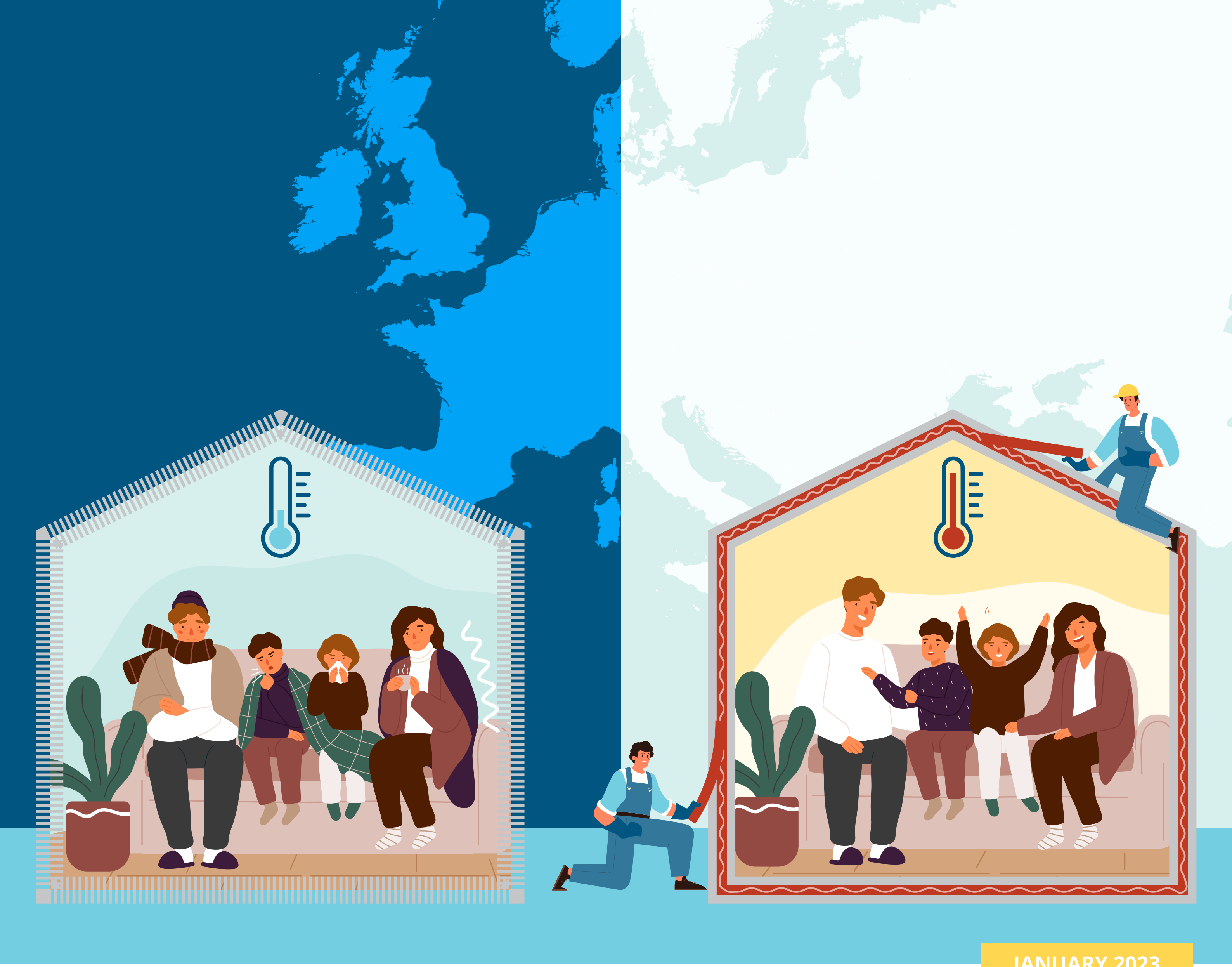

JANUARY 2023

HOW TO STAY WARM AND SAVE ENERGY

INSULATION OPPORTUNITIES IN EUROPEAN HOMES

BPIE

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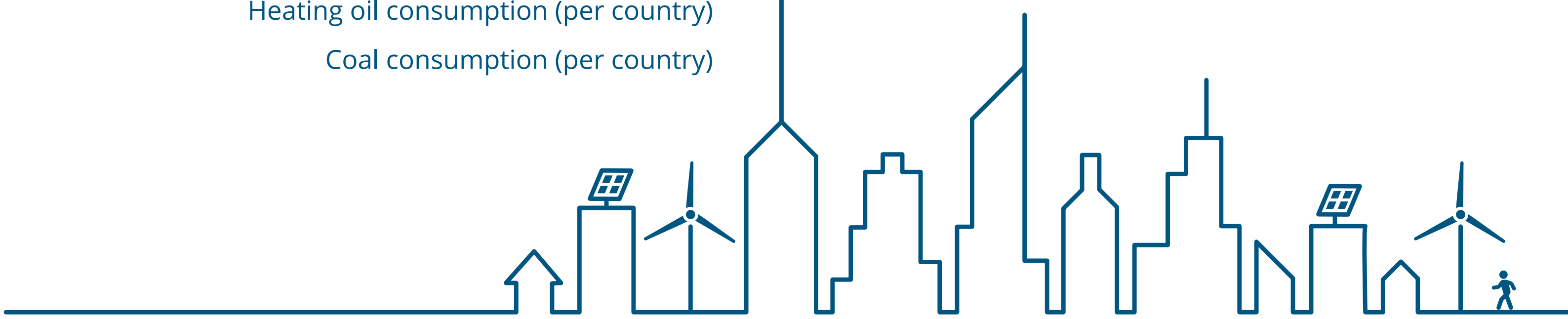

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INTRODUCTION

Since Russia's aggression against Ukraine in early 2022, the question of the EU's energy security and dependency from fuels import has been on the front of political and social debates. Paired with sky-rocketing energy prices and inflation, no one is immune to the economic and social changes made evident by this crisis.

As a result, the EU debate shifted towards secure and affordable energy supply, sometimes even at the cost of reduced or slowed down climate action. A prosperous EU will require reduced use of fossil fuels and a diversified energy supply where increased renewable energy supply is matched by reduced demand.

THERE ARE THREE OPTIONS TO IMPROVE EU ENERGY PROSPECTS:

1. **Reduce energy demand by stopping energy waste and improving efficiency in all sectors**

2. **Replace fossil fuels with renewable energy sources as quickly as possible**

3. **Diversify fossil fuel supply by increasing imports from countries other than Russia and countries run by undemocratic or unstable governments.**

When considering different alternatives, it is important to set a clear list of priorities since these may have long-term effects on the planned outcomes. Although diversified energy supply may be a (relatively) fast solution, reduced energy demand should be prioritised for at least two reasons: it contributes to securing energy independence and supports EU climate targets of reducing overall GHG emissions by 55% by 2030 and achieving climate neutrality by 2050.

The challenge is two-fold: reduce the EU's dependence on fossil fuels in the short-term, and boost renovation activities to deliver the Renovation Wave and deliver a 60% reduction of GHG emissions in the buildings sector by 2030.

As part of the EU's vital infrastructure, and one of the sectors vulnerable to gas supply disruptions, buildings are a critical part of the solution. Reducing energy demand in residential buildings should be one of the priorities when planning for improvements in EU energy security: energy consumption in EU household is 21% of EU energy imports and space heating in residential buildings requires 17.3% of final energy consumed in EU[1].

The purpose of this report is to show how improving energy performance of residential building envelopes in the EU contributes to EU energy security by reducing oil and gas imports for residential heating, and climate targets.

THIS IS ACHIEVED BY FOCUSING ON THREE MAIN ASPECTS:

1. **Assess potential reduction in final energy consumption for space heating in the EU27**
2. **Estimate the reduction in demand for different energy carriers with focus on fossil fuels, and**
3. **Project savings over time considering current and future EU renovation rates.**

The purpose of this report is to show how improving energy performance of residential building envelopes in the EU contributes to EU energy security by reducing oil and gas imports for residential heating, and climate targets.

[1] EU 27 Energy balance, Eurostat

METHODOLOGY

The analysis is based on the datasets produced by BPIE for the AmBIENCe project[2] merging data from Hotmaps and Tabula[3]. These datasets contain the most important characteristics of the EU reference buildings and the EU building stock. At a country level, for different building uses and construction periods, the AmBIENCe dataset describes a) reference buildings, including their size, geometry, materials used, and thermal characteristics of their envelopes, and b) building stock size, containing, for instance, the floor area and energy consumption.

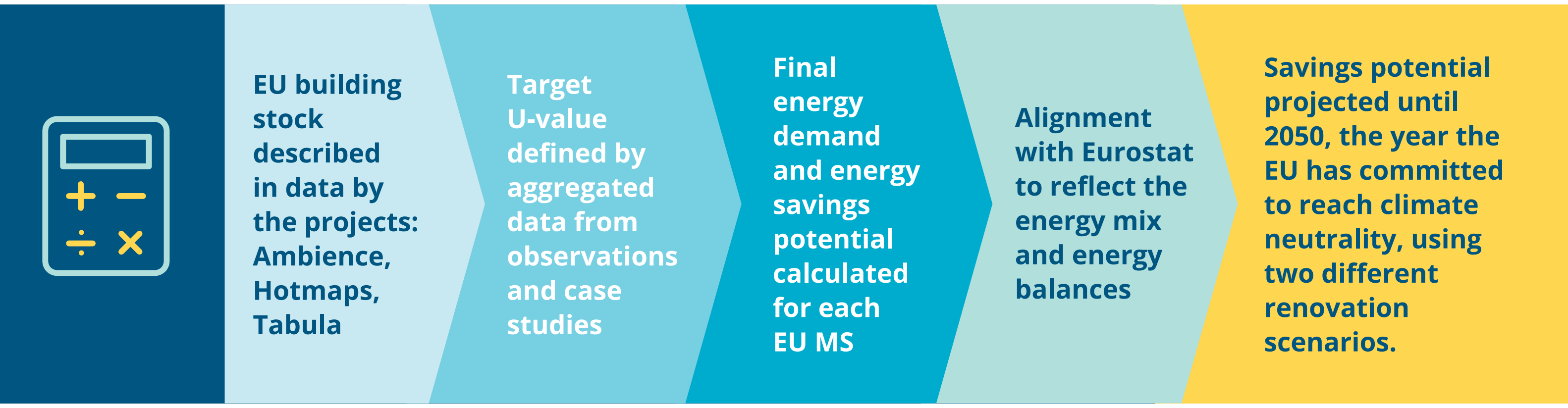
The study has two main components:

1. **Estimation of energy and fossil fuel savings through better insulation[4] of residential buildings in 27 Member States (MS), resulting in potential energy savings of 777 TWh (see Figure 3), and**

2. **Projection of energy savings in EU residential buildings considering 0.1% annual demolition rate until 2050, resulting in 750 TWh savings (see Figure 13).**

A brief overview of the calculation approach is presented in Figure 1, while the full approach is described in the following sections.

Figure 1: Calculation approach in 5 steps



2 https://ambience-project.eu/wp-content/uploads/2022/03/AmBIENCe_Deliverable-4.1_Database-of-greybox-model-parameter-values.xlsx

3 www.ambience-project.eu, www.hotmaps-project.eu, Tabula

4 In this study, better insulation is considered through reduced U-values of walls and roofs.

CALCULATION OF THE ENERGY SAVINGS POTENTIAL

The calculation of the energy savings potential assumes that current building envelopes of EU residential buildings are renovated to a pre-defined level of building envelope quality. For the purpose of this project, improving building envelope quality considers the improvement of the U-values (W/m²/K) of walls and roofs only[5]. The energy savings potential is expressed as the reduction of final energy consumption.

As the basis for this target (goal U-value), we considered a review of implemented and proposed building code requirements[6] supported by scientific case studies[1].

Table 1 lists the target post-renovation U-values. A different value for Italy reflects its architectural characteristics, with a high share of old and historical buildings and small, narrow urban structures that are more difficult to insulate.

Table 1: Target values (goal U-values) applied in each country

Building component	U-values currently present in the building stock W/(m²K)	Target U-value in W/(m²K)	Exception: Italy Target U-value in W/(m²K)
Pitched roof	1.1 average	0.15	0.26
Flat roof			
Solid wall	1.04 average	0.20	0.30
Cavity wall			

Post-renovation heating needs were calculated using target U-values. Current and post-renovation energy needs are then converted into the final energy consumption by using efficiency rates of the buildings' heating systems[7]. Finally, the energy savings potential is calculated as the difference in final energy consumption before and after the renovation.

The current final energy consumption is aligned to Eurostat[8] values to reflect energy mix and energy consumption for space heating reported by each country. This step was introduced to enable the comparison of the projection results with existing EU scenarios such as the impact assessment for the Fit for 55 package and the EU Green Deal.

For this analysis it is additionally assumed that the total improvements of the building envelope achieve a minimum final energy savings of 20%. In other words, well insulated existing buildings where energy savings would be lower than 20% are not considered. This threshold was defined to exclude renovation of already highly efficient buildings.

The savings are shown by energy carrier on the level of final energy consumption. This means that gas savings include only the gas savings occurring when gas is burned for space heating directly in the building.[9]

[5] Changing U-values of ground floors and windows, as well as improving other building envelope characteristics, such as airtightness, are not considered.
[6] [3], [4], [5], [6]
[7] The same heating system efficiency rates are used for calculating current and post-renovation energy needs.
[8] https://ec.europa.eu/eurostat/databrowser/view/NRG_D_HHQ__custom_3573874/d efault/table
[9] The energy carriers were analysed at the level of final energy delivered to households. Consequently, gas saved due to less district heat or electricity needed for space heating is not included in the gas savings presented.

PROJECTIONS OF POTENTIAL ENERGY SAVINGS TO 2050

The potential energy savings were projected to 2050 following two scenarios for the renovation of the entire building stock to a pre-defined level.

This was done through two main steps:

1. Projecting the building stock development until 2050, and

2. Assessing annual energy savings based on the results of step 1.

The starting point for projecting potential energy savings is to understand how the existing EU building stock would change until 2050. For this purpose, only existing buildings are considered, and no projections are made about new constructions between 2022 and 2050.

The rate of demolition is assumed to stay constant throughout the 2022-2050 period and at the rate researched for EUCalc[10] of 0.1%. per year[11].

Two renovation scenarios were used for projecting energy savings by 2050; they are explained below and summarised in Table 2.

Table 2: Renovation scenarios

Scenarios	Current renovation rate	Renovation rate in 2030	Renovation rates between 2031-2050
Full Renovation	1%	2%	Reaching 100% of renovated building stock by 2050[12]
2% Renovation Rate			2%

The starting point for defining renovation scenarios is the current renovation rate, commonly assumed to be at the level of 0.9 – 1.0%[13]. It is further foreseen that the renovation rate in both scenarios will linearly grow until doubled in 2030, which would fulfil the EU renovation targets set in the EU Renovation Wave[14].

The difference between the two scenarios is visible in the renovation rates assumed for after 2030.

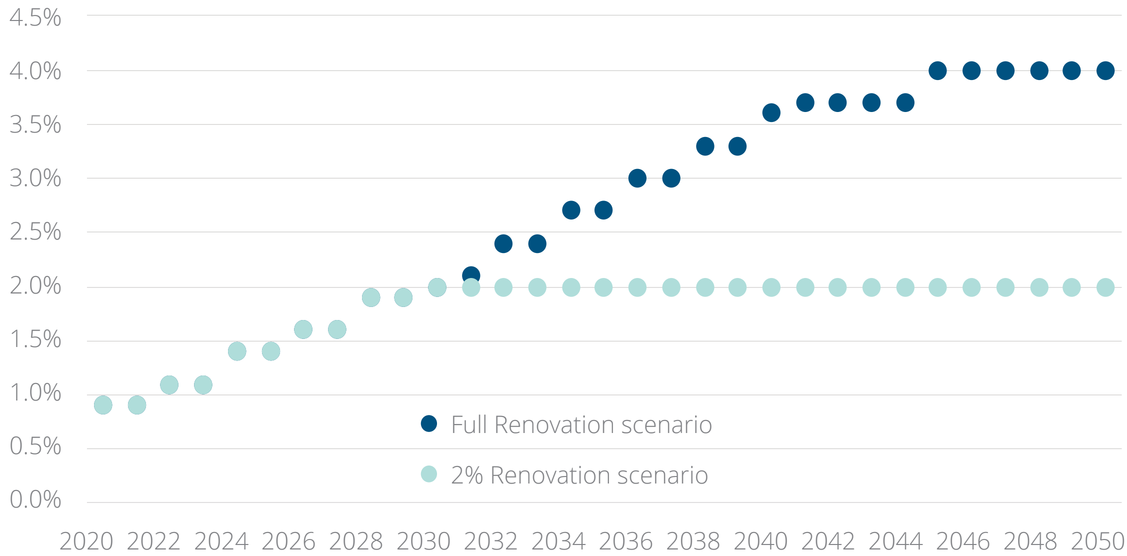
To reflect on the existing EU targets, the **Full Renovation scenario** assumes that after 2030 the renovation rate will continue to grow at the speed needed to renovate all existing residential buildings before 2050 (resulting in rates going up to 4% in 2045).

The **2% Renovation scenario** covers the possibility that after 2030 the renovation rate will stabilise at 2% and assumes a constant renovation rate from 2030 onwards. We assume that renovation includes only building insulation improvements and that no building is renovated twice.

Both renovation scenarios are presented in Figure 2. The same annual renovation and demolition rate were assumed for all countries.

[10] http://www.european-calculator.eu/wp-content/uploads/2020/04/EUCalc_D2.8_Pathways-explorer-buildings.pdf
[11] As noted by [7, p. 9]
[12] Resulting in up to 4% of renovation per year, as explained in the following sections.
[13] As noted by [8, p. 58], [9, p. 103], [10, p. 62], [2, p. 16]
[14] A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives (European Commission, 2020)

Figure 2: Renovation rate assumptions



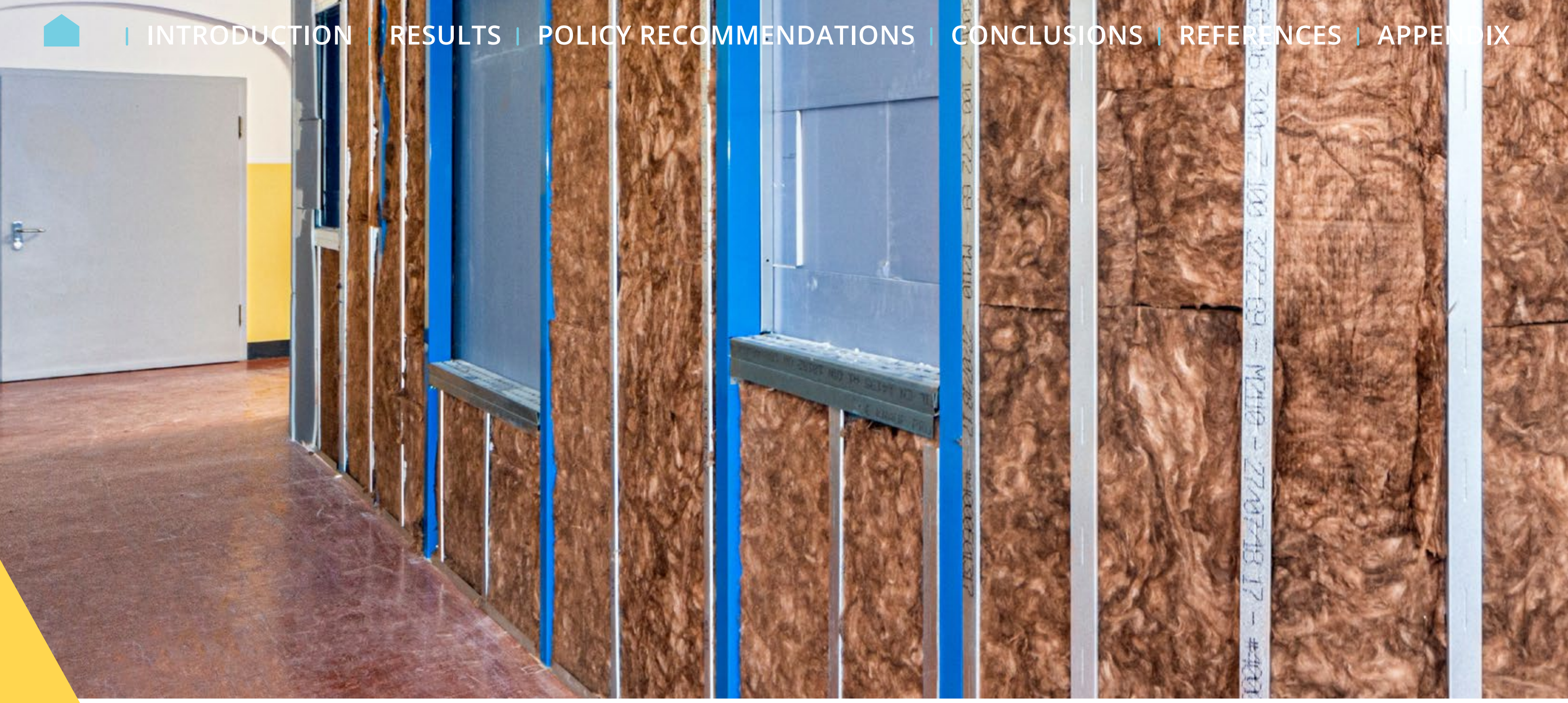
DIFFERENCES BETWEEN PHASE 1 AND PHASE 2 REPORT METHODOLOGY

The energy savings potential assessment was already performed for eight EU countries in a previous publication[15] and the calculation was entirely based on Ambience and Hotmaps datasets, which contained all data necessary for the analysis, including building stock U-values, energy consumption, and fuel mix. By expanding the analysis to all EU 27 and adding projections to 2050 some adjustments in data sources were necessary while the energy savings calculations remained the same.

Eurostat was adopted as an additional data source to address two main issues. Firstly, the expansion to 27 EU Member States included some new countries with residential fuel mix that were not detailed in Ambience/Hotmaps datasets while Eurostat provides enough information to cover this extremely important aspect[16]. Secondly, the annual projections of potential energy savings by 2050 required the alignment of the current final energy consumption and fuel mix with Eurostat[17] values to enable the comparison of the results with the existing EU scenarios, such as the impact assessment for the Fit for 55 package and the EU Green Deal.

As a result, while some data may differ, the relative final energy and gas savings remain unchanged.

[15] https://www.bpie.eu/publication/putting-a-stop-to-energy-waste-how-building-insulation-and-reduce-fossil-fuel-imports-and-boost-eu-energy-security-2/
[16] For all 27 EU countries Eurostat provides info on final energy consumption for space heating and cooling, domestic hot water, appliances, cooking and lighting, per energy carrier and fuel type.
[17] https://ec.europa.eu/eurostat/databrowser/view/NRG_D_HHQ__custom_3573874/default/table



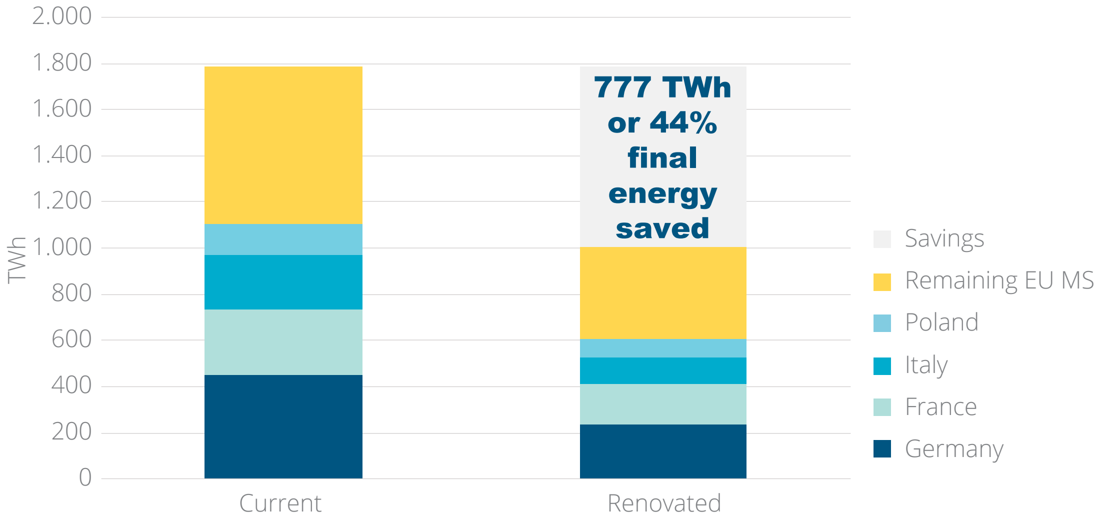
RESULTS

ENERGY SAVINGS POTENTIAL

If all existing residential buildings in the EU were renovated to achieve the goal U-values, 777 TWh, or 44% of final energy used for space heating could be saved.

The countries with the largest absolute final energy consumption and savings in residential space heating are Germany (453 TWh, -214 TWh), France (283 TWh, -113 TWh), Italy (233 TWh, -115 TWh) and Poland (135 TWh, -52 TWh).

Figure 3: Final energy consumption for residential space heating in current and renovated buildings (in TWh) and final energy saved in EU 27



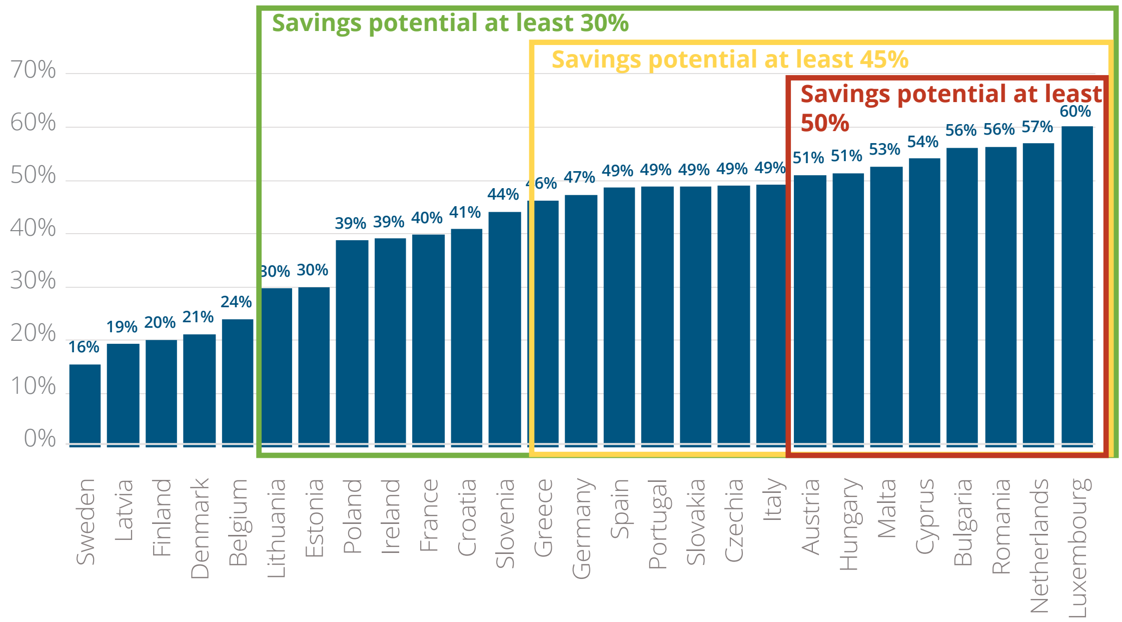
Each country would witness a substantial decrease in its final energy consumption, as shown in Figure 4. The highest relative savings would be achieved in Luxembourg (60%), the Netherlands (57%), Romania (56%) and Bulgaria (56%). One third of EU countries would achieve a reduction in final energy consumption of at least 50% (green frame) and more than half of the countries could save at least 45% of final energy for space heating in residential buildings (yellow frame).

The achievable relative energy savings depend on various factors related to the current building stock, like final energy demand per square meter, the construction period, the climate, and the composition and architecture of the building.

For example, higher relative savings in the Netherlands compared to Poland originate from a higher final energy demand per square meter. The energy-need per square meter in Poland is lower than in the Netherlands because the building stock is younger (35% was built after 2000 with u-values of about 0.2 W/ m²K) and the composition of the stock is different.

In Poland only 56% of the buildings are single-family homes versus 85% in the Netherlands, where 44% of the building stock was built before 1970 when construction material was scarce, and u-values were higher.

Figure 4: Final energy savings potential for residential heating in EU Member States[18]



[18] Please note that in case of small Member States like Cyprus these saving potentials cannot be exactly calculated with the rounded values in Table 3.

If all residential buildings in the EU were renovated today, 44% of final energy consumption for space heating could be saved.

Table 3 provides the saving potential by energy carrier at the level of final energy consumption[19] showing that 60% of the savings result in a decrease of the final consumption of fossil fuels: about 40% of potential savings in final energy is today provided by gas, 16% by oil, and 5% by coal. Renewable energy sources cover 27% of potential savings.

Table 3: Potential savings in final energy for space heating by energy carrier (in TWh)

Country	Final energy consump-tion[20] 2020 (TWh)	Potential savings in final energy for residential space heating (TWh)						
		Coal	Natural gas	Oil	Renewables and biofuels	Electricity	Heat	Total potential savings
Germany	452.6	1.7	93.8	60.0	36.0	3.5	19.2	**214.3**
France	283.1	0.1	34.8	18.3	38.4	16.1	4.9	**112.6**
Italy	233.3	-	68.8	7.9	33.2	0.5	4.4	**114.8**
Poland	135.3	26.6	7.7	0.4	11.0	0.3	6.4	**52.4**
Spain	68.3	0.2	9.1	10.4	10.9	2.6	-	**33.2**
Belgium	67.0	0.1	7.1	6.7	1.7	0.5	-	**16.1**
Netherlands	65.9	-	31.5	0.2	3.5	1.1	1.2	**37.5**
Romania	57.8	0.2	10.4	-	17.2	0.1	4.7	**32.5**
Czechia	57.5	4.0	7.5	0.2	11.8	1.3	3.4	**28.2**
Austria	54.3	0.1	7.4	5.0	9.8	1.3	4.0	**27.8**
Sweden	46.5	-	-	0.3	1.4	2.1	3.4	**7.2**
Finland	39.1	-	-	0.4	3.2	2.0	2.3	**7.9**
Hungary	34.8	0.3	15.1	-	-	0.4	2.1	**17.9**
Denmark	29.3	-	1.1	0.2	2.4	0.2	2.3	**6.2**
Greece	28.3	-	2.2	6.1	3.8	0.7	0.3	**13.1**
Slovakia	23.3	0.2	5.7	-	3.2	0.7	1.6	**11.4**
Ireland	22.1	1.5	1.9	4.7	0.2	0.3	-	**8.7**
Croatia	18.0	-	1.8	0.3	4.7	0.1	0.5	**7.4**
Bulgaria	15.1	0.6	0.5	-	5.3	0.7	1.4	**8.5**
Lithuania	11.5	0.1	0.4	0.1	1.6	0.1	1.2	**3.4**
Portugal	10.7	-	0.1	0.3	4.5	0.3	-	**5.2**
Latvia	8.3	-	0.1	0.1	0.8	-	0.6	**1.6**
Estonia	7.9	-	0.1	-	1.2	0.1	0.9	**2.4**
Slovenia	7.7	-	0.1	0.6	1.9	0.4	0.5	**3.4**
Luxembourg	4.7	-	1.6	0.9	0.1	0.2	-	**2.8**
Cyprus	1.6	-	-	0.5	0.2	0.1	-	**0.9**
Malta	0.2	-	-	-	0.1	-	-	**0.1**
TOTAL	**1784.4**	**36**	**309**	**124**	**208**	**36**	**65**	**777**

Note: Empty cells imply that the energy carrier is either not used or used in insignificant quantities.
Due to rounding of decimals, the numbers provided in the column 'Total potential savings' can slightly differ from the sums of the individual values.

[19] The fuel savings shown include only those used for local heat generation directly in the building. Electricity and heat generation savings will indirectly lead to fuel savings at primary energy level and are not explicitly shown.
[20] In descending order of final energy consumption for space heating in residential buildings.

NATURAL GAS SAVINGS

When looking at gas savings, the renovations would reduce the final consumption of natural gas[21] by 46% (309 TWh) at EU level. Figure 5 shows that Germany, Italy, France and Netherlands together represent three quarters of the gas savings and provide about 30% of the total final energy savings.

Figure 5: Final gas consumption for residential space heating in current and renovated buildings (in TWh) and gas saved in EU 27

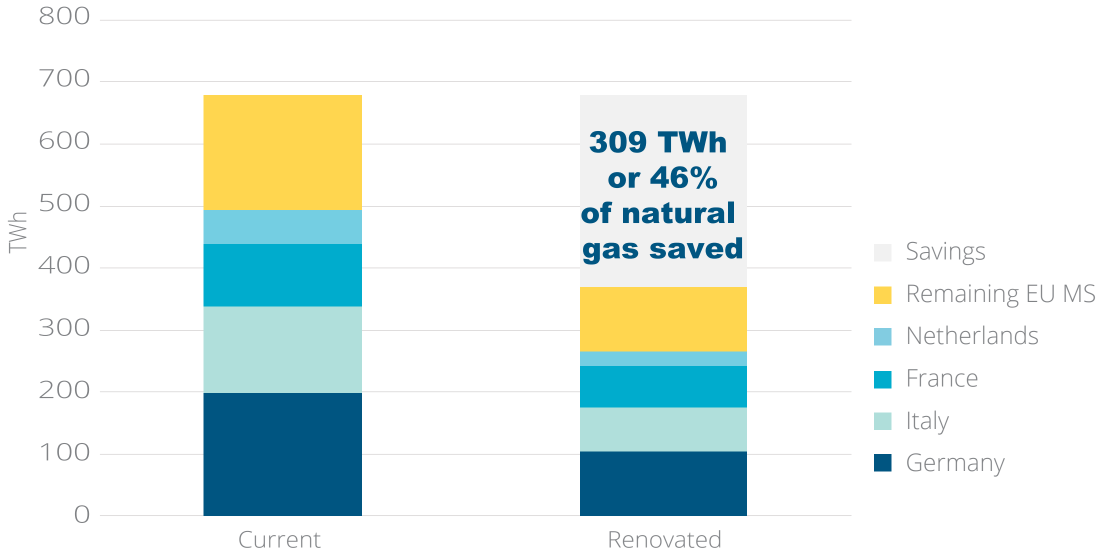
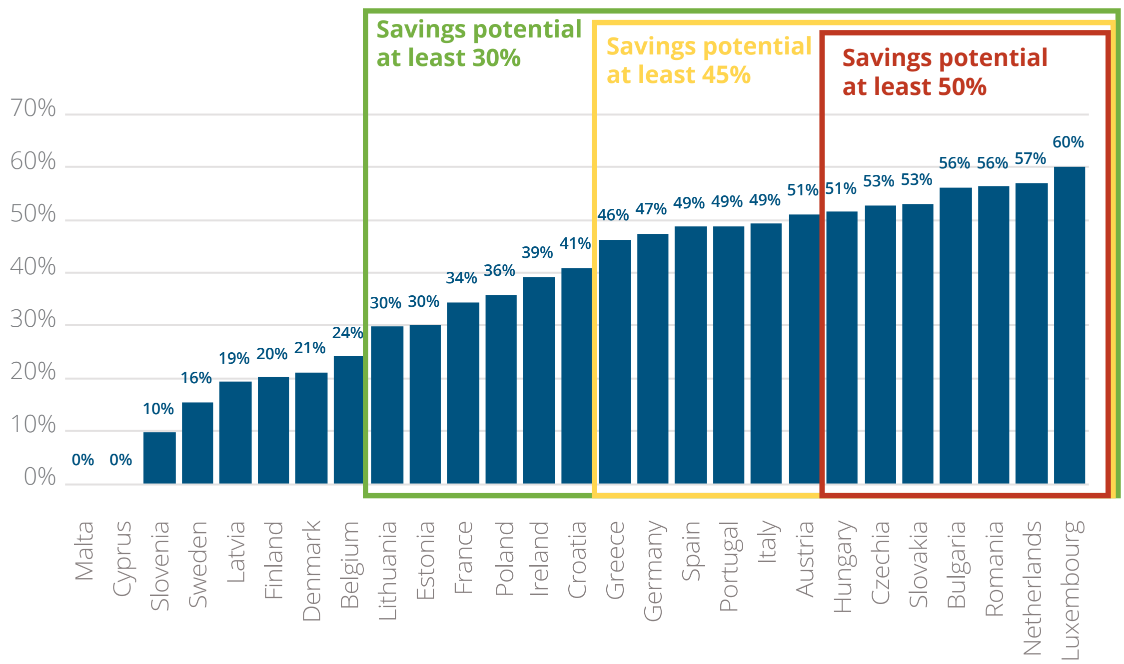


Figure 6 shows the relative savings in final gas consumption for each country: Luxembourg, Netherlands, Romania and Bulgaria would see the highest relative savings (60%, 57%, 56% and 56% respectively). The graph shows that one third of the countries would potentially save more than 50% of gas used as the final energy carrier (red frame). About 50% of the countries have a gas savings potential of at least 45% (yellow frame) and two thirds could at least save 30% of the final energy provided via natural gas (green frame).

Figure 6: Gas savings potential for residential heating in EU Member States[22]

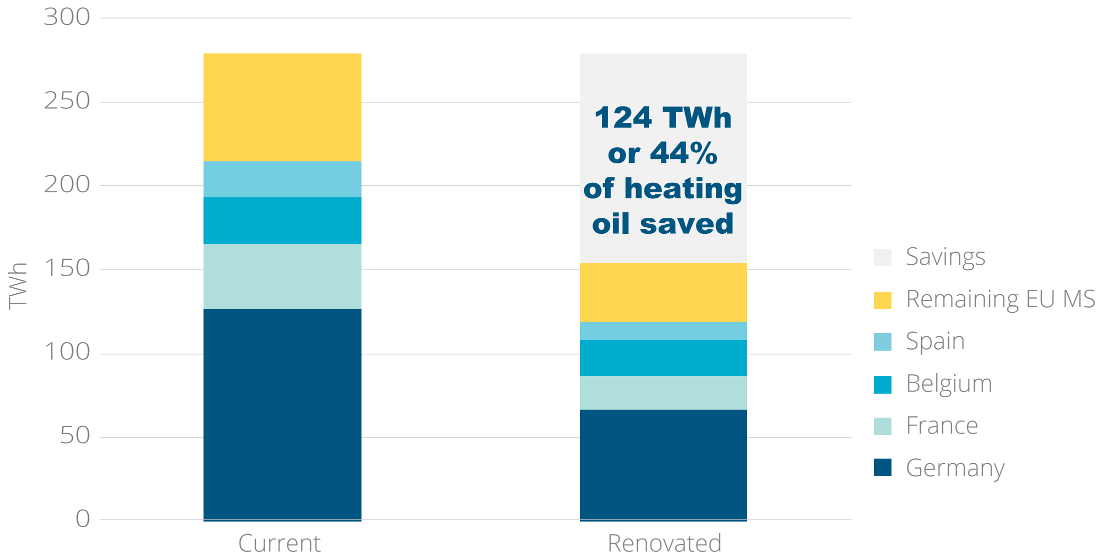


[21] This is gas used directly in buildings to generate space heating.
[22] In some cases, such as Finland and Sweden, the gas consumption is very low and the relative saving potential shown in this graph cannot be derived from absolute saving potential shown in Table 3.

HEATING OIL SAVINGS

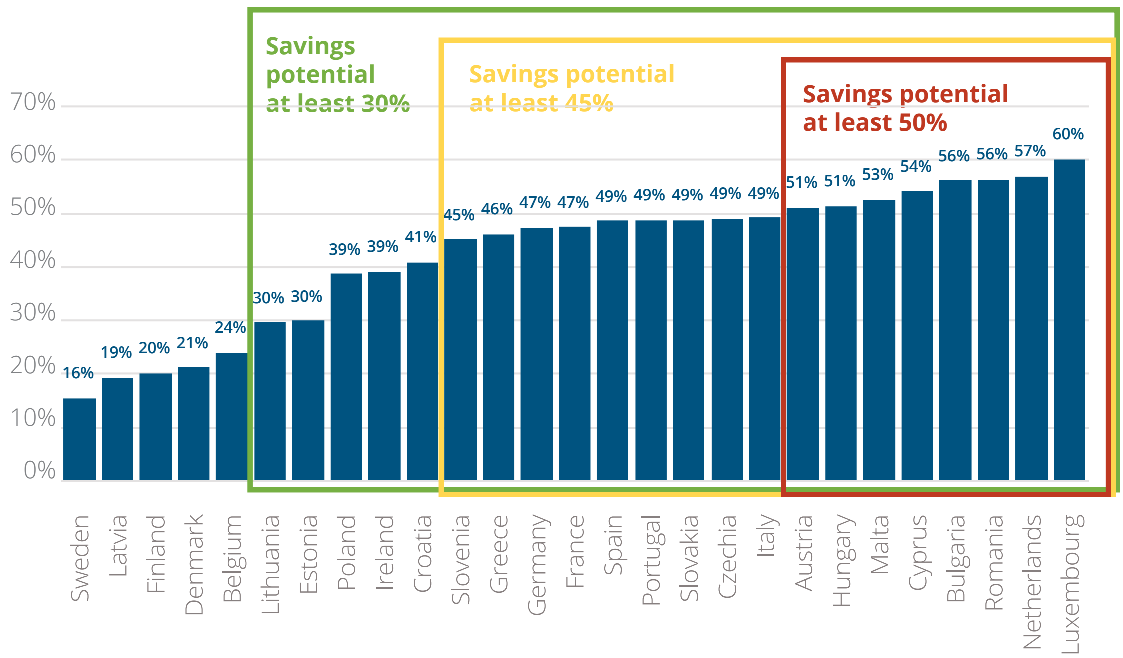
Final consumption of heating oil can be reduced by 44% when achieving the target U-values. Figure 7 shows that the four largest consuming countries (Germany, France, Belgium and Spain) provide 77% of the heating oil savings and 12% of the total final energy savings.

Figure 7: Final heating oil consumption for residential space heating in current and renovated buildings (in TWh) and heating oil saved in EU 27



The highest relative savings would occur in Luxembourg (60%), Netherlands (57%), Bulgaria (56%) and Romania (56%). Figure 8 shows that one third of the countries would potentially save more than 50% of the final energy provided by heating oil (red frame). About two thirds of the countries have a heating oil savings potential of at least 45% (yellow frame). All countries except Sweden, Latvia, Finland, Denmark and Belgium could at least save 30% of the final energy attributed to heating oil (green frame).

Figure 8: Heating oil savings potential for residential heating in EU Member States



COAL SAVINGS

The final consumption of coal in all countries could be reduced by 48% after renovating to the targeted U-values, as Figure 9 shows. Poland, Czechia, Ireland and Germany show the main absolute consumption and savings of coal. They provide 94% of the coal savings potential and 4% of the total final energy saving potential. In relative terms, coal provides a relevant share of final energy consumption in Poland (40%, 54.5 TWh), Czechia (14%, 8.2 TWh), Ireland (17%, 3.8 TWh), and Bulgaria (7%, 1.1 TWh).

Figure 9: Final coal consumption for residential space heating in current and renovated buildings (in TWh) and coal saved in EU 27

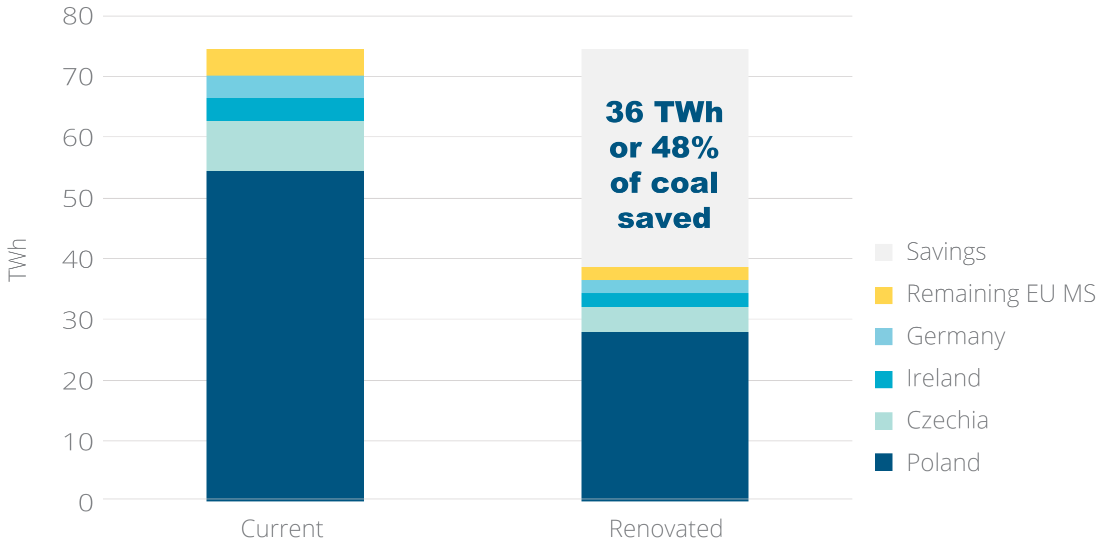
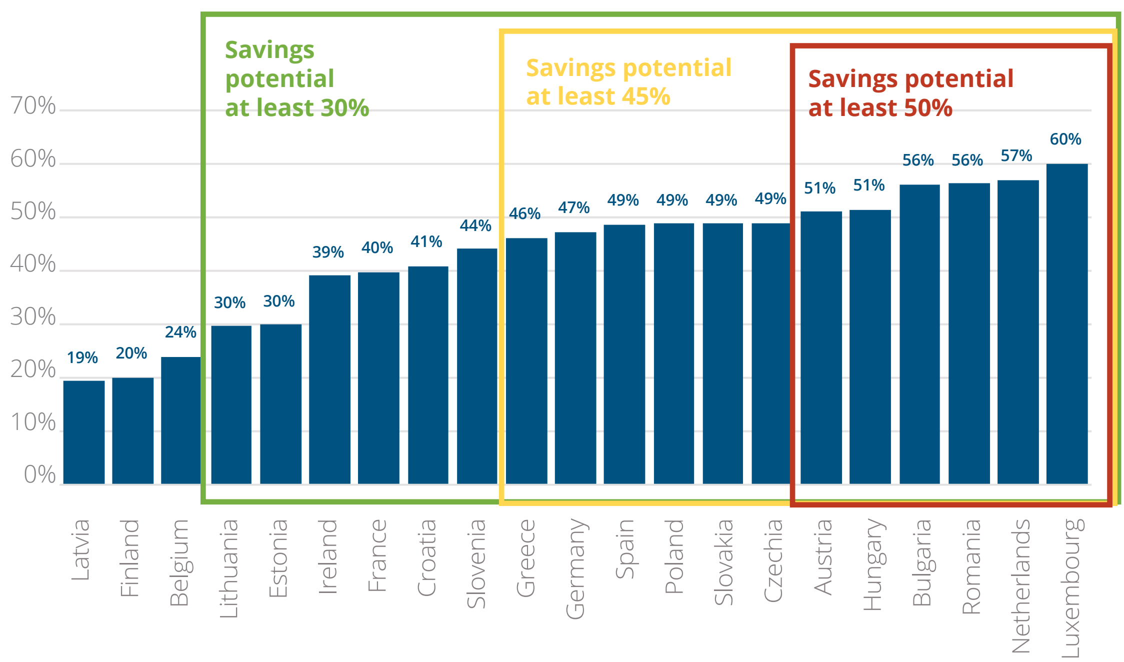


Figure 10 shows that six countries (Austria, Hungary, Bulgaria, Romania, the Netherlands and Luxembourg)[23] would potentially save more than 50% of the coal used as final energy for heating buildings (red frame). About half of the countries have a coal saving potential of at least 45% (yellow frame). Two thirds of the countries could at least save 30% of the final energy from coal in residential buildings (green frame).[24]

Figure 10: Coal savings potential for residential heating in EU Member States



[23] While relative savings for the Netherlands and Luxembourg are high, absolute savings for coal are rather low compared to other countries because of their low coal consumption (see Annex for details).

[24] Countries not shown were not consuming coal for residential space heating in 2020.

ENERGY SAVINGS PROJECTIONS

DEVELOPMENT OF THE EXISTING BUILDING STOCK

Under the suggested renovation rates for the Full Renovation scenario and the 2% Renovation scenario[25], it is estimated that respectively 96% and 66% of the total energy savings potential can be realised by 2050.

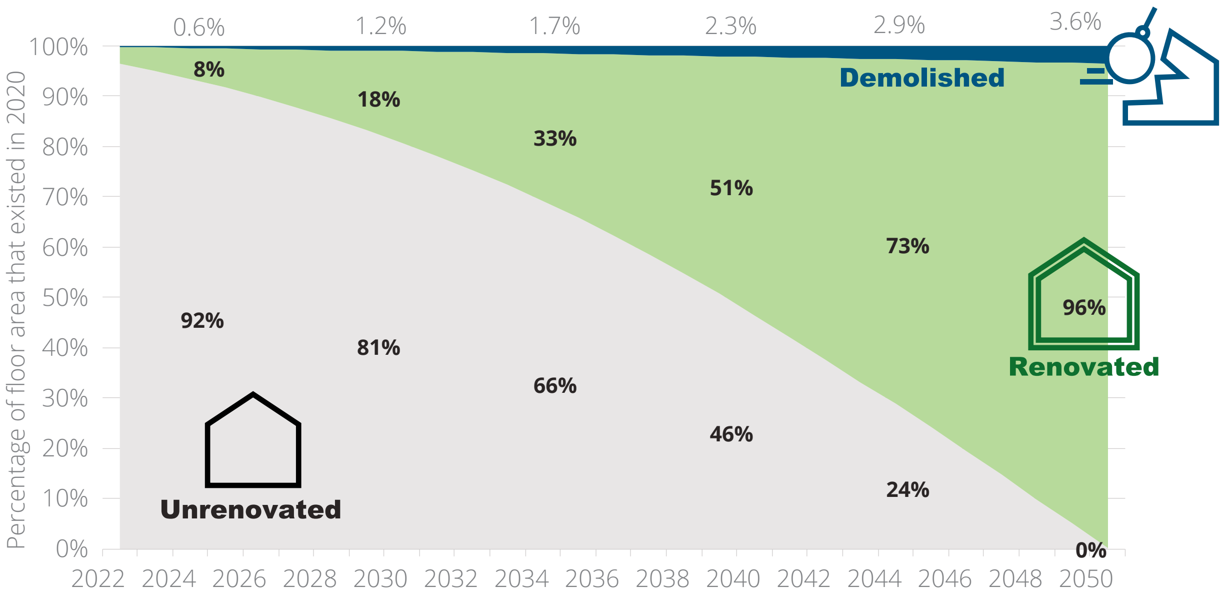
We assume that 3.6% of the current building stock will be demolished by 2050, which means that the energy savings shown for the Full Renovation scenario in Figure 13 are slightly lower than the potential savings shown in figure 3.

Figure 11 shows the cumulative share of the 2020 building floor area renovated and demolished before 2050 in the Full Renovation scenario.

The share of floor area that is renovated applies to all building types and hence corresponds directly to the share of energy saving potential that could be realized.

In the Full Renovation scenario, the renovation activity will have affected 18% of the floor area by 2030, 51% of the floor area by 2040, and 96% by 2050.

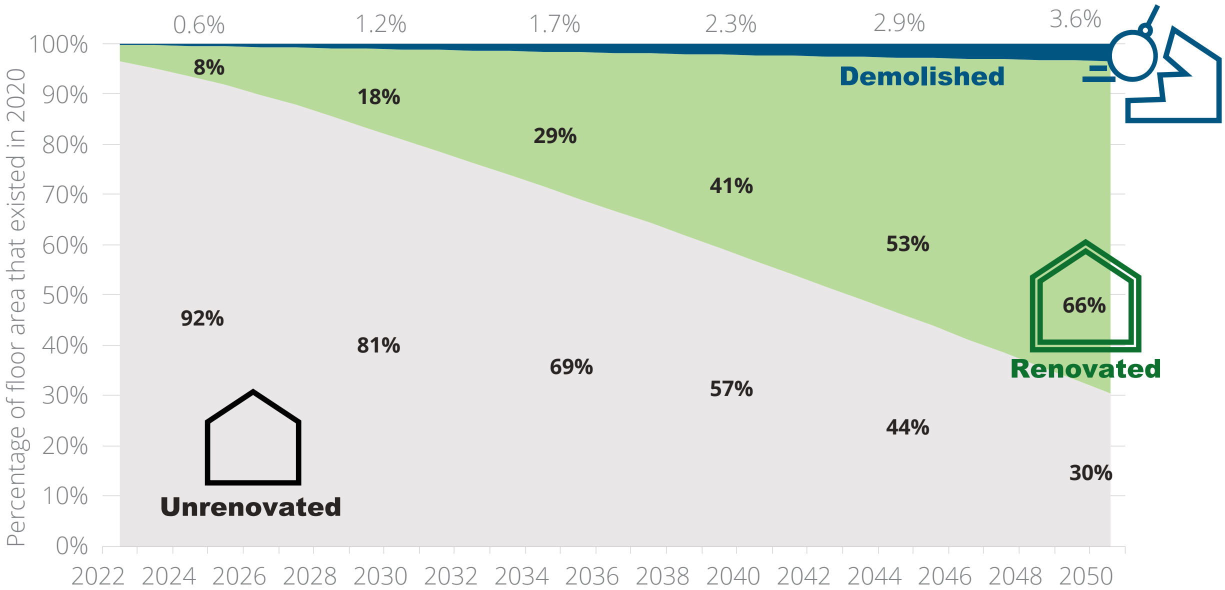
Figure 11: Projection of renovation and demolition activity of buildings existing in 2020 until 2050 in the Full Renovation scenario (all stock renovated by 2050)



In the 2% Renovation scenario, the renovation activity by 2030 will be the same (18% of the floor area), but only 41% of the floor area will be renovated by 2040 and 66% by 2050.

[25] Linear increase of the renovation rate to 2% until 2030 and then remaining constant.

Figure 12: Projection of renovation and demolition activity of buildings existing in 2020 until 2050 in the 2% Renovation scenario (renovation rate increased to 2% until 2030 then kept constant)



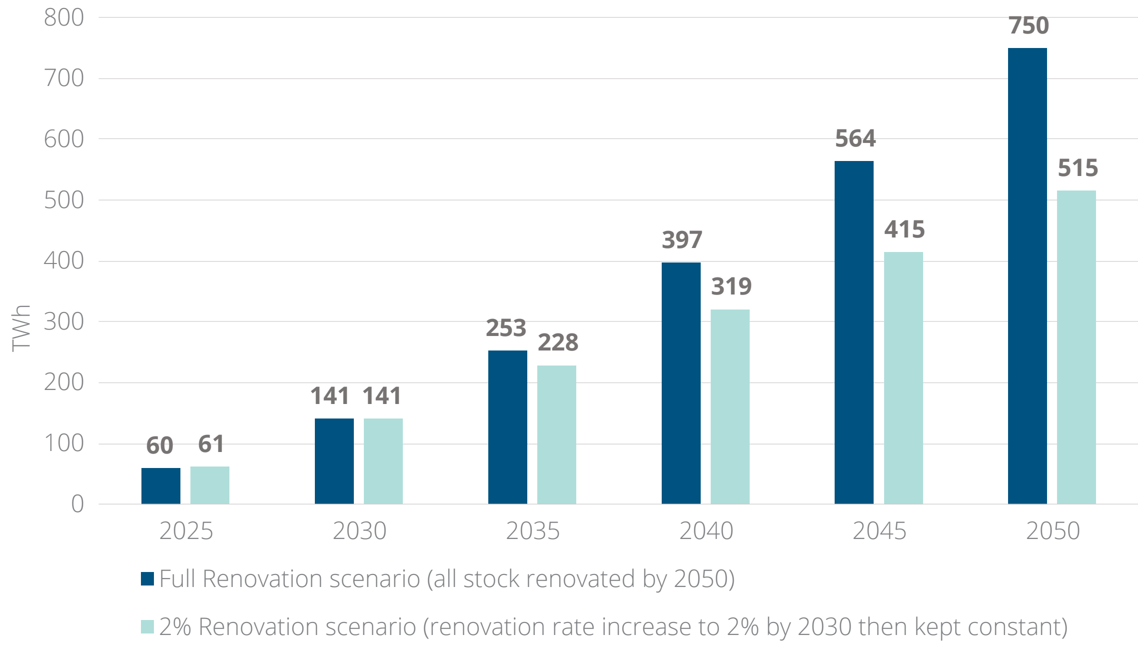
Renovation scenarios refer only to the existing buildings that are not well insulated and will achieve more than 20% final energy savings with the target U-values. Buildings that have low U-values are not considered for renovation in this analysis.

ENERGY SAVINGS PROJECTIONS AT EU LEVEL

Based on the development of the building stock defined under our two scenarios, cumulative energy savings are projected until 2050 as shown in Figure 13. In both scenarios, by 2030 EU residential buildings can save 141 TWh in residential space heating and more than twice that amount will be achieved by 2040, i.e., 397 TWh and 319 TWh respectively. It is worth noting that a doubling of savings for space heating is possible before 2030.

In the decade between 2040 and 2050, the savings could grow by about 90% in the Full Renovation scenario to reach 750 TWh, and by about 60% in the 2% Renovation scenario (515 TWh).

Figure 13: Cumulative savings in final energy used for residential space heating in EU 27, by 2050



ENERGY SAVINGS PROJECTIONS BY COUNTRY

The analysis shows that by renovating only roofs and walls to the target U-values[26], about 60% of the EU countries can save between 8% and 11% of final energy consumption (Table 4) by 2030, compared to 2020 values. Under the Full Renovation scenario, by 2050 seven countries (NL, RO, HU, BG, LU, CY, MT) can save at least 50% of their final energy consumption with these measures and 16 countries can achieve more than 40% savings.

Table 4: Cumulative absolute savings and share of the final energy consumption that could be saved by the year indicated for residential space heating in EU 27, compared to 2020 values

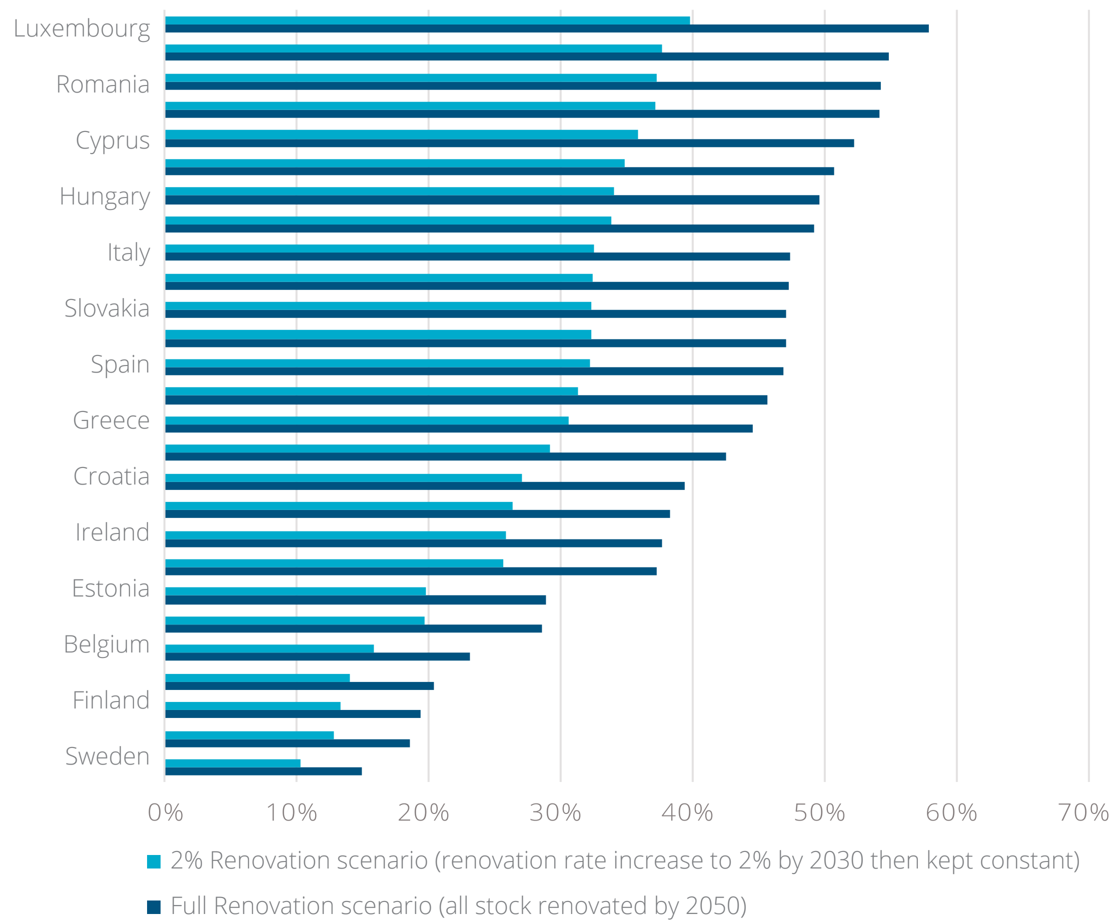
Country	Absolute savings (TWh)						Relative savings					
	Full Renovation scenario / 2% Renovation scenario		Full Renovation scenario		2% Renovation rate scenario		Full Renovation scenario / 2% Renovation scenario		Full Renovation scenario		2% Renovation scenario	
	2025	2030	2040	2050	2040	2050	2025	2030	2040	2050	2040	2050
Germany	16	39	109	207	88	142	4%	9%	24%	46%	19%	31%
Italy	9	21	59	111	47	76	4%	9%	25%	47%	20%	33%
France	9	20	57	109	46	75	3%	7%	20%	38%	16%	26%
Poland	4.0	10	27	51	22	35	3%	7%	20%	37%	16%	26%
Netherlands	2.9	6.8	19	36	15	25	4%	10%	29%	55%	23%	38%
Spain	2.6	6.0	17	32	14	22	4%	9%	25%	47%	20%	32%
Romania	2.5	5.9	17	31	13	22	4%	10%	29%	54%	23%	37%
Czechia	2.2	5.1	14	27	12	19	4%	9%	25%	47%	20%	32%
Austria	2.1	5.0	14	27	11	18	4%	9%	26%	49%	21%	34%
Hungary	1.4	3.3	9	17	7	12	4%	9%	26%	50%	21%	34%
Belgium	1.2	2.9	8	16	7	11	2%	4%	12%	23%	10%	16%
Greece	1.01	2.4	7	13	5	9	4%	8%	24%	45%	19%	31%
Slovakia	0.88	2.1	6	11	5	8	4%	9%	25%	47%	20%	32%
Ireland	0.67	1.6	4	8	4	6	3%	7%	20%	38%	16%	26%
Bulgaria	0.65	1.5	4	8	3	6	4%	10%	29%	54%	23%	37%
Finland	0.61	1.4	4	8	3	5	2%	4%	10%	19%	8%	13%
Croatia	0.57	1.3	4	7	3	5	3%	7%	21%	39%	17%	27%
Sweden	0.55	1.3	4	7	3	5	1%	3%	8%	15%	6%	10%
Denmark	0.48	1.13	3	6	3	4	2%	4%	11%	20%	9%	14%
Portugal	0.40	0.95	3	5	2	3	4%	9%	25%	47%	20%	32%
Lithuania	0.26	0.62	2	3	1	2	2%	5%	15%	29%	12%	20%
Slovenia	0.26	0.62	2	3	1	2	3%	8%	23%	43%	18%	29%
Luxembourg	0.22	0.51	1	3	1	2	5%	11%	31%	58%	25%	40%
Estonia	0.18	0.43	1	2	1	2	2%	5%	15%	29%	12%	20%
Latvia	0.12	0.29	1	2	1	1	1%	4%	10%	19%	8%	13%
Cyprus	0.07	0.16	0	1	0	1	4%	10%	28%	52%	22%	36%
Malta	0.01	0.02	0	0	0	0	4%	10%	27%	51%	22%	35%
Total	**60**	**141**	**397**	**750**	**319**	**515**	**3%**	**8%**	**22%**	**42%**	**18%**	**29%**

[26] Excluding renovations that save less than 20% final energy consumption per building.

As presented in Table 4, relative and absolute savings in final energy change significantly as we switch from one scenario to the other, which is the direct consequence of reduced renovation rates in the 2% Renovation Rate.

Relative savings at country level drop when moving from the Full Renovation scenario to the 2% Renovation Rate, as shown in Figure 14.

Figure 14: Relative savings in final energy at country level for both scenarios



> **Under the Full Renovation scenario, by 2050, seven countries can save at least 50% of their final energy consumption with these measures, and 16 countries can achieve more than 40% savings.**

POLICY RECOMMENDATIONS

Since the beginning of the war in Ukraine, the EU's attempts to show leadership in addressing climate change and guide the clean energy transition have been increasingly challenged. Torn between the need to meet the short-term challenges brought by the energy crisis and to continue the transition towards climate neutrality, the EU and its Member States are called to make bold choices to secure a prosperous future. This study shows that buildings are critical to reducing energy dependence from fossil fuels and must be treated as vital infrastructure enabling higher energy security and climate neutrality.

The challenge is two-fold: reduce the EU's dependence on fossil fuels in the short-term, and boost renovation activities to deliver the Renovation Wave. The EU must deliver a 60% reduction of GHG emissions in the buildings sector by 2030, thereby contributing to its 2030 climate target of reducing overall GHG emissions by 55%, putting the EU on the path to achieve climate neutrality by 2050.

This research shows that increasing the energy performance of the building envelope in residential buildings contributes to both objectives and that there are some clear choices that must be made now to achieve energy and climate security.

To tap into the full energy savings and fossil fuel savings potential, renovation activity in the residential sector must accelerate and increase in the next decade:

- If the current average annual renovation rate of 1% is doubled by 2030 as stated in the Renovation Wave strategy, and the rate is stagnating at 2% until 2050, the full potential energy savings outlined in this study will not be tapped by 2050. In this scenario, 30% of buildings will be left unrenovated by mid-century and 235 TWh of potential final energy savings will be wasted. This waste is more than the savings potential for Germany alone, or the potential for Italy and France combined.
- To fully benefit from the savings potential (777 TWh) the entire building stock must be renovated by 2050, the renovation rate must be at least doubled by 2030, and further increases must occur to reach 3% by 2035 and almost 4% by 2040.

What does this mean for the EU and its renovation strategy?

EU building policies must align short-term actions with long-term needs and ambitions. Building renovation must be delivered at a high pace to reduce the energy consumption in the long-term and to enable a quick and successful phaseout of fossil fuels in residential buildings. The study shows that an approach aiming at doubling the renovation rate by 2030 would only result in the renovation of 18% of the residential building stock by 2030. Without an acceleration in renovation now, more than one third of the building stock will remain unrenovated in 2050. A bolder approach in the next ten years, one attempting to match the increasing rate and depth of renovation, with a push towards serial renovations, would better address the need to get rid of fossil fuel imports and rapidly reduce energy demand in buildings.

The recast of the Energy Performance of Buildings Directive (EPBD) could not be more timely.

> **It is now imperative to set rules and incentives to drive the changes needed to achieve a highly efficient and decarbonised building sector by 2050.**

Recommendations

for the recast and implementation of the EPBD

The EPBD should introduce a definition of "deep renovation" and require that financial programmes and advisory services prioritise projects achieving deep renovation.

Minimum Energy Performance Standards (MEPS) should be effective and fair, in line with the following key principles:

A differentiated design based on the ownership structure is preferable to a general approach.

- MEPS should be designed with clear milestones and a long-term vision up to 2050. This will give clarity to building owners and will help the construction and renovation supply chain to organise itself and plan their resources accordingly, thereby boosting innovation and workforce training.
- They should be in line with the deep renovation ambition and the EU's 2030 and 2050 climate neutrality targets. This means that even in a step-by-step approach, the "first step" should pull the building out of the category of the worst-performing, preferably in one-go.
- They should be easily communicable to citizens and foresee an effective compliance and penalty system to ensure credibility and delivery of results[27].

- MEPS design should focus on individual buildings and meet the owners' ability to invest. They should be embedded in a well-designed ecosystem of financial support and advisory services, where a strong and coherent enabling financial framework is in place to support citizens undertaking deep renovations.
- Funds currently used for emergency relief measures against high energy prices should be progressively phased out and redirected to support building renovation programmes, specifically targeting worst-performing buildings owned by low-income households.
- National financial support to building renovation should prioritise multi-annual, stable and predictable programmes. It should ensure proportionality between the amount of subsidy and the level of energy performance achieved, and further support renovations where a substantial amount of energy is saved either in one-go or in the first step of a staged deep renovation.
- Subsidy schemes for the installation of fossil fuel boilers should be stopped and funding should be redirected to support the rollout of renewable heating alternatives.

MEPS should first focus on the worst performing buildings[27] across all segments in order to deliver high amounts of energy savings and show quick positive results contributing to energy security and the alleviation of energy poverty.

[27] For more info see EPBD recast: new provisions need sharpening to hit climate targets (BPIE, 2022)

[28] The European Commission defines worst performing buildings as those in Energy Performance Certificate (EPC) classes G, where the G rating corresponds to the 15% worst performing buildings in each country (EPBD recast, art.16). The EPBD Rapporteur Ciaran Cuffe in its report considers worst performing buildings "buildings corresponding to energy performance classes E, F and G (AM51, Art 2§1 new)", which covers a larger share of buildings in each country.

Member States should not wait for a ban of fossil fuel boilers to be introduced by the EPBD and should stop fossil fuel subsidies immediately.

Support in the form of advisory services is also key:

- Member States should use the EU Year of Skills in 2023 as an opportunity to launch initiatives in upskilling and training in the construction and renovation sector to boost deep and serial renovations before 2030 and help deliver the Renovation Wave.
- Member States should boost industrialised / serial-type renovations, targeting especially multi-apartment buildings and social housing[29].
- Member States should put in place a network of public and private one-stop-shops to ensure reliable energy renovation advice is available throughout their territories, and roll out the deployment of Renovation Passports, in line with the upcoming EU scheme, to guide citizens in their renovation journey, outlining the right sequence of renovation measures to implement.

[29] More specific recommendations available here: https://www.bpie.eu/wp-content/uploads/2022/07/BE_WLC_PolicyRecs_Final.pdf

This analysis confirms that investing in better insulation can drastically reduce the use of fossil fuels for heating across all Member States and substantially contribute to securing the EU's energy needs and climate targets. Sustained energy savings will increase the EU's independence from fossil fuels.

To tap into the full energy and fossil fuel savings potential, renovation activity in the residential sector must accelerate and increase in this decade and continue until full renovation of the building stock is achieved by 2050.

Conclusions

- **This analysis confirms that investing in better insulation can drastically reduce the use of fossil fuels for heating across all Member States and substantially contribute to securing the EU's energy needs and climate targets. Sustained energy saving will increase the EU's independence from fossil fuels.**

- **To tap into the full energy and fossil fuel savings potential, renovation activity in the residential sector must accelerate and increase in the next decade and continue until the full renovation of the building stock is achieved by 2050.**

- **It is now time to apply the energy efficiency first principle and give it real life by designing and implementing building renovation and decarbonisation policies to save energy and phase out fossil fuels. This shift will deliver substantial impact as shown by this study.**

- **Boosting deep renovations now is the best way to protect citizens from being dependent on an unstable energy supplier, from being trapped in high energy bills, and from living in unhealthy buildings.**

REFERENCES

[1] R. Holopainen, A. Milandru, H. Ahvenniemi, and T. Häkkinen, "Feasibility Studies of Energy Retrofits - Case Studies of Nearly Zero-energy Building Renovation," Energy Procedia, vol. 96, no. October, pp. 146–157, 2016, doi: 10.1016/j.egypro.2016.09.116.

[2] Navigant and IPSOS, "Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU." p. 87, 2019.

[3] KORE Insulation, "No Title," 2021. [Online]. Available: https://www.kore-system.com/services/low-energy-building/.

[4] Concerted Action Energy Performance of Buildings, "Implementation of the EPBD in Hungary," 2016. [Online]. Available: https://epbd-ca.eu/ca-outcomes/outcomes-2015-2018/book-2018/countries/hungary.

[5] T. Boermans and C. Petersdorff, "U-values for better energy performance of buildings," 2007.

[6] B. Atanasiu, M. Joana, D. Staniaszek, I. Kouloumpi, and T. Kenkmann, "Overview of the EU-27 building policies and programs. Factsheets on the nine ENTRANZE target countries." p. 256, 2014.

[7] N. H. Sandberg et al., "Dynamic building stock modelling: Application to 11 European countries to support the energy efficiency and retrofit ambitions of the EU," Energy Build., vol. 132, pp. 26–38, 2016, doi: 10.1016/j.enbuild.2016.05.100.

[8] D. D'Agostino et al., Synthesis Report on the National Plans for Nearly Zero Energy Buildings (NZEBs). 2016.

[9] Buildings Performance Institute Europe (BPIE), Europe's Buildings Under The Microscope. 2011.

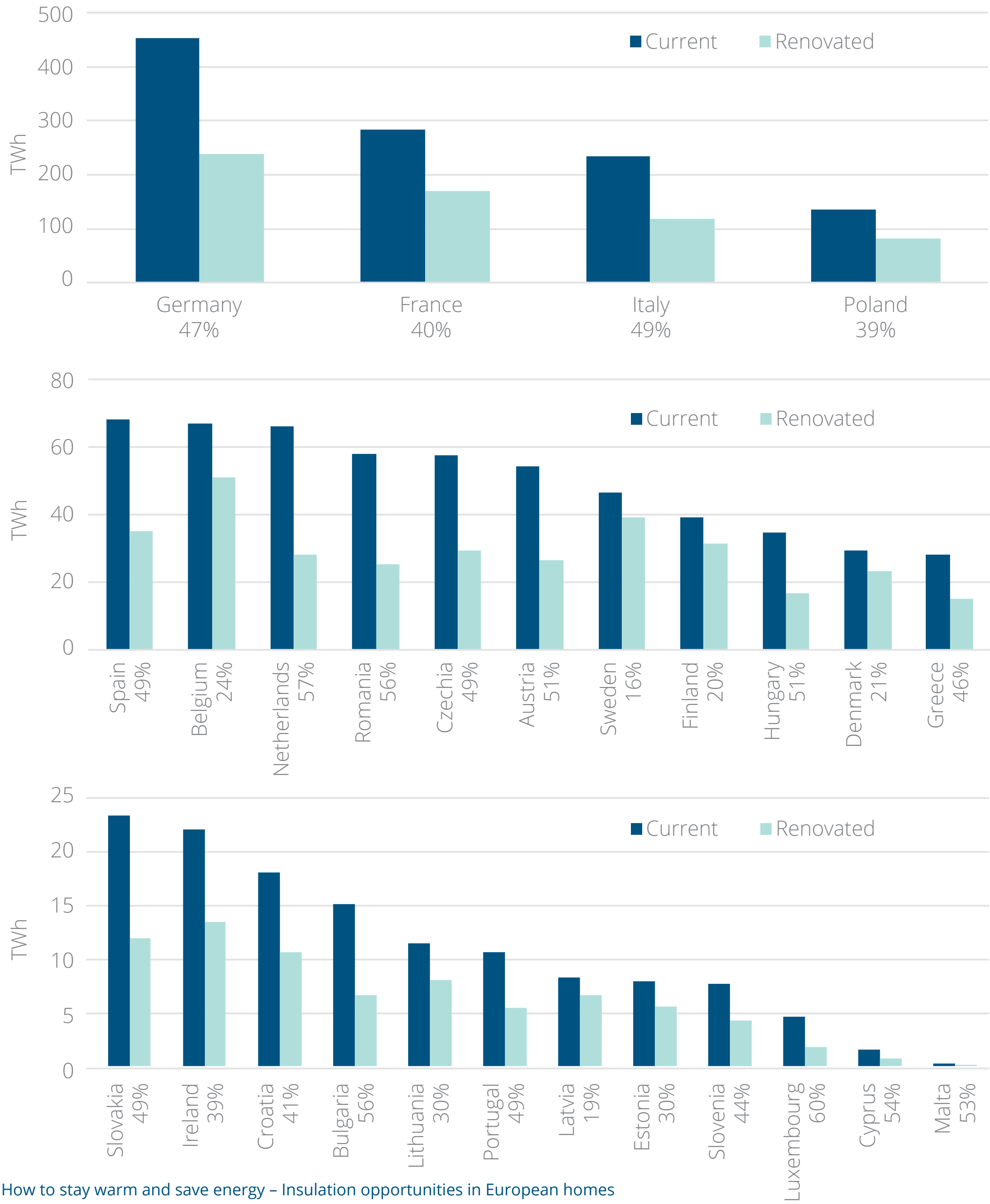
[10] M. Kleemann and P. Hansen, "Evaluierung der CO 2 -Minderungsmaßnahmen im Gebäudebereich," 2005.

APPENDIX

The appendix below shows potential savings per type of fuel and per country. It includes only space heating in residential buildings. Countries are arranged in descending order of consumption. Only countries consuming gas, heating oil or coal for residential space heating in 2020 are shown in the figures. The figures show the energy savings potential of the currently existing building stock, not the scenario results.

FINAL ENERGY CONSUMPTION (PER COUNTRY)

Figure 15: Final energy consumption for current and renovated buildings (in TWh) and final energy savings potential (in %) per country

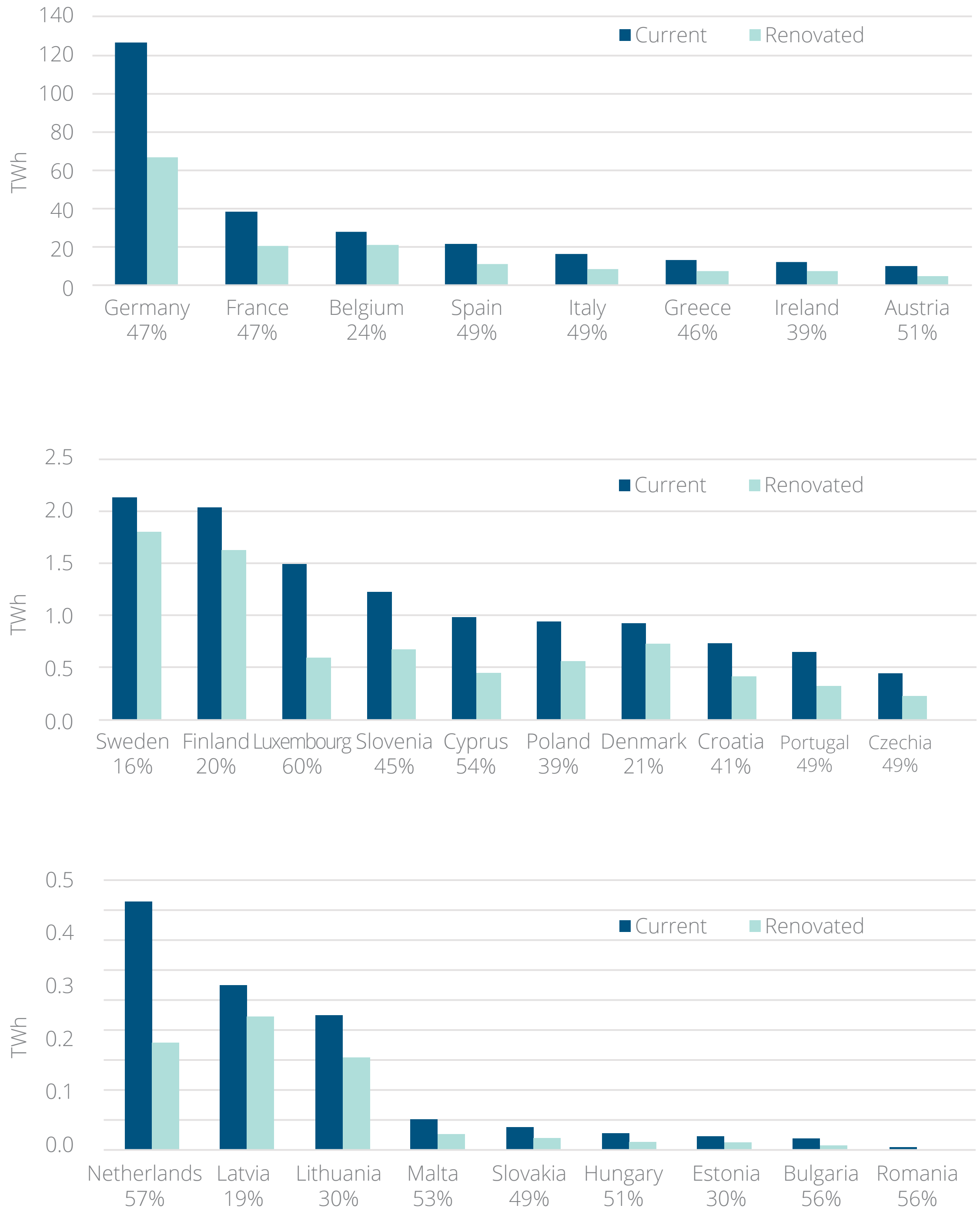


GAS CONSUMPTION (PER COUNTRY)

Figure 16: Gas consumption for current and renovated buildings (in TWh) and gas savings potential (in %) per country

HEATING OIL CONSUMPTION (PER COUNTRY)

Figure 17: Heating oil consumption for current and renovated buildings (in TWh) and heating oil savings potential (in %) per country



COAL CONSUMPTION (PER COUNTRY)

Figure 18: Coal consumption for current and renovated buildings (in TWh) and coal savings potential (in %) per country

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