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Subsidies for fossil heating appliances in the EU and UK

Full Report

Trinomics

Report for

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EC register for interest representatives:
Identification number 06798511314-27
BCM identification number 0415.814.848
RPM Tribunal de l'entreprise francophone de Bruxelles.

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Date

Rotterdam, 30th March 2023

Donors

With the support of the European Climate Foundation and the LIFE Programme of the European Union.

This report reflects the authors' views and does not commit the donors.

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Introduction and method

This report aims to quantify the total subsidies provided to install new or replacement fossil fuel heating appliances in Europe, with the logic that these subsidies are harmful to moving to a low carbon future for Europe as they lock in fossil technologies. Sub-objectives include: Highlighting the impact that could be achieved by using the fossil subsidies for other more climate friendly investments; identifying those countries that offer a subsidy to support biomass heating appliances and quantifying these support schemes.

This work is focused on residential heating appliances. For compiling the database on fossil fuel heating subsidies we have drawn upon two key sources: Previous research work[1] for DG ENER on Energy subsidies and the recently published work by the Cool Products initiative[2] / Oeko. Our starting point was the eleven countries identified in the Cool Products work as having active subsidy schemes. Initial scoping work indicated that Ireland, Romania and Spain also operated subsidy programmes within scope. Therefore in total the following 15 countries were examined for fossil, biomass and low-carbon heating subsidies, which covers the large majority of all remaining fossil heating subsidies in the EU (+UK): Belgium, Bulgaria, Croatia, Estonia, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Romania, Slovenia, Spain and the UK.

Existing subsidies

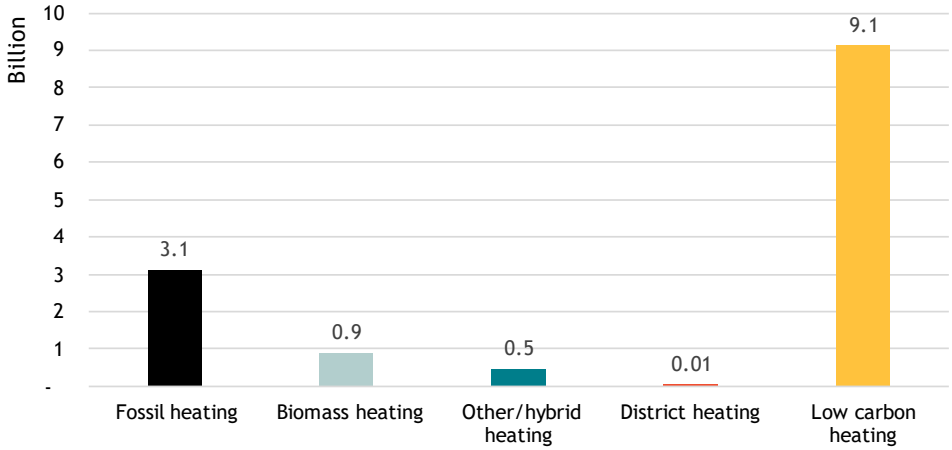
Our analysis[3] has identified 108 schemes subsidising the installation of heating systems in the countries in scope (EU and the UK). These schemes cover fossil boilers (gas, oil, coal boilers), biomass, district heating, heat pumps and other types of heating systems.

Fossil heating appliance subsidies remained significant in the EU with a €3.1 billion annual budget[4] in 2022. Germany, France and Italy are responsible for 91% of the total remaining fossil heating subsidies in the EU, though the total subsidy will drastically reduce from 2023 onwards due to e.g. the phase-out of fossil heating subsidies in Germany since the end of 2022. Belgium, Bulgaria, Greece and Poland also subsidised fossil heating with more than €10 million per year per country.

The total annual budget[4] spent on heating appliance subsidies (both fossil and low-carbon) for the EU countries was €13.6 billion, with Germany accounting for 50% of this (€6.9 billion), Italy 29% (€3.9 billion) and France 12% (€1.6 billion), while the remaining countries combined covered 9% (€1.4 billion) of the budget.

[1] https://energy.ec.europa.eu/study-energy-costs-taxes-and-impact-government-interventions-investments_en
[2] https://www.coolproducts.eu/wp-content/uploads/2022/07/Coolproducts-report-2022-19-July-22.pdf
[3] As mentioned in the methodology section, given the lack of homogeneity on the year that the subsidies refer to, we use the year with the most recent available data for each subsidy. That is usually between 2020 and 2023.
[4] The budget amount refers to the most recent year with available data, which is usually 2022.

Figure 0-1 Total amount of subsidies per heating type per country (billion €)



Note: The budget presented refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

The share of fossil fuel heating subsidies is significantly lower than low carbon heating subsidies. Subsidies for low carbon systems (€9 billion) account for over 67% of the total budget of €13.6 billion, while fossil fuel system subsidies account for 23%. Support for biomass covers only 6.5% of the total budget while the support to district heating was €6 million (0.01%) and other/hybrid systems €460 milion (3.4%).

Looking at the subsidies' per country and per heating type, **Belgium, Bulgaria, Greece and Poland have the highest shares of their support spent on fossil fuel heating systems**, with all of them directing over 45% of their subsidies towards fossil fuel systems. **Spain and Ireland have the highest share of renewable energy heating systems support**, with more than 90% of their subsidies assigned to reenwable systems. With regard to biomass systems, Estonia and Croatia have the highest shares, with 55% and 30% of their total budget respectively.

The largest spenders on residential heating system subsidies in the EU are Germany, Italy and France. Germany provides by far the largest subsidies compared to all the other countries, with €6.8 billion in total. The majority of the subsidies (72%) are assigned to low carbon heating systems, with less than 15% going to fossil fuel heating systems. Germany had the highest fossil subsidy, both absolute and per capita, although all the German fossil subsidies were discontinued in late 2022. Italy and France assigned more than 30% of their subsidies to support the installation of fossil fuel systems (€1.3 billion for Italy and €563 million for France) while the low carbon share was in the range of 60%-66% (€2.3 billion for Italy and €1.6 billion for France). For all three countries biomass only represents a marginal share.

Spain and Poland come next in terms of the total subsidies allocated for residential heating systems. However the scale of expenditure is on a much smaller scale. Spain spent the majority of their budget on low carbon heating systems, while the opposite is true for Poland.

Figure 0-2 Total amount of subsidies for heating installations per country and per fuel (billion €)

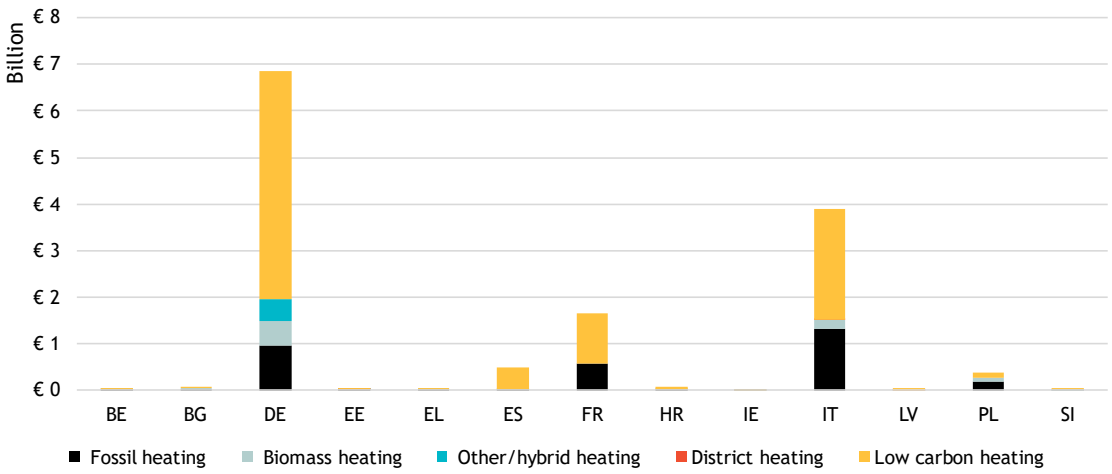
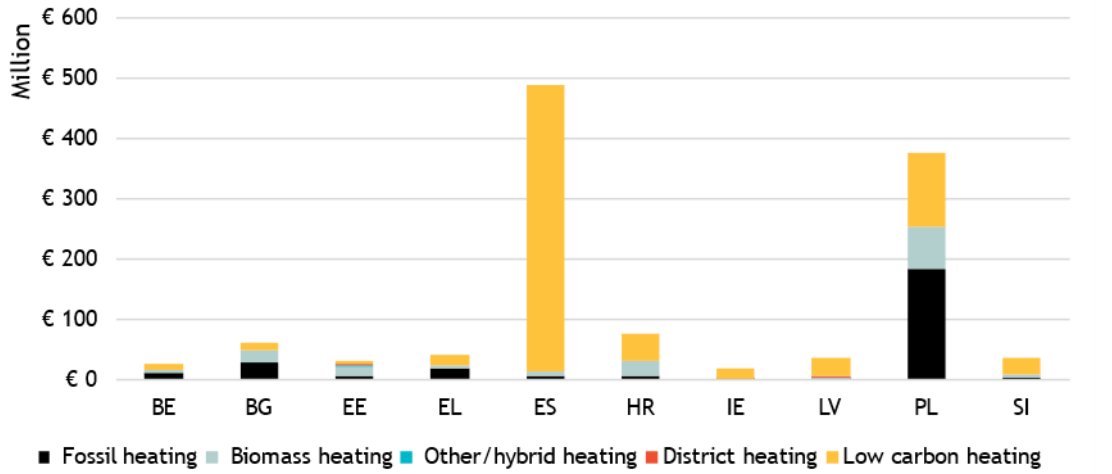


Figure 0-3 Total amount of subsidies for heating installations per country and per fuel (Excluding DE, IT and FR (million€)



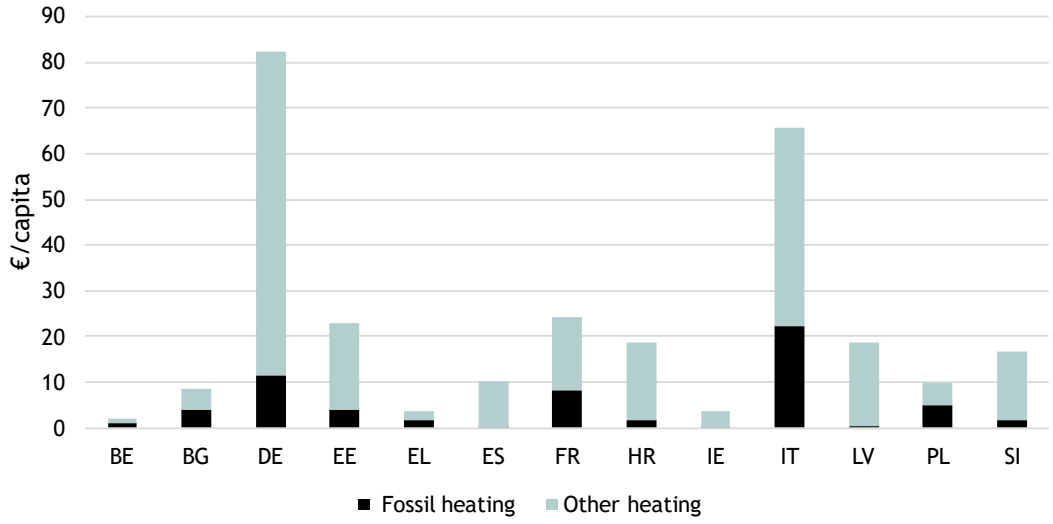
Note 1: The budget refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

Note 2: Romania is excluded from the graph due to a lack of disaggregated data per fuel

The subsidy intensity, i.e. total amount of subsidies per capita, shows that **Germany is still the frontrunner in the EU, providing 82 €/capita of subsidies for heating installations**, followed by Italy with 66 €/capita, while France's subsidy intensity is significantly lower to almost 25 €/capita. Looking at the subsidy intensity of the remaining EU countries (Figure 3-9), **Estonia, Croatia and Latvia have significantly high subsidy intensity**, with more than 18 €/capita. **The intensity in Belgium, Greece and Ireland is considerably lower at less than 4 €/capita**.

When looking at the subsidy intensity for the fossil fuel heating systems, **Italy ranks first with 22 €/capita followed by Germany and France with 12 and 8 €/capita** respectively. Poland, Bulgaria and Estoniarange from 4€ to 5 €/capita. Looking at the subsidy intensity of the other types of heating installations (low carbon, biomass, hybrid and other) **the top three are Germany, Estonia and Italy, while France ranks only 6th**. Latvia and Croatia perform better than France, with a subsidy intensity of about 18 €/capita.

Figure 0-4 Total amount of subsidies per capita for heating installations per country and per heating type



The UK spent a total budget of €260 million in subsidies for heating installations. From this budget, 11% went to subsidies for fossil fuel heating systems, 17% to biomass and 72% to low carbon systems. While **€28 million was spent in supporting fossil fuel heating systems in 2022, €190 million[5] went to the installation of low carbon systems**, indicating a strong decarbonisation focus of the heating sector.

Heat pump economics and redirecting fossil heating subsidies

If all subsidies were redirected, it would be possible to make heat pumps **financially attractive for around 0.5 to 1 million additional households in the EU and the UK.** This is equal to 0.2-0.5% of all households in the selected countries. **It would also reduce natural gas demand by 1 to 2 bcm annually,** on a total natural gas consumption in the EU of 405 bcm,[6] when heat pumps are installed instead of high-efficiency gas boilers. This would lead to an **annual emission reduction of around 1 to 2 Mton CO_2 eq**, with an **additional 0.5 Mton possible** through further decarbonising the European electricity grid. Over the heating system's lifetime, cumulative emission savings from redirecting fossil fuel heating subsidies to clean heating could amount to 30 Mton. For comparison, total GHG emissions in 2020 from Malta were 2.1 Mton and 3124 Mton for the whole EU27.[7]

In order to estimate what could be done by redirecting subsidies, we have estimated the subsidy required to reach an attractive payback time of seven years per country. This shows that on average a €4700 subsidy is needed per heat pump, without additional policy measures. A policy mix including measures such as shifting taxes from electricity to gas or carbon pricing instruments (such as the upcoming European ETS for Buildings and Transport) **could substantially lower subsidy needs** per household.

Heat pumps are already a cost-efficient alternative compared to fossil heating in many cases: In 6 of the 15 countries heat pumps provide the lower cost heating solution over their lifetime without subsidies for the standardised reference household. In countries where heat pump heating costs are

[5] Budget corresponds to years 2021 and 2022 depending on the data available per scheme.
[6] Eurostat(2022). Total energy Supply by Product.
[7] UNFCCC(2022). National Communication Malta.

higher the cost difference is still relatively small, with the largest cost difference in Belgium, Germany and Poland. In two countries the payback time without subsidies is already below 7 years (Slovenia, Greece); a payback time of seven years is seen as attractive for consumers. If we take existing subsidy schemes into account, heat pumps would become the cheaper solution in more countries.[8] In addition to these potential cost savings, heat pumps can significantly reduce energy consumption and CO_2 emissions. This is mainly due to their very high efficiency (up to >4x than fossil) as well as the lower emission intensity of electricity, which lead to an average emission reduction of 56% (unweighted) with current electricity emission intensities, which increases up to 95% with the further decarbonisation of the European electricity grid.

[8] Coolproducts (2021). Analysis of the affordability of switching to renewable heating

1 Introduction

In 2020, a Cool Products report[9] found that a majority of EU Member States provided subsidies for the installation of new gas (and occasionally oil) boilers, often as part of energy efficiency or clean air programmes. Following the Russian invasion of Ukraine,and the subsequent gas and oil price increases, several Member States have moved to end subsidies for gas boilers and other fossil-fuelled energy systems in order to increase the speed of transition towards low-carbon heating, such as heat pumps. In addition, the European Commission, in its EU Save Energy Communication[10], part of the REPowerEU plan, has called on Member States to end subsidies for fossil fuel boilers by 2025 as a minimum, noting that such incentives are contrary to Article 7(2) of the Energy Labelling Regulation. Nonetheless, a July 2022 update to the Cool Products report by EEB and Oeko Institut[11] found that 10 Member States continue to provide financial support for fossil fuel boilers. This project aims to understand how much funding is actually used to support fossil fuel heating systems, with the goal of using this information to highlight how this public subsidy could be better spent to achieve climate goals.

The main objective of this work is to produce a report that quantifies the total subsidies provided to install new / replacement fossil fuel heating appliances in the EU. Sub-objectives include: Highlighting the impact that could be achieved by using the fossil subsidies for other more climate friendly investments; and, identifying those countries that offer a subsidy to support biomass heating appliances.

The sections of this report are as follows:

- **Methodology** – a brief summary of the scope of the work and the approach taken.
- **Subsidies for residential heating systems** – a description of the overall picture of subsides for the installation of domestic scale fossil fuelled heating systems.
- **Redirecting fossil heating subsidies** – a description of how the subsides could arguably be better spent on low-carbon heating – mainly heat pumps.
- **Annexes** – a per country summary of the subsidies and details on the alternative investments analysis.

2 Methodology

This work is focussed on residential heating appliances. This includes appliances that provide space heating and combi-appliances that provide water and space heating. The work focuses on the latest years for which data is available, this is typically between 2020-2023, although where we have an update on more recent changes, especially where subsides are known to have been ended, this has been recorded.

For compiling the database on fossil fuel heating subsidies we have drawn upon two key sources:

[9] https://www.coolproducts.eu/failing-rules/mapping-europes-subsidies-for-fossil-fuel-heating-systems/
[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A240%3AFIN&qid=1653033053936
[11] https://eeb.org/library/impact-of-a-ban-of-fossil-heating-technologies-on-necps-and-national-energy-dependency/

1. Previous research work[12] for DG ENER on Energy subsidies.
2. The recently published work by Cool Products[13] / Oeko.

We have combined and updated the information from these sources. The Cool Products study provided a mapping, but not quantification, of the most relevant subsidies; and the work for DG ENER provided information to help us make quantifications of the total subsidy amounts quickly and accurately. We have engaged country level experts to update the information on subsidies per country. Our starting point was the eleven countries identified in the Cool Products work as having active subsidy schemes. Initial scoping work indicated that Ireland, Romania and Spain also operated in scope subsidy programmes. Therefore in total the following 15 countries were examined for fossil and biomass subsidies:

• Belgium, Bulgaria, Croatia, Estonia, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Romania, Slovenia, Spain and the UK.

Quality checks have been performed on the country experts inputs to ensure a harmonised approach across countries.

In addition to the review of fossil and biomass subsides we have carried out some analysis to highlight the opportunity cost of subsidising domestic fossil-fuelled heating systems in comparison to heat pump systems. This is intended to highlight both the financial costs and differences, as well as differences in energy consumption and emissions. This task involved the compilation of information on the average cost of heat pumps, focussing primarily on the technology cost. We also compiled estimates of the estimated labour and other costs associated with a heat pump to provide an average total installation cost. In addition to the information on cost we also gathered data on the energy consumption and efficiency of heat pumps. To complete the calculation for the comparison we have used future price assumptions for natural gas and electricity.

As with any work of this nature there are some important limitations to the accuracy of the work. Perhaps the most important one of these is the variation between countries on the level and timeliness of detail that they provide on their subsidy schemes. There is no consistent requirement for this information to be made public, so we are reliant on what is published in each country. Data on the total amount of subsidy, and on the split between its end use (e.g. fossil or renewable fuel sources) is not consistently available. Where assumptions have had to be made to fill in these gaps these are highlighted (in the detailed work sheets per country).

It is also important to highlight that the scope of this work is on subsidies to heating systems and not to specific fuels. This means that subsidies aimed at (fossil) fuels, including the majority of the recent subsidies to support households in paying their energy bills, are not in scope. Examples of this are the temporary VAT reductions in many countries for buying heating fuels (e.g., natural gas) and the Polish one-off subsidy for households to buy coal.

We have also had to make some assumptions on which subsidies (and how much of some of the subsidies) are within our scope. Most of the countries provide some high level information on the total budget of the schemes. However, these budgets often include measures and expenditures unrelated to

[12] https://energy.ec.europa.eu/study-energy-costs-taxes-and-impact-government-interventions-investments_en
[13] https://www.coolproducts.eu/wp-content/uploads/2022/07/Coolproducts-report-2022-19-July-22.pdf

new fossil heating installations (e.g., energy efficiency measures). Where detailed data was not available on the budget split, the country experts estimated the share of the budget that was expected to go to heating installations and from that, the share that goes to each heating type (e.g., fossil fuel, biomass). The **number of subsidies reported includes all the measures identified** that provide some support to the installation of heating systems, but the **total budget only includes the measures** for which the country experts could **identify or estimate the share disaggregated per heating type** (which consequently covers only the share assigned to heating installations). This approach has been taken in order to avoid overestimating the subsidies provided for heating systems alone, however the actual expenditure may be higher compared to the results presented in this report.

3 Subsidies for residential heating systems

This section provides an overview of the public subsidies for installing heating systems, mainly focussing on subsidies covering fossil fuels and biomass boilers. The analysis also provides some information on the subsidies provided to subsidise the installation of renewable energy heating systems.

This section begins with a presentation of the results at EU level. This is followed by a review of some specific countries and support schemes. We then provide the results of the heating installation subsidies for the UK, as it is an in scope for this study but not part of the EU. Annex A provides a per country list and description of all in scope measures, including their budget per heating type (when available).

3.1 EU level

3.1.1 Overall statistics

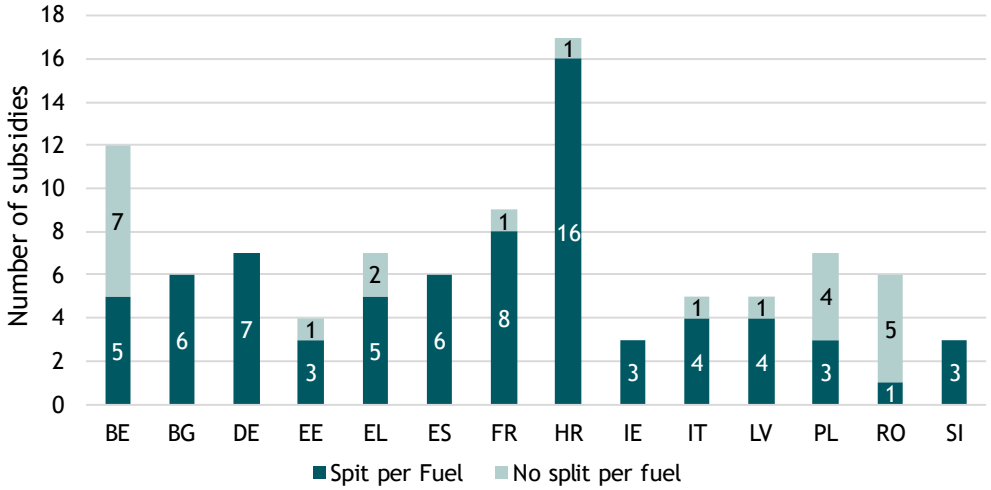
Our analysis[14] has identified 97 schemes subsidising the installation of heating systems in the EU countries in scope. These schemes cover fossil, biomass, district heating, low carbon and other[15] types of boilers.

The availability of data differs between countries, with budget data not possible to find for some schemes. In these cases with no data, the subsidies were included in the total count of subsidies, but were excluded from the budget results. The availability of data also differs between countries regarding the budget assigned per heating type (e.g., fossil fuels, biomass etc.). As shown in Figure 3-1, five countries (BG, DE, ES, IE,SI) provided detailed information for all schemes regarding the budget distribution per heating type (enough information to make estimates), five countries provided adequate information for the majority of the schemes (EE, EL, FR, HR, IT, LV), while three countries did not have enough information for most of their schemes (BE, PL, RO).

The budgets shown in the sections below include the schemes that provide a split per heating type, i.e., fossil, biomass, low carbon, district heating and other/hybrid heating (which are the budgets that targeted heating installations).

[14] As mentioned in the methodology section, given the lack of homogeneity on the year that the subsidies refer to, we use the year with the most recent available data for each subsidy. That is usually between 2020 and 2023.
[15] For example waste heat (case of Germany)

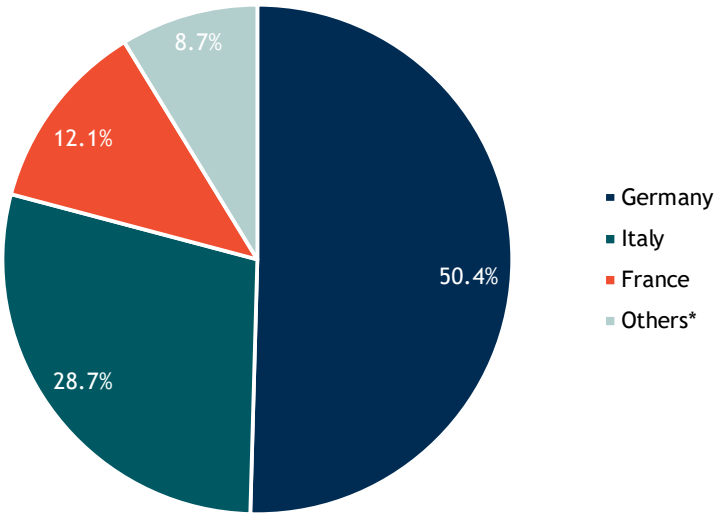
Figure 3-1 Total number of subsidies supporting installation of heating systems per country with and without data available on their budget split per heating type



Note: The subsidies covered refer to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

The total budget spent for all the in-scope EU countries was €13.6 billion, with Germany accounting for 50.4% of this (€6.9 billion), Italy 28.7% (€3.9 billion) and France 12.1% (€1.6 billion), while the remaining countries combined covered 8.7% (€1.4 billion) of the budget.

Figure 3-2 Share of budget out of the total supporting heating installations per key countries



**Others: Belgium, Bulgaria, Estonia, Greece, Spain, Croatia, Ireland, Latvia, Poland, Romania, Slovenia*

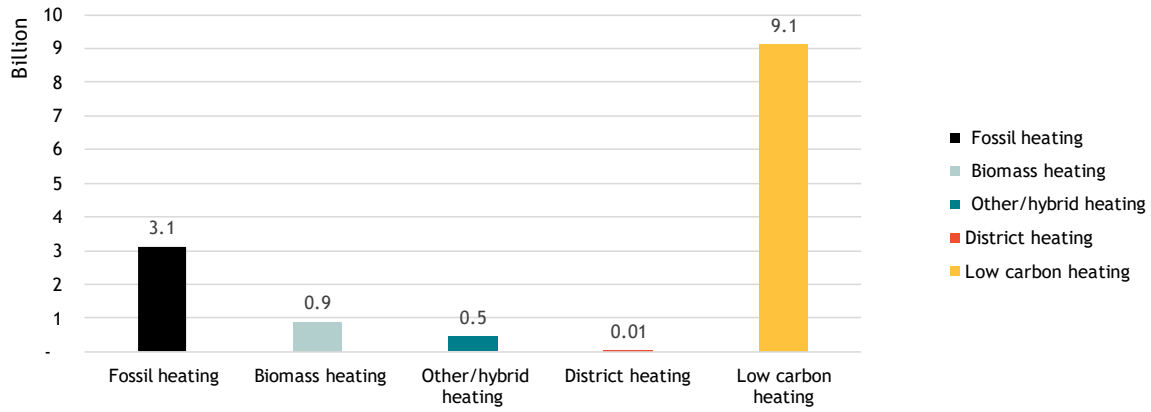
Note: The budget covered refer to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

3.1.2 Subsidies per fuel

The budget spent per heating type (Figure 3-3) shows that the **fossil fuel share is significantly lower than for low carbon heating, indicating that overall the subsidy schemes are more focussed on**

decarbonising the heating sector. Subsidies for low carbon systems account for over 67% of the total (€9.1 billion), while fossil fuel system subsidies accounted for 23% (€3.1 billion). The biomass specific support cover 7% of the total expenditure (nearly €1 million) while support to district heating and other/hybrid systems combined was just below 3.5% (around €500 million).

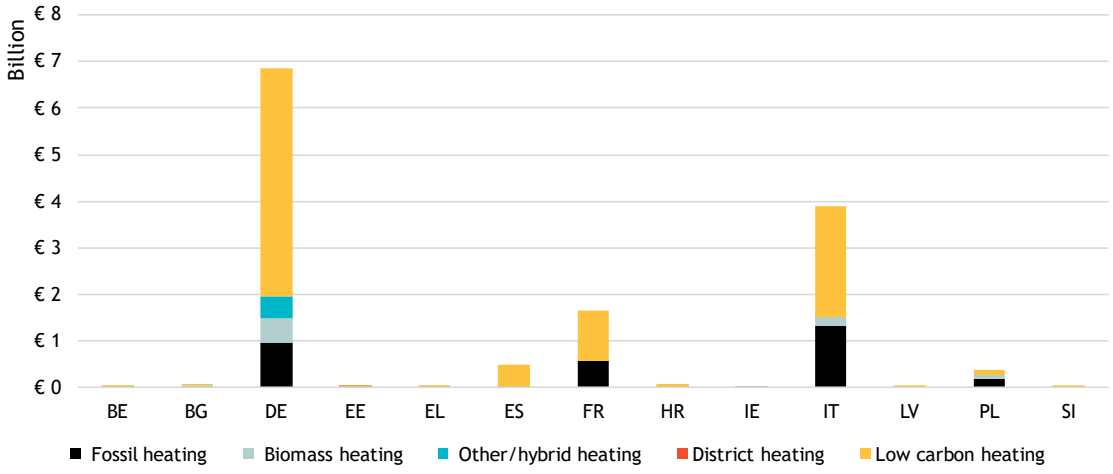
Figure 3-3 Total amount of subsidies per heating type per country (billion €)



Note: The budget presented refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

By looking at how this budget is split per country we see that Germany provides by far the largest subsidies compared to all the other countries, amounting to €6.8 billion in total. The majority of the subsidies (72%) are assigned to low carbon heating systems, with less than 15% going to fossil fuel heating systems. Italy and France assigned more than 30% of their subsidies to support the installation of fossil fuel systems (€1.3 billion for Italy and €563 million for France) while the low carbon share was in the range of 60%-66% (€2.3 billion for Italy and €1.6 billion for France). For all three countries biomass only represents a small share.

Figure 3-4 Total amount of subsidies for heating installations per country and per fuel (billion €)

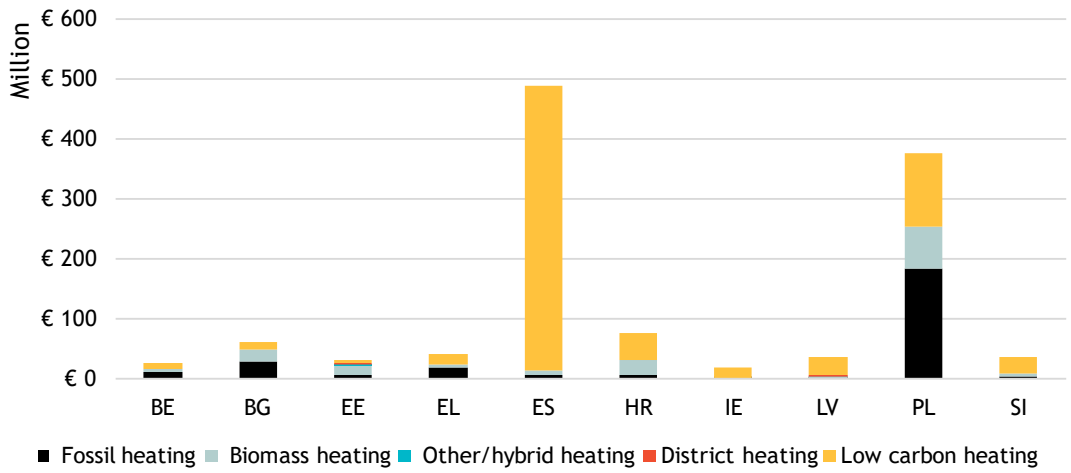


Note 1: The budget refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

Note 2: Romania is excluded from the graph due to a lack of disaggregated data per fuel

Spain and Poland come next in terms of the total subsidies allocated for residential heating systems. However, the scale of expenditure is on a much smaller scale (Figure 3-5**Error! Reference source not found.**). Spain spent the majority of the budget on low carbon heating systems (around 90%), while the opposite is true for Poland (33%).

Figure 3-5 Total amount of subsidies for heating installations per country and per fuel excluding Germany, Italy and France (million €)

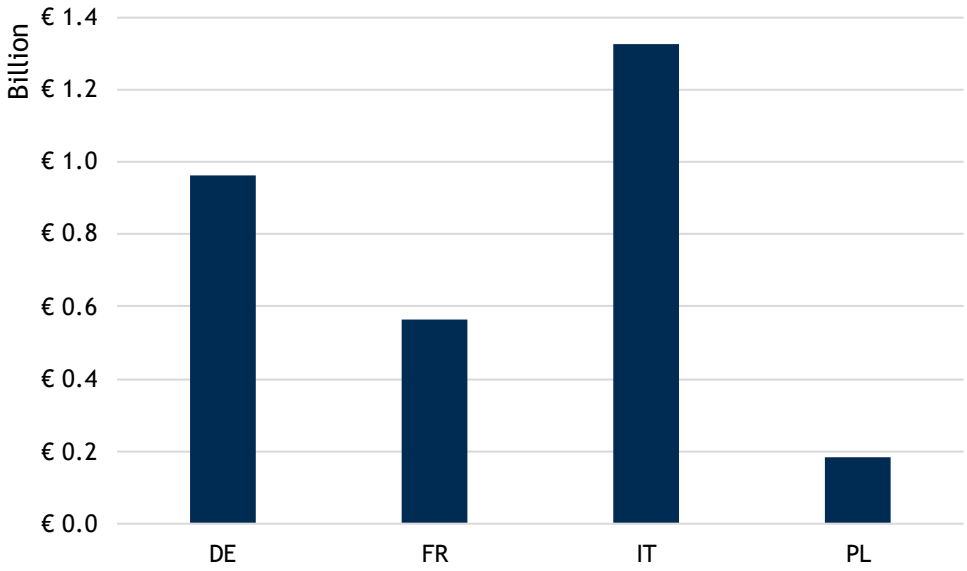


Note 1: The budget refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

Note 2: Romania is excluded from the graph due to a lack of disaggregated data per fuel

When looking at the absolute budget spent in subsidies for fossil fuel heating installations, **the largest spenders in the EU were Italy with €1.3 billion[16], Germany with almost €1 billion in 2022, France with half a billion in 2022 and Poland with almost €200 million in 2022** (Figure 3-6**).**

Figure 3-6 Total budget spent in fossil fuel heating installations per country (Germany, Italy, France and Poland)

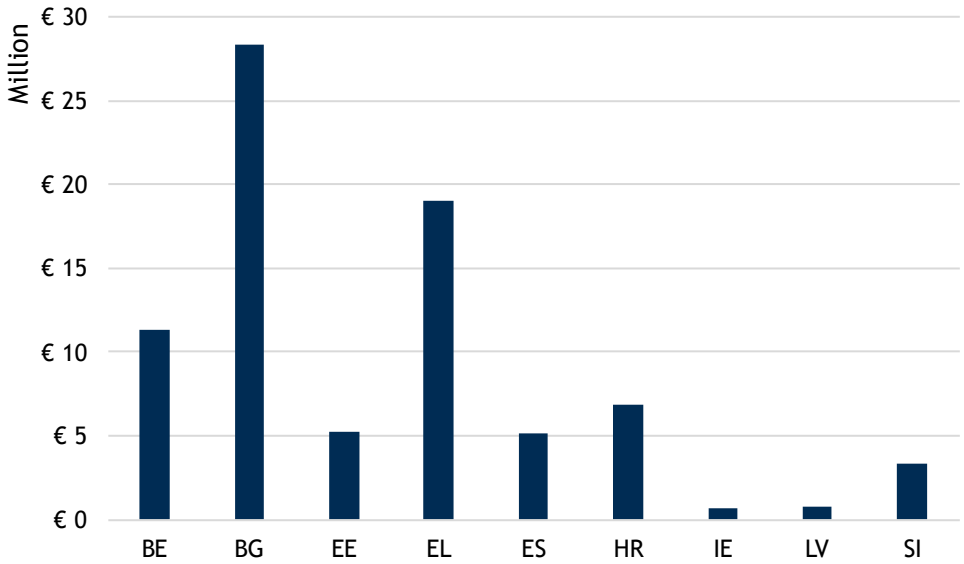


[16] This total budget for Italy corresponds to subsidies data from 2020, 2021 and 2022.

Note: The budget presented refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

Among the remaining countries, **Bulgaria recorded the highest subisdy support in fossil fuel systems** with almost €30 million[17], **followed by Greece** (€20 million[18]) **and Belgium** (€11 million[19]). We see that countries relying on fossil fuels other than natural gas tend to have higher levels of fossil subsidies, mostly aimed at the switch to natural gas to both increase energy efficiency and improve air quality.

Figure 3-7 Total budget spent on fossil fuel heating subsidies per country (all in scope countries excluding Germany, Italy, France and Poland)



Note: The budget presented refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

The subsidy intensity i.e., total amount of subsidies per capita (Figure 3-8) shows that **Germany is still the frontrunner of the EU providing 82 €/capita of subsidies for heating installations**, followed by Italy with 66 €/capita. France's subsidy intensity is significantly lower at25 €/capita. Looking at the subsidy intensity of the remaining EU countries (Figure 3-9), **Estonia, Croatia and Latvia have relatively high subsidy intensity**, with more than 18 €/capita. **The intensity in Belgium, Greece and Ireland is considerably lower at less than 4 €/capita**. When looking at the subsidy intensity for the fossil fuel heating systems, **Italy ranks first with 22 €/capita followed by Germany and France with 12 and 8 €/capita** respectively. Poland, Bulgaria and Estonia follow,ranging from 4 to 5 €/capita. Looking at the subsidy intensity of the other types of heating installations (low carbon, biomass, hybrid and other) **the top 3 are Germany, Italy and Estonia, while France ranks only 6th**. Latvia and Croatia are also performing better than France, with a subsidy intensity of about 18 €/capita.

[17] This total budget for Bulgaria corresponds to subsidies data from 2021 and 2022.
[18] This total budget for Greece corresponds to subsidies data from 2021 and 2022.
[19] This total budget for Belgium corresponds to subsidies data from 2021 and 2022.

Figure 3-8 Total amount of subsidies per capita for heating installations per country and per heating type

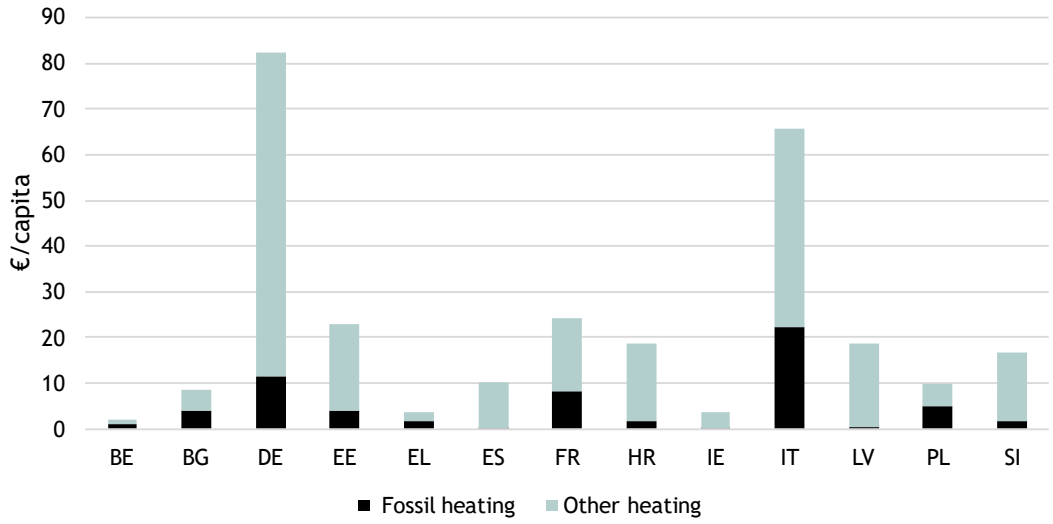
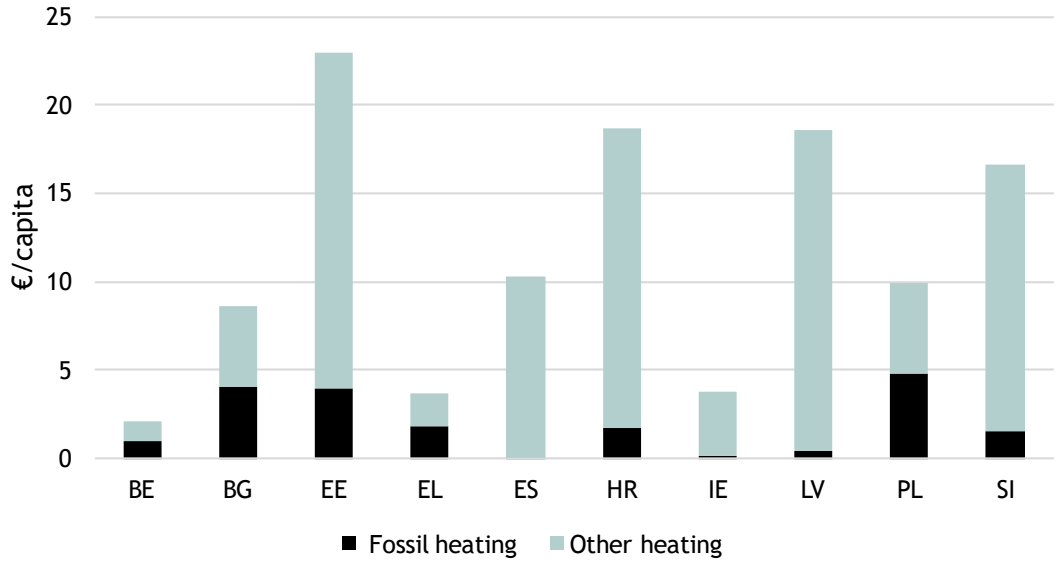


Figure 3-9 Total amount of subsidies per capita for heating installations per country and per heating type excl. Germany, Italy and France (€/capita)



Note 1: The budget shown refers to the most recent year with available data within the period 2020-2023. In most cases this is 2022.

Note 2: Romania is excluded from the graph due to a lack of disaggregated data per heating type

Note 3: 'Other' category includes biomass, low carbon, district heating and other types of heating systems

3.2 Country level

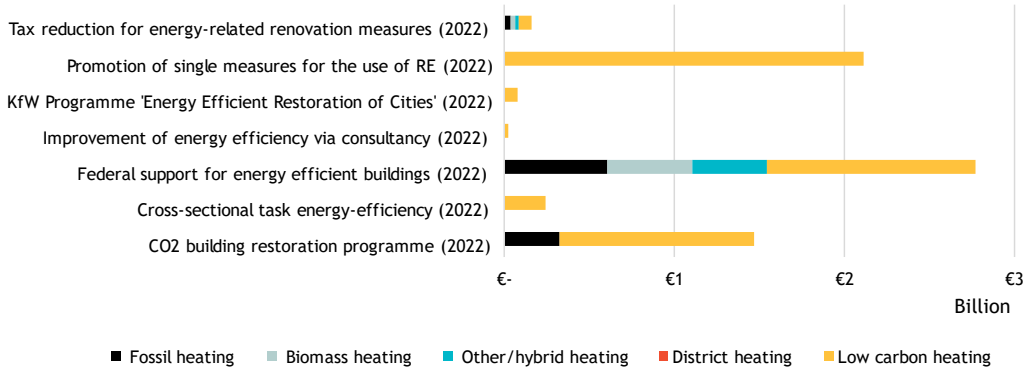
3.2.1 European key players

Based on the results of the analysis and as shown in section 3.1, Germany, Italy and France are the countries that provide the largest amount of subsidies for heating installations support in terms of budget spent. They are discussed in more detail in the sections below. This section also presents an overview of the largest funding programmes on fossil fuel heating systems of the other countries. Note that since the year with available data is different per countries and even per subsidy within the same country, comparison between the countries is not straight forward. At the end of this section we provide the overview of the UK results.

Germany

Germany is the European country that provides the largest amount of subsidies for installing residential heating systems, with subsidies amounting to €6.8 billion in 2022. Fossil fuel systems received just below €1 billion, while low carbon systems received almost €5 billion in the respective year. The largest scheme is *Federal support for energy efficient buildings*, which is a grant scheme promoting energy efficiency measures and increasing energy efficiency and renewable energy in the heating and cooling of buildings. The subsidy amounted to €2.7 billion, from which about €600 million went to fossil fuel heating systems, €1.2 billion went to low carbon systems and just below €1 billion on biomass and waste heat systems. **Note that this scheme stopped subsidising fossil fuel systems after August 2022**[20], yet, the fossil fuel share we present is the estimated expenditure for the months of 2022 that a fossil subsidy was still available. The second largest German subsidy scheme is the *Promotion of single measures for the use of renewable energy, which* provided €2.1 billion to low carbon systems. The *CO2 building restoration programme* and *Tax reduction for energy-related renovation measures* are the two other German schemes that subsidised fossil fuel systems, with €321 million and €34 million respectively, in the form of loans and tax reductions. However, both schemes will exclude fossil heating systems as of 2023, meaning that **no fossil heating subsidies remain in Germany as of 2023**.

Figure 3-10 Subsidies of residential heating systems per heating type, Germany (2022)



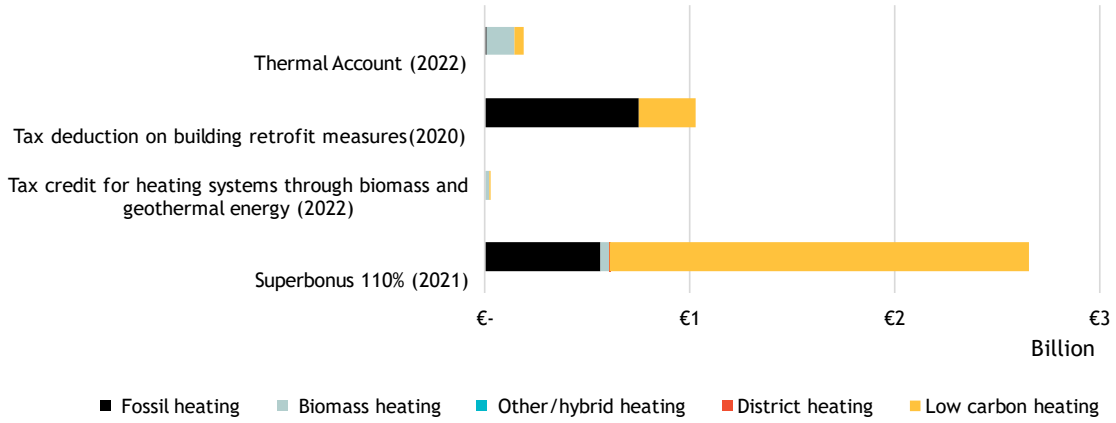
Italy

Italy is the second largest provider of subsidies for residential heating systems in the EU. Italy **provided €1.3 billion of subsidies for fossil fuel systems and €2.3 billion to subsidise low carbon systems in**

[20] https://www.bmwk.de/Redaktion/DE/Evaluationen/Foerdermassnahmen/evaluation-der-forderprogramme-ebs-wg-im-forderzeitraum-2020.html

the most recent year with data per scheme[21], while biomass and district heating combined accounted for around €200 million. The *Superbonus 110%* scheme is by far the largest scheme in Italy in the form of a tax allowance, with €565 million subsidising fossil fuel heating systems (condensing gas boilers) and €2 billion subsidising low carbon systems in 2021. This scheme has received a high level of political interest in Italy, and it was recently (February 2023) announced that the rules of the scheme will be amended and the state incentive will be reduced from 110% to 90%[22]. The second largest tax allowance scheme is called *Tax deduction on building retrofit measures* which mainly benefited fossil fuel systems (condensing gas boilers), providing €750 million, compared to €270 million to low carbon systems in 2020. Finally, Thermal Account (Conto Termico) was the main grant scheme subsidising biomass systems (€130 million in 2022).

Figure 3-11 Subsidies on residential heating systems per heating type, Italy (values depicted are annual and concern the years with the most available data ranging from year 2020 to 2023)

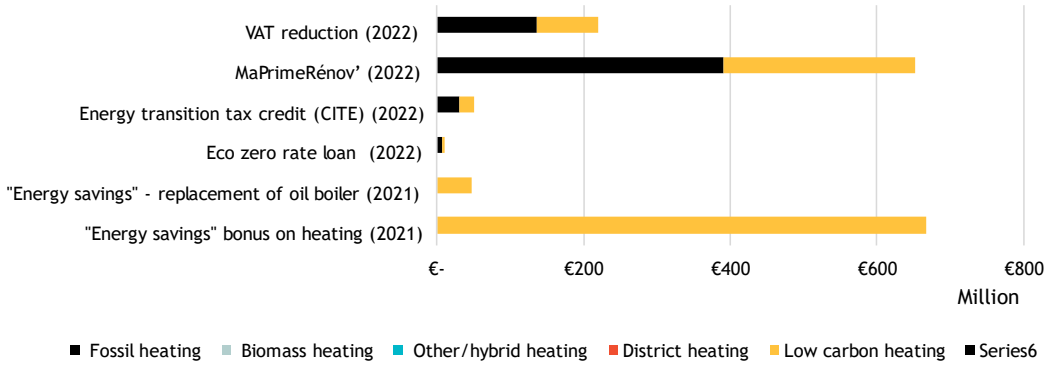


France

France spent €1.6 billion on subsidies for residential heating systems in the most recent year with data per scheme, with almost 66% of it going to low carbon systems and 34% to fossil fuel systems. *MaPrimeRénov'* is the largest scheme in terms of fossil fuel support, providing almost €400 million in 2022, mainly for condensing gas boilers, although it also supported low carbon systems with €260 million. However, since January 2023 condensing boilers will not be eligible for support under this scheme. France also supported fossil fuel system by *reducing the VAT* rate to 10% or 5.5% for the purchase of gas boilers accounting for €135 million of subsidy in 2022. In 2021 France provided more than €600 million in grants for the installation of low carbon systems under the *"Energy savings" bonus on heating scheme*.

[21] The years of available data depend per subsidy but it concerns data of the years 2020, 2021 and 2022.
[22] 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/

Figure 3-12 Subsidies on residential heating systems per heating type, France (values depicted are annual and concern the years 2021 and 2022)



3.2.2 *Main fossil fuel schemes in EU countries*

Figure 3-13 illustrates the largest subsidies provided for fossil fuel heating installations for all the in scope EU countries. Besides Italy, Germany and France which have the largest subsidies by absolute budget value, as detailed in section 3.2.1, **Poland is one of the countries with the largest subsidy schemes** (Clean Air Program) **with €180 million supporting oil, coal and gas boilers.** Among the remaining countries Bulgaria provides the largest subsidy scheme, financed under the Recovery and Resilience Plan, exceeding €20 million, followed by Greece suppoting oil and gas boilers with €12 million. **Ireland and Latvia are the countries with the lowest subsidies on fossil fuel heating systems**, with the budgets of their largest scheme being €700 thousand and €450 thousand respectively (Figure 3-14).

Figure 3-13 Largest subsidies targeting fossil fuel heating systems identified per country (year with the most recent available data)

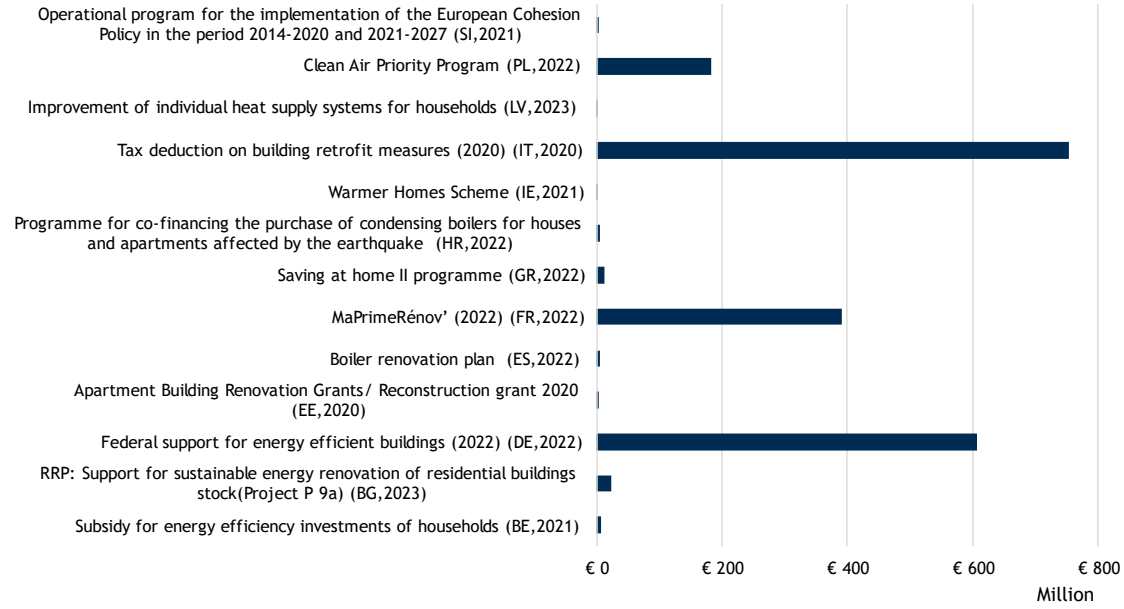
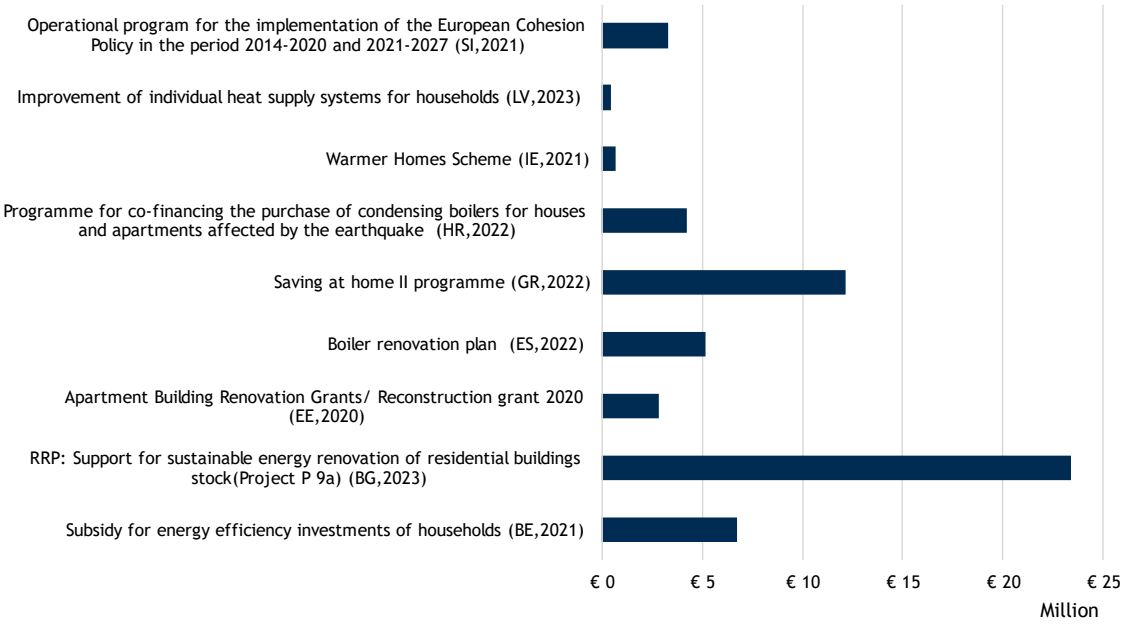


Figure 3-14 Largest subsidies targeting fossil fuel heating systems identified per country excluding Germany, Italy, France and Poland (year with the most recent available data)



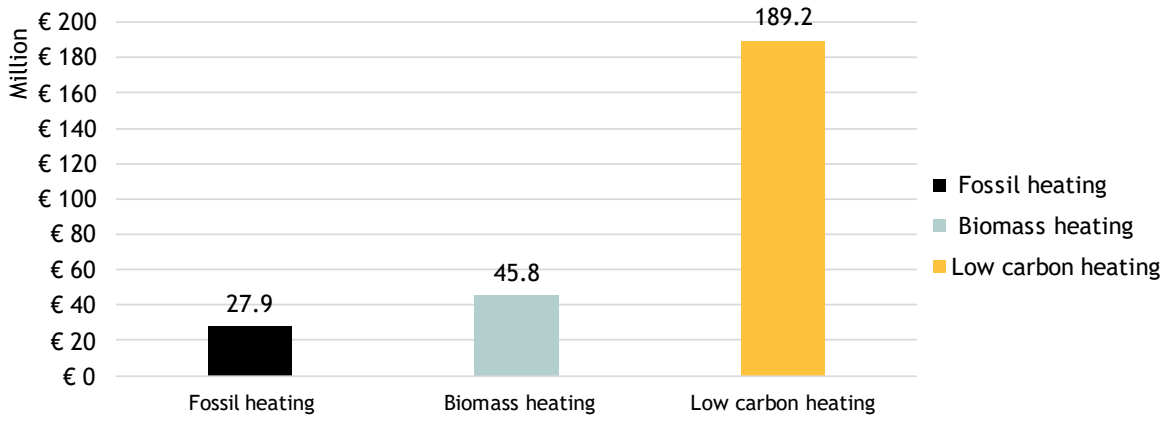
Note 1: The graph excludes DE, FR, IT as they were mentioned in detail in section 3.2.1, as well as RO due to lack of disaggregated data. Poland is also excluded from the graph due to the different scale of subsidy compared to the other countries.

Note 2: This graph only accounts for the subsidy components that target fossil fuels heating systems. The measures may have other components targeting low carbon or other types of fuels, yet they are not shown in the graph.

3.2.3 UK

The UK operated 12 support schemes in the years with the most recent data[23], with a total budget of €260 million. From this budget, 11% went to subsidies for fossil fuel heating systems, 17% to biomass and 72% to low carbon systems.

Figure 3-15 Total amount of subsidies per heating type in the UK (million €)

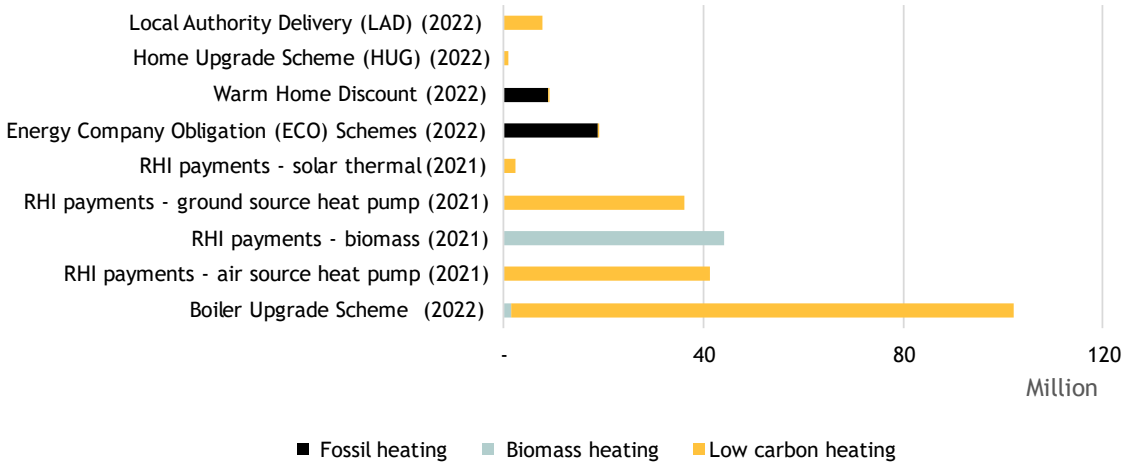


Note: The budget presented refers to the most recent year with available data, which is 2021 and 2022.

The total budget corresponds to a subsidy intensity of 4 €/capita, disaggregated to 2.8€/capita for low carbon systems, and 0.4 €/capita and 0.7 €/capita for fossil fuel and biomass systems respectively.

The subsidies that provided **support to fossil fuel systems were the *Warm Home Discount (2022)* and *Energy Company Obligation (ECO) Schemes (2022)*, amounting to €9 and €18 million** respectively. The *Boiler Upgrade Scheme* was the largest subsidy scheme supporting low carbon systems, exceeding €100 million, while the other schemes provided also almost €90 million combined, making the **UK one of the largest subsidisers of low carbon systems across all the in scope countries**.

Figure 3-16 Subsidies of residential heating systems per heating type, UK



[23] I.e., 2021 and 2022

4 Redirecting fossil heating subsidies

4.1 Methodology

In this chapter we look at the benefits of low-carbon heating solutions and the extent to which redirecting current fossil heating subsidies could contribute to the transition towards a low-carbon built environment. The detailed methodology can be found in Annex B: Heating system analysis

We analyse the benefits of low-carbon heating by using a standardised family home profile in the selected countries with fossil heating subsidies. For this home, we compare the most prevalent fossil heating system (mainly gas boilers) with a low-carbon heating alternative (heat pumps) in terms of both costs and emissions (section 4.2). Our focus is on heat pumps, since heat pumps – in different types and sizes – are currently regarded as a central technology in the transition towards fully sustainable heating by 2050. For example, the IEA estimates that 60% of global heating demand in 2050 needs to be fulfilled by heat pumps to reach net zero.[24]

To calculate fuel costs, we estimate the average market fuel prices over the 15-20 year lifetime of heating systems. Energy market prices are notoriously difficult to predict. In this report, we use oil, gas and coal price forecasts from the RepowerEU report of the Commission.[25] Electricity prices are based on Cambridge Econometrics modelling based on the same RepowerEU forecasts for other fuels. These forecasts take into account recent increases in energy prices and forecast a slight decrease to a 'stable' price level that is still structurally higher than pre-energy crisis levels. Electricity prices are country-specific, while a uniform market price in all countries is assumed for other fuels. Current tax and network tariff levels per country are also used in the analysis, leading to large differences in consumer fuel prices in countries.

Table 4-1 Used estimates of fuel prices. Prices include taxes and network tariffs.

Fuel	Average EU27 price over heating system lifetime
Electricity	210 EUR/MWh
Natural gas	74 EUR/MWh
Heating oil	107 EUR/MWh (1.20 EUR/litre)
Coal	33 EUR/MWh (270 EUR/tonne)

This table shows the EU average, while in the analysis country-specific estimates are used.

For every country that currently has some fossil subsidies we analyse the subsidy that would be needed to make heat pumps and low-carbon heating attractive for consumers, and place this in the perspective of the whole policy mix necessary for the transition for household heating.

In section 4.3 we extrapolate the results on a household-level to the scale of the current fossil subsidy. This provides an illustration of what could be done if the current fossil heating subsidies discussed on the previous section were redirected to promote low-carbon heating instead.

It is important to state that this analysis is a simplification of the complex dynamics and local differences at play when it comes to low-carbon heating. The analysis in this chapter should be

[24] IEA (2022). The future of heat pumps.
[25] EC (2022). SWD REPowerEU Plan.

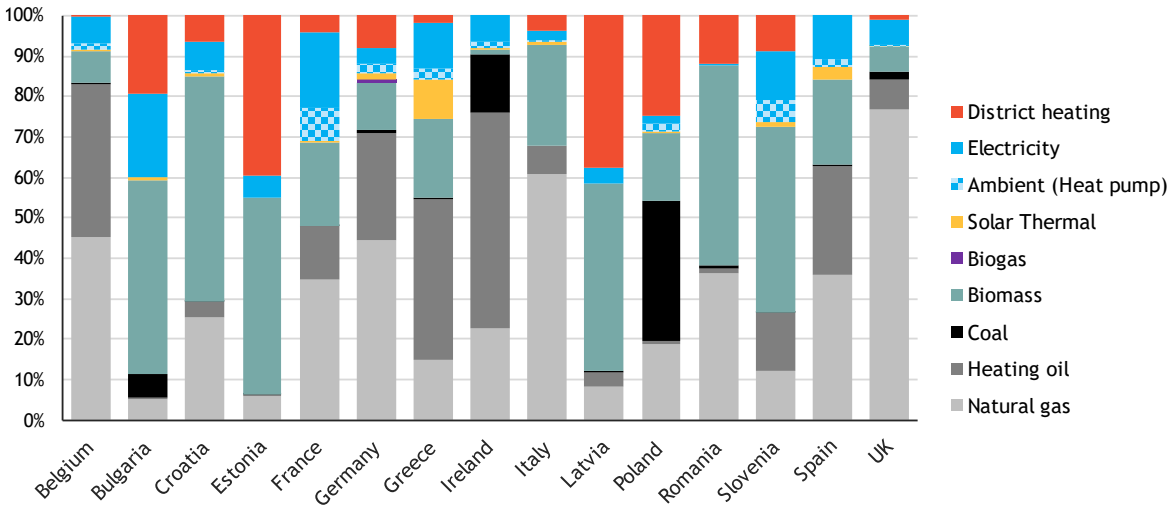
interpreted as an indicative estimate of what is needed per household and the role which redirecting fossil subsidies could play. We show some of the main dynamics that are important, but also do not touch upon many other barriers, such as (local) regulatory and non-cost barriers to consumer adoption.

4.2 Benefits of low-carbon heating solutions

Current heating systems in Europe

Most homes in Europe and the selected countries are still heated with heating systems relying on fossil fuels. The household energy consumption of the European countries we have included for space and water heating in 2021 consisted of 38% natural gas, 20% biomass, 15% heating oil, 11% district heating and only 11% by electricity (and not all electricity is used in heat pumps; see Figure 4-1).[26]

Figure 4-1 Overview of heating fuels used (final energy consumption) in 2021.



Note: UK data is for 2020. The category 'electricity' also partially includes consumption through heat pumps, hence making the share of heat pumps potentially higher than only the category 'ambient'. Also note that since this graph shows final consumption this underestimates the heating demand fulfilled by heat pumps and other high efficiency systems.

While heat pump sales are increasing year-on-year in Europe, only about 15% of households have heat pumps installed in 2022 (including hybrid systems partially using fossil fuels).[27] In the countries in scope natural gas boilers are most common. In Ireland, Greece and Slovenia heating oil is the dominant fossil heating fuel. Poland heavily relies on coal, both through coal boilers and district heating based on coal-plants.

Characteristics of low-carbon heating systems

To better understand the potential of heat pumps to reduce both costs and emissions, it is important consider the differences in characteristics between most fossil heating systems and heat pumps. Generally speaking, fossil boilers, such as high-efficiency gas boilers or oil boilers, are relatively cheap to purchase and install – gas boilers are around €2.5k - and most costs over the life-cycle of the appliance are for fuel. Heat pumps require a larger initial investment (€10k for an air-to-source heat

[26] Eurostat (2022). Final energy consumption in households.
[27] European Heat Pump Association (2022). Record growth for Europe's heat pump market in 2021, including 3 million new heat pumps sold in 2022.

pump[28]) to purchase and install the system, but generally have lower operational costs due to their very high electric efficiency (or Coefficient of Performance: COP) of more than 300% to 400% compared to below 100% for most fossil heating. This is (partially) counteracted by the higher energy price for electricity compared to fossil fuels due to higher market prices but also tax levels in many cases. Simply put, the relative financial benefit of heat pump heating depends on the investment premium compared to boilers and the ratio between the electricity and fossil fuel price.

There are three main types of heat pumps, depending on the medium from which it extracts and delivers heat to. **Air-source heat pumps (ASHP)** are most common and generally the preferred option in cold and average climates. We assume this is the most likely heat pump in most countries in scope. **Ground-to-source heat pumps (GSHP)** have a higher COP, mainly in winter with cold ambient temperature. However, the purchase + installation costs of GSHPs are substantially higher than ASHP (~€17k compared to ~€10k [29]) which is a financial barrier to uptake and hence these are not taken into account. In warmer climates **air-to-air heat pumps** are viable, due to their lower initial cost (around €3.5k), limited need for retrofits and option to also provide cooling. The lower heating comfort mean that air-to-air heat pumps are less suited for colder climates, but in warmer climates this is less of an issue, making it the most likely heat pump type in warmer climates such as Greece and Spain. In warm climates with high solar irradiation the assumed heating system also includes a **solar thermal installation** to provide the majority of water heating demand.

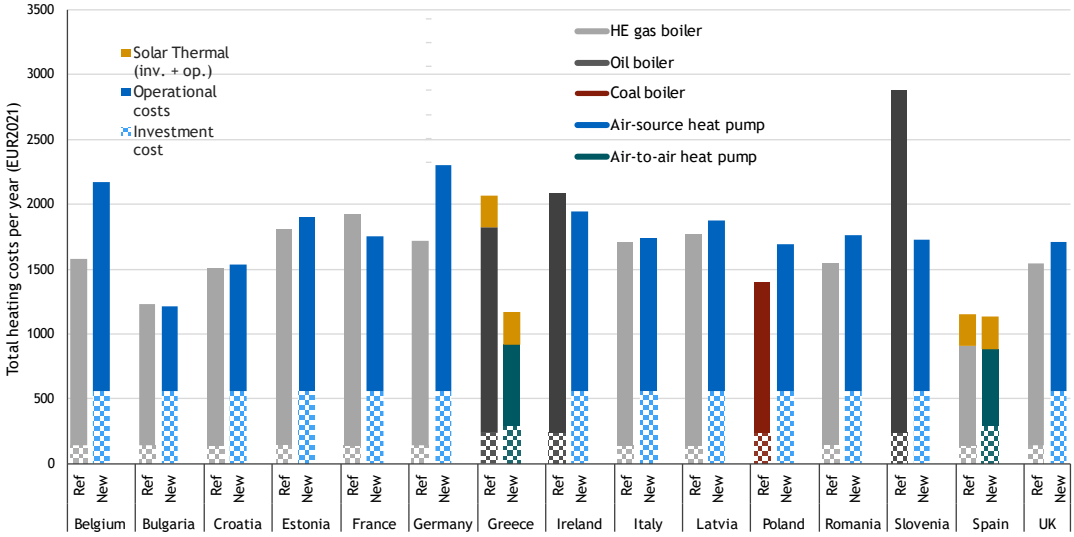
Cost benefits

Figure 4-2 shows that **in 6 of the 15 countries heat pumps currently provide the lower cost heating solution without subsidies** when taking into account all lifetime costs. On average for the countries in scope, **heating costs with a heat pump are estimate to be equal to the fossil alternative**. In countries with higher heat pump heating costs the cost difference is relatively small; it is only in 3 countries (Germany, Belgium and Poland) that heat pump heating costs more than 20% higher than the fossil alternative. The high heat pump heating costs are mainly the result of the high ratio between electricity and gas prices. When taking existing subsidy schemes into account, heat pumps would become the cheaper solution in more countries.[30]

Heat pump installations ideally – and especially in poorly insulated homes – should be **combined with improved insulation measures in order to further reduce total heating costs** and increase heating comfort. This is not taken into account in the cost estimations however. Similarly, solar thermal installations for water heating in countries with high solar irradiation are in most cases a cost-effective addition to a heat pump as well at €9ct/kWh in our calculation.

[28] All price assumptions for heating systems can be found in Annex B
[29] Note that installation costs can significantly depend per home, since in many (older) houses substantial retrofits might be needed in order to install a heat pump, such as floor heating or installing new radiators and pipes. While we also assume constant investment costs throughout Europe, costs will be lower in countries with lower labor costs.
[30] Coolproducts (2021). Analysis of the affordability of switching to renewable heating

Figure 4-2 Estimation of total annual heating costs (operational + investment) for both fossil (ref) and low-carbon heating (new) in selected countries.



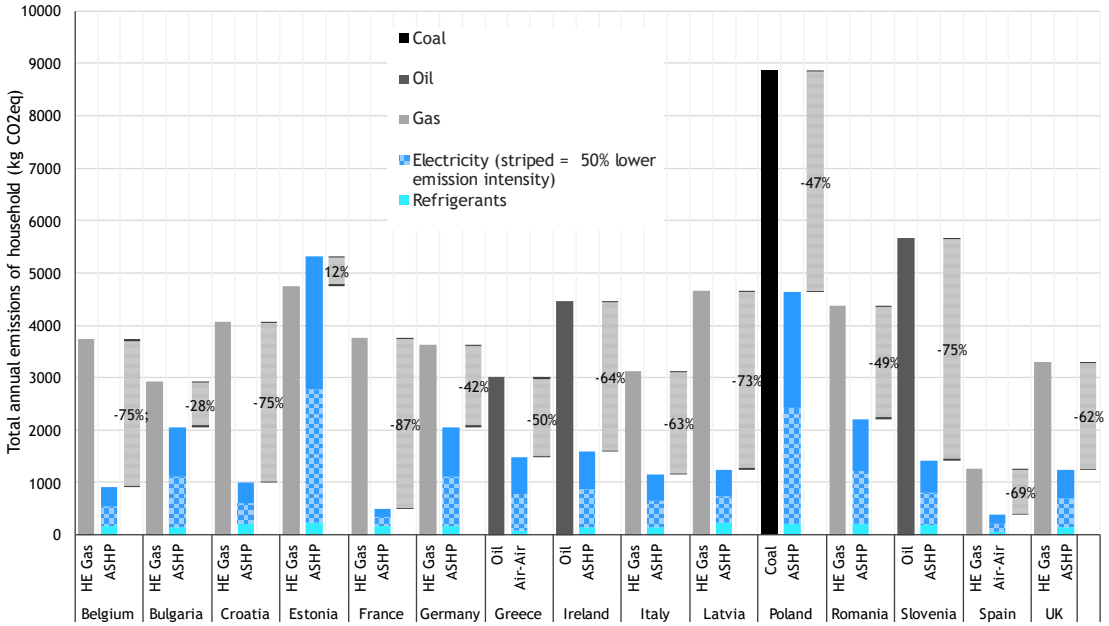
Note: see annex B for assumptions and values used. It presents the heating costs without any existing subsidy schemes. Energy price forecasts are based on 2021 prices and forecasted for the lifetime of the heating system.

Climate benefits

In addition to potential cost savings, heat pumps can significantly reduce energy consumption and CO_2 emissions. There are two main reasons why heat pumps can reduce emissions: first, their high electrical efficiency significantly reduces energy consumption. Second, electricity is the energy carrier that can be most 'easily' decarbonised, through renewable electricity production technologies such as solar PV and wind. A switch to heat pumps is thus an essential prerequisite to enable future efficient and decarbonised heating. As can be seen in Figure 4-3 **heat pumps with the current grid emission intensities will lead to an average 56% emission reduction in the selected countries, which will increase up to 90% per year,** when renewable electricity becomes the main generation source in the EU over the lifetime of the heat pump. Only in Estonia emissions will (on the short term) increase due to high share of coal in electricity generation. Heat pumps do currently lead to refrigerant emissions with high global warming potential. While these refrigerant emissions can be significant, proper maintenance and leakage prevention in combination with the use of lower GWP refrigerants can mitigate emissions from new heat pumps to a low level[31]. In addition, natural refrigerants with low GWP are entering the market and becoming compulsory due to the European F-gas regulation.

[31] Damgaard et al (2022); Direct greenhouse gas emissions from low and zero carbon heating systems

Figure 4-3 Emission reduction for an average household switching from fossil heating to heat pump heating.



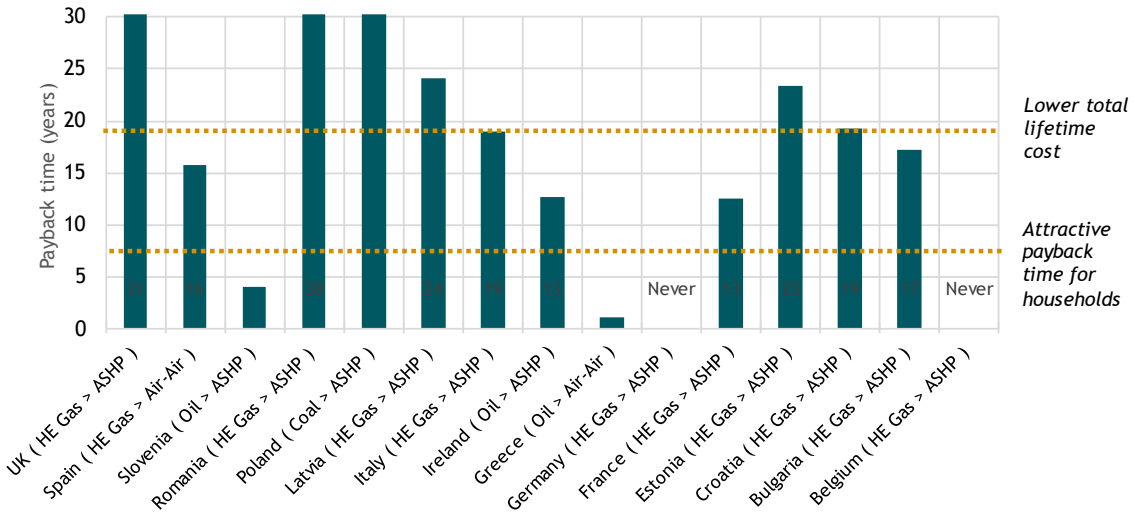
Note: figure uses average emission intensity in 2021, as well as shows the further emission reduction possible if emission reduction is reduced on average with 50% over the heating system lifetime.

Policy and subsidy needs to support the transition to low-carbon heating

The analysis above shows that in many cases low-carbon heating can be a more cost effective solution when taking all lifetime costs into account. However, the higher initial investment cost of heat pumps can be a major barrier to uptake, especially for lower income households. Most current subsidy schemes therefore aim to reduce the initial investment costs and lower the **payback time** for households. This means the number of years after which the initial investment premium is recovered through lower energy bills.[32] We assume a payback time of **7 years** as a sufficient incentive for households to switch to heat pumps.[33] Figure 4-4 shows that currently there are **only two countries where the payback time is sufficient to make widespread adoption attractive without subsidies** (Slovenia, Greece) and that there are five countries where the payback time is more than 30 years or non-existent (Romania, Poland, UK, Germany and Belgium). We see a clear trend that especially in countries that rely on cheap natural gas (and high electricity prices) heat pumps are relatively unfavorable, also when taking the recent energy crisis into account.

[32] In formula form: (CAPEX new – CAPEX ref)/-(OPEX new-OPEX ref)=payback time.
[33] since in many cases without subsidy a heat pump already has lower costs over the whole lifetime, another possible policy option would be an low-interest loan for households that helps spread out the high initial cost

Figure 4-4 Payback time of heat pump without subsidies compared to fossil alternative. Yellow lines show the 7 year attractive payback time for households as well as the payback time needed to make heat pumps cheaper over their lifetime.



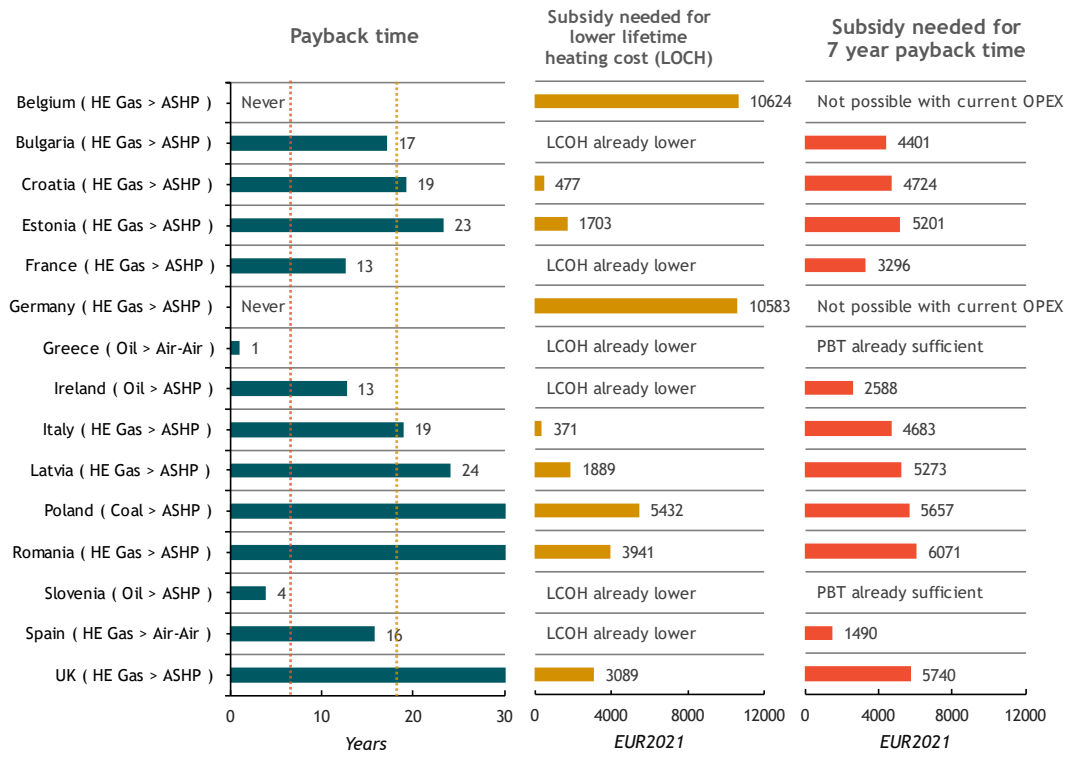
Note: UK, Romania and Poland have a >30 payback time and are not visible in the graph. In Germany and Belgium the OPEX of heat pumps is higher than the fossil alternative, due to the high ratio between electricity and gas prices. As a result, an investment cost subsidy alone in these countries cannot lead to a payback time and lower lifetime cost of heating (LCOH).

In Figure 4-5 we estimate the subsidy required to reach an attractive payback time per country. This shows that **on average €4700 subsidy is needed per heat pump to reach a 7 year payback period** without any other policy measures in place.[34] To get the total lifetime heating costs (LCOH) of heat pumps below the fossil alternative the required subsidy is logically lower: **on average €2550 and 45% lower.**

The average needed subsidy in absence of other measures is thus relatively high. This shows the importance of a balanced policy mix also including regulation and tax measures. As an example, the high OPEX in Germany and Belgium is largely due to **higher taxes on electricity than gas** per energy content and even more based on emission intensity. Hence, taxation reflecting energy use or emissions could reduce the need for public subsidies considerably: a **1 ct/kWh tax shift from electricity to fossil (gas) could reduce the investment subsidy required by 40-60%**. Countries are implementing measures in this direction. The Netherlands has reduced the energy tax rate for electricity and increased the gas rate and in Denmark a reduced tax tariff was introduced above 4000 kWh for heat pump owners. A recent report from RAP discusses the role of taxes and levies in more detail.[35]

[34] Unweighted average for the analysed countries.
[35] Regulatory Assistance Project (2022). Levelling the playing field: Aligning heating energy taxes and levies in Europe with climate goals

Figure 4-5 Overview of payback time per country, the necessary subsidy to achieve a 7 year payback time and necessary subsidy to lower the lifetime heating cost below the fossil alternative.



Note: PBT = payback time. HE gas = High-efficiency gas boiler; ASHP = Air-to-Source heat pump; air-air heat pump; oil = oil boiler; coal = coal boiler. Both in Spain and Greece a air-air heat pump is combined with solar thermal. If the OPEX of using electricity via a heat pump is higher than use of reference, the payback time is 'infinite' and a sufficient payback time can only be reached through additional policies that lower the OPEX of heat pumps compared with fossil heating.

4.3 Impact of redirecting spending on fossil heating

In chapter 3 we presented an overview of the remaining subsidies in Europe for fossil heating systems. In this section we present an estimate of what could be done if these subsidies were redirected to low-carbon heating. This is done for the situation without existing subsidies schemes. Figure 4-6 recaps that the total fossil heating subsidies in Europe are €3.2 billion, with France, Germany and Italy in 2022 having the highest total subsidy but also the highest subsidy intensity.

If all fossil subsidies were redirected, in the EU (+UK) it would be possible to make heat pumps **financially attractive for 600,000 additional households**, equal to 0.3% of all households in the EU + UK.[36] If subsidies per household decrease – for example because subsidies 'only' aim to cover the lifetime cost gap between heat pumps and fossil boilers – the number of additional households increase; logically if the subsidy per household increases – for example because more subsidy is needed to retrofit old or badly insulated homes – the number of additional households decreases.

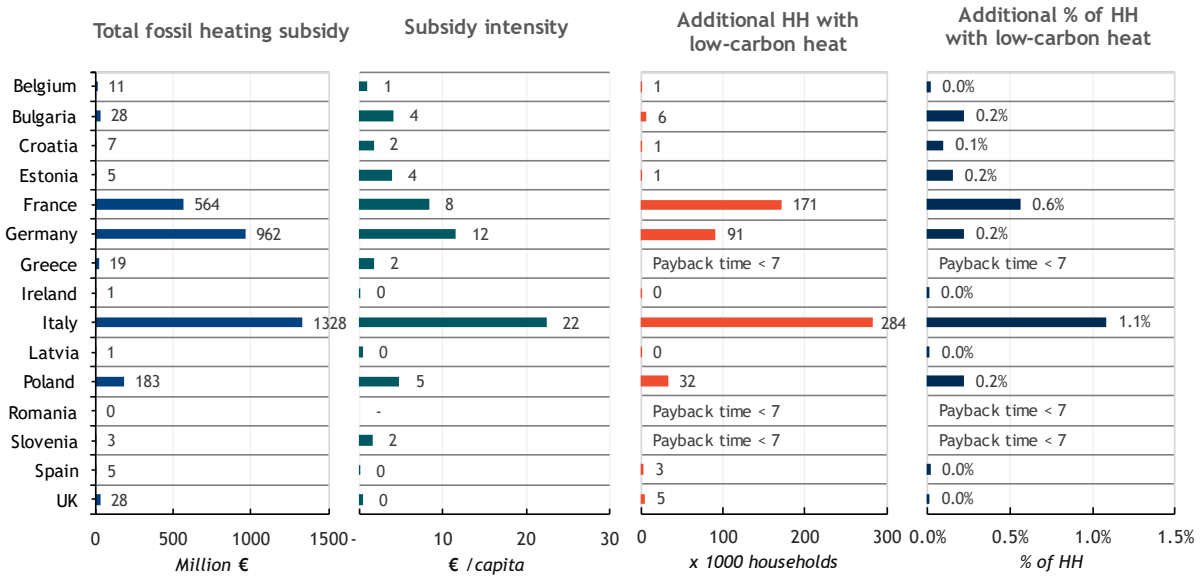
It could reduce natural gas demand by 1 bcm annually, out of a total natural gas consumption in the EU of 405 bcm,[37] when heat pumps are installed instead of high-efficiency gas boilers. This would lead to an **annual emission reduction of around 1.3 Mton CO_2 eq** if fossil boilers are replaced, with an

[36] Given the inherent uncertainties of our estimation in the previous section, the results are rough estimations and should be interpreted as such; to make this clear, in the **executive summary we present the results as a range** instead of concrete numbers

[37] Eurostat(2022). Total energy Supply by Product.

additional 0.4 Mton possible towards 2040 through a further decarbonised electricity mix powering the heat pump. Over the heating systems' lifetime, cumulative emission savings could increase up 30 Mton. For comparison, total GHG emissions in 2020 from Malta were 2.1 Mton and 3124 Mton of the whole EU27.[38] Text box 1 provides a few caveats and considerations to help interpret the results.

Figure 4-6 Total fossil heating subsidy in 2022 (some cases 2021), the subsidy intensity per capita, as well as the number of households that could receive low-carbon heating through redirecting fossil subsidies.



Note: Using this methodology, Italy has the most addiontal households that could receive funding to make heat pumps attractive, since the subsidy needed per household is significantly lower there than e.g. in Germany (see Figure 4-5). HH = households.

Box 1 Caveats and considerations to take into account when interpreting results.

In this chapter we have presented an analysis that shows both the economics of heat pumps and an estimate of the subsidy needs. However, there are a number of additional factors that complicate this analysis. These factors include:

- We do not take into account existing subsidy schemes for low-carbon heating in the calculations. Hence, the implicit assumption is that the budget for low-carbon heating schemes is not enough (there is unmet demand and supply) and that additional budget will thus lead to additional heat pump installations. This assumption does not take into account other implementation barriers. For example, the Italian Superbonus schemes has led to such an increase in heat pump demand that there are not sufficient skilled installers available. Additional budget would then in the short term not lead to more heat pumps as long as these barriers persist.
- In some cases, fossil subsidies are aimed at replacing low-efficiency fossil heating with modern, higher efficiency technology. For example, in Belgium until 2022 a subsidy could be received for replacing heating oil installations with high-efficiency gas boilers. This would lead to some emission reductions, albeit neglible compared with the savings that heat pumps would bring, and most importantly result in a lock-in on fossil heating for up to 20 years.
- We assume that an average 7 year payback time is financially attractive for households. However, for some low-income households this might not be sufficient. Also, while energy prices (over the long term at least) and heat pump purchase costs are comparable between households installation and additional costs can significantly vary. Especially in older homes additional

[38] UNFCCC(2022). National Communication Malta.

retrofits are often needed, for example installing floorheating or modernising radiator systems. This raises costs of the low-carbon heating system and might require additional (financial) support. Not taken into account in calculations, but equally as important, is improved **insulation**. This can greatly reduce energy costs, reduce stress on the electricity grid and improve living comfort, and in many cases installing a heat pump at the same with insulation measures is preferable.

- As mentioned before, (investment/purchase) subsidies should be approached from a broader policy perspective, and combined with fiscal measures (e.g. tax shift) and regulation, such as bans or standards in e.g. the Ecodesign directive.
- The supply side can be constrained by the lack of skilled installers. This highlights the reality of the skills shortages that have been discussed for many years as a key barrier.

While we mainly focused on the direct alternatives for fossil heating, current fossil subsidies could of course also be redirected to support many other necessary investments that are required to reach net zero, preferably where a finance gap still persists. As illustrative examples, €3.2 billion could for example be used to pay for ~1.4 million rooftop solar PV installations (2kW capacity) annually [39], ~65 TWh of annual electricity generation with utility-scale PV or 3.2 million €1000 insulation measure vouchers for households.

[39] IRENA (2022). Renewable Energy Generation Costs.

Annex A: Subsidies per country

This section includes the list of measures that support the installation of residential heating systems identified per country. The title, description, subsidy instrument and the year with available data are provided in the tables, while the figures show the disaggregation of the budget for each measure per heating type (when data are available).

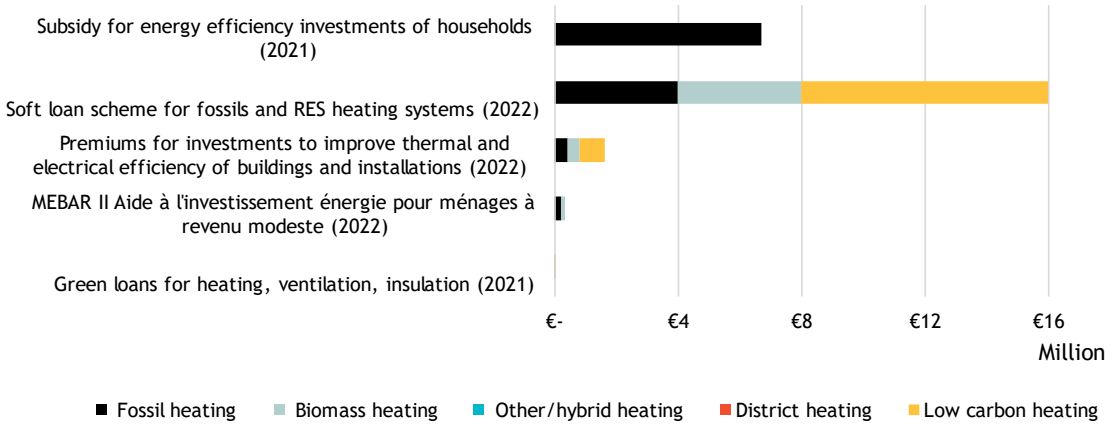
Belgium

Table A- 1 List of support schemes for residential heating installations, Belgium

Measure Title	Description	Subsidy instrument	Most recent year with available data
Reduced interest rate for green loans	Reduced interest rate for green loans	Soft loans	n.a
Tax reduction for green loans	Tax deduction for financing of energy efficiency investments by private house owners	Soft loans	n.a
MEBAR II Aide à l'investissement énergie pour ménages à revenu modeste	Premiums for energy efficiency in houses or apartments (insulation, heating, lighting, etc)	Grants	2022
Premiums for investments to improve thermal and electrical efficiency of buildings and installations	Premiums for investments to improve thermal and electrical efficiency of buildings and installations. Primes du fonds énergie.	Grants	2022
Soft loan scheme for fossils and RES heating systems	Soft loan scheme for fossils and RES heating system (and renovation works in general)	Soft loans	2022
Subsidy for energy efficiency investments of households	Subsidy for energy efficiency investments of households	Grants	2021
Green loans for heating, ventilation, insulation	Green loans for heating, ventilation, insulation of buildings - mentioned subsidy covers administrative costs + interest advantage granted to investors	Soft loans	2021
Property tax reduction for energy efficient buildings	A tax rebate can be obtained in case of energy renovation of buildings, with the total replacement of the heating and the insulation (of at least 75% of the building surfaces). Only valid if energy level max E60 (100 kWh/m2/year) is reached.	Tax reduction	n.a
Investment subsidy for energy saving measures (incl. insulation, PV, thermal solar, HP) in existing and new buildings	Investment subsidy for energy saving measures (incl. insulation, PV, thermal solar, HP) in existing and new buildings	Grants	n.a
Loan for energy saving measures (incl. insulation, PV, thermal solar, HP) in existing and new buildings	Loan for energy saving measures (incl. insulation, PV, thermal solar, HP) in existing and new buildings	Soft loans	n.a
Grant scheme for fossil heating system (gas)	Grant scheme for fossil heating system (gas)	Grants	n.a
VAT reduction for renovation works	Tax reduction scheme for fossils and RES heating systems	Tax reduction	n.a

In green: the schemes with no total budget available

Figure A- 1 Subsidies on residential heating systems per heating type, Belgium (Note: only subsidies with available data are displayed)

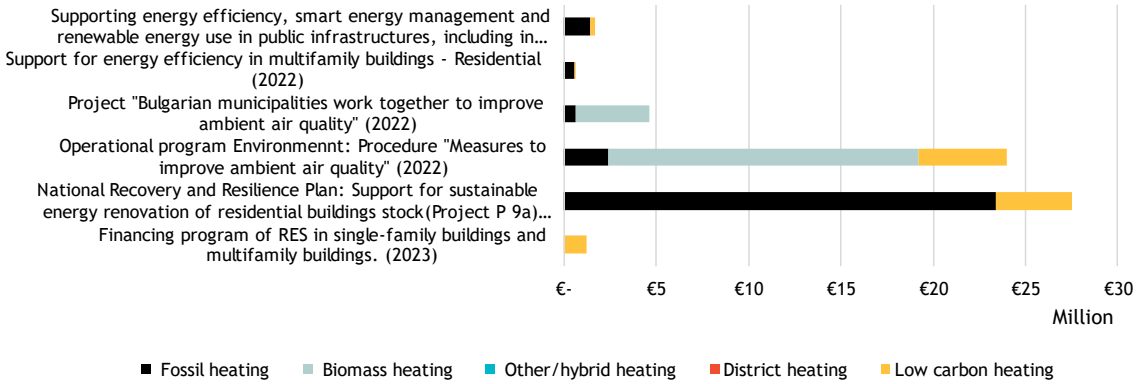


Bulgaria

Table A- 2 List of support schemes for residential heating installations, Bulgaria

Measure Title	Description	Subsidy instrument	Most recent year with available data
Support for energy efficiency in multifamily buildings – Residential	New national program for energy efficiency in multifamily residential buildings was adopted on by ordinance №18, from February 2, 2015 of the Council of Ministers. The initial financing was 1 billion BGN.	Grants	2022
National Recovery and Resilience Plan: Support for sustainable energy renovation of residential buildings stock(Project P 9a)	Support sustainable energy renovation of residential buildings stock(Project number P9a). Only for multifamily residential buildings.	Grants	2023
Financing program of RES in single-family buildings and multifamily buildings.	Financing program for RES in single-family buildings and multifamily buildings(Project P10).	Grants	2023
Supporting energy efficiency, smart energy management and renewable energy use in public infrastructures, including in public buildings, and in the housing sector	Implementation of energy efficiency measures in residential buildings.	Grants	2022
Project “Bulgarian municipalities work together to improve ambient air quality”	The project includes switching from wood and coal heating to biomass pellets and natural gas.	Grants	2022
Operational program Environmennt: Procedure “Measures to improve ambient air quality”	The project includes switching from wood and coal heating to biomass pellets and natural gas.	Grants	2022

Figure A- 2 Subsidies on residential heating systems per heating type, Bulgaria (Note: only subsidies with available data are displayed)

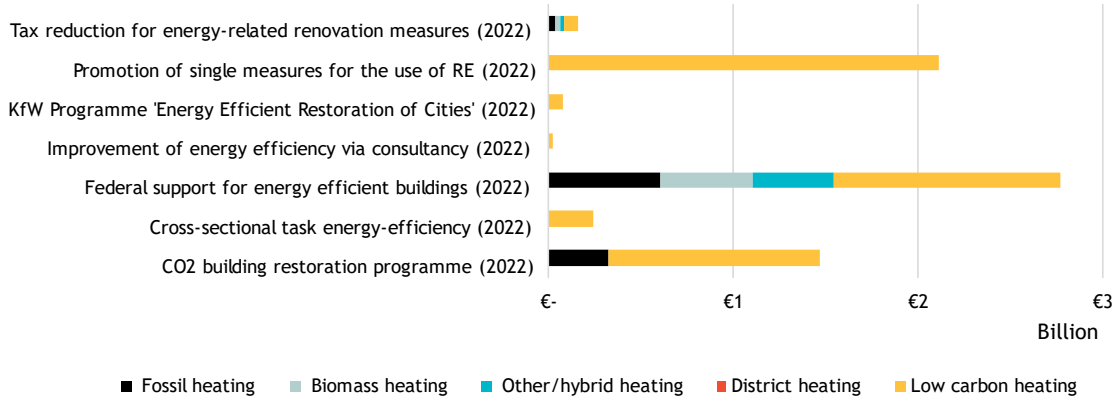


Germany

Table A- 3 List of support schemes for residential heating installations, Germany

Measure Title	Description	Subsidy instrument	Most recent year with available data
Improvement of energy efficiency via consultancy	Fostering of energy efficiency measures in heating, RES use, processes and procedures of buildings and facilities for SMEs and private households via consultancy	Grants	2022
Cross-sectional task energy-efficiency	Fostering of rational and economical usage of energy	Grants	2022
Promotion of single measures for the use of renewable energy	Seeks to boost the share of renewable energy for heating and cooling. § 13 EEWaermeG	Grants	2022
KfW Programme 'Energy Efficient Restoration of Cities'	Comprehensive measures for energy efficiency of buildings and infrastructure to incorporate usage of renewable energy more broadly in antique inner-city quarters.	Grants	2022
CO2 building restoration programme and incentive programme for energy efficiency	The main goal is to reduce heating demand in private and public buildings. This incorporates energy efficient construction and restoration of buildings above and beyond the legal requirements. Funded by the government and KfW.	Soft loans	2022
Federal support for energy efficient buildings	Creating incentives to invest in measures to improve energy efficiency and increase the share of renewable energies for heating and cooling in buildings.	Grants	2022
Tax reduction for energy-related renovation measures in buildings used for own residential purposes	Tax benefits for building refurbishments in addition to existing measures (grants).	Tax reduction	2022

Figure A- 3 Subsidies on residential heating systems per heating type, Germany (Note: only subsidies with available data are displayed)



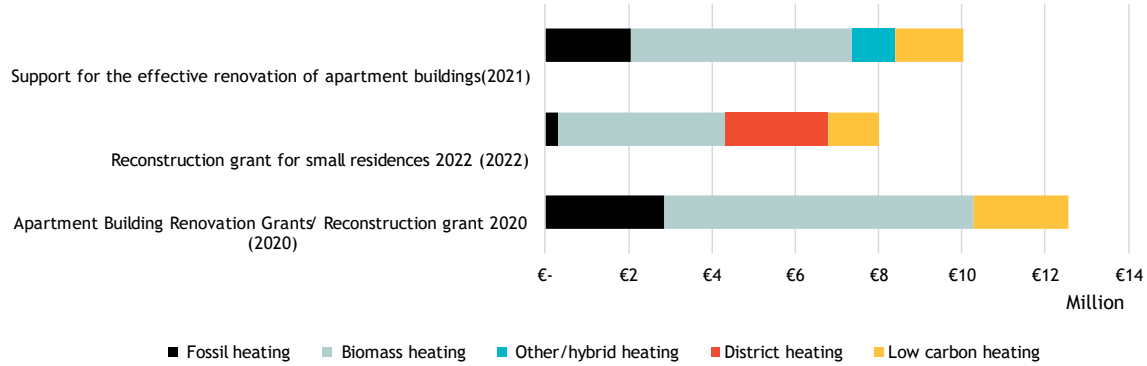
Estonia

Table A- 4 List of support schemes for residential heating installations, Estonia

Measure Title	Description	Subsidy instrument	Most recent year with available data
Support for the effective renovation of apartment buildings	The objectives of the support are: encouraging the introduction of new technical solutions in the reconstruction of apartment buildings; achieving energy efficiency and a better indoor climate in apartment buildings; reducing energy dependency and greenhouse gas emissions.	Grants	2021
Apartment Building Renovation Grants/ Reconstruction grant 2020	The goal of this measure is to support the reconstruction and renovation of apartment buildings for achieving indoor climate and energy efficiency, improving the energy-performance as well as using renewable energy in the existing apartment buildings.	Grants	2020
Reconstruction grant for small residences 2022	The aim and result of the support is to achieve energy efficiency and a better indoor climate in small dwellings, to reduce energy costs, to encourage the use of renewable energy, to increase the number of dwellings with improved energy efficiency and to save annual primary energy consumption.	Grants	2022
Renovation of district heating boilers and replacement of fuel	Upgrading of boiler houses and piping, local heating solutions The aim of the grant is to reduce final energy consumption through the more efficient production and transmission of heat. The activities supported were: the renovation of district heating boilers and fuel replacement; the renovation of obsolete and inefficient heat pipework; the replacement of district heating solutions with local heating ones.	Grants	2021[40]

[40] It was not possible to make estimations on the budget split per heating type, therefore this subsidy has not taken into account in the calculations of the budgets for Estonia.

Figure A- 4 Subsidies on residential heating systems per heating type, Estonia (Note: only subsidies with available data are displayed)



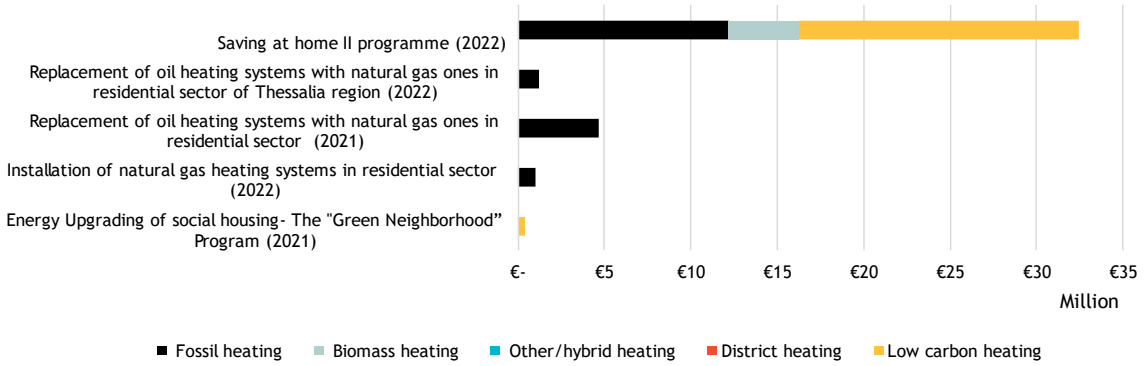
Greece

Table A- 5 List of support schemes for residential heating installations, Greece

Measure Title	Description	Subsidy instrument	Most recent year with available data
Energy Upgrading of social housing- The "Green Neighborhood" Program	The program aims to the energy upgrade of four social building blocks to almost zero energy consumption buildings, and to optimise the local microclimate.	Grants	2021
Saving at home II programme	The 'Saving at home II' Program was designed as a follow-up to the "'Saving at home' . The program regards energy saving interventions in the domestic building sector to increase energy savings and reduce emissions. The intervations are related to: 1. Replacement of frames 2. Installing/upgrading thermal insulation 3. Heating/cooling system upgrade 4. ZNX System using Renewable Energy Sources (RES)	Grants	2022
Replacement of oil heating systems with natural gas ones in residential sector of Thessalia region	The28ncentn 'Replacement of oil heating systems with natural gas ones in households' involves the subsidy for the cost of the installation of natural gas boilers, in order to replace existing oil heating systems in residential sector of Thessalia region	Grants	2022
Replacement of oil heating systems with natural gas ones in residential sector	The action concerns the subsidisy of the cost of installation of natural gas heating systems in residences, to replace the existing oil heating systems	Grants	2021
Installation of natural gas heating systems in residential sector	The action concerns the subsidy of the cost of installation of natural gas heating systems in residences located on an active natural gas network	Grants	2022
New-Installation of natural gas heating systems in residential sector	The action concerns the subsidy of the cost of installation of natural gas heating systems in residences located on an active natural gas network	Grants	n.a
Tax regulation mechanism: income tax relief for energy upgrading renovations	Law No. 2238/1994 provides for an income tax relief for natural and legal persons who have performed an energy upgrading of their building. It covers 40% of the expenditures with a maximum expenditure amount of €16,000. To be eligible the interventions need to be paid by card or online and the building should not be included under another support scheme (e.g. Saving at home)	Tax reduction	n.a

In green: the schemes with no total budget available

Figure A- 5 Subsidies on residential heating systems per heating type, Greece (Note: only subsidies with available data are displayed)

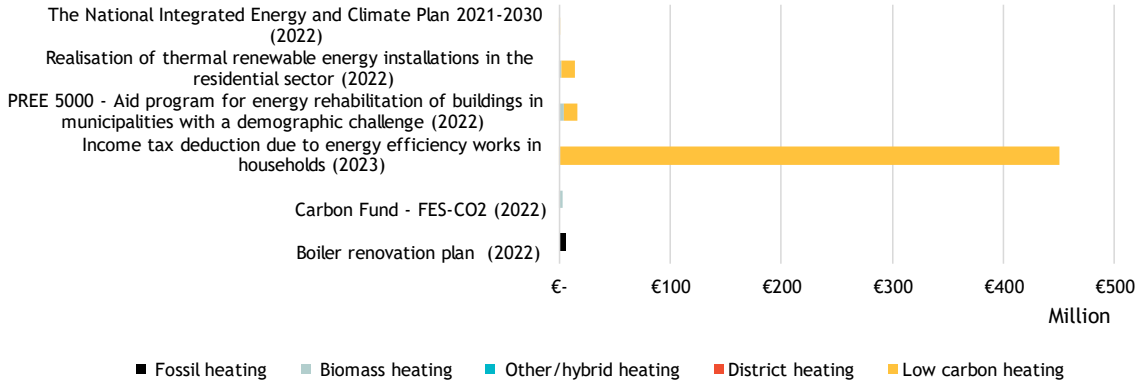


Spain

Table A- 6 List of support schemes for residential heating installations, Spain

Measure Title	Description	Subsidy instrument	Most recent year with available data
Income tax deduction due to energy efficiency works in households	Tax deductions to incentivise the energy renovation of households	Tax reduction	2023
The National Integrated Energy and Climate Plan 2021-2030	The National Integrated Energy and Climate Plan defines the objectives of reducing GHG emissions, RES development and energy efficiency.	Grants	2022
Carbon Fund – FES-CO2	A fund for projects allowing a reduction in GHG emissions in various sectors (transport, agriculture, residential, waste, etc.). As such it targets residential houses, industry, transport, retail. Example of relevant projects concern (gradual actions for) the replacement of fossil fuel powered boilers to biomass boilers.	Grants	2022
PREE 5000 – Aid program for energy rehabilitation of buildings in municipalities with a demographic challenge	Central government grant scheme for RES heating systems	Grants	2022
Realisation of thermal renewable energy installations in the residential sector	Central government grant scheme for RES heating systems	Grants	2022
Boiler renovation plan	Central government (locally applied) grant scheme for fossil heating systems	Grants	2022

Figure A- 6 Subsidies on residential heating systems per heating type, Spain (Note: only subsidies with available data are displayed)



France

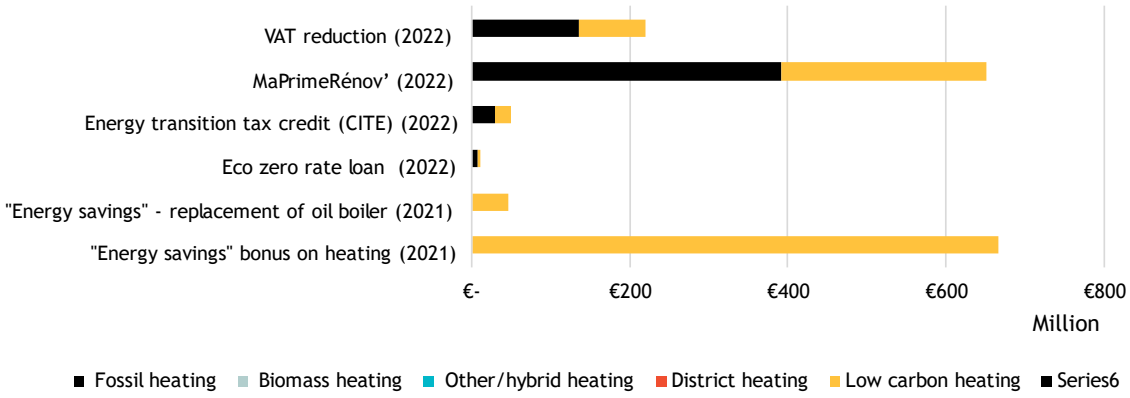
Table A- 7 List of support schemes for residential heating installations, France

Measure Title	Description	Subsidy instrument	Most recent year with available data
Home Improvement Energy Retrofit Program Living Better and Thermal Retrofit Fund (FART)	Habiter Mieux program and fund for thermal renovation (fonds d'aide à la 30ncentiviz thermique, FART) managed by the National Agency of Habitat (Agence Nationale de l'Habitat, ANAH) provide grants for low income dwelling to retrofit their 30ncentivised30 in order to reduce thier energy bills. The ANAH supports up to 50% of the amount of work for housing over 15 years. This aid is up to EUR 10,000 depending on household resources. Subsidies granted under the Habiter Mieux program are conditional on an improvement in the energy performance of housing above 25%.	Grants	2019[41]
MaPrimeRénov'	Until the end of 2019, the main form of financial assistance for home energy conservation was a tax credit called the Crédit d'Impôt de la Transition Énergétique (CITE). As this tax credit was being phased out as from 2019, it has been replaced by a grants system called MaPrimeRénov. One of the major changes is that the grant is paid at the end of the works, and not later following submission of your income tax return. It is also possible to obtain interim progress payments. Until January 2021, the new grants system sat alongside the tax credit system CITE. Since January 2021, it has fully replace the former system.	Grants	2022
Eco zero rate loan for works to improve the overall energy performance of homes	Éco-prêt à taux 30nce (éco-PTZ): allows financing works that improve the energy efficiency of houses. The house must be older than 2 years. Covered are: roof isolation, wall isolation, isolating glass, installation or replacement of heat systems, heating systems that work on renewable energy, any work that is required to make the house meet a minimum energy performance standard. After the loan is given, the receiver has 2 years to carry out the work. The maximum amount is 50 000 euro per house (when combining several types of works), to be paid back without interest. The maximum duration of the loan is 10 years. No conditions on the household's resources are required.	Soft loans	2022
Energy transition tax credit (CITE), former Sustainable Development Tax Credit (CIDD)	Tax credits for purchases of equipment for primary residences to promote both sustainable development and energy conservation. Specifications regarding equipment covered have been modified several times since its launch in 2015. To be eligible for the tax credits the building in which the equipment is used must be a primary residence and at least two years old; for renewable energy equipment the building can be new or old. Since 1 January 2016, the tax credit mechanism has been simplified and the tax credit is set at -30% for eligible equipment. The tax credit can cover purchase of boilers with a high energy efficiency rate, thermal insulation works, heating regulation devices, heat pumps, charging points for electric vehicles, etc. The tax credit is limited to EUR 8000 per person, EUR 16 000 for a couple and EUR 400 for each additional dependent. This measure has been replaced by the one called MaPrimeRénov' as from January 2020.	Tax allowance	2022
"Energy savings" bonus on heating	"Coup de pouce chauffage" helps to finance: - (Coup de pouce chauffage) the installation of a performant biomass boiler, of a very performant	Grants	2021

[41] It is not clear if this programme was completely replaced by MaPrimeRénov'or still exists in another form. Therefore, due to lack of clarity the budget is not considered in the calculations of the total budget for France.

	wood heating system, of a HP (air/water, water/water or hybrid), of a combined solar system or the connection to a renewable district heating system. Until 2025.		
"Energy savings" bonus on the replacement of an oil boiler	"Coup de boost fioul" helps to finance: - (Coup de boost fioul) replacement of an oil boiler up to EUR 1500 by a more environmentally friendly heating system. From October 2022 until June 2023.		2021
VAT reduction	Reduced VAT rate (10% or 5.5% instead of 20%) for improvement and renovation works, including energy renovations, for homes over 2 years old, when equipment is installed by a professional.	Tax reduction	2022
Energy check	The energy check is a voucher that helps paying energy bills or purchase of heating installations, among others	Grants	2022
Exceptional energy check	The Exceptional energy checks are aid schemes that can go up to €200 for people using oil heating and wood heating (logs, sticks, chips or granules/pellets).	Grants	2022

Figure A- 7 Subsidies on residential heating systems per heating type, France (Note: only subsidies with available data are displayed)



Croatia

Table A- 8 List of support schemes for residential heating installations, Croatia

Measure Title	Description	Subsidy instrument	Most recent year with available data
System with solar thermal collectors	Installation of system with solar thermal collectors	Grants	2022
Heat pump for space heating, domestic hot water (DHW) preparation and space cooling	Installation of heat pump for space heating, domestic hot water (DHW) preparation and space cooling	Grants	2022
Space heating, domestic hot water (DHW) preparation system	Installation of space heating, domestic hot water (DHW) preparation system	Grants	n.a
Condensing gas boiler	Installation of condensing gas boiler	Grants	2021
Program for Energy Renovation of Family Houses- comprehensive energy renovation- M2.1. Wood chip/pellet boiler or firewood pyrolytic boiler for space heating and/or domestic hot water (DHW) preparation	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy	Grants	2022

	efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021. For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.		
Program for Energy Renovation of Family Houses- comprehensive energy renovation- M2.2. Heat pump for space heating, domestic hot water (DHW) 32ncentivise and space cooling (GWP≤ 2150)	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021. For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.	Grants	2022
Program for Energy Renovation of Family Houses- comprehensive energy renovation- M2.3. System with solar thermal collectors	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and	Grants	2022

	experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021. For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.		
Program for Energy Renovation of Family Houses- RES heating systems- M2.1. Wood chip/pellet boiler or firewood pyrolytic boiler for space heating and/or domestic hot water (DHW) preparation	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021. For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.	Grants	2022
Program for Energy Renovation of Family Houses- RES heating systems- M2.2. Heat pump for space heating, domestic hot water (DHW) 33ncentivise and space cooling (GWP≤ 2150)	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021.	Grants	2022

	For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.		
Program for Energy Renovation of Family Houses- RES heating systems- M2.3. System with solar thermal collectors	The Government of the Republic of Croatia, the Ministry of Construction and Physical Planning, and the Ministry of Environmental and Nature Protection, adopted on 27 March 2014 the Programme of energy renovation of family houses, which is implemented by the Environmental Protection and Energy Efficiency Fund. The goal of the Programme is to increase energy efficiency of the existing houses, to reduce energy consumption and emissions of CO2 into the atmosphere, and to reduce the monthly costs for the energy generating products, with the overall improvement of the quality of living. At the same time, the planning of such interventions implies the engagement of the local companies and experts, meaning it stimulates economic activities. Amendments to the Programme were first adopted in 2015, and the second amendments were adopted in 2020, after which the Government adopted the Decision on extending the programme in 2021. For the purposes of this Programme, a family house means a building: • in which more than 50% of the surface area is used for living, and • meets one of the two requirements: has no more than 3 residential units and has the gross floor surface smaller or equal to 600 m2.	Grants	2022
Programme for co-financing the purchase of condensing boilers for houses and apartments affected by the earthquake	On 22 March 2020, a strong 5.5 earthquake (on the Richter scale) occurred leaving many buildings completely or partially destroyed in the City of Zagreb, Zagreb County, and Krapina-Zagorje County. Therefore, on 7 May 2020 the Croatian Government adopted the Decision amending the State budget to provide HR 141 million for urgent repairs and purchase of condensing boilers for the citizens whose property was damaged. The primary goal was to dedicate these funds to raise the level of safety in the areas struck by the earthquake, and to make possible for the citizens who would be able to return to their homes after repairs to have hot water and heating. The programme is intended to help owners/co-owners of the buildings damaged in the earthquake in repairs and to get a more energy efficient and environmentally friendly heating and hot domestic water systems. To exercise the right to co-financing, the people had to apply to the Fund's Public Call launched in 10 June 2020.	Grants	2022
Public Call for implementation of renewable energy sources in family houses- M1. Wood chip/pellet boiler or firewood pyrolytic boiler for space heating and/or domestic hot water (DHW) preparation	As part of the Call, projects that are using renewable energy sources for their self-consumption are co-financed, i.e. measures to install systems for the use of renewable energy sources in existing family houses. For the application, it is important that the house is energy certified and falls in one of the following energy categories (according	Grants	2023

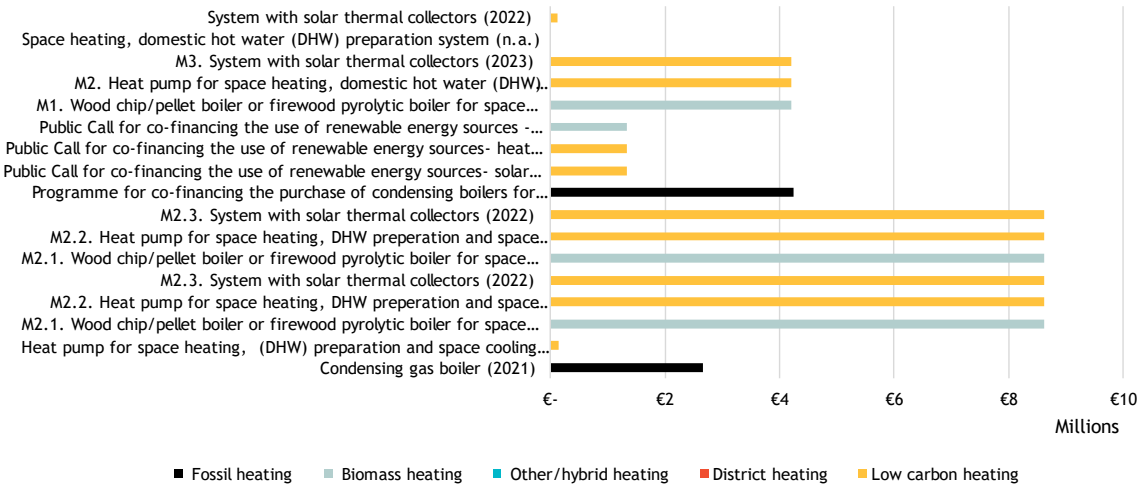
	to the annual thermal energy required for Heating, QH,nd): • C or better in continental Croatia, • B or better in coastal Croatia. Beneficiaries of the Fund's resources can be natural persons – citizens, owners, or co-owners of a family home with residence at the address of the property in scope (properties damaged in the earthquake are not in the scope of the Call).		
Public Call for implementation of renewable energy sources in family houses- M2. Heat pump for space heating, domestic hot water (DHW) 35ncentivise and space cooling (GWP≤ 2150)	As part of the Call, projects that are using renewable energy sources for their self-consumption are co-financed, i.e. measures to install systems for the use of renewable energy sources in existing family houses. For the application, it is important that the house is energy certified and falls in one of the following energy categories (according to the annual thermal energy required for heating, QH,nd): • C or better in continental Croatia, • B or better in coastal Croatia. Beneficiaries of the Fund's resources can be natural persons – citizens, owners, or co-owners of a family home with residence at the address of the property in scope (properties damaged in the earthquake are not in the scope of the Call).	Grants	2023
Public Call for implementation of renewable energy sources in family houses- M3. System with solar thermal collectors	As part of the Call, projects that are using renewable energy sources for their self-consumption are co-financed, i.e. measures to install systems for the use of renewable energy sources in existing family houses. For the application, it is important that the house is energy certified and falls in one of the following energy categories (according to the annual thermal energy required for Heating, QH,nd): • C or better in continental Croatia, • B or better in coastal Croatia. Beneficiaries of the Fund's resources can be natural persons – citizens, owners, or co-owners of a family home with residence at the address of the property in scope (properties damaged in the earthquake are not in the scope of the Call).	Grants	2023
Public Call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption- Wood chip/pellet boiler or firewood pyrolytic boiler	On September 7, 2020, the Fund for Environmental Protection and Energy Efficiency published a public call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption. The available funding per Public Call was HRK 30,000,000.00. The subject of the Public Call is the allocation of funds from the Fund to natural persons, and citizens, for the installation of one or more new systems for the use of renewable energy sources for the production of heat or heat and cooling energy: • with a wood chip/pellet boiler or with a firewood pyrolytic boiler for space heating or space and domestic hot water (DHW) (below: biomass system); • with heat pump for domestic hot water (DHW) and space heating or for domestic hot water (DHW) and heating and cooling space (below: system with heat pump); • with solar thermal converters for domestic hot water (DHW) or for domestic hot water (DHW) and space (below: system with solar thermal converters);	Grants	2021

	into existing energy categories (according to QH,nd) • A, B and C in continental Croatia • A and B in coastal Croatia An existing family house in the Call is defined as a building: - which is legal; - in which more than 50% of the gross floor area is intended for housing - which meets one of the two stated conditions: has a maximum of three residential units OR has a gross construction area less than or equal to 600 m2.		
Public Call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption- heat pumps	On September 7, 2020, the Fund for Environmental Protection and Energy Efficiency published a public call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption. The available funding per Public Call was HRK 30,000,000.00. The subject of the Public Call is the allocation of funds from the Fund to natural persons, and citizens, for the installation of one or more new systems for the use of renewable energy sources for the production of heat or heat and cooling energy: • with a wood chip/pellet boiler or with a firewood pyrolytic boiler for space heating or space and domestic hot water (DHW) (below: biomass system); • with heat pump for domestic hot water (DHW) and space heating or for domestic hot water (DHW) and heating and cooling space (below: system with heat pump); • with solar thermal converters for domestic hot water (DHW) or for domestic hot water (DHW) and space (below: system with solar thermal converters); into existing energy categories (according to QH,nd) • A, B and C in continental Croatia • A and B in coastal Croatia An existing family house in the Call is defined as a building: - which is legal; - in which more than 50% of the gross floor area is intended for housing - which meets one of the two stated conditions: has a maximum of three residential units OR has a gross construction area less than or equal to 600 m2.	Grants	2021
Public Call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption- solar thermal converters	On September 7, 2020, the Fund for Environmental Protection and Energy Efficiency published a public call for co-financing the use of renewable energy sources for the production of heat or heat and cooling energy in households, for self-consumption. The available funding per Public Call was HRK 30,000,000.00. The subject of the Public Call is the allocation of funds from the Fund to natural persons, and citizens, for the installation of one or more new systems for the use of renewable energy sources for the production of heat or heat and cooling energy: • with a wood chip/pellet boiler or with a firewood pyrolytic boiler for space heating or space and domestic hot water (DHW) (below: biomass system);	Grants	2021

	• with heat pump for domestic hot water (DHW) and space heating or for domestic hot water (DHW) and heating and cooling space (below: system with heat pump); • with solar thermal converters for domestic hot water (DHW) or for domestic hot water (DHW) and space (below: system with solar thermal converters); into existing energy categories (according to QH,nd) • A, B and C in continental Croatia • A and B in coastal Croatia An existing family house in the Call is defined as a building: - which is legal; - in which more than 50% of the gross floor area is intended for housing - which meets one of the two stated conditions: has a maximum of three residential units OR has a gross construction area less than or equal to 600 m2.		

In green: the schemes with no total budget available

Figure A- 8 Subsidies on residential heating systems per heating type, Croatia (Note: only subsidies with available data are displayed)



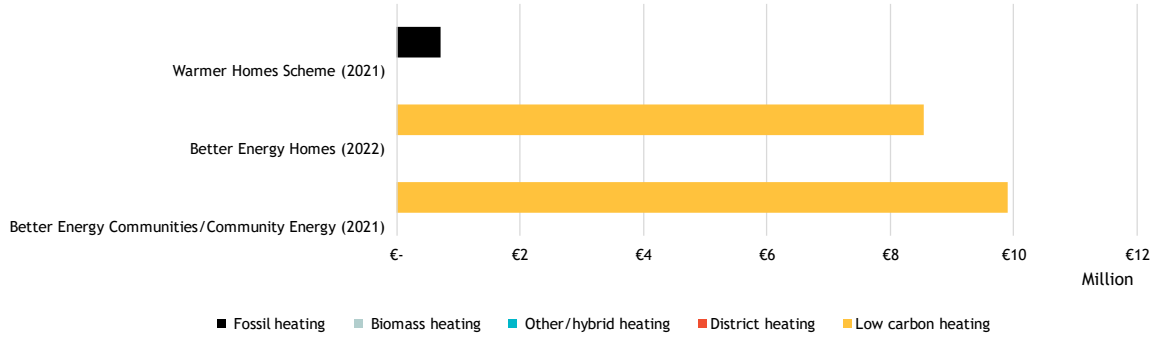
Ireland

Table A- 9 List of support schemes for residential heating installations, Ireland

Measure Title	Description	Subsidy instrument	Most recent year with available data
Better Energy Communities/Community Energy	This SEAI capital grant programme began in 2012 and brings together various organisations and sectors within communities under the same retrofit programme. The aim of the programme is to deliver energy savings so it is classified under CreMA 13B: Heat/Energy saving and management. Better Energy Communities is a national retrofit initiative. We support new approaches to achieving energy efficiency in Irish communities. Upgrades can take place across building types to reduce energy use and costs throughout the community. We aim to deliver energy savings to homeowners, communities, and private sector organisations. All projects should be community oriented	Grants	2021

	with a cross-sectoral approach, and you must show that you can sustainably finance the proposed project.		
Better Energy Homes	The SEAI Better Energy Homes Scheme was introduced in 2009 with the aim of encouraging home-owners to improve the energy efficiency of their homes by providing a capital grant to participants. The scheme operates nationally and is open to owners of dwellings built prior to 2006. It is classified under CreMA 13B: Heat/Energy saving and management.	Grants	2022
Warmer Homes Scheme	The Warmer Homes scheme began in 2001. This SEAI programme supports energy efficiency improvements to privately owned homes experiencing fuel poverty and is classified as a social transfer in kind under CreMA 13B: Heat/Energy saving and management. It was partially included for its environmental objectives through the application of a coefficient.	Grants	2021

Figure A- 9 Subsidies on residential heating systems per heating type, Ireland (Note: only subsidies with available data are displayed)



Italy

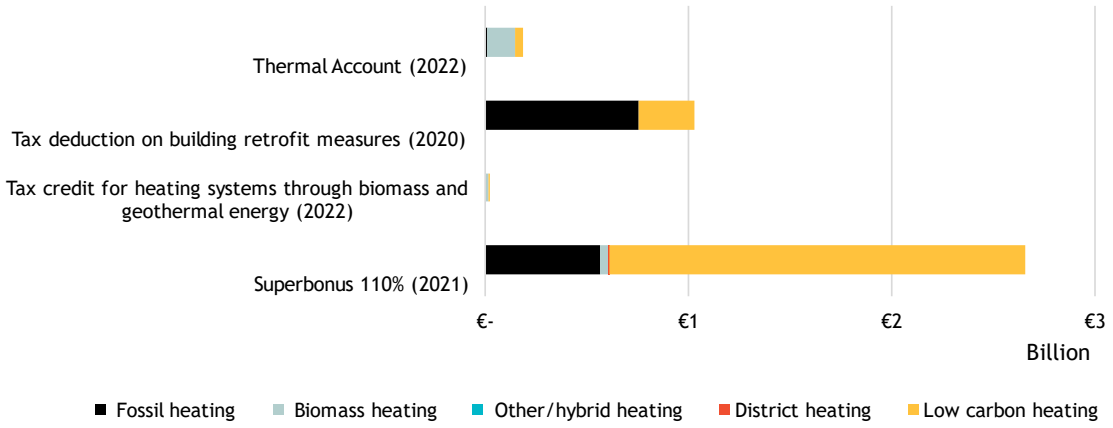
Table A- 10 List of support schemes for residential heating installations, Italy

Measure Title	Description	Subsidy instrument	Most recent year with available data
Tax deduction for the purchase of furniture and home appliances	Law 90/2013 on the energy performance of buildings. 50% IRPEF (income tax of physical persons) deduction for the purchase of furniture and domestic appliances.	Tax allowance	2022[42]
Tax deduction on building retrofit measures	This facilitation consists of a tax deduction, to the extent of 65% of the costs (since June 2013, it was 55% before) up to a limit of deduction, changing according to the kind of the interventions. These deductions concern IRPEF (income tax of physical persons) and IRES (corporate income tax) and are granted for interventions that increase the energy efficiency of existing buildings.	Tax allowance	2020
Tax credit for heating systems through biomass and geothermal energy	Law 448/1998: Tax credit for heating systems through biomass and geothermal energy	Tax credit	2022
Thermal Account	Ministerial Decree 28/12/2012 The Thermal Account incentives interventions for the increase of energy efficiency and the production of thermal	Grants	2022

[42] Not possible to disaggregate the budget of this programme for heating systems and therefore it is excluded from the calculations of the budget for Italy.

	energy from renewable sources for small plants.		
Superbonus 110%	Law Decree ('Decreto Rilancio') 34/2020 Tax relief consisting of a 110% deduction of the expenses incurred for the implementation of specific interventions aimed at energy efficiency and static consolidation or reduction of the seismic risk of buildings.	Tax allowance	2021

Figure A- 10 Subsidies on residential heating systems per heating type, Italy (Note: only subsidies with available data are displayed)



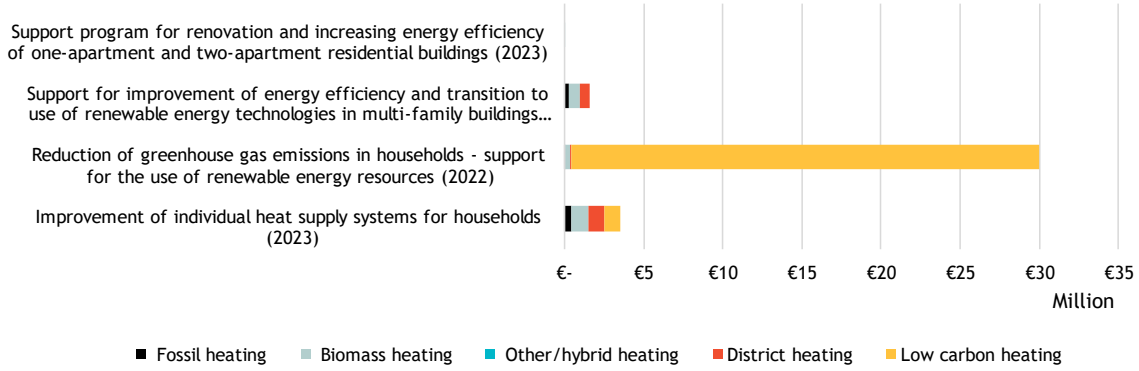
Latvia

Table A- 11 List of support schemes for residential heating installations, Latvia

Measure Title	Description	Subsidy instrument	Most recent year with available data
Support program for renovation and increasing energy efficiency of one-apartment and two-apartment residential buildings	To carry out energy efficiency improvement in up to 5000 single-family buildings, the subsidy and guarantee of loan programme is established. Subsidy upto 5000 EUR (construction works) and 1000 EUR (technical assistance).Guarantee upto 30% and upto 20 thousand EUR. At least 20%heat energy consumption decrease should be reached and building energy class after renovation shall correspond at least class "C".	Loan guarantee, Tecnical 39ncentiviz, Grant	2023
Reduction of greenhouse gas emissions in households – support for the use of renewable energy resources	The aim is to reduce greenhouse gas emissions and improve energy efficiency in households by supporting (1) the purchase of heat or electricity generation technologies; (2)the connections of household to the district heating networks.	Grant	2022
Support for improvement of energy efficiency and transition to use of renewable energy technologies in multi-family buildings	The aim is to support energy efficiency measures in multi-apartment residential buildings.	Loan, Quarantee, Capital rebate	2023
Improvement of individual heat supply systems for households	The aim is reduce the negative impact of air pollution on the environment and human health by replacing combustion boilers in residential buildings with low-emission technologies and increase of the efficiency of individual heat supply systems, including connecting to district heating networks.	Grant	2023
Open tender under Emission Allowances Auction Instrument "Reducing greenhouse	The object"ve of the tender is the reduction of carbon dioxide emissions by	Grants	n.a

gas emissions in the national protected architectural monuments of national importance"	rebuilding, restoring or renewing buildings which are nationally protected architectural monuments. Additional information in Latvian available here: https://www.varam.gov.lv/lv/emisijas-kvotu-izsolisanas-instrumenta-finansetais-atklatais-projektu-iesniegumu-konkurss-siltumnicefekta-gazu-emisiju-samazinasana-valsts-nozimes-aizsargajamos-arhitekturas-piemineklos		

Figure A- 11 Subsidies on residential heating systems per heating type, Latvia (Note: only subsidies with available data are displayed)



Poland

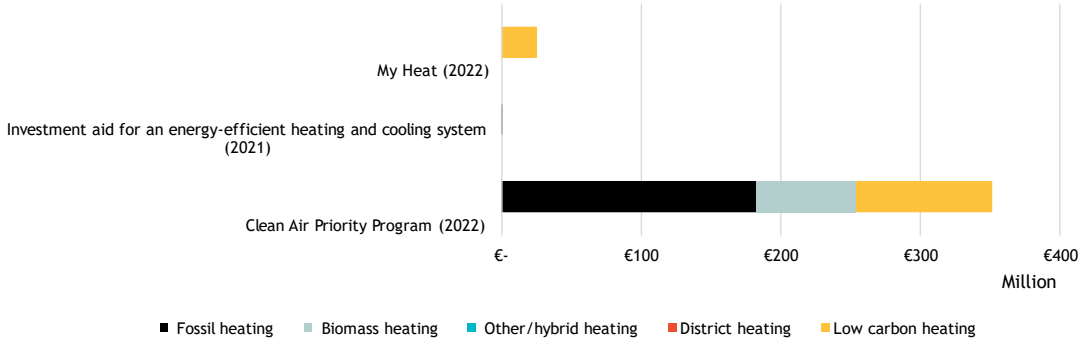
Table A- 12 List of support schemes for residential heating installations, Poland

Measure Title	Description	Subsidy instrument	Most recent year with available data
Clean Air Priority Program	The purpose of the programme is to improve air quality and reduce greenhouse gas emissions by replacing heat sources and improving the energy efficiency of single-family residential buildings. It is the main scheme for this type of buildings. There are three grant-levels: basic grant level (for natural persons who are owners or co-owners of single-family residential buildings, with an annual income not exceeding PLN 100.000), increased grant level (for natural persons who are owners or co-owners of single-family residential buildings, with an monthly income per one member not exceeding PLN 1,564 (multi-person household) or PLN 2,189 (single-person household), and highest grant level (for natural persons who are owners or co-owners of single-family residential buildings, with an monthly income per one member not exceeding PLN 900 (multi-person household) or PLN 1,260 (single-person household), or have an eligible right to receive an allowance. The programme co-finances the replacement of old and ineffective solid fuel heat sources with efficient ones and other interventions. The programme runs till 2027.	Grants	2022
Clean Air Priority Program Stop Smog	The programme finances the replacement or liquidation of heat sources and thermal modernisation in single-family residential buildings of energy poor people in heavily polluted areas. The programme is intended for energy poor people who own or co-own single-family residential buildings. Scope of the programme is the replacement or elimination of high-emission heat sources with low-emission ones; the thermomodernisation of single-family residential buildings; the connection to the heating or gas	Grants	n.a

	network. The support is through municipalities, municipalities apply to the programme. Source:https://www.coolproducts.eu/wp-content/uploads/2022/07/Coolproducts-gas-boiler-ban-2022-_11-July-22.pdf		
Investment aid for an energy-efficient heating and cooling system	Investment aid for an energy-efficient heating and cooling system under Infrastructure and Environment Operational Programme 2014-2020.	Grants	2021
Thermo-modernisation and Renovation Fund	The Fund's primary objective is to provide financial assistance to investors undertaking 41ncenti-modernisation and repair projects and to pay compensation to owners of residential buildings.	Grants	2020[43]
Polish Recovery and Resilience Plan	The RRP foresees 201 million EUR for replacing heating systems and energy efficiency in residential buildings. This money is not 41ncentivize linked yet to a specific program.	n.a	n.a
Polish Recovery and Resilience Plan	The Polish RRP includes grants for investments (B1.1.1) in heat sources in district heating. The investments are to be aimed at 41ncentivise the district heating and lowering its GHG emissions. They are also to support renewable uptake into the system.	n.a	n.a
My Heat	Co-financing of investments consisting in equipping and installing new heat pumps (air and ground) for heating in new single-family homes.	n.a.	2022

In green: the schemes with no total budget available

Figure A- 12 Subsidies on residential heating systems per heating type, Poland (Note: only subsidies with available data are displayed)



Romania

Table A- 13 List of support schemes for residential heating installations, Romania

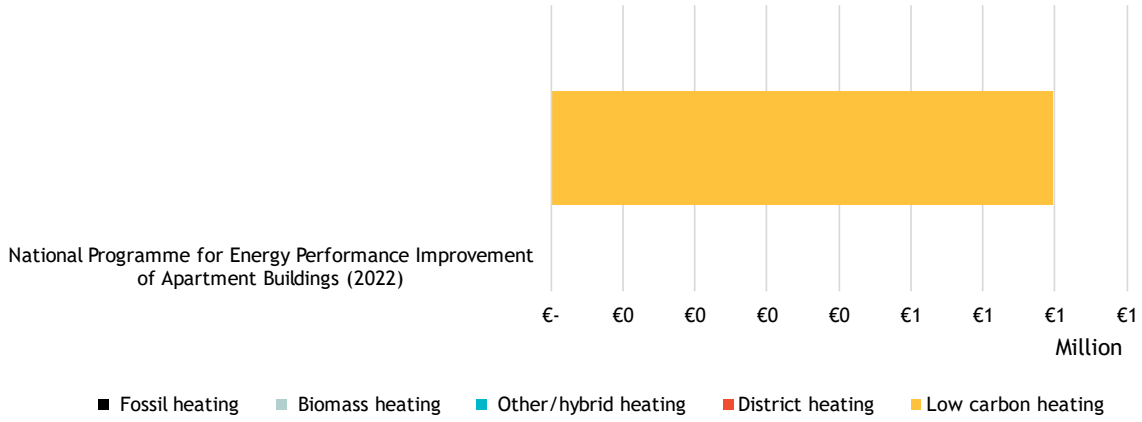
Measure Title	Description	Subsidy instrument	Most recent year with available data[44]
"Green House" Classic regards the installation of heating systems using renewable energy, including the replacement or complementing the classic heating systems. Beneficiaries are natural persons, though a similar	The Green House program was approved by AFM (Environmental Fund Administration) through Order no. 565/2009, as further 41ncenti and supplemented. The grants are awarded to individuals or administrative territorial units for replacing or supplementing the heating system with other systems based on solar, geo-thermal and wind	Grants	2022

[43] Not possible to disaggregate the budget of this programme for heating systems and therefore it is excluded from the calculations of the budget for Poland.
[44] The total budget for most of the programmes for Romania are available, however there were no information on what share of them goes to heating systems and a split per heating type. Therefore only one measure is included in the calculations of the costs.

program also exists for legal entities	energy or other systems that leeds to improvement of air, water and soil quality.		
Energy-efficient House	It is a programme for carrying out works to increase energy efficiency in single-family dwellings, beneficiaries are individuals.	Grants	2022
National Programme for Energy Performance Improvement of Apartment Buildings	The program was defined by GED nr.18/2009 & amendments and aims to finance (partially) the thermal rehabilitation of low energy performance blocks of flats built some 30-40 years ago. Basically the programme should finance from the state budget 50% of the costs, the rest left in charge of local authorities or other sources. The programme funds were not sufficient, and other contribution to cover up to now the works on cca 9,000 blocks (cca 10% of the blocks total), come from local authorities attracting Regional Operational funds and bank credits (e.g. EIB).	Grants	2022
One-time subsidies for district heating based on coal, heating oil and biomass	The subsidy was approved through Governmental Decision in November 2022 to provide financial aid to certain localities that have 42ncentiv heating fueled with coal, heating oil or biomass. The funds are 42ncentivi through the Ministry of Development which will reimburse up to 50% of the amount invoiced for the purchase of coal, fuel oil or biomass (including VAT) by the heat producer between October 2022 and March 2023, within the limit of the amounts allocated from the state budget for this purpose. The reimbursement is taking place through the administrative-territorial units that provide the heating fo the population, on a first-come-first-served basis.	n.a	2022
STATE AID SCHEME to support investments to promote the production and distribution of 42ncentivize heat energy from less exploited renewable sources, i.e. biomass, biogas, geothermal energy | Gov. Decision 1037/2020	The scheme is dedicated to district heating utilities with the aim of ensuring the supply with 42ncentivize termal energy for the population, helping to improve efficiency of the public utilities.	n.a	n.a
Recovery and Resilience Plan: Component 5 – Renovation Wave	I1.a – Axis 1 – Grant scheme for energy efficiency and resilience in multi-family residential buildings (90% of the budget for renergy efficiency and 10% for reinforcement against earthquakes)	n.a	n.a

In green: the schemes with no total budget available

Figure A- 13 Subsidies on residential heating systems per heating type, Romania (Note: only subsidies with available data are displayed)

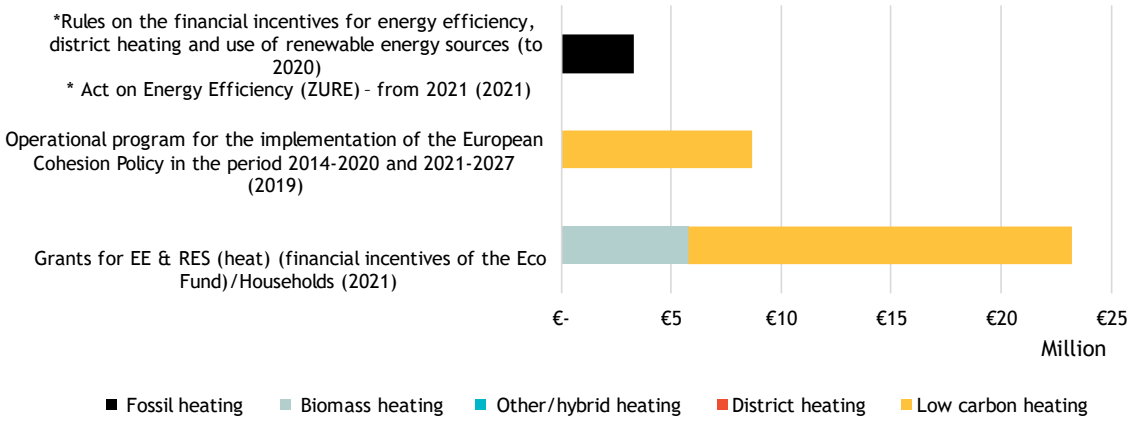


Slovenia

Table A- 14 List of support schemes for residential heating installations, Slovenia

Measure Title	Description	Subsidy instrument	Most recent year with available data
Grants for EE & RES (heat) (financial incentives of the Eco Fund)/Households	Eco Fund, Slovenian Environmental Public Fund is public institution responsible for the implementation of the programs related energy efficiency. Eco Fund is an independent legal entity, with the Ministry of the Environment and Spatial Planning. Eco Fund's main activities are to promote development in the field of environmental protection. The grant supports investments in thermal efficiency of buildings including insulation and heating installations. The Eco Fund is a public institution responsible for creation and implementation of programs for efficient use of energy and renewable energy sources at the national level. The Eco Fund shall provide financial incentives in accordance with the Energy Act and based on the energy efficiency measures and utilization of renewable energy specified in national action plans. One of the programs includes soft loans for environmental investment,in energy efficiency and renewable energy technologies. To fulfill its mission Eco Fund made use of the following loan or grant financing programmes: • Loans to legal entities (municipalities and/or providers of public utility services, enterprises and other legal entities) and soletraders for investments in environmental infrastructure, environmentally sound technologies and products, energy efficiency, energy saving investments, and use of renewable energy sources; • Loans to individuals (households) for conversion from fossil fuels to renewable energy sources, energy saving investments, investments in water consumption reduction, connections to sewage system, small waste water treatment plants, replacement of asbestos roofs; • Grants to individuals (households) for investments in electric cars and for investments in residential buildings (energy efficiency and use of renewable energy sources); • Grants to legal entities (municipalities and/or providers of public utility services, enterprises and other legal entities) for investments in electric cars and buses for public transport on compressed natural gas or biogas; • Grants to municipalities for investments in buildings where public education takes place (schools, kindergartens, libraries etc.), newly constructed as low energy and passive buildings or renovated in passive standard.	Grants	2021
Rules on the financial incentives for energy efficiency, district heating and use of renewable energy sources (to 2020) Act on Energy Efficiency (ZURE) - from 2021	Subsidy for replacing old heating devices with a gas condensing boiler (reduction of air pollution with PM10 particles)	Grants	2021
Operational program for the implementation of the European Cohesion Policy in the period 2014-2020 and 2021-2027	Financial support of district heating using renewable resources (wood biomass and solar energy) from European cohesion funds	Grants	2019

Figure A- 14 Subsidies on residential heating systems per heating type, Slovenia (Note: only subsidies with available data are displayed)



United Kingdom

Table A- 15 List of support schemes for residential heating installations, UK

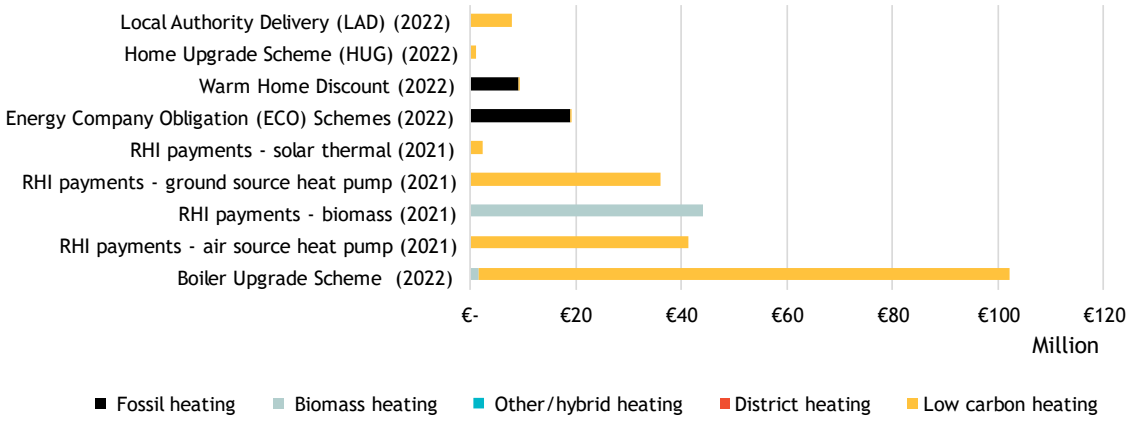
Measure Title	Description	Subsidy instrument	Most recent year with available data
Northern Ireland Sustainable Energy Programme (NISEP)	The Northern Ireland Sustainable Energy Programme (NISEP) is a voluntary 44ncentivised programme of energy efficiency/renewable energy schemes, funded by electricity consumers through the electricity system in the form of a Public Service Obligation. The NISEP was introduced in 2010/11 (when it replaced the Energy Efficiency Levy). The NISEP works by way of a small sum of money being collected from electricity customers through a Public Service Obligation element of use of system charges and is used to provide funding for energy efficiency schemes. A competition to bid for funds to run energy efficiency schemes is carried out on an annual basis. Applications for funding can be made to the Utility Regulator by any organisation that is either licensed by the Utility Regulator or has registered as a Primary Bidder with the NISEP. Applicants to become a Primary Bidder have to meet certain qualifying criteria.	Grants	2023[45]
Domestic Renewable Heat Incentive (RHI) payments – biomass	The Renewable Heat Incentive (RHI) is similar to the Feed-in Tariffs, a comparable scheme for electricity. The scheme targeted at supporting RES-H installations with a fixed amount per kWth produced. The level of payment varies depending on the technology and the system size.	Feed-in tariffs	2021
Domestic Renewable Heat Incentive (RHI) payments – air source heat pump	The Renewable Heat Incentive (RHI) is similar to the Feed-in Tariffs, a comparable scheme for electricity. The scheme targeted at supporting RES-H installations with a fixed amount per kWth produced. The level of payment	Feed-in tariffs	2021

[45] Not possible to disaggregate the budget of this programme for heating systems and therefore it is excluded from the calculations of the budget for the UK.

	varies depending on the technology and the system size.		
Domestic Renewable Heat Incentive (RHI) payments – ground source heat pump	The Renewable Heat Incentive (RHI) is similar to the Feed-in Tariffs, a comparable scheme for electricity. The scheme targeted at supporting RES-H installations with a fixed amount per kWth produced. The level of payment varies depending on the technology and the system size.	Feed-in tariffs	2021
Domestic Renewable Heat Incentive (RHI) payments – solar thermal	The Renewable Heat Incentive (RHI) is similar to the Feed-in Tariffs, a comparable scheme for electricity. The scheme targeted at supporting RES-H installations with a fixed amount per kWth produced. The level of payment varies depending on the technology and the system size.	Feed-in tariffs	2021
Energy Company Obligation (ECO) Schemes	The energy companies obligation provides support for the installation of energy efficiency measures to reduce energy consumption in the UK and to help people living in fuel poverty and in properties that are hard to treat. The ECO is funded by the energy suppliers. It is intended to run alongside the green deal and can be provided directly to customers, or through pre-approved arrangements, such as green deal providers.	Energy efficiency obligations	2022
The boiler replacement scheme	The scheme is open to owner occupiers whose household income is less than £40,000 and who have an inefficient boiler of at least 15 years old. You will only be eligible to replace your existing gas boiler if the gas connection to your property was made at least 15 years ago. The allowance does not apply to Economy 7 heating, stoves used only for cooking, back boilers or room heaters.	Grants	n.a
Warm Home Discount	The Warm Home Discount (WHD) scheme has three different elements: the Core Group, Broader Group and Industry Initiatives. BEIS coordinates the Core Group, while we administer the Broader Group and Industry Initiatives. Under the scheme, medium and larger energy suppliers support people who are living in fuel poverty or a fuel poverty risk group. Some smaller suppliers also voluntarily participate in part of the scheme. The Department for Business, Energy and Industrial Strategy (BEIS) is responsible for WHD policy and legislation. Ofgem's role is to administer certain elements of the scheme.	Grants	2022
Boiler Upgrade Scheme	The Boiler Upgrade Scheme (BUS) supports the decarbonisation of heat in buildings. It provides upfront capital grants to support the installation of heat pumps and biomass boilers in homes and non-domestic buildings in England and Wales.	Grants	2022
Home Upgrade Scheme (HUG)	Grants distributed by local governments. Grant targeted at rual poor households which are an off-gas-grid home with EPC rating D-G.	Grants	2022
Local Authority Delivery (LAD)	Grade A measures must represent at least 60% of total measures costs across a project.	Grants	2022

In green: the schemes with no total budget available

Figure A- 15 Subsidies on residential heating systems per heating type, UK (Note: only subsidies with available data are displayed)



Annex B: Heating system analysis

The main assumptions used in the analysis of heating systems.
All prices are in EUR2021 constant values.

Energy prices and emission factor

Average end-user household energy prices for the period 2022-2037 are used for the relevant countries. This aims to reflect the average energy price over the lifetime of the heating system (~15-20 year) if a system is installed now. Though energy prices are very hard to predict - especially due to the current energy crisis - for the 4 energy carriers the following sources and assumptions are used (see **Error! R eference source not found.**):

- **Electricity:** The market price in 2021 is used as a base (EU27 average: 84 EUR/MWh) and forecasts of Cambridge Econometrics of the RepowerEU package are used to assess the average change between 2022-2037. This leads to the assumption that the average market price will be 10% higher than 2021 levels on average (93 EUR/MWh for EU27, with differences between countries). 2021 levels per country for network costs, taxes and VAT are used, and are assumed to stay fixed over the period (source: Eurostat (2022). Electricity prices by type of user).
- **Natural gas:** Market price for natural gas from the RepowerEU Staff Working Document of the Commission is used (EC(2022). SWD RepowerEU plan) of 40 EUR/MWh. It is assumed the natural gas market price is uniform among countries, which is a simplification. The 2021 rate per country for network tariffs, taxes and VAT are assumed to stay fixed until 2037 (source: Eurostat (2022). Gas prices by type of user; medium-size household).
- **Coal:** Since coal for households is mostly used in Poland, the average coal price in Poland from 2021 is used as a base (208 EUR/tonne; 26 EUR/MWh) and it is assumed the 2022-2037 average will be 30% higher (270 EUR/tonne; 33 EUR/MWh). Coal for domestic use is not taxed is Poland.
- **Heating oil:** The crude oil price forecast of the RepowerEU SWD is used (57 EUR/MWh; EC(2022). SWD RepowerEU plan). A constant 'premium' of 15 EUR/MWh on top of the crude oil price is used for refinery and other costs in the supply chain is used. Per country the excise duty and VAT rates are taken from Trinomics & Enerdata Prices and Costs study (tbp).
- **Emission factor:** Emission factors were used from IPCC (RVO/IPCC (2022). List of fuels and emission factors). Refrigerant emissions from heat pumps are taken into account but discussed in the section on heating systems. For electricity the average emission intensity in 2021 was used (EEA (2022). Greenhouse gas emission intensity of electricity generation in Europe).

Table B- 1 Energy prices and emission factors used in this analysis. All prices are household prices, incl all network costs, taxes and VAT in EUR2021/MWh

	Coal	Oil	Electricity		Natural gas
Emission factor (kg CO2eq/MWh)	342	267	n/a		204
Country	Price	Price	Price	Emission Factor (kg CO2 /MWh)	Price
Belgium	33	90	295	154	68
Bulgaria	33	123	113	463	63

Croatia	33	96	137	138	59
Estonia	33	93	172	757	63
France	33	104	206	67	86
Germany	33	93	331	402	77
Greece	33	122	196	604	66
Ireland	33	98	301	363	77
Italy	33	133	243	247	90
Latvia	33	93	172	155	63
Poland	33	95	161	750	62
Romania	33	123	165	323	56
Slovenia	33	114	177	222	74
Spain	33	98	297	232	92
UK	33	87	226	254	74

Heating demand

For every country an average household heating profile is constructed for an average dwelling size:

- Average space heating consumption per m2 per country in 2019 used (source: Odyssee-Mure (2021). Heating consumption per m2). This consumption is adjusted for the average heating system efficiency in a country. This means that countries with a high percentage of high-efficiency heating(i.e. heat pumps) have a higher heating demand than its consumption, due to the high efficiency of heat pumps. Source for end-use per energy source: Eurostat (2022). Disaggregated final energy consumption in households.
- Average water heating demand assumed to be constant in the EU per person (source: Odyssee-Mure (2021). Energy consumption by end-use). Average of 2105 kWh per dwelling converted to 915 kWh/per person/annually using the average EU household size of 2.3 persons (Eurostat (2022). Size of housing).
- The above heating demand indicators are used to calculate the average heating demand of an average 110 m2, 4-person household, similar to the average household in the Coolproducts study (Coolproducts (2021). Analysis of the affordability of switching to renewable heating).

Below table shows the resulting heating demand indicators per country:

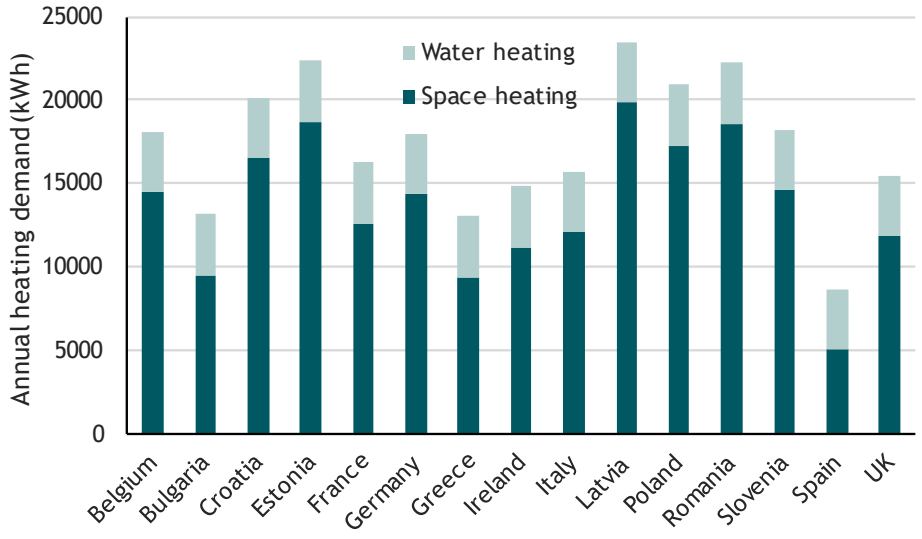
Table B- 2 Average annual heating demand per country and most used current fossil heating system, as well as most optimal low-carbon heating system per country

	Heating demand				Heating system	
Country	Space heating consumption	Heating system efficiency correction factor	Water heating demand	Total heating demand	Reference (old)	New (low-carbon)
Unit	*kWh/year*		*kWh/year*	kWh/year		
Belgium	14456	0.95	3661	17397	HE Gas	ASHP
Bulgaria	9518	1.05	3661	13669	HE Gas	ASHP
Croatia	16503	0.93	3661	19011	HE Gas	ASHP
Estonia	18678	0.99	3661	22162	HE Gas	ASHP
France	12601	1.10	3661	17569	HE Gas	ASHP
Germany	14328	0.93	3661	16944	HE Gas	ASHP
Greece*	9352	0.95	3661	12541	Oil	Air-Air
Ireland	11155	0.96	3661	14374	Oil	ASHP

Italy	12077	0.91	3661	14612	HE Gas	ASHP
Latvia	19829	0.91	3661	21744	HE Gas	ASHP
Poland	17271	0.92	3661	19471	Coal	ASHP
Romania	18550	0.90	3661	20415	HE Gas	ASHP
Slovenia	14584	1.00	3661	18282	Oil	ASHP
Spain*	5015	1.02	3661	8767	HE Gas	Air-Air
UK	11808	1.00	3661	15415	HE Gas	ASHP

HE gas = High-efficiency boiler, oil = oil boiler, coal = coal boiler, ASHP = Air-to-source heat pump, Air-Air = air-to-air heat pump.
*Countries with solar thermal use for water heating.

Figure B- 1 Average annual heating demand in countries in scope for a standardised 110 m2, 4 person household



Heating system characteristics

Heating system characteristics were included of several heating technologies. Most important values can be seen in below table. Other assumptions used were:

- Since heating systems have different lifetimes, total investment costs were adjusted to reflect a similar lifetime. For the system efficiency the Seasonal Coefficient of Performance (SCOP) in Gross Calorific Value is used that takes into account (slightly) reduced efficiency in cold ambient temperatures.
- Financing costs are assumed to be 0.
- The solar thermal installation (used in Spain and Greece) delivers 78% of water heating demand (2855 kWh/annual). Other parameters can be found in **Error! Reference source not found.**.
- Refrigerant emissions of heat pumps are 35 kg CO2eq/MWh, based on Damgaard et al (2022; Direct greenhouse gas emissions from low and zero carbon heating systems). Most current heat pumps have higher refrigerant emissions, but this number reflects the possible emissions for modern heat pumps, using low-GWP refrigerants and with good leakage prevention in place.

Table B- 3 Overview of data on heating systems

Heating system	Energy source	SCOP	Lifetime	CAPEX	OPEX
	Unit	%	Years	EUR2021	EUR2021/y

ASHP	Electricity	360%	18	10000	190
GSHP		420%	18	15000	210
Air-Air		420%	12	3500	175
Standard Gas	Natural gas	80%	17	1701	191
HE Gas		95%	17	2430	191
Coal	Coal	75%	15	3500	296
Oil	Oil	86%	17	4000	210
Solar thermal	n/a	n/a	25	5000	47
	Source	Coolproducts (2021). Analysis of the affordability of switching to renewable heating	IEA (2022). The future of heat pumps	In line with Coolproducts study and complemented with IEA (2022). Residential Heat Economics Calculator	IEA (2022). Residential heat economics calculator and VHK (2019). Space heaters: environment and economics.

HE gas = High-efficiency boiler, oil = oil boiler, coal = coal boiler, ASHP = Air-to-source heat pump, Air-Air = air-to-air heat pump.

Additional tables

			Annual heating costs (in EUR)			
Country (for graph)	Type	Reference technology	Investment cost	Operational costs (incl. fuel)	Solar thermal	Total
Belgium	Ref	High Efficiency boiler	143	1437	-	1580
	New	Air-to-source heat pump	556	1615	-	2171
Bulgaria	Ref	High Efficiency boiler	143	1090	-	1233
	New	Air-to-source heat pump	556	658	-	1214
Croatia	Ref	High Efficiency boiler	143	1366	-	1509
	New	Air-to-source heat pump	556	980	-	1536
Estonia	Ref	High Efficiency boiler	143	1665	-	1808
	New	Air-to-source heat pump	556	1347	-	1902
France	Ref	High Efficiency boiler	143	1788	-	1931
	New	Air-to-source heat pump	556	1198	-	1753
Germany	Ref	High Efficiency boiler	143	1572	-	1715
	New	Air-to-source heat pump	556	1748	-	2303
Greece	Ref	Oil boiler	235	1586	247	2069
	New	Air-to-air heat pump	292	626	247	1165
Ireland	Ref	Oil boiler	235	1846	-	2081
	New	Air-to-source heat pump	556	1392	-	1947
Italy	Ref	High Efficiency boiler	143	1569	-	1712
	New	Air-to-source heat pump	556	1177	-	1732
Latvia	Ref	High Efficiency boiler	143	1628	-	1771
	New	Air-to-source heat pump	556	1321	-	1876
Poland	Ref	Coal boiler	233	1158	-	1392
	New	Air-to-source heat pump	556	1138	-	1693
Romania	Ref	High Efficiency boiler	143	1402	-	1545
	New	Air-to-source heat pump	556	1209	-	1764
Slovenia	Ref	Oil boiler	235	2638	-	2873
	New	Air-to-source heat pump	556	1169	-	1724

Spain	Ref	High Efficiency boiler	143	762	247	1153
	New	Air-to-air heat pump	292	593	247	1132
UK	Ref	High Efficiency boiler	143	1398	-	1541
	New	Air-to-source heat pump	556	1157	-	1712

Ref = reference 'business as usual' system type ; new = new low-carbon heating system type.

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