Assessing Ecobonus as Energy Poverty Mitigation Policy: Is Energy Efficiency for All?

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1 Introduction

About 35 million EU citizens (approximately 8% of the EU population) were unable to keep their homes adequately warm in 2020, representing a critical issue with health, social, economic and environmental implications. This problem is likely to become more significant with the current crisis and surge in energy prices, with different effects according to the country energy dependence. In European Member States strategies to tackle with energy poverty, energy efficiency measures are more and more recognised as a long-term solution, to accompany and complement social security policies. The long-term objectives in clean energy transition could imply an increase in energy prices and then such a process could have consequences on energy poverty.

At European level, while there is common agreement on the main drivers of energy poverty (among which poor energy performance of buildings), there is not a shared definition of the phenomenon. In the directives adopted after the Winter Package, energy poverty has assumed a key role, which is also reflected in national policy strategies, such as the Integrated National Climate and Energy Plans (NECPs) and Long-Term Renovation Strategies of the Building Stock (LTRS). The role of energy poverty is becoming even more relevant with the Energy Efficiency Directive and Energy Performance of Buildings Directive recast. The phenomenon is relevant for the European governance and policy strategy at several levels (Papada and Kaliampakos 2018). The EU building stock needs, in the long term, to be renovated, converted to Nearly Zero Energy Buildings (NZEBs) as more as possible, and

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national renovation strategies should facilitate a cost-effective process, taking into account also that some households suffer an energy poverty condition.

An integrated approach could successfully deal with energy poverty, namely: choosing a comprehensive definition and to compare countries/regions; improving data availability and to integrate database; creating enabling conditions for energy efficiency potential to be exploited; implementing measures to address all relevant dimensions (split incentives, appliances, transport, etc.); recognising the role of non-technological actions; measuring energy poverty trend, to identify its main drivers and to elaborate sound projections.

The European Energy Network elaborated five recommendations for the European Commission (EnR 2019), which can be summarised as follows:

1. To introduce a unique EU energy poverty measure, which could be a Low-Income-High-Cost (LIHC) measure, and accompanying it by country-specific indicators, to be set according to country-specific characteristics;
2. To promote energy efficiency measures as key solutions to energy poverty, allowing for multiple benefits and structural change, and to act at local level;
3. To develop an integrated approach to tackle with energy poverty and to elaborate policy responses at country level;
4. To examine energy poverty implications in terms of cost distribution of the measures adopted to achieve the long-term energy and environmental objectives;
5. To recognise that training and information campaigns are essential to achieve a behavioural change and then boost the rate of energy renovation of dwellings of household in energy poverty.

This work is focused in different ways to the points above. It tries to highlight the linkage that definition and measurement have with policy action. It investigates MS strategies for energy poverty mitigation and provides a contribution in assessing if the policies in force are effective. In particular, most energy efficiency policies have been conceived with a wider scope than energy poverty mitigation: they are targeted also to energy-poor households, namely to households facing difficulties in satisfying their energy needs, but not specific to them. A crucial aspect is to check if they have differentiated impacts on different income groups, in terms of who is using the financial incentives or who is paying their cost. In this vein, a case study will be provided concentrating on the main energy efficiency policy for residential sector in Italy, namely the tax relief scheme for energy renovation of existing building stock (Ecobonus). This policy is mentioned in the Italian NECP as a key policy to achieve the 2030 energy-saving target. In the case study the regional differentiation in access to the tax relief scheme for energy efficiency is investigated, as a proxy of the effectiveness of Ecobonus in tackling energy poverty.

The chapter is structured as follows: first, the indicators available in the EU and the strategies adopted for energy poverty definition are briefly described, focusing on Italy for the latter; second, the trend in EU legislation is described as well as the different policy approaches for mitigation, providing an overview at MS level and a more detailed description of Italian policy mix; third the investigation method is

described and its results provided; last two sections are devoted to discussion and conclusions.

2 Energy Poverty Measurement and Definition

In order to understand the incidence of the energy poverty phenomenon and effectively deal with it at policy level, the availability of proper data and measurement options is certainly a key issue. It is widely acknowledged in the literature that there are three main components at the basis of energy poverty (Ntaintasis et al. 2019; IEA 2011; BPIE 2014; Papada and Kaliampakos 2018; Bouzarovski and Petrova 2015; Pye et al. 2015; Ugarte et al. 2016; J. Schleich 2019): low household income; high/growing energy prices; inefficient energy performance of buildings concerning thermal insulation, heating systems and equipment.

These three components can be measured by different types of indicators and reflected in the definitions adopted by MS. There is a twofold link, since the definition is associated with the indicators available in the different countries but also to the adopted political strategies. According to the NECP, seven EU countries have an official definition of energy poverty and they are represented by Austria, France, Spain, Ireland, Cyprus and Italy. Also in the United Kingdom an official definition exists. In Italy a definition has been adopted in official documents as the National Energy Strategy and National Integrated Energy and Climate Plan, but it has not been officially adopted. In most of the countries the definitions are expenditure based.

Despite the growing attention devoted to energy poverty at EU level, shown in Clean Energy for all Europeans and later on in Green New Deal and Next Generation EU, a shared methodology to identify energy poverty households has not yet been elaborated. There is a general consensus on the multi-dimensional character of energy poverty; at the same time, indicators to adequately represent this complexity are not always available.

In order to help Member States (MS) to fight energy poverty, through the improvement of measuring, monitoring and sharing of knowledge and best practices, in January 2018 the European Commission launched the Energy Poverty Observatory (EPOV), consistently with Regulation 2018/1999. In 2021, the Energy Poverty Advisory Hub (EPAH) was created, building upon the work of EPOV.

EPOV selected a set of consensual (subjective) and expenditure-based (objective) indicators that should be used in combination in order to measure energy poverty. Primary[1] and secondary indicators are defined, and primary indicators are represented by (EPOV 2020):

[1] In particular, four different primary indicators for energy poverty are identified, two of which based on self-reported experiences of limited access to energy services (based EU Statistics on Income and Living Conditions—EUSILC data) and other two calculated using household income and/or energy expenditure data (based on Household Budget Survey—HBS data).

1) Consensual-based indicators

   - Ability to keep home adequately warm, based on self-reported thermal discomfort[2]
   - Arrears on utility bills, based on households' self-reported inability to pay utility bills on time in the last 12 months[3]

2) Expenditure-based indicators

   - M/2—Hidden energy poverty: absolute (equivalised) energy expenditure below half the national median
   - 2 M—High share of energy expenditure in income: share of (equivalised) energy expenditure (compared to equivalised disposable income) above twice the national median

Using information on EPOV website, these four indicators can be displayed also by second-level disaggregating variables: income deciles, tenure type, urbanisation density and dwelling type. Additionally, a set of 19 secondary indicators are extracted from different data sources, mainly the Eurostat (ESTAT) website, SILC and the Building Stock Observatory (BSO). They are relevant in the context of energy poverty, but not directly indicators of energy poverty themselves (e.g. energy prices and housing-related data). Each indicator captures a different aspect of the phenomenon. These indicators should be seen as a means to provide a snapshot of energy poverty issues, which can then be investigated in more detail in research and projects on the ground, exploring if this phenomenon is more widespread than expected across the EU.

As shown in Table 1, the incidence of energy poverty in a country crucially depends on how it is measured: for example, in Portugal, Lithuania, Cyprus and Bulgaria the share of energy poor is relatively high with the consensual indicator "Ability to keep home adequately warm" and it becomes almost 1/3 lower with the expenditure based M/2 indicator ("Hidden energy poverty"). In Italy, estimates for 2 M indicator show that in 2015 energy poor are 15,5% of total population (ADL), implying a relative stability of the share except for the indicator "Arrears on utility bills". As clearly shown in the maps in Fig. 1, the different aspects of the phenomenon measured by the indicators overlap only partially. In other words, different indicators capture different segments of the population.

Table 2 provides an overview of indicators available at country level when a specific component of energy poverty is investigated, namely energy poverty in the rented sector. This sector is highly fragmented and targeted policies are scarce if

[2] The corresponding question in the EU SILC survey is "Can your household afford to keep its home adequately warm?".

[3] The corresponding question in the EU SILC survey is "In the past twelve months, has the household been in arrears, i.e. has been unable to pay the utility bills (heating, electricity, gas, water, etc.) of the main dwelling on time due to financial difficulties?".

Table 1 Comparison of EPOV primary indicators in EU member states (share of population, %)

	Arrears on utility bills (2018)	Ability to keep home adequately warm (2018)	Hidden energy poverty M/2 (2015)	High share of energy expenditure in income 2 M (2015)
Austria	2,4	1,6	15,0	16,0
Belgium	4,5	5,2	9,8	13,0
Bulgaria	30,1	33,7	9,4	11,5
Croatia	17,5	7,7	7,5	12,0
Cyprus	12,2	21,9	13,2	12,0
Czechia	2,1	2,7	9,2	10,8
Denmark	5,1	3	–	–
Estonia	6,5	2,3	18,9	18,7
Finland	7,7	1,7	29,9	22,3
France	6,4	5	19,5	15,0
Germany	3	2,7	17,4	17,4
Greece	35,6	22,7	12,8	16,3
Hungary	11,1	6,1	9,3	9,0
Ireland	8,6	4,4	14,8	17,6
Italy	4,5	14,1	13,6	–
Latvia	11,6	7,5	10,7	12,7
Lithuania	9,2	27,9	14,4	13,9
Luxembourg	3,6	2,1	8,9	11,3
Malta	6,9	7,6	16,7	20,1
Netherlands	1,5	2,2	4,4	10,7
Poland	6,3	5,1	19,5	16,3
Portugal	4,5	19,4	6,8	15,1
Romania	14,4	9,6	16,8	16,9
Slovakia	7,9	4,8	7,9	9,3
Spain	7,2	9,1	13,0	14,2
Slovenia	12,5	3,3	8,9	13,9
Sweden	2,2	2,3	24,3	28,7
European Union	6,6	7,3	14,6	16,2

Source EPOV

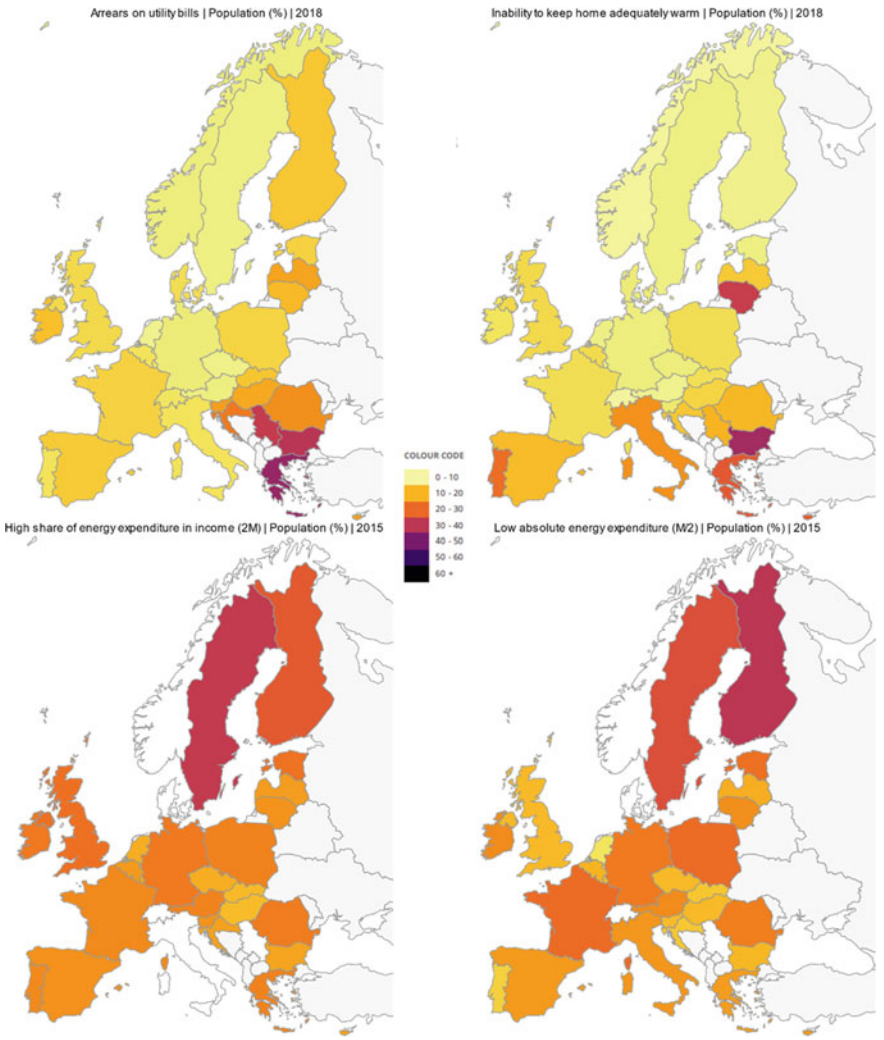

Fig. 1 Maps of EPOV primary indicators in EU Member States (*Source* Author' on EPOV data)

compared to social housing and homeowners' sectors. In addition, split incentives are a particularly relevant issue in delivering energy efficiency measures.[4]

As previously highlighted (Table 1, Fig. 1 and Table 2), each country made its own choices in measurement, given that no official EU-wide definition exists. Energy

[4] ENPOR projects investigates this specific aspect of the energy poverty phenomenon. Further information can be found in project deliverables such as D3.2 (https://www.enpor.eu/wp-content/uploads/2022/01/ENPOR-D3.2.pdf) and in analysis of national case studies, such as the German one (https://www.enpor.eu/27-05-22-enpor-submits-policy-recommendation-to-the-draft-law-on-sharing-co2-costs-between-tenants-and-landlords-in-germany/).

Table 2 Availability of indicators at different territorial levels

	National	NUTS1	NUTS2
Inability to keep home warm Arrears on utility bill Presence of leak, dump, rot Poverty risk	All MS	Austria—Belgium—Bulgaria—Croatia—Denmark—Estonia—Greece—Hungary—Ireland—Italy—Lithuania—Poland—Romania—Slovakia—Slovenia	Spain—Portugal—France— Czech Republic—Finland
Relative risk of asthma Size of the rental sector	All MS	–	–
Dwelling not comfortably cool High share of energy expenditure in income Low absolute energy expenditure Rented private housing energy poverty indicator	-	–	–

Source Author' on data from the energy poverty dashboard (https://www.enpor.eu/energy-poverty-dashboard/)

poverty measurement is controversial since the indicator choice is not neutral and the different pictures provided affect the adoption of mitigation policies. According to the non-binding requirements of the Integrated National Energy and Climate Progress Reports process, MS should measure and monitor energy poverty.

Italy anticipated this issue by using a new definition and measure in its 2017 National Energy Strategy, although this is not adopted as official definition. An ad hoc objective indicator was adopted, based on Faiella and Lavecchia (2015). The indicator combined three elements: the presence of a high level of energy expenditure, total expenditure below the relative poverty threshold, and a null value for the expenditure on heating. The measure is a Low Income-High Cost indicator, considering three dimensions: (1) a share of energy costs more than twice the average share of energy expenditure, (2) a household budget, after energy costs are deducted, below the national (relative) poverty line set by the National Statistical Institute (3) null heating purchases when total expenditure is below the median. Later on, the Integrated National Plan for Energy and Climate (NECP) adopted the same definition and in this work we refer to it.

According to this measure, in 2018 there were slightly more than 2 million of energy poor households (more than 5 million persons), equal to 8.8% of the total population. Energy poverty has a higher incidence in Southern Italy and in larger households.[5] According to the analysis in NECP, in 2007–2017 decade, the share

[5] More information can be found in 'Secondo Rapporto sullo stato della povertà energetica in Italia' (OIPE 2020).

of energy expenditure on the total has increased from 4.7% to 5.1%. This share is higher (around 8%) and it increased more (almost + 1%) for households in the first quintile of equivalent expenditure. When the official Italian indicator is computed by macro-region it is observed that North-East and North-West show lower shares of energy poverty, which instead are high adopting a hidden energy poverty indicator (OIPE 2020; ENEA, 2021).

NECP also developed energy poverty projections at 2030, using the following main drivers for energy poverty: the expected price trends for energy products, the trends in overall household expenditure, demographic changes and the trends in residential energy consumption and associated mix. Renovation rate of building stock is also relevant, as well as indirect benefits on sanitary system associated to a reduction in diseases related to living in apartments not adequately warm. According to the projections in NECP, in 2030 energy poverty incidence would remain in the range of 7–8%. This means that energy poverty would decrease by approximately one percentage point compared to 2016, corresponding to approximately 230,000 households; due, among others, to a number of people over the age of 65 equal to a quarter of the total in 2030, and to a fall by 15.5% of residential consumption in 2030 relative to 2016, with a growth in the electricity component against a reduction in natural gas. Clearly these projections are likely to be significantly affected by the recent geopolitical and energy prices developments.

Indeed, current energy prices are very likely to increase the number of energy poor household. Each household will experience a very significant surge in energy expenditure and thus, in some way, an increase in the risk to fall in energy poverty condition. Consumers' vulnerability can be considered connected with energy poverty (see next Section) and this confirms, once again, the interesting opportunities provided by energy efficiency technologies as well as behavioural solutions. Also the projections and targets for annual requalification rate developed in the Long-Term Building Renovation Strategies in 2021 are likely to affect the incidence of energy poverty at national level. An annual renovation rate in the range 0.6%-0.8% would be needed in residential sector to reach the 2030 NECP objective; clearly, apartments inhabited by energy poor household should be involved in such renovations and the financing of such interventions is a relevant challenge in the policy agenda.

3 Policy Strategies

Moderation of energy demand is one of the five dimensions of the Energy Union Strategy established in 2015. The vulnerability condition is mentioned for the first time in the second energy package (Directives 2003/54/EC and 2003/55/EC) and with the third energy package (Directive 2009/72/EC) energy poverty is explicitly indicated as one of the conditions determining vulnerability.

Over the past decade, the EU has increased its efforts to reduce and mitigate energy poverty, making it a key concept in the Clean Energy for All package adopted in 2019. Indeed, the package proposed a range of measures to address energy poverty through

energy efficiency, safeguards against disconnection and a better definition and monitoring of the issue at MS level through the integrated National Energy and Climate Plans (NECPs). As a consequence, the EU legislative context for energy poverty underwent several changes. Energy poverty is currently mentioned in the Energy Efficiency Directive (2018/2002), the Energy Performance in Buildings Directive (2018/844), the Electricity Directive (944/2019) and the Governance Regulation (2018/1999).

As specified in the Directive 2018/2002, energy efficiency should be considered as complementary to social security policies when tackling energy poverty at MS level. Particular attention should be devoted to the accessibility to energy efficiency measures for consumers affected by energy poverty as well as to the cost-effectiveness and affordability of the measures for both property owners and tenants. Moreover, current building renovation rates are insufficient to meet the objectives of the Paris Agreement and buildings occupied by consumers affected by energy poverty are the hardest to reach. These are the reasons why the Directive states that, when designing the measures to fulfil energy saving objectives, MS should take into account the need to alleviate energy poverty in accordance with criteria established by them. To do this, they could require "a share of energy efficiency measures under their national energy efficiency obligation schemes, alternative policy measures or programmes or measures financed under an Energy Efficiency National Fund, to be implemented as a priority among vulnerable households, including those affected by energy poverty and, where appropriate, in social housing" (article 7).

The EU Regulation 2018/1999 on the Governance of the Energy Union and Climate Action sets out that MS in their NECPs "assess the number of households in energy poverty taking into account the necessary domestic energy services needed to guarantee basic standards of living in the relevant national context, existing social policy and other relevant policies, as well as indicative Commission guidance on relevant indicators for energy poverty" (article 3). If MS find a significant number of households in energy poverty, a national indicative objective to reduce energy poverty should be included in their plan. Integrated reporting on energy poverty is consequently required, in terms of quantitative information on the number of households in energy poverty and available information on policies and measures addressing the problem.

Furthermore, according to Directive 2018/844, MS could define their own criteria to take into account energy poverty and establish which are the relevant actions for its alleviation, to be outlined in their long-term renovation strategies. Each strategy should encompass an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty (article 2).

According to the Electricity Directive, MS shall ensure the protection of energy poor and vulnerable household customers and may apply public interventions in the price setting for the supply of electricity to energy poor or vulnerable household customers (art.5). According to art. 28, the concept of vulnerability may refer to energy poverty and in particular to income levels, the share of energy expenditure

of disposable income and the energy efficiency of homes; the support for energy efficiency improvements is included among the actions to address energy poverty art. 29 states that MS shall define a set of criteria for the purposes of measuring energy poverty and that they shall report on its evolution to the Commission as part of their Integrated National Energy and Climate Progress Reports.

In 2020, as part of the Renovation wave strategy, the Commission published a Recommendation on energy poverty to support EU countries' efforts to tackle energy poverty. The recommendation provides guidance on adequate indicators to measure energy poverty and promotes sharing best practices between EU countries. Building on this recommendation, the Fit for 55 package, adopted in July 2021, proposed specific measures to identify key drivers of energy-poverty risks for consumers, such as too high energy prices, low household income and poor energy-efficient buildings and appliances, taking into account structural solutions to vulnerabilities and underlying inequalities. The Fit for 55 package also included a proposal for a revision of EED to put a stronger focus on alleviating energy poverty and empowering consumers. The recast proposal, which could be approved by the end of 2022, introduces an obligation for EU countries to implement energy efficiency improvement measures as a priority among vulnerable customers, people affected by energy poverty and, where applicable, people living in social housing. The criteria would take into account the different national contexts.

In autumn 2021, the Commission published the Communication "Tackling rising energy prices: a toolbox for action and support", where it lists a range of short- and medium-term initiatives that can be taken at national level to support and help the most vulnerable consumers. The EPBD recast also further stressed the importance of the mitigation of energy poverty in EU policies. According to recast, the alleviation of energy poverty is among the main considerations at the basis of the introduction of EU minimum energy performance standards to trigger the required transformation of the building sector. MS would need to provide adequate financial support and technical assistance, as well as to engage in the removal of barriers and the monitoring of social impacts, in particular on the most vulnerable. Connected to this, a wider new definition of "vulnerable households" is proposed, including also households with lower middle income that are particularly exposed to high energy costs and lack the means to renovate the building they occupy (new art.2).

In the vein of sharing best practices, the Commission Decision 2022/589 established in April 2022 the Commission Energy Poverty and Vulnerable Consumers Coordination Group, which aims to exchange best practices and increase coordination of policy measures to support vulnerable and energy poor households.

3.1 Energy Poverty Mitigation in EU Countries

The measurement of energy poverty is key to elaborate effective policy strategies. This is confirmed by comparing Table 2 in the previous section with Fig. 2. Indeed, MS having a high availability of indicators, not only at country level but also at NUTS

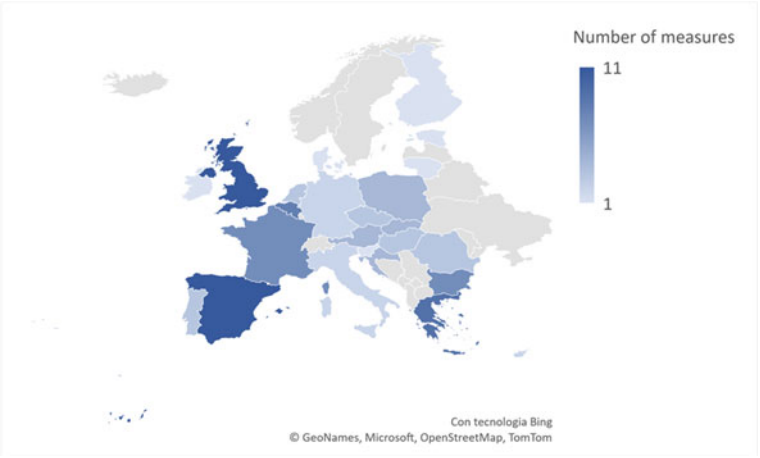

Fig. 2 Policy measures in different Member States (*Source* Author' on data from EPAH Atlas)

level 1 or 2 (Table 2), are likely to have a high number of policies, as depicted in Fig. 2, confirming the interlinkage between measurement and policy action (Faiella and Lavecchia 2021). It should be considered that Fig. 2 is based on the information available on EPAH Atlas, which is a database covering local, national and international projects and measures addressing energy poverty.[6] The list of local measures included there is not yet exhaustive, since the tool is continuously evolving and enriched by the uploading of new policy measures, as explained on the website. France and Spain represent countries having data at NUTS2 level and having also a significant number of policies in force.

Several policy approaches can be employed to fight and mitigate energy poverty. The approaches adopted by MS can be grouped in the following categories:

1. Support mechanisms to protect consumers, which lower energy cost by bill discounts or alternatively lower prices for specific customers;
2. Energy consultancies and information campaigns, aimed at promoting efficient energy use;
3. Financial tools to support energy efficiency, to sustain structural energy efficiency investments.

In addition to the three main components at the basis of energy poverty, namely household income, energy prices and building energy performance, a fourth one can be considered: it is represented by household behaviour. Behavioural economics could be helpful in this matter, suggesting two strategical actions (OIPE 2020). First one is related to improving the architecture of choices (nudging), for example, creating conditions to take better decisions relative to energy consumption, and second one to increasing competences (boosting).

[6] https://energy-poverty.ec.europa.eu/discover/epah-atlas_en.

The second category of measures above specifically deals with the behavioural component. Combining it with structural interventions, namely with the third category of measures, could prove to be particularly useful in order to effectively improve the living conditions of population segments affected by energy poverty. The most common approaches in MS are support mechanisms to protect consumers. They are followed by measures to improve energy performance of buildings targeted to energy poor households, which are becoming more frequent.

Support mechanisms to protect consumers are in force in Austria, France, Germany, Greece, Ireland, Italy Netherlands, Romania and United Kingdom. The discount is generally based on household component number and also, relative to gas bill, to expected temperature in the household territory. Some MS, among which Belgium, Greece, Portugal, Romania and Spain, have in force social tariff as alternative tools to support mechanisms.

The main schemes in the second category are EU-funded projects, such as ACHIEVE and ASSIST, as well as national schemes as those introduced in Czech Republic, Denmark, France, Germany, Spain and United Kingdom. They include: the analysis of energy bill, consumption and household behaviour; energy saving recommendations; assistance in identifying support mechanism that can be accessed (ENEA 2020). Information and training campaigns, conceived with wider scope and targets, can include specific activities devoted to energy poor households. This is the case of the ongoing campaign Italia in Classe A.

Financial tools include non-repayable fundings or subsidised loans, partially covering investment costs, and fiscal rebates, provided through tax reliefs in the years after the investment. Energy poor households can have difficulties in accessing financial tools due to several factors, such as: lack of competences to assess energy efficiency potential benefits and to access the incentive; lack of financial resources; insufficient fiscal capacity; decisional issues associated to living solutions in building blocks or rented apartments. In order to overcome such difficulties, some MS introduced targeted schemes to energy poor household: Belgium, France, Germany, Ireland, Poland and United Kingdom. They have common characteristics such as, for example, the presence of a promoting agent, different from the beneficiary; a higher intensity of the incentive; the exemption for the beneficiary to anticipate any funding for the investment (ENEA 2020).

A further categorisation can distinguish between protection and promotion measures. First type of measures are short term and they are aimed at ensuring a minimum level of energy services; bill discounts are included in this category. By contrast, protection measures have a long-term nature and they are able to introduce structural changes. This category covers the energy efficiency measures improving living conditions, as well as the measures improving awareness of household energy consumption.

3.2 Energy Poverty Mitigation in Italy

The Italian Integrated National Plan for Energy and Climate includes different measures to tackle with energy poverty, having different nature. In particular, they are categorised as follows:

- social measures, namely the electricity, gas and physical ailment bonuses;
- structural measures, the tax relief scheme for energy renovation of buildings;
- fiscal measures, namely the exemption from electricity and heating fuels excise duties respectively for households in the first consumption bracket and for households living in disadvantaged geographical areas.

Gas and electricity bonuses apply a discount on the final amount of the bill to customer having income lower than a specific threshold. The effectiveness of these measures had been hampered by their ability to reach only around one-third of the entitled households; for this reason they have become automatically granted since 2021.[7] Discounts are modulated according to the household size and the climate of the household location. Relative to the expenditure of a typical customer (annual consumption 2.700 kWh), in 2020 the electricity bonus was covered from a minimum of 24% (household with 1–2 components) of up to 33% (household with 4 or more components). The gas bonus represented from 3% up to 25% of the expenditure of a typical consumer (individual heating and annual consumption equal to 1.400 m^3).

NECP lists the tax relief scheme for energy renovation of existing building stock (Ecobonus) among the specific measures dedicated to energy poverty. Implemented as alternative measure under article 7 of EED (European Energy Efficiency Directive), Ecobonus allows the households in the no-tax area—which are likely to be energy poor—to transfer their tax credit to financial institutions, work suppliers or other private entities, reducing the investment cost for energy efficiency interventions.

ENEA collects the applications to access the incentive mechanism and is also charged of managing the monitoring system. Ecobonus incentive scheme has been in force since 2007: during the years, it was indeed confirmed by several Budget Laws, which introduced new features concerning, for some specific cases, tax credit rates, eligible actions and technical or performance requirements. In general, Ecobonus applies a tax relief on income tax paid by physical persons (or by companies), and the tax relief rate changes according to the eligible action considered.

According to 2018 Budget Law (Law dated 27 December 2017 no. 205) and 2019 Budget Law (Law dated 30 December 2018, no. 145), some examples of tax credit rates are:

- 50% for the expenses incurred for replacing windows and shutters, installing solar shading, replacing heating systems with at least class A energy-efficient condensation boilers;

[7] Decreto Fiscale 2019. Art 57 bis comma 5.

- 65% for replacing heating systems with at least class A energy-efficient condensation boilers and also installing an advanced thermoregulation system with efficiency classes V, VI or VIII as indicated in Commission Communication 2014/C 207/02;
- 65% for installing solar panels.

These tax credit rates are those relevant for the following analysis, evaluating Ecobonus incentive scheme based on 2018 data. The 2018 Budget Law also introduced a higher rate for energy efficiency actions on the building block and also for actions combined with anti-seismic interventions, for which the tax relief ranges from 70% up to 85% of the expense, depending on specific conditions. The Superbonus incentive scheme has been introduced in 2020 (Law Decree 34/2020, converted in Law 77, 17 July 2020), aimed to support deep renovation and at the same time to revitalise the economy during the covid pandemic. It incentivises energy efficiency and anti-seismic interventions on building blocks with a tax credit rate equal to 110%, reducing the number of payments from ten to five years and extending the tax credit transfer options. In this scheme, the tax credit rates for the expenses listed above change if the corresponding interventions are included in a deep renovation project. For example, the tax credit for windows and shutters becomes 110% if the intervention is associated to an intervention which improves building envelope and satisfies specific technical conditions.[8] These more recent legislative changes are not taken into account in the following analysis, since the evaluation is based on 2018 data.

The possibility of tax credit transfer for all eligible energy efficiency actions, for people in the no tax area and social housing institutes, was introduced by 2016 Budget Law (Law dated 28 December 2015, no. 209), and it was limited exclusively to suppliers who implemented works. For people in the no tax area, the tax credit transfer has been extended to other private entities, banks and financial institutions by 2017 Budget Law (Law dated 11 December 2016, no. 232). The tax credit transfer possibility is aimed to increase the access to Ecobonus scheme for households in difficult economic conditions, among which energy poor households are likely to be included. In the context of Superbonus incentive scheme the tax credit transfer has been extended to all taxpayers, not only those in the no tax area. After the first year of implementation, the tax credit transfer options have been restricted, with the aim of reducing the risk of carrousel frauds.

[8] More information on the Superbonus incentive scheme functioning can be found in Rapporto Annuale Detrazioni Fiscali 2021, https://www.pubblicazioni.enea.it/component/jdownloads/?task=download.send&id=459&catid=8&m=0&Itemid=101 as well as in the information leaflet available here https://www.efficienzaenergetica.enea.it/pubblicazioni/poster-riepilogativo-detrazioni-fiscali-2022.html

4 An Evaluation of the Ecobonus Incentive Scheme

The regional analyses developed in the last edition of Energy Efficiency Report (ENEA 2021) as well as those developed in the second report of the Italian Observatory on Energy Poverty (OIPE 2020) show a relatively higher incidence of energy poverty in Southern Italy. This result on energy poverty is in line with the incidence of relative poverty: high energy expenditures make critical situations even more problematic.

After having described the national definition of energy poverty and the overall mitigation strategy, in this section a methodological approach is defined to assess the effectiveness of a consolidated energy efficiency measure in mitigating energy poverty. In order to do so, a descriptive statistical analysis was applied and regional maps of the access to Ecobonus were elaborated. Italy offers an interesting case study because it combines a high climate diversity with heterogeneous socioeconomic conditions, as highlighted by recent studies on energy poverty in Italy (Besagni and Borgarello 2019).

4.1 Method

Based on information at regional level, namely ENEA microdata on Ecobonus, the possible relationship between household income and the access to Ecobonus is examined. Additionally, the method allows to investigate if this relationship changes for the different categories of interventions incentivised by the Ecobonus, such as the replacement of windows and shutters or of heating systems.

The hypothesis is that the incentive measure, in its current approach, has a regressive distributive effect on households, and it does not effectively support energy poverty eradication. To our knowledge, the relationship between income and interventions incentivised by Ecobonus has not been investigated before, neither at regional level nor in energy poverty framework.

The database of the Ecobonus incentive scheme includes data on investments in different types of interventions, based on different technologies, and on associated energy savings. Data on incentivised interventions are analysed in two different years, 2016 and 2018, namely before and post the introduction of the tax credit transfer.[9] To examine the results of Ecobonus incentive scheme at national level, a cost-effectiveness indicator can be computed, as the ratio between Euro spent per kWh saved. This indicator shows better values for interventions on envelope insulation, windows and shutters replacement and solar panels. Envelope insulation and windows and shutters replacement are also associated to a higher share of savings on the total; significant savings are also generated by replacing heating systems, in

[9] More recent data are available and can be found in the report on tax reliefs yearly published by ENEA, latest version available here https://www.efficienzaenergetica.enea.it/component/jdownloads/?task=download.send&id=559&catid=9&Itemid=101.

particular installing condensation boilers. The analysis of intervention distribution at national level also shows a relevant share of investment on buildings built before 1980 (77% of the total), which is consistent with a higher energy saving potential in these buildings. Finally, it is worth specifying that no information on households having transferred the tax credit is currently available in the database managed by ENEA.

The following analysis has its starting point by the higher incidence of energy poverty in Southern Italy shown by the adopted definition, and on this basis examines the regional distribution of investments activated by Ecobonus, considering different technologies. In particular, the ratio between regional investments, normalised (where relevant) to correct for climatic effects, and regional net available income will be shown in maps,[10] developed with a free online tool. This geographical representation is aimed at assessing the access to Ecobonus, showing evidence at qualitative and descriptive level. Some first insights on the effectiveness of Ecobonus in addressing energy poverty can be derived by connecting this evaluation with the available information on the geographical pattern of energy poverty incidence.

4.2 Results

At national level, 3.3 billion Euro of investments were activated by Ecobonus in 2016, among which 1.5 were associated to windows and shutters replacement and 950 million to envelope insulation. In 2018, total investment level was aligned and the replacement of windows and shutters was again the main component, with more than one billion of investments, followed by envelope insulation (900 million) and the replacement of heating system (slightly more than 870 million).

In 2018, regional total investments activated by Ecobonus incentive scheme range between a maximum equal to 785 million Euro and a minimum equal to 8 million Euro. Activated investments can be normalised by regional net available income, based on data provided by Italian National Statistical Institute.[11] After the normalisation, they show an asymmetric distribution. In fact, in 2016 only one region in Southern Italy was in the second quartile of the distribution, all the others being in the first one. The geographical incidence of energy poverty follows the opposite pattern, with a higher share of energy poor households in Southern Italy. The distribution of investments activated by Ecobonus slightly changed in 2018, with three regions in Southern Italy included in the second quartile (Fig. 3).

In terms of deviation from the average, Southern Italy regions are always below the national average, and this pattern has remained unchanged between 2016 and 2018.

[10] Maps are a tool more and more used to describe a wide range of phenomena, also thanks the availability of georeferenced data. Among others, it is interesting to mention the work by Hills (2012) devoted to map energy poverty in the United Kingdom and the work by Lelo et al. (2019), aimed at mapping a wide range of social phenomena in Rome.

[11] http://dati.istat.it/Index.aspx?DataSetCode=DCCN_SEQCONTIRFT, last accessed 2/12/2019.

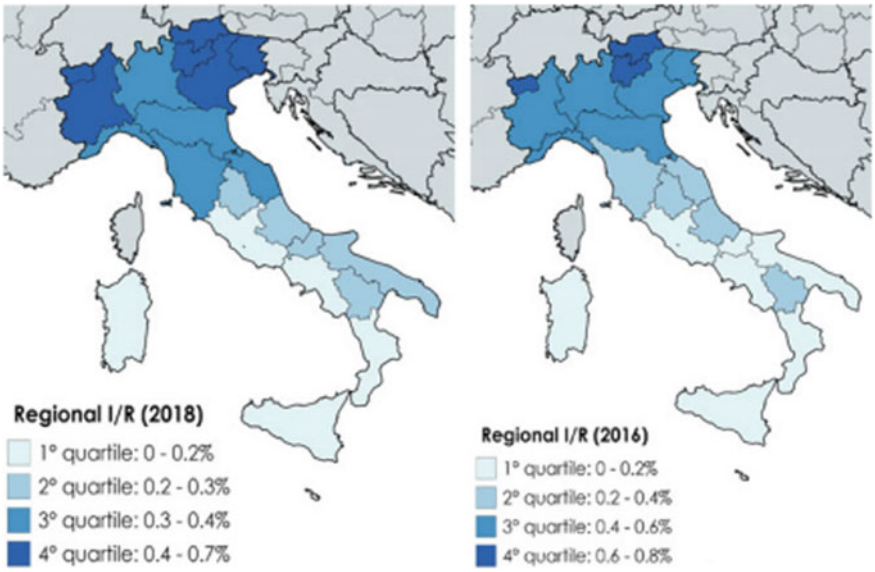

Fig. 3 Ratio between total investments activated by Ecobonus and net available income by region (I/R), 2018 and 2016 (*Source* Author' on ENEA data)

For example, Campania has the higher negative deviation from the average, followed by Sicilia and Sardegna, respectively in second and third position in 2018. By contrast, regions having higher positive deviation from the average are, in decreasing order, Trentino Alto-Adige, Valle d'Aosta and Piemonte.

The results can be mapped also relative to specific technologies, comparing 2016 and 2018: given their high share on total investment, windows and shutters, building envelope and heating system will be shown. For all these technologies, the investment activated by Ecobonus has been normalised by regional Heating Degree Days (HDD), available from Eurostat.[12]

In 2018, regional investments in the replacement of windows and shutters, normalised by HDD, range between 295 and 920 Euro per billion of net available income. The geographical asymmetry is less pronounced than for total investment, since already in 2016 three Southern regions are in the second quartile and another in the third one. An improvement in positioning of Southern regions is observed in 2018, with two regions in the third quartile and another in the fourth one (Fig. 4).

Regional investments in building envelope insulation, normalised by HDD, range between 120 and 965 Euro per billion of net available income in 2018. A pronounced geographical pattern is observed and a very slight improvement is observed, with a

[12] https://ec.europa.eu/eurostat/web/products-datasets/product?code=nrg_chddr2_m, last accessed 2/12/2019. In 2018, HDD in Italian regions ranged between a maximum value of 4,184 (Valle d'Aosta) and a minimum value of 946 (Sardegna). These two regions had the highest and lowest values also in 2016.

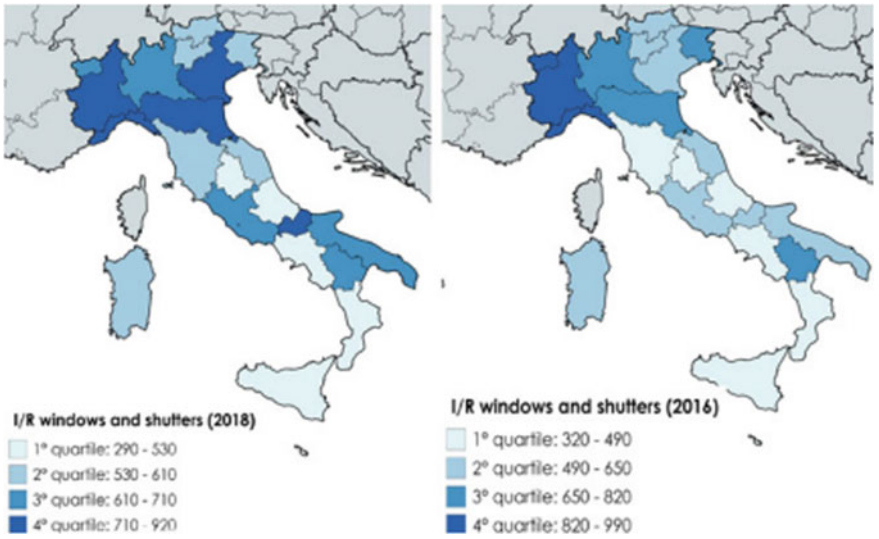

Fig. 4 Regional investments activated by Ecobonus normalised by regional HDD per billion of net available income (I/R), 2016 and 2018, windows and shutters (*Source* Author' on ENEA data)

Southern region moving to the third quartile and the number of regions in the second quartile of the investment distribution remaining unchanged (Fig. 5).

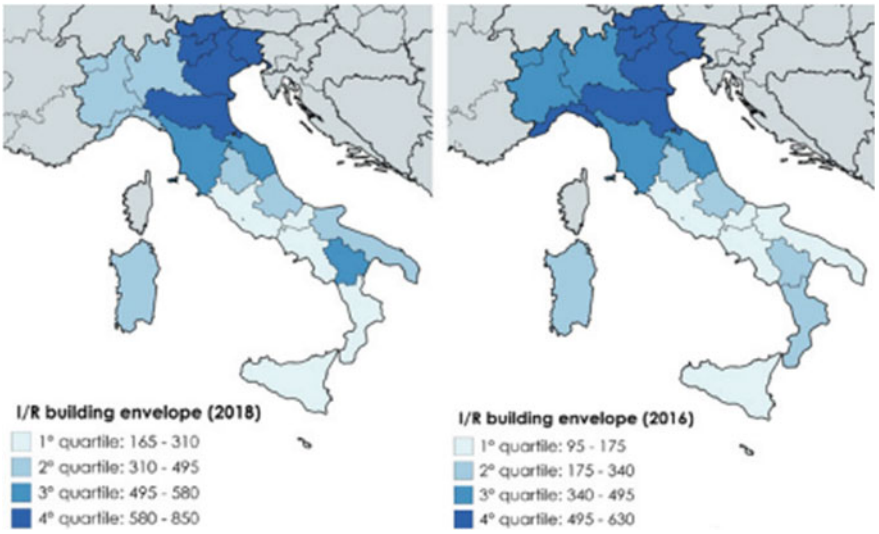

Fig. 5 Regional investments activated by Ecobonus normalised by regional HDD per billion of net available income (I/R), 2016 and 2018, building envelope (*Source* Author' on ENEA data)

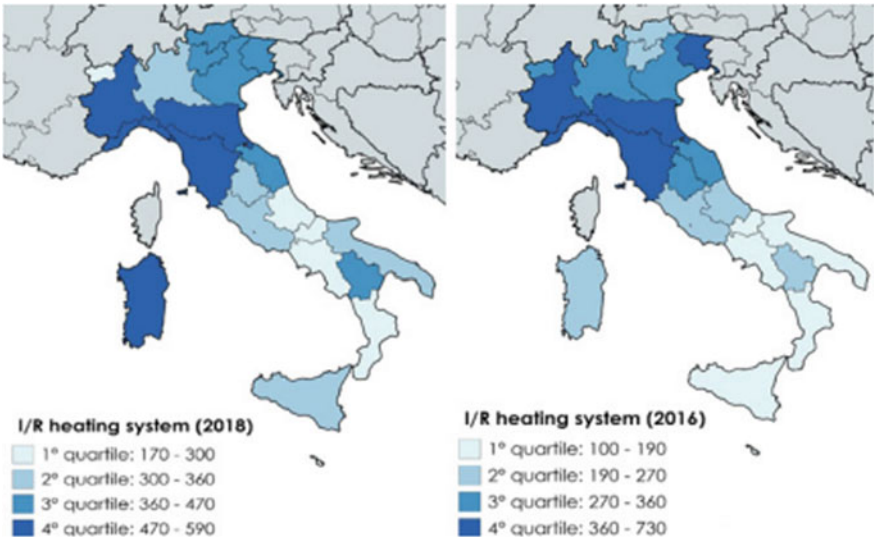

Fig. 6 Regional investments activated by Ecobonus normalised by regional HDD per billion of net available income (I/R), 2016 and 2018, heating system (*Source* Author' on ENEA data)

Looking at the replacement of heating system with a more efficient one, investments normalised by HDD range between 195 and 635 Euro per billion of net available income in 2018. The geographical asymmetry is again observed, as well as the improvement of Southern regions positioning in the quartiles. The number of Southern regions in the second quartile increases, and two regions pass in the third and fourth quartile (Fig. 6).

Finally, specific technologies which could theoretically have a larger potential in Southern than in Northern Italy, due to higher solar radiation, are investigated. This is the case, for example, of solar panel and solar shading; in 2018, total investments activated by Ecobonus in Italy amounted to 36 million Euro for solar panels and 128 million Euro for solar shading. For solar panels, regional investments range between zero and a maximum of 179 Euro per million of net available income; for solar shading, the range is between 10 and 223 Euro per million of net available income. The two maps shown in Fig. 7, relative to 2018 data, seem to suggest that a higher technology potential is not enough to support the access to Ecobonus incentive scheme in Southern regions. In other words, the higher potential in Southern Italy is not followed by a higher demand for tax reliefs at household level. This result is particularly relevant considering the fact that in energy poor household, renewable energy sources could represent a structural solution, similar to energy efficiency interventions.[13] The observed pattern could be due to, among others, the difficulties

[13] It is interesting to mention the local initiative "Reddito Energetico", financing small photovoltaic installations in buildings inhabited by energy poor households and also introducing a revolving

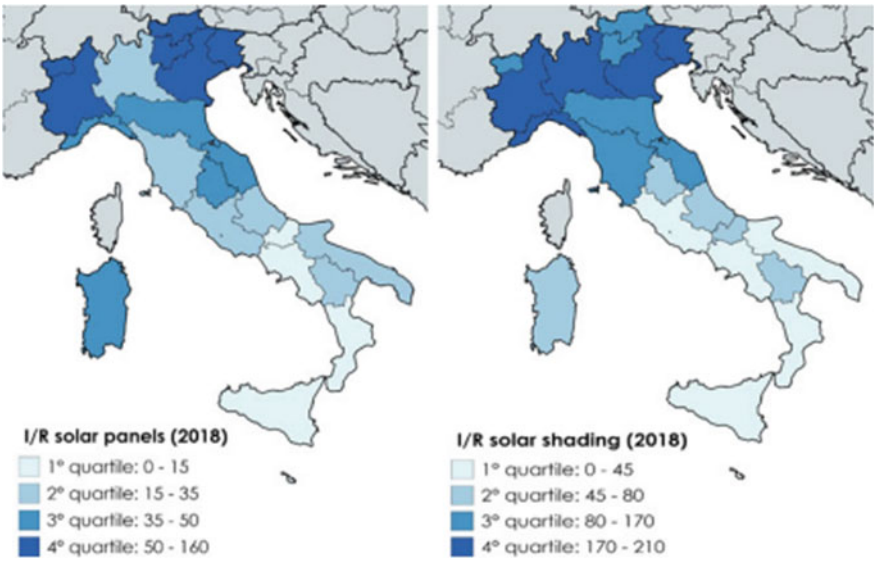

Fig. 7 Regional investments activated by Ecobonus normalised per million of net available income (I/R), 2018, solar panels and solar shading (*Source* Author' on ENEA data)

in accessing Ecobonus incentive scheme of household having a high potential but also a low-income level.

4.3 Discussion

According to the results shown in the previous section, Southern regions are very often in the lower distribution quintile of the ratio between investments activated by Ecobonus and household net available income. This is true at overall level (total investments activated) and also for specific technologies. In particular, this is true for both the technologies needing a correction for climate effects (interventions on windows and shutters, envelope insulation and heating system) and those having a higher potential in Southern Italy (solar panels and solar shading). The comparison between the first year in which tax credit transfer was made available (2016) and two years after its introduction (2018) shows small improvements in the access pattern at geographical level.

Italian NECP confirms that the results obtained through Ecobonus have been significant until now and that the incentive scheme will remain associated to a high saving potential in the next years. As described in Italian NECP, the overall cumulated contribution of tax reliefs to 2030 targets would be around 18.15 Mtoe of final

fund. This has been implemented by Gestore Servizi Energetici in Sardegna and more information can be found in Energy Efficiency Annual Report (ENEA 2019).

energy, which would cover almost all the saving target for residential sector.[14] Then, Ecobonus incentive scheme will certainly continue to play a key role to enhance energy efficiency in residential sector. The question is if the incentive would also contribute to energy poverty alleviation.

Indeed, some difficulties still remain for energy poor households to access Ecobonus, as already highlighted in general for the financial tools category. In particular, the beneficiary needs to anticipate the resources to finance the interventions, and until now the credit transfer has not been widely used. Moreover, limitations could also be linked to split incentives dilemma, in case of households renting their apartments.

Several development trends at policy level are envisaged in NECP to ensure and reinforce Ecobonus effectiveness in generating energy savings. Also in this case, it is worth to assess to what extent these interventions could contribute to increase the potential of the scheme in mitigating energy poverty. First of all, the tax relief schemes for energy renovation and for refurbishment of existing buildings would be optimised by integrating them into a single scheme. Additionally, this new scheme should provide a benefit scalable in relation to the expected saving, in order to reward those interventions with the best cost-efficiency ratio and to increase the trend towards deep renovation of buildings and seismic improvement. Finally, provisions aimed at promoting initial investments should be introduced, for example, extending the coverage and transferability of the tax credit and implementing a guarantee fund on green financing issued by credit institutions. This last intervention could modify the pattern in accessing Ecobonus incentive scheme for energy poor households.

Ensuring further adaptation of the Ecobonus incentive scheme to improve the access of energy poor households would be consistent also with the general approach proposed by EnR in its 2019 position paper. This analysis on the effectiveness of Ecobonus incentive scheme in tackling energy poverty and the eventual need to make it more suitable for energy poor households tries to comply with several EnR recommendations.

First, it is obviously in line with energy efficiency being a structural solution to energy poverty. Indeed, energy efficiency does not only alleviate energy poverty it acts on its causes, potentially allowing people to definitively exit their energy poverty condition. Supporting investments in building renovation would allow the strategies to contrast energy poverty to take into account that the energy needs change in an objective way according to technical building characteristics (Faiella et al. 2017). As widely known, energy efficiency is also associated to multiple benefits, such as social and health benefits, which are even more evident when energy efficiency interventions are implemented in energy poverty context (BPIE, 2014; Liddell and Guiney, 2015; Ntaintasis et al. 2019). If such benefits are opportunely translated into the investments' business plan, they may shorten the payback period and also

[14] Also the tax reliefs for refurbishment of existing buildings (Bonus Casa) would contribute to reach this overall figure. In 2018, interventions incentivised through Bonus Casa saved 0.225 Mtoe/year whereas those incentivised by Ecobnous 0.106 Mtoe/year. The contribution of Bonus Casa is calculated taking into account the energy savings generated by boiler substitution and not referring to other intervention in the renovation area.

increase the credit worthiness of low-income households. Besides, poorest deciles of the population are those where retrofit actions are usually more urgent, being more likely to live in non-refurbished homes with high fuel costs (Schleich, 2019). Ownership is another delicate issue to be taken into account: energy poverty condition could arise both in private residential sector, relative to households owning or renting their apartment, or in public residential sector, relative to social housing. Including renters among the eligible subjects of energy efficiency policies, as is the case in Ecobonus, could turn out not being fully effective due to the split incentive dilemma. Owners have no incentive to make investments whose benefits are mainly enjoyed by tenants and this problem could be especially acute in the energy poverty context. Sound solutions should provide incentives to both the owner and tenant, defining how multiple benefits due to energy efficiency could be split out among the two parties (Bird and Hernandez, 2012). Further research could extend this analysis to consider ownership information at regional level, to detect if relevant differences exist in accessing the Ecobonus incentive scheme. In Liguria region, Enershift project has promoted the use of Energy Performance Contract in social housing, according to an innovative financial mechanism that links energy efficiency incentives to the associated savings.[15] Finally, an innovative literature contribution (Vatikiotis, 2021) suggests that energy poverty could be an issue also in the context of micro-enterprises, which are managed at family level and very often share the company production and service sites with owners' living facilities.

Second, the regional figures shown in this work confirm the need of an integrated approach, where energy agencies work with regional and local institutions to promote and target the use of existing mechanism such as Ecobonus. As highlighted by Sanchez et al. (2020), in such a complex and multidimensional topic as energy poverty, governance should be a key element in promoting cooperation among different institutions. Additional resources can be provided by European structural funds, to be used both in private and public residential sectors, in particular in social housing. For example, several regional calls for tender have been published to finance energy renovation in social housing, and often these opportunities can also be associated with existing energy efficiency incentives such as Thermal Account.[16] Energy agencies could also contribute to the identification of consumers eligible for measures against energy poverty, for example, by looking at Energy Performance Certificates (EPCs) and to the associated integrated database at national level.[17] EPCs information could usefully complement the regional analysis developed here. Several studies use information from EPCs to investigate household vulnerability at municipal level: among others, Camboni et al. (2021) investigate energy poverty risk in Treviso, Fabbri and Gaspari (2021) use EPCs in mapping buildings that would imply

[15] Such a tool is perfectly in line with art.10 of Energy Performance of Building Directive (2018/844). More information can be found on the project website.

[16] More information on this incentive scheme for energy efficiency and renewable energy sources can be found in Ministerial Decree 16/02/2016.

[17] In Italy, an EPC integrated database exists and is managed by ENEA: it currently includes the EPCs from seven regions and two autonomous provinces.

risk of energy poverty in Bologna, Sanchez- Guevara et al. (2019) analyse summer energy poverty in London and Madrid and Yoon et al. (2019) study the water-energy nexus in low-income households in Barcelona. Although EPC certainly is a useful tool, it should be considered that referring to EPCs could provide partial information, since they are computed in simulated conditions and they do not refer to the effective energy use of a building. In general, the findings of different approaches in different countries confirm that low income and inefficient housing conditions interact to determine energy poverty: measurement and mapping of building conditions together with household in energy poverty would be very informative. This would also be of great importance to support the decision-making process in choosing the energy efficiency interventions to be adopted: despite the key role of insulation changing the overall building of thermal and energy performance, the replacement of windows, boiler and heating system is frequently preferred for they punctual nature, not requiring extensive and expensive works (Fabbri and Gaspari, 2021). Clearly, effective incentives may have a key boosting role in such a context.

Third, the analysis developed here is consistent with the need to deepen the knowledge on how existing energy policy measures could have differentiated impacts on income groups, in particular, in terms of who is paying their cost or who has better access to the financial incentives. If the distributive effects of energy policies are regressive, that is to say low-income households have a higher burden compared to richest ones, compensation should be envisaged or policy reforms should be implemented. Regressive effects of policy measures may worsen energy poverty incidence, as well as deteriorate indoor environmental conditions and, more in general, well-being of households (Berry 2019). This would be in deep contrast with the just transition principle, first used in the context of global employment movement (ETUC 2006) and then adopted in COP 21 and Paris Agreement (UNFCCC 2015). The principle is now one of the most prominent elements in the European Green Deal, to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind (COM/2019/640 final). Campagnolo and De Cian (2022) examined the distributional implications of climate-induced changes to household energy expenditure in 2050, comparing the response of different Italian regions and income groups. They also calculated selected expenditure-based indicators of energy poverty in different scenarios. According to their results, a carbon tax would increase the regressivity of climate change impacts, inducing the poorest deciles to spend more on energy. Also in this study the regional dimension proves to be important: indeed, the overall impact on energy poverty is the result of the decrease in heating demand due to global warming, which would affect in a different way Southern and Northern Italian regions. To make the transition socially fair, climate impacts, adaptation and mitigation should all be considered when designing policy actions.

Fourth and last, the efforts to improve the access to Ecobonus incentive scheme by energy poor households could also include training, information, dissemination and awareness-raising activities. To date, little attention has been given to dissemination and public awareness of the energy poverty issue (Bartiaux et al. 2016), as well as the way the topic is dealt with by the media (Scarpellini et al. 2019).

5 Conclusions

The evolution of EU legislation clearly points out that energy poverty should be considered more than a simple component of poverty. For this reason, it is important to elaborate indicators assessing its evolution and policy measures aimed at contrasting it. This is even more true in the context of clean energy transition. The results of this study would contribute to existing literature with implications for policymakers, to better understand how adjusting energy efficiency measures to deal with energy poverty.

The maps suggest that there is room for manoeuvre in further modifying the possibility of tax credit transfer, introduced in 2016, in order to facilitate lower income households in accessing the Ecobonus incentive scheme. Indeed, the analysis shows that two years after the introduction of tax credit transfer, a lower access to Ecobonus is still observed in Southern Italy regions, where the incidence of energy poverty is higher. As suggested in EnR position paper, energy efficiency measures could represent a structural solution to energy poverty. The low access to the Ecobonus incentive scheme in Southern regions confirms the need to apply a distributive analysis on the policy measures adopted to achieve long-term objectives. Clearly, regional policy action, in particular, associated to a targeted use of European structural funds, could help in making energy efficiency existing measures more effective in tackling energy poverty. An integrated policy approach, as well as action at local level and information and training campaigns, could help in improving the access to Ecobonus incentive scheme for energy poor households. Further research should explore which compensation instruments could be adopted to reduce the distributive imbalances potentially associated to existing energy efficiency measures. This is a relevant issue in our country since several measures mentioned in the Italian NECP may have had adverse distributive effects in last years (OIPE, 2020). At EU level, the revenues from the EU Emissions Trading System (ETS) extension to buildings and transport will be used through the newly established Social Climate Fund to address possible negative distributional effects.

This case study, devoted to Ecobonus, suggests also some general policy considerations. First, the need of a multidisciplinary approach to the assessment of energy poverty and on related mitigation strategies. Behavioural issues could indeed play a role in the decision-making for the implementation of specific energy efficiency interventions. This is true, in particular, for split incentives between landlords and tenants and also for decision process for interventions in building blocks. Second, and connected to previous point, looking at the interactions of different policy instruments is very much needed: for example, the effectiveness of financial tools to support energy efficiency in energy poor household may be improved if they are combined with targeted consultancies or awareness raising campaigns. Third, the perspective in tackling energy poverty would need to be widened, by looking both at consolidated issues, such as the distributional consequences of long-term energy and environmental objectives, and at newer ones, such as energy poverty risk in family-owned micro-enterprises.

Finally, further research would need to address the implications of pandemic on the energy poverty phenomenon in developed countries but also in developing countries. Looking at the access to energy services on a wider scale, shows that a strong inequality still characterises living conditions at global level. According to the World Energy Outlook (2020), as a consequence of the pandemic, only in Africa 100 million people will lose access to electricity. This seems to suggest that in order to sustainable development become a reality there is still room for behavioural change and awareness in everyday life. Energy sufficiency would need to inspire our behaviour and become more and more our standard of living.

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