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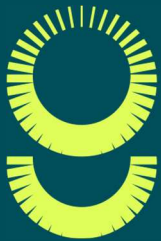


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Distributional Effects of the Superbonus and Ecobonus Programs in Italy

A survey of public housing tenants on the energy efficiency of their homes, energy expenditure, and thermal comfort: outcomes from the pilot project in the province of Reggio Emilia, Italy

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Executive summary

This policy brief presents the results of two research lines that examine the distributional impacts of energy-efficiency policies in Italy. Together, the studies provide novel evidence on how household socio-economic conditions, building characteristics, and policy design shape both access to energy-efficiency measures and the ability to achieve adequate levels of thermal comfort. The analyses cover the Italian population as a whole, through microdata on energy-efficiency investments, and a highly vulnerable subset (public housing tenants) through a pilot survey.

The first study investigates the distributional effects of Italy's flagship tax incentives for residential retrofitting: the Ecobonus and the Superbonus. Using newly collected microdata from the Italian Survey of Consumer Expectations (ISCE), administered in October 2024 to more than 5,000 households, the results indicate that the incentives have been mildly regressive. In fact, higher-income households were significantly more likely to undertake renovation works and captured a larger share of public resources. However, when focusing only on households that carried out retrofits and used at least some public funds, the distribution of benefits becomes much more equitable, even slightly progressive. The observed regressivity, therefore, arises not from unequal treatment among beneficiaries, but from unequal access to retrofitting. These findings highlight the need to complement tax-based incentives with additional measures to ensure that the green transition does not reinforce existing inequalities.

The second study describes a pilot survey conducted among 249 households living in public residential housing in the province of Reggio Emilia. By combining survey responses with administrative and technical data on buildings, this research provides a picture of socio-economic vulnerability, energy expenditures, and perceived comfort. The evidence reveals a population facing overlapping hardships: very low incomes and elevated energy expenses relative to income. The housing stock is often old and energetically inefficient, and this exacerbates these vulnerabilities. Although tenants express awareness of the need for housing improvements, their willingness to pay even modest rent increases is extremely limited.

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1. Presentation and description of the research activity undertaken

1.1 Distributional Effects of the Superbonus and Ecobonus Programs in Italy

This research investigates the distributional effects of Italy's main tax incentive schemes for household energy retrofitting—the Ecobonus and Superbonus. These programs have been among the most ambitious initiatives in Europe to promote the decarbonization of the residential building stock, reimbursing between 50% and 110% of renovation expenditures. While they aimed at achieving significant improvements in energy efficiency, their equity and social impacts remain unclear.

The study combines institutional and empirical analysis based on the Italian Survey of Consumer Expectations (ISCE), a nationally representative dataset covering more than 5,000 households. The survey, conducted in October 2024, includes a dedicated section on energy-efficiency renovations, expenditure levels, and the use of public subsidies. Using these data, the authors assess who accessed and benefited from the incentives, focusing on differences across income quartiles and socioeconomic characteristics. The empirical analysis employs concentration curves, linear probability models, and multinomial logit regressions to identify how income affects both the probability of retrofitting and the financing structure (public versus private funding).

1.2 A survey of public housing tenants on the energy efficiency of their homes, energy expenditure, and thermal comfort: outcomes from the pilot project in the province of Reggio Emilia, Italy

Public residential housing plays a crucial role in providing shelter to vulnerable households; however, it is often characterized by outdated buildings with poor energy performance.

According to recent analyses provided by Housing Europe, in 2025 countries like Austria, Denmark, Slovenia and the Netherlands are improving building conditions, while renovation of the stock is falling behind in Germany, Ireland, Italy and Sweden,

mostly due to financial budget constraints, and same for Belgium, despite the implementation of an ambitious plan (Housing Europe, 2025).

In the case of Italy, Campanini (2025) provides a detailed overview, based on data from the Italian Ministry of Economics and Finance, about the energy efficiency status of public housing owned by the municipalities, describing this part of the national building stock as mostly composed of old, inefficient residences, which exposes tenants to higher energy costs, limited comfort, and an increased risk of energy poverty.

In this context, improving energy efficiency is not only an environmental priority but also becomes a matter of social equity, as it directly affects low-income families' living conditions and their ability to access affordable, comfortable and healthy housing as well.

The research activity presented in this report aims at investigating the interplay between housing quality, perceived comfort, and energy poverty in Italy. More specifically, it presents the results of a new survey aiming at exploring whether tenants of public residential housing living in less efficient houses are more likely to experience energy poverty, how objective and subjective indicators of this condition align, and assess households' willingness to pay (WTP) for energy-efficiency improvements in their homes.

By combining structured survey data with administrative records provided by public housing authorities regarding tenants' socio-economic conditions and building technical information, this comprehensive approach seeks to inform policies at the intersection of energy efficiency, social housing and poverty alleviation. Operationally, it delivers a framework composed of: i) a survey for public bodies that can be scaled up to different spatial levels (regional, provincial and city), while also ii) showing how expenditure and consensus-based measures can be integrated with buildings' data, for the creation of comprehensive technical and policy indicators. The goal is to support decision-makers in designing interventions that improve building performance in public residential housing, enhance the quality of life for tenants and reduce the risk of energy poverty.

2. Relationship with the existing literature on the topic

2.1 Distributional Effects of the Superbonus and Ecobonus Programs in Italy

The research builds upon and extends existing studies on the distributional effects of environmental and energy subsidies, which typically find that higher-income households benefit disproportionately from tax-based incentives. Previous evidence from the United States and other European countries (e.g., Borenstein & Davis, 2025; Lekavičius et al., 2020) suggests that clean-energy tax credits and retrofit subsidies often exhibit vertical inequity, as low-income households face barriers such as insufficient tax liability or lack of information.

For Italy, earlier analyses (e.g., Del Ciello & Palmisano, 2025) pointed to the regressive pattern of the Superbonus using aggregate data at the geographical level, showing a higher take-up of the subsidy in the north of the country where mean income levels are higher than the national average. Yet they lacked detailed household-level evidence. This study contributes new microdata-based evidence, revealing a mildly regressive effect at the population level but a more equitable distribution among actual beneficiaries.

2.2 A survey of public housing tenants on the energy efficiency of their homes, energy expenditure, and thermal comfort: outcomes from the pilot project in the province of Reggio Emilia, Italy

Energy poverty is increasingly recognized as a multidimensional phenomenon that goes beyond high energy bills. It reflects the interaction between household resources, energy needs, and housing conditions (Hills, 2011; Bouzarovsky and Petrova, 2015; Faiella et al., 2022).

In Italy, expenditure-based indicators have been developed to capture different facets of energy poverty, including high energy costs relative to income, low residual income once energy expenses are deducted, and “hidden energy poverty”, referring to households with low equivalent total expenditure and no heating expenditure (Faiella and Lavecchia, 2015; OIPE Reports, 2021 and 2023).

Specifically, the energy poverty measure delivered by the Italian Observatory of Energy Poverty (OIPE) builds on the Low-Income High Costs (LIHC) approach, which defines vulnerability as the situation in which meeting basic energy needs forces households to sacrifice other essential goods and services (Hills, 2012).

Beyond expenditures, several studies also stress the importance of consensus-based measures, which capture households' perceptions of their ability to maintain adequate levels of comfort. Surveys such as the EU-SILC (EU Statistics on Income and Living Conditions) ask directly about the ability to keep homes adequately (emphasis added) warm in winter or cool in summer. Combining these subjective indicators with household income and demographic profiles provides a richer understanding of energy poverty as both an objective and a perceived condition.

Evidence from international housing surveys confirms the relevance of integrating expenditure and perception-based indicators. The English Housing Survey (UK Government, 2023), the National Social Housing Survey in Australia (AIHW, 2023), and the Housing Authority's monitoring in Hong Kong (Housing Monitoring, 2025) all emphasise the relationship between climate and local infrastructure conditions, building performance, tenants' socio-economic vulnerability, and affordability. These experiences show that social housing tenants are consistently more exposed to energy vulnerability, given both their fragile income profile and the below-average energy efficiency of the housing stock they occupy.

Apart from the national surveys conducted by the Italian National Institute of Statistics (ISTAT) on household spending and energy expenditure/consumption, several pilot studies have been implemented in Italy to investigate energy poverty and/or the living conditions of tenants in public housing. In the case of energy poverty, we find surveys by the Fondazione Vittorio on energy poverty in remote areas (Rugiero et al., 2022), as well as the yearly survey by Banco dell'Energia focusing on Italian citizens' perceptions (Banco dell'Energia, 2024). When considering energy poverty in the context of public housing, Grazini (2024) presents a pilot survey of households living in public housing in the Province of Viterbo, Italy.

All in all, the literature highlights that assessing energy poverty requires combining multiple approaches. Expenditure-based indicators provide comparability and objectivity, while consensus-based measures give voice to the tenant's lived experiences. Integrating both dimensions, while also linking survey data with administrative and technical information on buildings, represents a methodological innovation that strengthens the evidence base for designing effective housing and energy policies.

3. Research output

3.1 Distributional Effects of the Superbonus and Ecobonus Programs in Italy

The analysis provides new evidence on the distributional consequences of the Italian Ecobonus and Superbonus programs, two highly generous schemes designed to promote energy-efficiency investments in the residential sector. Using data from the Italian Survey of Consumer Expectations (ISCE)—a nationally representative panel of over 5,000 households conducted in October 2024—the study examines both the determinants of participation in retrofitting works and the distribution of public support across income groups.

Data shows that at the aggregate level the Italian retrofitting incentives have been mildly regressive. As illustrated in Figure 1, the concentration curve of public subsidies lies below the 45-degree line of equality, implying that higher-income households have received a higher share of public funds. The bottom half of the income distribution accounts for only about thirty percent of total subsidies, while the richest decile captures around twenty percent. The corresponding Gini coefficient of 0.26, compared to 0.31 for overall disposable income, confirms this slight but significant regressive pattern.

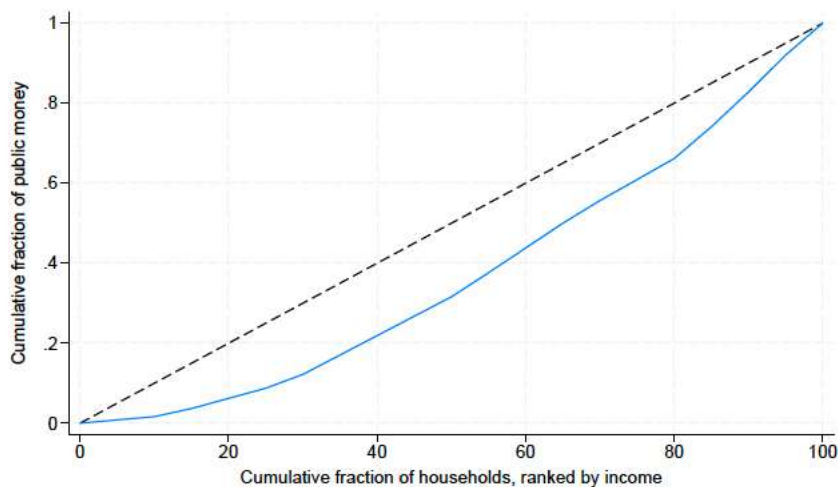


Figure 1: Concentration curve for all households

A major factor behind this outcome lies in the unequal probability of undertaking retrofitting works across income groups. A linear probability model shows that the likelihood of living in a retrofitted dwelling increases monotonically with income. Households in the top quartile are roughly ten percentage points more likely to have carried out an energy renovation than those in the lowest quartile. Regional and sociodemographic factors further accentuate these differences: retrofitting is more frequent in Northern Italy, among homeowners, and among individuals with higher educational attainment. In contrast, environmental attitudes and gender play no statistically significant role in explaining participation.

When the analysis is restricted to households that undertook retrofitting, the distribution of public support appears more balanced. Figure 2 shows that, among these households, public resources are distributed more evenly, as the Gini coefficient falls to 0.12. The lower half of the income distribution accounts for approximately forty-five percent of subsidies, while the top decile receives only slightly more than ten percent. Hence, most of the regressivity observed in the aggregate arises not from differential treatment among beneficiaries, but from disparities in participation.

Income differences also emerge in the scale and financing structure of retrofitting projects. According to our estimates, the average cost of renovations increases with income, suggesting that wealthier households tend to undertake larger or more technologically advanced projects. Similarly, the share of expenditures covered by public funds rises from roughly thirty-five percent among the lowest income quartile to nearly forty-five percent in the highest one. Self-financing is substantially more common among poorer households, who often lack sufficient tax liability or access to benefit from the schemes. In the lowest quartile, nearly half of all retrofits were funded entirely from family resources, compared with about thirty percent in the highest quartile.

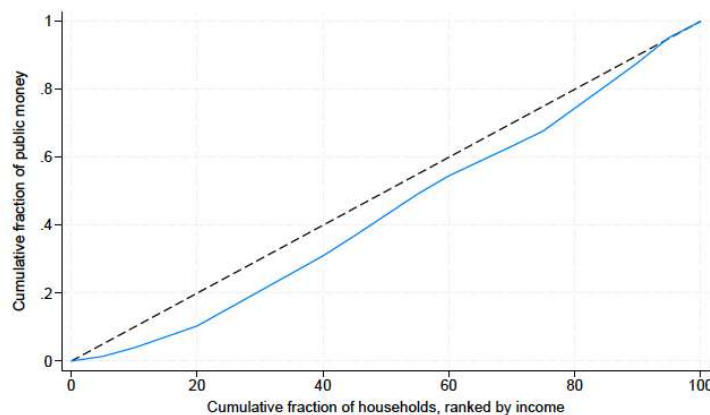


Figure 2: Concentration curve for all households who live in retrofitted dwellings

Additional evidence from survey questions sheds light on the mechanisms underpinning this unequal participation. Low-income households that relied on private funds did not view further financial aid or access to credit as a possible financing alternative, indicating that such options may lie beyond their perceived or practical reach rather than reflecting a lack of need. These respondents were also somewhat less inclined to view government intervention in promoting energy efficiency as necessary. Such attitudinal and informational gaps reinforce the structural barriers that hinder equitable benefit take-up.

Finally, Figure 2 encapsulates one important finding of the study. When focusing exclusively on households that both retrofitted their dwellings and used at least some

public funding, the concentration curve lies slightly above the equality line, revealing a mildly progressive distribution of benefits among beneficiaries. This means that, conditional on access, lower-income households do not receive systematically smaller transfers than wealthier ones. The apparent paradox—regressivity across the population but progressivity among participants—can thus be explained by differential rates across income groups in i) undertaking retrofitting works and ii) access to benefits conditional on retrofits, rather than according to biased allocation rules.

3.2 A survey of public housing tenants on the energy efficiency of their homes, energy expenditure, and thermal comfort: outcomes from the pilot project in the province of Reggio Emilia, Italy

The survey we present in this report provides a comprehensive picture of the socio-economic conditions, energy use, and housing experiences of tenants living in public residential housing in the province under study, while also accounting for the status of their dwellings. The results highlight the vulnerabilities of these households, their difficulties in meeting basic needs, and how energy efficiency and housing quality intersect with issues of affordability, comfort, and social inclusion.

Methodological overview

Study approach and ethics

In this observational study, data is collected from households living in public residential housing. No blinding is involved, since the aim is to understand tenants' living conditions and perceptions. To guarantee transparency and methodological rigour, the survey was pre-registered on the Open Science Framework online platform and received approval from the Ethics Committee of the University of Padua. These steps ensure that the study complies with ethical standards and that its design and objectives were clearly defined before data collection began.

Study design

The main objective is to analyze the Willingness To Pay (WTP) of tenants living in public residential housing for dwellings' improvements in relation to their perceptions of energy poverty, energy efficiency, and overall housing comfort. The data collection consists of structured telephone interviews, lasting about 15 minutes. The interviews include both closed and semi-open questions, covering topics such as respondent's demographic and household characteristics (nationality, level of education, and

employment status), the presence of individuals with disabilities, income indicators, energy-related expenditures (heating/cooling), rent payments and any possible arrears, whether the household received social benefits, perceived housing comfort, and the WTP for more energy-efficient housing. The sampling strategy aimed to reach approximately 800 households in the targeted area (province of Reggio Emilia), selected in collaboration with the local social housing authority. The selection follows a two-stage process: First, the housing authority compiled a list of buildings belonging to its stock, ensuring that the highest data detail is considered about related construction and energy features, as well as administrative information, then residents of those buildings are invited to participate. Finally, the survey data is integrated with administrative records provided by the housing authority, creating a comprehensive dataset that combines households' survey responses with objective housing and energy indicators, as well as households' socio-economic data.

Sample size

The study involves approximately 800 households (out of 3.435 renting from the local social housing authority, ACER, located in Reggio Emilia, a town of about 172.000 inhabitants in 2024, in the Emilia Romagna region) as the primary units of analysis, all living in the same province.¹ These households are drawn from a list of public residential buildings, ensuring the highest level of detail regarding construction and energy features, as well as administrative records, identified together with the local housing authority. In advance of the data collection, all potentially eligible tenants were informed about the upcoming interviews through a dedicated campaign. Information about the aim of the survey was distributed both in paper form, delivered directly to their residences with the energy bill, and digitally (video and text), via the website of the public housing authority. This effort was undertaken to ensure transparency and encourage participation.

Results from the pilot case of Reggio Emilia Province in Italy

Profile of respondents and households

The survey had a response rate of 40.3%, with a total of 249 interviews over 618 phone contacts, based on the 826 references provided by the local public housing authority.² Statistical analysis was carried out to verify whether the sample of 249 respondents reflected the general characteristics of the total number of names received. The two data sets were compared for certain essential database classification variables, namely: type of heating, rent arrears, net floor area of residential unit, year of

¹ The number of participants has been defined in accordance to the available data required for the planned analysis. Although no formal power analysis was conducted, a sample of this size is considered sufficient to capture variation across key socio-economic and housing-related characteristics. It allows for meaningful descriptive and exploratory analyses both within and across building types and household profiles, thus providing valuable insights for policy design.

² The difference between overall references (826) provided by the public authority managing the residential housing and the number of phone contacts made for the interviews (618) is due to wrong or not working phone numbers in the system.

construction of the building, presence of disabled persons. As no noteworthy differences were found, it was possible to conclude that the sample was representative of the reference population.

In more than four out of five cases, the survey was completed directly by the holder of the rental contract, although in 14.1% of cases the respondent was assisted by a family member (see Table 1 for related decomposition).

<i>Person providing assistance to the respondent</i>	<i>Shares</i>
Son	44.70
Wife	17.50
Husband	18.90
Brother	7.4
Other	11.50

Table 1. Person providing assistance to the respondent (shares)

The “typical” respondent is female (62%), with an average age of 60. Around 57% were born in Italy, while among foreign-born tenants, Moroccan citizens are the largest group, accounting for more than 23% of respondents.

Regarding education levels (Figure 3), 47% of the respondents hold only a lower secondary school certificate, while 31% have a high school diploma. In terms of employment and income, 73.9% of respondents reported being employed or pensioners, while 2.2% declared being unemployed and 7.6% looking for employment (Figure 4). The share of housewives is limited, at 6.2%. It should be noted that self-reported data can suffer from misreporting, and it could differ from the administrative information provided by the housing authority; this difference might be more relevant in the 18.7% of cases in which the questionnaire was not answered directly by the contract holder.

Household income levels are low. The average monthly net income reported is slightly above €1,100, corresponding to an average annual gross income just slightly above €13,000. Household size varies considerably: 37% of respondents live alone, while 24.6% belong to households with at least four members, with an average age of the person assigned the accommodation of 49 years and more than the 10% above the age of 65. A striking finding is that in 40% of families, at least one member has a disability, adding further vulnerability to already fragile socio-economic situations (Table 2).

<i>Number of people with disabilities in the family</i>	<i>Shares</i>
1	37.0
2	23.9
3	14.4
4 or more	24.6

Table 2. Number of people with disabilities in the family (shares)

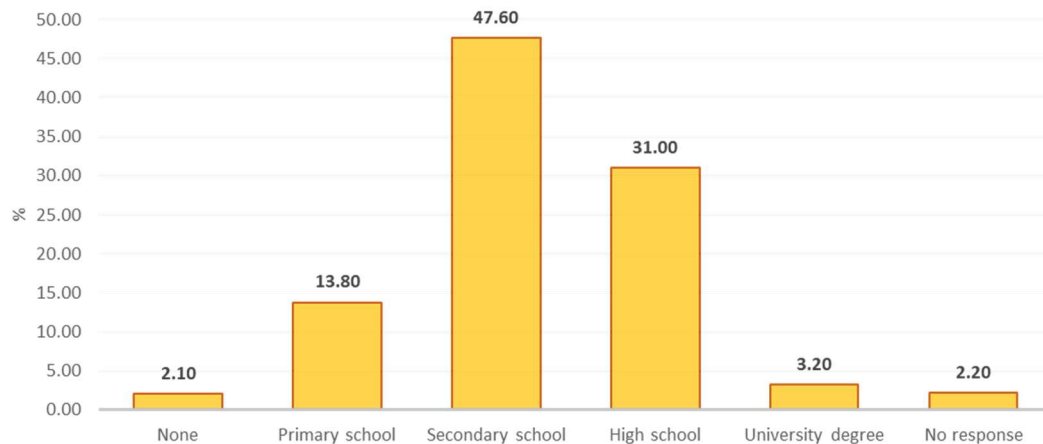


Figure 3. Respondents by education level



Figure 2. Shares of employment status and household size.

The status of the building stock and cooling and heating equipment

Figures 5 and 6 summarise the condition of the buildings in which the respondents live, created by combining information sourced from the database provided by the local authority, thus collecting construction and energy features, as well as administrative records, with feedback provided during the interviews. The analysis of the first source shows that half of the buildings date from before the 1990s, meanwhile, 47% date from the period 1991–2020. The majority are townhouses (56.1%), followed by tower buildings (14.9%), single-storey buildings (11.3 %), standalone buildings (11.1%) and stepped buildings (6.5%). The average year of intervention for the limited number of renovated buildings in the sample is 1997. The average size of a residential unit is 62 sqm. The largest part of the buildings in the sample have a centralised heating system (Table 3).

<i>Type of heating</i>	<i>Respondents/ Sample shares</i>	<i>Population shares</i>
Centralized	88.8	85.5
Indipendent	11.2	13.5

Table 3. Types of the heating (sample and population shares)

Analysis of responses to the questionnaire indicates that only 7.4% of respondents are responsible for the maintenance of hot water boilers, while 88.6% are not. Those in charge of it declared that they perform the maintenance on time.³

Furthermore, almost 60% of the respondents reported that they cannot rely on any type of air conditioning; 26.7% use a non-portable air conditioner (cooling only) for a single room; 8.8% portable ones, and 6.7% have multi-split systems that cool the entire home (including multi-split heat pumps). Even when available, respondents reported paying close attention to reducing the use of the cooling systems, mainly due to financial constraints.

³ The average score was 9.66 out of 10, where 10 refers to 'in-time maintenance'.

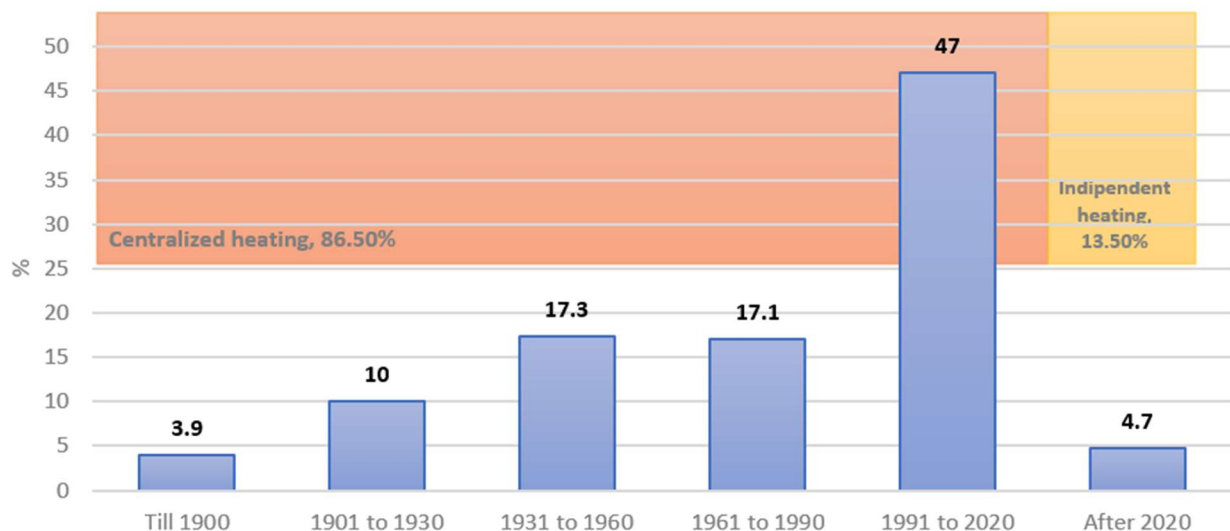


Figure 5. Shares of buildings according to the year of construction and type of heating

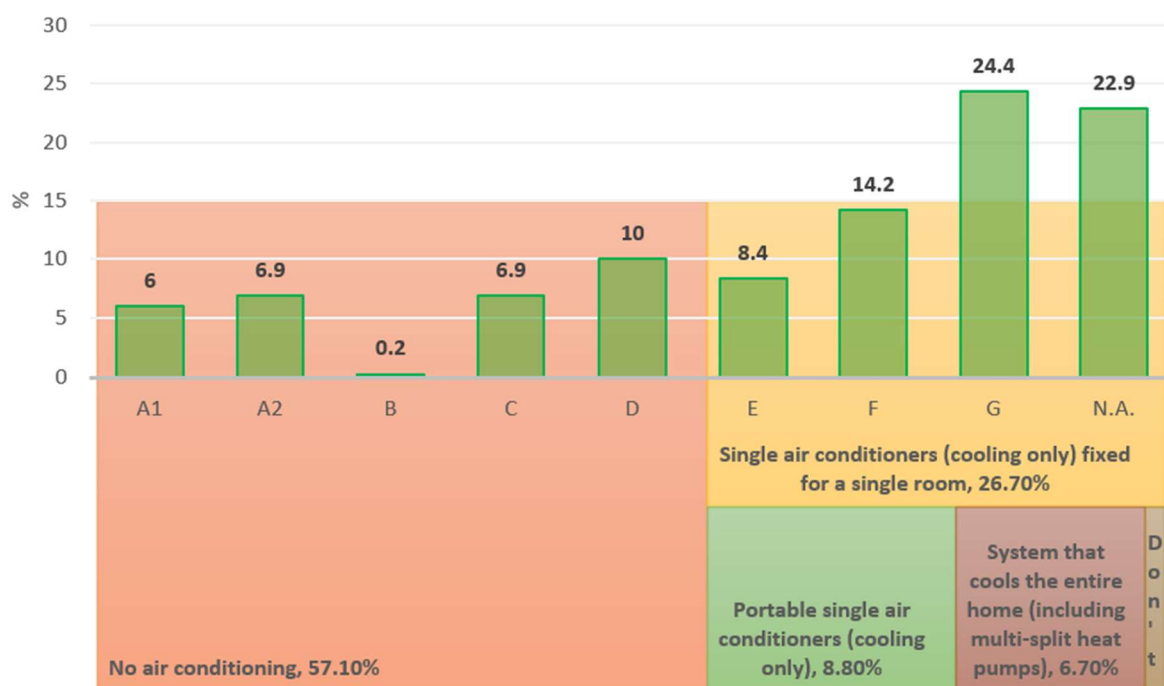


Figure 6. Shares of buildings energy performance class (with A1 as the maximum efficiency level and G di lowest one, while N.A. is collecting all the buildings without certification) and air conditioning mapping

Economic fragility and energy bills

Among the most relevant outcomes of the survey, we have that only one out of five families can reach the end of the month without financial difficulties after paying their energy bills. Roughly half of the respondents admitted to having delayed rent

payments at least once (Table 4), and in most cases more than twice, suggesting recurrent problems of affordability in the last year.

<i>Users in arrears/not in arrears</i>	<i>Respondents/ Sample shares</i>	<i>Population shares</i>
Users in arrears	39.40	38.40
Users not in arrears	60.60	61.60

Table 4. Types of the heating (sample and population shares)

The average declared monthly expenditure on energy is about €216, with expenditure rising with an indicator of the overall equivalized income and wealth situation (ISEE; Figure 7 and 8). This burden is considered by most respondents to be excessive in relation to their income and is higher compared to the previous year (Figure 9 and 10). To cope with these costs, a non-negligible share of tenants reduces their heating use, with almost 20% reporting that they did so to a significant extent. 44.3% of respondents stated that they had received a financial bonus to cover electricity/gas expenses. The majority of these were households with an ISEE of €9,233 or less, who were more likely to have received this financial support.

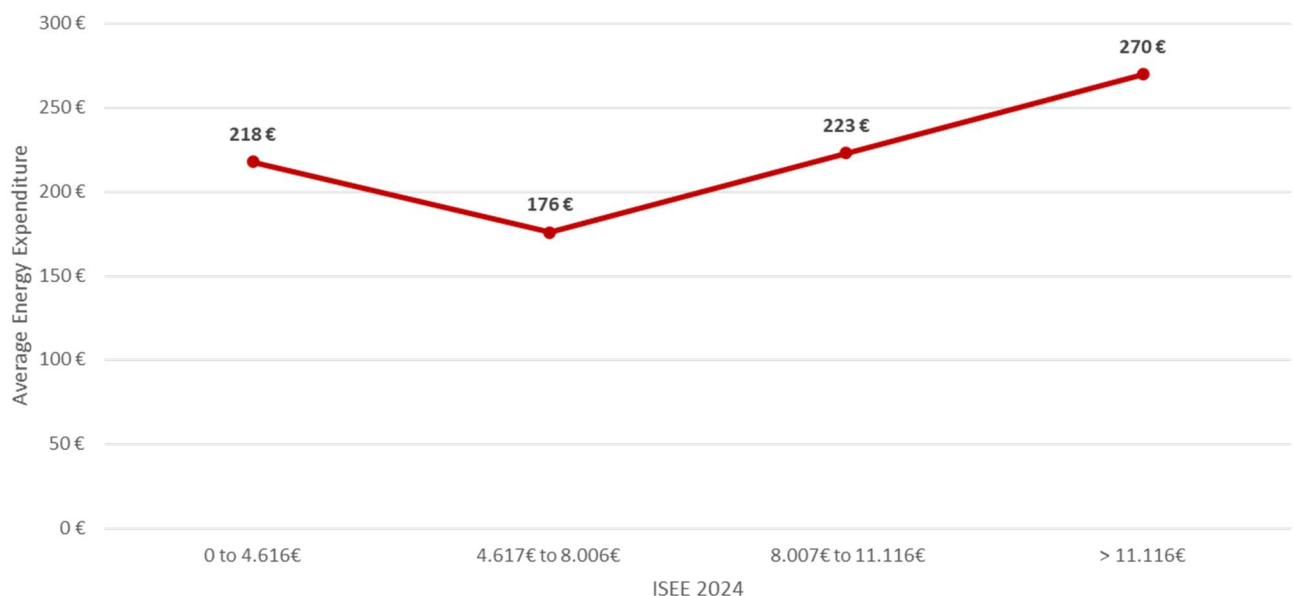


Figure 7. Average energy expenditure by ISEE 2024 intervals

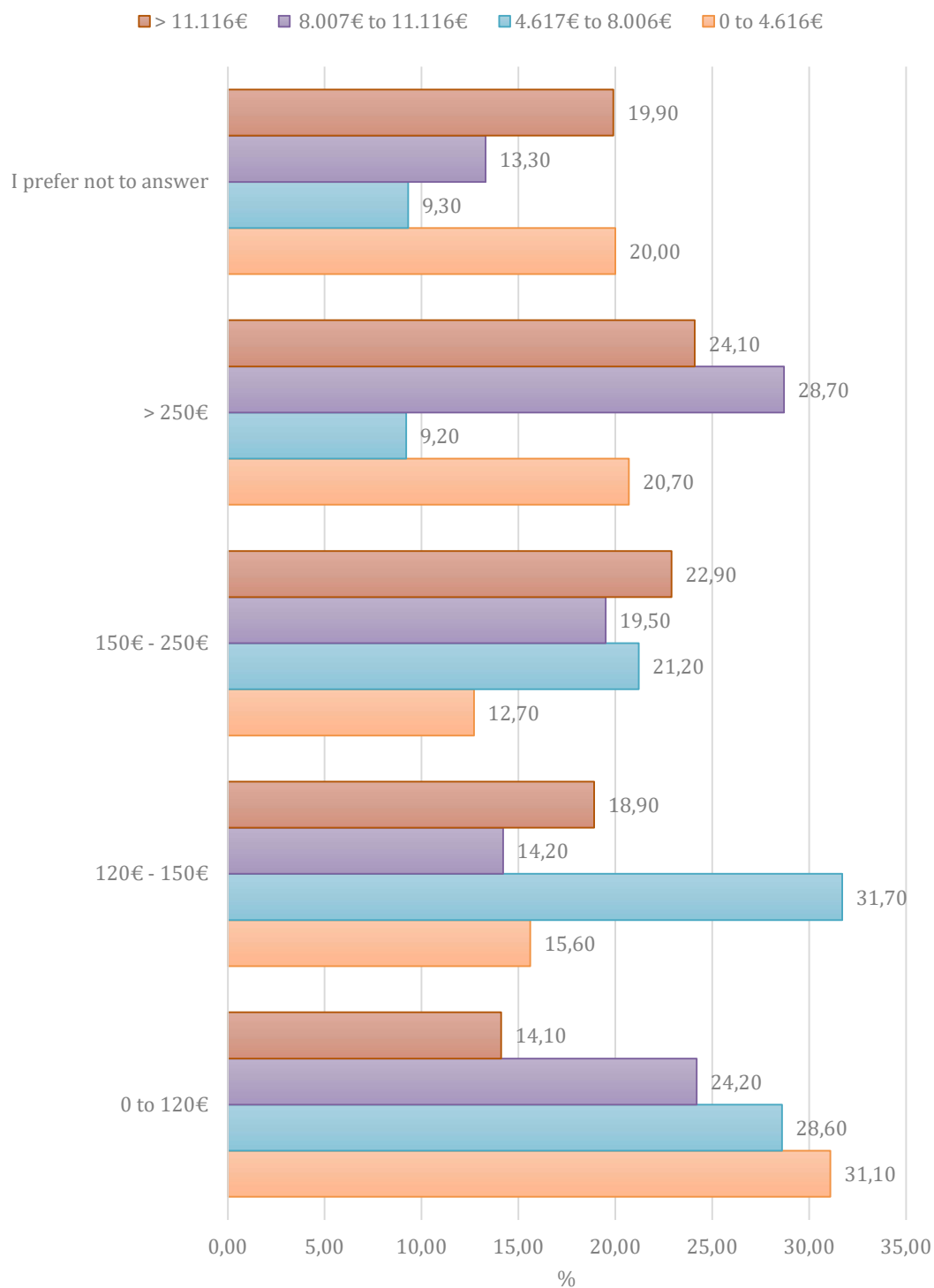


Figure 8. Shares/Distribution of households by ISEE level (x- axis and color) and energy spending class (y-axis)

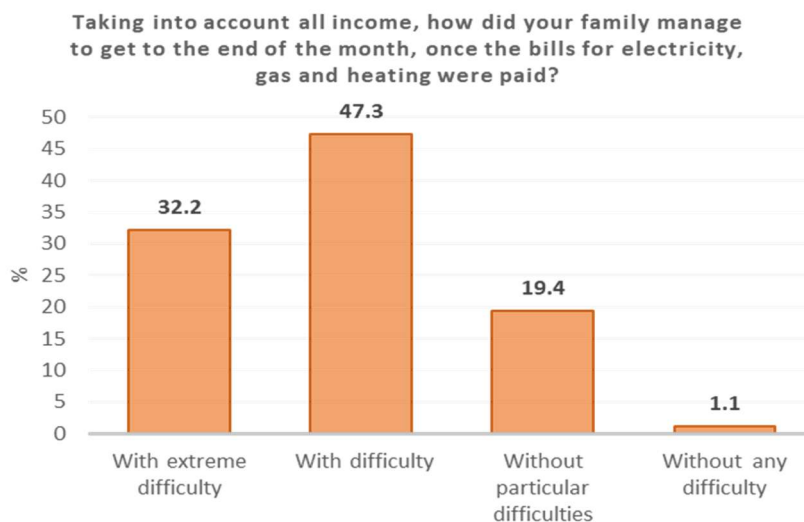


Figure 9. Impact of energy bills on income

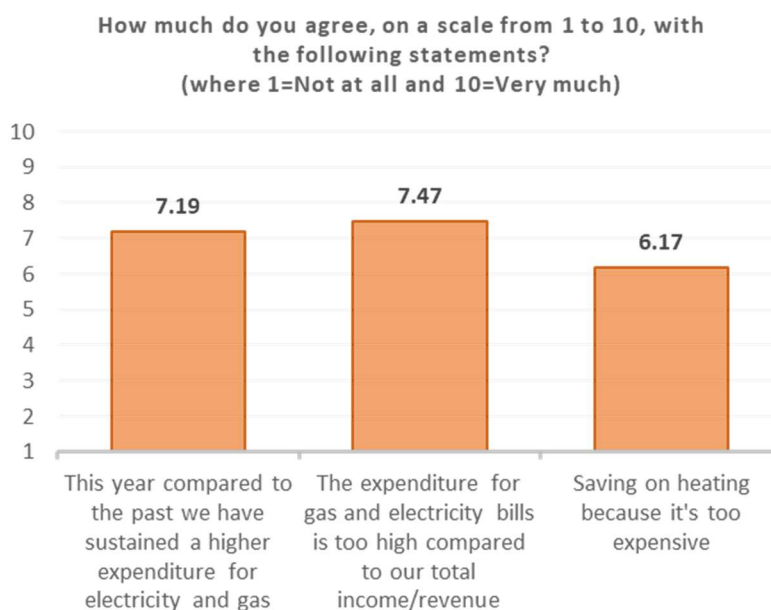


Figure 10. Energy expenditure perception and relation to income/revenue

Willingness to pay for buildings renovation

The questionnaire contained a set of items aimed at assessing respondents' willingness to pay for building renovations, measured through their level of agreement with a statement on a scale from 1 (totally disagree) to 10 (fully agree). Once the need for building renovation is assessed, the average value assigned is 5.1. However, once considering interventions specifically aimed at improving thermal comfort in winter, the average value increases to 5.21 (Figure 11).

In Figure 12, the willingness to pay for renovations is mapped in terms of additional monthly rent (10, 25 or 50 euros). More than 72% of the respondents said they would not pay anything extra for renovating their homes, even though this would ensure better thermal comfort and prevent utility costs from rising only 8% of the respondents are willing to accept a monthly rent higher than the minimum option (10 euros) and about 2% the highest one (50 euros).

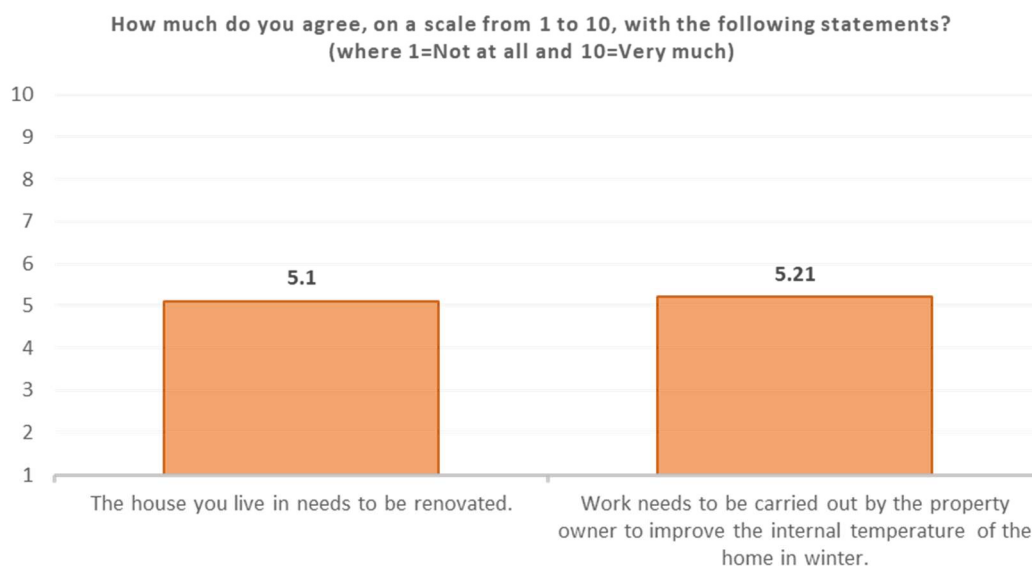


Figure 11. Need for building renovation (average values)

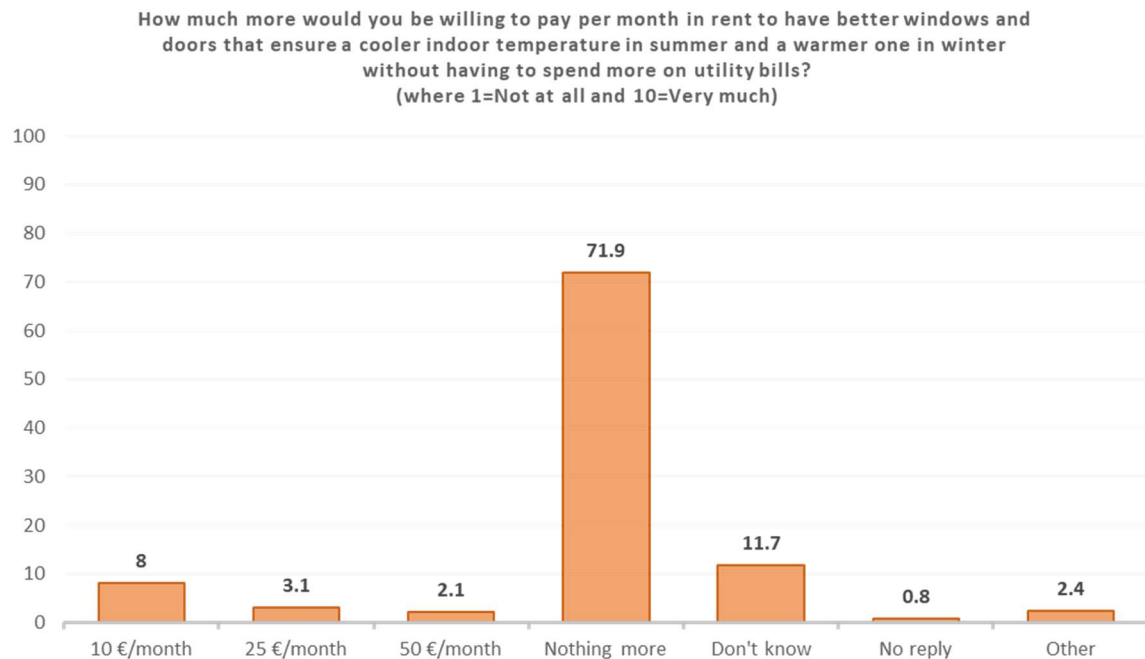


Figure 12. Willingness to pay for renovation (average values)

When we relate the respondents' willingness to pay monthly rent for better windows and doors to ensure temperature comfort to the buildings' construction year (Figures 13–14), we find that the highest number of positive responses are provided for buildings constructed in 1906 (4 out of 35), followed by 3 out of 35 for construction years 1914, 1985, 2001 and 2014 (thus 12 responses). The last two years refer to the construction year with the highest number of buildings (Figure 5). 1985 falls into the second category, while 1916 belongs to the second-to-last category and is associated with the highest number of responses and monetary values in terms of willingness to pay.

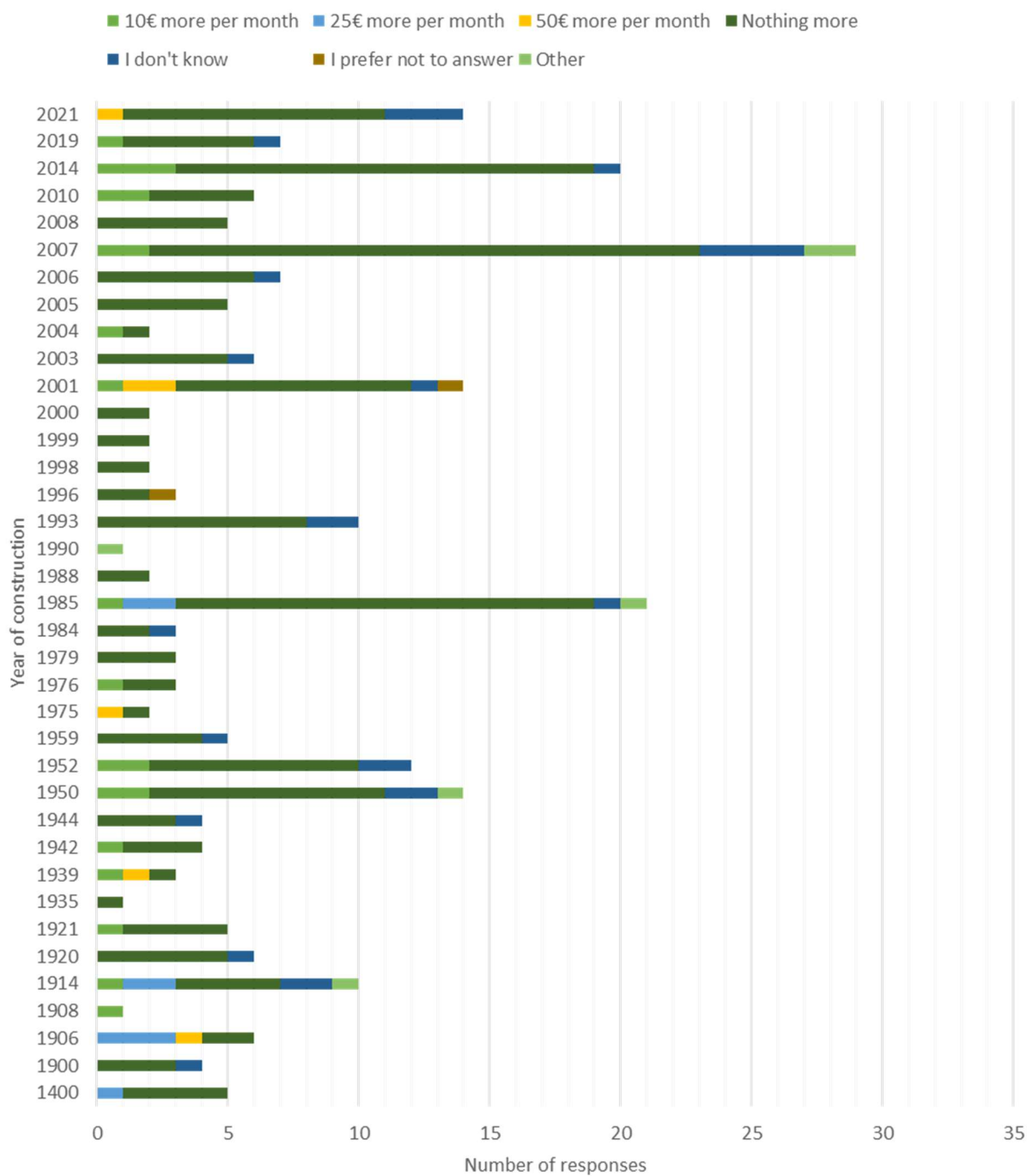


Figure 13. Willingness to pay a monthly rent premium for better windows and doors to improve the temperature of buildings constructed in different years (number of responses across the construction years of the buildings, with a total of 249 responses)

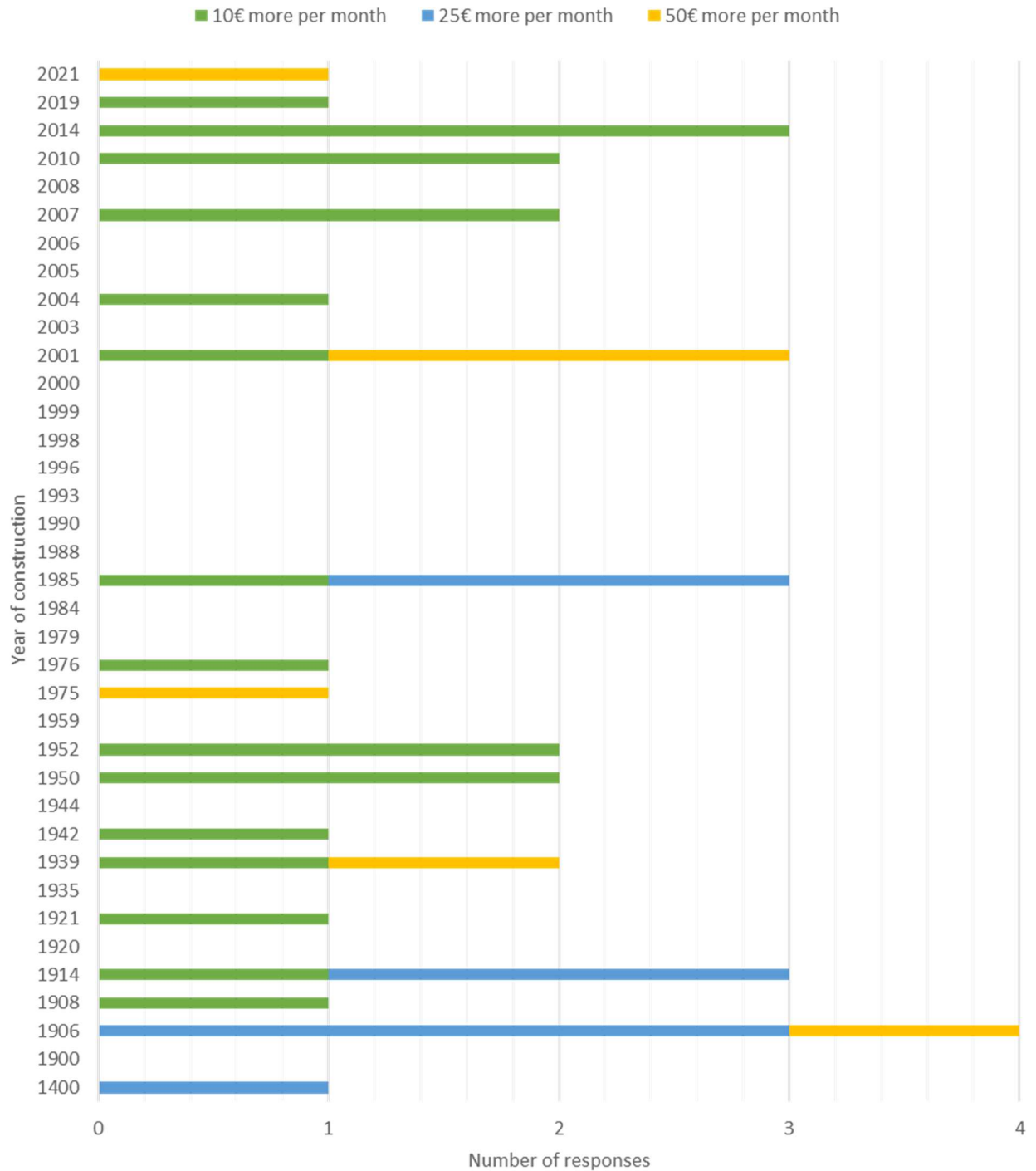


Figure 14: Positive willingness to pay a monthly rent premium for better windows and doors to improve the temperature in buildings constructed in different years (number of responses across buildings' construction years among those respondents willing to pay something – total responses 35 out of 249, i.e. 14%).

4. Policy implications

4.1 Distributional Effects of the Superbonus and Ecobonus Programs in Italy

Overall, the study concludes that Italy's energy-retrofitting incentives have had an uneven distributional impact. The regressivity of the programs stems from the fact that lower-income households face more significant financial, informational, and administrative barriers to participation. Once these barriers are overcome, the allocation of public funds becomes more equitable. These findings have broad implications for the design of future climate and energy policies, underscoring the need to complement tax-based incentives with upfront grants or easily transferable credits and to strengthen targeted outreach to ensure that the green transition does not reinforce existing social inequalities.

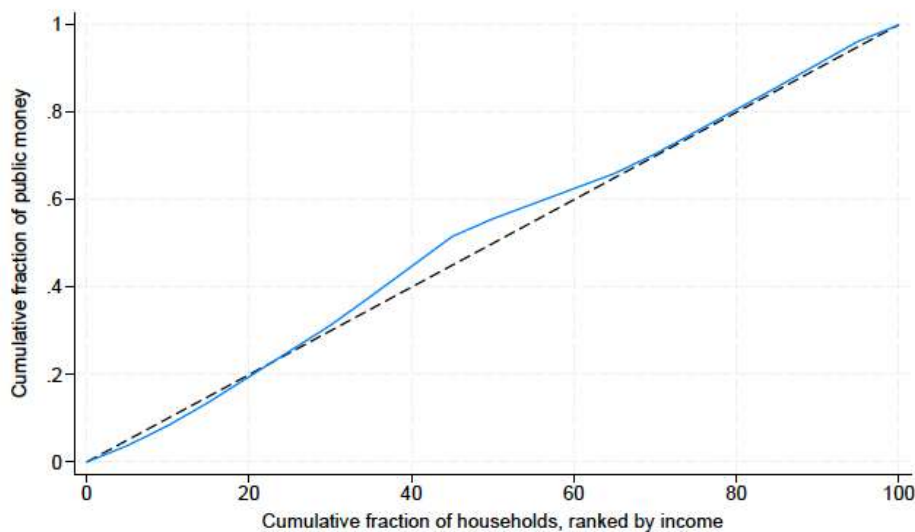


Figure 15: Concentration curve for all households who live in retrofitted dwellings and used some share of public money

4.2 A survey of public housing tenants on the energy efficiency of their homes, energy expenditure, and thermal comfort: outcomes from the pilot project in the province of Reggio Emilia, Italy

The findings confirm that public residential housing tenants face multiple and overlapping vulnerabilities: low incomes, high incidence of disability within households, frequent arrears in rent payments, and difficulty in sustaining energy costs. The combination of outdated buildings and limited capacity to invest in energy-efficient equipment exposes these families to energy poverty, both in its objective dimension (measured by expenditures and arrears), and in its subjective dimension (perceptions of high costs and reduced comfort).

The survey results provide valuable insights for policymakers and housing authorities. They point to the urgent need for integrated interventions that improve the energy performance of the housing stock, while at the same time addressing affordability, ensuring proper maintenance, and supporting vulnerable groups. By combining technical retrofitting with social policies, energy efficiency measures can become a lever not only for environmental sustainability but also for social inclusion and improved quality of life for disadvantaged households, allowing the achievement of a real “just transition”.

The survey results highlight a set of policy priorities for improving both the quality of public residential housing and the living conditions of tenants. A first and central implication is the need to tackle energy poverty as a multidimensional issue.

Households in public housing often combine low, and unstable incomes with dwellings of poor energy performance, generating a double burden that exposes them to higher utility bills, financial stress, and reduced comfort. Addressing this challenge requires policies that go beyond technical upgrading alone and that take into account the socio-economic profiles of tenants as well.

Energy efficiency interventions in public housing should therefore be designed in ways that maximise social benefits. Renovation programs must not only deliver reductions in energy use and emissions but also translate into tangible savings for households. This implies strengthening mechanisms that ensure cost reductions are passed on to tenants, while preventing situations where energy efficiency upgrades lead to rent increases or additional charges that neutralise potential benefits. Affordability must remain a guiding principle in the design and implementation of housing renovation strategies.

Another critical dimension is the support for vulnerable groups. The high incidence of households with members with disabilities, as well as the prevalence of single-person and elderly shows that retrofitting measures must be accompanied by targeted social support. This may include financial assistance for energy bills, accessible information campaigns, or dedicated services to help vulnerable tenants navigate new technologies and benefit fully from energy efficiency improvements.

The results further suggest that integrating administrative and technical housing data with tenants' perceptions is a powerful tool for policymaking. Objective indicators on energy use and building performance are essential, but subjective perceptions of comfort and affordability reveal lived experiences that numbers alone cannot capture.

Policymakers should therefore institutionalize mechanisms for combining quantitative and qualitative information, for example by strengthening survey-based monitoring at the local and national level. This would allow a more accurate identification of households at risk of energy poverty and a better targeting of interventions. Finally, the broader implication is that energy efficiency in public housing should be considered a lever for both climate policy and social policy. Investments in retrofitting reduce greenhouse gas emissions and contribute to national climate targets, but they also improve tenants' health, reduce arrears/increase disposable income, and enhance social cohesion by ensuring that disadvantaged households can live in safe, comfortable, and affordable homes. In this sense, energy efficiency is not only a technical or environmental issue but a cornerstone of inclusive and equitable housing policy.

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