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Targeted investments to address energy security and energy poverty

Shifting public spending from compensatory mechanisms on domestic energy use to energy efficiency and renewable energy measures

Freiburg/Berlin/Vienna,
July 2023

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Abbreviations

ANAH	National Housing Agency (France)
BEG	Federal subsidy scheme for efficient buildings (Germany)
CF	Cohesion Fund
CHP	Combined heat and power
CO_2	Carbon dioxide
eaD	Association of Agencies for Energy and Climate Protection (Germany)
EC	European Commission
EED	Energy efficiency directive
EP	European Parliament
EPC	Energy performance certificates
ERDF	European Regional and Development Fund
ESF+	European Social Fund
ESR	Effort sharing regulation
ETS	Emissions Trading System
EU-SILC	EU statistics on income and living conditions
FED	Final energy demand
FSATME	Social funds for energy management (France)
GDP	Gross domestic product
GHG	Greenhouse gases
GNI	Gross national income
GWh	Gigawatt hours
HBS	Household Budget Survey
JTF	Just Transition Fund
kW	Kilowatt
LEMON	Less Energy More OpportuNities (Italy)
MFH	Multi-family house

MS	Member States
Mt	Million tonnes
NGO	Non-governmental organisation
NKI	National Climate Initiative (Germany)
PAE	Energy Advice Points (Spain)
PV	Photovoltaic
RED	Renewable Energy Directive
RRF	Recovery and Resilience Facility
SCF	Social Climate Fund
SFH	Single-family house
SLIME	Local Intervention Service for Energy Management (France)
TIGER	Triggered Investments in Grouping of buildings for Energy Renovation (Italy)
TWh	Terawatt hour

1 Executive summary

The energy crisis in Europe following the war in Ukraine has put a high burden on many consumers with energy expenditure now taking up a substantial share of their income. For low-income households in particular the situation worsened considerably. Governments reacted by introducing compensation schemes of various sorts, mostly non-targeted.

The objective of this study is to gain an understanding of how national governments can better help their citizens prepare for the coming two winters (and also potentially extreme-temperature summers) by targeting public resources at energy efficiency and renewable energy measures, which nonetheless are not in contradiction with long-term measures leading to net zero emissions and can be rolled out to a large number of households. The study focuses on seven countries (France, Germany, Italy, Spain, Greece, Romania and Hungary) the following three elements:

- Firstly, we provide an overview of funding needs for compensatory measures in seven EU countries under different price projections (see Chapter 3).
- Secondly, we develop country-specific sets of energy efficiency and renewable energy measures and quantify the impact of their implementation on low-income households in these countries. The estimates include the impact on energy consumption, energy costs, greenhouse gas emissions as well as further indicators such as import dependency (see Chapter 4).
- Thirdly, an overview of different funding schemes at EU level and in selected countries to finance the abovementioned measures is provided in Chapter 5.

Compensating all households independent of their income requires substantially higher funding than providing targeted relief for vulnerable low-income groups. The budget needed to partially compensate all households is about three to four times higher – even if low-income households get compensation for about 80% of their additional energy costs. This calls for targeted relief for those who are most vulnerable.

Rather than providing direct compensation it is more sustainable to support households in investing in energy efficiency and renewable energy measures. This is particularly important because compensation needs would persist into the future if energy prices stay at high levels, resulting in substantial strain on governmental budgets. Looking into energy expenditure for a medium price scenario where demand is reduced by 15%, we find that the expenditure burden almost levels out to pre-crisis levels. Thus, compensation needs are very small. This calls for governments to focus on energy efficiency and renewable energy measures that can be rolled out quickly. Ideally these measures combine short-term as well as long-term savings. The remaining compensation needs should only be used for the most vulnerable households.

For the sets of energy efficiency and renewable energy measures considered, we find that measures targeted at low-income households and rolled out within a two-year period could lead to energy demand reductions between 9.5 percent (Italy) and up to 17.4 percent (Hungary).

The need for public investment support to help low-income households to invest in the set of measures considered ranges from around 2 bn Euros in Greece to up to 17 bn Euros in Germany, when considering a subsidy rate of 80% of the total investment costs. The resulting energy cost savings over the measures' lifetime are of the same order of magnitude reaching more than 2,5 bn Euros on Greece and up to 20 bn Euros in Germany.

The required public support for such measures can be provided through EU funds and by redirecting the existing funding schemes towards targeted support for low-income households. Our analysis shows that in the countries considered in the analysis, only few targeted schemes exist that provide specific support to low-income households.

We conclude that targeted support for low-income households for investing in energy efficiency and renewable energy is essential to address energy poverty, whilst at the same time contributing to marked reductions in energy use and greenhouse gas emissions in the EU. Additional benefits include a lower need for compensatory measures as well as a lowered dependency on fossil fuel imports. This calls for governments to focus on structural energy efficiency and renewable energy measures with short-term as well as long-term savings that can be rolled out quickly and to use compensation only for those households that are most vulnerable.

2 Introduction

The current energy crisis in Europe has put a high burden on many consumers with energy expenditure now taking up a substantial share of their income. In particular, for low-income households who already spend a large share of their income on energy the situation worsened considerably. This prompted national governments to put in place measures to shield consumers from the direct impact of rising prices. According to a recent analysis by Bruegel[1], between September 2021 and February 2023, financial allocation for these compensatory measures has amounted to €657 billion across the EU and the UK. Many of these measures are non-targeted, which means that they benefit poor and rich households alike.

While these compensations (e.g., energy vouchers, reduction of taxes on gas and electricity) can provide the relief that many households urgently need, they can divert public finance from structural solutions such as energy efficiency and renewable energy solutions, which reduce households' energy bills and Europe's dependence on (imported) fossil fuels both in the short-term and in the long-term.

Subsidies on energy bills do not incentivise energy savings or the installation of renewable energy solutions such as rooftop solar, making investments in these measures less attractive. Subsidising gas prices thus has a negative impact on the deployment of these technologies.

Recognising the need for a combination of compensation and structural solutions to the energy crisis such as energy efficiency and renewable energy, the objective of this study is to gain an understanding of how national governments can better help their citizens prepare for the coming two winters 2023-2024 and 2024-2025 (and also potentially extreme-temperature summers) by targeting public resources at energy efficiency and renewable energy measures, which nonetheless are not in contradiction with long-term measures leading to net zero emissions and can be rolled out to a large number of households.

To this end, the study includes the following elements:

- Firstly, we provide an overview of funding needs for compensatory measures in seven EU countries under different price projections (see Chapter 3).
- Secondly, we develop country-specific sets of energy efficiency and renewable energy measures and quantify the impact of their implementation on low-income households in seven EU countries. The estimates include the impact on energy consumption, energy costs, greenhouse gas emissions as well as further indicators such as import dependency (see Chapter 4).
- Thirdly, an overview of funding schemes at EU level and in selected Member States to finance the abovementioned measures is provided (Chapter 5).

The study focuses on the following seven countries: France, Germany, Italy, Spain, Greece, Romania and Hungary.

[1] Bruegel (2023): National fiscal policy responses to the energy crisis

3 Burden on households and spending on compensatory measures

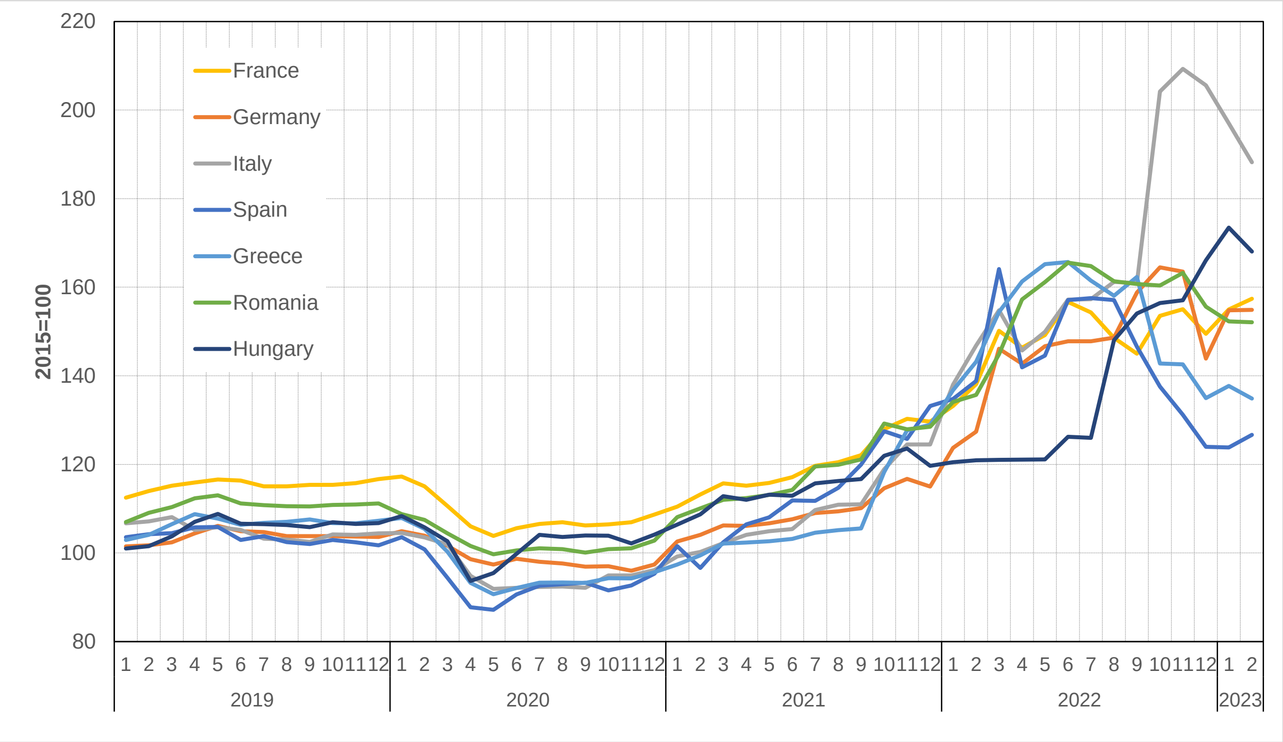
To assess public spending on compensatory measures, we first investigate energy price development and the resulting increased energy expenditure burden that households need to bear. We then look into compensation needs that occur if households were to be compensated for part of their additional costs. The analysis considers different price scenarios, i.e., sustained high prices and medium prices with and without adjustment of demand.

3.1 Additional household expenditure due to the energy crisis

3.1.1 Energy price development

The Russian invasion of the Ukraine in February 2022 has led to a disruption of energy markets which led to unforeseen energy price spikes, particularly for natural gas but also for electricity and other fossil fuels. Figure 1 shows the development of energy prices between January 2019 and February 2023 for the focus countries of this study. For the increase in energy prices, we use the harmonised index of consumer prices provided by Eurostat and compare current prices to before-crisis prices. We use 2019 data, to exclude the bias due to the Covid-19 crisis.

Figure 1: Development of energy prices in selected MS



Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX)

After a spike in the fall of 2022[2], prices have started to decrease in most Member States. However, it remains uncertain whether this trend will continue or whether prices will rise again, in particular with the start of the heating season in autumn 2023.

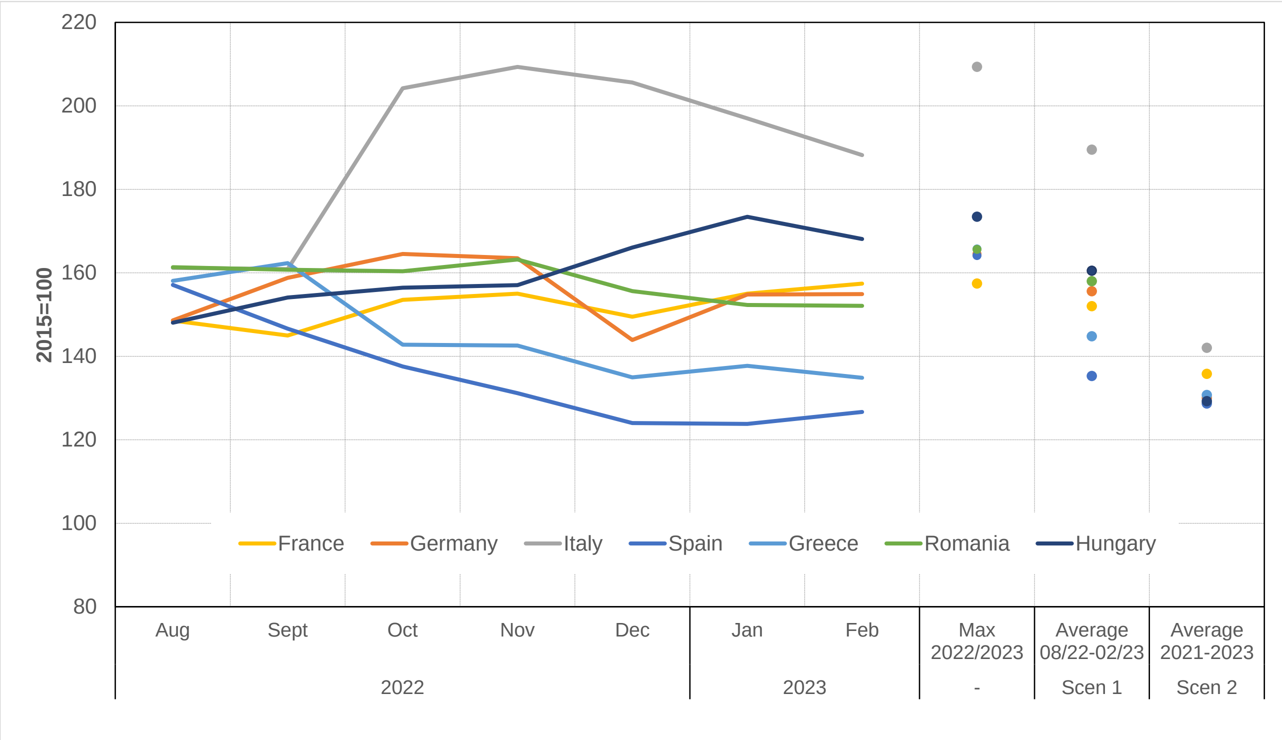
2 For some countries, the rise continued until early 2023.

In this study, we set up two scenarios for a possible development of energy prices:

- Scenario 1 “sustained high prices” assumes that prices continue to be high for the next few years. We assume that they remain at the average value that we have seen between August 2022 (just before the winter heating season) and February 2023 (latest available data).
- Scenario 2 “medium prices” assumes that prices somehow level out but do not go back to pre-crisis level. Specifically, we assume that prices come to an average of pre-crisis and crisis levels, and we assume that this would be at an average level of 2021 to the beginning of 2023.

These two scenarios plus the maximum price increase are shown in Figure 2.

Figure 2: Energy prices in selected MS: Maximum 2022/2023, Average 08/2022-02/2023 and Average 2021-2023



Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

3.1.2 Household energy expenditure

Household energy expenditure has substantially increased due to the energy crisis. Figure 3 to Figure 6 show the increase of energy expenditure in relation to disposable income by income quintile. Except for Italy, data on expenditure and income is based on Eurostat Household Budget Surveys (HBS) Microdata. Quintiles are based on equivalent consumption expenditure. Due to missing data in the HBS dataset, expenditure data for Italy is taken from the Italian National Institute of Statistics and presented for equivalent expenditure quintiles. Mean disposable income for Italy is based on equivalent income quintiles from Eurostat EU-SILC microdata.

We compare the expenditure share by income quintile for the year 2019, the year before the Covid-19 crisis, to the share of energy expenditure that households were facing at the energy price spike, reflected by the maximum value between January 2022 and February 2023. We further assess the burden that would arise based on the two price development scenarios described above, sustained high prices in Scenario 1 and medium prices in Scenario 2.

Scenarios 1 and 2 assume that no adjustment in energy consumption takes place during this time. This assumption might not be realistic given that consumers react to changes in energy prices in the short and medium term. We have thus also created a scenario assuming that households respond to increased prices and policy encouragement and reduce their energy consumption by 15% compared to pre-crisis levels. It needs to be pointed out that this is a simple assumption and can only provide indicative information. We apply this assumption to Scenario 1 "sustained high price" and Scenario 2 "medium price" and label it "Scenario x with adjusted demand".

Rather than taking a simple assumption, it would be preferable to use short-term price elasticities from the literature to account for adjustments in energy use in response to higher prices. However, the price elasticities in the literature give a wide bandwidth and are usually not differentiated by income group (see Box 1).

Box 1: Some information on price elasticities of energy demand

In general, there is an abundance of studies focusing on price elasticities of energy goods. Since the applied methods vary by publication, e.g. in terms of macro- and microdata, time frame, etc., comparing estimate for calculated elasticities from different studies is hardly reasonable (Bach et al. 2019). There are, however, some statements that are consistent across the literature. Stating that energy presents a basic need/demand, price elasticities for energy are generally lower than for example for luxury goods.

Especially on a short-time scale, the reaction of energy demand is limited, as it is tightly interlocked with personal living conditions like housing, employment or mobility. These cannot easily be changed immediately after a rise in energy prices. The Federal Ministry for Economic Affairs and Energy of Germany (Bundesministerium für Wirtschaft und Technologie (BMWi) 2011) stated values for short-term price elasticities of domestic heating, independent of the used energy source, of -0.2, i.e. a doubling of energy prices would result in a demand reduction of 20%. Other sources state values less than -0.03. In comparison, long-term elasticities are estimated to be much higher, but still mostly well below -1. This is also interesting when looking at the amount of CO_2-pricing that is necessary to reduce consumption through price signals.

Elasticities for lower income households are often expected to be lower than those of wealthy population groups, due to their lower energy demand in general and inability to further reduce energy consumption. Households may not have sufficient allowance to invest in more efficient household appliances or may not be able to change their heating systems. The latter applies in general for tenants (Dullien und Stein 2022). (Gechert et al. 2019) proposes values for price elasticities of -0.2 for short-term and -0.5 for long-term, whereas they estimate half the value for the first five income deciles.

Comparing the literature with the current situation, the elasticities are also in line with the EU recommendation of reducing energy demand by 15% in response to the energy crisis (European Commission (EC) 2022a).

Another point to mention is the variation between different countries, due to their energy supply system, residential building composition or national specific policies (Asche et al. 2008). A more precise approach, that is commonly used in economics would be a description through an arc elasticity. The demand then follows a curve, which pictures the inertia of societies in a better way and accounts for the slope of the price rise.

Figure 3 to Figure 6 show that the price spike, i.e. *the maximum energy price in the winter of 2022/2023*, led to substantial increases in energy expenditure, in particular for lower income households within the first income quintile. The increase was as high as 10.9 percentage points for the first income quintile in Italy, rising from an expenditure share of 11% to almost 22%. The lowest increase is seen in France with an increase of 1.6 percentage points, rising to a share of 5.8% for energy expenditure in income.

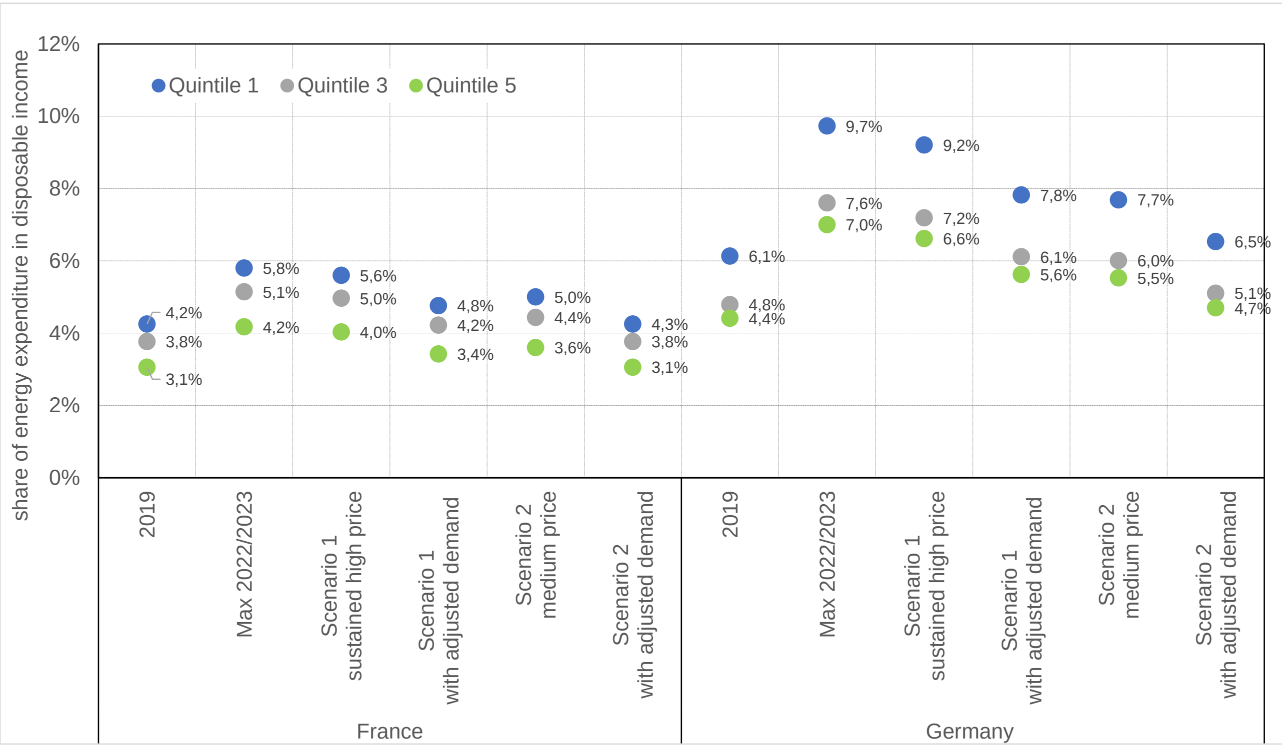
Scenario 1 with sustained high energy prices shows a continued high burden, in particular for low-income households. The share of energy expenditure in income for the lowest income quintile remains above 10% for several countries, in particular Italy, Hungary, Greece.

Scenario 2 with medium prices assumes that prices do not go back to pre-crisis levels but average out between pre-crisis and crisis levels, reflecting the average price level of the year 2021 to the beginning of 2023. The energy expenditure share is lower than in the high price scenarios but still high and above 10% for the lowest income quintile for Italy and Hungary.

Scenarios with adjusted demand: Assuming adjustment in demand of 15% as recommended by the European Commission (*EC*, 2022) in a world of

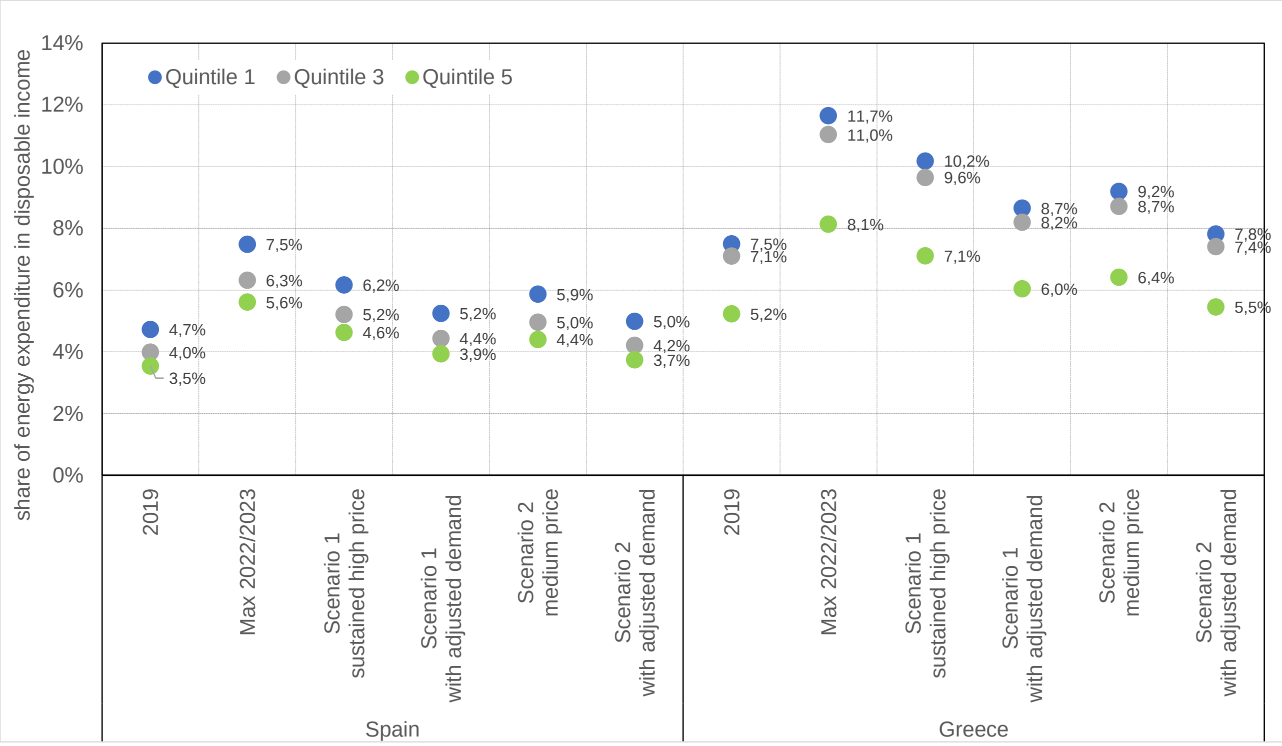
- sustained high prices (*Scenario 1 with adjusted demand*) shows that the energy expenditure burden would be reduced to a level comparable to the medium price scenario without demand adjustment.
- medium high price development (*Scenario 2 with adjusted demand*) shows that the energy expenditure burden would be close to the pre-crisis level. The reduction in demand is able to just about level out the increase in energy prices.

Figure 3: France and Germany: Share of energy expenditure in disposable income by income quintile



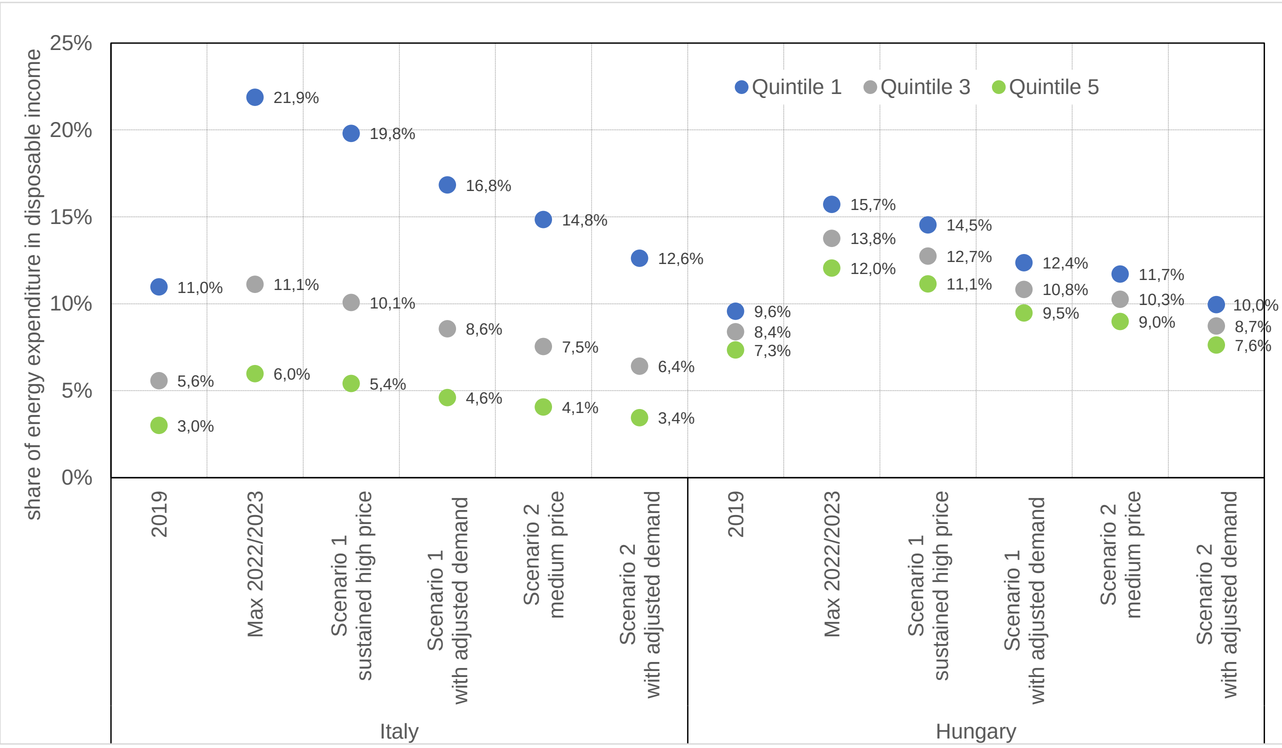
Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

Figure 4: Spain and Greece: Share of energy expenditure in disposable income by income quintile



Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

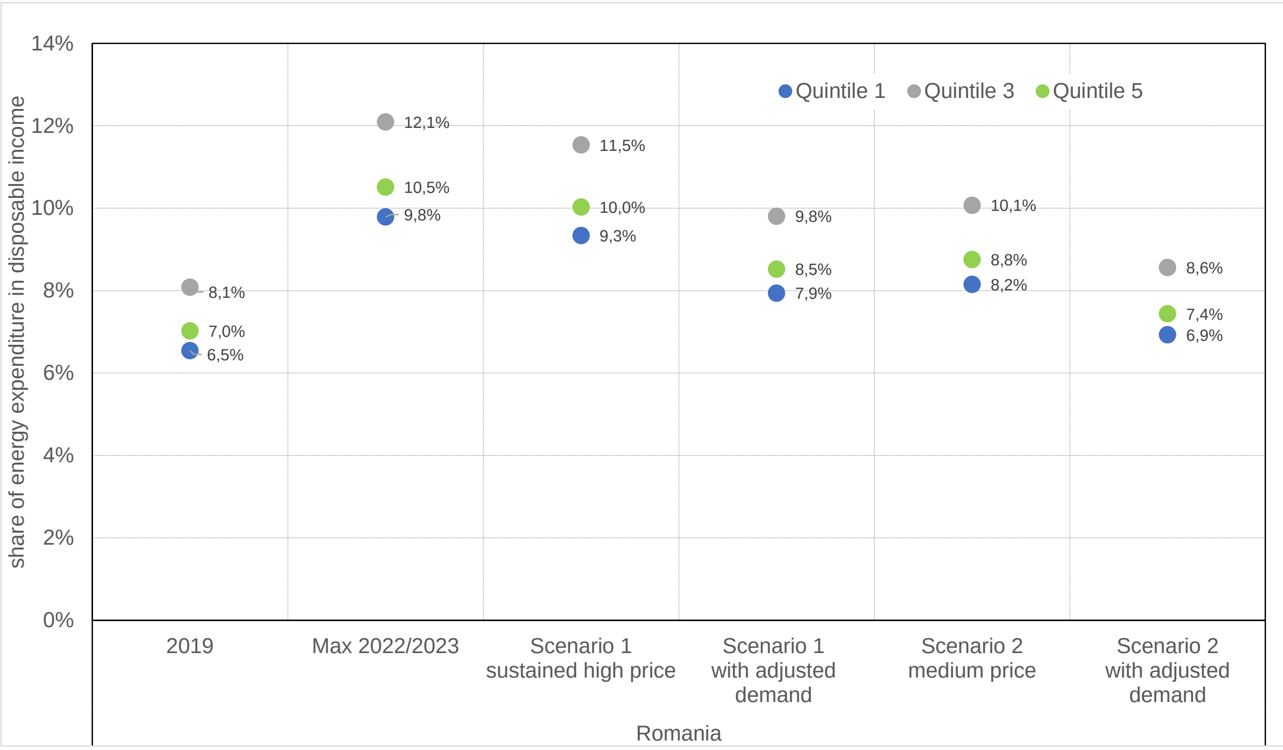
Figure 5: Italy and Hungary: Share of energy expenditure in disposable income by income quintile



Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

In Romania the picture is different to the one for the other Member States: middle income households in Romania spend substantially more of their income on energy than lower income households. Even high-income households (fifth income quintile) spend a higher share of their income on energy. The reason for this reverse pattern is in the energy consumption structure in Romania. Households in Romania use a large share of biomass for heating which they collect locally and do not purchase on the market. This is particularly true for low-income households. Thus, on-bill energy expenditure is lower. In addition, it might also be an indication of energy poverty for low-income households, in the way that households might not be able to afford their energy needs and thus spend less on energy than they would if their income was higher. While this might apply to all countries, it is particularly of concern in countries with higher levels of poverty such as Romania.

Figure 6: Romania: Share of energy expenditure in disposable income by income quintile



Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

3.2 Assessment of budget needs for compensatory measures

The previous section shows that lower-income households spend more of their disposable income on energy. This is particularly the case with the recent energy price spikes. While reducing demand helps to ease the burden, lower-income households are at risk of underheating their houses even more if they further reduce consumption by 15%. Therefore, targeted support for these groups is important. Short term energy efficiency and renewable energy measures help to provide comfortable room temperate while sustainably reducing costs. Their potential and associated costs are discussed in Chapter 4.

To alleviate the increased energy expenditure burden of households, many Member States use short term compensatory measures in supporting income, reducing taxes or putting a cap on energy prices. While these measures provide short term relief, they do not help to reduce energy expenditure in the longer term if prices remain high. In fact, if prices remain high over the coming years and insufficient investment in energy efficiency is taken the need for compensation will continue, adding up to substantial government burden over the years.

The need for short term compensation varies between Member States depending on price development, energy use and expenditure, income and the affordability of energy by income groups. The focus in this section is on the government budget that would be needed for compensatory measures.

We look into the amount of government budget needed if households were to be compensated for (parts of) the additional costs; the additional costs are derived in Section 3.1.2 for different price scenarios and are calculated compared to costs in the year 2019. We compare the need for government funds under these scenarios to current government spending by Member States (MS) in relief packages to compensate for the high burden, as laid out by Bruegel[3]. In a final step, we compare the government funding needed for compensation (from Section 3.1.2) to national GDP:

For compensation of households, we set up four compensation schemes:

1. In a first step (scheme 1), we assume that all households independent of their income qualify for compensation. Specifically, we assume that all households get compensated for 30% of their additional energy expenses (additional energy expenses compared to year 2019). The compensation share is hypothetical.
2. In a second scheme, we restrict compensation to low-income households who are most vulnerable to rising energy costs. We assume that households in the first income quintile get direct income support for 30% of their additional energy costs.
3. In schemes three and four, we still restrict compensation to households in the first income quintile but allow for 50% and 80% compensation for these households.

The resulting government budget needs to compensate households in each scheme, price scenario and Member State are shown in detail in Table 14 to Table 17 in Annex I. Table 1 highlights the range of the results in providing government budget needs for compensating expenditure at the maximum price increase to compensating at a medium price increase with demand reduction of 15%. The main insights that can be drawn are as follows:

- Compensating **all households independent of their income** requires a substantial amount of funding, in particular if the peak price is taken as a starting point (maximum price of 2022/2023) or it is assumed that prices continue to be high. Absolute total compensation costs would be particularly high in Germany because of the high population number and in Italy because of a pronounced price spike.
- Compensating **only those who are most affected and most vulnerable**, i.e., in our analysis the first income quintile, is targeted and requires substantially less budget. This is the case even if low-income households were to be compensated for 80% of their additional energy costs.
- **Demand reduction of 15%** as indicated by the European Commission helps to level out additional costs. For the medium price scenario, a 15% demand reduction brings down costs to almost pre-crisis levels. Consequently, government funding needed for compensation is very low and can specifically be used for those households that are most in need.

[3] https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices

Table 1: Annual government budget needed for compensation of additional energy costs – Maximum price and Scenario 2 medium price without and with adjusted demand (in Mio. Euro)

Country	Price scenario	Comp. Scheme 1: 30% of additional energy costs for all households	Comp. Scheme 2: 30% of energy costs only for households in first income quintile	Comp. Scheme 3: 50% of energy costs only for households in first income quintile	Comp. Scheme 4: 80% of energy costs only for households in first income quintile
France	Max price 2022-2023	5,227	610	1,016	1,626
	Scenario 2 medium price	2,538	296	493	790
	Scenario 2 with adjusted demand	9	1	2	3
Germany	Max price 2022-2023	14,089	1,873	3,121	4,994
	Scenario 2 medium price	6,087	809	1,349	2,158
	Scenario 2 with adjusted demand	1,570	209	348	557
Italy	Max price 2022-2023	11,442	1,294	2,157	3,451
	Scenario 2 medium price	4,059	459	765	1,224
	Scenario 2 with adjusted demand	1,724	195	325	520
Spain	Max price 2022-2023	3,807	419	699	1,118
	Scenario 2 medium price	1,581	174	290	464
	Scenario 2 with adjusted demand	368	41	68	108
Greece	Max price 2022-2023	882	102	170	272
	Scenario 2 medium price	360	42	70	111
	Scenario 2 with adjusted demand	68	8	13	21
Romania	Max price 2022-2023	737	57	95	153
	Scenario 2 medium price	365	28	47	76
	Scenario 2 with adjusted demand	88	7	11	18

Country	Price scenario	Comp. Scheme 1: 30% of additional energy costs for all households	Comp. Scheme 2: 30% of energy costs only for households in first income quintile	Comp. Scheme 3: 50% of energy costs only for households in first income quintile	Comp. Scheme 4: 80% of energy costs only for households in first income quintile
Hungary	Max price 2022-2023	789	90	150	240
	Scenario 2 medium price	275	31	52	83
	Scenario 2 with adjusted demand	49	6	9	15

Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation. All values are calculated for, or scaled up to account for, one year (i.e. in this case the year 2022/2023).
Note: Additional energy costs are calculated for each scenario compared to energy costs in the year 2019. Compensation needs in France in "Scenario 2 medium price with adjusted demand" are very low because energy prices had risen already in 2019 so that the medium price scenario is not much higher. Scenario 2 with adjusted demand thus causes very little additional costs.

In Table 2, we compare the need for government funding for the compensation schemes to current government spending on shielding consumers from the energy crisis as laid out by Bruegel (for more background on the information we collected from the Bruegel study, see Box 2). Furthermore, in Table 3, we compare the government funding needed for compensation to national GDP to show what percentage of GDP it represents. For the compensation need, we use the maximum price increase during the winter of 2022/2023 and relate it to the relief packages and GDP respectively. We chose the maximum price increase to give an upper bound value.

Box 2: Shield packages in response to the energy crisis in the Bruegel study

Bruegel (Bruegel 2022) provides an in depth-analysis of government earmarked and allocated funding to shield households and firms from the energy crisis. They provide an excel chart for each of the considered countries and lists the measures and governmental funding used to support consumers. The measures are mostly grouped according to whether they target households, firms or industry as well as according to their roll-out and end dates.

In our analysis, we only incorporate those measures that are actually targeted towards energy costs of households. We exclude support that is not directly related to energy costs. For consistent comparison between countries and further data application, only expenses for the year 2022 are taken into account. If measures affect a longer time period, the expenses are calculated pro rata for 2022.

In our analysis, we compare the excel sheets and written report by Bruegel with additional literature such as governmental announcements and reports to reduce uncertainties and gain additional insights, e.g. in some cases shield packages do not distinguish between households, commerce and industries or single measures do not sum up consistently.

Following our method, we arrive at an indication for government funding to help with energy costs for private consumers. Germany allocated about €74 bil., France €58 bil., Italy €24 bil., Greece €8 bil. and Romania €3 bil. to energy related support for households in 2022. Unfortunately, Hungary has not provided information on their petrol and gas price cap so far, which constitutes their main measure. For Spain (ca. €12.5 bil.), there are also several measures where the exact sum that went into the support of vulnerable households cannot be identified.

Table 2 provides an indication of the share of government shield funding if it was used as direct income support according to the described compensation schemes. Notably, Scheme 1 which supports all households independent of their income would constitute quite a large part of the government funding. In contrast, targeted support for the first income quintile requires only a significantly lower share of shield funding even if those households are compensated for 80% of its additional expenditure.

The share is highest in Italy which also showed the highest increase in energy prices. It should be noted that the values are only indicative and hypothetical. Measures supported by the shield funding vary by country and most often do not provide direct income support. Most countries chose to put caps on prices or reduce taxes to keep energy affordable. In addition, some measures aim to support households in investing in energy efficiency or renewable energy to provide long-term and sustainable resilience to volatile energy prices.

Table 2: Government funding needed for compensation for increased energy costs as % of national shield packages – Maximum price increase in winter 2022/2023

Compensation scheme	FR	DE	IT	ES	EL	RO	HU
Scheme 1: 30% of additional energy costs for all households	8.98%	19.00%	47.59%	30.04%	10.69%	25.40%	n.a.
Scheme 2: 30% of energy costs only for households in first income quintile	1.05%	2.53%	5.38%	3.31%	1.24%	1.97%	n.a.
Scheme 3: 50% of energy costs only for households in first income quintile	1.75%	4.21%	8.97%	5.51%	2.06%	3.29%	n.a.
Scheme 4: 80% of energy costs only for households in first income quintile	2.79%	6.74%	14.35%	8.82%	3.30%	5.26%	n.a.

Source: https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices; own calculation. All values are calculated for, or scaled up to account for, one year (i.e. in this case the year 2022/2023).

Looking into the share of government funding for compensation of private consumers in relation to national GDP in Table 3 we see that it provides rather low percentages of GDP. This is true even in lower income countries, such as Romania and Hungary. The table shows compensation needs for households for the highest possible price scenario, i.e. the maximum price level that occurred in 2022/2023 within each MS. The share of support is even lower for the medium price scenario (Scenario 2) and particularly small if demand is reduced by the envisioned 15% (Scenario 2 with adjusted demand). It should be noted that these numbers reflect only partial energy cost compensation and private consumers only. Governments also used funding to shield business and industry from high energy costs. Comparing the cost of all measures taken to national GDP reveals shares as high as 5-6% for example for Germany (Bruegel, 2022). If prices continue to be high, it will not be possible to continue such high general support. Targeted support to vulnerable consumers, however, does not require a large share of funding and will be highly effective in helping vulnerable groups.

Table 3: Government funding needed for compensation for increased energy costs in % of GDP – (GDP 2019) – Maximum price increase in winter 2022/2023

Compensation scheme	FR	DE	IT	ES	EL	RO	HU
Scheme 1: 30% of additional energy costs for all households	0.21%	0.41%	0.64%	0.31%	0.48%	0.33%	0.54%
Scheme 2: 30% of energy costs only for low-income households	0.03%	0.05%	0.07%	0.03%	0.06%	0.03%	0.06%
Scheme 3: 50% of energy costs only for low-income households	0.04%	0.09%	0.12%	0.06%	0.09%	0.04%	0.10%
Scheme 4: 80% of energy costs only for low-income households	0.07%	0.14%	0.19%	0.09%	0.15%	0.07%	0.16%

Source: own calculation. GDP data from Eurostat (NAMA_10_GDP NAMA_10_PC). All values are calculated for, or scaled up to account for, one year (i.e. in this case the year 2022/2023).

3.3 Insights

To sum up, the assessment provides an indication of the budget needs for compensatory measures based on assumptions for different hypothetical compensation schemes. Compensating all households independent of their income requires substantially higher funding than providing targeted relief for vulnerable low-income groups. The budget needed to partially compensate all households is about three to four times higher – even if low-income households get compensation for about 80% of their additional energy costs. This calls for targeted relief for those who are most vulnerable.

Rather than providing direct compensation it is more sustainable to support households in investing in energy efficiency and renewable energy. This is particularly important because compensation needs would persist into the future if energy prices stay at high levels, resulting in substantial strain on government budgets. Looking into energy expenditure for a medium price scenario where demand is reduced by 15%, we find that the expenditure burden almost levels out to pre-crisis levels. Thus, compensation needs are very small. This calls for governments to focus on energy efficiency and renewable energy measures that can be rolled out quickly. Ideally these measures combine short-term as well as long-term savings. The remaining compensation needs should only be used for the most vulnerable households.

4 Targeted energy efficiency and renewable energy measures

In this chapter we identify several targeted energy efficiency and renewable energy measures that contribute to reducing energy costs in households, which can be implemented within the next two years. Their impact on energy savings and energy cost saving is both short-term and long-term. We calculate the energy savings, energy cost savings and greenhouse gas emissions savings for a chosen set of measures in each of the seven countries considered in the study. We also calculate the investment costs for implementing these measures given different subsidy rates. Finally, we compare the energy and emissions savings with the total energy consumption and greenhouse gases (GHG) emissions of low-income households. We also compare the different compensation schemes (cf. Chapter 3) with the measures' investment costs.

4.1 Overview of measures

The measures considered in the assessment are chosen for each country based on the following country-specific characteristics:

- the building stock
- the share of low-income households in single- and multi-family houses
- the amount of energy that can be saved via a measure's implementation
- the costs associated with each measure
- the measures' ease of implementation

Table 4 gives on overview of the considered measures.

Table 4: Overview of measures

Category	Measures
Space heating and hot water *Building envelope*	• Roof insulation (flat or pitched) • insulation of upper-most storey • exterior wall insulation • cavity wall insulation • basement insulation • replacement of old windows
Space heating and hot water *Heating system*	• heat pump installation • installation of solar thermal collectors • hydraulic balancing
Electricity	• installation of solar photovoltaics
Campaign	• reducing room temperatures • not heating every room • insulation foil and tape for windows • smart thermostats for radiators • insulation of heating distribution pipes • energy saving shower heads • installation of LEDs

The measures fall into the categories *space heating and hot water* as well as *electricity*. For the first category we consider measures concerning the insulation of the building envelope as well as those making the heating and hot water systems more energy efficient or switching to renewable energy sources. These sub-categories include the insulation of the roof, either as an **exterior insulation of a flat or pitched roof** or as an **insulation of the upper most storey**, if the attic is not used as living space. Similarly, for the outer wall, we consider the more efficient but more resource and time-consuming measure **exterior wall insulation**, as well as **cavity wall insulation**, which is not applicable everywhere, but which allows for a comparatively fast implementation. Additionally, we consider **basement insulation** as well as the **replacement of old windows** as measures concerning the building envelope. The sub-category addressing the heating systems entails the switch to renewable energy sources such as ambient heat made available via **heat pumps** for space heating and hot water, solar heat via **solar thermal collectors** for hot water as well as **hydraulic balancing** as a measure which enhances the efficiency of the existing heating system.

In the category electricity we focus on the **installation of** solar photovoltaic (**PV)** in order to switch to a renewable electricity source and relieve households of high electricity prices.

We also introduce the measure of launching a **campaign** which should aim at distributing information as well as small-scale technological solutions to low-income households to allow them to save energy without high investment costs. The idea is that energy advisors inform low-income households on strategies to save energy and provide them with a low-cost starter set of the respective technologies. More specifically, the campaign entails the spread of information on changes in heating behaviour such as turning down the temperature or not heating every room as well as easy, short-term technological fixes such as insulation foil and tape for windows, smart thermostats for radiators (and their installation), energy-saving shower heads, the insulation of heating distribution pipes in the basement as well as exchanging light bulbs for LEDs.

4.2 Allocation of measures to countries

In order for the measures to be efficient and effective we identify an individual mix of measures in the different building types and member states. The different climate zones, housing situations of low-income households and different building stocks make a one-size-fits-all approach unreasonable. We therefore assemble a more individualised set of measures for each country. All measures are selected in close collaboration with national experts.

The building type is one important factor in choosing which set of measures to apply: As renovation measures such as roof and basement insulation have a bigger effect on single-family houses (SFH) than on multi-family houses (MFH) we only address SFHs with these measures. The switch to renewable energy sources is also applied to SFHs only, because in MFHs distributional problems arise and the positive effect on energy bills will be less pronounced compared to SFHs where energetic independence is more easily achievable. The replacement of old windows is assigned to both MFHs and SFHs. Hydraulic balancing has more potential benefits in MFHs where the heating distribution system is larger and more likely to be distributing heat inefficiently. We therefore assign hydraulic balancing to MFHs only. As the campaign targets the household level instead of the building level, we apply the campaign to SFHs and MFHs alike.

Our approach is supported by the housing situation of low-income households in the different countries (cf. Section 4.3.2 below and Table 6 therein). Except for France and Germany low-income households either live primarily in SFHs or are distributed evenly between the SFHs and MFHs. In combination with the higher effectiveness of many measures in SFHs this led us to assign most measures concerning the building envelope to SFHs only. We assign the cavity wall insulation solely to Germany, Spain, and Italy, as these are the only countries where data on uninsulated cavity walls were available. For all other countries we apply the outer wall insulation to SFHs.

Generally, we choose a mixture of, on the one hand, short-term, low-effort measures, such as the campaign, hydraulic balancing and the insulation of the basement, upper story ceiling and cavity wall. On the other hand, we also include measures with a higher effort, such as exterior roof insulation and outer wall insulation. This combination of measures allows for both immediate relief of low-income households suffering from high energy prices as well as longer term, structural increases in efficiency and the compatibility with climate goals. All measures have realisation factors assigned. The realisation factors are the result of combining the applicability of a given measure in the respective building, the feasibility of there being sufficient skilled workers as well as the willingness of the landlords/tenants to implement a measure. We assume that high-effort renovation measures cannot be implemented to the same degree as measures which take less time and effort. Table 5 gives an overview of the different measures in each country split by the two building types SFH and MFH. Table 18 in Annex II shows the share of low-income households that implement a given measure within a two-year period.

Table 5: Assigned measures for each country and building type

	Germany		Spain		France		Greece		Hungary		Italy		Romania	
	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH
Ext. roof insulation (pitched)	✓		✓		✓		✓		✓		✓		✓	
Ext. roof insulation (flat)	✓		✓		✓		✓		✓		✓		✓	
Top story ceiling insulation	✓		✓		✓		✓		✓		✓		✓	
Replacing old windows	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outer wall insulation					✓	✓	✓		✓		✓		✓	
Cavity wall insulation	✓	✓	✓	✓								✓		
Heat pump[4]	✓		✓		✓		✓		✓		✓		✓	
Solar thermal collectors	✓		✓		✓		✓		✓		✓		✓	
Installing PV	✓	✓	✓		✓		✓		✓		✓		✓	
Basement insulation									✓					
Hydraulic balancing		✓		✓		✓		✓		✓		✓		✓
Campaign	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

4.3 Data sources and methodology

This section describes the various data sources we use for selecting the energy efficiency and renewable energy measures.

4.3.1 Data on building stock characteristics (Invert model)

We use the building stock database of the building stock model Invert and its energy demand calculation module. The building stock database contains a detailed representation of the residential and tertiary built environment of the EU member states via building archetypes, which are similar

[4] Only installed when the outer wall has been insulated sufficiently beforehand.

(but not identical) with the data presented by the EPISCOPE/TABULAR[5] or the Hotmaps building stock database[6]. The following properties distinguish these typical building archetypes: geometry and physical properties of the building shell (u-values and thermal capacity of different components, share and orientation of windows, shading installations), type of use and related occupancy profiles, construction period, region of location relevant for climate and energy carrier availability, status and period of the last renovation if already renovated, and installed heating system together with the installation period.

The Invert database on existing building stocks was compiled over the last decade in the course of numerous projects. An important data source for residential buildings is the Tabula/Episcope building stock database for residential buildings, described e.g., in Loga et al. (2016). Physical properties of the buildings like thermal capacity, infiltration, natural ventilation as well as occupancy profiles were taken from EN ISO 13790:2008 (CEN 2008). Furthermore, national and EU-wide statistical data and publications were used to define the number of buildings, gross floor area and u-values for different building types and construction periods, as well as demand for energy carriers for space heating and hot water. ENTRANZE (2014), ZEBRA2020 (2015) and CommONEnergy (2017) offer a representation of the data contained in the Invert database on existing building stocks. Eurostat (2022b) and Eurostat (2022a) were used to calibrate the energy demand in the base year 2019 used in this study. Additional details and data are presented in Müller (2015).

In addition to representation of the status quo, we use the model to derive the energy losses per building component. We use this information to calculate the energy saving potential of different building retrofitting measures.

Besides the energy needs of the buildings, the database also contains information on the installed heating systems. This allows us to not only to evaluate the effects of different energy efficiency options, but also estimate the impact on the final energy consumption per energy carrier type, especially the impact on natural gas and electricity consumption.

4.3.2 EU-SILC data

In order to gain an insight into the connection between low-income households and the buildings these households typically live in, we used data from the EU statistics on income and living conditions (EU-SILC)[7]. Low-income households as defined by EU-SILC are households with an income of less than 60% of the median income in each country. This definition of low-income household does not necessarily correspond to the definition of low-income household as defined in Chapter 3, which is based on the lowest income quintile in each country from the HBS data. In many countries, however, the two definitions overlap: Table 6 shows the share of the population living with low-income according to EU-SILC split by two different housing types "house" and "flat". The data show that in Germany and France the share of low-income households is a lot higher in flats compared to houses. Spain, Hungary and Italy have a relatively equal distribution across housing type, whereas Greece and especially Romania have markedly higher shares of low-income households in houses rather than flats.

[5] https://episcope.eu
[6] https://gitlab.com/hotmaps/building-stock
[7] See https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

Table 6: Share of population with low-income (defined as below 60% of the median income in the respective country) in houses and flats in 2021

	House	Flat	Total
Germany	11%	19%	16%
Spain	22%	21%	22%
France	10%	23%	14%
Greece	24%	16%	20%
Hungary	13%	11%	13%
Italy	20%	20%	20%
Romania	32%	5%	23%

For the purpose of this study, we assign the percentages of population with low-income living in "houses" to single-family houses (SFH) and those in "flats" to multi-family houses (MFH).

4.3.3 Energy savings

We calculate the typical final energy savings per measure under the assumption that each measure is applied individually. Heat pumps are the only exception, as in our calculations heat pumps are only allowed if the building has a sufficiently insulated outer wall. To calculate the typical energy savings of a household we use the Invert data to identify the most common building type both for SFHs and MFHs according to the highest number of buildings or largets total floor area of the occupied building stock in each country. We calculate the energy savings per measure by comparing the u-values and associated transmission losses of each component before and after implementing insulation to the respective parts of the building's envelope.

For the measures connected to switching to renewable energy sources we use different approaches:

- Heat pumps are defined to save up to 66% of the fossil final energy demand (FED) for space heating and hot water of the replaced fossil heating system based on the assumption of an annual coefficient of performance of three.[8]
- For solar thermal collectors we assume that, after installation, 50% of the final energy demand for hot water is based on solar heating.
- For solar PV we assume a 5 kW_p photovoltaic installation. We then use the typical full load hours for PV in the respective country to derive the amount of electricity produced each year. We then assumed that only half of this PV-generated electricity can actually be consumed by the household. The other half is fed into the grid.

[8] The total final energy demand of a house/flat after installing a heat pump is roughly the same as before, but there has been a switch from fossil energy (oil or gas) to electricity and ambient heat.

- The energy savings achieved by hydraulic balancing of the heating system are derived from desktop research.
- For the energy savings achieved through the campaign we use a weighted average of the various measures included in the campaign under the assumption that rather than implementing all components of the campaign, every household chooses and implements only a subset of the measures included in the campaign.

An overview of the different measures' relative energy savings in the respective building type in each country is given in Table 7.

Table 7: Measures and their typical relative energy savings in each MS

	Germany		Spain		France		Greece		Hungary		Italy		Romania	
	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH	SFH	MFH
Roof/attic insulation*	11%	17%	17%	6%	20%	10%	29%	18%	19%	18%	20%	18%	21%	6%
Replacing old windows*	10%	6%	13%	26%	6%	23%	4%	12%	5%	9%	7%	14%	6%	13%
Outer wall insulation*	24%	26%	33%	32%	29%	21%	26%	32%	22%	27%	33%	28%	29%	36%
Cavity wall insulation*	20%	22%	29%	28%	24%	18%	23%	29%	18%	23%	28%	24%	25%	31%
Heat pump**	0%													
Solar thermal collectors***	0%													
Installing PV****	2,100 – 2,500 kWh													
Basement insulation*	11%	10%	9%	4%	12%	6%	18%	10%	27%	9%	9%	8%	14%	4%
Hydraulic balancing*	8%													
Campaign*	10%													

*SFH: Single-family house; MFH: Multi-family house; * Share of final energy demand (FED) space heating; ** Heat pump: no actual reduction of FED for space heating and hot water, but a replacement of fossil energy by ambient heat and electricity; *** Solar thermal: no actual reduction in FED for hot water, rather a 50% replacement of fossil energy by solar energy; **** PV: no actual reduction in electricity use, rather an estimate of the reduction in electricity demand from the grid.*

4.3.4 Investment cost and energy price data

In order to calculate the investment costs for the measures in each country, we use the costs as derived by Hinz (2015). As this data is based on investment costs in 2015 in Germany we use the construction cost index[9] for Germany to arrive at a 2022 cost basis. In order to make the prices applicable to the other countries considered we then use the construction cost index for the respective countries with German prices as the base line. The country-specific cost curves as well as insulation thicknesses applicable to each country allow us to calculate the costs per component surface. For measures not described by Hinz (2015) we use cost curves and prices attained through desktop research.

We use the typical SFH and MFH from the Invert model to calculate the full costs of each measure for each building type. To make sure the costs sufficiently apply to each country we got feedback from national experts and adjusted the numbers when necessary. Annex III lists the investment costs per country. To calculate the total investment costs, we multiply the costs per building/dwelling with the number of buildings/dwellings of low-income households in the respective country. For this calculation, we use the definition of low-income households as explained in Section 4.3.2: Households which earn less than 60% of the median income. We derive the number of buildings occupied by low-income households from multiplying the percentage of low-income households in each building type (see Table 6) with the number of buildings. The total costs of each measure do not vary solely based on their individual costs but also on the total number of implemented measures. Annex II lists the realisation factors for each measure and country over a two-year period. The realisation factors are the result of combining the applicability of a given measure in the respective buildings, the feasibility of there being sufficient skilled workers as well as the willingness of the landlords/tenants to implement a measure. We assume that high-effort renovation measures cannot be implemented to the same degree as measures which take less time and effort.

Energy prices are based on average consumer prices of the different energy carriers for 2022.

4.3.5 Methodological approach

The calculations for the energy savings, energy cost savings, greenhouse gas emissions savings as well as total investment costs are calculated for each country by following three steps: Firstly, the dominant SFH and MFH from the countries' building stock as described in the Invert model with its given geometries as well as typical energy carrier distributions are considered (cf. section 4.3.1). Second, the share of low-income households living in either houses (SFH) or flats (MFH) from the EU-SILC data (cf. section 4.3.2) is multiplied with the Invert-derived buildings in order to calculate the current energy uses and energy carrier distributions present in low-income households. Third, this information is combined with the typical energy savings per measure (cf. section 4.3.3) as well as the realisation factors for each country and measure as shown in Table 18 (see Annex II) in order to determine the total energy use and energy carrier distribution after implementing the measures. This allows for calculating the measures' total energy savings, greenhouse gas savings, replacement of fossil fuels etc. Fourth, the total investment costs and energy price savings are calculated based on the input data as described in section 4.3.4.

4.4 Results

In this section, the results of calculating the energy and GHG-emissions savings when implementing the measures are presented in three sub-sections: final energy savings, CO_2 emissions savings and costs (investment costs as well as energy cost savings). These results are then put into perspective comparing the investment costs and energy cost savings with the different options/scenarios for direct compensation as outlined in section 3.2. It is important to note that high-investment, long-term

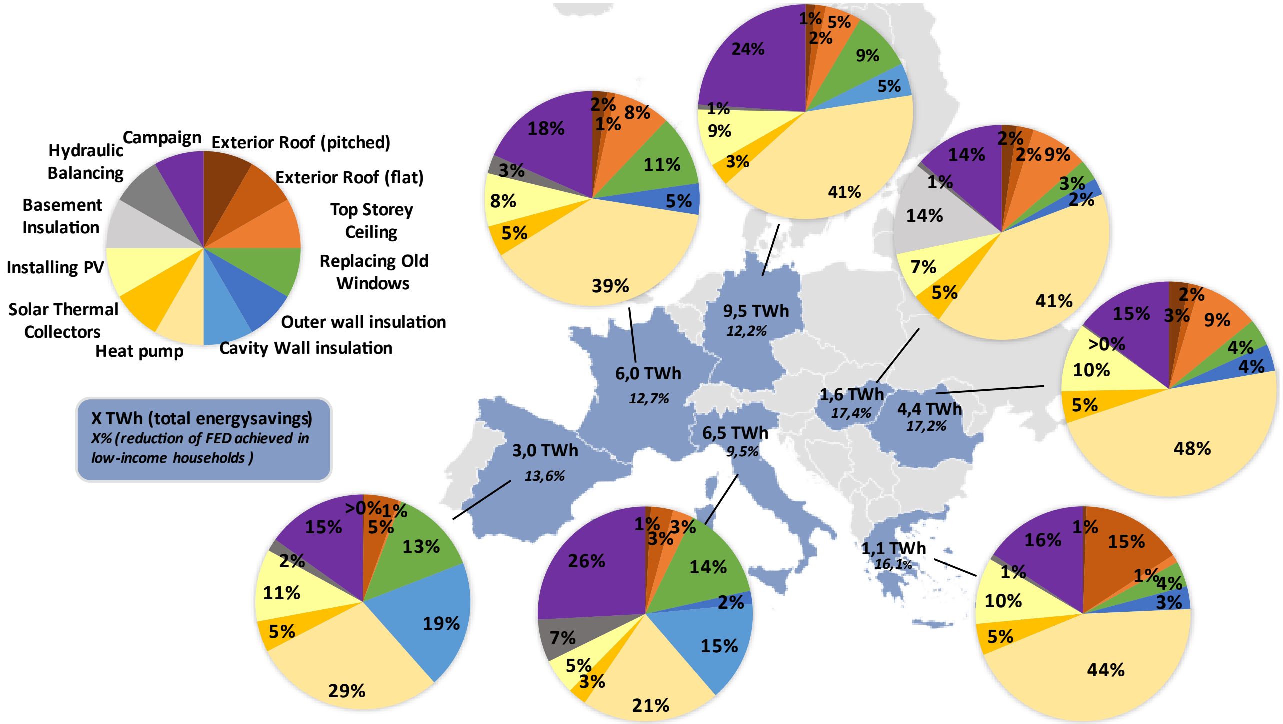
[9] https://bki.de/baupreisindex.html

measures such as those addressing a building's envelope are rolled out to a lower degree as low-investment, short-term measures such as installing solar PV or the campaign. This is due to different realisation factors we assume in this study regarding the availability of workers, suitability of the buildings concerned for a given measure as well as the willingness of the landlords/ landladies/ tenants to implement them (cf. Table 18 in Annex II). Thus, the share of the high-investment, long-term measures in the total final energy savings, emissions savings and energy cost savings is lower when compared to the low-investment, short-term measures.

4.4.1 Final energy savings

Figure 7 shows the absolute final energy savings in TWh achieved by implementing the nine to eleven measures assigned to each country (see Table 6 in section 4.3.2). The pie charts illustrate the share each measure contributes to the total energy savings. The campaign achieves between 14% and 26% of the overall savings depening on the country. The three renewable energy source measures – installing heat pumps, solar thermal collectors or solar PV – in combination make up around half of the achieved energy savings in all countries, with the exception of Italy. Furthermore, the cavity wall insulation can achieve a remarkable share of the overall savings in Italy and Spain.

Figure 7: Absolute final energy savings (in TWh) and their relative reduction (in %) of the total FED of low-income households in each country over a two year period



The percentages shown within the countries in the map in Figure 7 indicate the share these energy savings achieve of the total final energy demand (FED) of low-income households. These relative savings give a more nuanced perspective: In Hungary, Romania and Greece the relative savings are all higher than 16% with Hungary even achieving a 17.4% reduction in final energy demand. Spain, France and Germany would reduce their FED by around 12-13% when implementing all measures. Italy achieves a reduction of close to 10%.

The final energy savings achieved in the two-year period considered in this study is compared to the requirements for energy savings that Member States have to achieve under Article 8 of the revised Energy Efficiency Directive (EED). To calculate the required savings, the saving target of 1.3 % per year specified in Art. 8 (1) b ii is considerd, where the base consumption is calculated as the average final energy demand in the years 2016-2018 based on Eurostat data[10]. Table 8 shows the share of the target specified in Art. 8 of the revised EED that is achieved solely through the measures considered in this study. The table shows that, while the contribution differs largely between 12% (Spain) and 63% (Romania), the measures provide a significant contribution across all countries.

Table 8: Share of the total final energy savings with respect to the EED energy savings obligation for each country

Country	Share of savings of energy savings obligation
Germany	14%
Spain	12%
France	13%
Greece	22%
Hungary	29%
Italy	19%
Romania	63%

The measures considered in this study additionally address the requirement of Art. 8.3 EED to deliver a share of the savings among people affected by energy poverty, vulnerable customers, low-income households and, where applicable, people living in social housing.

Contribution to deployment of renewable energies

As indicated in Table 9, the implementation of renewable energy sources plays an important part in abandoning fossil fuels in the buildings sector. With the set of measures in this study, installing heat pumps and solar thermal collectors can together achieve a replacement of 4,886 GWh of fossil fuels per year for space heating and hot water in all countries combined. Heat pumps contribute more than 85% towards that replacement.

[10] Dataset NRG_IND_EFF

Table 9: Space heating and hot water: amount of fossil fuels replaced by renewable energies (in GWh)

Country	Heat pumps	Solar thermal	Total renewable	Total fossil[11] before	share of replaced fossil fuels in low-income households
Germany	1,964	203	2,167	59,736	3.6%
Spain	357	74	431	13,859	3.2%
France	882	142	1,024	29,112	3.5%
Greece	169	23	192	3,896	4.9%
Hungary	228	38	266	4,726	5.6%
Italy	324	44	368	44,555	1.4%
Romania	393	49	442	6,525	6.8%
total	4,313	573	4,886	162,409	3.0%

4.4.2 CO_2 emissions savings

Figure 8 shows the CO_2 emissions savings achieved by the implementation of the respective measures. As in Figure 7 each pie chart shows the share the individual measures make up in the total emissions savings. In combination, the three measures addressing renewable energy sources directly make up between one third and two thirds of the emissions savings. The campaign makes up a in between 14% to 25% of the emissions savings – a similarly high percentage as for the energy savings (see Figure 7).

Again, as in Figure 7, the absolute numbers per country are complemented by the relative reduction in CO_2 emissions achieved for low-income households. This share ranges from 9.6% (Italy) to 18.1% (Greece).

Generally, the emissions savings depend on the absolute final energy savings as well as the energy carrier mix in each country. Depending on the emissions factors for electricity, emissions savings can be higher or lower. For instance, replacing a gas boiler by a heat pump in France with its relatively low electricity emissions factor achieves higher emissions savings than doing the same in Germany with a comparatively higher electricity emissions factor.

[11] Fossil fuels include gas, oil and coal

Figure 8: Absolute CO_2 emissions savings in million tonnes (Mt) and the relative reduction in total emissions for space heating and hot water in low-income households (in %) over a two-year period

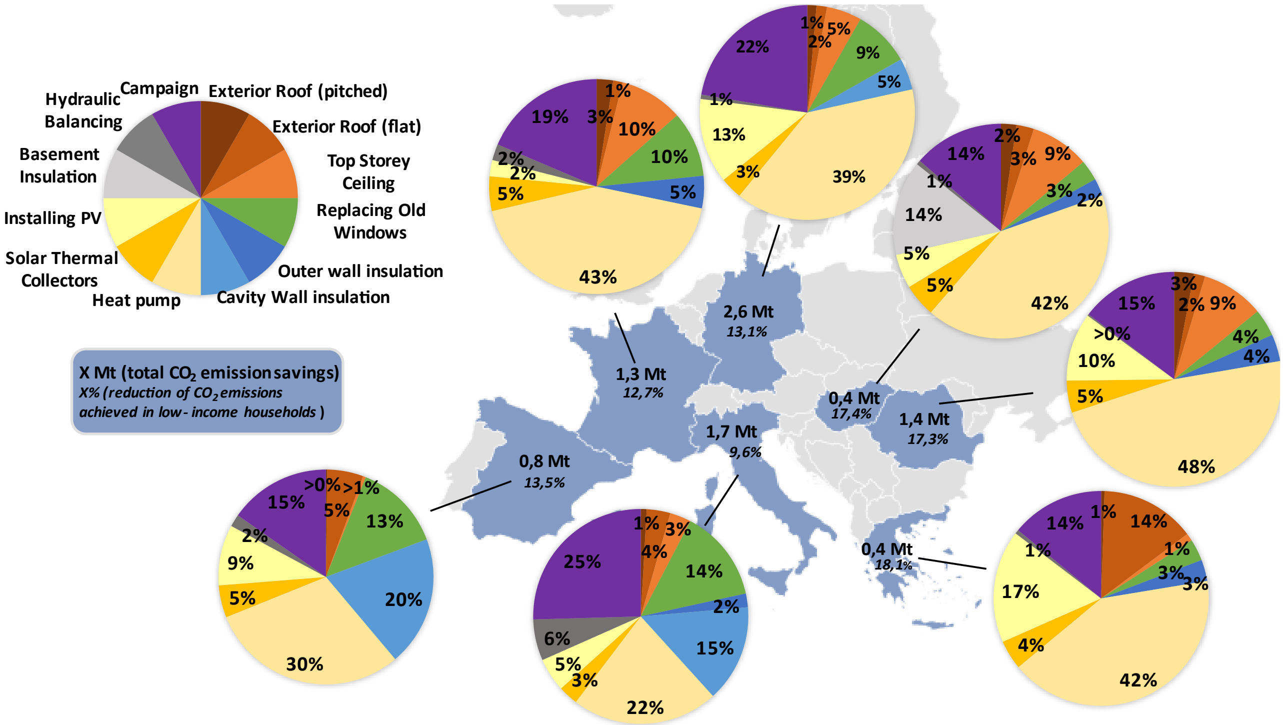


Table 10 lists each country's share of the effort sharing regulation (ESR)[12] target achieved by implementing the chosen energy efficiency and renewable energy measures. Since the individual targets differ substantially, the range the measures' contribution also differs substantially: countries such as Romania (83.5%) and Hungary (11.4%) achieve double digit percentage contributions to their ESR targets, whereas the remaining five countries' ESR target contributions stay in the low single digit percentage contributions (0.8% in France to 3.7% in Greece).

Table 10: Share of measures in achieving the effort sharing regulation target

Country	Share of target in Effort Sharing regulation
Germany	1.1%
Spain	1.3%
France	0.8%
Greece	3.7%
Hungary	11.4%
Italy	1.3%
Romania	83.5%

[12] The effort sharing regulation is a policy framework that sets binding CO_2-emission reduction targets for EU member states complementing the EU's emissions trading system (ETS).

4.4.3 Investment costs and energy cost savings for low-income households

Figure 9 presents the total costs and the proportions of each measure. The figure also depicts the required budgets for three different hypothetical subsidy programmes, with subsidy rates of 100%, 80%, or 50% of the investment costs of the measures in low-income households. The campaign is the only exception in this respect since it is always fully projected with 100%. Not surprisingly, the higher the population in a given country, the higher the costs for implementing the measures. At the same time the total amount of low-income households is also visible, if only indirectly: Hungary's population is roughly half that of Romania's, yet the required budget for a subsidy programme at any given rate is only about 30% of the Romanian one. This is because the combined total of low-income households in Hungary is 13% compared to Romania's 23% (see Table 6).

Figure 9: Total costs in millions of Euros for the subsidy rates of 100%, 80% and 50% over a two-year period[13]

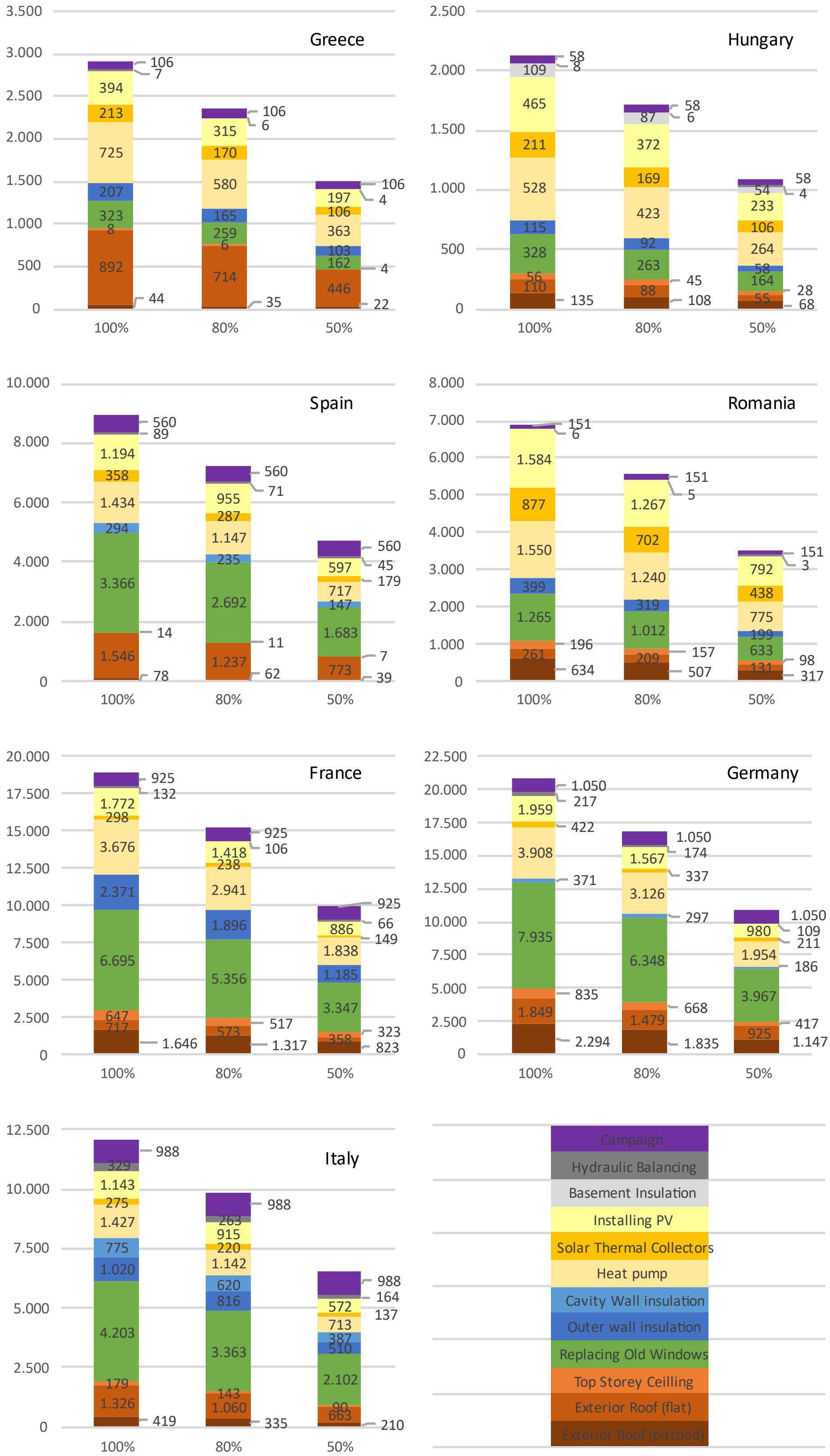


Figure 10 shows the **energy cost savings** in millions of Euros achieved in low-income households through the implementation of the various measures over a two-year period. Analogous to Figure 7 and Figure 8 (see above) the pie charts describe the proportion of the energy cost savings achieved by the different measures in each country. The absolute energy cost savings over two years in low-income households amount to between 56 million Euros (Hungary) to 943 million Euros (Germany). As indicated in italic, the reduction in energy costs cover between 9.6% (Italy) and 21% (Romania) of the total energy costs low-income households face. As can be seen in the pie charts, installing heat pumps contributes the highest share to the energy cost savings in most countries, closely followed by installing solar PV and the campaign.

Figure 10: Total energy cost savings in millions of Euros and the relative reduction in energy costs for low-income households over a two-year period

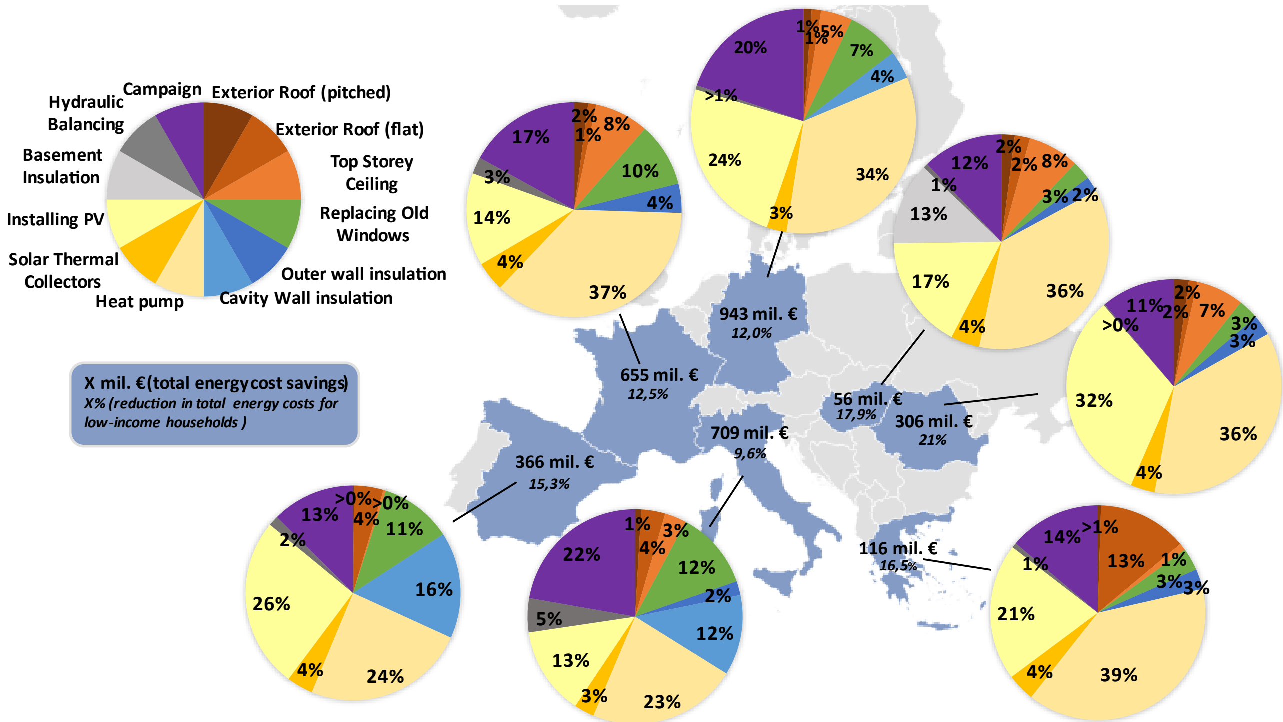


Figure 11 shows the energy cost savings over the lifetime of the implemented measures rather than the two-year period (cf. Figure 10). These lifetime savings amount to between 1.4 bn EUR in Hungary to nearly 20 bn EUR in Germany. The assumed lifetimes of the individual measures are shown in Table 19 of Annex III.

Figure 11: Energy cost savings in billions of Euros over the lifetime of the implemented measures and the relative reduction in energy costs for low-income households

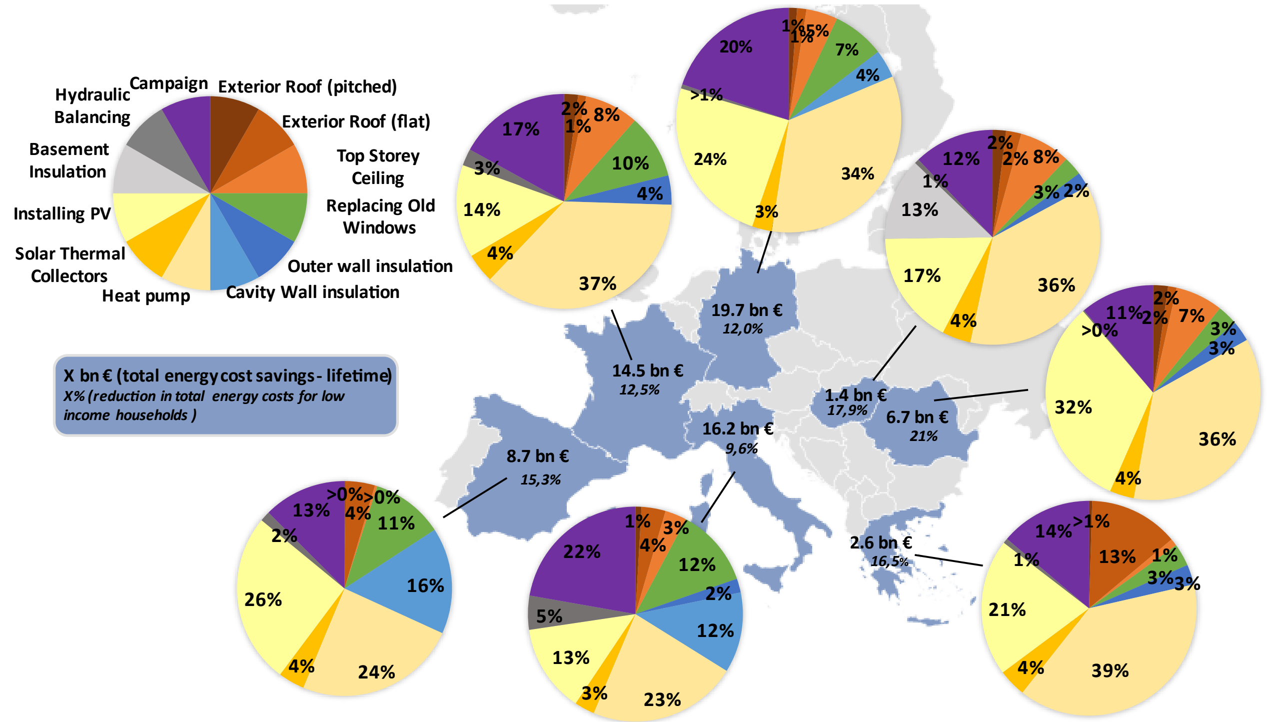


Table 11 shows a comparison of different compensation schemes (cf. section 3.2) with investment costs at varying subsidy rates as well as the associated energy cost savings of the measures developed in Chapter 4. Whereas the total investment costs are usually an order of magnitude higher than any of the listed compensation schemes, the energy cost savings over the lifetime of the different measures are close to, or higher, than the total investment costs at a subsidy rate of 80% (Hungary being the exception with total investments of 1,700 million Euros at an 80% subsidy rate against only 1,400 million Euros of energy price savings). Even though compensation schemes seem a lot cheaper now, the long-term perspective shows, that investments in energy efficiency and renewable energy measures eventually pay for themselves (or indeed achieve positive returns).

Table 11: Comparison of costs for different compensation schemes with investment costs at different subsidy rates as well as energy costs savings (in millions of Euros)

Country	Price scenario	**Comp. Scheme 1:** 30% of additional energy costs for all households	**Comp. Scheme 3**: 50% of energy costs only for households in first income quintile	**Comp. Scheme 4**: 80% of energy costs only for households in first income quintile	Averaged annual **investment costs** for subsidy rate of			**Total investment costs** for subsidy rate of			**Energy cost savings**		
					50%	80%	100%	50%	80%	100%	Annual total	Lifetime total	Lifetime per household[14]
	Max price 2022-2023	5,227	1,016	1,626									
France	Scenario 2 medium price	2,538	493	790	188	300	375	9,439	15,103	18,878	327	14,500	3,072
	Scenario 2 with adjusted demand	9	2	3									
	Max price 2022-2023	14,089	3,121	4,994									
Germany	Scenario 2 medium price	6,087	1,349	2,158	210	336	420	10,420	16,671	20,840	471	19,736	3,420
	Scenario 2 with adjusted demand	1,570	348	557									
	Max price 2022-2023	11,442	2,157	3,451									
Italy	Scenario 2 medium price	4,059	765	1,224	127	203	253	6,042	9,667	12,083	355	16,200	2,780
	Scenario 2 with adjusted demand	1,724	325	520									

[14] in EUR instead of Mio. EUR.

Country	Price scenario	**Comp. Scheme 1:** 30% of additional energy costs for all households	**Comp. Scheme 3**: 50% of energy costs only for households in first income quintile	**Comp. Scheme 4**: 80% of energy costs only for households in first income quintile	Averaged annual **investment costs** for subsidy rate of			**Total investment costs** for subsidy rate of			**Energy cost savings**		
					50%	80%	100%	50%	80%	100%	Annual total	Lifetime total	Lifetime per house-hold[14]
Spain	Max price 2022-2023	3,807	699	1,118	94	150	187	4,466	7,146	8,932	183	8,700	2,400
	Scenario 2 medium price	1,581	290	464									
	Scenario 2 with adjusted demand	368	68	108									
Greece	Max price 2022-2023	882	170	272	29	47	59	1,460	2,336	2,920	58	2,600	3,517
	Scenario 2 medium price	360	70	111									
	Scenario 2 with adjusted demand	68	13	21									
Romania	Max price 2022-2023	737	95	153	74	118	148	3,461	5,538	6,923	153	6,700	4,102
	Scenario 2 medium price	365	47	76									
	Scenario 2 with adjusted demand	88	11	18									
Hungary	Max price 2022-2023	789	150	240	23	36	45	1,062	1,700	2,124	28	1,400	2,700
	Scenario 2 medium price	275	52	83									
	Scenario 2 with adjusted demand	49	9	15									

5 Financial instruments and existing instruments at national and EU-level

Chapter 4 introduced a set of measures that can be deployed. This raises two questions: first, how can such measures be financed, and second, how these measures relate to existing instruments and measures to improve energy efficiency and ensure the deployment of renewable energies at the household level. In this chapter we therefore take a look at the existing instruments for financing energy efficiency upgrades and renewable energy measures both on EU level and within the national context of the seven countries considered in this study. The focus here is on more long-term financial support measures for energy efficiency and renewable energy implementation that can work in tandem with the measures proposed. This chapter focuses particularly on measures targeted at low-income and vulnerable households.

First, this chapter gives an overview of the existing financing instruments at EU-level. This includes the major financing programmes of the EU, including the European Social Climate Fund, and to what extent these finances are related to energy efficiency and renewable energy deployment. Second, existing programmes at national level are considered and, for a selected number of programmes, detailed factsheets are provided to allow for mutual learning between the Member States.

5.1 Financing instruments available at the EU-level

There are a number of financing instruments available at EU-level. These are usually large programmes that provide funding for multiple aspects and where it is up to Member States to decide and to specify how funding is used. In this section we consider the Recovery and Resilience Facility, as a fund that was introduced as a temporary recovery instrument in response to the Covid-19 pandemic and the energy market disruptions following Russia's invasion of the Ukraine, as well as those funds under the European Cohesion Policy, which include the European Regional and Development Fund (ERDF), the Cohesion Fund (CF), the European Social Fund (ESF+), and the Just Transition Fund (JTF). Additionally, EU Member States generate significant Emissions Trading System (ETS) revenue, which is often also used to fund energy efficiency measures and the implementation of renewable energies. Finally, the European Social Climate Fund will come into force in the coming years to support Member States in the offsetting of additional financial burdens on households caused by a carbon price to be placed on the transport and heating fuels they use (hereafter referred to as the ETS2).

5.1.1 An overview of relevant EU-Funds

The EU Cohesion Policy is a core funding body within the EU. One third of the total EU budget, €392 billion, were allocated to the policy for 2021-2027 (EU Commission 2023). Table 12 provides an overview of the EU Cohesion Policy funds.

Table 12: Overview of EU Cohesion Policy funds

Cohesion Policy Fund	Description
European Regional Development Fund (ERDF)[15]	Around **€200 billion** has been allocated to the ERDF for the period 2021-2027 to correct imbalances between regions in the EU. Amongst its policy objectives is to move to a more competitive and smarter Europe (PO1) and a greener, low-carbon transitioning towards a net zero carbon economy and resilient Europe (PO2). More developed regions or MSs will dedicate at least 85% of their allocation to PO1 and PO2. This is less for transition regions (40% to PO1) and less developed regions (25% to PO1). 30% of the overall financial envelope will go to meeting climate objectives.
Cohesion Fund (CF)[16]	**€42.6 billion** has been allocated to the Cohesion Fund (2021-2027). The Cohesion Fund provides support to Member States with a gross national income (GNI) per capita below 90% to strengthen the economic, social, and territorial cohesion of the EU. This concerns Bulgaria, Czechia, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovakia and Slovenia. 37% of the overall financial allocation of the Cohesion Fund are expected to contribute to climate objectives. The MS' administrations choose which projects to finance and take responsibility for the day-to-day management.
European Social Fund Plus (ESF+)[17]	Almost **€99.3 billion** have been made available for the period 2021-2027. It is the EU's main instrument for supporting the implementation of the European Pillar of Social Rights. It is a contribution to the EU's employment, social, education and skills policies, including structural reforms in these areas. The Fund will also be one of the cornerstones of EU socio-economic recovery from the coronavirus pandemic reducing disparities between Member States and regions. Support under the ESF+ is mainly managed by Member States, with the Commission playing a supervisory role.
Just Transition Fund (JTF)[18]	The fund provides targeted support to help mobilise around **€55 billion** over the period 2021-2027. It was introduced in the context of the European Green Deal and supports the territories most affected by the transition towards climate neutrality to avoid regional inequalities. The Just Transition Fund will support EU regions relying on fossil fuels and high-emission industries in their green transition, supporting the transition to low-carbon and climate-resilient activities, creating new jobs in the green economy, investing in public and sustainable transport, facilitating employment opportunities in new sectors and those in transition, improving energy-efficient housing, and investing to fight energy poverty.

Source: Own compilation

[15] For more details see: https://www.europarl.europa.eu/ftu/pdf/en/FTU_3.1.2.pdf (European Parliament 2023b)

[16] For more details see: https://www.europarl.europa.eu/ftu/pdf/en/FTU_3.1.3.pdf (European Parliament 2023a)

[17] For more details see: https://ec.europa.eu/european-social-fund-plus/en/what-esf (European Commission 2023c) and https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works-people/jobs-growth-and-investment/european-pillar-social-rights_en (European Commission 2023a)

Often the fundings for a given period are, however, not used entirely and cohesion funds have been used a number of times to address crises (Bertelsmann Stiftung 2023). This was already the case during the 2008/2009 financial crisis where the deadline for spending of cohesion funds from was extended from 2006 to mid-2009. More recently, these funds were also used in response to the Covid-19 pandemic (see Bachtler et al. 2020), the energy price crisis, and in the support of Ukrainian refugees (see van Lierop 2022). In response to the high energy prices, €40 billion of unused 2014-2020 EU Cohesion Policy funds were redirected into the REPowerEU Plan that aims to reduce the EU's dependence on Russian fossil fuels (Nicolás 2022; European Union 2022). At the heart of the implementation of the Plan also lies the **Recovery and Resilience Facility (RRF)**, as dedicated REPowerEU have been integrated into existing Recovery and Resilience Plans through an amendment of the RRF Regulation.

The RRF is a temporary recovery instrument that finances reforms and investments in Member States from the start of the pandemic in February 2020 until 31 December 2026. It has a total budget of **€723.8 billion**, of which €385.8 billion are allocated as loans and €338 billion in the form of grants. The aim is to mitigate the economic and social impact of the coronavirus pandemic and make European economies and societies more sustainable, resilient, and better prepared for the challenges and opportunities of the green and digital transitions. To benefit from the support of the Facility, Member States submit their recovery and resilience plans to the European Commission. Each plan sets out the reforms and investments to be implemented by the end of 2026 and Member States can receive financing up to a previously agreed allocation. These RRF Plans address in particular the country-specific recommendations adopted by the Council. They should advance the necessary transitions and policies for next generation, health system, as well as energy independency. The RRF is performance based, meaning that the fulfilment of agreed milestones and targets towards achieving the reforms and investments in the plans will unlock regular payment.

Finally, the newly proposed **Social Climate Fund (SCF)** will play a significant role in the funding of instruments that target vulnerable households in the near future, although this will only be relevant from 2026 onwards and is not directly relevant in the next 2-3 heating periods. Under the 'Fit for 55' package the European Commission is extending the existing EU ETS to the building and transport sectors. This will result in higher prices and negative distributional impacts that affect low-income and other vulnerable households disproportionally. The aim of the SCF is to mitigate the social impacts of the proposed emissions trading system on vulnerable households, micro-enterprises, and transport users, through measures and investments as well as temporary direct income support. It has a total financial volume of €65 billion brought together from ETS 2 and ETS 1 revenues plus additional 25% co-financing by MS. In total this amounts to **€86.7 billion** for 2026-2030. The SCF stipulates that temporary direct income support shall not represent more than 37.5% in each country, meaning that the majority of the funding is to be used for financing measures and investment. Specifically, support under the Fund shall be *additional* to other Funds, programmes, and instruments. Eligible measures and instruments are described in the Regulation and need to be laid out in Social Climate Plans that will be subject to Commission assessment (European Commission (EC) 2021). Payments will be made upon completing and reporting milestones and targets indicated in these Social Climate Plans.

[18] For more details see: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en (European Commission 2023b)

5.1.2 ETS revenue use in the EU

EU Emissions Trading System (EU ETS) was introduced in 2005 and has steadily established itself as a key feature of EU climate policy. From January 2021 to June 2022, the EU ETS generated €51 billion of revenues (European Commission (EC) 2022b). This was particularly high due to high allowance prices. These peaked in February 2023 at over €100/tCO_2-eq., so it's to expect that the revenues for 2023 will be even higher (Hodgson und Sheppard 2023). The current EU ETS Directive states that 50% of auctioning revenues from stationary auctioning (Article 10(3)) and 100% from auctioning for aviation (Article 3d(4)) *should* go to climate action (European Commission (EC) 2022b). This makes the EU ETS revenue a significant revenue stream to finance energy efficiency and renewable energies.

Between 2013 and 2021 the EU ETS' revenues accumulated to a total of €88.5 billion. Of these, 72% were spent on climate action – 22% more than stipulated in the directive – while the rest went into government spending. Between 2013-2021, 26% of revenues were spent on renewable energies and 19% on energy efficiency (WWF 2022). How revenues are used varies between Member States. In some countries the revenues flow into a fund that is separate from the state budget (e.g. in Germany). Sometimes laws are used for direct allocation of revenues (e.g. in Italy, Greece, and France). And in some countries revenues flow directly into the state budget without any earmarking of the funds. Studies show that while in some instances new climate actions are implemented, other times revenues are used to pay off existing debts (rather than providing additional incentives) or are used to compensate households directly rather than investing in climate action (Haase et al. 2022). Additionally, WWF (2022) estimates that only 58% of all revenues are spent on genuine climate action, whilst other spending labeled as climate action (€12.4 billion) is actually spent on compensation for the ETS carbon price, for modernisations of coal infrastructures, for switching from coal-fired to gas-fired power plants, for fossil fuel-based based heating systems or for diesel cars. The ongoing revision proposes to raise the share to 100% and change the wording from 'should' to 'shall', making the provision mandatory (European Parliament (EP) 2022).

5.1.3 Relevant EU financing in the selected countries

Table 11 gives an overview of the level of EU funding in the selected MS. This includes the Cohesion Policy Funds, EU ETS revenues, as well as the Recovery and Resilience Facility. It should be noted that Hungary's EU Cohesion Policy Funds have been frozen since December 2022 (Abnett und Strupczewski 2022). This is due to high levels of corruption and the violation of basic human rights, related specifically to LGBTQI+ rights.

Table 13: Overview of EU-level funds and other relevant revenue streams

Country	European Regional Development Fund (ERDF)	Cohesion Fund (CF)	European Social Fund Plus (ESF+)	Just Transition Fund (JTF)	ETS Revenue	Recovery and Resilience Facility (RRF)
DE	**€10.9 billion** total. 30% for target 2: greener, less GHG-intense Europe. Incl. energy transition, circular economy, climate change adaption, risk management.	Not applicable.	**€6.5 billion** total. incl. investing in upskilling and reskilling to create a climate-neutral society.	**€2.5 billion** for Territorial Just Transition programme. To support the greening and phasing out of lignite.	**€18.4 billion** (2013-2021) Revenues allocated to Energy and Climate Fund, separate from the general state budget.	**€2.5 billion** for a large-scale renovation programme to increase the energy efficiency of residential buildings. At least 42% of the plan to support climate objectives.
EL	**€11.4 billion** total. **30% of the ERDF** for energy efficiency and reduction of carbon emissions, as well as in waste and water management measures.	**€3.9 billion** total. **55% of the CF** for energy efficiency and reduction of carbon emissions, as well as in waste and water management measures.	**€5.8 billion** total. Incl. skills upgrading for the digital and green transitions.	**€1.63 billion** to alleviate impact of the energy and climate transition on local economy and society. Targets energy transition, land use adaptation and the circular economy.	**€3.4 billion** (2013-2021) 100% of revenues for climate action. Finances renewable energy producers, but also include support for combined heat and power (CHP) plants.	**€1.3 billion** investments in the energy-efficient renovation of more than 100,000 residences. Including for low-income households.
ES	**€23.5 billion** total. **€9 billion** for green transition. **€1.8 billion** from this to reach target of primary energy savings of 39.5% in 2030. **€3.3 billion** to achieve target to produce 74% of electricity from renewable sources by 2030.	Not applicable.	**€11.1 billion** total. Incl. skills development, such as those needed for the green and digital transition.	**€870 million** total. Support regions that have closed or plan to close coal mines, carbon-intensive industrial facilities and coal power plants.	**€8.3 billion** (2013-2021) 17 % have not been spent on climate action (2013-2020).	**€7.8 billion** investments in energy efficiency of public and private buildings. **€3.4 billion** for energy renovation in residential buildings by 2026. Package of reforms, including tax incentives and renovation offices.

Country	European Regional Development Fund (ERDF)	Cohesion Fund (CF)	European Social Fund Plus (ESF+)	Just Transition Fund (JTF)	ETS Revenue	Recovery and Resilience Facility (RRF)
FR	**€9 billion** total. **€3.5 billion** to boost the competitiveness of regions. **€2.8 billion** dedicated to the European Green Deal.	Not applicable.	**€6.6 billion** total. Incl. training and career guidance to support the green and digital transitions.	**€1 billion** total. For six regions to cope with the impacts of the energy transition and to diversify their economic activities currently based on carbon intensive industries.	**€5 billion** (2013-2021) Revenues used to finance renovation schemes. Earmarked revenues are capped, with the remainder going into the state budget.	**€18 billion** for green investments. **€5.8 billion** of this for building renovation. **€1.4 billion** of this will finance “MaPrimeRenov”
HU	**€13.3 billion** total. **€6.7 billion** to improve the energy efficiency of public and private buildings and increase energy generation from renewable sources amongst others.	**€3.4 billion** total.	**€5.5 billion** total. Incl. development of skills required to thrive in the green and digital transition.	Over **€250 million** to support regions most affected by the phasing out of coal and the lignite-fired power plants. Incl. investments in low-carbon technology and innovation in energy efficiency.	**€1.2 billion** (2013-2021) 49 % have not been spent on climate action (2013-2020).	**€5.8 billion** total. 48.1% allocation dedicated to climate-related measures.
IT	**€26.6 billion** total. **€8.7 billion** to make energy more affordable, clean and secure. Investment in low-carbon and circular economy as well as energy-efficient renovations in public buildings.	Not applicable.	**€14.5 billion** total. Incl. invest in up-skilling and re-skilling of workers, and in empowering people for the green and digital transition.	**€1 billion** to help cushion the impacts of the green transition and support the diversification of the economic activities currently based on carbon intensive industries.	**€8.9 billion** (2013-2021) Spending on climate action varied from 69.8% in 2017 to 11.5% in 2019.	**€15.3 billion** investments in energy efficiency in residential and public buildings. Incl. a tax rebate if energy savings are higher than 30%. By 2025, building renovation completed for at least 32 million square meters.

Country	European Regional Development Fund (ERDF)	Cohesion Fund (CF)	European Social Fund Plus (ESF+)	Just Transition Fund (JTF)	ETS Revenue	Recovery and Resilience Facility (RRF)
RO	**€17 billion** total. **€2.3 billion** (ERDF & CF) to improve energy performance of residential and public buildings and to develop in renewable energy sources and smart energy systems.	**€4.6 billion** total. **€2.3 billion** (ERDF & CF) to improve energy performance of residential and public buildings and to develop in renewable energy sources and smart energy systems.	**€8.2 billion** total. No specific mentioning of green transition or climate related actions.	**€2.14 billion** to alleviate the social and economic impact of the green transition towards a climate neutral economy.	**€3.6 billion** (2013-2021) 60 % have not been spent on climate action (2013-2020).	**€2.7 billion** for energy-efficient renovation and seismic renovation of buildings. Aim to increase energy renovation rate of multi-family buildings and public buildings.

Source: Own compilation based on Haase et al. (2022), WWF (2022), and references from Annex VII

5.2 National instruments for financing energy efficiency and renewable energies

As the overview in Table 11 shows, there is a large variety of EU-level financing instruments that may be used to finance instruments for improving energy efficiency and the switch to renewable energies in the building sector. In some instances, this is already the case or explicitly planned, but putting these plans into action and using funds effectively to target vulnerable groups is still lacking. This section therefore discusses *existing* instruments and measures in the countries explored in this study. The focus is on energy efficiency measures and renewable energy implementation generally, but also on those instruments that target vulnerable households specifically. Annex V provides a non-comprehensive overview of existing or completed instruments in the countries that focus on building resilience and ensuring the equal participation of all households in the energy transformation. Some of these instruments are introduced in more detail in factsheets throughout this section.

5.2.1 Energy and climate policy for vulnerable households

Those groups who cannot afford to adequately heat or cool their homes or use sufficient electricity are considered to be affected by energy poverty (EC 2020). This has been increasingly recognised by the EU and is addressed in almost all energy and climate policies at EU level. Across the Member States this has also become increasingly important, but the recognition of energy poverty at the national level and implementation of policy remains varied (Noka und Cludius 2021; Bouzarovski et al. 2021). Income, prices, and energy use of households are generally understood as the causes of financial strain on households in this context (Tews 2013, 2014; Thomson et al. 2017; Thema und Vondung 2020; Energy Poverty Advisory Hub 2022). In turn, policies address these three elements. During the energy price crisis, most policies focused on prices and income, by either capping energy prices or the pass-through of costs to households and by providing short-term financial support to households through one-time payments or adjustments in the social welfare systems (Bruegel 2022; Schumacher et al. 2022). This affects the energy sector but is essentially a social policy instrument that ensures that vulnerable households are protected in the short-term. Nonetheless, more long-term solutions to addressing energy poverty and vulnerability need to focus on energy usage in the household. This is most directly addressed by improving energy efficiency, because particularly the most vulnerable households tend to live in the worst performing buildings. This is where energy and climate policies take on a more prominent role. These measures ensure higher resilience as well as participation of vulnerable groups in the energy transition. This means that energy and climate policies need to be designed in a way that is targeted to those groups and in a way that does not additionally burden them. Section 4.4.1 has already demonstrated that improving energy efficiency and deploying renewable energies can lead to significant savings for low-income households.

5.2.2 An excursion: targeting measures at (vulnerable) tenants

When designing and implementing energy efficiency measures and working towards the deployment of renewable energies in the residential sector one of the key questions is who these policies target. On the one hand, this relates to whether policies are designed to reach all households or are targeted at vulnerable households only. On the other hand, the split-incentive problem is central to policy design in the residential building sector. This is often also referred to the landlord-tenant dilemma, where there is a disconnect between who pays and who benefits from energy efficiency measures, for example.

The landlord-tenant dilemma is a result of either a usage or a technology problem. When heating and other energy costs are included in the rental payments, as is the case in Sweden for example, tenants have no economic incentives to reduce their energy consumption. This requires landlords to act by increasing rent, investing in energy efficiency (although this may not always lead to reduced consumption in such cases), or introducing better control equipment to regulate indoor temperatures, for example. When energy use is billed separately from rent, however, a technology problem, often also referred to as the efficiency problem, occurs (Petrov und Ryan 2021). While landlords control the level of energy efficiency of and in the property, tenants carry the costs directly and consequently also the savings if energy efficiency improvements occur. Landlords are more inclined to reduce investment costs rather than life-cycle costs (Broberg und Egüez 2018). The non-alignment of incentives for landlord and tenant result in an under-investment in energy efficiency measures.

There are a number of ways in which this split-incentive problem can be tackled. Much of the academic literature focuses on the asymmetry of information in such instances (Melvin 2018; Myers 2020). The introduction of energy performance labels, such as the energy performance certificates (EPC) aims at reducing this information gap by giving tenants and landlords equal information about the rental property. This can give tenants additional information when choosing a rental property and thus incentivise landlords to improve their energy efficiency rating. This also helps to identify “worst performing buildings” and prioritise investments. Studies show that energy efficiency is becoming an increasingly important part of the decisions that renters make (see Franke und Nadler 2019 on Germany for example). In Germany, however, Franke und Nadler (2019) also find that renters understand energy efficiency through financial indicators i.e., the costs of energy utilities, rather than directly through EPCs, which are understood better by homeowners and landlords. It therefore remains important to communicate energy efficiency improvements as financial savings (see also Wrigley und Crawford 2017 on Australia).

At the same time, Franke und Nadler (2019) also showed that monthly rent and location, alongside energy efficiency, are the key factors in rental decisions. This is echoed by Petrov und Ryan (2021) in their study on Ireland, which suggests that disclosing and advertising energy performance certificates alone does not address the split-incentives problem, particularly when the scarcity of other property characteristics, such as location persist. It also disregards that tenants in existing tenant agreements may not be able to or want to move and more broadly, that not all tenants have the financial and other means to freely choose a rental property. This can be constrained both by the market as well as the socio-economic characteristics of the household. When considering vulnerable households, it is therefore important to go beyond such information-based understandings of the landlord-tenant dilemma.

One way in which energy performance certificates have been used to improve energy efficiency in the rental sector is through Minimum Energy Performance Standards (MEPS). While MEPS are currently being discussed in the context of the revision of the EPBD, some countries have already introduced such standards. An example for a MEPS targeting the rented buildings sector is the UK, where since 2018 landlords have not been allowed to rent out properties that have an energy performance certificate below E. This is due to be increased to C in the coming years. A similar programme is being implemented in France, where in dwellings with an energy consumption above 450 kWh/m^2 per year no new rentals are possible. These standards will slowly increase until 2034. Additionally, a rent freeze has been applied to all dwellings with energy classes F and G since August 2022.

At the same time, increased renovation activity that may result from such regulatory measures often leads to higher rental costs if the costs of renovations are directly passed on to tenants. **Financial support** in the form of grants or subsidies to landlords can therefore provide incentives to landlords, that would not conduct or sometimes even be able to fund renovations without any financial support. Examples of such financial measures that consider the landlord-tenant dilemma are, for example, the MaPrimeRenov programme in France that provides subsidies for landlords and energy efficiency upgrades but regulates the extent to which the rent can be increased after these improvements have been made. More general regulations in Germany, that are not directly linked to financial support, stipulated the extent to which costs can be passed on to tenants and that only costs related to energy efficiency improvements may be part of rent increases. In the Netherlands energy efficiency is integrated into the rental system, where better energy indices (similar to energy efficiency certificates) allow landlords to set higher rents and vice versa. The STEP Subsidy with a total volume of €400 million (2014-2017) for investment in energy efficiency focused on short-term investments in rental properties in relation to this rental regulation.

Box 3: Factsheet – MaPrimeRenove Serenite

MaPrimeRenov Serenite	
Country	France
Scale	National
Target group	Eligibility is based on (low-)income
Timeframe	2023-ongoing Previously Habiter Mieux (2011-2021) and Habiter Mieux Serenite (2021-2023)
Key actors	ANAH (National Housing Agency) and energy suppliers
Financing	Funded through the ANAH budget (that is partially financed through ETS revenues), white certificates of energy suppliers, household budget (via tax on vacant dwellings and the Plan de relance)
Description	The idea of MaPrimeRenov is to bring together all the grants that are available from different organisations and put them in the hands of one central agency. It's an advisory support and financial aid programme that supports improving the overall energy situation of homes. The programme was initially implemented to support low-income households only but was extended to all households as a result of the 2020 crisis. Since 2021, landlords can also take advantage of this funding. MaPrimeRénov Serenite concerns all work allowing an energy efficiency gain of at least 35%. Households receive 35 or 50% grants depending on whether they are classed as low or very low-income households. Households can also receive additional bonuses if their houses move from an energy efficiency label of F or G to E or better or if their homes receive the efficiency class of A or B. Households also have access to professional, individualised support that accompanies the project throughout. Over 57,000 households have renovated their homes in 2021 via the Serenite programme.

Source: see Annex VI

There is also a range of **"soft" energy efficiency measures** that can address renters directly (see also Section 4.1). These are similar to the campaign measures described in this report and can be implemented very quickly. This includes for example the Stromsparcheck in Germany and the ASSIST Programmes, where rental households, particularly vulnerable households, are advised in their homes on their energy use. These home visits are often accompanied by small energy efficiency improvements such as the changing of lightbulbs, installing switch sockets, and providing vouchers for the trade-in of old appliances. These measures are often very effective because they can reach a large number of households and provide easy support. They do not, however, lead to big leaps in energy efficiency necessary for long-term resilience.

Box 4: Factsheet – Electricity Savings Check

Stromsparcheck (Electricity Savings Check)	
Country	Germany
Scale	Nationally implemented with local deployment
Target group	Recipients of social benefits and households with an income lower than the garnishment exemption limit (currently €1339.99 for a 1-person household)
Timeframe	2008-ongoing
Key actors	Caritas Germany and the Organisation of Agencies for Energy and Climate Protection Germany (eaD); Supported by the Federal Federal Ministry for Economic Affairs and Climate Action
Financing	Funded through the National Climate Initiative (NKI) which is funded via EU ETS revenues
Description	Trained electricity-saving assistants advise households in their homes on energy-saving options for electricity, water, and heat. After an initial electricity-savings check, the advisors give qualified tips on how consumption can be reduced. In addition, they provide emergency aid (e.g. plug strips, LEDs, shower-saving heads) and install them. These advisors are long-term unemployed that have been trained as part of this project. On average around 12 appliances per household are exchanged leading to savings per household per year of around €208 in the first year and around €1,400 in long-term savings. Between 2008-2023 over 400,000 households have benefitted from the programme and more than 830,000 t CO_2 reductions have been achieved.

Source: see Annex III

Finally, there are a few examples of **mediation programmes**, such as in Lille, France, that help to mediate between landlords and tenants when it comes to tackling energy efficiency, and a range of **one-stop-shops** that bundle these different activities and provide aid along multiple fronts in one place. These are often regional programmes set up by local policy actors or NGOs, meaning they do not currently reach many households but are effective in providing very comprehensive support. The Energy Poverty Advisory Hub[19], a support platform hosted by the EU, focuses on supporting such local actors in the fight against energy poverty.

[19] See: https://energy-poverty.ec.europa.eu

Box 5: Factsheet – Mediation Landlord/Tenant

Mediation Precarité Energetique (Energy Mediation landlord/tenants)	
Country	France
Scale	Local
Target group	Vulnerable households, specifically energy poor renters
Timeframe	2016-ongoing
Key actors	Trained technicians (Amelio network), the municipality of Lille, CCAS
Financing	60% Municipality of Lille, 15% Departement and Abbé-Pierre-Foundation, 15% by AG2R La Mondiale and Schneider Electric Foundation
Description	Project in Lille helping households in energy poverty in the private rented sector and convincing landlords to carry out works. Households are identified through other schemes (CCAS, SLIME, etc.), are supported by an energy mediator (le Graal association), with a socio-technical diagnostic visit (+ small actions) and socio-technical mediation with the landlord to negotiate and support the decision and implementation of works.

Source: see Annex VI

5.3 Overview of relevant instruments within the countries

The targeted deployment of energy efficiency and renewable energies for vulnerable households helps to ensure that **participation** in the energy transitions is just and fair. More often than not, low-income groups are not able to easily take advantage of subsidies for the installation of renewable energies meaning that targeted measures are key in this area. These kinds of measures can be implemented in the short-term and can bring significant savings for low-income households (see section 4.4). A national approach is being taken by Greece, where a new programme has been announced for the installation of solar PVs on the rooftops. The Government will subsidise up to 60% of the installation cost with a total project budget of €200 million. Generally, however, these tend to be regional programmes that focus on the installation of PV modules such as the Barrio Solar programme in Spain, that works on a neighbourhood level to install PV plants for shared consumption. Such programmes can be particularly successful when they take a holistic approach and provide legal, social, and technical support for households, as is the case with the Torreblanca Ilumina project in regional Spain. Similar programmes can also be found in Hungary and Romania. The Light for Romania project is particularly interesting because it tackles fundamental problems related to energy access which is often regarded as a non-EU issue.

Box 6: Factsheet – Light for Romania

Light for Romania	
Country	Romania
Scale	National
Target group	Vulnerable households
Timeframe	2013-ongoing
Key actors	Charity, commercial organisation, crowdfunding, media, NGO, and private company
Financing	Private funds by the Fundatia Fan Courier, Dedeman, Unicredit Bank, Nn România, Siemens Energy, Ropeco, Ikea, Cardif-Assurances, Tiab Sa, Mercedes-Benz Financial Services
Description	Light for Romania is a programme that supports families who do not have access to electricity. Individuals are identified via document analysis and field work, as well as through the support of local authorities. The project installs PV systems that provide free electricity to around 250 families and 1,000 individuals, 4 public schools and 2 churches. In total, about 300 photovoltaic systems were installed in 97 communes in 29 counties in Romania.

Source: see Annex VI

Most programmes focus on improving energy efficiency. If these programmes are targeted effectively, they are key to ensuring that vulnerable households can also benefit from the shift to a carbon neutral society and improves **resilience** against future price increases through high energy savings (see section 4.4.1 and 4.4.3). In most countries there is a mix of policies between those targeting all households and those targeting vulnerable groups. The latter group is usually identified via income criteria, which is also why this study focused on income as an indicator for vulnerability as described in section 4.3.2. This is for example the case in the MaPrimeRenov Serenite programme in France. Often subsidies are also tailored for social housing as was the case with the TIGER, LEMON, and EnerSHIFT projects in Italy. These often work at regional level and focus on providing advice and support regarding financing mechanisms as well as coordinating projects between the multiple actors involved. In Romania and Hungary financial energy efficiency programmes tend not to be targeted, although in Romania two schemes that are no longer on-going, the Sustainable Winterization Solutions and the Improving Energy Efficiency in Low-Income Households and Communities in Romania programmes, did focus on vulnerable groups specifically. Finally, it is worth mentioning that while few policies exist in Greece, the Recovery and Resilience Plan 2.0 now finances the newly introduced “I am Saving” programme 2023 which also provides support to vulnerable groups in the building sector (see Box 7).

Box 7: Factsheet – "I am Saving"

"I am Saving"	
Country	Greece
Scale	National
Target group	Owners of residential properties (either apartments or single family/multi-family buildings) with additional incentives and special budget for low-income/vulnerable households
Timeframe	2014 - ongoing
Key actors	Greek Ministry of Environment and Energy; Greek Public Employment Service
Financing	€300 million total with €200 million from the Recovery and Resilience Fund, € 50 million from national sources, €50 million from the Greek Public Employment Service.
Description	The programme provides subsidies for energy renovation in single and multi-family houses. The programme has been operating for over a decade. While in its early years the programme was very bureaucratic, changes made in the last years has have made the programme more consumer friendly. Funding is available for energy-related renovations such as thermal insulations, door/window replacements, heating and cooling and domestic hot water systems, etc. For the energy-related costs the programme covers from between 45% to 90% of the amount of eligible energy interventions, while the remaining amount can be covered by an interest-free loan. Grant rates are linked to personal or family income and differentiate between home ownership and rentals. The programme also targets energy-poor low-income/vulnerable households for which the subsidy rate is increased and there is a dedicated budget for energy-poor households within the overall programme budget (€60 million), along with a state guarantee for the loan. It is foreseen by the Greek NECP (National Energy and Climate Plan) that 600.000 households will be upgraded during the period 2021-2030 (around 60.000 households per year).

Source: see Annex VI

Alongside these financial energy efficiency measures there are a large number of informational campaign programmes that support vulnerable households and provide 'soft' energy efficiency measures (similar to the campaign measures from section 4.2). The Stromsparcheck in Germany has already been mentioned, but the Energy Advice Points (PAE) in Barcelona, Spain and the Energia in Periferia (Energy in the suburbs) in Italy work in similar ways. Often these projects are also regional, rather than national measures, since they are most effective at a small-scale, although national financing and institutionalisation (as is the case in Germany) can help to strengthen these instruments.

Box 8: Factsheet – Energy Advice Points

Energy Advice Points (PAE)	
Country	Spain
Scale	Local in Barcelona City
Target group	Open to all with a special focus on identifying the most vulnerable households through advice services
Timeframe	2017-ongoing
Key actors	Barcelona City Council
Financing	Local funds from the Barcelona City Council €4,4 million total
Description	The advisory service is open to all households that need help with their energy costs and bills with a particular focus on gas and electricity disconnections. They also give advice on providers and tariffs, help to apply for social discounts and carry out household-related energy efficiency diagnoses in order to identify options for action. The PAEs have been serving all districts of the city since January 2017 and have 11 contact points distributed throughout the city. In 2020, 13,355 households received advice. Around 42% of households were unemployed and 12% only marginally employed. The PAE also run a job placement programme that places 20 people each year in qualifications with the aim of creating employment opportunities. In 2020, this resulted in 80% of the participants finding employment afterwards.

Source: see Annex VI

An exemplary comparison of some already existing national instruments targeting support on low-income households with the different measures proposed in Chapter 4 shows that the proposed measures' implementation costs at a 100% subsidy rate are always substantially higher compared to the already existing instruments, in most cases by an order of magnitude. For instance, the Stromsparcheck in Germany costs around €10 million per year, whereas the campaign in Germany would costs €525 million annually. Even though the scope of the campaign is wider as it also includes various starter sets for quick-fix energy efficiency measures, the costs are more than 50 times higher than for the Stromsparcheck. Another example is the "I am saving" programme in Greece: The Greek government provides €300 million from 2023 to 2026, so on average €75 million per year. As can be seen in Box 7 (above) the programme supports all kinds of measures on the building envelope and heating system. Combining all measures we propose for Greece, however, the total annual investment needs amount to €1,2 billion (excluding the PV measure and the campaign), which is 16 times higher than the current "I am saving" programme. We conclude that in order to make a real and effective contribution to low-income households regarding their energy savings and energy cost savings, the already existing programmes need to be scaled up substantially.

6 Summary and Conclusions

Our assessment in Chapter 3 provides an indication of the budget needs for compensatory measures based on assumptions for different hypothetical compensation schemes. Compensating all households independent of their income requires substantially higher funding than providing targeted relief for vulnerable low-income groups.

Solely providing direct compensation is less sustainable than supporting households by investing in energy efficiency and renewable energy. Looking into energy expenditure for a medium price scenario where demand is reduced by 15%, we find that the expenditure burden almost levels out to pre-crisis levels. Thus, compensation needs are comparatively small.

For the sets of measures considered in Chapter 4, we find that measures rolled out within a two-year period and addressed specifically at low-income households can achieve energy demand reductions between 9.5 percent (Italy) and up to 17.4 percent (Hungary). This reduces the need for alternative compensatory measures considerably.

The need for public investment support to help low-income households to invest in the set of measures considered in the study ranges from around 2 bn Euros in Greece to up to 17 bn Euros in Germany, when considering a subsidy rate of 80% of the total investment costs. The resulting energy cost savings over the measures' lifetime are of the same order of magnitude reaching more than 2.5 bn Euros in Greece and up to 30 bn Euros in Germany.

The required public support for such measures can be provided through EU funds and by redirecting the existing funding schemes towards targeted support for low-income households. Our analysis in Chapter 5 shows that in the countries considered in the analysis, only few targeted schemes exist that provide specific support to low-income households.

We conclude that targeted support for low-income households for investing in energy efficiency and renewable energy is essential to address energy poverty, whilst at the same time contributing to marked reductions in energy use and greenhouse gas emissions in the EU. Additional benefits include a lower need for compensatory measures as well as a lowered dependency on fossil-fuel imports. This calls for governments to focus on structural energy efficiency and renewable energy measures with short-term as well as long-term savings and to use compensation only for those households that are most vulnerable.

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Annex

Annex I. Annual government budget needed for compensation of additional energy costs

Table 14: Annual government budget needed for compensation of additional energy costs – FR, DE (in Mio. Euro)

	France					Germany				
Price scenario/ compensation scheme	**Max price 2022-2023**	**Scenario 1 sustained high price**	**Scenario 1 with adjusted demand**	**Scenario 2 medium price**	**Scenario 2 with adjusted demand**	**Max price 2022-2023**	**Scenario 1 sustained high price**	**Scenario 1 with adjusted demand**	**Scenario 2 medium price**	**Scenario 2 with adjusted demand**
Scheme 1: 30% of additional energy costs for all households	5,227	4,555	1,724	2,538	9	14,089	12,017	6,611	6,087	1,570
Scheme 2: 30% of energy costs only for low-income households	610	531	335	296	1	1,873	1,597	1,465	809	209
Scheme 3: 50% of energy costs only for low-income households	1,016	886	201	493	2	3,121	2,662	879	1,349	348
Scheme 4: 80% of energy costs only for low-income households	1,626	1,417	536	790	3	4,994	4,260	2,343	2,158	557

Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

Table 15: Government budget needed for compensation of additional energy costs – IT, ES (in Mio. Euro)

	Italy					Spain				
Compensation scheme	**Max price 2022-2023**	**Scenario 1 sustained high price**	**Scenario 1 with adjusted demand**	**Scenario 2 medium price**	**Scenario 2 with adjusted demand**	**Max price 2022-2023**	**Scenario 1 sustained high price**	**Scenario 1 with adjusted demand**	**Scenario 2 medium price**	**Scenario 2 with adjusted demand**
Scheme 1: 30% of additional energy costs	11,442	9,267	6,151	4,059	1,724	3.807	1,995	720	1,581	368

Compensation scheme	Italy					Spain				
	Max price 2022-2023	Scenario 1 sustained high price	Scenario 1 with adjusted demand	Scenario 2 medium price	Scenario 2 with adjusted demand	Max price 2022-2023	Scenario 1 sustained high price	Scenario 1 with adjusted demand	Scenario 2 medium price	Scenario 2 with adjusted demand
for all households										
Scheme 2: 30% of energy costs only for low-income households	1,294	1,048	1,160	459	195	419	220	132	174	41
Scheme 3: 50% of energy costs only for low-income households	2,157	1,747	696	765	325	699	366	79	290	68
Scheme 4: 80% of energy costs only for low-income households	3,451	2,795	1,855	1,224	520	1,118	586	211	464	108

Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

Table 16: Government budget needed for compensation of additional energy costs – EL (in Mio. Euro)

Compensation scheme	Greece				
	Max price 2022-2023	Scenario 1 high price	Scenario 1 with adjusted demand	Scenario 2 Medium price	Scenario 2 with adjusted demand
Scheme 1: 30% of additional energy costs for all households	882	570	246	360	68
Scheme 2: 30% of energy costs only for low-income households	102	66	48	42	8
Scheme 3: 50% of energy costs only for low-income households	170	110	29	70	13
Scheme 4: 80% of energy costs only for low-income households	272	176	76	111	21

Table 17: Government budget needed for compensation of additional energy costs, RO, HU (in Mio. Euro)

Compensation scheme	Romania					Hungary				
	Max price 2022-2023	Scenario 1 sustained high price	Scenario 1 with adjusted demand	Scenario 2 medium price	Scenario 2 with adjusted demand	Max price 2022-2023	Scenario 1 sustained high price	Scenario 1 with adjusted demand	Scenario 2 medium price	Scenario 2 with adjusted demand
Scheme 1: 37.5% of additional energy costs for all households	737	634	316	365	88	789	638	358	275	49
Scheme 2: 37.5% of energy costs only for low-income households	57	49	41	28	7	90	73	68	31	6
Scheme 3: 50% of energy costs only for low-income households	95	82	25	47	11	150	121	41	52	9
Scheme 4: 80% of energy costs only for low-income households	153	131	66	76	18	240	194	109	83	15

Source: Source: Eurostat HICP - monthly data (2015=100) (online data code: PRC_HICP_MIDX); own calculation

Annex II. Realisation factors for energy efficiency and renewable energy measures

Table 18: Realisation factors: share of low-income households implementing a given measure over a two-year period in each country

	France	Germany	Italy	Spain	Hungary	Greece	Romania
Roof							
Exterior Roof Insulation (pitched)	2.8%	2.8%	2.0%	0.4%	2.8%	0.4%	2.8%
Exterior Roof Insulation (flat)	1.6%	3.2%	8.0%	11.2%	3.2%	11.2%	1.6%
Top Storey Ceiling Insulation (non-walkable)	10.8%	10.8%	7.2%	0.9%	10.8%	0.9%	9.0%
Outer Wall							
Outer Wall Insulation	2.8%		2.8%		2.8%	2.8%	2.8%
Cavity wall insulation		5.4%	9.0%	12.6%			
Basement Insulation					12.6%		
Replacing Old Windows	12.6%	12.6%	12.6%	12.6%	12.6%	12.6%	12.6%
Installing PV	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
Solar Thermal Collectors	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%
Hydraulic balancing	13.5%	2.3%	11.3%	9.0%	13.5%	11.3%	15.8%
Heat Pump	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
Campaign	28.0%	28.0%	28.0%	28.0%	28.0%	28.0%	28.0%

Annex III. Assumed lifetimes of energy efficiency and renewable energy measures

Table 19: Typical lifetimes of energy efficiency and renewable energy measures

	Lifetime (years)
Roof	
Exterior Roof Insulation (pitched)	40
Exterior Roof Insulation (flat)	40
Top Storey Ceiling Insulation (non-walkable)	40
Outer Wall	
Outer Wall Insulation	40
Cavity wall insulation	40
Basement Insulation	40
Replacing Old Windows	30
Installing PV	20
Solar Thermal Collectors	20
Hydraulic balancing	10
Heat Pump	20
Campaign	10

Annex IV. Investment costs for energy efficiency and renewable energy measures[20]

Table 20: Investment costs for individual measures in France and Germany in EUR

	France		Germany	
	SFH	**MFH**	**SFH**	**MFH**
Roof				
Exterior Roof Insulation (pitched)	39,423		50,319	
Exterior Roof Insulation (flat)	30,029		35,494	
Top Storey Ceiling Insulation (non-walkable)	4,016		4,747	
Outer Wall				
Outer Wall Insulation	37,050	90,884		
Cavity wall insulation			4,220	51,950
Basement Insulation				
Replacing Old Windows	9,870	111,035	22,028	209,391
Installing PV	9,905		8,500	
Solar Thermal Collectors	2,080		2,697	
Hydraulic balancing		3,032		16,435
Heat Pump	20,540		20,000	
Campaign	668	6,676	650	20,800

Table 21: Investment costs for individual measures in Italy and Spain in EUR

	Italy		Spain	
	SFH	**MFH**	**SFH**	**MFH**
Roof				
Exterior Roof Insulation (pitched)	21,149		19,530	
Exterior Roof Insulation (flat)	16,722		13,866	
Top Storey Ceiling Insulation (non-walkable)	2,511		1,566	
Outer Wall				
Outer Wall Insulation	36,758			
Cavity wall insulation		8,558	1,106	2,900
Basement Insulation				
Replacing Old Windows	6,571	27,001	8,731	46,952
Installing PV	9,615		9,991	
Solar Thermal Collectors	2,887		3,750	
Hydraulic balancing		2,904		2,327
Heat Pump	12,000		12,000	
Campaign	611	2,940	592	3,674

[20] Blank spaces indicate that the measure has not addressed in this country.

Table 22: Investment costs for individual measures in Hungary, Greece and Romania in EUR

	Hungary		Greece		Romania	
	SFH	**MFH**	**SFH**	**MFH**	**SFH**	**MFH**
Roof						
Exterior Roof Insulation (pitched)	14,000		29,542		15,432	
Exterior Roof Insulation (flat)	10,000		21,608		11,116	
Top Storey Ceiling Insulation (non-walkable)	1,500		2,441		1,487	
Outer Wall						
Outer Wall Insulation	11,920		20,010		9,703	
Cavity wall insulation						
Basement Insulation	2,500					
Replacing Old Windows	5,895	61,438	5,018	29,237	6,475	135,714
Installing PV	11,237		8,905		8,992	
Solar Thermal Collectors	6,375		6,009		6,224	
Hydraulic balancing		6,176		2,431		8,671
Heat Pump	12,766		16,392		8,800	
Campaign	415	7,053	533	7,458	334	12,130

Annex V. Overview of relevant national instruments in the selected countries

Country	Name of programme	Target group	Scale	Description
Financial instruments related to energy efficiency				
DE	Bundesförderung für effiziente Gebäude (BEG)	All HH	National	This programme supports owners of residential and non-residential buildings with either grants or low-interest rate loans for a variety of energy efficiency and renewable heating measures
EL	"I am Saving" 2023	Low-income	National	The programme addresses individuals whose main residence falls under a high energy consumption category. It is financed by the National Recovery and Resilience Plan Greece 2.0 and provides financial incentives.
ES	Solidarity Fund for Energy Rehabilitation	Social housing	National	The Naturgy Foundation collects donations for low-cost renovations, including the repair or replacement of household equipment and improvements to electricity and gas installations.
FR	MaPrimeRenov Serenite	Low-income	National	A financial aid and advisory programme that supports households with low-income with energy renovations in their home.
FR	Social funds for energy management (FSATME)	Families	Local	Provides financial support to families for renovation work by developing simple financial schemes for small yet essential renovations.
FR	Energy performance contracts*	Co-owned properties	Local	The contract is an innovative tool adapted to energy retrofits and offers a long-term solution to the problems co-owned properties are facing. This includes consultations between multiple actors, dialogue forums, and monitoring support.
HU	Warmth of Homes*	All HH	National	The programme provided funding for energy efficiency including for heating system modernisation, replacement of old household appliances, and complex building modernisation.
HU	Renovation Subsidy*	Families	National	A subsidy for home renovations carried out by households with at least one child. This covered half of the renovation costs (with a max. limit) per renovation. This covered energy upgrades, kitchen and bathroom renovations, and extensions.
HU	Residential soft loan*	All HH	National	An interest-free loan for homeowners, multi-apartment buildings, and housing cooperatives. Energy efficiency investments, such as thermal insulation, heating and cooling system modernisation, summer heat protection, etc., and renewable energy projects, such as installation of solar energy system or solar panel, heat pump, or other renewable energy-based heating system were financed.

Country	Name of programme	Target group	Scale	Description
IT	Superbonus	All HH	National	110% cost coverage of energy efficiency measures including insulation, new boilers, improving insulation and windows. Currently being revised under the new government due to high costs.
IT	TIGER - Triggered Investments in Grouping of buildings for Energy Renovation	Social housing	Local	Experiment for a new financing model for refurbishment in social housing through a holistic approach in the Abruzzo region. This integrates resources and incentives at regional and national level (tax deductions, incentives, ERDF, subsidised loans, thermal account, etc.) together with Energy Performance Contracting (EPC).
IT	LEMON - Less Energy More OpportuNities*	Social housing	Local	Provided technical assistance to accelerate energy renovations in social housing units in Reggio Emilia and Parma. It integrated different funds, including regional and national loans and incentives, and provided legal regulation between affected parties.
IT	EnerSHIFT*	Social housing	Local	An energy refurbishment project for 44 public housing buildings in Liguria using innovative financing mechanisms. Energy performance contracts (EPC) were used to ensure that investments were offset by part of the energy savings obtained.
RO	Energy-Efficient House	All HH	National	The programme covers 60% of the value of the improvements, after a new specialised audit of the house. Eligible costs include installation of new windows with a low heat transfer coefficient, insulating materials for exterior walls, purchase, assembly and commissioning of a more efficient central heating system, solar panels, improved ventilation systems, lighting fixtures with LEDs. The energy efficiency of the building must be increased by at least one class.
RO	Renovation Wave	All HH	National	Programme to improve energy efficiency for over 4,000 buildings including 1,300 residential blocks. It is aimed to apartment blocks and requires no co-financing of investments.
RO	Sustainable Winterization Solutions*	Vulnerable	National	Financial support for insulating and heating improvements, complemented by education measures and investing in the development of new skills, which allowed beneficiaries to find a job.
RO	Improving Energy Efficiency in Low-Income Households and Communities in Romania*	Vulnerable	National	Addressed energy efficiency needs; developed appropriate policy measures; strengthened the capacity for the implementation of energy-efficiency measures in poorer regions; stimulated the market for locally produced energy-efficient building materials.

Country	Name of programme	Target group	Scale	Description
Financial instruments related to renewable energies				
ES	Torreblanca Ilumina	Vulnerable	Local	A pilot for holistic assistance (legal, social, and technical) on collective PV installation on the roof of public schools. Generated electricity benefits families in energy poverty in Torreblanca directly.
ES	Barrio Solar	All HH	Local	Installation of PV for shared consumption in Actur, a neighbourhood in the city of Zaragoza. Barrio Solar aims to provide clean, cheap local energy on the basis of solidarity.
HU	LightBringers Foundation	Low-income	Local	Transforms the village Baks into an energy community involving low-income households. The project provides solar panels for households affected by energy poverty that have no access to electricity.
RO	Light for Romania	Vulnerable	National	A social campaign dedicated to families who live without electricity and light that are identified via document analysis and field work. The project installs PV that provide free electricity to almost 250 families.
Informational instruments including 'soft' energy efficiency measures				
DE	Stromsparcheck	Vulnerable	National	Energy saving advice & installation of energy saving products at home and free of charge for low-income households across Germany, with formerly long-term unemployed people who received a specific training
ES	Energy Advice Points (PAE)	Vulnerable	Local	A service by the Barcelona City Council that offers the information and intervention so that people can exercise their energy rights and companies do not deny them access to basic supplies. The PAEs have served all the city's districts since January 2017 and have 11 points distributed throughout the city.
ES	Valencia Energy Office	Vulnerable	Local	One-stop-shop to assess, inform and support citizens in terms of energy efficiency, renewable energy, energy poverty and energy transition.
FR	Mediation Precarité Energetique	Vulnerable	Local	Project supporting energy poor rental households. Households are identified through other schemes, supported by an energy mediator, with a socio-technical diagnostic visit (+ small actions), and socio-technical mediation with the landlord to negotiate and support the decision and implementation of works.
FR	Local Intervention Service for Energy Management (SLIME)	Vulnerable	National	One-stop-shops that centralise reporting on energy poverty and organising solutions available to households. Includes identifying households in or at risk of energy poverty, assessing the situation through a home visit, and finally advising households on the support available to them.

Country	Name of programme	Target group	Scale	Description
FR	Alisée Project	Multiple actors	National	The Alisée association aims supports initiatives to reduce energy vulnerability through networking the actors involved in renovation work. This equips professionals and volunteers with tools and methods to support households in energy poverty.
IT	Energia in Periferia (Energy in the suburbs)	Vulnerable	National	Support for families living on the outskirts of cities and linked to energy poverty are supported with their energy bills. Includes training focused on energy savings and efficiency.
IT	Consumare meno per vivere meglio*	Vulnerable	Local	Implementation of the ASSIST model in the municipality of Berceto. Advisors are trained and provide advice on financial schemes or consumption habits as well as providing energy efficient tools (such as more efficient household appliances, LED lamps, etc.).
IT	Energia su Misura*	Vulnerable	National	Supports vulnerable families living in social housing to reduce energy consumption and energy costs through the energy bill support and the installation of smart devices.

Source: See Annex III; *instrument is no longer ongoing

Annex VI. Links related the overview of relevant national instruments in the selected countries

Country	Instrument	Link
DE	Renovation subsidy	https://www.kfw.de/inlandsfoerderung/Bundesförderung-für-effiziente-Gebäude
	Stromsparcheck	https://www.bundesregierung.de/breg-de/suche/stromspar-check-2022430
EL	Exoikonomo 2021	https://www.piraeusbank.gr/en/idiwtes/daneia/stegastiko-daneio/eksoikonomw-2021 https://www.aftodioikisi.gr/epidomata/exoikonomo-2023-pote-xekinoyn-oi-aitiseis-oria-dapanon-kai-kritiria-fek-amp-pinakes/ Country expert
ES	Solidarity Fund for Energy Rehabilitation	https://atlas.energypoverty.eu/node/636
	Torreblanca Ilumina	https://atlas.energypoverty.eu/node/937 http://www.torreblancailumina.com/ https://www.interregeurope.eu/powerty/library/
	Barrio Solar	https://atlas.energypoverty.eu/node/530
	Energy Advice Points (PAE)	https://atlas.energypoverty.eu/node/521
	Valencia Energy Office	https://atlas.energypoverty.eu/node/934
FR	MaPrimeRenov Serenite	https://reno.fr/en/tout-savoir-ma-prime-renov/ https://artisancentral.fr/blog/accessing-maprimerenov-french-energy-efficiency-grant/
	Social funds for energy management (FSATME)	https://atlas.energypoverty.eu/node/773 https://www.lamayenne.fr/page/le-conseil-departemental-de-la-mayenne-engage-dans-la-lutte-contre-la-precarite-energetique-0
	Energy performance contracts	https://atlas.energypoverty.eu/node/863 https://www.epamsa.fr/accueil/lepamsa/nos-metiers/le-contrat-de-performance-energetique/
	Mediation Precarité Energetique	https://www.lille.fr/Actualites/Combattre-la-precarite-energetique shorturl.at/qCDM9
	Local Intervention Service for Energy Management (SLIME)	shorturl.at/iPQTU
	Alisée Project	https://atlas.energypoverty.eu/node/905
HU	Warmth of Homes	https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/hungary.html

		https://epbd-ca.eu/ca-outcomes/outcomes-2015-2018/book-2018/countries/hungary
	Renovation Subsidy	https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/hungary.html
	Residential soft loan	https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/hungary.html https://www.global-climatescope.org/markets/hu/
	LightBringers Foundation	https://atlas.energypoverty.eu/node/527
IT	Superbonus	https://www.theguardian.com/world/2023/feb/17/italy-scraps-superbonus-110-green-tax-credit-scheme https://www.euractiv.com/section/energy/news/italy-overturns-superbonus-scheme-for-housing-renovation/
	TIGER - Triggered Investments in Grouping of buildings for Energy Renovation	https://atlas.energypoverty.eu/node/740 https://www.aisfor.it/progetti-39-tiger
	LEMON - Less Energy More OpportuNities*	https://atlas.energypoverty.eu/node/920 http://www.lemon-project.eu
	EnerSHIFT*	https://atlas.energypoverty.eu/node/913 https://enershift.eu/en/communication/
	Energia in Periferia (Energy in the suburbs)	https://atlas.energypoverty.eu/node/963
	Consumare meno per vivere meglio	https://atlas.energypoverty.eu/node/541
	Energia su Misura	https://atlas.energypoverty.eu/node/520
RO	Energy-Efficient House	https://projects2014-2020.interregeurope.eu/agrores/news/news-article/10198/energy-efficient-house-programme-launched-in-romania/
	Renovation Wave	https://www.romania-insider.com/new-romanian-govt-program-energy-efficiency-buildings
	Sustainable Winterization Solutions	https://blog.worldvision.ro/category/proiectul-winterization/ https://atlas.energypoverty.eu/node/747
	Improving Energy Efficiency in Low-Income Households and Communities in Romania	https://atlas.energypoverty.eu/node/923 http://www.thegef.org/projects-operations/projects/4115
	Light for Romania	https://atlas.energypoverty.eu/node/526

Annex VII. Links related to the overview of relevant EU funding and revenue streams

Country	Link
DE	https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/germanys-recovery-and-resilience-plan_en https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Europa/DARP/2-03-klimafreundliches-bauen-und-sanieren.pdf?__blob=publicationFile&v=5 https://www.bmwk.de/Redaktion/DE/Downloads/P-R/Partnerschaftsvereinbarung%20DEU-EU-KOM%20zur%20FP%202021-2027.pdf?__blob=publicationFile&v=8 https://ec.europa.eu/european-social-fund-plus/en/support-your-country/esf-germany-0 https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6275
EL	https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3907 https://ec.europa.eu/european-social-fund-plus/en/support-your-country/esf-greece https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3711
ES	https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/spains-recovery-and-resilience-plan_en https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6964
FR	https://www.economie.gouv.fr/files/files/directions_services/plan-de-relance/PNRR%20Francais.pdf https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/frances-recovery-and-resilience-plan_en https://ec.europa.eu/commission/presscorner/detail/es/ip_22_3368
HU	https://commission.europa.eu/system/files/2022-12/HU%20RRP%20Summary.pdf https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7801 https://ec.europa.eu/european-social-fund-plus/en/support-your-country/esf-hungary
IT	https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/italys-recovery-and-resilience-plan_en https://www.italiadomani.gov.it/content/sogei-ng/it/en/Interventi/investimenti/interventi-per-la-resilienza-la-valorizzazione-del-territorio-e-l-efficienza-energetica-dei-comuni.html https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4562 https://ec.europa.eu/european-social-fund-plus/en/support-your-country/esf-italy
RO	https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/recovery-and-resilience-plan-romania_en https://gov.ro/fisiere/stiri_fisiere/Annex_to_the__Proposal_for_a_Council_Implementig_Decision.pdf https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4662 https://ec.europa.eu/european-social-fund-plus/en/support-your-country/esf-romania