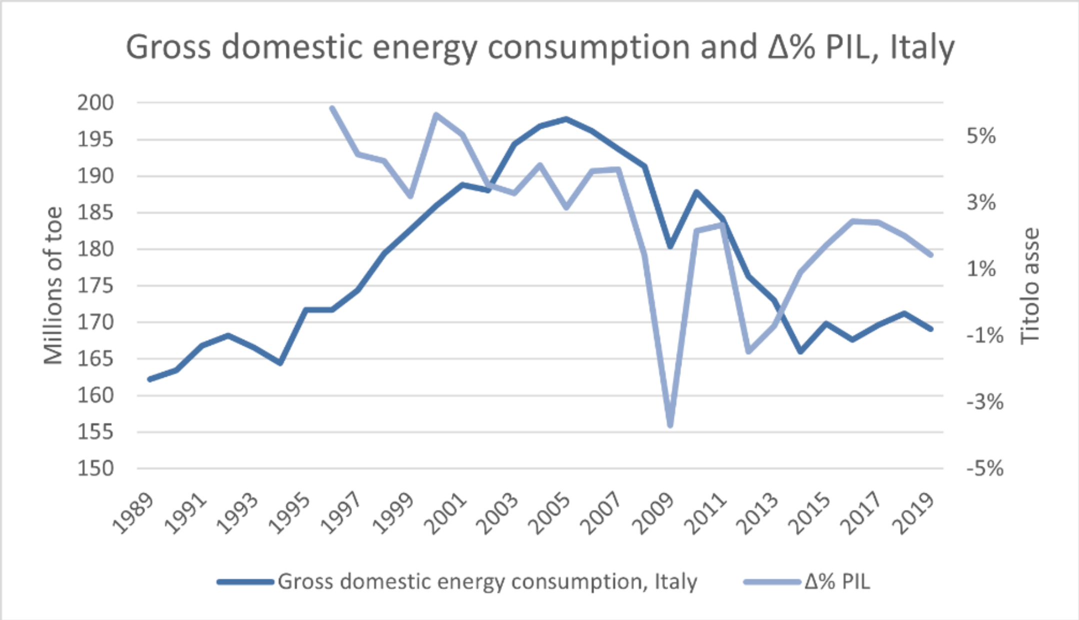

Figure 7: Gross domestic energy consumption and Δ% PIL, Italy 1989-2019
Source: ISTAT data elaboration

As can be seen from the graph, which also includes the percentage change in Italian GDP, a trend of energy consumption reduction began around 2006. With the exception of a rebound in 2010, the most significant drops occurred during the hardest periods of the Great Recession and the sovereign debt crisis for Italy. The graph clearly shows how corresponding reductions in energy consumption occurred during periods of negative GDP variation, resulting in an overall decline of almost 15% between 2005 and 2015. As one might easily deduce, despite the increased awareness of environmental issues and energy consumption over time, it is evident that the impact of production value, particularly industrial production and the resulting energy consumption it causes, was the main driver of these reductions in energy consumption. However, it can also be seen from the graph that starting in 2014, after the most severe period of the economic crisis ended and with GDP returning to growth, energy consumption has maintained a more or less stable trend, with an overall increase of less than 2% between 2014 and 2019. This could be seen as a sign of increased energy efficiency, especially in production; however, a more careful reflection that takes into account the vicissitudes of the Italian economy might consider that the reduction in energy consumption is attributable to a decline in Italian industrial production due to relocations and closures, while GDP growth is also driven by an increase in other sectors such as services, which require less energy consumption.

The following graph is useful for further understanding what has just been discussed. Indeed, it illustrates the final energy consumption by sector in Italy in 1990 and 2018, effectively highlighting the changes during this period.

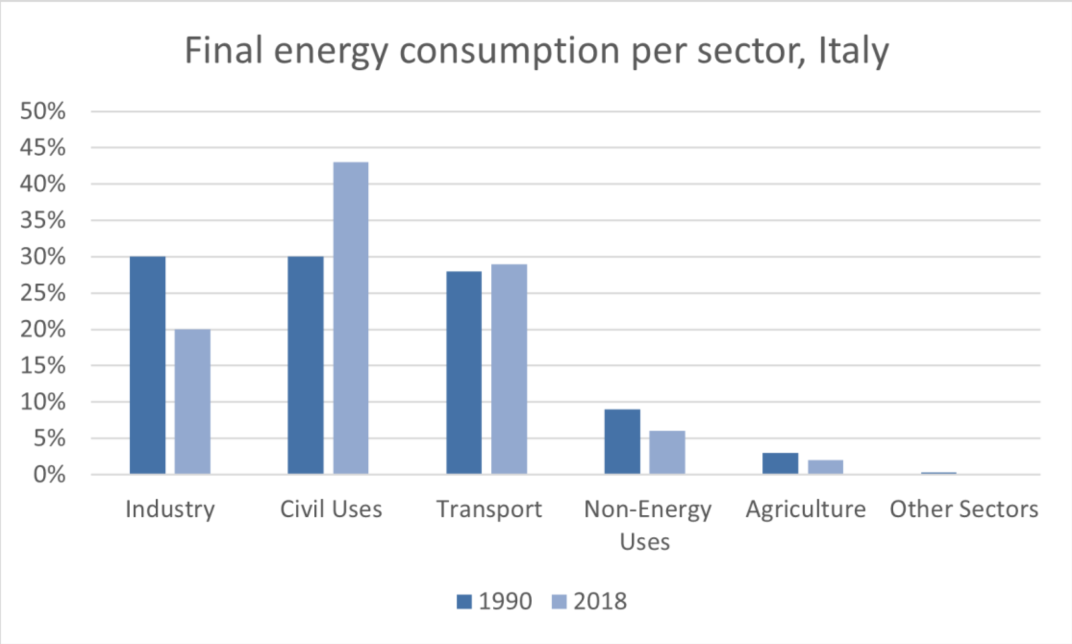

Figure 8: Final energy consumption per sector, Italy, 1990 and 2018
Source: Eurostat data elaboration

From the graph, it is immediately evident, as anticipated, that energy consumption in industry has significantly reduced its share of the country's overall consumption over the past 30 years. The overall decline was about 35%, the highest reduction sustained across the various sectors, all of which decreased except for the civil uses, which include residential buildings, which increased by more than 40%, and the small increase in the transport sector.

Moving on to a more detailed analysis of the role of buildings and over a more recent period, the following graph illustrates, again based on BSO data processing, the role of buildings in total final energy consumption compared to other sectors between 2010 and 2021. Specifically, the graph shows the distribution between residential and non-residential buildings and other sectors in 2021, the average distribution between 2010 and 2021, and the variation between these two years.

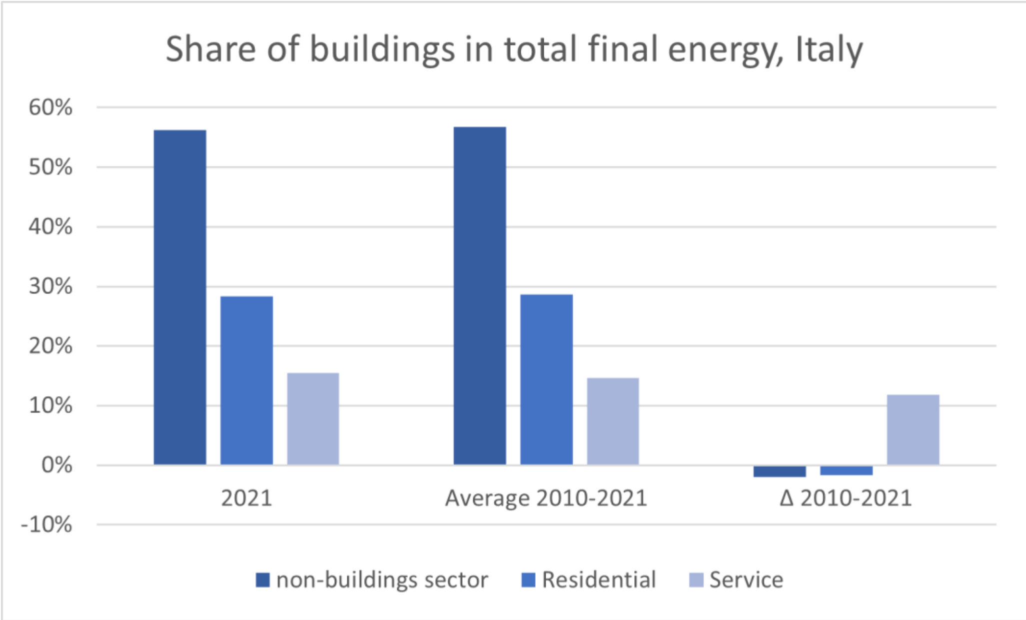

Figure 9: Share of buildings in total final energy, Itali 2010 - 2021
Source: BSO data elaboration, op. cit.

As can be seen from the graph, Italian buildings in 2021 represent almost 44% of energy consumption, which is more than the European average, and of this, 65% is attributable to residential buildings alone. As can be seen from both the average and the variations, moreover, between 2010 and 2021, there was an increase in energy consumption in service buildings, confirming the hypothesis previously made. Nonetheless, the significant role of buildings in energy consumption in Italy remains, about 4% more than the European average, despite the generally milder climate compared to other European countries.

Further confirmation of this significant importance can be provided by Odyssee data, which allows for the presentation of the following two graphs. They illustrate the trend in overall energy savings and residential building energy savings, comparing Italy with the European average in the first 20 years of the second millennium.

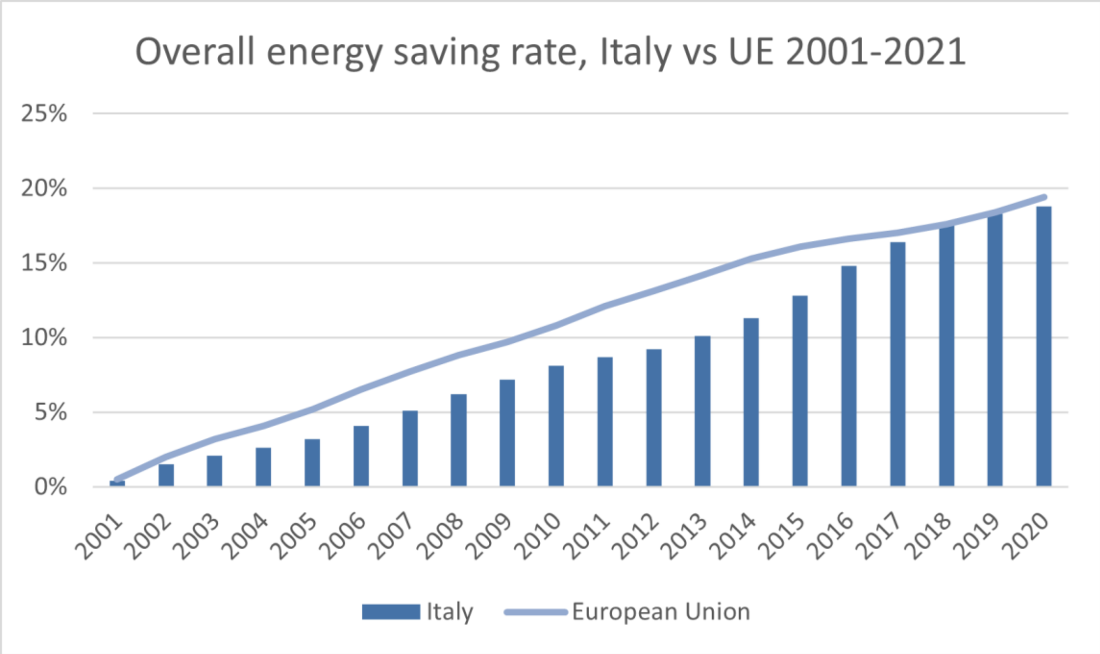

Figure 10: Overall energy saving rate, Italy vs UE 2001-2021
Source: Odyssee data elaboration, op. cit

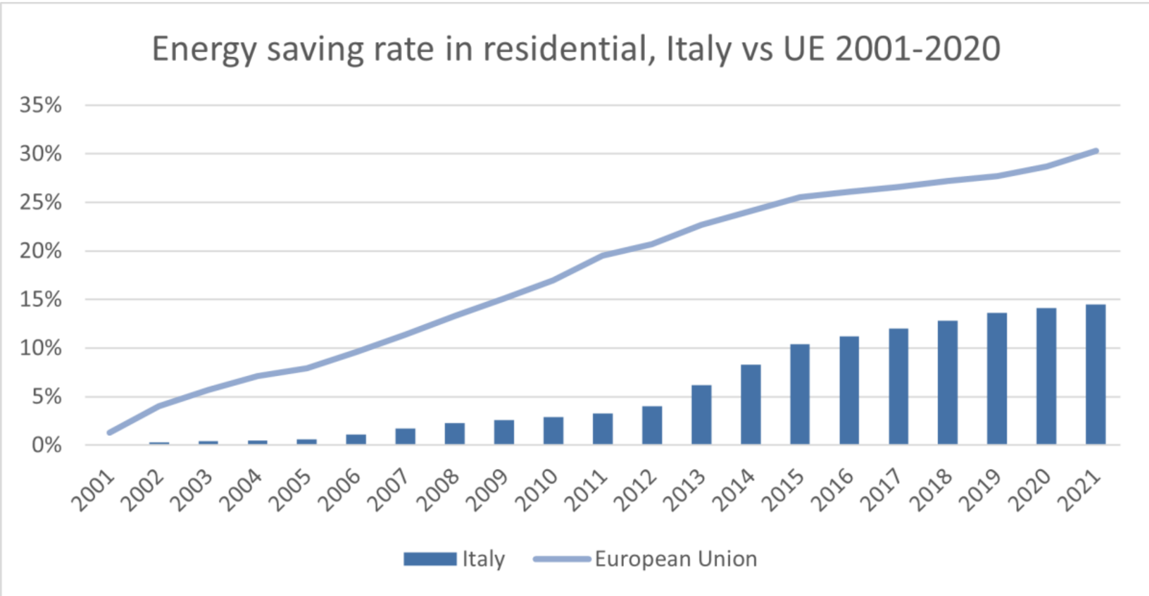

Figura 11: Energy saving rate in residential, Italy vs UE 2001-2020
Source: Odyssee data elaboration, op. cit

As is evident from the two graphs, without a doubt, Italy is fairly in line with the rest of Europe regarding energy savings, with some gaps during the most intense years of the economic crisis, but these were then closed during the recovery years when Italy once again reached European levels in terms of energy saving rates by 2021, nearly doubling since 2012. However, when observing the energy savings of residential buildings alone, it becomes clear that Italy performs far worse than European values, with a savings rate in recent years equal to less than half that of the European counterpart. This clearly shows that although Italy manages to significantly reduce its overall energy consumption, it is unable to do so with residential buildings, which make up the majority of the building stock.

At this point, having understood or rather highlighted and reiterated the importance of buildings in energy consumption in Italy, it is necessary to delve deeper into the sector, trying to understand trends, performance, and the causes of these levels in terms of both consumption and its composition.

For this reason, the following graph illustrates the trend of final energy consumption in buildings, again between 2010 and 2021, expressed in TJ/year for both Italy and the 27 EU countries, with data on two different axes to compare the trend. Specifically, the curve referring to Italy is related to the data on the left axis, and the one referring to European countries is related to the data on the right axis, with values almost ten times greater than the former.

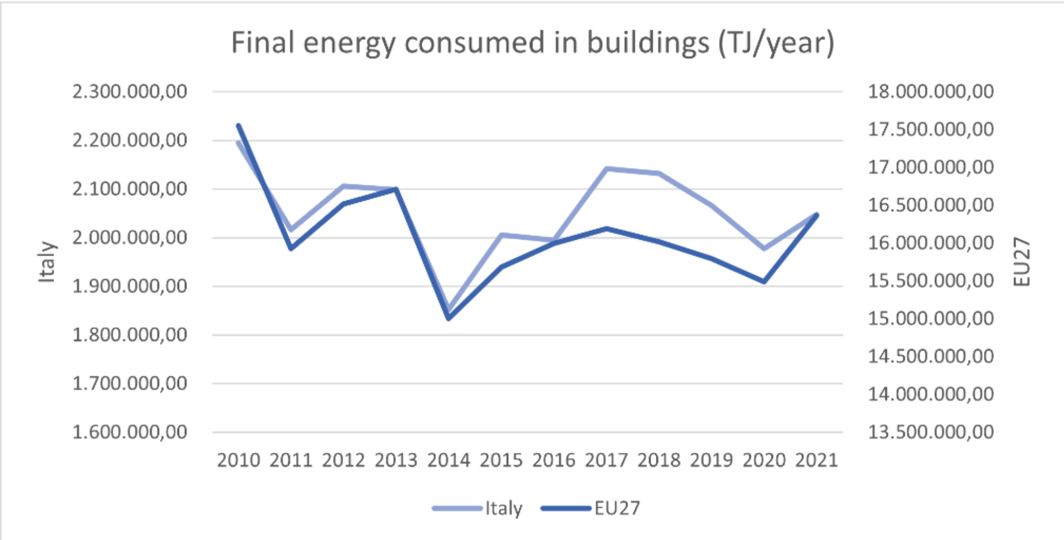

Figure 12: Final energy consumed in buildings, Italy vs Europe, 2010-2021
Source: BSO data elaboration, op. cit.

Thanks to the graph, it is possible to note how the trend in consumption between Italy and the EU, net of the differences in values, is very similar until 2014, showing Italy in line with European levels during the consumption declines in the years of the economic crisis. From 2014 onwards, however, it can be seen that with the economic recovery, consumption increased much more for Italian buildings, which grew proportionally more than European ones.

To fully understand the reasons for this difference in trends, it is essential not to forget the climatic differences between Italy and the rest of Europe, which makes it necessary for Italy to use less energy for heating, for example. For this reason, the following graph presents a processing of Odyssee data that illustrates energy consumption per square meter adjusted to climate, thereby leveling the climatic differences. Specifically, the data for 2022 is presented for both Italy and the European Union, but also for the EU with the climate adjusted to that of Italy.

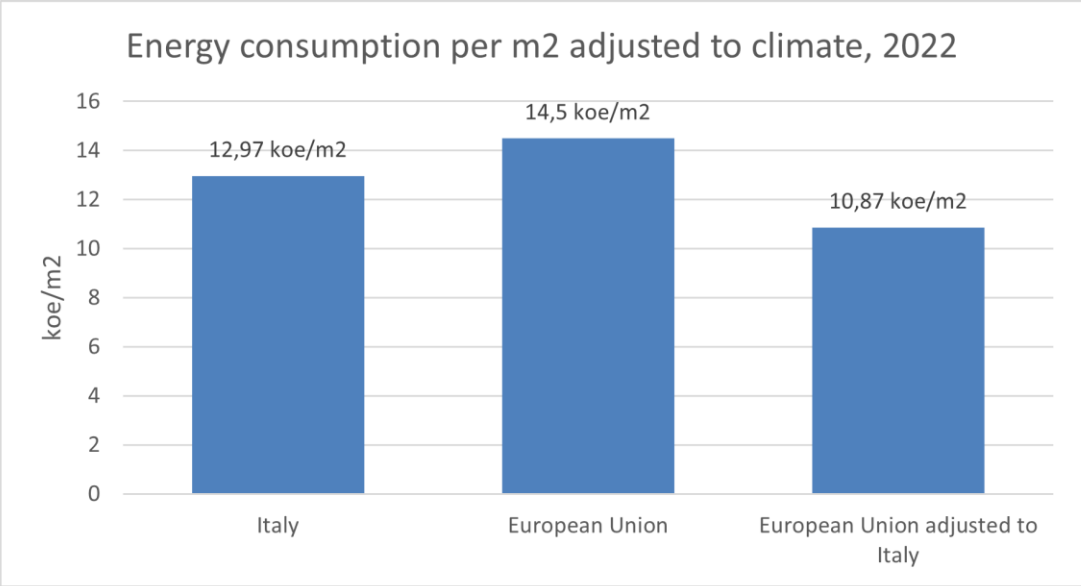

Figure 13: Energy consumption per m2 adjusted to climate, Italy and UE, 2022
Source: Odyssee data elaboration, op. cit

As shown in the graph, and as can be inferred from the previously presented data, the average energy consumption in Italy is lower than in Europe; however, when adjusting the European average consumption for the Italian climate level, the value is much lower. This indicates that if the entire EU were to live under the same climatic conditions as Italy, its energy consumption per square meter would be lower than both the unadjusted EU average and, more importantly, Italy's. Before reaching the obvious conclusions, it is also useful to quantify the climatic difference between Italy and the rest of Europe to understand how significant the gap is. For this purpose, the following graph again presents the already used metric of degree days, the measure to quantify the energy demand needed to heat or cool a building based on external temperatures. In this case, the trend obtained from BSO data of heating degree days, i.e., the measure for heating buildings, is represented between 2000 and 2022 for both Italy and the 27 EU countries.

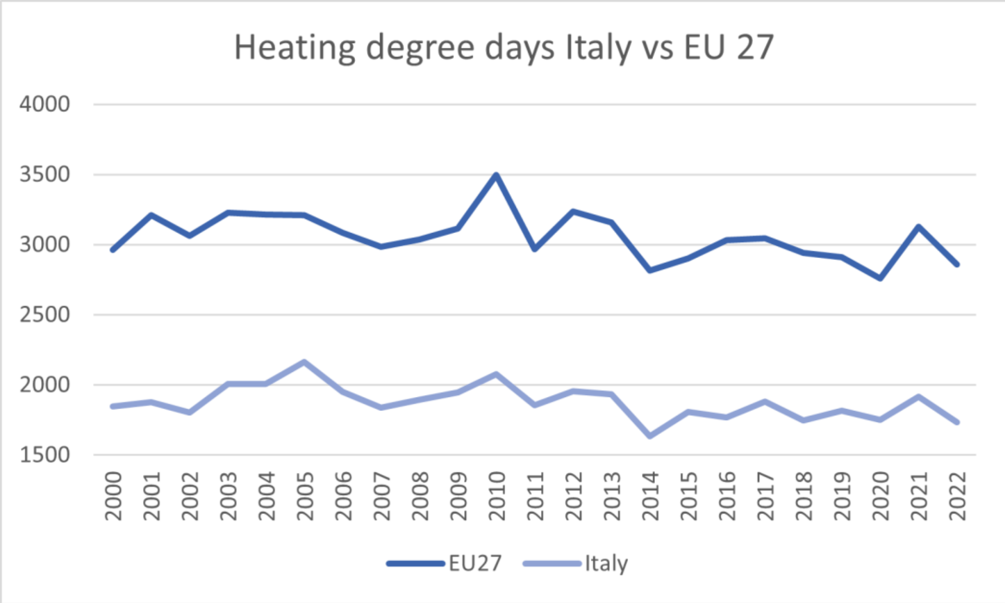

Figure 14: Heating degree days, Italy vs UE 27, 2000-2022
Source: EU BSO data elaboration, op. cit

As illustrated in the graph, although the trend is generally similar in terms of variations, such as the peaks in 2010, 2021, or the decline in 2014, it is evident that Italy has a much lower level than the EU average, equal to just over half, with an average for the period of 61%. This clearly means, as one might easily guess, that Italy requires much less energy than the European average to heat its buildings. Nonetheless, as already indicated by the data presented earlier, under the same climatic conditions, Italy actually consumes more than other European countries, almost 20% more according to Odyssee data.

Undoubtedly, one might wonder whether the differing climatic levels that cause heterogeneous consumption levels among different countries are the primary reason for this negative performance and, therefore, how significant the component of space heating is within overall consumption. The data presented below aims to resolve this doubt. Specifically, the following graph illustrates the variation between 2015 and 2020 in the allocation of energy consumption in Italian households. It should be noted that, for greater understanding and visual clarity of the trend, only a portion of the total consumption equal to 28% is shown in the graph. What is excluded from the graph corresponds partly to space heating, the lowest segment that reaches levels between 65% and 68% of the total, and other uses that fluctuate between 14% and 15%.

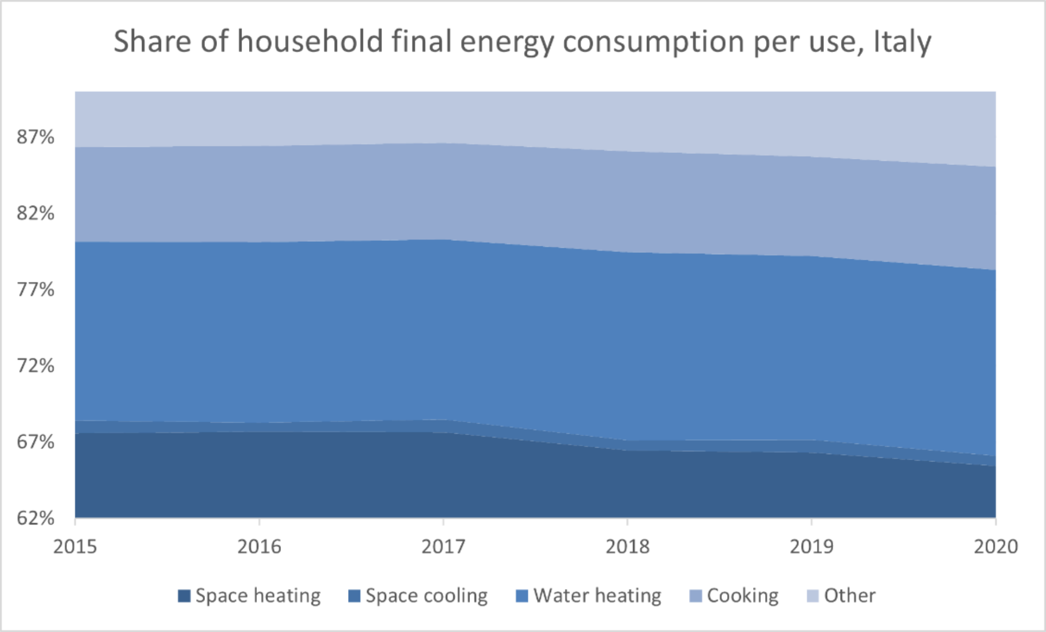

Figure 15: Share of household final energy consumption per use, Italy 2015-2020
Source: Eurostat data elaboration

As can be understood, heating represents the main destination for the energy used, accounting for more than two-thirds of the total, while just over the remaining 30% is used for space cooling, water heating, cooking, and other uses. Despite this evident data, it is still necessary to point out that this value has undergone some changes. Analyzing the data presented in the graph, it emerges that heating has seen a slight decline of about 3%, but especially space cooling, which, although at lower values, has decreased by 19% over these five years, a very significant figure. On the other hand, energy use for water heating and, above all, for cooking and other uses both increased by 9%. There are many reasons for these small variations, although it is not the objective of this analysis to identify them but rather to quantify the importance of certain factors, such as heating, in overall consumption.

Returning to heating, the following graph, based on Odyssee data processing, again shows the share of energy consumed by heating over a more extended period, represented by vertical bars, and the average unit consumption per dwelling and the average consumption for space heating per dwelling, both expressed in toe per dwelling.

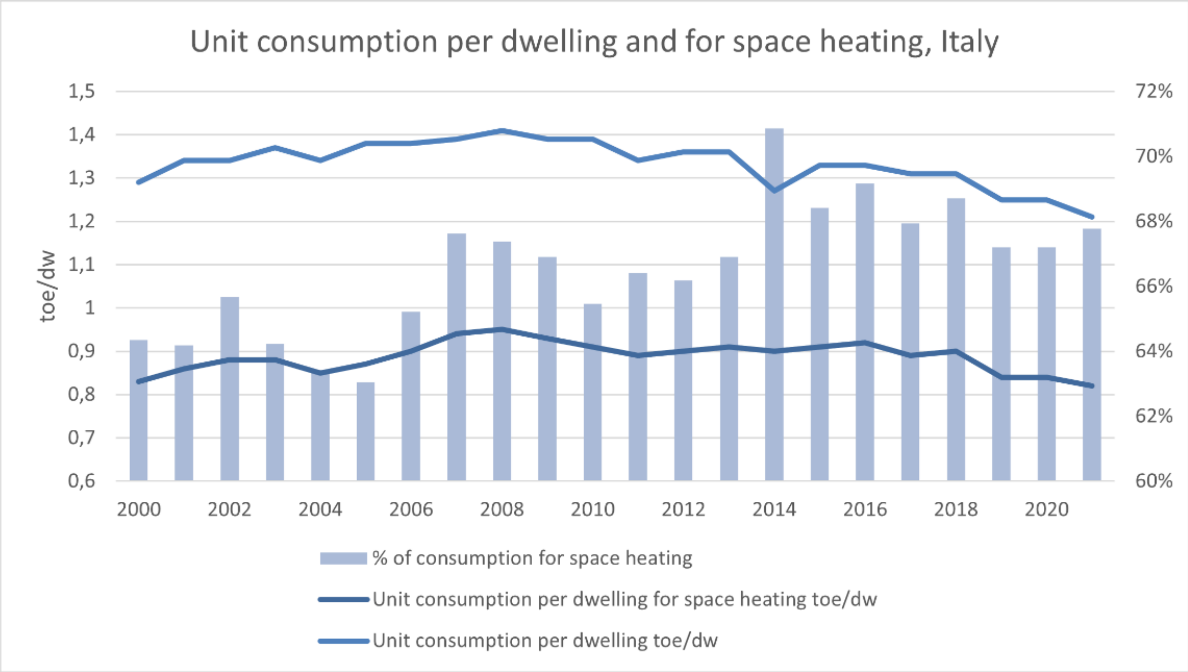

Figure 16: Unit consumption per dwelling and for space heating, Italy 2000-2020
Source: Odyssee data elaboration, op. cit

As can be seen, in addition to confirming the high percentages here more evident of consumption for space heating, analyzing the average consumption per dwelling shows that unit consumption per dwelling remains relatively stable, while unit consumption for heating shows a similar trend but highlights a slight difference in periods of reduction. Indeed, in 2014, amid an overall energy consumption decline of about 7% compared to the previous year, heating consumption fell by only 1%. This could be caused by various factors; however, it is significant that during a general decline in household energy consumption, heating remained unchanged, demonstrating how it is perceived as an indispensable element by citizens.

In any case, having understood the significant role of heating, even in a warm country like Italy, it becomes clear how large the gap with the rest of Europe is in terms of energy efficiency and how Italy is particularly lagging behind, using much more energy for heating in proportion to countries with harsher temperatures. This situation is undoubtedly attributable to various factors, including probably a higher intensity of energy waste caused by low overall consumption and therefore a lower cost of potential waste, making it bearable, but also and especially due to buildings that are less energy efficient than those in other countries. At this point in the analysis, it becomes necessary to focus on the situation of buildings, living conditions, with attention to the level of energy efficiency and related energy renovations.

First, for the considerations that will be made later, it is useful to understand the types of buildings present in Italy and their distribution. The following graph, based on BSO data, shows the breakdown of residential buildings in Italy in 2022, classified into single-family homes, multi-family homes, and apartment buildings.

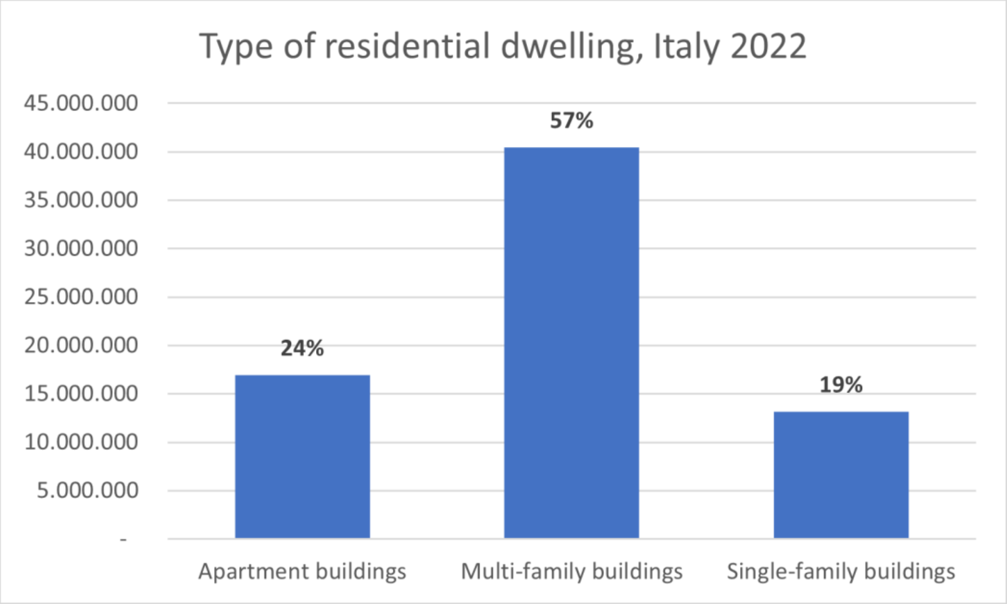

Figure 17: Type of residential dwelling, Italy 2022
Source: EU BSO data elaboration, op. cit

As clearly shown in the graph, the majority of residential buildings in Italy are units intended for one or a few families, while less than 25% of residential buildings are apartment buildings, large complexes where many families live, sharing many spaces, especially in cities. This significant disproportion, even though the data includes secondary residences, vacant units for rent, as well as public housing, indicates that a large part of the Italian population lives in a very limited number of buildings, probably due to both location needs and income reasons. This results in many families having less ability to influence the energy performance of the entire building, depending on administrators, and facing organizational as well as financial complexity in carrying out interventions.

In addition to the existing use of buildings, it is very important to consider the age of buildings to understand how many of them are characterized by construction techniques that ensure higher levels of energy efficiency. For this reason, the following graph, again based on BSO data processing, presents the number of Italian buildings by construction period, represented by columns, while the round indicators represent the percentage share of buildings for each construction period in both Italy and the 27 EU countries as of 2020.

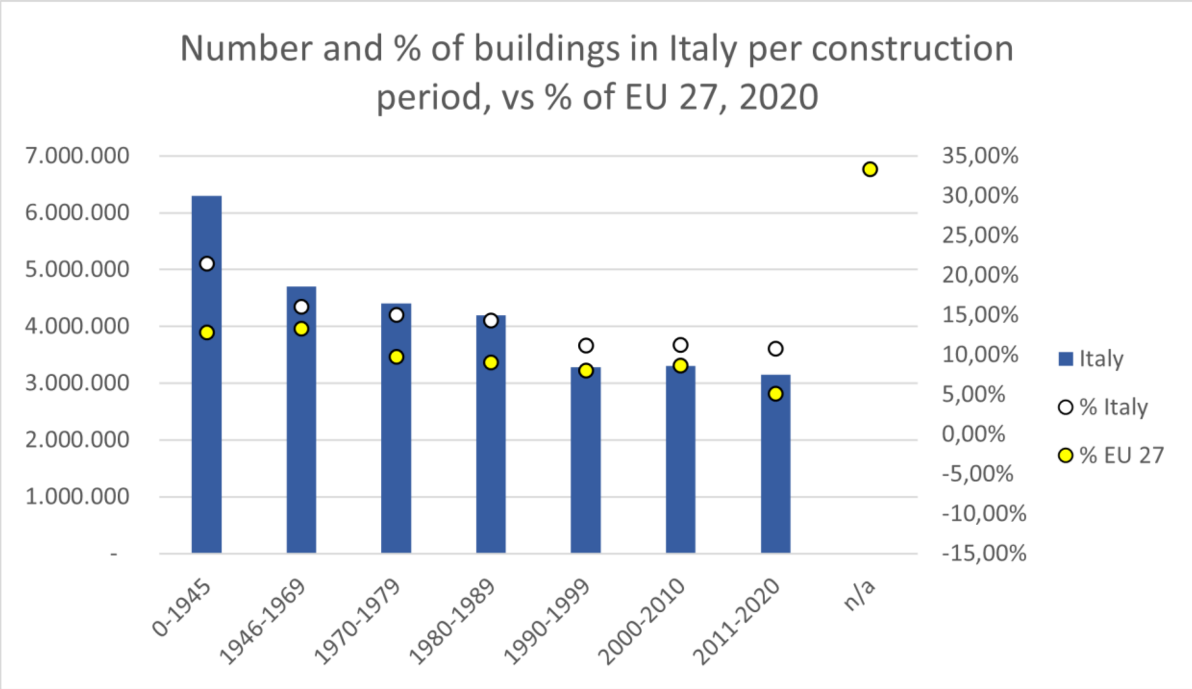

Figure 18: Number and % of buildings in Italy per construction period, vs % of EU 27, 2020
Source: EU BSO data elaboration, op. cit

As can be seen from the graph, the stock of Italian buildings is particularly old; in fact, the largest share of buildings, over one-fifth of the total, was built before 1945, undoubtedly with techniques and technologies incapable of ensuring good levels of energy efficiency. Additionally, by extending the period by just over two decades, it is found that more than half of Italian buildings were built before 1980, 52.5% to be precise, a very significant share of non-modern buildings. And if one considers as modern, and therefore more efficient, buildings constructed in this millennium, they account for about 22% of the total stock. These are undoubtedly low numbers; however, a comparison with the average of other EU countries can help provide an effective benchmark. As can be seen from the graph, there is a significant gap, particularly in the share of buildings constructed before 1945, where Italy has a much higher value, but the comparison is certainly compromised by the fact that about one-third of European buildings' construction periods are unknown and are, in fact, indicated as n/a, which distorts the other shares. Excluding the unknown buildings from the count, despite this excluding a significant share of the total stock, it emerges that a larger share of European buildings was constructed between 1945 and 2010 compared to Italy. This may indicate that more buildings were constructed in Europe over the decades than in Italy, thus presenting slightly better energy performance, except for the last decade, where more was built in Italy instead. However, this data cannot be an extremely reliable indicator given the partiality of the European data.

Having understood the nature of the Italian building stock, it is necessary to take a step forward in assessing its level of energy efficiency. To better understand the energy performance of buildings, ENEA, the National Agency for New Technologies, Energy and Sustainable Economic Development, annually publishes some very useful reports, including the Annual Report on Energy Certification of Buildings, whose 2020 edition[83] provides interesting data.

Specifically, the report, based on over 45 million Energy Performance Certificates (APE) issued between 2016 and 2019, 85% of which pertain to residential properties, reveals that a substantial 60% of Italian buildings have received particularly low energy ratings, specifically belonging to the so-called F and G classes, which indicate the lowest levels of energy performance—a critical data point. Nevertheless, the trend is beginning to show optimistic signs; in fact, during the same three-year period, the buildings with higher energy performance increased from 7% to 10% of the total. Finally, confirming the differences already noted earlier, the buildings belonging to the non-residential sector, which account for 15% of the total APEs, fall for over 50% into the intermediate energy classes (C-D-E) and for more than 10% into the most efficient ones (A4-B). Therefore, a complex situation emerges, characterized by very low performance, especially in the residential sector, despite an initial trend of improvement.

Before delving into the topic of energy-related renovations in more detail, it is very important, however, to focus on the already anticipated housing and economic conditions to understand the actual conditions with which the Italian population faced measures like the 110% Superbonus.

First, considering the importance of heating in consumption, it is interesting to note that according to ISTAT data from 2023, there are numerous differences between the various Italian regions, particularly with respect to the South. In fact, the data shows that in southern Italy, many families live in homes without heating systems. In Sicily, almost 28% of families fall into this category, meaning nearly a third of the population. The percentage drops to about 20% in Sardinia, Campania, and Calabria, while in Puglia, it is just above 10%, and it drops to 5% in Basilicata. These are the only regions with this figure above 5%; in all other regions, at least 95% of the population has access to heating.

Although there are evident climatic differences between the South and the rest of Italy, one cannot ignore the different economic conditions of the areas, where often it is not so much the cost of energy consumption but the cost of living in suitable homes, whether for renovation or purchase of new ones. In this regard, a very interesting data point available in the BSO database is the price index for the construction of new buildings, calculated on a base of 100 in 2020, whose trend is represented in the following graph.

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[83] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). (2020). Rapporto annuale sulla certificazione energetica degli edifici 2020. https://www.pubblicazioni.enea.it/download.html?task=download.send&id=8:rapporto-annuale-sulla-certificazione-energetica-degli-edifici-2020&catid=3

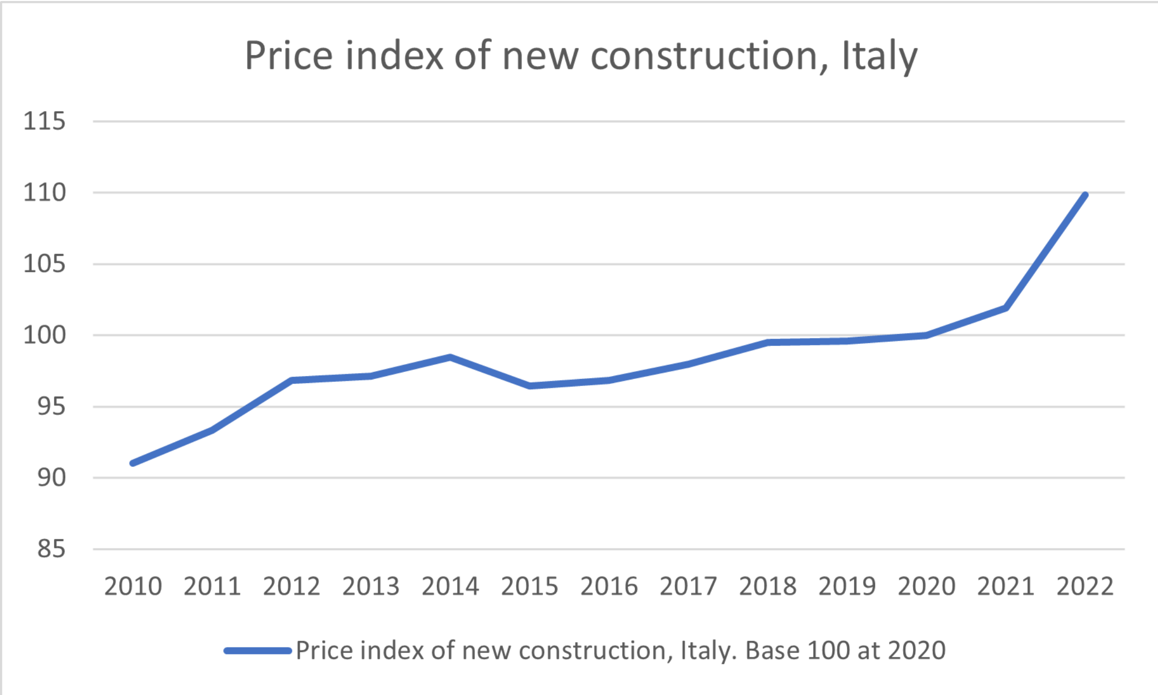

Figure 18: Price index of new construction, Italy. Base 100 at 2020
Source: EU BSO data elaboration, op. cit

As can be seen from the graph, with the exception of the period between 2014 and 2015, the price of new homes has continued to rise, although not excessively, throughout the decade. In particular, between 2010 and 2020, the figure increased by more than 11%, with an average of more than 1% annually. Although not an excessive increase, considering, however, the price of homes, where a variation of one percentage point can easily represent an increase of thousands of euros in price, it is clear that the increase in the cost of new homes prevents many families from living in more modern and energy-efficient homes, forcing them to remain in their previous homes or to find less modern and less efficient solutions.

Similarly, focusing on housing conditions, the BSO database contains a very specific and interesting data point, namely the share of the population that each year reported delays in paying energy-related bills. The following graph illustrates the trend in Italy between 2005 and 2022 for this share of the population.

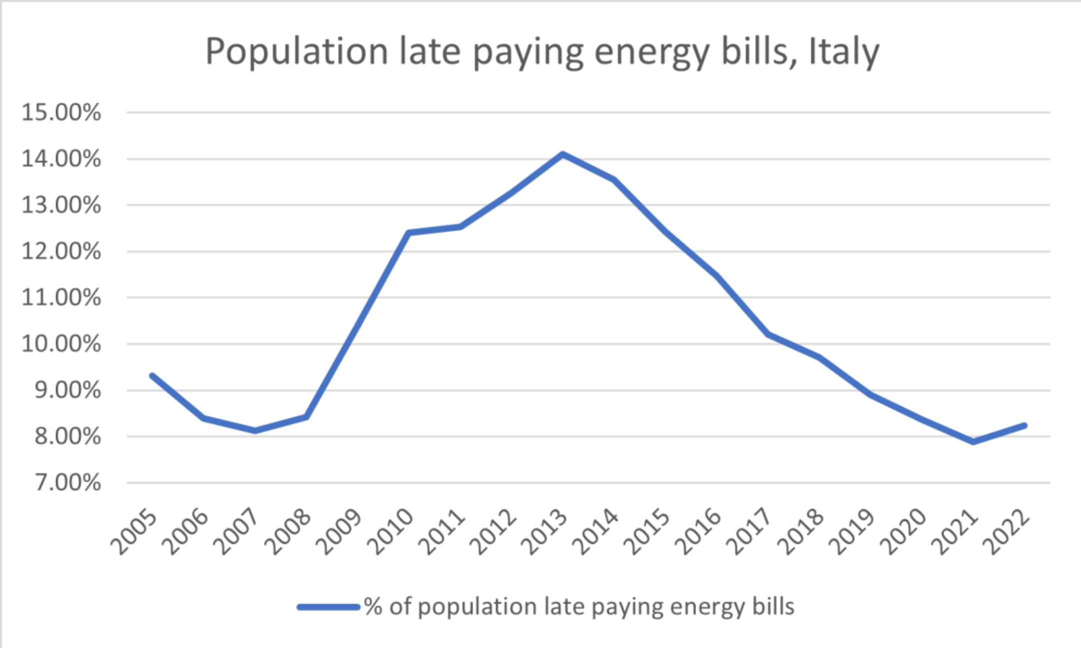

Figure 19: Share of population late paying energy bills, Italy 2005-2022
Source: EU BSO data elaboration, op. cit

It is clearly evident from the trend illustrated in the graph how there is a strong correlation between the moments when the share of the population late in paying energy bills increases and the most recessionary phases of the economy, such as between 2009 and 2013. Similarly, during economic recovery periods, starting from 2014, the percentage decreases, returning in 2021 to pre-Great Recession levels. This data is certainly not an unexpected insight, nor is it surprising; however, it is important to highlight it here to understand the importance of the economic element in families' decision on whether to carry out energy efficiency improvements that would allow them to reduce their expenses. This is, in fact, a very important topic to consider, as many families' housing-related expenses, including energy bills, represent a significant burden. Specifically, according to ISTAT data, in 2019, families that reported housing expenses as too high accounted for 55.2% of the total, meaning more than half.

At this point, it becomes necessary to discuss energy efficiency improvements in Italian buildings. In this context, reports produced by ENEA provide many useful data and insights that, combined with databases such as BSO and Odyssee, allow for a fairly clear overview with many interesting insights into the overall scenario, although a complete classification of the energy efficiency level of each building is complex to achieve given the available data.

Nevertheless, the initial data presented below immediately highlight the general conditions. Indeed, according to BSO data, in 2016, only 2.33% of Italian buildings saw significant energy renovation activities. Moreover, residential buildings have undergone energy renovation interventions to a significantly lesser extent than those dedicated to services; this phenomenon is measured by a specific index, the total renovation rate, which in 2016 for residential buildings was less than half that of service buildings. Specifically, there is a gap between 10.17% of service buildings and 4.53% of residential buildings.

If we also consider the data presented earlier, which indicated that non-residential buildings were a minority of the total building stock, it becomes clear that the less substantial building stock has been more renovated. Moreover, confirming the previous hypothesis, it is evident that, in proportion, the private sector manages or wants to invest more in these renovations for the buildings it uses than families do for the buildings they live in.

The importance of energy renovations in a country like Italy, which has an aging building stock, should not be underestimated or confused with mere refurbishments. Some data published by ENEA in the 2020 Annual Energy Efficiency Report[84] can help clarify this concept very well. Specifically, according to ENEA, new buildings constructed today tend to consume at least half the energy of similar buildings built 20 years ago—a relatively recent period—and particularly, almost 80% of real estate transactions for these buildings involved properties in energy classes A or B, which are the most energy-efficient categories.

However, one cannot rely solely on new constructions, as it is estimated that about 80% of today's buildings will still be in use in 2050, and 75% of this stock is energy inefficient. The evident impossibility of immediately replacing older buildings with new constructions must therefore necessarily be compensated for through energy renovation interventions. Italians do not seem entirely unaware of this fact; indeed, ENEA reports that the percentage of refurbished properties for greater energy efficiency that were subject to sales transactions has incredibly increased in recent years. Specifically, if between 2013 and 2017, this share was stable at around 10%, in 2018, it rose to 22%, and in 2019, it reached 36%, almost quadrupling in three years.

The growing interest in energy efficiency among Italian citizens has been confirmed by a survey conducted by the Demopolis Institute in early 2020, also reported by ENEA, aimed at analyzing Italian public opinion by studying the levels of knowledge, practices, perceptions, and sensitivities of citizens on the topic of energy efficiency and related interventions and institutional tools. According to the survey, which reveals a general increase in Italian awareness of energy efficiency issues, 71% of respondents admitted to living in energy-inadequate homes that need improvement and require interventions to reduce consumption. Furthermore, when asked which interventions would be most useful for optimizing the energy performance of their homes, the answers obtained are presented in the following graph.

[84] ENEA. Relazione sull'efficienza energetica nazionale 2021. https://www.efficienzaenergetica.enea.it/component/jdownloads/?task=download.send&id=453&catid=40%20&Itemid=101

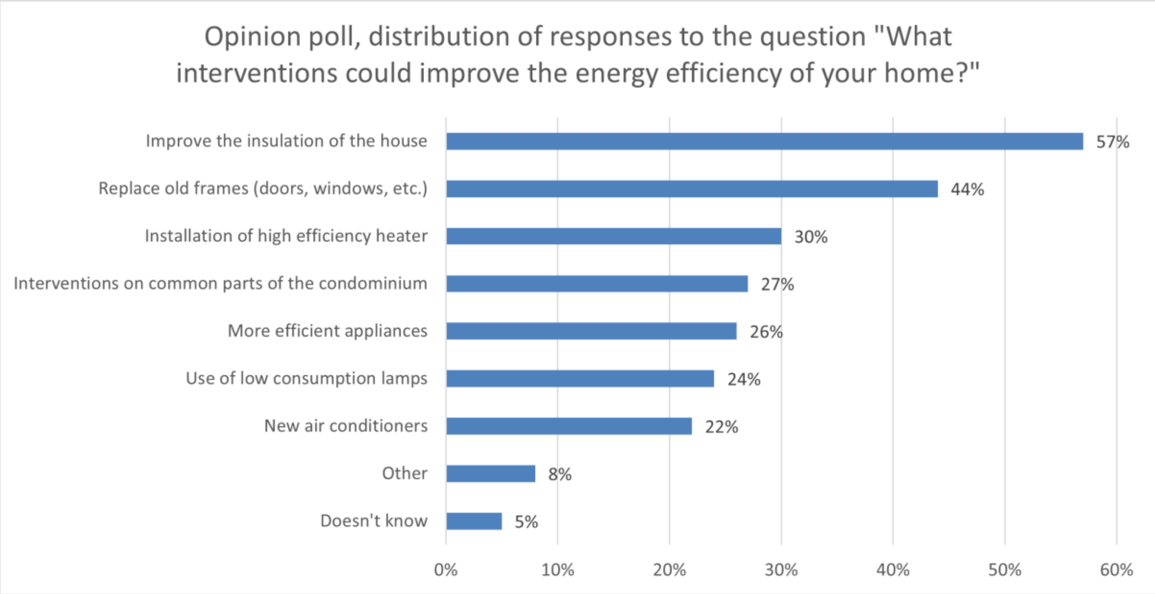

Figure 20: Demopolis opinion poll on energy interventions
Source: Data elaboration form ENEA, Relazione sull'efficiena energetica nazionale 2021, op. cit.

According to respondents, the most important intervention to carry out, with 57% of the responses, is to improve home insulation, followed by replacing outdated windows and frames with 44% of the responses. As shown in the graph, other solutions, all certainly useful, as already discussed in the first chapter, follow. However, despite this awareness, the survey authors report that the percentage of respondents who actually plan to intervene decreases to 34%[85]. Among the various reasons that result in a much less widespread willingness to act than awareness of the problem and its benefits, economic factors stand out, namely the high cost of these interventions and the fact that they have a very long payback period, which reduces their actual convenience.

By now, it may have been noticed that there is a continuous focus on the economic conditions and perceptions of Italian citizens regarding this issue, and the reason is very simple. At first glance, energy efficiency in buildings appears to be such a useful and beneficial element that it is natural to wonder why it is still so underutilized, especially in Italy, and why significant interventions have not been carried out in every home. The answer at this point in the analysis, thanks to the previous mentions, may seem clear; however, it is not to be underestimated. The economic and psychological components of citizens become fundamental for them to independently and autonomously decide to carry out an energy efficiency intervention. While important, it is easy to understand how environmental protection is secondary in the minds of most citizens compared to the potential savings in energy consumption and thus in costs, and this latter becomes probably the most important factor when making the decision.

[85] Guida Finestra. (2020, November 18). Italiani, casa e infissi: Un rapporto complesso. https://www.guidafinestra.it/italiani-casa-infissi/

Without a doubt, energy savings are welcome by everyone; however, an inevitable question arises about how much these savings might cost, how much investment is necessary to carry out these interventions, and how long it will take to recoup this investment solely through energy savings. While a precise and specific estimate for each intervention is extremely complex, as well as difficult to make due to the availability of data, an illustrative attempt here can be very useful to fully understand the criticality inherent in investing in energy efficiency interventions.

For this purpose, the company Viessmann, active precisely in the field of energy efficiency interventions, has made an estimate of this type concerning heat pumps[86], which are certainly one of the interventions that result in the greatest energy savings and still have neither a minimal nor excessively high cost. The estimate was made for two case studies: a single-family home and an apartment in a condominium.

The single-family home with a surface area of 200 square meters, with a gas boiler in energy class C, and a consumption equal to a bill of almost €1,200 per year, if subjected to the installation of a high-quality heat pump with sanitary accumulation for hot water, could move to energy class A3 and have a reduction in the bill of more than half, reaching about €530 per year, and if the cost of producing hot water is also added, an overall savings of about €850 per year would be obtained, reducing the bill to 30% of what was previously paid. In the case of the condominium apartment with a surface area of 110 square meters, with a traditional boiler in energy class F and a bill of about €725 per year, the installation of a medium-high quality heat pump would allow a leap to class C and an overall annual savings of €435.

It is evident how significant the energy savings are, also from an economic point of view, and for many families, they could represent significant additional resources. However, when considering the cost incurred to install the heat pump, the situation appears very different. There are obviously various types of heat pumps, more or less efficient and therefore more or less expensive; however, the price must also include the cost of all the necessary interventions to install it, leading to a total outlay generally exceeding €15,000 and which can even reach up to €25,000[87]. At this point, it becomes clear that the payback period for such an investment from bill savings alone would occur in no less than 20 years. Moreover, this would be significantly influenced by the volatility of energy prices, which, as witnessed in recent years, can change quickly, especially due to geopolitical causes, reducing or increasing the time needed for payback. Undoubtedly, these are investments that pay for

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[86] Viessmann Italia. Pompa di calore: Costo, agevolazioni e vantaggi. https://residenziale.viessmannitalia.it/pompa-di-calore-costo-agevolazioni-vantaggi

[87] Infobuild Energia. (2022, July 1). Pompe di calore: 3 in uno. https://www.infobuildenergia.it/approfondimenti/pompe-di-calore-3-in-uno/

themselves in the long run; however, it is easy to understand how, despite this, they are not very attractive and profitable investments from a purely financial perspective.

These simple calculations show how the truth about energy efficiency interventions is much more complex than the apparent benefits might have led one to believe. However, once the importance, particularly environmental, of increasing energy efficiency is understood, along with the inherent difficulty, especially in Italy, of achieving these increases, it becomes clear that the only possible way to reach energy saving targets through building energy efficiency is through institutional and government support for those who need to carry out this type of intervention, in order to increase its economic convenience, that is, through bonuses.

2.2 Main Italian targets and policies for ecological transition and energy efficiency

Before presenting the main actions implemented by the Italian State to encourage energy efficiency actions, especially the 110% Superbonus, it is also important to provide an overview of the main Italian energy efficiency targets. In this way, it will be possible to understand the motivations behind the actions taken, the goals in relation to the targets to be achieved, and how they influenced the funds made available. Italy has indeed established a series of goals to address environmental challenges and promote sustainability, some at the European level according to EU directives, others on a national basis.

At the European level, Italy aligns with the European Union's energy efficiency targets, including the already mentioned Fit for 55, which aims to reduce greenhouse gas emissions by 55% compared to 1990 levels by 2030. Additionally, Italy is subject to the European energy efficiency directives previously outlined, which commit member states, through national transposition, to improve energy performance, particularly that of buildings.

As reported by the European Commission[88], several binding targets have been set by the EU for member states, such as reducing final energy consumption by 11.7% by 2030 compared to 2020 projections, achieving a primary energy consumption level of 992.5 Mtoe, and final energy consumption of 763 Mtoe by 2030. Furthermore, EU member states must achieve an average annual energy saving rate of 1.49% from 2024 to 2030 compared to the requirement of 0.8% for the period 2021-2023.

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[88] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). Ecobonus e Bonus casa: Detrazioni fiscali. https://www.efficienzaenergetica.enea.it/servizi-per/cittadini/gli-incentivi-per-chi-realizza-gli-interventi/ecobonus-e-bonus-casa-detrazioni-fiscali.html

Adherence to European objectives and policies is very important for a country like Italy as it allows for greater resources, personnel, departments, and studies to identify the most suitable specific targets, as well as greater independence from various reasons, including political and electoral ones, and consequently a higher quality of work performed. In a European Commission document from May 2022, it is reiterated that EU intervention in renewable energy and energy efficiency brings added value, being more efficient and effective than interventions by individual member states[89]. However, it is also necessary to consider some limitations that may have or have had community participation in policy and target definition. Indeed, a 2005 study that analyzes the general conditions for energy certification regulations and systems for buildings to be effective in controlling and limiting energy consumption in the construction sector[90], when analyzing EU energy building legislation, highlighted some limitations that seriously compromised its ability to be translated into effective national legislation capable of significantly reducing energy consumption in the construction sector.

Nonetheless, despite the pros and cons that every type of approach may have, it cannot be denied that the European Union, as a promoter of such measures, has a much greater impact, especially if coordinated, than that of a single state in a continent.

At this point, moving towards Italy's main national targets, it is possible to analyze those most relevant to reducing energy consumption and increasing energy efficiency.

In particular, there is the commitment to decrease final energy consumption by 0.8% annually compared to the average consumption of the 2016-2018 period for each year from 2021 to 2030. Added to this is the goal of reaching 30% renewable energy in total energy consumption and 55% renewable energy in electricity production, with evident environmental benefits[91]. And on the environmental side, consistent with Fit for 55, there is an important decarbonization target, i.e., reducing CO2 emissions by 33% in non-ETS sectors (Emission Trading System) by 2030 compared to 2005 levels[92].

However, beyond these general objectives, it is interesting for this analysis to delve into the situation of energy efficiency targets and prospects in the months immediately preceding the

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[89] Ministero delle Imprese e del Made in Italy. (2024, September 6). Ecobonus 2024: Pubblicato in Gazzetta Ufficiale il DPCM con le misure per il nuovo piano incentivi auto. https://www.mimit.gov.it/it/notizie-stampa/ecobonus-2024-pubblicato-in-gazzetta-ufficiale-il-dpcm-con-le-misure-per-il-nuovo-piano-incentivi-auto

[90] Van der Laan, J., van der Maas, J., & Verhoef, L. (2005). Renewable energy policies in the European Union. Energy Policy, 33(17), 2403-2413. https://doi.org/10.1016/j.enpol.2005.01.001

[91] Agenzia delle Entrate. Agevolazioni per le ristrutturazioni edilizie. https://www.agenziaentrate.gov.it/portale/web/guest/aree-tematiche/casa/agevolazioni/agevolazioni-per-le-ristrutturazioni-edilizie

[92] Odyssee-Mure: Odyssee-Mure. Energy efficiency trends and policies in Italy. https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/italy.html

introduction of the 110% Superbonus. To this end, an in-depth study of the Integrated National Energy and Climate Plan (PNIEC), presented by the Italian government at the end of 2019, is very useful. It was presented by the same government that introduced the Superbonus, making it useful for understanding the intentions and background that influenced the decision. The PNIEC represents a strategic response by Italy to global climate change challenges, outlining a series of goals aimed at reducing greenhouse gas emissions and improving energy efficiency by 2030.

One of the pillars of the PNIEC is the reduction of greenhouse gas emissions. With it, Italy commits to reducing emissions in sectors not covered by the EU Emissions Trading System (non-ETS) by 33% compared to 2005 levels by 2030; these sectors include transport, agriculture, waste disposal, and the residential and commercial building sectors. For sectors included in the ETS, the European target is a 43% reduction compared to 2005, with specific targets for large industry and the tertiary, land transport, and civil sectors. This approach highlights a sectoral differentiation aimed at balancing emission reduction efforts with Italy's economic and productive peculiarities.

Another fundamental element of the PNIEC is the targets for increasing renewable energy. The goal is to achieve 30% of renewable energy in gross final energy consumption by 2030, a considerable increase from the 18% recorded in 2017. Specifically, it is expected that renewable electricity will reach 55% of the energy mix. In the transport sector, the goal is set at 21.6% for the introduction of renewable energy, exceeding the requirements of the so-called RED II directive, the EU Directive 2001 of 2018 on the promotion of the use of energy from renewable sources, with a share of advanced biofuels equal to 8%. The thermal sector, on the other hand, sees a push towards the use of technologies such as heat pumps, biomass heating systems, and solar thermal systems to mitigate the environmental impact of heating and cooling buildings.

On the energy efficiency front, Italy aims to reduce final energy consumption by 0.8% annually compared to the average consumption of the 2016-2018 period for each year from 2021 to 2030. An additional goal concerns the energy refurbishment of the building stock, with an annual refurbishment rate of 2% by 2030, focusing on both public and private buildings. The reduction of primary energy consumption is set at 125 Mtoe by 2030, representing a 43% reduction compared to the Primes 2007 reference scenario. This target, to be achieved through energy efficiency interventions, should generate cumulative energy savings of 514 Mtoe from 2021 to 2030.

Although the goals outlined so far, both of the 2019 PNIEC and others, are ambitious and in line with European directives, doubts may obviously arise about their practical implementation in Italy, in particular. The complexity of achieving the proposed goals through adequate measures requires effective coordination between institutions, citizens, and productive sectors, as well as substantial public and private investments for the reasons already discussed.

With these premises, the need for an effort by the Italian State to also financially incentivize energy efficiency interventions becomes evident. Although this is not a great novelty, as there have been various measures with this goal over the years, it is nevertheless important here to reiterate how the analyses conducted have shown the necessity of such measures to achieve these goals. At this point in the analysis, the main measures introduced in Italy for these purposes over the last 15-20 years, particularly in the last five years in a season characterized by the introduction of numerous such bonuses[93], will be presented and analyzed.

Specifically, between 2018 and early 2021, Italy saw two governments led by Giuseppe Conte, a lawyer and university professor who had until then been outside the world of politics. Conte, aligned with the Five Star Movement, a populist, Eurosceptic, and environmentalist party, led a first government together with the League, a right-wing populist and sovereigntist party, which pursued a Eurosceptic and populist line. However, following the League's departure from the majority in the summer of 2019, he formed a second government together with the Democratic Party and other left-wing and center-left parties, as well as the Five Star Movement, shifting to more pro-European and social positions. In particular, the second Conte government, which faced the outbreak of the Covid-19 pandemic in March 2020 and the beginning of the planning of the PNRR, the National Recovery and Resilience Plan, the Italian plan for how to use the nearly 200 billion euros allocated to Italy by Next Generation EU, the approximately 750 billion euro fund approved in July 2020 by the European Council to support member states affected by the pandemic[94]. This government, in a time of both severe economic crisis due to the pandemic and great availability of financial resources to address the pandemic and economic emergency, was characterized by the introduction of numerous bonuses aimed at citizens of various kinds[95]. In addition to those introduced by the government, including the Superbonus, which is the subject of the entire analysis, numerous other energy-related bonuses and measures were renewed or modified, which will be described in the following section.

Ecobonus

The Ecobonus is an important fiscal incentive tool introduced in Italy with the aim of promoting the energy refurbishment of buildings. It was initially established with Law No. 296 of December 27, 2006, i.e., the 2007 financial law, and over the years has undergone numerous modifications and extensions, adapting to emerging needs and progressively expanding the scope of eligible

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[93] Italia Oggi. Tutti i bonus del governo Conte. https://www.italiaoggi.it/news/tutti-i-bonus-del-governo-conte-2470902#google_vignette

[94] Wikipedia. Giuseppe Conte. https://it.wikipedia.org/wiki/Giuseppe_Conte

[95] Formiche.net. (2021, September 16). Conte e i 5 Stelle: Una storia di bonus e malus. https://formiche.net/2021/09/conte-e-i-5-stelle-una-storia-di-bonus-malus/#content

interventions[96]. This incentive allows taxpayers to deduct a significant percentage of the expenses incurred for energy efficiency improvement interventions from their taxes. Eligible interventions include, among others, the replacement of windows and frames, the installation of solar panels, and the replacement of heating systems with more efficient solutions such as condensing boilers or heat pumps. The variety of interventions allows flexibility in adhering to the incentive, enabling interventions to be tailored to the specific energy needs of buildings and not limiting them to specific interventions.

The deduction rates provided by the Ecobonus vary depending on the type of intervention. Generally, they range from 50% to 65% of the expenses incurred, with the possibility of an increase up to 75% for more complex interventions. Specifically, in the case of interventions on common parts of condominium buildings that reduce seismic risk, the deduction can reach 85%[97]. This flexibility in rates was designed to further encourage interventions that contribute both to energy efficiency and to the structural safety of buildings[98]. Over time, the Ecobonus has been subject to extensions and modifications, with one of the most significant revisions made by the 2020 Budget Law. Despite changes in applicable deduction percentages, the measure has maintained an important role in the policies to encourage the energy refurbishment of Italian buildings over the years[99].

In terms of resources, the Ecobonus does not provide a fixed allocated amount since it is a tax deduction rather than a direct fund. However, according to data provided by ENEA, the total annual investments related to Ecobonus-incentivized interventions have reached considerable figures, ranging between 2 and 3 billion euros in terms of total deductions requested. In 2020, the resources associated with this incentive were particularly significant, with a total of around 1 billion euros[100].

Bonus Casa

The Bonus Casa, is a fiscal incentive introduced in Italy with Article 16-bis of DPR 917/86 (Consolidated Income Tax Act - TUIR) and subsequently extended and modified through a series of legislative measures, including Decree-Law No. 83 of June 22, 2012. This tool was designed to promote building renovation work on residential properties, offering taxpayers the opportunity to

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[96] Ministero delle Imprese e del Made in Italy. (2024, September 6). Ecobonus 2024: Pubblicato in Gazzetta Ufficiale il DPCM con le misure per il nuovo piano incentivi auto. https://www.mimit.gov.it/it/notizie-stampa/ecobonus-2024-pubblicato-in-gazzetta-ufficiale-il-dpcm-con-le-misure-per-il-nuovo-piano-incentivi-auto

[97] Informazione Fiscale. (2020, January 20). Ecobonus 2020: Detrazione risparmio energetico, come funziona?. https://www.informazionefiscale.it/ecobonus-2020-detrazione-risparmio-energetico-come-funziona-spese-limiti-novita

[98] Informazione Fiscale. (2023, March 10). Bonus facciate 2023: Guida alla dichiarazione dei redditi. https://www.informazionefiscale.it/bonus-facciate-2023-guida-dichiarazione-redditi

[99] Ministero delle Imprese e del Made in Italy. (2021). Le agevolazioni: Contributo 2021. https://ecobonus.mise.gov.it/contributo-2021/le-agevolazioni

[100] Ministero delle Imprese e del Made in Italy. Ecobonus: Risorse stanziate. https://ecobonus.mise.gov.it/ecobonus/risorse-stanziate

deduct 50% of the expenses incurred for a wide range of works from IRPEF[101]. The Bonus Casa covers a variety of interventions, ranging from ordinary and extraordinary maintenance to restoration and conservation, the adoption of renewable energy sources, and complete building renovation.

Financially, the Bonus Casa provides a deduction of 50% of the expenses incurred, with a maximum deductible expenditure limit set at 96,000 euros per individual property unit[102]. This deduction is spread over ten annual installments of equal amount, allowing beneficiaries to distribute the tax relief over a decade. The extension of the Bonus Casa, confirmed by the 2020 Budget Law (Law No. 160 of December 27, 2019), extended the validity of the incentive until December 31, 2024, ensuring continuity for a measure that has proven central to the construction sector[103].

The legislative evolution of the Bonus Casa has seen several extensions and modifications that have kept the 50% deduction constant, while adapting it to the economic and social needs of the moment[104]. Subsequent budget laws have confirmed and, in some cases, modified the conditions of the bonus, ensuring that this tool remains in line with the needs of modernizing Italian buildings.

Bonus Facciate

The Bonus Facciate is a fiscal incentive introduced in Italy with the 2020 Budget Law (Law No. 160 of December 27, 2019), which came into effect on January 1, 2020[105]. This measure was designed with the aim of encouraging the restoration and renovation of the external facades of existing buildings with a dual purpose: improving urban aesthetics and simultaneously enhancing the energy efficiency of the buildings themselves.

The Bonus Facciate allows taxpayers to deduct a significant percentage of the expenses incurred for such interventions from their taxes. Specifically, for expenses incurred in 2020 and 2021, the deduction was set at 90%, a particularly generous rate aimed at encouraging widespread use of this tool. However, starting in 2022, the rate was reduced to 60%, and although lower, it remains a significant tax benefit for taxpayers[106]. Eligible interventions under the Bonus Facciate include

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[101] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). Ecobonus e Bonus casa: Detrazioni fiscali. https://www.efficienzaenergetica.enea.it/servizi-per/cittadini/gli-incentivi-per-chi-realizza-gli-interventi/ecobonus-e-bonus-casa-detrazioni-fiscali.html

[102] Agenzia delle Entrate. Agevolazioni per le ristrutturazioni edilizie. https://www.agenziaentrate.gov.it/portale/web/guest/aree-tematiche/casa/agevolazioni/agevolazioni-per-le-ristrutturazioni-edilizie

[103] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). Detrazioni fiscali. https://www.efficienzaenergetica.enea.it/detrazioni-fiscali.html

[104] Informazione Fiscale. (2020, February 10). Bonus casa 2020: Detrazioni fiscali, tutte le novità. https://www.informazionefiscale.it/bonus-casa-2020-detrazioni-fiscali-novita

[105] Informazione Fiscale. (2023, March 10). Bonus facciate 2023: Guida alla dichiarazione dei redditi. https://www.informazionefiscale.it/bonus-facciate-2023-guida-dichiarazione-redditi

[106] Agenzia delle Entrate. (2021, July 30). Guida Bonus Facciate. https://www.agenziaentrate.gov.it/portale/documents/20143/233439/Guida_Bonus_Facciate+20210730.pdf/b6adbc6b-b57e-0fb8-7d90-99f18e14bd2e

cleaning or external painting of the facade's opaque structures, as well as interventions on architectural elements such as balconies, decorations, and friezes. These works must concern only the visible parts of the building, i.e., those that directly affect the external appearance and, consequently, urban decorum.

Being a tax deduction, the Bonus Facciate does not provide a predetermined amount allocated by the State; however, the incentive has generated a significant economic impact. According to estimates from the Revenue Agency, the tax deductions recognized through this bonus reached several hundred million euros during 2020 and 2021[107].

Invoice Discount

The invoice discount is a fiscal incentive mechanism introduced in Italy with the Relaunch Decree (Decree-Law No. 34/2020) aimed at facilitating access to tax deductions for energy efficiency and building renovation interventions[108]. This option allows beneficiaries to obtain an immediate reduction in the cost of the intervention equivalent to the applicable tax deduction without having to wait for the recovery of sums through annual tax returns.

The operation of the invoice discount provides that the beneficiary of the incentive can transfer the tax deduction to the supplier who performs the work. In return, the supplier applies a direct discount on the invoice, thus reducing the cost of the intervention up to a maximum amount equal to the due consideration. Subsequently, the supplier can recover the amount of the discount in the form of a tax credit, which can be used in compensation or transferred to third parties, including credit institutions and other financial intermediaries. The invoice discount can be applied to a wide range of interventions covered by various building bonuses, including the 110% Superbonus, the Ecobonus, the Bonus Facciate, and the Bonus Casa. However, the regulatory context has continued to evolve, and in 2023, Decree-Law No. 11/2023 scaled back the possibility of applying the invoice discount and credit transfer for certain interventions[109].

White Certificates

White Certificates, also known as Energy Efficiency Certificates (TEE), represent an incentive mechanism aimed at promoting energy savings through energy efficiency interventions. Introduced in Italy in 2005, these certificates are tradable instruments that certify the energy savings achieved:

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[107] Agenzia delle Entrate. Guida Bonus Facciate. https://www.agenziaentrate.gov.it/portale/documents/20143/233439/Guida_Bonus_Facciate.pdf/129df34a-b8b7-5499-a8fb-55d2a32a0b12

[108] Lavori Pubblici. (2023, May 18). Bonus edilizi: FAQ su detrazioni, cessione del credito e sconto in fattura. https://www.lavoripubblici.it/news/bonus-edilizi-faq-detrazioni-cessione-credito-sconto-fattura-31825

[109] Viessmann Italia. (2020, October 5). Sconto in fattura e cessione del credito 2020: Facciamo chiarezza. https://residenziale.viessmannitalia.it/sconto-in-fattura-e-cessione-del-credito-2020-chiarezza

each certificate corresponds to the saving of one tonne of oil equivalent (TEP), a measure that allows quantifying the energy saved in terms of a common unit of primary energy[110].

The White Certificates system is primarily aimed at electricity and gas distributors, who are required to achieve certain energy saving targets set annually. However, other entities, including volunteers such as companies and individuals, can also participate in the mechanism, thereby contributing to the achievement of the country's energy efficiency targets. This tool has proven effective both in promoting energy-saving interventions and in encouraging more efficient technologies and improving energy management practices. White Certificates are issued following the verification of the actual energy savings obtained and can be traded on the market, creating a direct economic incentive for companies to invest in energy efficiency[111]. During 2020, the White Certificates system recognized over 17 million TEE, equivalent to about 0.57 Mtep of energy savings[112].

Thermal Account

The Thermal Account is an incentive mechanism introduced in Italy with the Ministerial Decree of December 28, 2012, subsequently updated with the Interministerial Decree of February 16, 2016, known as Thermal Account 2.0. This tool was designed to promote the production of thermal energy from renewable sources and improve energy efficiency, targeting a wide audience of beneficiaries, including individuals, companies, and Public Administrations[113].

The Thermal Account provides coverage of up to 65% of the expenses incurred for a series of targeted interventions. Among these, the replacement of traditional heating systems with biomass systems or heat pumps and the installation of solar thermal collectors are particularly important. The Thermal Account mechanism has seen significant growth over the years, with a particular increase recorded in 2020. In particular, the solar thermal systems sector has greatly benefited from these incentives, contributing to an increasingly widespread adoption of these technologies[114]. The Thermal Account 2.0 provides for an annual maximum allocation of 900 million euros, divided into 700

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[110] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). (2020, June 30). Certificati bianchi: Il Gestore dei Servizi Energetici (GSE) pubblica il Rapporto annuale 2020. https://www.efficienzaenergetica.enea.it/vi-segnaliamo/certificati-bianchi-il-gestore-dei-servizi-energetici-gse-pubblica-il-rapporto-annuale-2020.html

[111] Ministero dell'Ambiente e della Sicurezza Energetica (MASE). Certificati Bianchi. https://www.mase.gov.it/energia/incentivi/certificati-bianchi

[112] Luce e Gas. Certificati Bianchi: Guida all'efficienza energetica. https://luce-gas.it/guida/efficienza-energetica/certificati-bianchi

[113] Agenzia delle Entrate. Bonus Facciate: Informazioni per i cittadini. https://www.agenziaentrate.gov.it/portale/web/guest/bonus-facciate/infogen-bonus-facciate-cittadini

[114] Edilizia.com. (2020, January 22). Conto termico 2020: La guida completa. https://www.edilizia.com/conto-termico/conto-termico-2020/

million for individuals and 200 million reserved for Public Administrations, and it is noted that from 2016 to 2020, the use of these funds has grown steadily[115].

National Energy Efficiency Fund

The National Energy Efficiency Fund is a financial instrument established in Italy with the aim of promoting energy efficiency interventions in businesses and Public Administrations, created at the Ministry of Economic Development based on Legislative Decree No. 102 of July 4, 2014, and subsequently regulated by the Interministerial Decree of December 22, 2017[116]. The Fund offers a combination of subsidized loans and guarantees aimed at supporting interventions that reduce energy consumption in industrial processes, improve the efficiency of public services and infrastructure, including street lighting, and promote the energy refurbishment of buildings, allowing a wide range of projects to be incentivized in both the public and private sectors[117].

For the 2019-2020 biennium, the National Energy Efficiency Fund allocated approximately 310 million euros to support these interventions. Of this amount, 30% was reserved for guarantees, while the remaining 70% was allocated in the form of subsidized loans[118]. This distribution reflects the dual nature of the Fund, which not only provides capital at advantageous conditions for the implementation of energy efficiency projects but also ensures greater financial security for investors, reducing the risk associated with such interventions.

Having now provided an overview of the main measures and incentives aimed at promoting energy efficiency active at the beginning of 2020, particularly for buildings, it is time to present and analyze the most important of these measures, the subject of this thesis: the 110% Superbonus, to which the next paragraph is dedicated.

2.3 The Superbonus 110%: structure, characteristics and controversies

Having illustrated, explained, and understood the complex scenario of building energy efficiency and the policies aimed at promoting it, we can finally arrive at the focus of this analysis: the 110% Superbonus. Despite these energy-related premises, the genesis of this measure may seem

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[115] Conto Corrente Online. (2023, March 24). Conto termico 2.0: Guida completa. https://www.contocorrenteonline.it/2023/03/24/conto-termico-2-0-guida-completa/

[116] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA). Il Fondo Nazionale per l'Efficienza Energetica: Un'opportunità per le pubbliche amministrazioni, le imprese e le ESCO. https://www.efficienzaenergetica.enea.it/vi-segnaliamo/il-fondo-nazionale-per-l-efficienza-energetica-un-opportunita-per-le-pubbliche-amministrazioni-le-imprese-e-le-esco.html

[117] Enel Italia. Fondo efficienza energetica: Come funziona. https://www.enel.it/it/imprese/cosa-e-come-funziona-fondo-efficienza-energetica

[118] Invitalia. Fondo Nazionale per l'Efficienza Energetica: A chi è rivolto?. https://www.invitalia.it/cosa-facciamo/rafforziamo-le-imprese/fnee/a-chi-e-rivolto

somewhat peculiar. The Superbonus was introduced as an extraordinary measure by the Conte II government in May 2020 in response to the severe economic emergency caused by the COVID-19 pandemic.

During the pandemic, the global economy suffered a significant contraction, with Italy being among the countries most affected in various sectors, including construction. In 2020, Italian GDP contracted by 8.9%, one of the most severe declines among advanced economies[119], with an overall loss of approximately 150 billion euros, distributed mainly between consumption, investment, and exports[120]. The Italian construction sector was particularly affected, with a 10% reduction in investments in 2020, leading to a 30% decrease in production compared to 2008 levels. Building permits plummeted, with a 13.6% decrease for residential buildings and a 39% decrease for non-residential buildings in the first half of 2020. Working hours in the sector also decreased by 10%, although there was a slight increase in the number of workers. Real estate transactions recorded a 22% decline in the first half of 2020, followed by a slight recovery in the summer months[121].

In this scenario, the Superbonus, conceived by the Undersecretary to the Presidency of the Council Riccardo Fraccaro, a member of the Five Star Movement, comes into play with the objective of reviving the construction sector and improving the country's energy efficiency[122]. The measure represents one of the pillars of the so-called Relaunch Decree (Decree-Law No. 34 of May 19, 2020), a complex and articulated legislative package designed to support the economic sectors most affected by the pandemic crisis and to promote economic recovery[123, 124].

The 110% Superbonus was conceived as a tool to massively incentivize energy efficiency and seismic improvement interventions in buildings, two areas where Italy has historically shown significant room for improvement. The uniqueness of the measure lies in the 110% tax deduction of the expenses incurred, which not only covers the entire cost of the interventions but also allows for a

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119 Repubblica. COVID-19: Bilancio 2020, l'economia italiana ha perso 150 miliardi di PIL. https://www.repubblica.it/economia/rapporti/osserva-italia/mercati/2021/03/17/news/covid-19_bilancio_2020_l_economia_italiana_ha_perso_150_miliardi_di_pil-292640598/

120 Banca d'Italia. L'impatto della pandemia di COVID-19 sull'economia italiana: Scenari illustrativi. https://www.bancaditalia.it/media/notizia/l-impatto-della-pandemia-di-covid-19-sull-economia-italiana-scenari-illustrativi/

121 Repubblica. Costruzioni e edilizia: Andamento del settore nel 2021. https://www.repubblica.it/economia/2021/02/10/news/costruzioni_edilizia-286883551/

122 Il Foglio. La seconda vita di Fraccaro: Consulente per i danni del suo Superbonus. https://www.ilfoglio.it/politica/2023/05/11/news/la-seconda-vita-di-fraccaro-consulente-per-i-danni-del-suo-superbonus-e-lavora-anche-con-tremonti-5253347/

123 Wikipedia. Superbonus 110%. https://it.wikipedia.org/wiki/Superbonus_110%

124 Gazzetta Ufficiale. DPCM 23 settembre 2020, n. 123, Gazzetta Ufficiale del 19 novembre 2020, n. 282. https://www.gazzettaufficiale.it/eli/id/2020/11/19/20A06317/sg

"fiscal gain" for the taxpayer, making economically appealing works that would otherwise have been difficult to carry out[125].

The measure was welcomed as a major economic policy intervention with the aim of achieving multiple goals simultaneously. First, it sought to support Italian families by offering them the opportunity to improve the quality of their homes through energy efficiency and seismic safety interventions, thereby reducing energy consumption and increasing the property value of the buildings. Secondly, the Superbonus was designed to stimulate the economic recovery of the construction sector, involving a wide range of economic actors, from construction companies to material suppliers, from engineers to architects, to specialized technicians[126]. The construction sector, already struggling for years due to economic stagnation and the real estate crisis, saw the Superbonus as an opportunity for revival.

The decision to intervene through such a high tax deduction was driven by the need to provide a decisive boost to the economy during a time of deep recession. This incentive represented a groundbreaking innovation in the landscape of Italian fiscal policies, marking a turning point in the strategy of supporting families and businesses, although it is part of a broader context of public policies already presented earlier.

The 110% Superbonus is part of a particularly complex and articulated regulatory framework, characterized by a layering of laws and decrees aimed at incentivizing energy efficiency and the seismic safety of buildings. The Relaunch Decree represents a set of interventions to support the Italian economy, made possible also through the amendment and integration of the Consolidated Income Tax Act (TUIR), introducing new provisions to allow for the 110% deduction of expenses incurred for specific energy efficiency and seismic improvement interventions[127].

However, the regulatory path of the 110% Superbonus has been far from linear. Immediately after its introduction, several critical issues emerged, necessitating numerous corrections and integrations. Among the first legislative interventions that modified the Superbonus was Decree-Law No. 104 of August 14, 2020, known as the August Decree. This decree introduced some important changes, including the extension of the Superbonus to second homes and single-family homes, thus expanding the pool of beneficiaries[128]. Subsequently, the 2021 Budget Law represented a further step forward in the refinement of the measure. This provision extended the duration of the Superbonus,

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[125] CED System. Superbonus 110%: Genesi e storia. https://www.cedsystem.com/superbonus-110-genesi-e-storia/

[126] Avvenire. Storia del Superbonus. https://www.avvenire.it/attualita/pagine/storia-superbonus

[127] Lavori Pubblici. Superbonus 110%: Trama, protagonisti, regia e finale di stagione. https://www.lavoripubblici.it/news/superbonus-110-trama-protagonisti-regia-finale-stagione-31341

[128] Edilizia.com. Il Superbonus dal 110% al 90%: Le modifiche del 2023. https://www.edilizia.com/economia-finanza/il-superbonus-dal-110-al-90-le-modifiche-del-2023/#google_vignette

originally set until December 31, 2021, to December 31, 2022, for condominiums and until June 30, 2023, for single-family homes, provided that 60% of the work was completed by June 30, 2022. Furthermore, the Budget Law introduced new benefits, such as extending the benefit to housing cooperatives and Social Housing Institutes (IACP)[129].

The regulatory framework of the 110% Superbonus continued to evolve with further legislative changes. The 2022 Budget Law provided for a reduction in the tax deduction from 110% to 90% for new interventions starting from January 1, 2023. This change was motivated by the need to contain the financial impact of the measure on the state's finances while still maintaining a significant incentive to promote building renovation work. Over time, the 110% Superbonus has seen an expansion of the pool of beneficiaries, both in terms of types of buildings involved and categories of eligible subjects. In addition to condominiums and single-family homes, the Superbonus has also been extended to ONLUS and third-sector entities[130]. However, these extensions further complicated the regulatory and bureaucratic management, necessitating the intervention of various explanatory circulars from the Revenue Agency and other competent bodies.

The ongoing changes to the regulatory framework of the 110% Superbonus were motivated by the need to address the critical issues that emerged during the implementation of the measure and to adapt it to changing economic and social conditions. However, these revisions also generated uncertainties among taxpayers and industry operators, complicating the planning of interventions and access to tax benefits[131].

When analyzing the Superbonus in detail, it is crucial to focus on the fiscal aspects and the covered interventions. The tax deduction provided is, as mentioned, equal to 110% of the expenses incurred for specific renovation and building improvement interventions. The deduction, spread over five years, thus allows for the recovery of more than the total expenses incurred through a reduction in income taxes.

The 110% Superbonus was structured to incentivize two categories of interventions: the so-called "leading" and "driven" interventions. The leading interventions represent the main works that entitle the taxpayer to the 110% deduction and include various types. Among them are thermal insulation interventions covering at least 35% of the building envelope, the replacement of winter air conditioning systems with centralized condensing boilers, heat pumps, biomass boilers, or micro-

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[129] Gazzetta Ufficiale. Legge di Bilancio 2022, Gazzetta Ufficiale del 31 dicembre 2021, n. 322. https://www.gazzettaufficiale.it/eli/id/2021/12/31/21G00256/sg

[130] Infobuild Energia. Superbonus: Come cambia nel 2023. https://www.infobuildenergia.it/approfondimenti/superbonus-cambia-nel-2023/

[131] Informazione Fiscale. Superbonus 2023: Novità, regole, scadenze. https://www.informazionefiscale.it/superbonus-2023-novita-regole-scadenze#google_vignette

cogeneration systems that ensure a significant improvement in the building's energy class. Additionally, another very important type of renovation covered by the Superbonus is seismic interventions, such as structural reinforcement of buildings, particularly in seismic zones 1, 2, and 3.

Alongside these leading interventions, the Superbonus also provides for the possibility of carrying out "driven" interventions that can benefit from the deduction only if carried out in conjunction with one of the leading interventions. Among the driven interventions are the replacement of windows and frames for better thermal insulation, the installation of photovoltaic systems with energy storage systems for the production and use of renewable energy, and the construction of infrastructure for recharging electric vehicles[132].

This distinction between leading and driven interventions was crucial for the application of the Superbonus as it allowed property owners to maximize tax benefits by combining various works into a single renovation project. However, it also increased the complexity of planning and managing the interventions, requiring careful coordination among the various professionals involved, such as architects, engineers, technicians, and tax consultants.

One of the most innovative aspects of the 110% Superbonus is the possibility of opting for credit transfer or invoice discount, two mechanisms designed to facilitate access to incentives by taxpayers[133].

The transfer of credits for the 110% Superbonus allows beneficiaries of tax deductions to transfer the accrued tax credit to third parties, such as banks or other financial intermediaries, in exchange for immediate liquidity or an invoice discount from suppliers[134]. As an alternative to the direct deduction provided by the measure, beneficiaries can opt for the transfer of the credit. This involves transferring the accrued tax credit to third parties, which can be banks, financial intermediaries, or other entities. The transfer can also occur multiple times, allowing for greater financial flexibility. Another option is the invoice discount, where the supplier applies an immediate discount on the cost of the work, recovering the amount as a tax credit[135]. The need for a measure like this to have a form of credit transfer is evident since a simple tax deduction would have caused some issues. Indeed, one element to consider is that the deduction given by the Superbonus cannot exceed the taxes paid by the beneficiaries, even when spread over several years. To understand this, it is

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[132] Agenzia delle Entrate. Superbonus 110%. https://www.agenziaentrate.gov.it/portale/superbonus-110%25

[133] CAF Acli. Superbonus 110%: Guida fiscale e approfondimenti. https://www.cafacli.it/it/guida-fiscale/approfondimenti/superbonus_137_af/

[134] Agenzia delle Entrate. Circolare n. 30 del 2020. https://www.agenziaentrate.gov.it/portale/documents/20143/2957155/Circolare+n.+30_2020.pdf/179bbe13-8a49-f082-625b-3344f6175fa4

[135] Agenzia delle Entrate. Guida Superbonus 110%. https://www.agenziaentrate.gov.it/portale/documents/20143/233439/Guida_Superbonus_110_2022.pdf/21e9100a-9d7e-f582-4f76-2edcf1797e99

useful to provide a somewhat unrealistic but very effective example: a taxpayer who has a constant annual tax liability of €20,000 and decides to carry out energy efficiency work amounting to €150,000. According to the Superbonus deduction, this amount is transformed into a tax deduction of €165,000 to be spread over 5 years, i.e., an annual deduction of €33,000, which in itself exceeds the tax liability and does not become a credit against the state but is exhausted with the tax liability. In this example, the taxpayer would lose €13,000 each year for a total of €65,000, receiving only the €100,000 he would have paid in taxes over the 5 years, i.e., a return of only 60% and not 110%. Additionally, the credit transfer and invoice discount made it possible to access the Superbonus for a category that would logically have been excluded, namely the non-taxpayers. Non-taxpayers are individuals who, due to very low income, do not have to pay income taxes or pay such small amounts that they cannot benefit from tax deductions like the Superbonus; however, thanks to these measures, they were included among the beneficiaries of the provision.

It is easy to see how the credit transfer generated a very peculiar movement of transactions related to the Superbonus. In fact, families often did not pay the company for the work done but instead transferred the credit to it, which in turn transferred it to banks or financial institutions in exchange for the corresponding liquidity, minus a commission, of course.

The regulations regarding credit transfer for the Superbonus have undergone numerous changes over time, mainly to combat fraud and improve the effectiveness of the system. In 2022, the Draghi government introduced restrictions to combat tax fraud, limiting the number of possible transfers and imposing more stringent controls. Before this regulation, credits could be transferred an unlimited number of times, creating a secondary market that, while legitimate, had become fertile ground for fraud and abuse[136]. Multiple transfers made it difficult to trace the origin and legitimacy of the credits, increasing the risk of fraudulent transactions. Specifically, with the Anti-Fraud Decree, the government established that credits can only be transferred once to third parties, in addition to the first transfer made by the original beneficiary. This means that after the first transfer, the credit can be further transferred only once, thus limiting the total number of transfers to two. This measure aims to make the credit transfer process more transparent and traceable, reducing the possibility of fraud. Furthermore, for each transfer, a compliance check is required, certifying the correctness of the documentation and the existence of the requirements to obtain the bonus[137]. This additional check is intended to ensure that only legitimate credits can be transferred, increasing the security of the system.

[136] Finanza Repubblica. Superbonus: Franco, fino ad oggi individuati redditi d'imposta inesistenti per 4,4 miliardi. https://finanza.repubblica.it/News/2022/03/02/superbonus_franco_fino_ad_oggi_individuati_redditi_dimposta_inesistenti_per_4_4_miliardi-169/

[137] Banca d'Italia. L'impatto della pandemia di COVID-19 sull'economia italiana: Scenari illustrativi 2024. https://www.bancaditalia.it/pubblicazioni/qef/2024-0860/index.html

With the Aid-quater Decree approved in 2023, further changes were introduced, such as increasing the number of possible transfers to the banking system and the possibility of spreading the credits over 10 years instead of 5. In 2024, further updates clarified the procedures for communicating tax credits and introduced new provisions for managing transfers[138].

Despite the 110% Superbonus being enthusiastically received for the opportunities it offered, its practical implementation encountered numerous obstacles and challenges that limited its effectiveness and spread. The regulatory and bureaucratic complexity, frequent legislative changes, and operational difficulties raised doubts about the sustainability and overall effectiveness of the measure.

One of the main problems reported by beneficiaries and industry operators is the bureaucratic complexity associated with requesting and managing the 110% Superbonus. The measure requires a series of formal steps, including obtaining specific certifications such as the Energy Performance Certificate (APE) both before and after the interventions to demonstrate the improvement of the building's energy class[139]. These requirements, necessary to access the tax deduction, significantly slowed access to the Superbonus, causing delays in work and increasing costs for taxpayers. The need to comply with stringent technical requirements and prepare detailed documentation made it necessary to involve numerous professionals, including technicians, engineers, architects, and tax consultants, to ensure that all procedures were correctly completed. However, coordinating these professionals often proved problematic, causing further delays and complicating the management of interventions. This bureaucratic complexity discouraged many potential beneficiaries from undertaking the work, especially those who did not have sufficient resources or skills to manage the complexities of the process.

Another significant issue was the regulatory uncertainty that characterized the implementation of the 110% Superbonus. From the early stages of the measure, the legislator intervened several times to modify and integrate the regulations, introducing new rules and clarifying previously undisciplined aspects. This continuous revision process created confusion among beneficiaries and industry operators, making long-term planning of interventions difficult. Regulatory uncertainty also negatively impacted the management of credit transfers and invoice discounts, two key tools for making the Superbonus accessible to those who did not have immediate liquidity. Legislative changes forced banks and credit institutions to frequently update their systems and procedures, causing delays

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[138] Corte dei Conti. Relazione sulla gestione finanziaria del Superbonus 110%. https://www.corteconti.it/Download?id=644d75b9-86aa-4c52-a1eb-cc9f3b71278a

[139] Agenzia delle Entrate. Circolare n. 24 del 8 agosto 2020. https://www.agenziaentrate.gov.it/portale/documents/20143/2624559/Circolare+n.+24+del+8+agosto+2020.pdf/53b2ee8b-88bc-09c0-c95f-0bb6dbd16c77

in the disbursement of funds and hindering the liquidity needed to start and complete the work. These difficulties led some industry operators to complain about a lack of confidence in the system, with potentially harmful effects on the entire construction sector[140].

Additionally, the high incentive offered by the 110% Superbonus attracted attention not only from honest citizens but also from individuals' intent on exploiting regulatory loopholes to obtain undue tax benefits. Several journalistic investigations and reports from authorities highlighted cases of false declarations, fictitious or inflated work, and other fraudulent practices carried out to improperly access the Superbonus. These episodes raised concerns about the institutions' ability to effectively control the application of the measure and prevent abuses. To counter these phenomena, the government introduced stricter control measures and strengthened the documentation requirements, making additional verification and certification steps mandatory[141]. However, these measures further increased the complexity and costs for honest taxpayers, generating a vicious cycle that made managing the Superbonus increasingly burdensome and complicated.

The premises of this presentation of the measure are broad, and from this description alone, one may have already noticed elements that cast both a positive and negative light on the effectiveness of this measure. However, being able to give, or at least attempt to give, a definitive answer to this doubt is precisely the goal of this analysis, and more specifically, of the next chapter, where a 360° analysis of this measure will be conducted, covering both the energy-related and economic aspects.

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[140] Il Sole 24 Ore. Il Superbonus visto dai player: La misura sia strutturale. https://www.ilsole24ore.com/art/il-superbonus-visto-player-la-misura-sia-strutturale-ADR2WDVB

[141] Università degli Studi di Genova. Analisi del Superbonus 110%: Impatti e prospettive. https://unire.unige.it/handle/123456789/4194

CHAPTER 3. Cost-Benefit analysis of the Superbonus 110%

3.1 Impact and effectiveness analysis of the incentives

At this point in the analysis, after having conducted a comprehensive 360° overview of the topic of building energy efficiency, the policies promoting it, and the Superbonus 110%, we can proceed to initiate the actual cost-benefit analysis. The objective of this type of analysis is to determine whether the overall benefits of an undertaken action exceed the incurred costs, thus allowing for a complete judgment on the decision. An important and characteristic element of cost-benefit analysis is that it does not merely evaluate whether a certain action had a positive impact and achieved its goals, but also whether the achieved result justifies the incurred costs, thus understanding if resources that could have been invested for greater results were wasted.

Conducting a cost-benefit analysis of a measure like the Superbonus is not as simple as one might think, as it is not a purely economic measure or project as often happens, but rather a measure with multiple purposes, which has caused consequences in numerous areas, and whose results are difficult to quantify and evaluate, especially in a way that can be compared with the allocated economic resources. In fact, being a measure with a primary environmental objective, it is difficult to say what the economic value of an environmental benefit is. Indeed, in the context of the climate change we are witnessing, it is also likely to observe individuals supporting positions on how environmental protection is a priority and must be achieved at any cost, literally, thus ignoring the aspect of resources. While without any doubt the importance of the environmental issue is recognized here, it is obvious that the economic factor cannot be disregarded in making such considerations, even just to make the ecological transition sustainable.

Having clarified or, better, introduced this point, it is now possible to illustrate the approach used to conduct this analysis. Very simply, the analysis is divided into two parts: the attempt to quantify the benefits and the estimation of the costs, both direct and indirect, which will then be compared at the end.

Starting with the benefits, a first essential element to understand and clarify is the issue of whether or not the benefits can be attributed to the measure. In fact, unlike the more classic business projects evaluated with these approaches, in this case, it cannot be assumed that all the achieved objectives are certainly attributable to the implemented measure and its rationale. Specifically, in this case, it cannot be assumed that all improvements in building energy efficiency were made possible thanks to the Superbonus, even if carried out through it. Being a measure aimed at and used by millions of citizens, it is necessary to verify which possible factors may have influenced the behaviour of millions of citizens in this regard.

In the first chapter of this analysis, the numerous benefits of efficiency improvements have already been illustrated, so it is easy to imagine what some of the motivations might have been. Among these, we can identify obtaining economic savings, improving living conditions, reducing energy waste, and thus benefiting the environment. Certainly, however, these are valid motivations and causes in any historical period, and therefore, if there has been a significant increase in energy efficiency since the measure came into force, the temporal coincidence would suggest a correlation with the Superbonus. However, and it would be a grave mistake, one should not think that a simple correlation, even if strong, can represent an actual cause-effect relationship, as there may be other factors that have not been considered that, occurring in the same period, may have had a significant impact. For this reason, reflecting more on the already mentioned motivations that can drive a citizen to invest in efficiency, and on the historical period in which the measure came into force and the immediately following one, further hidden factors that may have influenced can be identified.

In particular, thinking about the factor of energy savings, it is worth remembering the Russian invasion of Ukraine started in February 2022, which caused a significant increase in energy prices, especially in Europe, as Russia is a major gas exporter[142]. Specifically, in 2022 there was an average increase in energy prices of 57%, with a consequent increase in bills of 108%, and inflation reached 9% at the end of the year. To understand the extent of the energy factor, it is enough to think that it has been estimated that over 70% of the overall inflation was attributed to energy price increases[143]. It is easy to understand how such a situation could have led many citizens to reassess the importance and previously underestimated convenience of improving energy efficiency, thus encouraging them to undertake efficiency measures. This effect is also mixed with another dynamic triggered by inflation, namely the loss of value of savings, which over time are eroded and thus decrease in value. To address this problem, the most convenient solution is to invest in some activity that can put that capital to good use and generate returns. And certainly, the Superbonus can be considered an investment, as it guarantees a return of the entire invested capital through the tax deduction, and an additional return given by 10% of the invested capital, always in the form of deductions, and by savings on energy bills. And not only can the erosion of savings caused by inflation incentivize an investment like this, but also the opposite, such as an increase in disposable income, perhaps due to the post-pandemic rebound effect. A citizen who has seen an increase in their income might want to find solutions to invest it or even to reduce the higher taxes to be paid. It is clear how the increase in

[142] Wikipedia. Invasione russa dell'Ucraina del 2022. https://it.wikipedia.org/wiki/Invasione_russa_dell%27Ucraina_del_2022

[143] Sky TG24. (2023, February 22). Guerra in Ucraina: Impatti sull’Italia. https://tg24.sky.it/economia/2023/02/22/guerra-ucraina-italia

income is caused by an increase in the results of one's activity, which translated on a macroeconomic scale, corresponds to an increase in production. And it should be noted, usually, an increase in industrial production is almost always immediately followed by an increase in energy consumption, further demonstrating how this is a constantly intertwined issue.

It is therefore well understood how numerous factors may have driven Italian citizens, from 2020 onwards, to implement energy efficiency and savings solutions, more or less independently of the Superbonus. At this point, having clearer the doubts that may arise, we can return to the issue of whether or not to attribute the energy savings achieved in these years to the Superbonus, and we can clearly outline the question we will try to answer.

The question asks which factors among the Superbonus, the increase in energy costs, inflation, and income and production better explain, and therefore may have caused, the energy savings achieved in Italy in these years?

3.1.1. Attribution of Benefits: Statistical Analysis

To be able to give, or at least try to give, an answer to this question, the statistical tool of regression was used. This tool allows us to understand, through the construction of a model, whether one or more defined independent variables explain the behaviour of a variable called dependent, and to what extent they explain it. Regression is a very powerful tool, and it has the great added value of providing certain answers to specific questions, obviously if there are sufficient conditions. In fact, to perform a significant regression, and therefore with a model that well explains the dynamics of the system, it is necessary to have a large amount of data available, and data that are especially representative of the behaviour of the variables. The factor of data availability and representativeness was somewhat problematic for this analysis, as data that certainly represent a specific trend, and with a sufficient level of detail and frequency to have a significant model, are not accessible or easily obtainable, or in some cases not yet collected. Despite this, an attempt was made, using data from different sources, to perform a regression analysis to understand if it was possible to have a certain answer to the research question.

First, the dependent variable was defined, which in the research question is represented by the energy savings achieved in Italy in recent years, and the most suitable data to represent it was sought. Based on the available data, the most suitable measure of this variable was found in data published by Terna[144] on the overall demand for electricity in Italy, on a monthly basis. Unfortunately, the data

[144] Terna. Rapporto mensile del sistema elettrico. https://www.terna.it/it/sistema-elettrico/pubblicazioni/rapporto-mesile

appears very general, but being one of the very few with monthly frequency, a frequency necessary to have a level of detail of a trend of very few years that is sufficient, it was chosen as the most suitable. A first limitation of this data is that it did not refer only to households, but also to industries, agriculture, transport, etc.; however, Terna cites the average annual distribution among the various sectors[145], and therefore it was possible to proportion the monthly data on the annual average of the percentage of electricity requested by households. In this way, a trend, on average representative, of how the demand for electricity by households has evolved in these years can be obtained, being able to represent any energy savings.

The second step was to define the independent variables, and obviously, one could not start without the Superbonus 110%. For this measure, fortunately, there is a lot of public data, however, the data of interest for this analysis are somewhat fragmented. Specifically, the data used to represent adherence to this measure, obtained from ENEA sources, are the investments made on a monthly basis for efficiency interventions that were granted the 110% deduction[146], and therefore the resources spent to finance the interventions. The original data consisted of cumulative amounts, however, it was immediate to calculate the single monthly value, but unfortunately, this data series does not cover the entire period of activity of the measure; in fact, the published cumulative amounts start in August 2021, a little more than a year after the entry into force of the Relaunch Decree. This meant that the start of the actual monthly data series does not coincide with the entry into force of the measure, and therefore does not allow the reconstruction of the entire trend.

The other independent variables are the other factors that were hypothesized to have influenced energy savings, and they are the increase in energy prices, the inflation rate, and the growth of national production. The inflation rate was easy to find, also on a monthly basis, using ISTAT data, as well as GDP, representative of national production, although it is only available on a quarterly basis. Finally, for the level of energy prices, two very useful sources of this data were found. The first is again ISTAT, with monthly data expressed in base 100 on 2015 levels, the second is ARERA[147], the authority for the regulation of the energy, water, waste, and more generally environmental markets. ARERA provides the nominal level of energy prices, however expressed on a quarterly basis, like GDP.

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[145] Terna. Consumi di energia elettrica per settore. https://www.terna.it/it/sistema-elettrico/statistiche/evoluzione-mercato-elettrico/consumi-energia-elettrica-settore

[146] ENEA. Risultati Superbonus. https://www.efficienzaenergetica.enea.it/detrazioni-fiscali/superbonus/risultati-superbonus.html

[147] ARERA. Andamento del prezzo dell'energia elettrica per il consumatore domestico tipo in maggior tutela. https://www.arera.it/dati-e-statistiche/dettaglio/andamento-del-prezzo-dellenergia-elettrica-per-il-consumatore-domestico-tipo-in-maggior-tutela

A fundamental consideration to make about these data is that inflation, although it may have pushed citizens to make investments for reasons other than simple cost savings, i.e., not to lose the value of accumulated capital, however, as already mentioned, it is inflation caused by the increase in energy prices, and this means that they are closely linked, especially at a quantitative level. This can represent a risk in the regression analysis phase, that is, finding oneself in the presence of collinearity. This occurs when two or more independent variables in a regression model are highly correlated, causing instability in the coefficients and difficulty in interpreting the individual effects of the variables. This can reduce the statistical significance of the variables, complicating the identification of those that are actually influential. This element was taken into account, as will be read later, in the setting of the regression.

Having collected data that can be considered fairly representative of the identified variables, the next step, before proceeding with the analysis, was to adapt and make the data consistent with each other. In fact, it is necessary that the data series used in a regression have the same number of observations, as each observation must have a corresponding value for all the variables involved in the regression model. This factor led to an overall reduction of all the series, so that they could coincide in terms of length with the data series on the amounts spent for Superbonus interventions, that is, starting from September 2021, and up to June 2024, the last available data at the time the analysis was carried out.

The fact that the available data were at different temporal frequencies, either monthly or quarterly, necessitates making a selection of the data. Given the short time horizon in question, just over two years, it is easy to understand how the number of quarterly observations is very limited and provides little validity to the regression model. However, rather than removing some of these series, it was decided to conduct several different analyses involving data at different frequencies, in order to increase the number of possibilities, perform a more comprehensive and diversified analysis, and most importantly, not exclude the GDP variable, which is only available on a quarterly basis. In this way, it was possible, albeit through multiple analyses, to verify the impact of the dependent variable GDP and to use the base frequency of monthly data.

Three different multiple regression analyses were conducted using Microsoft Excel software. One analysis was conducted on a quarterly basis, including GDP as an independent variable along with energy costs and the amounts spent on the Superbonus. The other two were conducted on a monthly basis, including either only energy costs and the amounts spent, or also inflation. This approach was taken to reduce the risk of encountering multicollinearity issues by performing one analysis with both energy costs and inflation, and another excluding inflation, which is summarized by energy costs as it is influenced by them.

The first attempt at multiple regression was, as mentioned, on a quarterly basis. Keeping energy demand as the dependent variable, the independent variables selected for the analysis were the energy costs provided by ARERA, the amounts spent on the Superbonus, summed to obtain the quarterly levels, and GDP.

The results showed that the model has an R-squared of 0.391, meaning the model is able to explain 39.1% of the variability in energy demand. However, neither the energy costs nor the amounts spent on the Superbonus were statistically significant (with a p-value > 0.05), indicating that they do not have a significant impact on the dependent variable. GDP also showed a p-value close to significance (0.108), but did not reach the conventional level of significance (0.05). Below is the summary table of results, with the data mentioned in the text highlighted in yellow.

Statistica della regressione	
R multiplo	0,624940744
R al quadrato	0,390550933
R al quadrato corretto	0,085826399
Errore standard	689,2227006
Osservazioni	10

ANALISI VARIANZA

	gdl	*SQ*	*MQ*	*F*	*Significatività F*
Regressione	3	1826462,079	608820,693	1,281652411	0,362827406
Residuo	6	2850167,586	475027,931		
Totale	9	4676629,665			

	Coefficienti	*Errore standard*	*Stat t*	*Valore di significatività*	*Inferiore 95%*	*Superiore 95%*	*Inferiore 95,0%*	*Superiore 95,0%*
Intercetta	28070,66291	5780,775408	4,855864642	0,00283472	13925,61505	42215,71076	13925,61505	42215,71076
Costi energia	-18,06757161	17,19075309	-1,051005242	0,333732298	-60,13182907	23,99668585	-60,13182907	23,99668585
Importi spesi superbonus	6,74074E-08	7,75045E-08	0,869722045	0,417882501	-1,22239E-07	2,57054E-07	-1,22239E-07	2,57054E-07
PIL	-2,13933E-08	1,13184E-08	-1,890139366	0,107631309	-4,90883E-08	6,30175E-09	-4,90883E-08	6,30175E-09

Figura 22: tabella risultati regressione multipla n° 2
Fonte: elaborazione dati TERNA, ISTAT, ENEA tramite Microsoft Excel

Overall, the model explains only a limited portion of the variability in energy demand, with a significant impact from energy costs, but it is only partially significant as a whole. Once again, the analysis yields limited success; however, compared to the previous analysis, in this case, a variable—the energy costs—emerges as having an impact on energy consumption. After conducting the third analysis, which includes the inflation rate, a clearer overall picture will be possible.

In this third attempt, again on a monthly basis, energy demand was used as the dependent variable, while the independent variables included energy costs and the inflation rate provided by ISTAT, along with the amounts spent on the Superbonus.

The results showed an R-squared of 0.213, indicating that the model explains 21.3% of the variability in energy demand. However, none of the independent variables (energy costs, amounts spent on the Superbonus, and the inflation rate) were statistically significant (p-value > 0.05), with energy costs being the furthest from significance with a p-value of 0.416.

Statistica della regressione	
R multiplo	0,461854835
R al quadrato	0,213309888
R al quadrato corretto	0,134640877
Errore standard	1502,187732
Osservazioni	34

ANALISI VARIANZA

	gdl	SQ	MQ	F	Significatività F
Regressione	3	18355954,54	6118651,515	2,711485567	0,062547655
Residuo	30	67697039,46	2256567,982		
Totale	33	86052994			

	Coefficienti	Errore standard	Stat t	Valore di significatività	Inferiore 95%	Superiore 95%	Inferiore 95,0%	Superiore 95,0%
Intercetta	37547,63484	6231,213593	6,025733877	1,29753E-06	24821,79895	50273,47073	24821,79895	50273,47073
Costi energia	-12,7471286	15,46079764	-0,824480658	0,416173951	-44,32228978	18,82803257	-44,32228978	18,82803257
Importi spesi superbonus	2,21886E-07	1,65537E-07	1,340403472	0,190177593	-1,16185E-07	5,59957E-07	-1,16185E-07	5,59957E-07
Tasso di inflazione	-89,6353287	64,19104866	-1,396383617	0,172846074	-220,7309393	41,46028193	-220,7309393	41,46028193

Figure 23: tabella risultati regressione multipla n° 3
Fonte: elaborazione dati TERNA, ISTAT, ENEA tramite Microsoft Excel

Consequently, the current model explains only a limited portion of the variability in energy demand, and none of the independent variables have a significant impact.

Overall, the three attempts at multiple regression have shown limited results in their ability to explain the variability in energy demand. In the first attempt, the model explained 39.1% of the variability, but none of the independent variables were significant. In the second attempt, the model explained only 16.2% of the variability, with energy costs being significant, but with a negative impact, while the amounts spent on the Superbonus were not significant. In the third attempt, the model explained 21.3% of the variability, and once again, none of the independent variables showed a significant impact.

In summary, none of the models proved particularly effective in explaining energy demand, and only energy costs showed a significant impact, but only in one of the attempts. This overall conclusion may certainly be perplexing, as it seems to provide no answer to the research question and thus compromises the entire purpose of this research. At the same time, considering only the positive results, one might think that there is an answer: that investments in the Superbonus did not lead to energy savings, but rather the increase in energy costs induced people to consume less. However, it would be wrong to stop at these initial thoughts and preliminary deductions, as these results still conceal elements of great interest, particularly concerning the limitations of these models, which must necessarily be considered. Specifically, the main limitation of this analysis, beyond the medium-low level of explanation of the statistical model, lies in the independent variable used to represent the Superbonus.

Indeed, although the monthly investment is the most detailed and accurate measure available and thus most suitable for this type of model, it is important to consider how the investment translates into a real effect. Not only how, but especially when. In fact, the data reported by ENEA corresponds to the resources that were approved for the interventions at a time that does not coincide with the completion of the work. Very often, in fact, the energy efficiency works began later, or some earlier, and even if they started at the same time as the approval of the expenses, they certainly had a prolonged duration over time, lasting weeks or months, depending on the type of intervention or building. This clearly indicates how, obviously, the results from these investments, in terms of energy efficiency, are temporally shifted forward. Only once all the work is completed will all the energy efficiency systems installed be operational and able to produce results, and of course, we are often talking about work still in progress, which has yet to be completed. ENEA, in the Superbonus usage data, also indicates the percentage of work completion, and by the summer of 2024, it was over 90%; therefore, more than four years after the measure was introduced, the vast majority of the work had been completed. However, it does not provide information on the average duration of the work, so as to understand when, relative to the investment, the interventions began to bear fruit. In summary, this temporal misalignment prevents considering with certainty, or at least with the certainty necessary for statistical analysis, the amounts spent on the Superbonus as already operational in increasing energy efficiency.

3.1.2. The Supposed Results: Analysis of Usage and Trends

In any case, despite this issue, the analysis as a whole is not entirely compromised. Certainly, it is not possible to provide a clear, definitive answer to the research question posed earlier; however, it is still possible, thanks to the available data, to conduct analyses, comparisons, and estimates to understand, with a broader perspective, what results have been achieved in terms of energy efficiency by the Superbonus. For this reason, a series of data and statistics will be analyzed and presented below to understand how much, between 2019 and 2024, the energy efficiency of buildings has improved. It will not be assumed that every improvement is attributable to the Superbonus, but rather an effort will be made to understand, based on the available sources, how much each variation is realistically due to these interventions.

The data to conduct this analysis come from numerous sources; however, it is necessary to point out that during the research and analysis phase, yet another problem emerged, namely that there are not many updated and complete data available for the most recent periods. Most sources, including the most official and authoritative ones such as BSO, Odyssee, and ENEA, report data mostly updated to 2022, a period in which access to the measure was still at its peak, and certainly not complete. In fact, analyzing the usage data provided by ENEA, it emerges that as of December 31, 2022, the number of buildings for which work had been started and deductions recognized was just over 350,000, for a total of eligible investments of just over 60 billion. The most recent and updated data, also from ENEA, up to August 2024, report a number of buildings close to half a million, and more than 110 billion euros in eligible investments. This means that most of the data available to understand the improvements presumably brought about by the Superbonus date back to when work had been started on only 70% of the buildings compared to the total counted until the summer of 2024, which in fact would have increased by nearly 40% during that period. Furthermore, on the investment side, the disparity is even greater; at the end of 2022, funds equal to 53% of those allocated up to August 2024 had been allocated, which would have grown by 87%. Additionally, at the end of 2022, ENEA estimates that only 74.6% of the work started up to that point had been completed, with peaks in single-family and independent buildings and lower levels in condominiums, for obvious reasons of complexity and size of the work. It is therefore easy to understand how these data are incomplete and insufficient to have a certain and complete idea of the impact of the energy efficiency work and therefore of the tens of billions of euros invested. Moreover, an important element to consider, especially when reflecting on energy performance and hypothetical comparisons with the rest of Europe, is that 2022 is the year when the war in Ukraine broke out and the consequent energy and inflation crisis, which reached its peak in the following months. Therefore, it must be considered that, most likely, energy consumption and savings trends were more influenced by the increase in energy costs, as revealed by the regression model, albeit not significantly, rather than by the still partial and incomplete work.

In any case, although it is clear that a comprehensive and reliable assessment of the improvement in energy performance and efficiency, in relation to the Superbonus, cannot be obtained, it is useful and still important to observe and analyze the data related to the measure's adoption, usage, and the main energy trends of that period.

First of all, the analysis will begin by observing the measure's adoption, to understand how much success it had among citizens and how many funds were allocated for it. In the graph below, based on ENEA data, the number of buildings and the related allocated funds subject to interventions recognized by the Superbonus are illustrated. It should be noted that the data is cumulative, not annual, and that, as previously mentioned, cumulative data is available starting from October 2021, so it is not possible to separate the data for 2020 and 2021, which are aggregated, and that the data for 2024 is still partial.

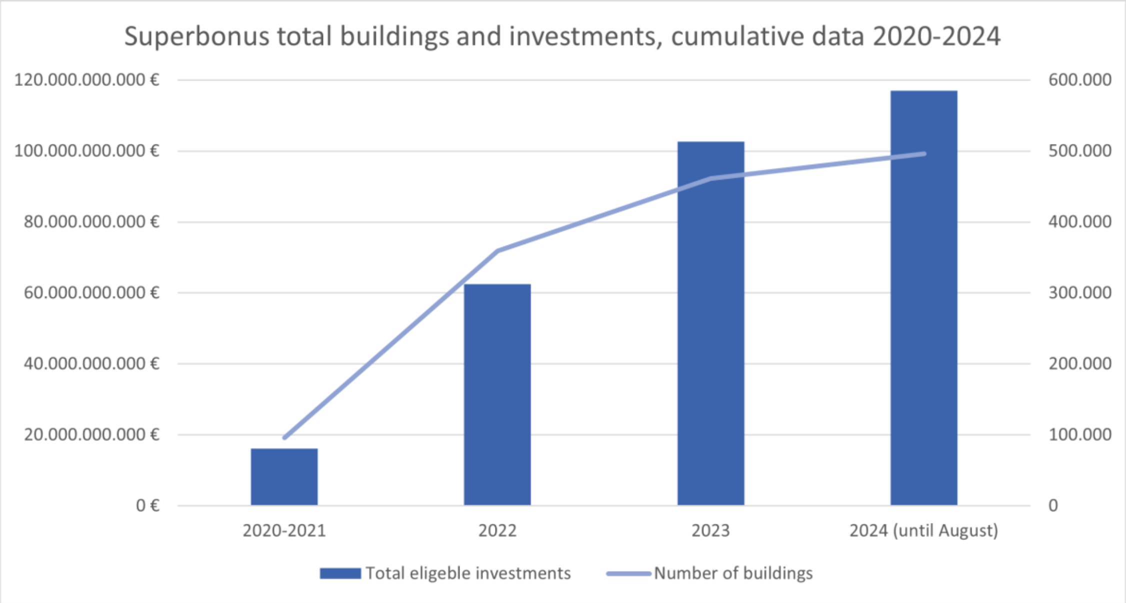

Figure 23: Number of buildings and eligible investments for the Superbonus 110%
Source: ENEA data elaboration, op. cit.

As can be clearly seen, and as already mentioned, 2022 was a boom year for participation in the measure, with an increase of nearly 300% in terms of both buildings and investments compared to the previous year and a half. This likely reflects, first and foremost, the initial hesitation to adopt a new measure until it was launched and its functionality proven and guaranteed, but above all, it reflects the significant opportunity it represented during a time of rising energy costs due to the energy crisis. Levels continued to grow in 2023 and 2024, albeit with smaller variations, reaching a total of half a million homes, including condominiums, single-family homes, independent units, and even some castles.

The data presented below refer to the most recent levels reached in August 2024. Condominiums, although representing less than 30% of the total buildings, attracted the majority of investments, 67% of the total. This figure reflects not only the large presence of such buildings but also their need for large-scale interventions. Most importantly, the impact on those living in them should be considered, as condominiums house more families compared to independent homes, whose living conditions should improve. Precisely for this reason, condominiums, housing a large number of families, require more complex and costly interventions, which justify the high average investment per unit, amounting to approximately €592,437.25. The complexity and scale of the necessary interventions in these buildings, however, result in greater energy efficiency once the work is completed.

On the other hand, single-family homes, while representing nearly half of the total buildings involved, show a lower average investment, amounting to €117,170.36 per unit. This figure highlights how interventions in single-family homes are generally less expensive, but despite requiring less complex interventions than condominiums, they have benefited significantly from the Superbonus. In fact, although they represent a smaller share of the total investments, they showed an average investment of €98,262.90, the lowest among all categories. Similarly, functionally independent real estate units represent a significant portion of the total buildings, nearly 24%, but the investment dedicated to them is just under 10% of the total.

Finally, castles, which constitute a very particular type of building, saw a small number of projects, only 8, but with a total investment of €1,937,699.12. Despite the complexity of such interventions, the percentage of work completed was high (90.4%), indicating that even for historically and culturally valuable buildings, the Superbonus represented an efficiency opportunity that would otherwise have been unlikely.

In the graph below, also based on ENEA data, the share of buildings and investments assigned to them is shown. Note that for ease of visualization, castles have been excluded and single-family and independent buildings have been grouped into a single category.

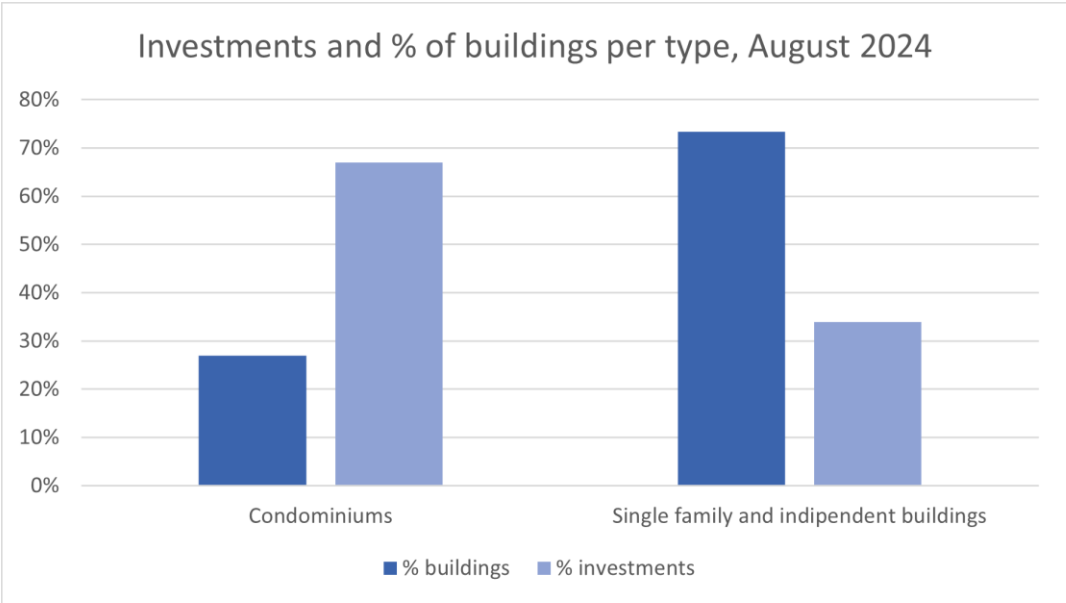

Figure 24: Distribution of investments and number of buildings per type, August 2024
Source: ENEA data elaboration, op. cit.

This data provides an interesting reflection on the issue of housing inequalities. Despite the fact that the majority of buildings renovated through the Superbonus were independent houses and villas, most of the actual funds were allocated to condominiums, where a larger number of families live, accounting for about three-quarters of the Italian population[148]. This has therefore allowed, if not to reduce, at least to prevent the increase in inequalities in housing conditions.

[148] Banca del Piemonte. Tre italiani su quattro in condominio. https://www.bancadelpiemonte.it/in-condominio-tre-italiani-su-quattro/#:~:text=Ma%20a%20detta%20dell'Anacidi%20italiani%2C%20tre%20su%20quattro.

As can be understood from this data, the buildings that underwent interventions certainly reached a very high number, representing an improvement in the living conditions of millions of Italian citizens. Furthermore, it is realistic to assume that without such a measure, it is likely that so many buildings would not have undergone this type of renovation in such a short period of time. However, it is important to consider that this number represents a small portion of the overall Italian residential stock, which amounts to 12 million homes[149], of which about 1.2 million are condominiums[150]. Therefore, it is easy to calculate that, as of August 2024, the Superbonus covered approximately 4% of the total Italian housing stock and about 11% of condominiums, likely reaching just under 10% of the total population. These are certainly very high numbers, but if approximately 120 billion euros were spent to reach these figures, then, with a rough calculation, it can be hypothesized that ten times that amount would be needed to renew the entire Italian residential stock, equivalent to more than half of Italy's GDP in 2023[151]. Additionally, it should be noted that this data refers to buildings that underwent interventions, but without specifying the type of interventions and the level of energy efficiency achieved. As already mentioned, there are numerous solutions for improving the energy efficiency of buildings, some more straightforward and cost-effective, others more complex and expensive, and the Superbonus covered them all. For this reason, it is very important to analyze what interventions were carried out and how they are distributed.

A very useful source for this purpose is provided by ENEA, in its Annual Report on Tax Deductions, the latest edition of which, unfortunately, is from 2023 and refers to 2022 data[152], as mentioned earlier. The report presents the results of the Superbonus in terms of the number of interventions carried out, covered surface area, cost, and resulting energy savings.

Interventions on building envelopes represent a significant portion of the total, with a total of 1,042,797 operations carried out. Among these, the insulation of vertical walls (PV) was particularly significant, with 222,889 interventions executed, accounting for approximately 21.4% of the total. This type of intervention covered a total surface area of over 54 million square meters, corresponding to 55.4% of the total surface area affected by interventions on the building envelope. In terms of energy savings, the insulation of vertical walls resulted in savings of 2,897 GWh/year, demonstrating

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[149] ISTAT. Censimento della popolazione e degli edifici. http://dati-censimentopopolazione.istat.it/Index.aspx?DataSetCode=DICA_EDIFICIRES

[150] Legambiente. Civico 5.0: Legambiente lancia la sfida per condomini più green. https://www.legambiente.it/comunicati-stampa/civico-5-0-legambiente-lancia-la-sfida-per-condomini-piu-green/

[151] ISTAT. PIL e indebitamento delle AP anno 2023. https://www.istat.it/comunicato-stampa/pil-e-indebitamento-delle-ap-anno-2023/#:~:text=Nel%202023%20il%20Pil%20aicresciuto%20dello%200%2C9%25.

[152] ENEA. Le detrazioni fiscali per l'efficienza energetica e l'utilizzo delle fonti rinnovabili di energia negli edifici esistenti: Rapporto annuale 2023 (Dati 2022). https://www.efficienzaenergetica.enea.it/pubblicazioni/rapporto-annuale-detrazioni-fiscali/le-detrazioni-fiscali-per-l-efficienza-energetica-e-l-utilizzo-delle-fonti-rinnovabili-di-energia-negli-edifici-esistenti-rapporto-annuale-2023-dati-2022.html

remarkable effectiveness relative to the costs incurred. Following this, interventions on dispersing ceilings and roofs (PO) were also significant, with 159,727 interventions accounting for 15.3% of the total, covering over 20 million square meters, corresponding to 20.5% of the total surface area. This type of intervention generated energy savings of 1,107 GWh/year, lower than that of wall insulation, but still important for energy efficiency.

Of particular interest is the replacement of windows, which was the most common intervention with 458,705 operations, accounting for 44% of the total interventions on the building envelope. However, these interventions affected a relatively smaller surface area, approximately 8 million square meters, 8.3% of the total surface area, and resulted in energy savings of 1,138 GWh/year. Despite their prevalence, the specific cost per square meter of these interventions was significantly higher compared to other types of work, suggesting that window replacement, while widespread, may not be the most efficient solution in terms of cost-benefit ratio.

Interventions on horizontal surfaces (PS - Floors) represented 6.7% of the total interventions with 70,356 operations, covering 7.3% of the total surface area. The energy savings achieved from these interventions amounted to 351 GWh/year, with a specific cost per square meter slightly lower compared to other interventions on the building envelope. Solar shading, divided into darkening closures and blinds/shutters, was less common, representing 9.4% and 7.8% of interventions, with a very small surface coverage (1.6% and 1.3%). Despite their limited but not irrelevant distribution, these interventions contributed modest energy savings, with relatively high specific costs, with shutters resulting in one of the interventions with the highest cost per KWh saved.

Technological systems also played an important role among the various interventions. Condensing boilers, with 161,567 interventions, and electric vapor compression heat pumps, with 198,059 interventions, were among the most common. Heat pumps, in particular, generated significant energy savings of 1,000 GWh/year, with a specific cost that, although high, reflects the high effectiveness of these technologies. In the renewable energy sector, photovoltaic systems stood out for their wide distribution, with 341,101 systems installed for a total peak power of over 2.1 million kW. This type of intervention made a substantial contribution to overall energy savings, despite the rather high specific costs per kWp, highlighting the growing importance of renewable energy sources in the Italian energy landscape.

The analysis reveals that, although window replacement was the most common intervention, interventions on vertical walls were the most extensive and potentially the most effective in terms of energy savings per square meter. This suggests that to maximize overall energy efficiency, a balance is needed between the spread of interventions and their surface area coverage. Technological systems, though less widespread in terms of the number of interventions compared to interventions on building envelopes, demonstrated a high potential for energy savings, justifying the higher investments required for their installation. In any case, among the various interventions, the combination of interventions on building envelopes and the adoption of advanced technologies like heat pumps and photovoltaic systems has proven to be the best solution in terms of energy savings.

This analysis has shown that, at least for the data up to 2022, the most common interventions are not always the most efficient in terms of energy savings, indicating that the potential that could have been achieved with this measure was not fully realized. However, it should be noted that this factor was influenced by the choices of individual citizens or condominium administrators regarding the types of interventions they wanted and could undertake.

Having now provided a broad overview, though with several limitations, of the measure's figures and the interventions carried out, we can approach the aspect of the results, both in terms of building improvements, energy savings, and emissions, albeit with the previously illustrated limitations. In this sense, it is very useful to consult another ENEA publication, the Annual Report on the Energy Certification of Buildings. The most recent edition is from 2023[153], which again reports 2022 data, so it must be considered only partially in the overall assessment.

A first consideration to report concerns the geographical distribution of interventions, a very interesting topic to address given the systematic differences between Italian regions, but one that could not be thoroughly analyzed here, though a useful insight will be provided. According to the report, the interventions were distributed across the entire national territory, with a higher concentration in colder climate zones; climate zone E indeed saw the highest number of interventions, followed by zone D. This is due to the higher heating needs in these areas, which makes energy retrofit interventions much more advantageous compared to warmer areas, suggesting that there were more interventions in the northern regions. To validate this hypothesis, the study published by the Chamber of Deputies at the end of May 2024 on the economic dimension of the Superbonus[154] is very useful, revealing that the region with the most work started is Lombardy (77,992 buildings for a total of over 21.8 billion euros in investments eligible for deduction), followed by Veneto (59,588 interventions and 10.9 billion euros in investments) and Emilia-Romagna (44,364 interventions already started and 11.3 billion euros in investments). These data suggest that a significant portion of the invested

[153] ENEA. Rapporto annuale sulla certificazione energetica degli edifici 2023. https://www.efficienzaenergetica.enea.it/pubblicazioni/rapporto-annuale-sulla-certificazione-energetica-degli-edifici/rapporto-annuale-sulla-certificazione-energetica-degli-edifici-2023.html

[154] ENEA. Rapporto annuale sulla certificazione energetica degli edifici 2023. https://www.efficienzaenergetica.enea.it/pubblicazioni/rapporto-annuale-sulla-certificazione-energetica-degli-edifici/rapporto-annuale-sulla-certificazione-energetica-degli-edifici-2023.html

resources and interventions were concentrated in regions that were already richer and more developed, likely contributing to the divide between the north and south of the country.

Additionally, a useful element to consider the immediate benefit of the Superbonus is the Energy Performance Certificates (APE), which provide all the information on how a building was constructed in terms of thermal insulation and energy consumption. According to the report, the number of APEs saw a significant increase, with over 13 million certificates issued in 2022. In detail, the percentage of APEs issued for energy retrofits increased from 41% in 2021 to 57% in 2022, demonstrating the effectiveness of the Superbonus in promoting significant energy improvement interventions. At the same time, the percentage of APEs issued for major renovations rose from 26% in 2021 to 41% in 2022, highlighting an increase in large-scale renovation projects. The introduction of the Superbonus thus contributed to the increase in the number of certified buildings registered in SIAPE (Information System on Energy Performance Certificates), the national tool for collecting APEs. The number of buildings certified and registered in SIAPE increased significantly, with about 5.4 million APEs issued by 2023, compared to 4.9 million the previous year, an increase of nearly 5%. This improvement will be visible primarily in the energy classes in which the homes are categorized.

According to the report, the buildings that benefited from the Superbonus showed a significant reduction in the percentage of buildings in the lower energy classes (F and G), with an increase in the more efficient classes (A4-B). In particular, the percentage of buildings in classes A4-B increased by about 5.1% for the residential sector and by 1.5% for the non-residential sector compared to 2022. This improvement is attributed to energy retrofit interventions, which led to the replacement of inefficient systems and the thermal insulation of buildings. Furthermore, certified buildings saw a significant increase in the higher energy classes (A4-B), with an improvement of 3.7% compared to 2022. The graph below illustrates in detail the changes between the various energy classes compared to the levels of 2019, using data from the 2020 report.

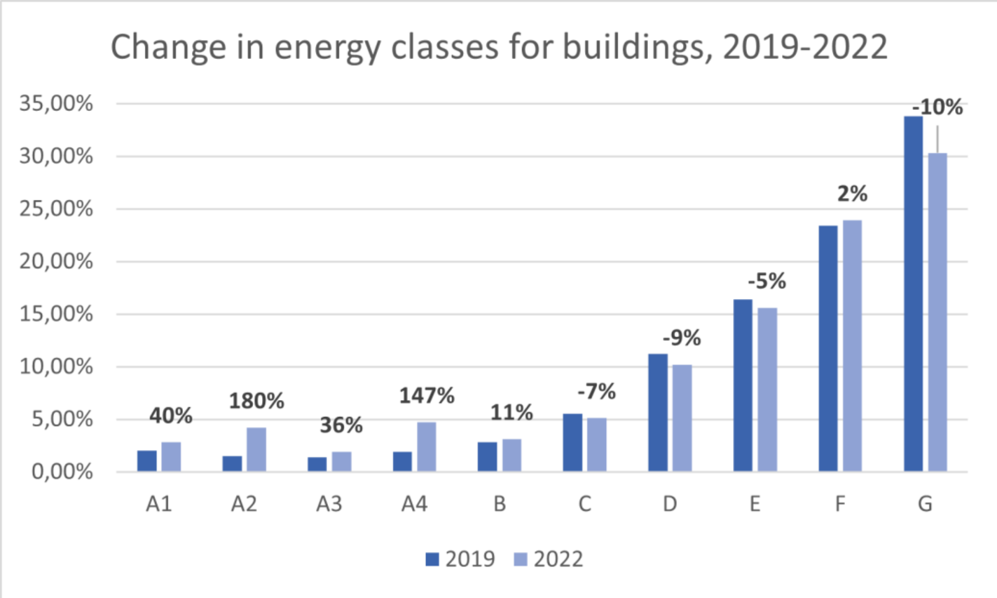

Figura 25: Changes in energy classes for buildings, Italy 2019-2022
Source: ENEA data elaboration, op. cit.

As the report already anticipated, and as can be deduced from the graph, it is evident that there has been a significant increase in buildings in the higher-performing categories and a noticeable reduction in those in the lower categories. However, the change has not been dramatic. By 2022, most buildings, nearly 70%, were still in the very low categories, from E to F, compared to 73% in 2019. In the intermediate categories, from B to D, the level remained almost unchanged, around 19%, indicating a gradual transition, while the share of buildings in class A, the most efficient, doubled from 6.80% to 13.60%. In short, there have certainly been positive effects in improving the energy classes, but the situation is still far from ideal, and many more efforts will be needed.

In terms of energy efficiency scores, the report cites the Global Energy Performance Index (EPgl), which indicates the annual consumption for heating, domestic hot water, and cooling in kWh per square meter. The report shows a decrease in the median EPgl values for certified residential buildings between 2018 and 2022. Specifically, the EPgl for residential buildings dropped from 192.55 kWh/m²/year in 2018 to 181.79 kWh/m²/year in 2022, a reduction of nearly 6%. Buildings that used the Superbonus saw a significant improvement in the use of non-renewable energy, with the EPgl,nren (non-renewable energy performance index) decreasing from 181.04 kWh/m²/year in 2018 to 165.20 kWh/m²/year in 2022 for residential buildings, almost 9%.

Another element provided by the ENEA tax deduction report, mentioned earlier, is the average cost borne by the state through the Superbonus for each kWh/year saved by each intervention. By calculating a weighted average of this cost across the various interventions, based on the number of interventions, we can obtain the average cost of each kWh saved, which turns out to be 8€/kWh/year. It is interesting to compare this data with the energy prices of recent years to understand the measure's cost-effectiveness. Referring to the ARERA quarterly data already used in the regression, it becomes clear that, roughly speaking, the cost per kWh/year is slightly lower than the average cost of the energy component alone, excluding transportation, system charges, and taxes, which are then borne by the consumer. It is necessary to point out that the cost of the energy component was calculated as an average over several years, including both recent ones from 2020 and the entire available period from 2004 to 2024, even excluding 2022 and 2023, which were characterized by highly distorting effects from the war in Ukraine. In short-term observations, the price per kWh is around €10, which rises to almost €20 when including 2022 and 2023, while in long-term observations, the price is nearly €9, rising to only €11.50 when including the two years in question, now diluted over a longer time horizon, and thus less impactful. Therefore, it can be concluded that, on average, the cost incurred to achieve energy savings, based on 2022 data, was slightly lower than the actual cost of the energy component, meaning that there was indeed an economic benefit from the savings, but it was very costly, with a low margin.

At this point, having analyzed the direct impact, albeit still presumed, of measures like the Superbonus, it is appropriate to move on to the indirect impact, that is, the trends that actually occur, in energy terms and beyond. Of course, the temporal limitations previously expressed must always be kept in mind.

The first element to be observed is the actual primary energy consumption, an index of energy efficiency, expressed in the following graph as a trend from 2013 to 2022 based on Eurostat data.

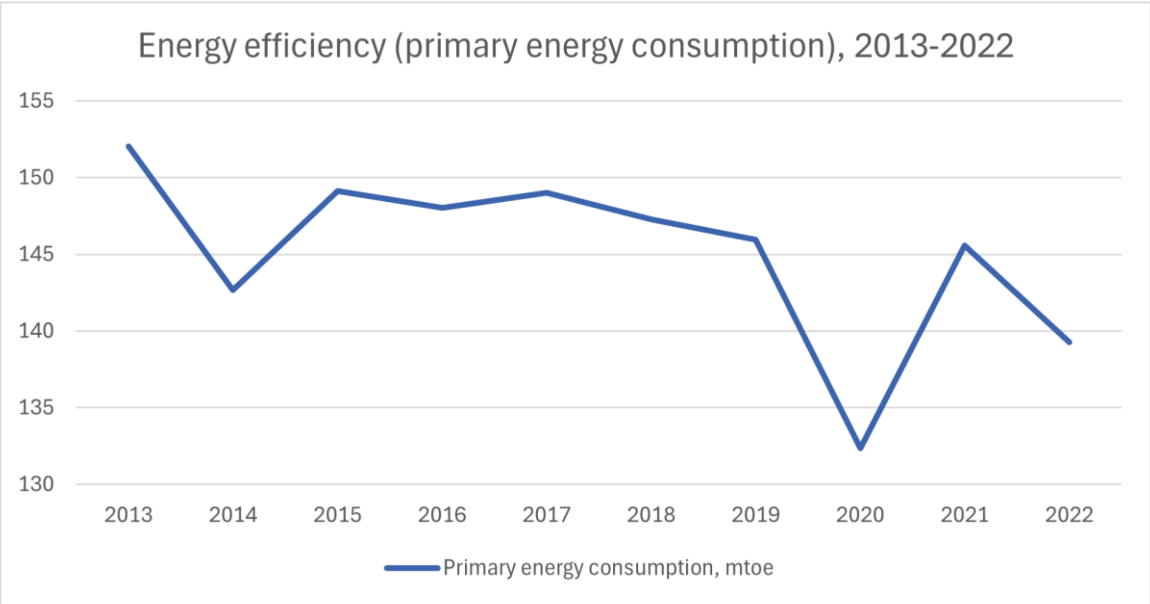

Figure 26: Energy efficiency (primary energy consumption), Italy 2013-2022
Source: Eurostat data elaboration

As you can see, with the exception of the peak in 2020, which can be attributed to the pandemic, there was a slight decrease in 2021 compared to 2019 levels, while the drop was much more significant in 2022. However, as mentioned earlier, it is not certain whether this can be attributed to the initial work carried out or the impact of the energy crisis, which influenced consumption. In any case, this data is attributed to all sectors, so it is not immediately representative of the situation in buildings, as the next graph is, which illustrates the final energy consumption in homes between 2015 and 2022.

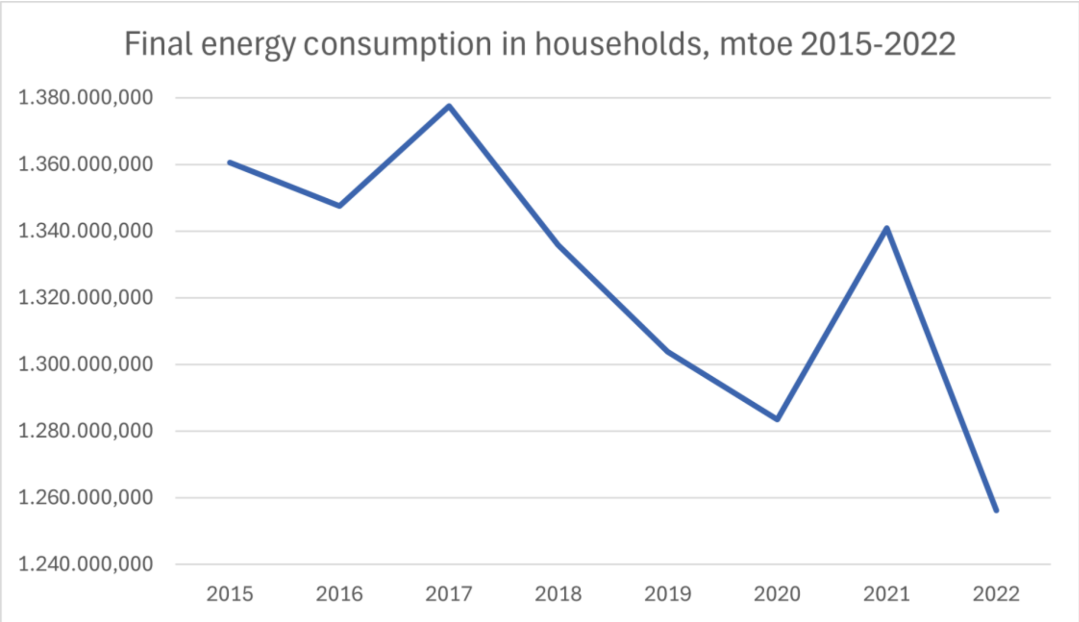

Figure 27: Final energy consumption in households, Italy 2015-2022
Source: Eurostat data elaboration

In this case, too, there is a trend indicating a reduction, but much more pronounced, both in the decline and in the peak of 2021, likely due to the post-pandemic rebound effect. The year 2022 also shows a significant decrease, but doubts remain about the reasons behind this decline.

Going even further into detail, the following graph illustrates, using data from the Odyssee-Mure database, the actual energy savings derived from homes, both as absolute savings and as year-on-year variation.

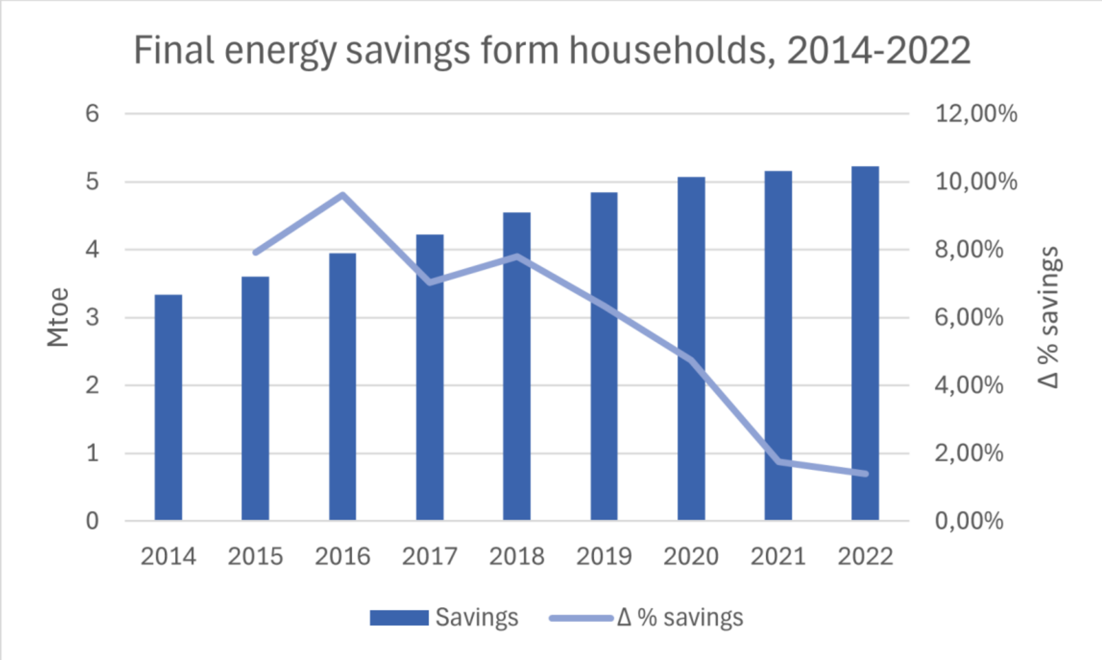

Figure 28: Final energy savings from households, Italy 2014-2022
Source: Odyssee-Mure data elaboration

In this case, what clearly emerges is that the level of energy savings, although growing over the years, saw the pre-pandemic years as the most significant, while the more recent years, which are of interest here, experienced more modest increases in savings. It would certainly be interesting to investigate this trend further, but the limited data and the significant impact of exogenous factors prevent the clear identification of a single cause. Despite this, a study conducted by Censis in 2022[155] provides an interesting insight. According to the study, the investments made in these two years have generated energy savings that can be estimated at nearly 11,700 GWh/year, equivalent to about 1 mtoe, thus contributing significantly to the overall savings, which, according to the Odyssee-Mure data represented above, have oscillated between 4 and 5 mtoe per year on average in recent years.

At this point, since there have indeed been energy savings, it is important to consider how they have impacted the environment, particularly in terms of CO2 emissions. The following graph shows the average emission level per Italian household caused by heating and appliances, thus from the use of energy in homes, in the years between 2019 and 2022.

[155] Censis. Superbonus: Rapporto Censis. https://www.censis.it/sites/default/files/downloads/4_Censis Superbonus_def-ok.pdf

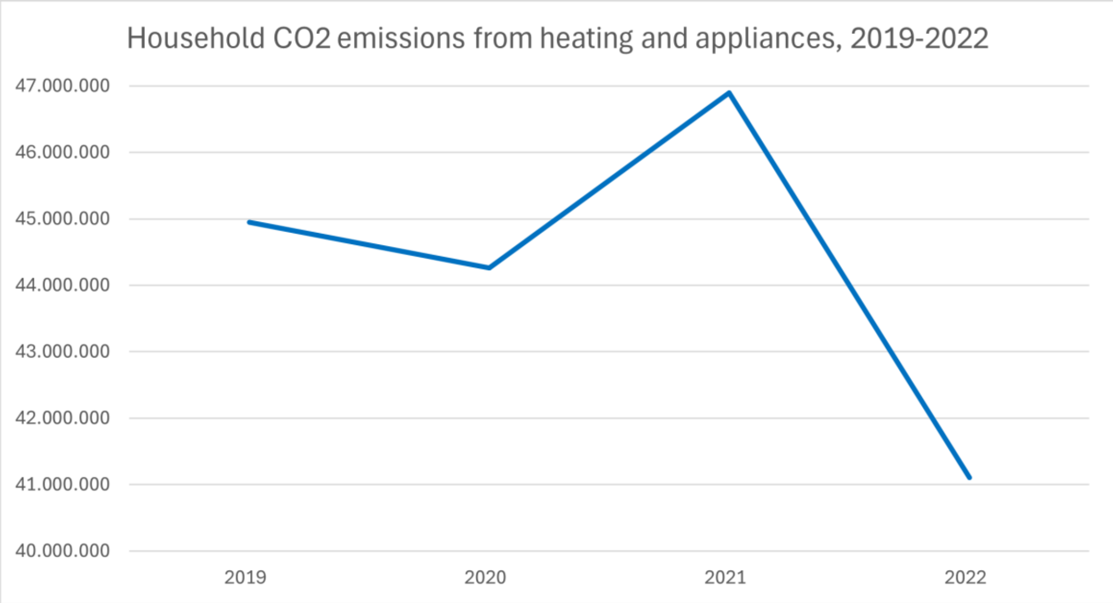

Figure 29: Families CO2 emissions from heating and appliances, Italy 2019-2022
Source: ISTAT data elaboration

In this case, we can observe a significant reduction in emission levels during 2022, despite a sharp increase in 2021, which is also likely attributable to the economic rebound and, consequently, to increased consumption. The reduction in emissions is significant, particularly over 12% in 2022. Identifying the exact cause is complex, but the previously mentioned ENEA report on the energy performance of buildings provides an interesting insight. According to the report, buildings that benefited from Superbonus interventions saw a reduction in CO2 emissions due to the increased use of renewable energy sources and the efficiency of the installed systems. In the residential sector, average CO2 emissions decreased from 35.58 kg/m²/year in 2018 to 33.23 kg/m²/year in 2022. Therefore, it can be understood that, although the impact of the Superbonus is difficult to determine with certainty, the measure has brought environmental benefits, albeit modest. The reduction in question is, in fact, 6.6%.

These numbers contrast sharply with the statements made by former Prime Minister Conte, who defended the effects of the Superbonus, citing a 50% cut in CO2 emissions, referencing an analysis published by a Nomisma observatory[156]. Nomisma is a company that provides consulting and market research services for businesses, associations, and public institutions, but it also has a potential conflict of interest with the building bonuses: among its services, it offers some to help citizens and companies benefit from the Superbonus[157]. Furthermore, Nomisma's estimates were not published in a proper study but rather in a press release, which stated that with the Superbonus, buildings would

[156] Nomisma. Superbonus: Comunicato stampa. https://www.nomisma.it/press-area/superbonus-nomisma-comunicato-stampa/

[157] Pagella Politica. Conflitto d'interessi e benefici del Superbonus. https://pagellapolitica.it/articoli/conflitto-interessi-benefici-superbonus

have achieved a 50% reduction in CO2 emissions and that the total reduction in CO2 emissions in the atmosphere was estimated at 1.42 million tons. Even assuming that this estimate was true, and we've seen the data suggest otherwise, it refers to a reduction equivalent to 0.5% of the CO2 emissions produced in a year by Italy, which is still a very modest result.

A final aspect to consider when trying to understand the benefits of this measure is one of the primary arguments presented in support of energy efficiency, namely savings in energy costs, and thus for households. The following graph illustrates the average expenditure per household between 2019 and 2022, both in absolute terms and adjusted to an index based on €100 of monthly income, to provide a more general index for the entire population that is not influenced by actual income levels.

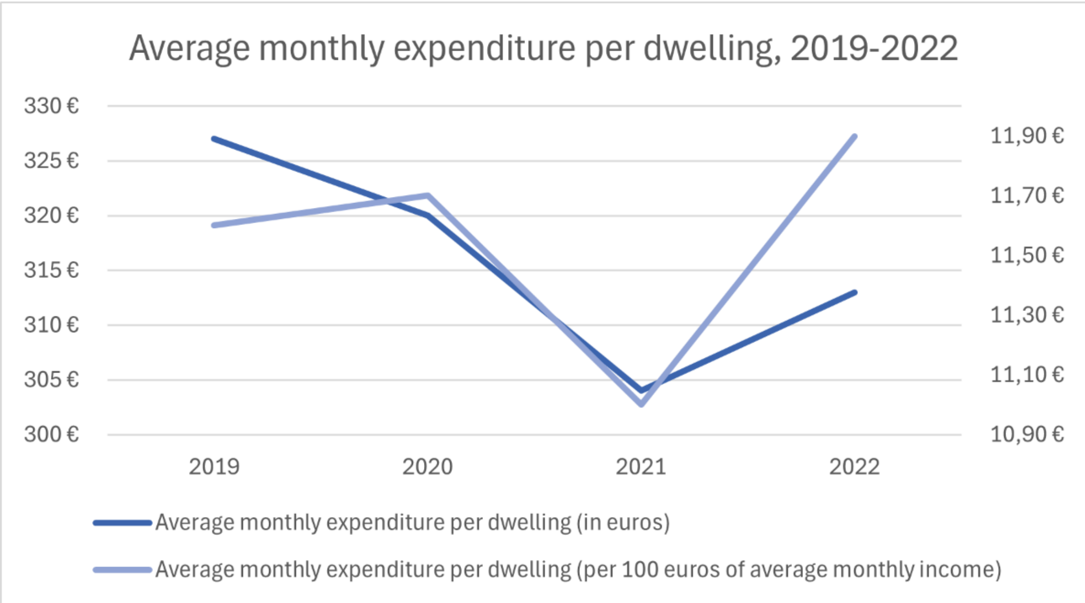

Figure 30: Average monthly expenditure per dwelling, 2019-2022
Source: ISTAT data elaboration

In this case, what emerges from the graph is very clear, namely that in 2022 the costs for households increased significantly, and it is implicit that the impact of the energy crisis played a fundamental role. Unfortunately, even in this situation, we are unable to understand how much the Superbonus might have potentially mitigated the effects of these increases, for the reasons already explained.

3.1.3 Conclusions of the benefit analysis

Attempting to summarize, conclude, and understand the benefits brought by the Superbonus—the first step of the cost-benefit analysis—a clear picture emerges within its uncertainty. The available data do not sufficiently cover the complete and more recent application of the Superbonus, which saw its peak in the initiation of works in the last year for which data is available, the same year when, due to the war in Ukraine, energy prices saw an increase across Europe, with a considerable impact on consumption.

What is certain is that the Superbonus recorded a very high number of adherences, probably with few precedents, and undoubtedly contributed to the improvement of Italy's energy performance, even though the exact benefits are not calculable at this time. Despite this, the results so far suggest that the benefits, while present, were still limited, not revolutionary, raising questions about the resources used. Similarly, it is currently impossible to compare with other European countries to understand whether the success of this measure can also be found in countries that have not implemented similar provisions and to determine whether the Superbonus has generally improved Italy's position relative to the rest of Europe.

The limitations of this analysis are therefore manifold, due to both temporal proximity and the presence of distorting exogenous factors, as well as the availability of data. For this reason, in the coming years, it will be crucial, with the presence and availability of more data and a long-term trend that allows for the stabilization of exogenous factors, to attempt to repeat this type of analysis, including a comparison with other European countries and a deeper examination of the energy savings achieved by the measures.

For the purposes of this analysis, the next step will be to shed light on the costs incurred for this measure. Thus, the focus will shift to a more economic field, analyzing both the direct and indirect costs—and benefits—such as the impact on the country's economy.

3.2 Analysis of costs and economic impact

As previously mentioned, this paragraph is dedicated to the cost side of the overall cost-benefit analysis and aims to understand not only the direct cost of the measure, which is easily calculable and already anticipated, but also to analyze the entire economic impact caused by the Superbonus in all its positive and negative effects. It could certainly be argued that the positive impacts should have been analyzed earlier along with the benefits, rather than in this section. However, since the focus of this research is on the impact of the Superbonus on the energy efficiency of buildings, it was deemed more coherent to include only the energy-related benefits in the benefits section and to keep the economic ones in the costs section, in order to clearly distinguish between the two sides of this issue, facilitating the analysis.

To carry out this analysis, we will start by examining the costs incurred, their financing, and their impact on public finances. Secondly, we will analyze the macroeconomic impact of the measure, specifically on the entire country system, and a final section will be dedicated to a deeper examination of the increase in costs caused by the interventions, a topic deserving separate treatment due to the importance of the inflationary aspect in the entire analysis.

As of August 31, 2024, according to ENEA data, the total investments eligible for deduction amounted to €116,962,233,649.00, which is almost 120 billion euros, a very high amount and greater than initially estimated. Initial estimates, in fact, developed by the State General Accounting Office, predicted that the Superbonus would have an impact on public finances of about 35 billion euros by 2035[158]. Initially, it was planned that the implementation would be supported by both national and European resources. The Government had initially allocated 145 billion euros through the "Decreto Rilancio." Subsequently, the National Recovery and Resilience Plan (PNRR) supplemented these resources with 139.5 billion euros and with another 45.6 billion from the Complementary Fund, for a total of 185.1 billion euros of European funds[159]. Overall, adding up national and European resources, the budget allocated for financing the Superbonus amounted to 333 billion euros. However, these predictions turned out to be largely underestimated.

Over time, estimates were continually revised and significantly increased. In 2023, the Economic and Financial Document (Def) indicated a total cost of the Superbonus at 67 billion euros. Just three months later, the Def Update Note (Nadef) updated this figure, raising it to over 81 billion euros. This represents an increase of 45 billion compared to the initial estimates by the State General Accounting Office, a figure that equates to almost twice the last financial maneuver. In 2024, Istat certified a further worsening of the deficit, attributing almost 40 billion euros of increase over the forecasts to the weight of the Superbonus and building bonuses in general. This situation is reminiscent of what happened with the facade bonus, initially estimated at less than 6 billion euros, but over three years, its cost rose to over 20 billion[160]. Between 2020 and 2023, the combined weight of these incentives had a comparable impact on public finances as about five Budget Laws.

The burden of the Superbonus and other building bonuses will not end in the short term. Until 2026-2027, it is expected that many tax credits will expire, with the Ministry of Economy having to manage an increase in public debt of at least 22 billion euros per year. Initial estimates spoke of a total expenditure of 40 billion euros, but the tax credits generated by all the building bonuses were much higher. It is estimated that about 165 billion in tax credits were created (135 billion from the 110% Superbonus and the facade bonus, and 30 billion from other incentives), of which only 25

[158] Today. Superbonus: Costo e benefici, previsioni 2024. https://www.today.it/economia/superbonus-costo-benefici-previsioni-2024-quanto.html

[159] Agenzia delle Entrate. Gli immobili in Italia 2023, Capitolo 6. https://www.agenziaentrate.gov.it/portale/documents/20143/5327584/Gli+immobili+in+Italia_2023_cap_6.pdf/26017dd9-6f0d-725b-e21a-06ef8e77762e#page=30

[160] Today. Superbonus: Costo e benefici, previsioni 2024, *op. cit.*

billion have been compensated so far. Therefore, 140 billion in credits remain to be compensated in the coming years[161].

These amounts are of excessive magnitude and unprecedented or unparalleled for this type of measure. Indeed, as also stated by the Minister of Economy and Finance, Giorgetti, the Superbonus is the most generous incentive in Europe for home renovations. And although in other countries there are similar measures with significant deduction percentages, even up to 70 or 80%, most provide for a maximum deductible amount[162]. This highlights a significant difference with the Italian measure, which did not provide for this type of limit, except through the theme of fiscal capacity, which could be nullified through the transfer of credit, making the adherence to the measure potentially unlimited in financial terms.

It is clear that this last concept—a potentially unlimited adherence—implied a potential exponential increase in the resources to be allocated for tax deductions, a significant problem for the tax authorities. It would be wrong to think that since these are deductions, they do not represent an outflow of cash and therefore the problem would be contained as they then turn out to be a missed revenue, which for a state without a budget surplus implies having to find resources elsewhere to support the other expenses it must guarantee. And obviously, as in any case, these resources are gathered on the private market, that is, through an increase in public debt. But if the resources allocated from the beginning were not able to cover the planned interventions, then the consequences of potentially intensive recourse to indebtedness were certainly not evaluated with a cautious approach. It is certainly also understandable that at the time of adopting the measure, at the end of the first pandemic phase and immediately after the announcement of the 700-billion-euro Next Generation EU fund for the hardest-hit countries[163], the government thought it would have no problem accessing further funding and that there would be no serious consequences. But obviously, this can almost never be true.

The increase in debt financing linked to the Superbonus has indeed had a significant impact on Italian public finances, with projections and evaluations highlighting a worrying growth in public debt. According to estimates by the Parliamentary Budget Office, the total impact on public debt for the three-year period 2024-2026 could be around 1.8% of GDP, equivalent to about 170 billion

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[161] Sky TG24. (2024, February 14). Superbonus 110%: Costo. https://tg24.sky.it/economia/2024/02/14/superbonus-110-costo

[162] Pagella Politica. Confronto del Superbonus in Italia e in Europa. https://pagellapolitica.it/articoli/superbonus-confronto-italia-europa

[163] Wikipedia. Next Generation EU. https://it.wikipedia.org/wiki/Next_Generation_EU

euros[164]. This increase is mainly due to the need to finance the high cost of tax incentives, which, as mentioned, exceeded initial forecasts. The Italian Public Accounts Observatory also highlighted how the Superbonus caused an additional deficit, further worsening the country's financial situation. The measure has indeed led to an extra deficit of about 40 billion euros, with a consequent increase in public debt that could reach critical levels in the coming years. The slowdown in the implementation of debt containment measures, combined with growing uncertainty on the macroeconomic front, could further exacerbate the situation[165]. According to a study by InfoBuild, the cost of the Superbonus represents one of the most significant items in the public budget in recent years, contributing significantly to the increase in deficit and public debt[166].

Finally, from an external point of view, it is important to note that Fitch, one of the leading rating agencies, has expressed an even more pessimistic view. According to Fitch, the increase in public debt resulting from the Superbonus could be underestimated, with a potential increase in the risk of deterioration of Italy's sovereign rating. The agency stressed that although the government has taken measures to reduce the impact, the effectiveness of these actions remains uncertain, and public debt could continue to grow at alarming rates[167].

One could certainly argue that any active government measure to intervene in the economy must be financed by debt, and that this debt can be easily repaid with the tax revenue generated by the economic growth caused by such interventions, thanks to the so-called Keynesian multiplier. This is one of the positions often supported by Giuseppe Conte, Prime Minister of the government that introduced the measure, who stated that the Superbonus would have so far brought in about 140 billion euros more in revenue for the State, thus almost offsetting all the expenses[168]. Moreover, in the first years of the measure's operation, some studies supported the same thesis, conducting analyses on the impact of the measure on the entire economic and productive system, such as the already mentioned study by Nomisma, according to which the overall economic impact of the 110% Superbonus on the national economy was 195.2 billion euros, with a direct effect of 87.7 billion, 39.6 billion of indirect effects, and 67.8 billion in induced effects. Additionally, the same Nomisma study

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[164] La Stampa. (2024, April 19). Superbonus: Impatto sul debito. https://finanza.lastampa.it/News/2024/04/19/superbonus-upb-impatto-debito-+1-8percento-nel-triennio-2024-26-conto-pari-a-circa-170-miliardi/NzlfMjAyNC0wNC0xOV9UTEI

[165] Osservatorio CPI. Post-mortem per il Superbonus: Extra deficit, extra debito e rallentamento in atto. https://osservatoriocpi.unicatt.it/ocpi-pubblicazioni-post-mortem-per-il-superbonus-extra-deficit-extra-debito-e-rallentamento-in-atto

[166] Infobuild. Superbonus 110%: Impatto sul deficit e costo per lo Stato. https://www.infobuild.it/approfondimenti/superbonus-110-impatto-deficit-costo-stato/

[167] Build News. Superbonus: Aumento del debito pubblico secondo Fitch. https://www.buildnews.it/articolo/superbonus-aumento-debito-pubblico-fitch-piu-pessimista-del-governo

[168] YouTube. Video di Sky TG24: Superbonus 110%. https://www.youtube.com/watch?v=XAbfxiKh-ns&t=488s

reported an analysis by the National Council of Engineers (CNI) dating back to 2021, which found that the deficit for state finances would be offset by the increase in GDP. According to the study, the measure could have been considered sustainable over a period of 4 or 5 years, during which, based on previous experiences, the demand for renovations and energy efficiency interventions in buildings could have remained high, generating further positive effects on the economy.

However, in verifying this information, especially over time, the situation appears to be quite different. Firstly, regarding Conte's statements, it is useful to report an article by Pagella Politica[169], an independent Italian fact-checker active for almost 15 years, which analyzes in detail Conte's claims, firmly contesting them as exaggerated and lacking in foundation in official data.

The article reports that during the period between 2020 and 2023, tax revenues in Italy actually increased from 446.8 billion euros to 568.5 billion euros, by about 120 billion. However, this increase cannot be attributed entirely to the Superbonus. For example, in 2021, part of the increase in revenue was due to the payment of taxes suspended in 2020, while in 2022, other taxes, such as those on gambling, saw an increase independent of both the economic situation and the Superbonus. Even in 2023, the increase in revenue was influenced by fuel excise duties, contributing to the overall result without a direct correlation to the Superbonus.

Moreover, to shed light on the actual impact, the article reports a calculation made by the Revenue Agency in a simulation according to which the total revenue generated by the Superbonus between 2021 and 2022 amounts to 19% of the expenditure incurred, equal to about 23 billion euros, a figure far lower than the 140 billion claimed. The article also analyzes the estimates by Censis, which hypothesized a recovery of 70% of the Superbonus expenditure in state coffers, which are criticized for being excessively optimistic and overestimated. Censis indeed attempted to quantify the multiplier effect of the Superbonus by trying to estimate the value of production activated by related investments, but ended up overestimating the tax revenue by more than double compared to the actual reality. Additionally, it is also worth noting that earlier in this analysis, the issue of Nomisma's conflict of interest concerning the Superbonus was highlighted, as well as the fact that only a press release was published and not the full study, making it a less reliable source.

Although what is reported in the article is clear and straightforward, it is interesting to delve into the study by the Revenue Agency[170] along with other authoritative sources to better understand the actual impact of the measure. In the simulation conducted by the Revenue Agency to assess the

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[169] Pagella Politica. Dichiarazioni di Conte sul Superbonus: 140 miliardi di gettito. https://pagellapolitica.it/articoli/conte-superbonus-140-miliardi-gettito

[170] Agenzia delle Entrate. Gli immobili in Italia 2023, Capitolo 6. https://www.agenziaentrate.gov.it/portale/documents/20143/5327584/Gli+immobili+in+Italia_2023_cap_6.pdf/26017dd9-6f0d-725b-e21a-06ef8e77762e#page=30

impact of the Superbonus on GDP, employment, and public finance aggregates, tax revenues showed an estimated increase of 11% in the first two years, with a cumulative variation of 16.2% expected by 2030. By comparing this absolute increase in revenue to the total cost of the measure, estimated at 37.6 billion euros, a coverage of 19.24% of the expenditure in the first two years cited by Pagella Politica is obtained, a percentage that then rises to 28.75% at the end of the reference period.

The economic analyses carried out using the CGE model (general economic equilibrium model) highlighted two significant results. On the one hand, from an economic perspective, the Superbonus had an expansionary effect, contributing to the increase in production and employment. On the other hand, in terms of public finance, the measure was not neutral regarding tax revenue, resulting in a significant increase in the public deficit, equal to 80% of the total expenditure in the 2021-2022 biennium. Extending the analysis to the entire period up to 2030, the deficit stands at 71% of the total expenditure. In summary, according to the study, while the Superbonus generated positive effects in terms of economic growth and employment, it also led to a significant increase in the public deficit, with partial coverage of costs through increased tax revenue.

Undoubtedly, the macroeconomic studies carried out using these systems are currently the most valid and, depending on the executor, reliable methods for evaluating the impact of the measure on the economic system. In this light, an interesting and recent study conducted by the Bank of Italy, an authority in economic analysis, published in the June 2024 edition of "Economic and Financial Issues"[171] is reported.

The research conducted revealed that the two fiscal measures, the facade bonus and the 110% Superbonus, active since 2020, resulted in a cost to the Italian state exceeding 170 billion euros between 2021 and 2023, corresponding to about 3% of annual GDP. Despite the substantial investment, the overall economic impact may be considered less significant than expected. Indeed, even considering the economic benefits deriving from the activity induced by the bonuses, the net cost to the state coffers is estimated at about 100 billion euros.

One of the major positive effects was recorded in the construction sector, where incentives accounted for about three-quarters of the increase in added value between 2020 and 2023. However, the impact on other sectors of the economy was limited. A detailed analysis suggests that over 45 billion euros of work would have been carried out even in the absence of the incentives, highlighting a "deadweight loss" equal to about a quarter of the total expenditure. This aspect contributed to reducing the effectiveness of the bonuses, causing the fiscal multiplier to be less than one. In other

[171] Banca d'Italia. (2024). Quaderni di economia e finanza 860. https://www.bancaditalia.it/pubblicazioni/qef/2024-0860/QEF_860_24.pdf

words, GDP grew less than the state spent to finance the two bonuses. Istat estimated that the real additional growth of GDP attributable to the expenses related to the 110% Superbonus and the facade bonus varies between 1.4 and 2.6 percentage points, highlighting a significant contribution of residential construction investments to the economic growth of the past two years, equal to two percentage points. However, the research emphasizes that without the incentives, a significant portion of these investments would have been carried out anyway, which diminishes the overall effectiveness of the measures.

It is important to note that the study did not consider other relevant aspects of the Superbonus, such as environmental benefits, the increase in housing prices and the construction sector, nor the complexities related to the transfer of credit. These factors may further influence the overall analysis of the Superbonus's effects on the Italian economy and will indeed be addressed later.

The archive of the Budget, Treasury, and Planning Commission provides another useful element of evaluation, namely the hearing as part of the fact-finding investigation into the macroeconomic and public finance effects resulting from the fiscal incentives in the construction sector, conducted by Dr. Pietro Tommasino of the Bank of Italy's Economic Structure Service in March 2023[172], one year before the Bank of Italy study just cited.

According to Dr. Tommasino's testimony, in recent years, the construction sector has made a significant contribution to economic growth, thanks in particular to the strengthening of construction incentives. However, the cost of these incentives for public finances has been significant, despite involving only a small part of the national real estate assets. Preliminary analyses indicate that in the 2021-2022 biennium, the additional expenditure due to the strengthening of the bonuses represented almost half of the total value of investments that benefited from such incentives.

In addition to the direct effect of increased investments, there was a multiplier effect resulting from the activation of aggregate demand and the increase in employment. According to assessments based on the elasticities incorporated in the Bank of Italy's econometric model, the multiplier associated with the increased spending on construction could be greater than one, in line with that typically associated with public investments. However, the multiplier associated with the public resources used to finance "substitute" interventions, meaning investments that would have been carried out even in the absence of the incentive, is lower. These considerations suggest that although the overall multiplier may approach one, the precise assessment of the measures' effects is complicated by various factors that tend to diminish their impact.

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[172] Camera dei Deputati. Audizione della Banca d'Italia sugli incentivi fiscali edilizi. https://www.camera.it/application/xmanager/projects/leg19/attachments/upload_file_doc_acquisiti/pdfs/000/008/482/03_BANCA_D_ITALIA_Audizione_incentivi_fisc_edil.pdf

The overall impact on public finances of the facade bonus and the Superbonus has been subject to variations over time, both due to regulatory changes and the increased demand for incentives, which turned out to be more intense than initially expected. The expansion of deductions and changes in the methods of use, including the possibility of transferring credits to third parties, further stimulated the demand for work in the short term. Additionally, the renovation work facilitated by the Superbonus contributed in part to the ecological transition.

However, as repeatedly emphasized previously, these incentives entail a high cost for public finances, which must be considered in light of the lower impact of this type of investment on productivity and long-term economic growth compared to possible alternative uses. Deductions with rates equal to or greater than 100% can also inflate costs, as taxpayers, not participating in the expenditure or participating only to a limited extent, have no interest in containing them. In fact, the cost of interventions turned out to be much higher than initial estimates, confirming the problems related to the transparency of the sums actually allocated and the control of public accounts connected to the use of tax credits as a fiscal policy tool. Although the fiscal multiplier of the intervention was relatively high but not greater than one as hoped, it was probably not sufficient to make the measure free from negative impact on the economic account of public administrations.

While most of these analyses carried out by renowned and expert Italian research centers quantify the multiplier effect of this measure as close to but less than one, a much more negative opinion is given by the International Monetary Fund, which, according to an article in Il Sole 24 ORE, defines it as a "mini-multiplier" with a value of 0.3, meaning that it managed to create 30 new cents of GDP for every euro of public spending incurred[173].

Another authoritative testimony worth mentioning in this thesis is that of Pio Silvestri, Attorney General at the Court of Auditors, who during his requisition at the hearing of the Joint Sections on the Judgment of Parification of the General State Account for the 2023 financial year[174], highlighted how the various building incentives in Italy, although they contributed to the economic recovery and the improvement of buildings, were accompanied by serious problems. In particular, Silvestri pointed out the presence of fraud and undue perceptions, especially in relation to the Superbonus, which had very negative consequences on the state budget. Originally conceived for interventions to be carried out by December 31, 2021, the Superbonus measure was progressively extended, causing increasingly difficult-to-control effects on the public budget. This expansion of objectives and repeated extensions

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173 Il Sole 24 Ore. (2024). Conti pubblici: Niente aumenti del debito previsti per il 2024. https://24plus.ilsole24ore.com/art/conti-pubblici-oggi-piano-niente-aumenti-debito-2024-AF9gN0wD

174 Italia Oggi. (2024, June 27). Superbonus: Ricadute assai negative sul bilancio dello Stato. https://www.italiaoggi.it/news/superbonus-la-corte-dei-conti-ricadute-assai-negative-sul-bilancio-dello-stato-202406271154022378

of deadlines led to an increase in spending far beyond initial forecasts. The negative effects of these measures on public finances reached significant dimensions, aggravated by the spread of fraudulent behavior that further amplified the financial impact of the measure. Silvestri also noted that the imbalance of burdens related to the Superbonus was a determining factor in the initiation of the excessive deficit procedure by the European Commission against Italy. Finally, he highlighted how the credits related to the Superbonus from previous years to 2024 are considered payable credits, causing a significant and growing impact on the public administrations' deficit, further worsening the country's financial situation.

As anticipated, however, the economic impact of such a measure does not end exclusively with the effect on public finances and the multiplier effect for the economy, even if this has not occurred. Rather, one must also consider the effect caused on the price level. As has now been well clarified, the introduction of the Superbonus had a significant impact on the Italian economy, especially in the construction sector. Although the measure aimed to stimulate the recovery of the sector and, more generally, the entire system, it also had significant consequences in terms of inflation and increased raw material costs.

A first alarming figure concerns the increase in construction material prices, fueled by the high demand generated by the Superbonus. According to ANSA, the spending ceilings for interventions covered by the Superbonus were revised upwards by 20% precisely to account for the increase in raw material costs and inflation[175]. This adjustment was due to the need to adapt the spending ceilings to new market costs, influenced by strong demand and reduced material availability, partly due to the crisis in global supply chains.

However, the cost increase is not limited to materials but extends to the overall cost of renovation work. An article in Wired highlights that the initiative generated a domino effect, driving up costs in the construction sector in general. In particular, the increase in material prices led to a 30% increase in the total cost of work compared to pre-Superbonus prices. This factor can be easily understood due to the effect of 110% deductions, as it disincentivized the client—since there was no actual outlay on their part—from negotiating with the builder and suppliers, who were able to raise prices without problems. However, the increase in raw material prices and construction costs had significant repercussions on construction companies themselves[176]. As reported by InfoBuild, many

[175] ANSA. (2022, February 14). Superbonus: Massimali del 20% per costi materie prime e inflazione. https://www.ansa.it/sito/notizie/economia/2022/02/14/superbonus-massimali-20-per-costi-materie-prime-e-inflazione_f2840d86-21e6-462e-9c27-2e7c31a09464.html

[176] Wired Italia. Superbonus 110%: Il costo dell'edilizia secondo Draghi. https://www.wired.it/article/superbonus-110-costo-edilizia-draghi/#:~:text=Cifra%20che%20si%20ottiene%20sottraendoil%20costo%20effettivo%20dei%20lavori

companies found it difficult to obtain the materials needed to complete the work already underway. The price increase reduced profit margins, making it more difficult to honor contracts signed earlier when prices were lower. Some companies had to renegotiate contracts, while others suffered significant economic losses. This context put pressure on the sector, with repercussions on the financial sustainability of many small and medium-sized enterprises. Finally, according to an analysis by Immobilgreen, the Superbonus also contributed to a distortion of the real estate and construction market. The sudden increase in demand for construction work led not only to a spike in raw material costs but also to an increase in lead times for material procurement and project completion[177]. These delays further aggravated the difficulties of companies already struggling with price hikes. The combination of inflation, rising costs, and delays thus created a complicated scenario for companies, which found themselves navigating an increasingly uncertain and burdensome economic environment.

Therefore, although the Superbonus undoubtedly stimulated the economy and the revenues of construction companies, it also exacerbated inflationary pressures and created significant difficulties for the companies themselves, which faced rising costs and greater complexity in project management. Once some of the most authoritative opinions and studies of the most expert entities in economic matters, which have allowed a rather clear picture of what the economic impact of the Superbonus has been, have been analyzed and understood, a very different picture emerges from that presented by some lower-level studies and the measure's proponents.

Trying to summarize these analyses briefly, it can be stated that the Superbonus had a significant impact on the Italian economy, characterized by high costs and a substantial increase in public debt. Although it stimulated economic growth and the construction sector, the total cost of the measure far exceeded initial estimates, worsening the deficit and increasing public debt to worrying levels. Estimates indicate that the overall impact of the Superbonus could contribute to a debt increase of up to 18% of GDP by 2026, with an increase of about 170 billion euros. Moreover, the effectiveness of debt containment measures remains uncertain, and the risk of further deterioration of the sovereign rating is high. Despite the observed economic benefits, which are still limited, the overall effect of the Superbonus on public finances has been negative, with costs exceeding the fiscal benefits generated.

In the next chapter, the critical issues in the implementation of the entire measure will be further analyzed to understand what some of the technical problems of the measure were, both inherent in it

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[177] Infobuild. Superbonus e l'aumento dei prezzi dei materiali edili. https://www.infobuild.it/approfondimenti/edilizia-superbonus-aumento-prezzi-materiali-edili/

from its design and arising later, as well as some policy proposals to avoid similar problems with analogous measures in the future.

3.3 Critical Issues in the Implementation of Incentives

As just mentioned, this paragraph will be dedicated to the analysis of the critical issues in the implementation of the Superbonus, that is, the problems that arose with the launch of the incentives, generated both by the measure's own shortcomings and by changes both to the measure and the external environment that occurred over time, with the aim of also suggesting some improvement proposals for similar measures to be carried out in the future.

Two main topics will be analyzed and discussed in this paragraph, namely the issue of fraud related to the bonus in question and the connected issue of credit transfer, which extends a bit to the panorama of building incentives already illustrated in the previous chapter.

The issue of fraud related to the Superbonus and building bonuses represents a critical and worrying aspect in the context of the fiscal incentive policies promoted by the Italian government. According to data released by the Revenue Agency, frauds linked to these incentive tools amount to about 15 billion euros, a figure that highlights not only the magnitude of the problem but also the complexity of the situation, according to the statement of the Revenue Agency director, Ernesto Maria Ruffini. This figure emerged during a hearing before the Senate Finance Commission on April 16, 2024, where Ruffini explained that of these 15 billion, 8.6 billion were preventively seized by the judicial authority, while 6.3 billion were discarded from the credit transfer platform.

The detected fraud methods were diverse and numerous. Some fraudsters created fictitious tax credits for non-existent work, while others took advantage of the lack of attention or complicity of other subjects to use these credits in paying taxes. Among the various elements, the mechanism of tax credit transfer and invoice discount undoubtedly opened the way for the most fraud; the frauds indeed manifested primarily through the creation and transfer of false tax credits. Specifically, some subjects transferred credits for construction work never carried out, exploiting the possibility of obtaining immediate liquidity or reducing the tax burden. Ruffini, however, pointed out that not all tax credits subject to fraud were actually used to pay less tax; in many cases, the fraud was discovered before the credits could be exploited.

Another critical aspect concerned the infiltration of organized crime into the construction sector, which exploited regulatory loopholes and the complexity of bureaucratic procedures to perpetrate large-scale fraud. Criminal organizations often acted through fictitious companies that claimed to have carried out work never done or incurred expenses far below what was declared in the invoices. These fictitious credits were then monetized through transfer to banks or other companies, triggering a chain of transactions that made it even more difficult for the authorities to control. The crackdown operations initiated by law enforcement and the Revenue Agency led to the discovery of numerous frauds and the arrest of several individuals involved. However, the effectiveness of such operations was often limited by the difficulty in tracking financial flows and the complexity of the corporate structures used to conceal fraudulent operations.

Trying to make estimates, it becomes clear how the phenomenon of fraud had a significant impact on the state budget, representing almost 7% of the total tax credits related to the building bonuses of those years, which amount to about 219 billion euros in total. Of these, knowing the data, it emerges that the Superbonus represents the majority of the incentives; however, updated data on the distribution of fraudulent amounts among the various bonuses are not yet available. An attempt to shed light on this can still be made by citing another hearing of Director Ruffini dating back to February 2022. On that occasion, a year and a half after the measure was introduced, it was declared that the Superbonus accounted for only 3% of the 4.4 billion euros of building bonus fraud discovered up to that point. The majority of the frauds, about 80%, concerned two other incentives: the facade bonus and the Ecobonus. However, it is important to note that at that time, the accumulated deductions for work completed with the Superbonus amounted to just over 16 billion euros, a figure that, as already mentioned, has now exceeded 120 billion. The frauds, as observed, have tripled in these two years, which implies that the fraud percentages may no longer be the same, but the intrinsic weakness of measures like the facade bonus can be clearly understood[178].

It should also be taken into account that while the Superbonus was conceived from the outset with the credit transfer system and therefore also the related controls and preventions, the facade bonus, activated by the Conte II government the previous year, in 2019, did not foresee this system. The transfer was simply extended to this measure as well at the time of the Superbonus's birth[179], thus not reflecting the same control mechanisms included in the Superbonus and opening up the possibility of defrauding the tax authorities much more easily, as the 2022 data indeed demonstrated.

Below, solely for illustrative purposes, some of the most substantial frauds related to the Superbonus that have emerged will be reported to help understand the scale and severity, as well as to give an idea of how some of the fraudulent proceedings took place.

[178] Pagella Politica. Frodi legate al Superbonus nel settore edilizio. https://pagellapolitica.it/articoli/frodi-superbonus-edilizia

[179] Gazzetta Ufficiale. Decreto-legge n. 34 del 2020. https://www.gazzettaufficiale.it/eli/id/2020/05/19/20G00052/sg

A case that received significant media coverage concerns the investigation conducted by the television program "Striscia la Notizia," which exposed a massive fraud orchestrated by the company AGM Group. The fraud involved over 2,000 people and concerned phantom construction sites where renovation work was never initiated, despite documentation stating otherwise. In particular, the investigation revealed how the company had created a sophisticated system of document falsification, thanks to which it managed to obtain tax credits worth tens of millions of euros[180]. Another emblematic and widely covered case occurred in Marilleva, in Trentino-Alto Adige, where the condominium known as "Val di Sole" achieved the record for the highest amount of funding obtained through the Superbonus for a single building, almost 39 million euros[181]. Despite the extraordinary amount disbursed, most of the promised work was never carried out. Investigators found that the funds allocated for the energy and structural improvement of the building were largely diverted to foreign accounts or used for personal purposes by the project managers. In Ancona, on the other hand, an operation conducted by the Guardia di Finanza uncovered a criminal organization dedicated to Superbonus fraud. In this case, through a complex system of false declarations and altered documentation, the fraudsters managed to obtain large sums of money intended for renovation work that was never actually carried out. The investigation led to the seizure of non-existent tax credits worth 3 million euros, along with additional financial assets worth 2 million, and revealed how the criminal network operated with the complicity of corrupt professionals and technicians who certified the completion of interventions that never took place[182].

These examples of fraud are just the tip of the iceberg of a phenomenon that has highlighted the vulnerabilities of the building incentive system. Ongoing investigations throughout Italy are gradually uncovering the extent of the problem, raising critical questions about the effectiveness of control measures and the management of public funds. The combination of large sums of money and the bureaucratic complexity linked to the Superbonus created an environment where fraud could thrive, causing not only significant economic damage to the State but also a loss of confidence in the measure itself.

It can certainly be imagined that a certain level of fraud, especially in a country like Italy, will always occur in public incentives; however, analyzing the entire case of building bonuses, which

[180] Striscia la Notizia. (2022). Superbonus 110%: I cantieri fantasma e la truffa AGM Group. https://www.striscialanotizia.mediaset.it/news/superbonus-110-i-cantieri-fantasma-e-l-inchiesta-di-morello-la-truffa-di-agm-group-coinvolge-oltre-2mila-persone_666077/

[181] Corriere della Sera. Superbonus a Marilleva: Il record per il condominio più finanziato d'Italia. https://www.greengrid.cloud/2024/06/16/corriere-della-sera-superbonus-a-marilleva-il-record-per-il-condominio-piu-finanziato-ditalia/

[182] Ancona Today. (2023). Sequestro per frode sul Superbonus ad Ancona. https://www.anconatoday.it/cronaca/sequestro-frode-superbonus-ancona-gico-guardia-di-finanza.html

accumulated frauds worth almost a tenth of their total value in a few years, one should be rightly alarmed, in the opinion of the author. Nevertheless, in addition to the impact on public finances, the issue of fraud had very powerful consequences on the rest of the measure and also on the system and supply chain that had been created around it. As already illustrated earlier, one of the most innovative and problematic aspects of the Superbonus was the credit transfer mechanism, which allowed beneficiaries to transfer the tax credit to third parties, such as banks or other financial institutions, in exchange for immediate liquidity or invoice discounts. The most recent monitoring data indeed show that only a minority of taxpayers benefited from the incentive through IRPEF deduction[183]. The preference for other methods of utilization, such as transfers, could be justified by the fact that the eligible interventions are often of significant amounts, and taxpayers find it difficult to advance the expenses unless they resort to credit transfer. This system, while born with the intention of expanding access to incentives to those without fiscal capacity, soon revealed vulnerabilities. The credit transfer system introduced with the Superbonus was then extended to other incentives, such as the already mentioned facade bonus, without, however, maintaining the same level of regulation, which allowed for the emergence of numerous frauds.

One of the main problems was the excessive complexity of the credit transfer mechanism, which made it difficult to control and verify operations[184]. The Superbonus was designed with flexibility that allowed for multiple credit transfers, but without an adequate monitoring system. This opened the door to fraudulent practices where fictitious credits were created and exchanged without the work actually taking place. Banks, initially enthusiastic about the potential of these credits, began to withdraw when they realized the enormous exposure to risk. The lack of effective tools to track and verify credits led to a loss of confidence in the system. Moreover, the continuous legislative changes created an environment of uncertainty that made planning difficult for companies and families. Regulations were modified several times, often with little notice, making the regulatory context unstable and discouraging investments. Another crucial cause was the lack of a support system for financial institutions tasked with managing credit transfers. The proliferation of stranded credits, i.e., credits that could not be transferred or used for tax deductions, created a financial bottleneck, paralyzing the system[185].

In 2021, the increase in fraud cases related to credit transfers attracted the attention of authorities. In particular, illegal practices emerged in which fictitious credits were transferred

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[183] Agenzia delle Entrate. Gli immobili in Italia 2023, op. cit.

[184] Valore Energia. Tutti i problemi del Superbonus 110%. https://www.valoreenergia.it/blog/tutti-i-problemi-superbonus-110/

[185] Wall Street Italia. Superbonus: Quali rischi per imprese e famiglie dallo stop alla cessione dei crediti. https://www.wallstreetitalia.com/superbonus-quali-rischi-per-imprese-e-famiglie-dallo-stop-alla-cessione-dei-crediti/

multiple times or for work never carried out. In this context, the government deemed it necessary on several occasions to intervene with drastic measures to stop the frauds, but also to contain a problem that was getting out of control, including several restrictions to limit credit circulation, making it more difficult for companies and homeowners to access the liquidity needed to complete the work[186]. In 2022, the Draghi government sought to curb the situation by introducing new regulations that limited credit transfers to a maximum of three passages, reducing initial flexibility. However, these changes were not enough to solve the problems already triggered. Banks, concerned about the amount of stranded tax credits and the difficulties in verifying the legitimacy of such credits, began to block credit transfer operations, leaving thousands of businesses and families with unusable credits and unfinished work. In February 2023, the Meloni government decided on a total halt to Superbonus credit transfers, a drastic move aimed at stopping fraud but leaving the construction sector in a very serious situation[187].

The halt to Superbonus credit transfers indeed had a devastating impact on several fronts. For construction companies, it meant the interruption of already started projects and an unprecedented liquidity crisis. Many companies found themselves on the brink of bankruptcy, unable to bear the costs of the projects without the possibility of transferring the credits. Property owners, for their part, faced growing uncertainty: blocked energy renovation work, unfinished buildings, and the prospect of having to bear costs they had not anticipated. Some were forced to halt work, missing the opportunity to improve the energy efficiency of their buildings and, in many cases, increase the value of their properties.

The banking sector, initially involved in the transfer process, had to face a crisis of confidence and the management of a mass of stranded credits that could no longer be traded. This created a chain reaction where banks began withdrawing from financing operations related to the Superbonus, further aggravating the situation for businesses and individuals[188]. Systemically, the halt generated widespread distrust of state incentive policies. The perception that the government was unable to guarantee regulatory and financial stability discouraged investments in the energy efficiency sector, a sector that should have been one of the engines of post-pandemic economic recovery. Furthermore, this situation contributed to creating social and political tensions, with numerous families and businesses feeling abandoned by the State and becoming involved in legal disputes to seek justice,

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[186] Il Sole 24 Ore. (2023). Cessione crediti: Stop delle Poste, ma continua la corsa al 110%. https://www.ilsole24ore.com/art/cessione-crediti-stop-poste-ma-continua-corsa-110percento-AEh6AvEC?refresh_ce=1

[187] Il Post. (2023, February 17). Blocco dei crediti del Superbonus. https://www.ilpost.it/2023/02/17/blocco-crediti-superbonus/

[188] ANSA. (2022, July 20). Draghi contro chi ideò la cessione dei bonus. https://www.ansa.it/sito/notizie/economia/2022/07/20/draghi-contro-chi-ideo-la-cessione-dei-bonus_f33a829a-f789-4705-9023-035573d7930e.html

even through the creation of ad hoc associations such as the "Esodati del Superbonus" Association, which in November 2023 had about 10,000 members[189].

There is no complete data and statistics on the impact of this extraordinary measure; however, it can be understood that the interruption of what had been one of the measure's flagship elements, which had attracted so many, undoubtedly decisively changed the history and nature of the Superbonus. However, a critical analysis of this intervention, given the serious consequences it had, is necessary. The attempt to stop or slow down the frauds was certainly necessary, but it is more complex to judge the evaluation of the consequences that is presumed to have been made in making the decision. The pressure from the fraud emergency likely led to drastic measures, or it may have been intended to end this tool also as a disincentive to the more general adherence to the measure, which was starting to cost the state huge sums. After all, on more than one occasion, Draghi had expressed his opposition to this measure, despite the political pressures from the majority of his government initially leading him to renew the incentive's validity[190]. It should also be taken into account that, as the most recent data of that period attested, most of the frauds were related to the facade bonus and not the Superbonus, leaving valid the objection that it might have been sufficient to slow down the transfer only to the first of the two, thus reducing a substantial part of the frauds, although not all, but at the same time avoiding harmful consequences on the economy, instead of treating all building bonuses in the same way. It was certainly a complex decision made under great pressure and with partial data, which had to clash with measures that had not been thoroughly thought out in every critical aspect two years earlier. It is difficult to determine whether it can be considered a solution or a worsening of a problem that had nevertheless arisen due to limitedness in designing these measures and, as often happens in cases like this one, the solutions arrive too late.

After reviewing the main issues, as anticipated, in this last section of this chapter, which precedes the final conclusions, some proposals are presented, both emerging from the analysis and reporting some already presented by other sources such as the National Council of Engineers and the European Commission[191], aimed at improving the design approach of fiscal incentive measures for energy efficiency interventions.

First, it is deemed necessary to extend the implementation period of these programs to give applicants the time necessary to complete the approved interventions and receive reimbursement, thereby reducing the risk that a project remains unfinished and the need for tools such as credit

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[189] Esodatidelsuperbonus. Chi siamo. https://www.esodatidelsuperbonus.it/chi-siamo/

[190] Il Post. (2023, February 17). Blocco dei crediti del Superbonus. https://www.ilpost.it/2023/02/17/blocco-crediti-superbonus/

[191] Infobuild Energia. Superbonus: Analisi costi-benefici di una misura controversa. https://www.infobuildenergia.it/approfondimenti/superbonus-analisi-costi-benefici-misura-controversa/

transfer, which has proven to be very dangerous. A longer time frame in which to recover the tax credit would expand the pool of eligible recipients, significantly reducing the number of those without capacity without resorting to credit transfer.

Secondly, the scope of these measures should be expanded to include a wider range of building types, such as hotels, to promote greater diversification of economic benefits, not limiting them to only the residential sector but also commercial. Another proposal concerns the simplification of procedures and communications, making them more accessible to individuals and small businesses. Moreover, it would be appropriate to include in the program to be presented the costs of building assessment and preliminary design, even if the intervention is not carried out, to ensure that assessments are conducted by reliable and efficient companies.

Furthermore, it is suggested to introduce a more flexible incentive system that takes into account different financial needs. Instead of relying exclusively on improving energy classes as currently required, the energy needs could be adopted as the main criterion for accessing incentives, in line with the recommendations of the European Union. Specifically, a scaling incentive system could be implemented, starting from the maximum level and gradually reducing the rate for interventions that do not achieve high levels of energy efficiency. This approach would reward interventions that guarantee significant energy savings while penalizing less effective ones, thus promoting more sustainable redevelopment from both an economic and environmental standpoint.

With these proposals, this journey into the world of building energy efficiency and one of the most important measures in Italy, but probably also at the European level, to promote it, the 110% Superbonus, comes to an end. In this chapter, numerous sources, a large amount of data, and analyses were examined to understand the impact of this measure, which can certainly be defined as unprecedented, in order to conduct as comprehensive a cost-benefit analysis as possible, whose conclusions will be illustrated below.

Conclusions

In trying to conduct a cost-benefit analysis of the impact of the 110% Superbonus on the energy efficiency of buildings during this research, several topics were thoroughly examined, starting with a general introduction to understand the importance of the issue and then delving into the specific measures. Beginning with an introduction to energy efficiency in buildings and analyzing the scenario in the residential sector, both European and Italian, as well as the regulations and policies aimed at promoting it, the analysis then moved on to the Superbonus itself and especially to an attempt to analyze the impact of this measure.

In this final section, the conclusions of the analysis will be drawn, contextualized in the varied scenario of energy efficiency.

Energy efficiency represents a fundamental element for achieving ecological and energy transition objectives, especially when applied to the context of buildings. They indeed represent a significant component of energy waste and $CO2$ emissions, especially due to outdated and inefficient systems and installations. This factor is certainly heavily influenced by the high average age of buildings, but also by the high costs required to install new systems, costs that do not appear to be convenient due to the energy savings, which, although present, would be limited compared to the required investment.

To promote the energy efficiency of buildings, a decisive element within the European Union's strategies for ecological transition, the necessary solution is a system of public incentives to assist citizens in carrying out this type of intervention. In this context, Italy, in the years immediately following the Covid-19 pandemic, was characterized by a large number of bonuses aimed at the construction sector, which guaranteed tax incentives to citizens in the form of tax credits proportional to the investments made for renovation and refurbishment work, including those for improving the energy performance of buildings.

In May 2020, after the first phase of the pandemic, which proved very tough for Italy but also opened the door to a high possibility of obtaining additional funds given the state of emergency, the Conte II government introduced a temporary measure called the 110% Superbonus, as it guaranteed a credit equal to 110% of the work carried out for the energy efficiency of homes. Designed also to revive the construction sector, which was severely affected by the pandemic's impact, this measure was conceived with an innovative feature that was on that occasion extended to other bonuses, namely the possibility of freely transferring the generated tax credit, in such a way as to include among the beneficiaries of the incentive the taxpayers without fiscal capacity who otherwise would not have been able to recover the investment.

The great convenience of this measure, both in terms of return on investment and actual monetary outlay, soon led a large number of citizens to adhere to it, quickly surpassing the initially allocated funds. This led to a continuous increase in resources obtained through increased public debt and numerous renewals of the measure, even despite the arrival of a national unity government supported by almost all parties, led by Mario Draghi, who on several occasions expressed opposition to the excesses of the measure. Gradually weakened in the years immediately following, both in credit transfer—eventually eliminated—and in deductible amounts, but still in force, the measure has been the subject of numerous debates, undergoing both attacks from critics and defense from supporters, especially regarding its effectiveness and impact on the economy.

To provide a comprehensive judgment on both the energy and economic impact of the Superbonus, a cost-benefit analysis was conducted to highlight every feature and thus develop a certain and clear opinion. However, the specific analysis proved complex and compromised, especially in the energy benefits part, due to a lack of updated data, mostly dating back to 2022 when the measure was in its initial phases and had not yet undergone substantial modifications.

The first step in the statistical analysis carried out through multiple regressions aimed at understanding whether investments in the Superbonus actually resulted in energy savings from its implementation turned out to be not very significant. The main reason for this is due to the fact that the work carried out, lasting months, significantly delayed over time, especially over a short horizon, the achievement of higher efficiency levels than those at the start. Nevertheless, despite the low significance, the main result that emerged from the analysis is that the factor that best explains the energy savings that occurred in Italy in recent years was the increase in energy prices due to the Russian invasion of Ukraine that began in 2022, which caused a major energy crisis across Europe. The analysis of available data still provided some clear insights into the measure's benefits. It saw a very high number of adherences, with a stock of interventions carried out that was very broad, probably with few comparable precedents, and consequently a very high allocation of public resources; however, overall, it involved less than 5% of Italian residential buildings, a certainly limited portion. The energy improvements were there, and indeed, an increase in the energy classes of buildings was recorded, but it concerned small percentages of the overall stock, whose overall composition improved only slightly. Although any improvement is welcome, the high quantity of resources allocated to achieve very limited results suggests how many further investments would be necessary and how ineffective these seem to have been. The data related to energy and environmental trends show positive performance and improvements, albeit limited; however, being limited to 2022, they are certainly compromised by the exogenous shock caused by the war in Ukraine, which prevents the identification and evaluation of the Superbonus's contribution, which will absolutely need to be analyzed in more detail in the future, with more data available and medium-term effects determinable.

On the cost and economic impact side of the Superbonus, a highly debated topic despite very different positions, the analysis of the most authoritative studies draws a particularly clear conclusion. The measure certainly had positive effects on the economy; however, it failed to reach the level of a public spending multiplier equal to 1, thus failing to create added value in the economy and a return for the State on the resources allocated, heavily burdening already struggling public finances with a significant increase in the deficit and the risk of a downgrade in the country's rating. Additionally, some structural criticalities and problematic interventions in response to the large quantity of frauds perpetrated on all building bonuses, especially on the credit transfer mechanism, created numerous liquidity problems for construction companies and the citizens on whose homes the companies were working. To these problems, we can add an additional inflationary push on raw materials created by the high demand generated by the boom in interventions.

In short, the opinion reached at the end of this analysis is that while incentives for energy efficiency are necessary, the 110% Superbonus has overall brought limited energy, environmental, and economic benefits at the cost of a serious worsening of public finances and numerous problems for the economic system due to an overly generous and optimistic approach that made adherence to the measure virtually unlimited and without limits in the hope of an economic return that did not materialize. For this reason, the final judgment on the measure's impact is negative, and some proposals aimed at improving this type of incentive system have been presented.

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Ringraziamenti

"Roma nostra vedrai. La vedrai da' suoi colli:
dal Quirinale fulgido al Gianicolo,
da l'Aventino al Pincio più fulgida ancor ne l'estremo vespero,
miracol sommo, irraggiare i cieli…
Nulla è più grande e sacro. Ha in sé la luce d'un astro.
Non i suoi cieli irraggia solo, ma il mondo, Roma."
[Gabriele D'Annunzio]

Questa tesi è stata concepita nel suo oggetto durante gli ultimi 10 giorni del 2023, che sono stati per me anche gli ultimi giorni a Roma prima di partire per il Canada, dopo avervi vissuto e studiato per 4 anni. Questa tesi è stata completata durante i primi 10 giorni dal mio ritorno a Roma dopo 6 mesi, dove sono tornato per iniziare a lavorare. Roma o, meglio, due Rome diverse, la Roma da studente e la Roma da lavoratore, hanno rappresentato l'inizio e la fine di questo percorso che è stato un percorso di cambiamento e trasformazione, sia personale che di vita.

Questo percorso di cambiamento da una vita all'altra è iniziato senza sapere dove sarebbe terminato, in Canada che poteva apparire come una terra promessa in cui rimanere, di nuovo a Roma, o chissà dove altro. L'unica cosa che mi ha accompagnato in questo percorso, l'unica certezza, è stata il realizzare questa tesi, realizzazione che non è stata certo facile. Ma se questa era l'unica cosa, per fortuna ho avuto anche molte persone, che mi hanno accompagnato, supportato, con cui abbiamo riso e scherzato, persone vecchie e nuove, e che vorrei qui ringraziare.

Ella, ovviamente inizio da te, che sei entrata nella mia vita con irruenza e l'hai cambiata, facendomi scoprire così tanto; insieme abbiamo già vissuto tante vite, cambiandoci e rinnovandoci ogni volta, ma restando sempre felici, l'uno al fianco dell'altra. I nostri risultati più grandi sono quelli che dobbiamo ancora raggiungere.

E siccome di cambiamento si parla, voglio ringraziare i miei amici, Fabrizio, Leonardo, Luca e Giacomo, per essere sempre gli stessi ma sapendo creare tanto di nuovo per la nostra amicizia, che non invecchia mai, così come quella con Benedetta, che c'è sempre stata, senza un dubbio o un'esitazione, con cui abbiamo creato un'amicizia destinata a durare, grazie.

Un'altra vita che finisce ora, a cui non potrei essere più grato per tutto ciò che mi ha dato e mi ha fatto dare, è JELU Consulting, con tutte le persone con cui abbiamo condiviso questo percorso, su tutte Rachele, che hai sempre saputo dirmi, prima di tutti, quando mi sbagliavo, grazie.

E con JELU finisce, così come era iniziata, anche Mamma Luiss, che mi ha fatto vivere 5 anni meravigliosi con tante persone con cui ho condiviso moltissimo e cui sarò sempre grato

Grazie a tutti gli amici del MIB, con cui abbiamo condiviso la fredda e piccola Kingston ma che ci ha accolto e ospitato mentre vivevamo la nostra avventura oltreoceano.

Un immenso grazie ai miei genitori, per tutte le grandi opportunità che mi hanno dato, e per i consigli più difficili che un genitore possa dare, quelli più altruisti e meno disinteressati.

Tanti ancora vorrei ringraziare, a partire da Vincenzo, Livia, Roberto, Francesco, Giorgia, Vittorio, Michele, Daniela, Riccardo, Lorenzo, Sujan, Matteo, Edoardo, Nicola, Sara, Marco, David, la mia famiglia, Zia Lucia, Lorena, e ancora tanti altri, per aver lasciato un segno, tutti quanti, ognuno a modo suo.

Infine, un ringraziamento molto importante va al Professor Simone Mori, per essere stato un docente eccezionale, come non mi sarei aspettato, e a Daniele, per il fondamentale e costante supporto datomi durante questo lungo lavoro.