



Energy
Efficient
Mortgages
Initiative

Evaluation of the potential interest/ need of EE mortgages among EU members

Version: Final

Main author: Iva Hristova, Monica Billio

Dissemination level: Public

Lead contractor: Monica Billio

Due date: 20/04/2022



EeMMIP projects have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 894117 respectively.

1. Table of Contents

1. Table of Contents.....	2
2. Introduction	5
3. Evaluation of the EU residential mortgage market saturation	5
4. Evaluation of households' exposure to energy expenditure and residential age structure.....	12
4.1 EU households' energy consumption patterns.....	12
4.2 Residential characteristics- residential age structure	14
4.3 EU energy prices for household consumers.....	15
4.3.1 Electricity prices and expenditure for EU households	16
4.3.2 Natural gas prices and expenditure for EU households	18
4.4 ODYSSEE- MURE EU annual energy expenditures per household for housing.....	20
5. Evaluation of countries' climate vulnerability	21
5.1 The Climate Risk Index	21
5.2 The ND-GAIN country index.....	23
6. Evaluation of already implemented EE domestic initiatives and political readiness	25
6.1 Existing EE initiatives.....	25
6.2 Energy efficiency trends for households in the EU	27
6.3 ND- GAIN Country Index, Readiness component.....	28
6.4 ODYSSEE- MURE Overall energy efficiency scores for households.....	29
7. Analytical evaluation of the potential interest/ need of EE mortgages among EU members.....	31
8. Further improvements	33
9. References	33
10. Appendix	34

Executive Summary

The present report proposes an extension of the already developed under the EeMAP and EeDaPP projects reflection on buildings' Energy Efficiency (EE). Among the previous achievements, these two projects have allowed to study the effects of EE improvements on households' solvability, through reduced exposure to fluctuating energy prices and reduced energy bills, but also through increased property value. The obtained findings confirmed the relevance of EE mortgages (EEM) and expanded their evaluation beyond their role in achieving the EU 2030 EE target.

According to Economidou et al. (2019), among all of the private EE initiatives targeting buildings (commercial loans on EE, crowdfunding, EE insurance), EEM allow access to low-cost capital with a long repayment period and enhance the repayment borrower's ability. Nevertheless, for small projects, the transaction costs might be quite important, and the collateral requirements are quite consequent. For the time being, EEM initiatives have been developed in the UK, Germany, Sweden, and Romania.

Based on these considerations, the deliverable focuses on the specific needs of households and their capacity to gather and dedicate further means for EE investments. As far as this purpose is concerned, we propose a discussion on the residential mortgage market potential, and an evaluation of: i) the households' exposure to energy expenditures; ii) the EU members' vulnerability to climate risk and iii) their EE progress potential (few implemented EE initiatives are observed along a growing political concern).

Concerning the residential market potential, two major trends are observed: while Central and Eastern Europe EU members follow an important catch-up path and thus present a considerable potential growth capacity (low households' mortgage indebtedness), the Euro-Zone members benefit from a greater loan attractivity (low interest rates) and residential real estate affordability as well as expanding existing mortgage activities. Thus, while for the first group, the spread of EEM can be assimilated to the development of a new market, where socio-cultural and country characteristics might be an obstacle, for the second group it would rather correspond to a re-segmentation of an existing market by employing a niche strategy presenting greater advantages in terms of ease of implementation.

With regards to energy expenditure, most of the EU members are exposed at least to one of the four indicators that might affect the energy expenditure of households (property's age, energy consumption, gas and electricity prices), suggesting the necessity for EE improvements. The households' reliance on natural gas for space heating, water heating and cooking is more consequent in Western EU member states (except for Portugal and Spain), since Central and Eastern Europe countries benefit from greater renewable energy capacities. Nevertheless, on average 20 % of EU members' power generation relies also on natural gas (Statista, 2022), since the use of more polluting energy sources like coal and other fossil fuels have been reduced in the last ten years.

Concerning climate vulnerability, very few EU countries are not particularly exposed to climate change risk. Indeed, according to the last available data (2019 and 2018), only the Czech Republic, Finland, Luxembourg, and Sweden did not seem to be particularly vulnerable to climate changes. However, since then, important extreme weather events have been observed, especially in Northern Europe countries, highlighting therefore their possibly raising fragility.



Evaluation of the potential interest/ need of EE mortgages among EU members

As for the EE potential, despite a considerable quantity of mostly public initiatives and measures as well as a growing concern for the last 20 years, among all members, the reached EE progress in residential buildings is quite restricted and is rather correlated to energy prices fluctuations rather than to climate risk preoccupations. This situation highlights the confrontation between rather short-term prerogatives and long-term investment decisions.

In brief, most EU members are exposed to energy expenditures and climate risk and the achieved EE progress in residential buildings has been quite limited so far. Those analyses suggest an important need for more EE public and private initiatives.

The proposed study does not include the potential effects of the current economical and geopolitical context, given the important level of uncertainty. While the interest towards EE might arise, in the case of important energy price increases, the capacity of households to engage into further borrowing will be probably reduced and the currently observed relatively low interest rates will not last long in a post-pandemic instable situation.

Furthermore, due to restricted availability of some recent data (since 2014), it has not been possible to include considerations on buildings' characteristics, NetZero Building (NZB) and EPC standards. Thus, the evaluation of buildings' EE levels is based only on EE appliances data, excluding the effects of shell isolation (windows, roofs, floors, walls), which undoubtedly underestimates their effect on energy consumption and EE progression.

Acknowledgements:

The authors would like to thank Luca Bertalot, Jennifer Johnson and Daniele Westig for their valuable and constructive comments and suggestions that significantly contributed to the improvement of the deliverable.

2. Introduction

As highlighted in previous deliverables, the improvement of buildings' EE, might be beneficial to most economic actors, not only through reduced energy bills, lower exposure to fluctuating energy prices, but also through increased property value, reduced GHG emissions and improved living conditions. However, the development of EE mortgages (EEM) depends not only on the existing prudential regulation, but also on the specific needs of households and their capacity to gather and dedicate further means for EE investments.

For this reason, the present report aims to propose an analytical evaluation of the potential interest and need for EE mortgages among European Union member states and the United Kingdom¹. Namely, in a first step, it discusses the saturation of the EU mortgage market, the conditions that can stimulate its development through EEM and the potential limits that might arise (Section 2). Unfortunately, given the predominance of country-specific and socio-cultural characteristics, it will be difficult to evaluate with precision the capacity of EU households to engage in additional borrowing activities.

In a second step, the deliverable focuses on the energy expenditure burden for EU households given their energy consumption levels, the major energy prices (electricity and natural gas) that they are facing and the characteristics of their homes (Section 3).

Then, it proposes an additional standpoint through the evaluation of EU members' climate vulnerability through the occurred physical and financial losses (Section 4). At last, it discusses briefly, the already implemented initiatives promoting EE and the political readiness of EU countries in terms of EE (Section 5) in order to identify the countries with a larger potential for further EE improvements.

Section 6 concludes based on the cross-checking of the evaluated four factors (market saturation, energy expenditure burden, climate vulnerability, EE actions) and identifies the most exposed countries which might concentrate greater needs/interests for EE investments.

3. Evaluation of the EU residential mortgage market saturation

The present section discusses the interest and capacity of households to engage into EEM, but also the potential limitations that can arise due to country-specific and socio-cultural characteristics. For this purpose, we will focus on several indicators describing the share of mortgages already contracted by households (homeowner with mortgage share), their average amount (weighted average mortgage holder), the evolution since 2009, of new residential loans costs (annual average interest rates), of mortgage markets' growth (total outstanding residential loans to households' disposable income ratio) and of house affordability (nominal house price to households' disposable income of ratio).

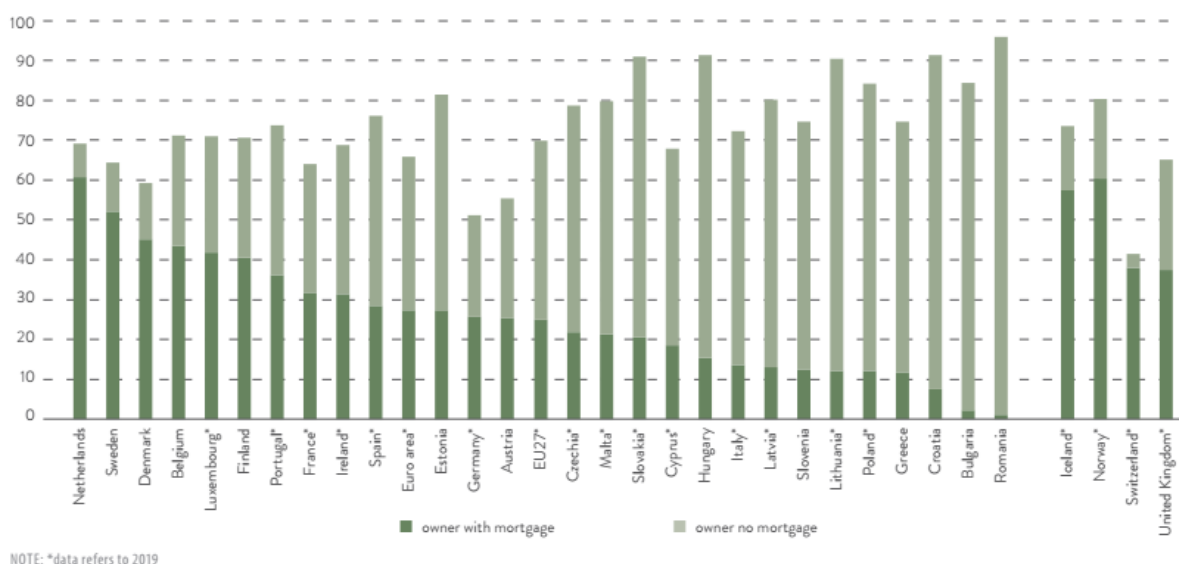
As described by Figure 1, in 2020, most of the euro-zone members present important levels of mortgages for the financing of home purchases, while Southern, Central and Eastern Europe members

¹ We chose to include the UK in the present study, as far as comparable data is available, given its relative importance in EE residential mortgage markets.

Evaluation of the potential interest/ need of EE mortgages among EU members

present the lowest levels of mortgages (below 20%). However, this significant difference relies rather on historical particularities and does not reflect for certain the “openness” of households towards this type of financing. Indeed, households more familiar with mortgages will more likely contract a new one. Besides, lower levels of mortgages within a given country, does not for certain involve greater interest for this type of credits, as it might correspond to a lower development due to country specifics (not typical for residential purchases, lower average capacities to have access to this type of funding (repayment conditions and etc.)).

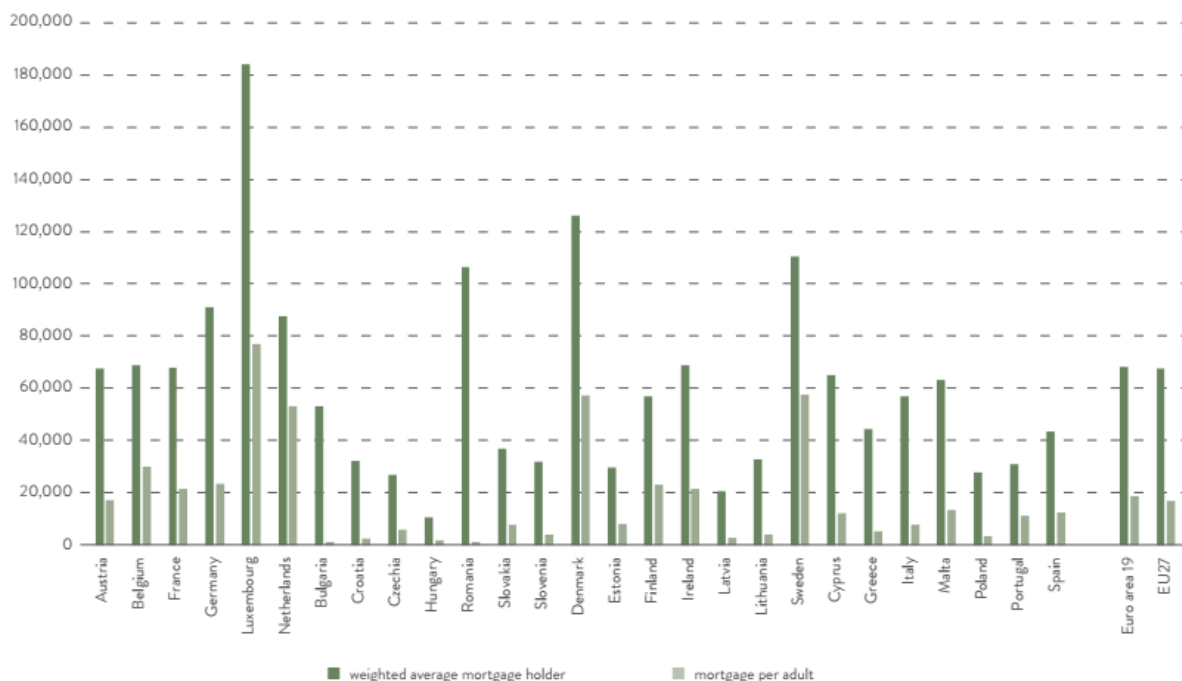
Figure 1: Homeowner share and mortgage holders in 2020, (%)



Source: Hypostat (2021)

Despite the lower share of homeowners with mortgages, another important issue for the evaluation of the market saturation concerns the average amount of contracted mortgages. The repartition of mortgages per adult confirms the presented above trend. However, when only mortgage holders are considered (dark green columns), the situation seems more moderate. The EU average, in 2020, amounts to EUR 60 000 and while Luxembourg, Romania, Denmark and Sweden exceed considerably this level, it is difficult to evaluate whether this trend is related to the living standards (to the actual mortgage market size or to other country specifics) and thus to state the saturation of mortgage markets in these countries.

Figure 2: Comparison outstanding mortgage per adult and per mortgage holder (2020, EUR)



Source: Hypostat (2021)

Indeed, an average mortgage level of more than EUR 100 000 in Romania, cannot be compared to the same amount in Sweden and Denmark, because of the differences in terms of real estate prices and the living standards in these countries. Thus, further information is necessary in order to capture the indebtedness of EU members' households. A potential indicator for this, can be the ratios of total outstanding residential loans to households' disposable income (i.e. after tax payment) (Table 1).

However, decreasing ratios can be either seen as an increasing capacity of households to face residential loans payments, or they can be interpreted as corresponding to a lower interest and need for mortgages. Therefore, we will use rather this variable, as a mean to evaluate the growing importance of the mortgage market.

Increasing ratios, for the period 2009- 2020, are observed in: Austria, Belgium, Czech Republic, Finland, France, Germany, Italy, Luxembourg, Poland, Romania, Slovakia, Slovenia, Sweden.

However, the affordability of a residential loan depends also on the interest rates paid by households (Table 2) and the evolution of the real estate market prices relative to the households' disposal income (Table 3).

Table 1: Total outstanding residential loans to households' disposable income ratios (2009 – 2020, %)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AUSTRIA	40.2	43.4	44.3	43.8	44.4	44.7	47.1	47.3	48.5	49.2	50.7	54.5
BELGIUM	70.3	74.0	76.4	79.3	80.7	82.9	85.9	88.6	90.4	92.6	94.8	96.5
BULGARIA	16.1	15.5	14.0	13.8	13.4	13.3	12.9	12.9	13.6	n/a	n/a	n/a
CROATIA	26.7	28.7	29.2	30.0	29.2	29.2	27.7	24.1	23.4	22.7	23.0	n/a
CYPRUS	79.3	89.0	91.6	95.3	94.1	98.8	98.8	92.1	84.3	61.5	58.9	61.8
CZECHIA	25.1	27.4	28.0	30.7	31.0	33.5	35.8	37.3	39.4	39.0	40.7	41.9
DENMARK	196.3	191.8	189.4	186.8	184.6	184.2	180.0	175.5	173.4	170.2	170.5	173.8
ESTONIA	71.9	70.3	63.9	61.5	57.2	55.6	55.0	56.4	55.1	53.9	52.4	55.8
FINLAND	68.0	69.8	71.5	73.4	73.2	73.6	74.2	74.4	74.2	73.1	72.7	74.5
FRANCE	57.4	60.7	63.2	64.5	60.6	61.2	62.9	64.1	66.3	68.2	70.6	73.7
GERMANY	70.8	69.5	67.8	67.4	67.6	67.5	67.9	68.1	68.4	69.2	70.9	74.9
GREECE	46.5	51.1	55.2	59.0	60.2	58.7	57.4	53.6	50.5	48.0	43.0	38.2
HUNGARY	40.8	42.9	36.2	33.4	30.7	28.3	23.8	21.3	19.1	17.8	16.7	17.0
IRELAND	159.9	114.0	118.8	111.6	108.9	102.0	94.8	88.7	80.9	76.5	69.9	65.7
ITALY	25.5	32.1	32.7	33.4	32.9	32.4	32.3	32.6	32.4	32.2	32.3	33.9
LATVIA	53.3	55.1	49.9	41.0	37.5	32.9	29.8	27.7	26.0	22.8	22.5	22.0
LITHUANIA	31.6	30.8	28.9	27.4	26.3	26.6	26.6	26.4	27.6	28.0	27.6	27.9
LUXEMBOURG	108.8	114.1	121.3	122.7	127.8	129.1	135.0	140.9	142.6	145.7	146.6	152.2
NETHERLANDS	206.3	209.5	209.2	209.3	204.4	200.0	197.7	195.0	192.9	186.7	181.6	181.0
POLAND	26.3	29.7	30.9	33.3	33.4	33.0	34.3	34.5	33.2	33.0	33.0	32.5
PORTUGAL	86.5	88.2	89.5	89.3	86.9	83.7	77.8	72.6	69.4	66.4	63.8	64.7
ROMANIA	8.7	9.3	10.5	12.5	12.0	13.0	13.8	14.1	13.7	14.0	13.2	13.4
SLOVAKIA	23.4	26.1	29.3	31.5	35.0	38.9	42.3	46.5	50.0	50.9	53.2	57.0
SLOVENIA	17.3	21.0	21.9	22.9	23.1	23.0	23.3	23.1	23.1	22.7	22.6	22.5
SPAIN	89.0	89.9	88.2	90.3	86.9	84.2	77.1	73.0	68.8	66.4	63.8	65.2
SWEDEN	150.0	158.1	150.6	150.6	148.4	150.6	165.0	164.9	167.8	174.3	176.6	193.5
EURO AREA 19	68.5	70.2	70.4	71.1	69.6	69.2	68.9	68.7	68.6	68.6	69.2	n/a
EU 27	69.3	71.3	71.4	72.3	71.0	70.8	71.0	70.6	70.4	70.3	70.8	n/a
NORWAY	151.3	147.6	147.5	153.8	142.5	143.0	143.2	165.2	156.9	162.0	169.0	178.5
SWITZERLAND	192.5	214.1	206.2	209.8	214.6	222.0	217.9	227.7	218.2	239.0	243.6	n/a
UNITED KINGDOM	111.8	109.3	112.2	104.7	104.4	104.2	96.4	94.0	98.3	96.7	100.9	98.9

Source: Hypostat (2021)

Due to the ECB quantitative easing measures implemented in consequence of the Global Financial Crisis (GFC), all EU countries present decreasing interest rates during the considered period (2009-2020). However, the countries where households can benefit from lower interest rates (below 2%) are concentrated in the Euro-zone: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom. This decreasing pattern is also observed in the remaining part of the European Union, even though the maintained levels are higher comparatively to the Euro-zone.

Table 2: Representative Interest Rates on New Residential Loans Ratios (Annual average, 2009- 2020, %)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TYPE
AUSTRIA	3.71	2.71	2.86	2.71	2.39	2.29	2.02	1.92	1.89	1.84	1.63	1.34	1
BELGIUM	4.25	3.59	3.81	3.63	3.45	3.17	2.49	2.11	2.09	1.91	1.78	1.57	1
BULGARIA	9.04	8.47	7.93	7.59	7.05	6.69	5.89	4.99	4.00	4.64	3.51	3.52	1
CROATIA	6.36	6.32	5.48	5.46	5.04	5.05	5.07	4.78	3.80	3.52	3.07	2.93	1
CYPRUS	6.05	4.73	5.31	5.33	5.03	4.43	3.59	3.06	2.77	2.41	2.12	2.10	2
CZECHIA	5.61	4.90	4.04	3.52	3.26	2.56	2.33	2.07	2.11	2.49	2.62	2.25	1
DENMARK	3.21	2.17	2.41	1.41	1.20	1.29	1.09	1.15	1.00	0.81	0.66	0.69	1
ESTONIA	3.87	3.50	3.42	2.86	2.54	2.43	2.25	2.28	2.34	2.59	2.54	2.48	1
FINLAND	2.45	1.98	2.50	1.97	1.98	1.80	1.35	1.16	0.95	0.86	0.73	0.69	1
FRANCE	4.09	3.42	3.80	3.56	3.19	2.96	2.32	1.88	1.60	1.55	1.36	1.26	1
GERMANY	4.26	3.69	3.84	3.06	2.76	2.49	1.95	1.76	1.83	1.87	1.52	1.25	1
GREECE	3.94	3.68	4.33	3.26	2.82	2.94	2.62	2.74	2.78	3.01	3.11	2.85	2
HUNGARY	11.55	10.88	10.46	10.51	9.85	8.48	6.21	5.32	4.70	4.43	4.86	4.56	2
IRELAND	3.14	3.13	3.46	3.28	3.44	3.42	3.49	3.26	3.19	3.01	2.93	2.81	1
ITALY	2.88	2.97	4.03	3.69	3.50	2.83	2.50	2.02	1.90	1.89	1.44	1.25	1
LATVIA	4.95	4.13	4.03	3.65	3.53	3.38	3.18	3.21	2.82	2.82	2.67	2.62	1
LITHUANIA	4.17	3.70	3.71	2.97	2.39	2.15	1.88	1.95	2.01	2.22	2.37	2.33	1
LUXEMBOURG	2.49	2.16	2.40	2.23	2.13	2.02	1.86	1.68	1.74	1.75	1.53	1.34	2
MALTA	3.51	3.43	3.38	3.40	3.03	2.85	2.99	2.84	2.83	2.71	2.58	2.60	1
NETHERLANDS	4.86	4.52	4.55	4.27	3.78	3.37	2.93	2.59	2.41	2.40	2.27	1.85	1
POLAND	7.23	6.48	6.70	6.95	5.14	4.10	4.40	4.40	4.40	4.40	4.40	2.90	1
PORTUGAL	2.69	2.43	3.74	3.89	3.26	3.21	2.38	1.90	1.59	1.38	1.20	0.92	2
ROMANIA	7.16	5.31	5.84	5.03	4.73	5.06	3.99	3.46	3.70	5.16	5.45	5.12	2
SLOVAKIA	5.87	5.21	4.84	4.69	4.07	3.39	2.72	1.97	1.82	1.54	1.35	1.12	1
SLOVENIA	4.45	3.34	3.77	3.37	3.20	3.21	2.53	2.33	2.50	2.44	2.35	1.82	1
SPAIN	3.25	2.53	3.37	3.30	3.04	2.96	2.24	2.01	1.95	1.97	1.99	1.73	2
SWEDEN	2.06	2.39	3.87	3.48	2.75	2.24	1.66	1.60	1.58	1.50	1.52	1.48	2
ICELAND	5.67	5.14	4.82	4.24	3.92	3.86	4.19	4.10	4.06	3.98	3.62	2.79	6
NORWAY	n/a	n/a	n/a	n/a	3.98	3.78	2.86	2.43	2.50	2.45	2.75	2.12	6
SWITZERLAND	2.79	2.58	2.39	2.18	2.02	1.89	1.77	1.63	1.53	1.45	1.37	1.28	6
UNITED KINGDOM	4.21	3.81	3.62	3.69	3.24	3.12	2.62	2.34	2.03	2.11	2.25	2.00	1

Source: Hypostat (2021)

Concerning residential affordability (residential prices compared to households' disposable income), increasing ratios suggest a reduced capacity of households to purchase a property (which might lead to a market saturation), while on the contrary, decreasing ratios might suggest greater capacities to purchase a residence. The countries benefitting from such decreasing ratios, for the period 2009- 2020 are: Cyprus, Denmark, Estonia, Finland, Greece, Ireland, Italy, Lithuania, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain.

Table 3: Nominal House Price to Disposable Income of Households Ratio (2015= 100)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AUSTRIA	81.4	85.6	88.6	91.4	95.9	96.6	100.0	104.3	106.2	107.4	107.6	118.1
BELGIUM	96.7	99.3	100.2	101.4	101.9	102.2	100.0	101.4	101.7	102.4	103.6	101.8
BULGARIA	136.8	120.8	106.6	104.2	100.3	101.0	100.0	102.2	103.8	n/a	n/a	n/a
CROATIA	114.6	107.0	108.0	110.1	105.8	106.8	100.0	97.7	96.5	96.6	100.9	n/a
CYPRUS	121.9	117.9	111.5	108.7	107.3	104.5	100.0	92.7	88.2	83.6	82.4	86.5
CZECHIA	100.5	95.3	91.5	91.5	94.4	100.4	100.0	106.2	104.8	105.1	108.0	115.2
DENMARK	116.3	113.0	105.3	98.4	97.6	97.7	100.0	99.1	100.3	101.2	101.4	104.8
ESTONIA	81.8	86.4	86.7	90.0	91.9	98.7	100.0	102.1	98.5	95.7	59.4	63.0
FINLAND	103.1	107.9	106.5	105.2	104.2	102.5	100.0	99.0	97.6	95.4	93.3	93.7
FRANCE	104.1	108.9	110.7	107.3	106.4	103.1	100.0	99.1	99.6	99.6	99.8	104.2
GERMANY	98.6	96.9	95.9	96.5	97.8	98.3	100.0	102.5	104.8	108.8	112.6	119.9
GREECE	108.9	114.3	119.9	118.8	113.5	104.9	100.0	100.3	97.6	98.0	101.2	107.3
HUNGARY	110.2	99.9	92.9	91.5	85.2	87.8	100.0	111.9	116.9	129.1	142.8	162.8
IRELAND	122.5	108.5	96.1	80.6	81.9	93.5	100.0	102.3	106.2	111.7	106.6	101.5
ITALY	118.4	120.6	119.1	119.4	111.1	105.3	100.0	99.0	96.0	93.7	92.9	97.5
LATVIA	97.1	102.6	107.7	105.4	109.9	99.1	100.0	102.3	104.5	108.4	113.5	115.8
LITHUANIA	110.4	100.7	102.6	98.0	94.7	99.5	100.0	98.2	102.4	103.2	100.1	99.9
LUXEMBOURG	95.4	96.9	98.0	96.4	97.9	96.3	100.0	103.9	102.6	104.0	107.0	116.3
NETHERLANDS	127.4	122.6	117.1	108.7	100.5	99.0	100.0	102.0	107.1	111.5	114.5	119.6
POLAND	141.9	121.7	118.4	105.9	103.4	102.0	100.0	101.7	98.6	104.7	107.9	116.9
PORTUGAL	105.5	104.6	101.5	97.0	96.0	100.4	100.0	103.2	113.3	122.8	128.5	138.2
ROMANIA	164.7	136.7	121.4	118.7	107.2	104.3	100.0	96.6	90.1	88.2	79.7	78.1
SLOVAKIA	126.1	118.2	113.2	108.0	106.5	103.5	100.0	101.0	102.7	99.2	101.5	111.7
SLOVENIA	121.7	120.2	120.8	115.5	109.5	101.0	100.0	99.1	102.1	105.4	129.6	105.5
SPAIN	129.1	123.5	115.9	111.6	105.4	102.8	100.0	99.2	98.4	98.8	99.3	101.5
SWEDEN	109.3	100.8	91.7	83.5	83.7	91.3	100.0	105.0	111.4	113.5	114.3	120.7
NORWAY	97.0	90.8	90.6	88.6	86.5	96.1	100.0	114.8	109.4	111.9	112.6	128.6
UNITED KINGDOM	107.8	108.8	116.9	112.7	112.9	112.6	100.0	124.6	129.0	127.8	126.2	137.5
SWITZERLAND	122.6	112.9	106.6	107.8	110.8	110.9	100.0	99.3	104.7	109.3	106.2	103.4

Source: Hypostat (2021)

In brief, while the indicators concerning mortgage shares and levels tend to identify Central and Eastern Europe as markets with a potential future growth, the indicators relative to the loan attractiveness (low interest rates), residential purchases affordability and the growing patterns of mortgage markets², since 2009, stress the potential of the Euro-zone. Furthermore, the latter benefits also from a greater familiarity of this type of products and thus from deeper knowledge and understanding of their specifics.

Thus, two types of trends can be identified: countries in Central and Eastern Europe following a catch-up path, but where socio-cultural characteristics lead to a lower degree of familiarity with loans, credits, mortgages and the euro-zone (the 11 founding members³) where financial products' use is quite well-spread, but where socio-cultural characteristics, as well as more favorable conditions, might ease the implementation of EE mortgages. Therefore, while for the first group of countries EEMs might be assimilated to a new market, for the second group, EEMs might be rather considered as a re-

² Except for the Czech Republic, Poland and Romania which are not members of the euro-zone.

³ These include Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain.



Evaluation of the potential interest/ need of EE mortgages among EU members

segmentation of an existing market by employing a niche a strategy (the latter presenting several advantages in terms of ease of implementation).

Furthermore, some country -specific characteristics might also influence the spread of this new type of products. For instance, the Spanish and Portuguese mortgage markets are characterized also by secondary residence acquisitions from non-residents. For this type of properties, the demand for EEMs will not obey to the same triggers as for primary residences (increased property value vs reduced energy bills, long-term operating and maintenance costs and improved living conditions). Therefore, the contraction of an EEM will be rather motivated by the potential extra- value that the upgraded property could benefit from, than by the discussed above indicators.

All this highlights the uncertainty of the potential growth and evolution of EEM markets in EU countries, given the potential weight of socio-cultural and country characteristics.

4. Evaluation of households' exposure to energy expenditure and residential age structure

The financial burden relative to an EE investment for households depends not only on their capacity to engage into an additional mortgage or loan, but also on their energy expenditure and the savings that they can benefit from EE.

Energy expenditure represents the energy burden born by a household for a given period of time. It takes into account not only the electricity, gas, or other primary energy prices but also the average household income. This approach allows to take into consideration the living standard in a given country and eases the comparison across countries or regions. In our case, it will be particularly insightful to dispose with an indicator providing information on the average financial burden related to heating, cooling and hot water needs of households in EU member states. As such it should reveal two major pieces of information: 1) the countries where households are exposed to higher energy bills relatively to their incomes (due to their exposure to more recurrent extreme weather events or to their specific energy systems) and in consequence 2) those countries that could be interested by an improvement of the EE, including buildings' EE.

However, an international comparison of households' energy expenditures requires a complex modelling taking into account not only the households' energy consumption, the country specific energy mix (the repartition of primary energies such as oil, natural gas, coal, nuclear power and renewables) and their inherent prices, but also the households' revenues, which is not the purpose of the present report. Thus, for sake of simplification, we will focus consecutively to all these indicators, in order to identify the EU countries, the most exposed to each indicator and propose an analytical summary. As such, the present section will focus first on the particularities of households' energy consumption across EU members and the age structure of homes, then on gas and electricity prices (as the former represents the dominant energy source for EU households (ODYSSEE-MURE, 2021)).

The Odyssee-Mure database proposes an interesting evaluation of households' energy expenditure, and we will include it in the present analysis. Nevertheless, for the elaboration of our cross-country indicators, we are choosing rather the separate energy consumption and energy prices, since they allow for a more accurate international comparison. Indeed, they present the advantage of including the dimension of the country-specific living standards through their conversion in Purchasing Power Standards.

4.1 EU households' energy consumption patterns

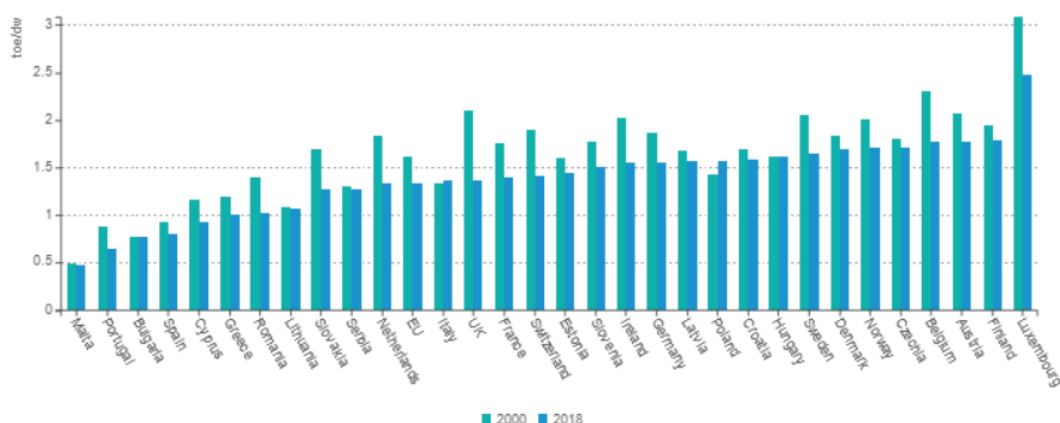
For most European countries, according to data provided by the Odyssee-Mure project⁴, the average energy consumption per dwelling has decreased for the period 2000-2018. Only Bulgaria, Hungary,

⁴ The Odyssee-Mure project is a H2020 project supported by the EU Commission and coordinating 36 partners (National energy efficiency agencies or their representatives) from 31 countries with the technical support of Enerdata and Fraunhofer -Gesellschaft.

Evaluation of the potential interest/ need of EE mortgages among EU members

Italy, Lithuania, Malta and Poland present stable levels of consumption or slightly increasing ones (Figure 3). Nevertheless, the consumption of a large majority of countries is above the EU average and the Nordic countries as well Austria, Belgium, Luxembourg and Croatia present the highest levels.

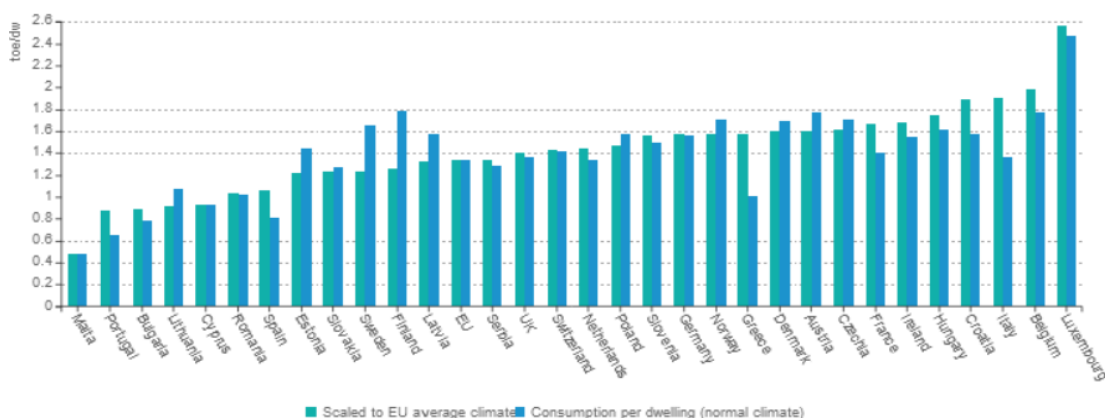
Figure 3: Average energy consumption per dwelling (at normal climate)



Source: ODYSSEE-MURE (2021)

When taking into account the adjustment of the energy consumption to the same climate (EU average climate conditions) (Figure 4), the countries having the highest level of per dwellings' energy consumption are: Luxembourg, Belgium, Italy, Croatia and Hungary. Indeed, this type of approach allows to identify more precisely the EU members which energy consumption is rather related to their energy systems (with probably a greater EE potential) rather than to their exposure to more severe climate conditions. Thus, it allows to go beyond the general understanding that Northern Europe presents higher needs for heating and Southern Europe for cooling and to focus on those countries which energy consumption is higher per se and which might need greater EE improvements.

Figure 4: Average energy consumption per dwelling (adjusted to EU climate, 2018)

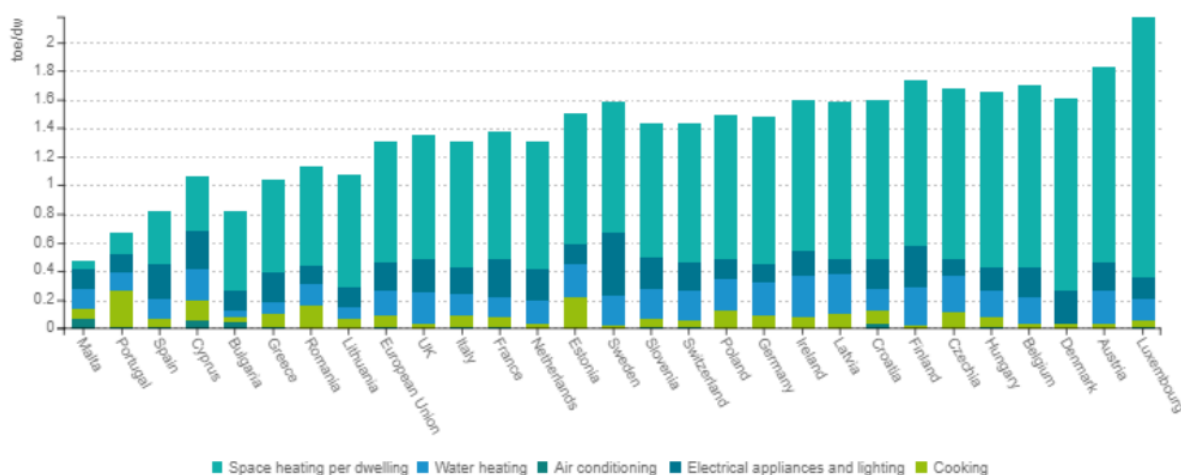


Source: ODYSSEE-MURE (2021)

At last, for all EU members, the very large majority of energy consumption is related to space heating (Figure 5) for which several EE appliances and techniques are already available and could be

implemented easily. While air-conditioning presents the lowest share of households' energy consumption, its recent evolution presents a growing trend. In the same time, space heating is rather subject to a drop (Figures A1 and A2 in Appendix).

Figure 5: Specific energy consumption of households by end-use (2019)



Source: ODYSSEE-MURE (2022)

In brief, according to their energy consumption levels, Luxembourg, Belgium, Italy, Croatia, Hungary, Ireland, France, Czech Republic, Austria, Denmark, Greece, Germany and Slovenia might present a greater potential and interest of the implementation of EE initiatives.

4.2 Residential characteristics- residential age structure

Real estate characteristics also have a direct impact on dwellings' energy consumption levels. Furthermore, they also can provide interesting insights on the EE potential of buildings. The EU Buildings factsheets⁵ present interesting and insightful information (shell performance, renovation rates and etc.) that could have been useful for the current analysis. Unfortunately, it has been updated for the last time in 2014. For this reason, we will focus, only on the house age structure (Figure 6).

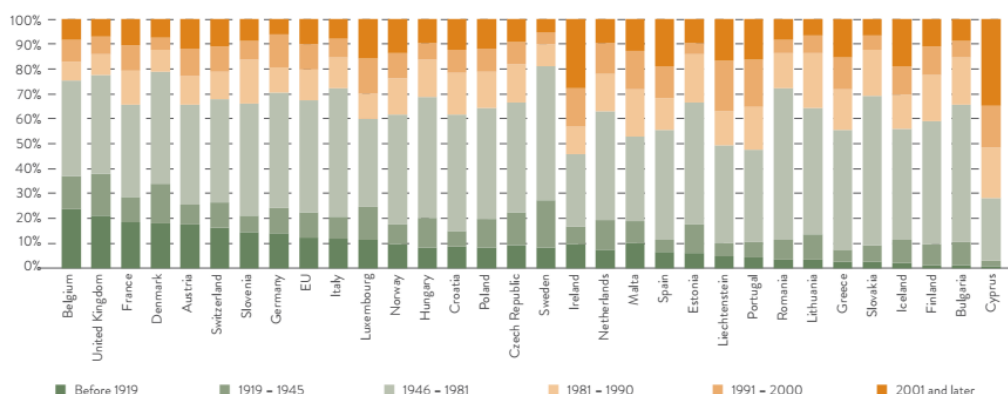
The age structure of dwellings might be considered as a good proxy for buildings' EE potential, since the shell performance of older residential buildings is less efficient than the currently used standards and leads to greater U-values⁶.

Figure 6: Residential age structure among EU members

⁵ https://ec.europa.eu/energy/eu-buildings-factsheets_en

⁶ U values represent the "heat transfer coefficient" measuring the heat loss operated through a building shell element (windows, walls, roofs, floors).

Evaluation of the potential interest/ need of EE mortgages among EU members



Source: Hypostat (2021⁷)

As one can notice, most of the countries in the EU have a large majority of old buildings, constructed before 1990. Indeed, with some few exceptions, the share of old buildings represents at least 60% of the building stock. The most exposed countries to this indicator are: United Kingdom, Belgium, Denmark, Sweden, Germany, Hungary, Italy, Romania and Slovakia.

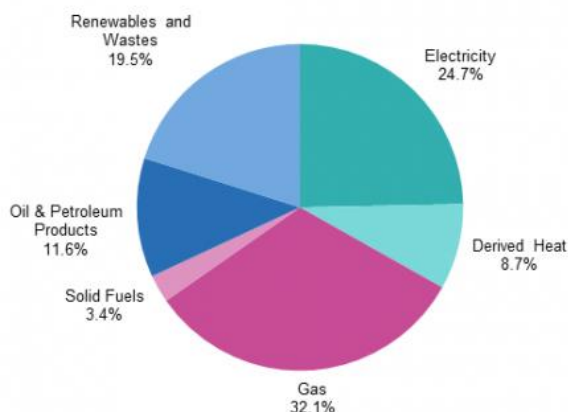
4.3 EU energy prices for household consumers

The previous two sections have allowed to identify the European countries with the highest households' energy consumption profiles as well as those presenting an ageing residential structure. Nevertheless, in order to provide a more precise overview of the households' energy expenditure, energy prices and households' purchasing power should be considered.

The two predominant energy sources for the residential sector in the European Union are gas and electricity accounting respectively for 32.1% and 24.7% (Figure 7).

⁷ This graph is based on data extracted from the EU Housing Census (2011). A new census has been performed in 2021, but a first set of data will be available through Eurostat by the end of December 2022 (<https://ec.europa.eu/eurostat/fr/web/population-demography/population-housing-censuses>).

Figure 7: Final energy consumption in the EU residential sector by fuel, 2019 (%)



Source: Eurostat ([nrq_bal_c, 2022](#))

The repartition of energy consumption by fuel varies across member states, but four major groups of households' consumption can be identified (Table A1 in Appendix):

- 1) **Relying for more than 25% on derived heat:** Denmark 37%, Finland 28%, Sweden 35%, Iceland 81%, Latvia 30.9%, Lithuania 30.8%, Estonia 34.3%;
- 2) **Relying for more than 25% on oil, oil products and coal:** Ireland 53%, Greece 28%, Cyprus 31%, Poland 31%, Belgium 29.6%;
- 3) **Relying for 30% and more on renewables:** Bulgaria 33%, Czech Republic 31%, Estonia 40%, Croatia 46%, Latvia 43%, Lithuania 34%, Austria 30%, Portugal 37%, Romania 39%, Slovenia 43%, Finland 31%);
- 4) **Relying for more than 20% on natural gas:** Belgium 41.5%, Czech Republic 25.6%, Germany 38.8%, Spain 20.4%, France 28.5%, Ireland 20.5%, Croatia 20.5%, Italy 51.8%, Luxembourg 53.4%, Hungary 49.2%, Netherlands 69.3%, Austria 21%, Poland 20%, Romania 32.6%, Slovakia 42.4%, UK 62.9%.

Concerning electricity consumption, for most of the countries the consumption is close to 20% or exceeds this level. In the cases of Spain, Portugal, Cyprus, Malta, Bulgaria, Sweden it is even above 40% of the total households' final energy consumption.

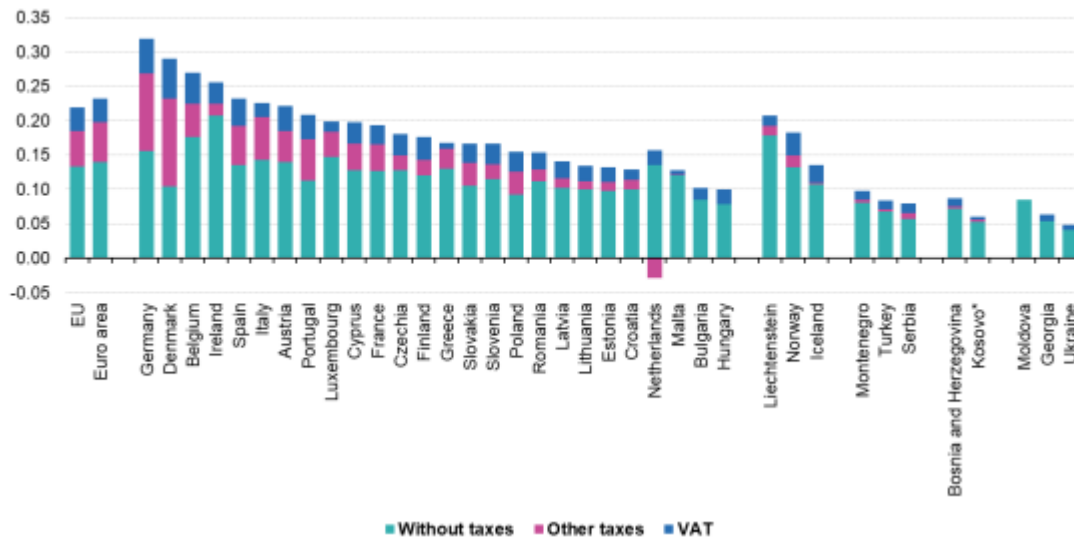
Therefore, given the predominance of gas and electricity as residential buildings' energy sources, the present report will focus on their prices for households in the EU.

4.3.1 Electricity prices and expenditure for EU households

According to Eurostat (2021) the European members with the most exposed to higher electricity prices households are: Germany, Denmark, Belgium, Ireland, Spain, Italy, Austria, Portugal and Luxembourg (Figure 8).

Figure 8: Electricity prices for household consumers, first half 2021 (EUR per kWh)

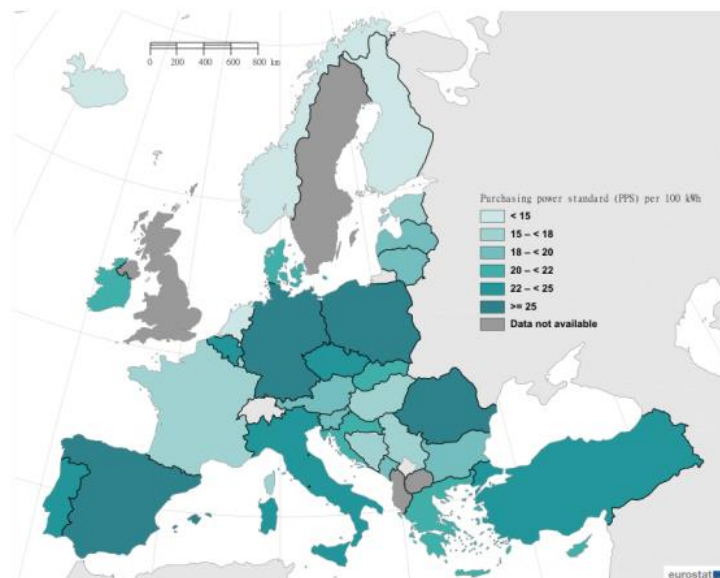
Evaluation of the potential interest/ need of EE mortgages among EU members



Source: Eurostat (2021)

However, electricity prices should be considered in the light of purchasing power or households' income in order to encompass at best the households' energy expenditure burden. According to Eurostat (2021) (Figure 9), the countries the most exposed are: Spain, Germany, Poland and Romania, followed by Czech Republic, Italy, Portugal, Belgium.

Figure 9: Electricity prices for household consumers (Purchasing Power standard (PPS) per 100 kWh)



Source: Eurostat (2021)

4.3.2 Natural gas prices and expenditure for EU households

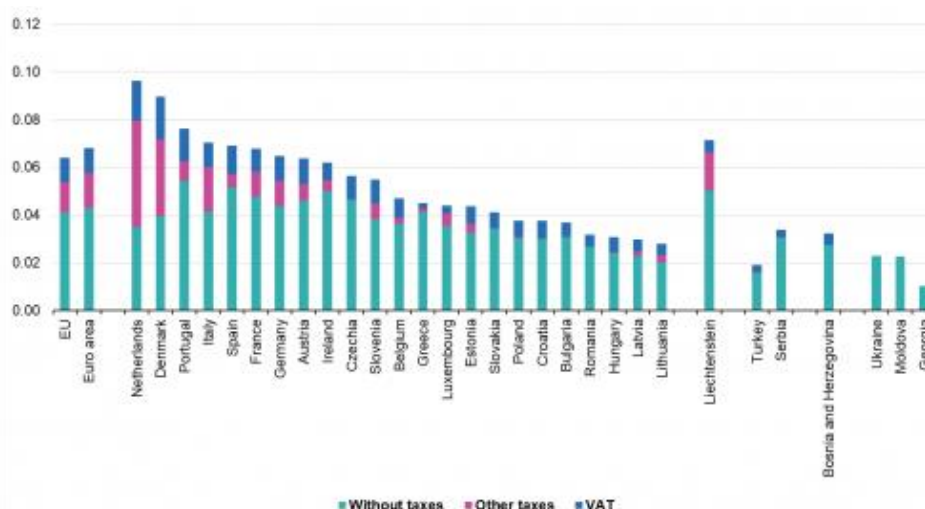
Concerning natural gas prices, the countries where households face the highest price levels in the EU are: Netherlands, Denmark, Portugal, Italy, Spain, France, Germany, Austria and Ireland (Figure 10). However, at the same time, most of these countries, apply higher taxation levels on gas consumption (especially the Netherlands, Denmark and Italy).

Another reason explaining, the observed heterogeneity among EU members relies on the definition of retail prices, depending on national energy regulators. Thus, even though, all EU countries face almost the same wholesale gas prices, the retail households' prices obey to complex country specific mechanisms, which can compensate or on the contrary exacerbate an increase of wholesale gas prices.

For instance, the current significant increase of gas bills for EU households is not only a consequence of wholesale price increases, but also of a depreciation of the euro (as most wholesale purchases are denominated in dollars) and an additional increase of oil prices. Several previous more consequent wholesale price increases (in 2005 and 2008) have poorly impacted households, thanks to a stronger value of the euro (2005 and 2008) or to lower oil prices (2005).

Furthermore, the exposure of households to gas expenditure depends also on their country-specific purchasing power capacity.

Figure 10: Natural gas prices for households consumers, first half 2021 (EUR per kWh)

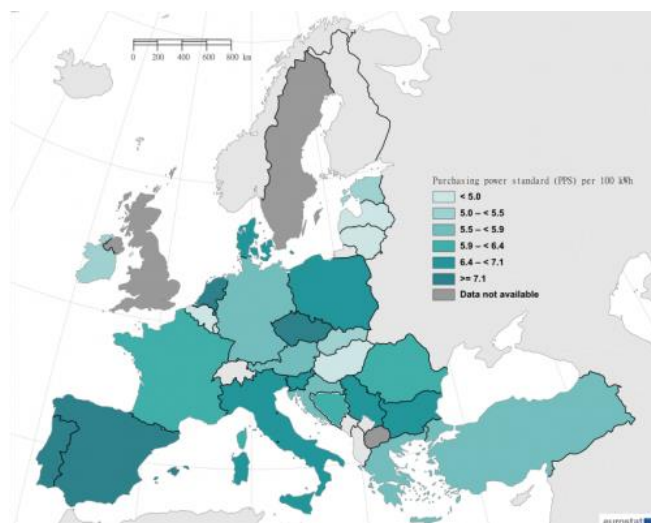


Source: Eurostat (2021)

Thus, when the purchasing power is taken into account, the list of the most concerned countries in terms of households' natural gas expenditure are: Portugal, Spain, Netherlands, Czech Republic, followed by: Italy, Bulgaria, Denmark, Slovenia, Poland, France and Romania (Figure 11).

Figure 11: Natural gas prices for household consumers (Purchasing Power standard (PPS) per 100 kWh)

Evaluation of the potential interest/ need of EE mortgages among EU members



Source: Eurostat (2021)

In a nutshell, with regards to the households' energy consumption levels, Luxembourg, Belgium, Italy, Croatia, Hungary, Ireland, France, Czech Republic, Austria, Denmark, Greece, Germany and Slovenia might be interested by a potential reduction through improved EE. When electricity prices are concerned, Spain, Germany, Poland, Romania, Czech Republic, Italy, Portugal, Belgium seem to be the most exposed, while when considering households' natural gas expenditures, Portugal, Spain, Netherlands, Czech Republic, Italy, Bulgaria, Denmark, Slovenia, Poland, France and Romania occupy the top ranking.

When crosschecking the three energy indicators, the countries where households are the most exposed to energy expenditures are: Belgium, Italy, Spain, Portugal, Poland, Czech Republic, Romania, France, Germany, Slovenia and Denmark (Table 4).

Table 4: Summary country exposition to households' energy expenditure

Energy expenditure			
Energy consumption		Electricity prices	Gas prices
Concerned countries	Belgium	Belgium	
	Italy	Italy	Italy
		Spain	Spain
		Portugal	Portugal
		Poland	Poland
	Czech Republic	Czech Republic	Czech Republic
		Romania	Romania
	France		France
	Germany	Germany	
	Slovenia		Slovenia
	Denmark		Denmark

Source: Authors' compilation (ODYSSEE-MURE (2021), Eurostat (2021))

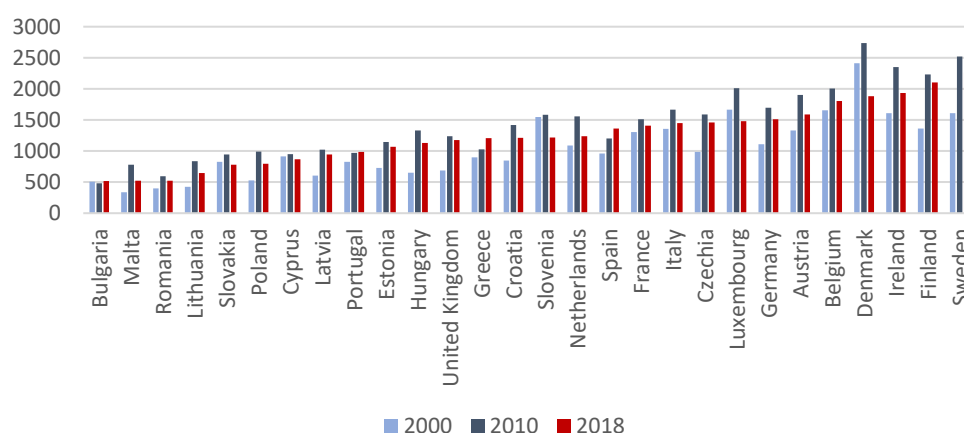
4.4 ODYSSEE- MURE EU annual energy expenditures per household for housing

As mentioned in the beginning of this section the estimation of households' energy expenditure requires a complex modelling able to encompass the households' energy consumption in a given country, its inherent split among primary energy sources and their corresponding prices. For sake of simplification, we have proceeded to a separated evaluation of each of the factors in order to reach to a global conclusion for each of the EU members.

However, the ODYSSEE- MURE database proposes an estimation of the annual energy expenditure per household for housing, thus excluding all energy costs related to transport, but covering all heating, cooling, hot water and other electricity appliances costs. The advantage of this indicator resides in its simple use and its availability for the last 20 years. Nevertheless, it does not take into account the purchasing power capacity of households and thus the real burden that it might represent for them.

Therefore, as highlighted by Figure 12, the countries presenting the highest energy bills are concentrated in Northern Europe, while the most recent EU member states (like Romania and Bulgaria) occupy rather the opposite side of the graph, which is quite logical given the extreme differences in terms of living standards.

Figure 12: Annual energy expenditures per household for housing (EUR2010/hh)



Source: Authors' compilation (ODYSSEE-MURE (2021))

Given this limit of the indicator, we will choose to use rather the variables allowing for a more accurate international comparison, presented in the previous sections.

5. Evaluation of countries' climate vulnerability

The promotion of EE in buildings can be triggered by the reduction of energy expenditure, but also by the exposure to the negative effects of climate change. Indeed, greater levels of EE involve lower GHG emissions and thus, reduce the potential harms of climate change.

In this section, the aim is to identify the EU members the most exposed to climate change and thereafter those that might be keener to adopt EE improvements. For this purpose, we will focus on two major indicators: the Climate Risk Index (CRI) elaborated by Germanwatch and the Notre Dame vulnerability score used for the ND-GAIN country index.

5.1 The Climate Risk Index

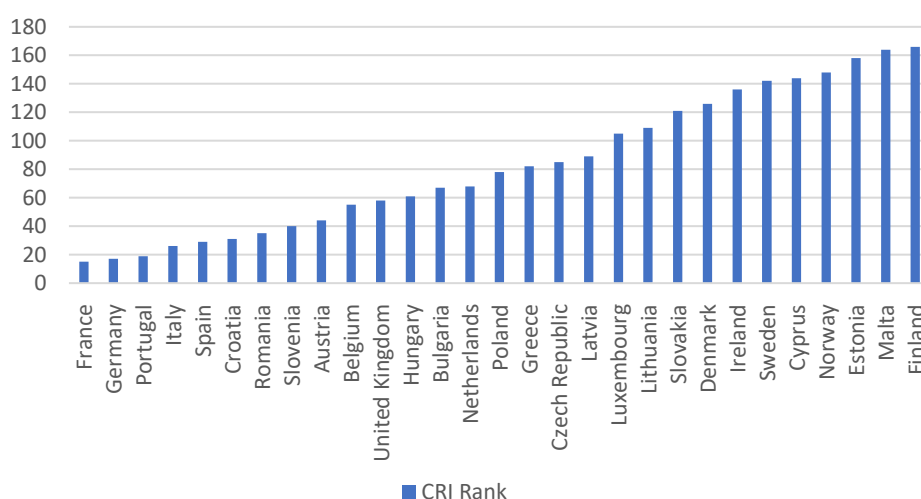
The CRI index combines four indicators: number of deaths, number of deaths per 100 000 inhabitants, sum of losses in US\$ in purchasing power parity (PPP), losses per unit of gross domestic product (GDP). Thus, the CRI score is obtained following the present formula:

$$\text{CRI Score} = \text{Rank Fatalities} \times 1/6 + \text{Rank Fatalities per 100 000 inhabitants} \times 1/3 + \text{Rank Losses in million US\$ (PPP)} \times 1/6 + \text{Rank Losses per unit GDP in \%} \times 1/3.$$

As the index is developed on the basis of a ranking of all countries, the country with the highest rank in a given category presents the less vulnerable condition. Thus, lower ranks and therefore lower SCI scores and ranks correspond to a greater vulnerability.

Nevertheless, according to their CRI score, the European countries that have suffered (in terms of economical and physical losses) the most, during the 1999-2018 period are: France, Germany, Portugal, Italy, Spain, Croatia, Romania, Slovenia, Austria and Belgium (Figure 13).

Figure 13: EU countries climate vulnerability -Climate Risk Index (rank 1999- 2018)



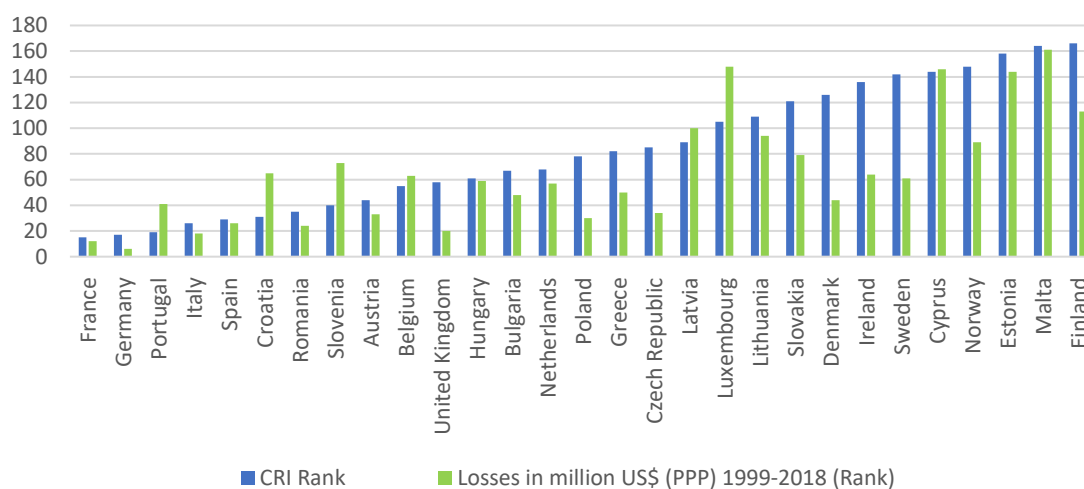
Source: Global Risk Index 2020 (Germanwatch, 2020)

When only the financial losses are considered (in \$ million PPP), the most exposed countries are: Germany, France, Italy, Romania, Spain, Poland, Austria, Czech Republic, Portugal, Denmark. Thus, the

Evaluation of the potential interest/ need of EE mortgages among EU members

vulnerability of Germany, France, Italy, UK, Spain, Romania, Poland, Austria, Czech Republic and Portugal, are further highlighted (Figure 14).

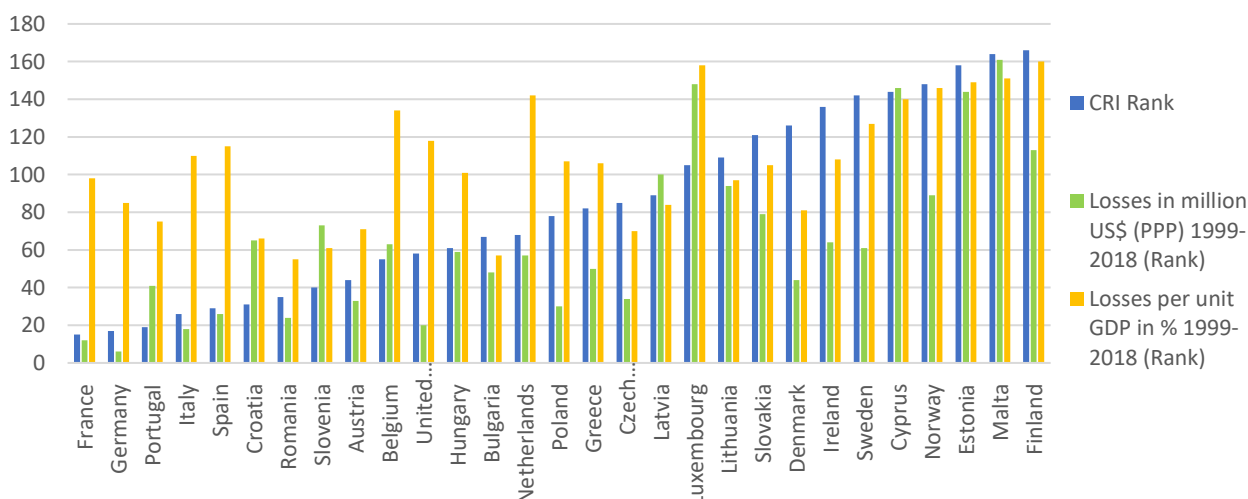
Figure 14: EU countries climate vulnerability - Climate Risk Index and economic losses (rank 1999-2018)



Source: Global Risk Index 2020 (Germanwatch, 2020)

However, when compared to the GDP levels, only Romania, Austria, Portugal, Czech Republic, Denmark and Germany maintain their position in the top 10 of the most exposed EU countries (Figure 15 and Tables A2, A3, A4).

Figure 15: EU countries climate vulnerability - Climate Risk Index and economic losses (US\$ PPP and % GDP, 1999- 2018)



Source: Global Risk Index 2020 (Germanwatch, 2020)

As per its construction, the Germanwatch index considers the vulnerability of a given country expressed only in terms of population and economic losses. Given its restrictiveness, we will further take into account also the ND-GAIN country index which covers a larger set of indicators.

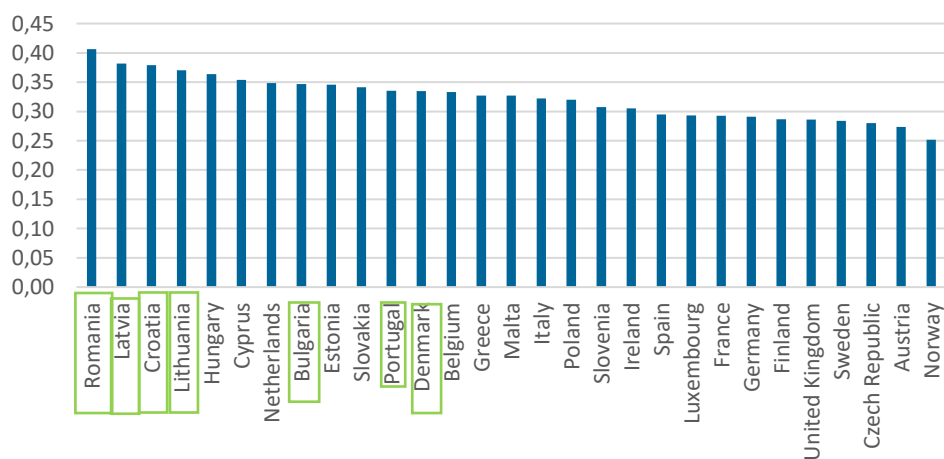
5.2 The ND-GAIN country index

The vulnerability to climate change represents the exposure to climate hazards and therefore affects a multitude of sectors and activities. For this reason, an evaluation only in terms of population and economic losses might be considered as succinct.

Thus, we choose to include to the present analysis also the University of Notre Dame Global Adaptation Index (ND- GAIN index) and more precisely its vulnerability component. As defined by Chen et al. (2015) the latter measures the vulnerability in six life-supporting sectors- food, water, health, ecosystem service, human habitat and infrastructure. According to the authors, the notion of vulnerability includes not only the country's exposure to climate change but also its sensitivity and capacity to adapt. Lower scores correspond to less vulnerable conditions.

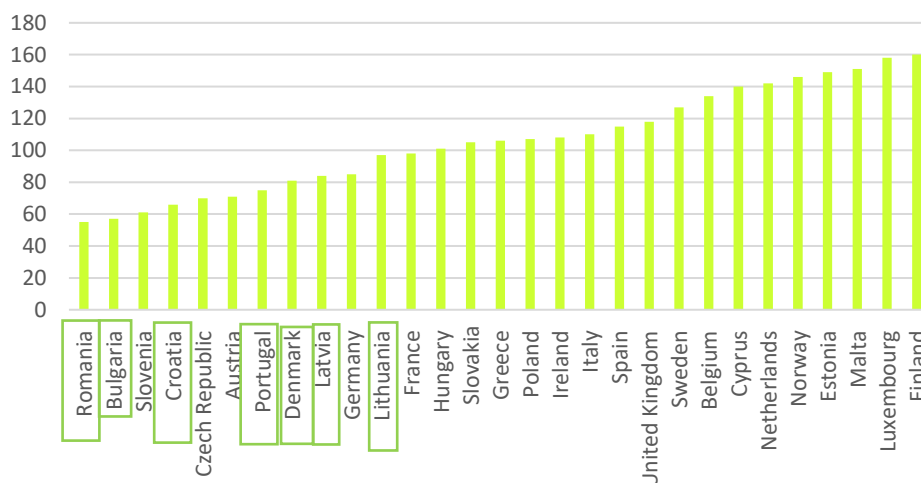
The obtained observations are quite similar to those obtained by Germanwatch ranks corresponding to the Losses per unit GDP in % (Figure 16). Indeed, Romania, Latvia, Croatia, Lithuania, Bulgaria, Portugal, and Denmark seem to be more exposed to climate change and its impacts on food and water provision, health, habitat, infrastructures, and ecosystems.

Figure 16: EU countries climate vulnerability – ND- GAIN Country Index, Vulnerability component (average levels 1995- 2019) vs Germanwatch CRI Rank Losses per unit GDP in % (1999-2018)



Source: ND-GAIN Country Index (2021)

Evaluation of the potential interest/ need of EE mortgages among EU members



Source: Global Risk Index 2020 (Germanwatch, 2020)

In short, the most vulnerable to climate change and its impacts EU countries are: Romania, Latvia, Croatia, Lithuania, Bulgaria, Portugal, and Denmark. They might be affected not only in terms of population and economic losses respectively to their GDP (CRI) but also in terms of habitat, health, water and food provision, infrastructures and ecosystems (ND-GAIN Country Index). When total economic losses are considered, the most vulnerable countries are France, Germany, Portugal, Italy, Spain, Croatia, Romania, Slovenia, Austria and Belgium.

It is important to stress that these evaluations are based on the 1998-2019 period, thus, excluding the extreme and harmful weather events observed since then, which have severely affected several EU members, like Germany, Belgium and Northern Europe countries (2021 floods and wildfires), Greece, Spain and Portugal (2020 and 2021 extreme heat and wildfires).

6. Evaluation of already implemented EE domestic initiatives and political readiness

The need/interest in EE residential mortgages might be conditioned not only by the capacity of households to bear an additional credit, or by their energy expenditure burden, or by their climate change vulnerability, but also by the already implemented EE initiatives and the political willingness to adopt further measures.

In the present section will be shortly discussed the EE measures already undertaken by EU countries, the resulting evolution of households' EE levels and the political readiness to adopt further actions improving national resilience.

The ODYSSEE- MURE database also proposes the Energy Efficiency Score for Households, which adopts a similar approach and encompasses three different stages describing the EE capacity of an EU members: the current EE performance (Level Score), the EE progress (Trend Score) and the future impact of recent EE policies (Policy Score). The EE performance and progress are obtained in result of a complex modelisation based on the performance of different end- use equipment (heating, water heating, cooking, cooling, lighting, refrigerator, freezer, washing machine, dishwashers, dryer and TV) and thus provide more precise insights on real achievements.

However, unfortunately, both approaches exclude the impact of EE related to shell isolation (windows, roofs, floors, walls) which undoubtedly affects energy consumption. This evident limitation of the analysis is related to the restricted availability of such type of data (the last available being from 2014). Thus, a potential further improvement might lie into the inclusion of such information.

6.1 Existing EE initiatives

The EU presents an extremely rich landscape of financial instruments promoting EE. Economidou et al. (2019) propose an extensive overview and several interesting classifications in terms of development stage of the EE initiatives/ instruments (traditional, growing and new) or their scope (residential, commercial, public buildings) or of their nature (public and private schemes).

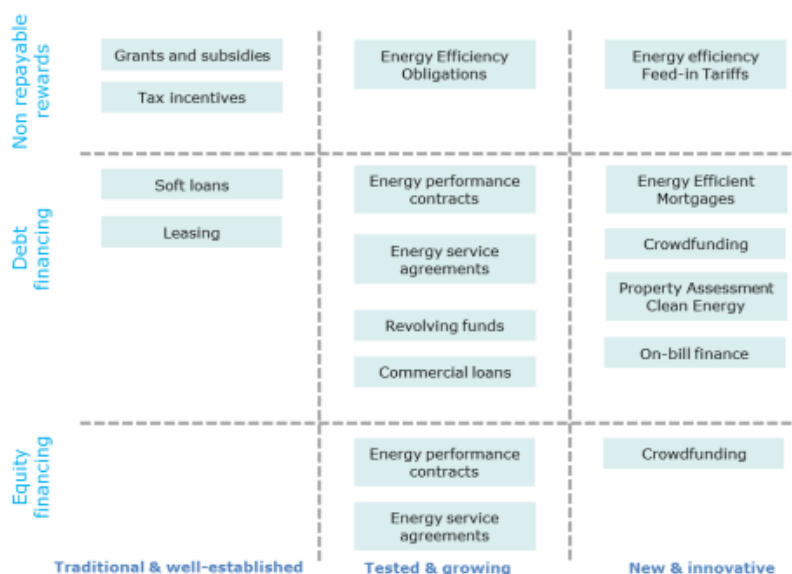
Indeed, Figure 17 regroups the large set of public and private schemes promoting EE. Among the traditional and well-established incentives, one can note tax incentives, grants and subsidies, leasing activities and soft loans. The EE mortgages appear among the new and innovative instruments, as well as EE feed-in tariffs, property assessment clean energy, on-bill finance, and crowdfunding.

According to the MURE database (2018), there were 142 incentive measures adopted across the UE and Economidou et al. (2019) count 193 public initiatives (Table A5 in Appendix). The table regroups the existing measures concerning residential, commercial and public buildings according to their type: grants and subsidies, loans and tax exemptions. The countries that have undertaken a large set of actions for all types of buildings are : Belgium, France, Germany, Italy and Portugal. For all of the EU members, the residential sector accounts for the majority of implemented instruments.

However, the countries presenting the lowest number of public measures (less than 4) concerning residential estate are: Croatia, Cyprus, Denmark, Finland, Estonia, Greece, Latvia, Lithuania, Malta, Romania, Poland, Slovenia, Spain, Sweden.

Figure 17: Current landscape of financial instruments supporting energy renovations in Europe

Evaluation of the potential interest/ need of EE mortgages among EU members

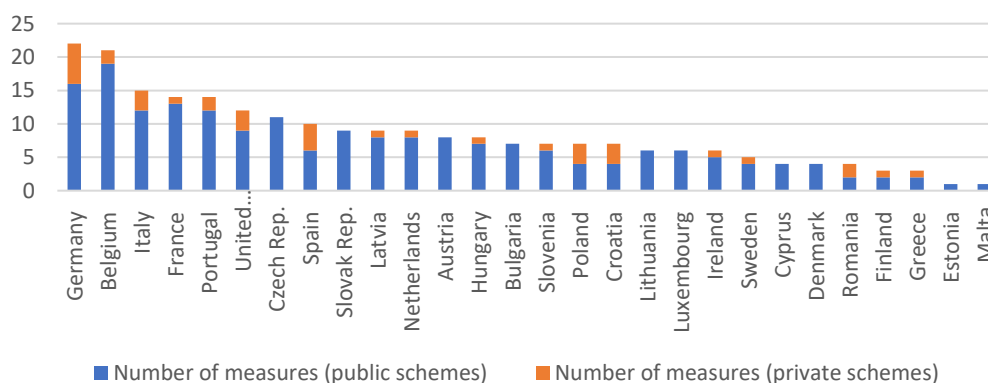


Source: Economidou et al. (2019)

In terms of private schemes development, the EU countries the most involved are: Germany, Italy, Spain, Poland, Croatia, UK, Belgium and Portugal (Table A6). More specifically, EE mortgages are proposed in UK, Germany, Sweden and Romania.

Thus, when both public and private measures are compiled (Figure 18), the countries presenting the lowest number of initiatives are: Malta, Estonia, Greece, Finland, Romania, Denmark, Cyprus and Sweden.

Figure 18: Number of EE measures and initiatives (public and private schemes)



Source: Authors' compilation (Economidou et al. (2019))

However, the number of publicly undertaken EE actions, as well as the existence of private supporting schemes cannot be assimilated to tangible EE improvements and cannot evaluate their efficiency, even though they provide indications on the countries where further actions can be undertaken.

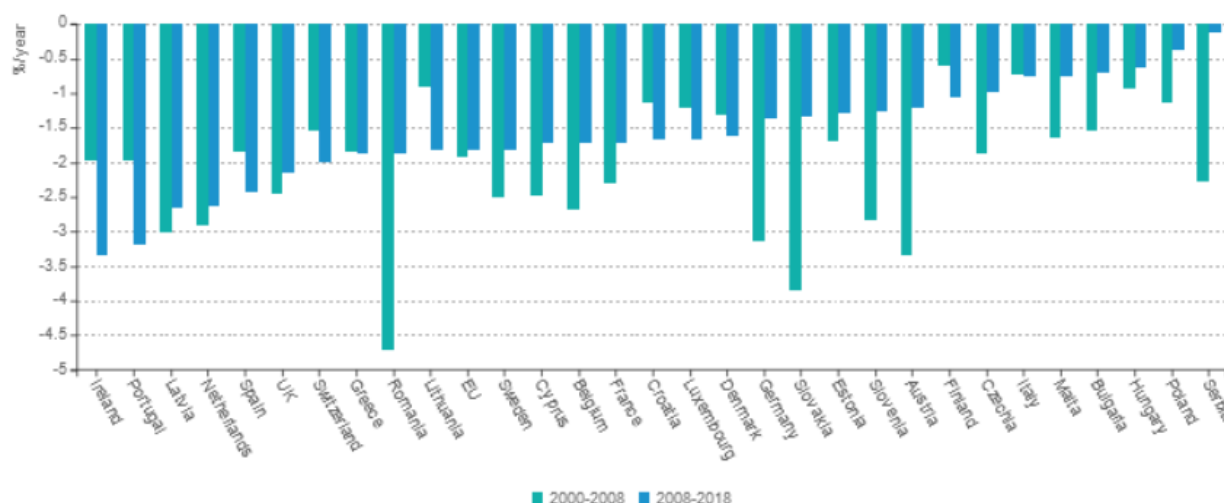
For this reason, we will further expand our analysis by considering the evolution of EE trends among EU members.

6.2 Energy efficiency trends for households in the EU

Even though EE has improved by almost 30% during the 2000-2018 period, since 2015, an important slowdown has been observed (ODYSSEE-MURE, 2021). This evolution is partially related to the decreasing trends in oil and natural gas prices and is the most evident for: Romania, Germany, Austria, Slovakia, and Slovenia (Figure 19).

The countries presenting the smallest EE progress for the 2008- 2018 period are Poland, Hungary, Bulgaria, Malta, Italy, Czech Republic, Finland, Austria. For this period, most of the EU countries have decreasing energy efficiency gains, except for: Portugal, Ireland, Spain, Lithuania, Croatia, Luxembourg, Denmark, Finland.

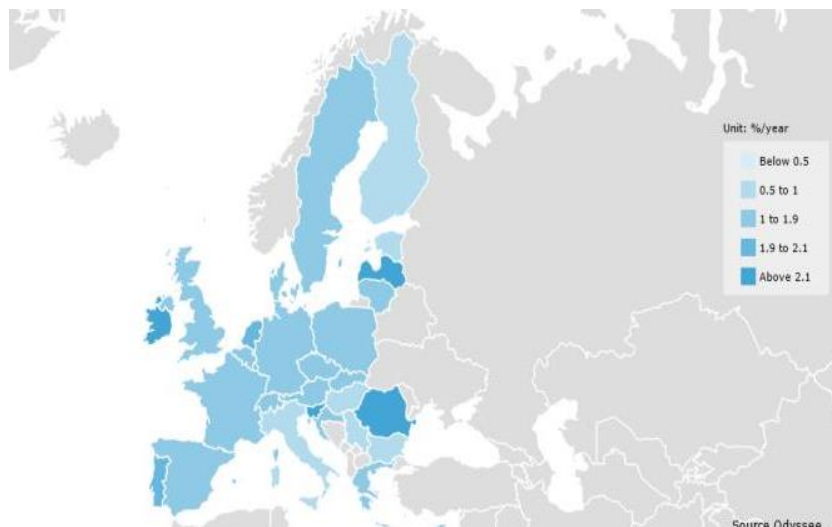
Figure 19: EE progress in EU countries (2000-2008 vs 2008-2018)



Source: ODYSSEE-MURE (2021)

In order to encompass the evolution of EE among EU members, during the whole period, 2000- 2019, we have also chosen to consider the Energy Savings Rate as a tangible proxy (Figure 20). Indeed, it presents the advantage to provide a clear information on the current state of the EE improvement level among member states.

Figure 20: Energy Saving Rate in households since 2000 (2019)



Source: ODYSSEE-MURE (2022)

According to the map above and Table A7 in Appendix, the countries presenting the lowest energy saving rates in 2019, comparatively to their levels in 2000 are : Italy, Hungary, Bulgaria, Finland, Malta, Estonia, Czech Republic, Lithuania, Croatia, Denmark and Poland. Thus, we can assume that these countries have benefitted the less from EE improvements for households.

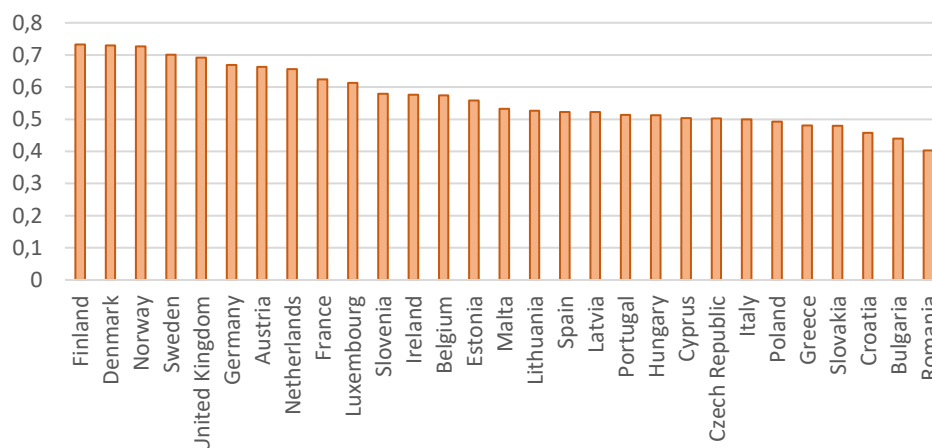
As mentioned above, the EE progress depends on several factors including the energy prices evolution, but also on the political involvement and readiness to adopt appropriate measures in the containment of climate change. In order to evaluate such political willingness, in the next subsection we will focus on the Readiness component of the ND-GAIN Country Index.

6.3 ND- GAIN Country Index, Readiness component

As previously discussed, the ND-GAIN Country Index captures the country's vulnerability or exposure to climate change challenges and the political capacity or readiness to face them. For the purposes of our evaluation, we will focus only on the readiness component.

Thus, as highlighted by Figure 21, the EU countries presenting lower levels of political anticipation concerning climate change vulnerability are: Romania, Bulgaria, Croatia, Slovenia, Greece, Poland, Italy, Czech Republic, Cyprus and Hungary. However, even for countries like Malta, Cyprus and Romania with more strongly fluctuating trajectories, the overall trend for the considered period is increasing (Figure A3), thus confirming the growing concern among EU members.

Figure 21: EU countries political readiness – ND- GAIN Country Index, Readiness component (average scores 1995- 2019)



Source: ND-GAIN Country Index (2021)

The overall energy efficiency score for households obtained by the Odyssee- Mure project can be considered as an interesting alternative approach for the evaluation of the EE progress and the political readiness.

6.4 ODYSSEE- MURE Overall energy efficiency scores for households

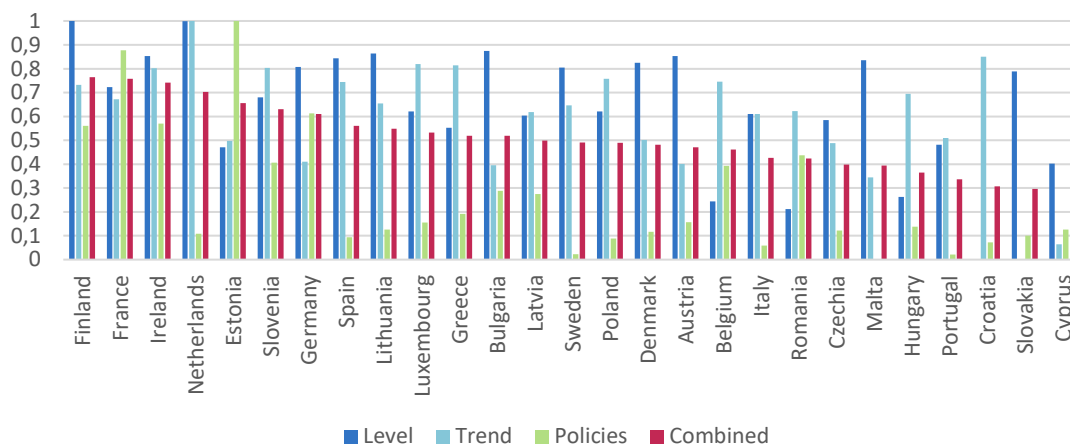
The overall energy efficiency score is defined as combination of the EE scores for four sectors: industry, transport, households, and services. For obvious reasons we will focus just on the households scores.

The final score is obtained as a weighted combination of the Level, Trend and Policies scores, each of them respectively reflecting the current EE state, the undergone EE progress and the future EE evolution given the recently implemented policies. These three dimensions propose a similar approach to the one discussed above, but the estimation process, of the first two, is based on the top-down EE indicators obtained from the ODYSSEE database, while the last one is derived from the MURE database.

We have chosen to represent in the next graph (Figure 22), not only the final scores, but also the inherent three dimensions for each country allowing to encompass all countries specifics.

The lowest ranks (below 0.5) are attributed to the following countries: Cyprus, Slovakia, Croatia, Portugal, Hungary, Malta, Czech Republic, Romania, Italy, Belgium, Austria, Denmark, Poland, Sweden, Latvia.

Figure 22: Energy efficiency scores for households (2021)



Source: Authors' compilation (ODYSSEE-MURE, 2022)

Comparatively to the conclusions derived from the previous three sections, the relatively low EE preparedness is confirmed for Slovakia, Croatia, Romania, Poland, Cyprus, Malta, Hungary and Denmark. In the meantime, Finland and Estonia present very high scores, much different from the previous conclusions. The observed difference is relative to the used methodology and the definition of the indicators. Thus, it is difficult to define the most accurate ones, but their comparison allows to confirm the profile of less performant countries in terms of EE.

In a nutshell, despite the promotion of a multitude of public actions supporting energy renovation in buildings at the European level, the observed drop since 2015 in the EE progress, highlights the undeniable importance of the energy prices' evolution. However, the long run character of EE policies and investments should rather anchor this type of decisions to the structural climate change vulnerability, rather than to conjunctural price evolutions.

Indeed, most of the countries present slightly reducing trends in their political readiness index since 2015, but for a vast majority the overall evolution during the observed period (1999-2019) has a growing pattern. Thus, the observed political willingness to contain climate change and its potential negative impacts might represent a trigger for a further development of private schemes supporting buildings' energy renovation, and more specifically EE mortgages.

7. Analytical evaluation of the potential interest/ need of EE mortgages among EU members

The present section aims to summarize the extensive information discussed above. In order to provide a clear overview of the current situation in EU members and in the UK, we have proceeded to the compilation of the major indicators that might pre-define a particular interest or utility of further EE improvements financed through private financial schemes.

Given the complexity of the mortgage markets' evaluation, we have chosen to propose rather a discussion on this topic. Based on the remaining indicators, we have tried to identify the countries for which: i) households are exposed to important energy expenditures; ii) climate vulnerability is important and iii) an important potential for further EE progress is present (restricted number of already implemented EE initiatives and small but growing political concern).

Concerning the residential mortgage market potential, we have proposed a discussion on its saturation, or on the conditions that might trigger or block its development. For this purpose, we have chosen five indicators describing the current mortgage share and average mortgage amount per household, and the evolution since 2009 of: the mortgage market, the interest rates relative to residential loans and the affordability of real estate. While the first two indicators tend to identify Central and Eastern Europe as markets with a potential growth capacity, the indicators relative to the loan attractivity (low interest rates), residential purchases affordability and recent mortgage market development stress the potential of the Euro-zone. Furthermore, the Euro-zone group benefits also from a greater familiarity of this type of products and thus from deeper knowledge and understanding of their specifics.

Thus, two types of potential trends for EEM can be identified: 1) the development as a new market for Central and Eastern Europe countries, which are following a catch-up path, but where socio-cultural characteristics lead to a lower degree of familiarity with loans, credits, mortgages and 2) the development as a re-segmentation of an existing market by employing a niche strategy in the euro-zone presenting more favorable economic and socio-cultural conditions.

Furthermore, markets like Spain and Portugal are characterized also by secondary residence acquisitions from non-residents. For this type of properties, the demand for EEMs will not respect the same mechanisms as for primary residences. The contraction of an EEM will be rather subject to the potential extra-value that the upgraded property could benefit from, than to the discussed above indicators.

With regards to energy expenditure, most of the EU members are exposed to at least to one of the four indicators that might affect the energy expenditure of households (property's age, energy consumption, gas and electricity prices), suggesting the necessity for EE improvements. The most concerned, however, are, Italy followed by the Czech Republic, Belgium, Denmark, Germany and Romania. In a lesser extent France, Poland, Slovenia, Hungary, Portugal and Spain are also concerned either by higher energy consumption profiles or are exposed to higher electricity or gas prices (Table A8 in Appendix).

As for climate vulnerability, according to the compilation of data that has been made (Table A9 in Appendix), very few EU countries are not particularly exposed to climate change risk. Indeed, only the Czech Republic, Finland, Luxembourg, and Sweden do not seem to be particularly vulnerable to

Evaluation of the potential interest/ need of EE mortgages among EU members

climate changes. However, these conclusions are based on data obtained up to 2019. Since then, important extreme weather events have been observed, especially in Northern Europe countries, highlighting therefore their fragility also. Thus, the most exposed countries are not only concentrated in Southern Europe (Greece, Portugal, Italy, Bulgaria, Croatia, Slovenia) but include also: Belgium, Hungary, Netherlands, Poland and Romania.

As for the EE potential, despite a considerable quantity of mostly public initiatives and measures implemented in EU members and a growing concern in all of them during the last 20 years, the tangible results in terms of EE progress are quite restricted and are rather correlated to the evolution of energy prices rather than to climate risks. This situation highlights the confrontation between rather short-term prerogatives and long-term investment decisions. The EE progress is evaluated by two different types of methodologies⁸ and the relatively low EE preparedness is confirmed for Slovakia, Croatia, Romania, Poland, Cyprus, Malta, Hungary and Denmark. If the ODYSSEE-MURE Scores are not considered, to this list can be added also: Bulgaria, Estonia, Greece, Finland, and Lithuania (Table A10).

When all the energy, climate and EE indicators are cross-checked, the countries, that should present a greater interest and need for a further development of EE mortgage markets, should be : Romania, Poland, Italy, followed by Denmark, Greece, Hungary, Croatia and Bulgaria (Table 5). As it appears, there is no clear regional similarity, and most EU members are exposed to energy and climate risk, while the achieved EE progress in residential buildings has been quite modest so far. Thus, there is an evident need for further EE improvements. As previously discussed, the spread of EEM can be influenced by more favorable economic and socio-cultural conditions, which are currently observed in the Euro-zone.

Table 5: Evaluation of potential interest/ need of EE mortgages among EU members

Country	Households' Energy Expenditure and homes age structure, Score (out of 4)	Climate Vulnerability, Score (out of 2)	Implemented EE domestic initiatives and political readiness, Score (out of 4)	Total Score
Austria	X	X	X	3
Belgium	XXX	XX	X	6
Bulgaria	X	XX	XXXX	7
Croatia	X	XX	XXXX	7
Cyprus		X	XXX	4
Czech Rep.	XXX		XX	5
Denmark	XXX	X	XXX	7
Estonia		X	XXXX	5
Finland			XXX	3
France	XX	X		3
Germany	XXX	X		4
Greece	X	XX	XXXX	7
Hungary	XX	XX	XXX	7

⁸ ODYSSEE- MURE EE Scores and a combination of three indicators relative to the quantity of implemented EE measures, the EE progress in terms of energy saving rates and the political readiness

Evaluation of the potential interest/ need of EE mortgages among EU members

Ireland	X	X	XX	4
Italy	XXXX	XX	XX	8
Latvia		X	XX	3
Lithuania		X	XXX	4
Luxembourg	X		X	2
Malta		X	XXXX	5
Netherlands	X	XX	X	4
Poland	XX	XX	XXXX	8
Portugal	XX	XX	X	5
Romania	XXX	XX	XXXX	9
Slovak Rep.	X	X	XXX	5
Slovenia	XX	XX	XX	6
Spain	XX	X	X	4
Sweden	X		X	2
UK	XX	X		3

Source: Authors' compilation (ODYSSEE-MURE (2021, 2022), Eurostat (2021), ND-GAIN Country Index (2021), Global Risk Index 2020 (Germanwatch, 2020), Economidou et al. (2019))

8. Further improvements

Given the important uncertainty, relative to the last economic and geopolitical situation, the present analysis does not include considerations on the short run and long run effects on EEM markets and the capacity of households to engage into further borrowing activities.

Furthermore, due to restricted data availability, EE related to shell isolation (windows, roofs, floors, walls) which undoubtedly affects energy consumption, was not included into the presented considerations.

At last, climate vulnerability data is based on observations up to 2019. However, since then, significant extreme weather events have been observed in normally spared regions such as northern Europe countries. Therefore, the vulnerability evaluation should be reexamined in the light of more recent data.

Potential further improvements might lie into the inclusion of such information.

9. References

Chen, C. Noble, I., Hellmann, J., Coffee, J., Murillo, M., Chawla, N. (2015). University of Notre Dame Global Adaptation Index, Country Index Technical Report. University of Notre Dame.

Economidou, M., Todeschi, V., Bertoldi, P. (2019). Accelerating energy renovation investments in buildings, Financial and fiscal instruments across the EU. EUR 29890 EN, Publications Office of the European Union, doi:10.2760/086805, JRC117816.

Eckstein, D., Künzel, V., Schäfer, L., Wings, M. (2020). Global Climate Risk Index 2020. Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2018 and 1999 to 2018. Germanwatch.

European Mortgage Federation. (2021). Hypostat 2021: A review of Europe's mortgage and housing markets.

Eurostat, Statistics explained. (2021). Energy consumption in households.

Eurostat, Statistics explained. (2021). Electricity price statistics.

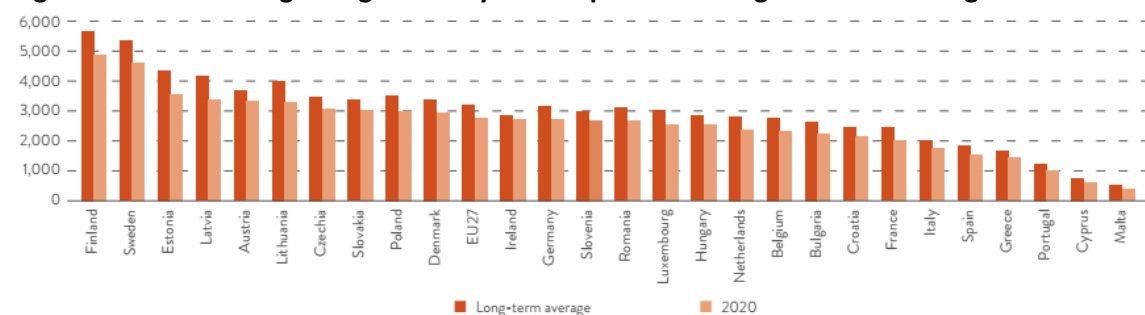
Eurostat, Statistics explained. (2021). Natural gas price statistics.

ND-GAIN Country Index (2021)

ODYSSEE-MURE database. (2022). Energy consumption. Sectoral Profile – Households.

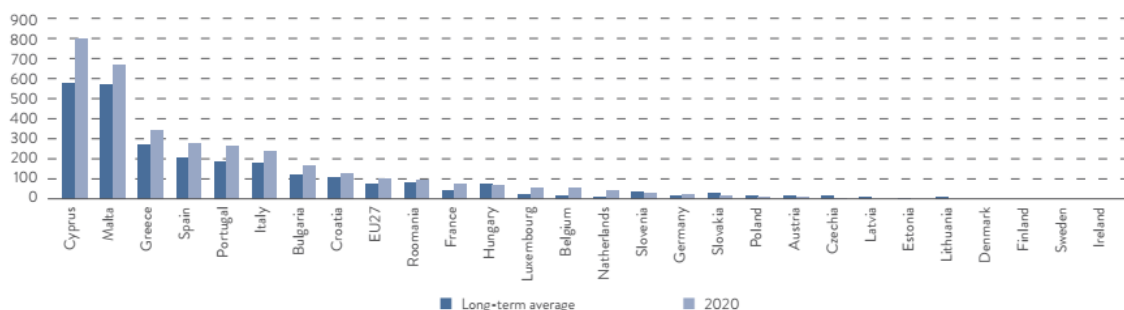
10. Appendix

Figure A1: Heating degree days comparison long term average and 2020



Source: Hypostat (2021)

Figure A2: Cooling degree days comparison long term average and 2020



Source: Hypostat (2021)

Evaluation of the potential interest/ need of EE mortgages among EU members

Table A1: Share of fuels in the final energy consumption in the residential sector, 2019 (%)

	Electricity	Derived Heat	Gas	Solid fuels	Oil & petroleum products	Renewables and Wastes
EU	24,7	8,5	32,1	2,8	11,8	20,1
Belgium	20,1	0,2	41,5	0,6	29,0	8,6
Bulgaria	43,2	14,2	3,5	4,7	0,9	33,4
Czechia	18,7	13,9	25,6	9,8	0,6	31,3
Denmark	20,1	37,0	14,1	0,0	4,6	24,1
Germany	18,8	6,9	38,8	0,6	20,6	14,4
Estonia	18,7	34,3	6,1	0,1	1,0	39,8
Ireland	24,3	0,0	20,5	11,7	41,0	2,5
Greece	36,3	1,3	9,3	0,1	28,0	24,9
Spain	42,6	0,0	20,4	0,4	16,3	20,3
France	34,5	3,2	28,5	0,1	10,9	22,8
Croatia	23,8	4,9	20,5	0,1	4,5	46,1
Italy	18,1	2,9	51,8	0,0	6,3	20,9
Cyprus	42,0	0,0	0,0	0,0	30,7	27,3
Latvia	11,9	30,9	9,3	0,4	4,5	43,0
Lithuania	17,3	30,8	11,1	3,2	4,1	33,5
Luxembourg	17,1	0,0	53,4	0,1	25,3	4,2
Hungary	17,6	8,0	49,2	1,2	1,3	22,6
Malta	70,6	0,0	0,0	0,0	15,6	13,8
Netherlands	21,6	3,1	69,3	0,0	0,4	5,6
Austria	23,6	11,5	21,1	0,3	14,0	29,5
Poland	13,9	20,0	20,0	27,4	3,6	15,2
Portugal	39,3	0,0	9,9	0,0	14,1	36,7
Romania	14,4	9,1	32,6	0,5	4,1	39,3
Slovenia	27,8	7,0	10,0	0,0	11,8	43,4
Slovakia	17,7	15,3	42,4	1,1	0,2	23,3
Finland	34,4	28,3	0,5	0,1	5,3	31,4
Sweden	51,2	34,9	0,3	0,0	2,6	11,1
Iceland	15,6	81,1	0,0	0,0	0,6	2,7
Norway	75,5	2,9	0,0	0,0	0,3	21,2
United Kingdom	23,4	0,7	62,9	1,2	6,3	5,5

Source: Eurostat ([nrg_bal_c, 2022](#))

Table A2: EU countries climate vulnerability (Climate Risk Index)

CRI Rank	Country	CRI score	Fatalities 1999- 2018 (Rank)	Fatalities per 100 000 inhabitants 1999-2018 (Rank)	Losses in million US\$ (PPP) 1999-2018 (Rank)	Losses per unit GDP in % 1999-2018 (Rank)
15	France	38	4	8	12	98
17	Germany	38,67	10	23	6	85
19	Portugal	38,83	20	11	41	75
26	Italy	43,67	6	9	18	110
29	Spain	47,33	8	10	26	115
31	Croatia	48,33	55	19	65	66
35	Romania	53,17	51	67	24	55
40	Slovenia	54,33	79	26	73	61
44	Austria	55,67	63	48	33	71
55	Belgium	63,83	26	13	63	134
61	Hungary	69	59	47	59	101
67	Bulgaria	70,83	85	89	48	57
68	Netherlands	71,83	30	30	57	142
78	Poland	77,17	43	88	30	107
82	Greece	78,83	71	70	50	106
85	Czech Republic	79,67	90	107	34	70
89	Latvia	83,83	107	64	100	84
105	Luxembourg	97,17	95	12	148	158
109	Lithuania	100,5	121	97	94	97
121	Slovak Republic	108	119	120	79	105
126	Denmark	112,83	147	162	44	81
136	Ireland	119,17	137	149	64	108
142	Sweden	129,5	136	163	61	127
144	Cyprus	129,67	150	101	146	140
148	Norway	138,83	140	156	89	146
158	Estonia	148,83	155	148	144	149
166	Finland	155,67	163	169	113	160

Source: Global Risk Index 2020 (Germanwatch, 2020)

Table A3 and A4: EU countries climate vulnerability (Economic Losses)

Country	Losses in million US\$ (PPP) 1999-2018 (average Rank)
Germany	6
France	12
Italy	18
Romania	24
Spain	26
Poland	30
Austria	33
Czech Republic	34
Portugal	41
Denmark	44
Bulgaria	48
Greece	50
Netherlands	57
Hungary	59
Sweden	61
Belgium	63
Ireland	64
Croatia	65
Slovenia	73
Slovak Republic	79
Norway	89
Lithuania	94
Latvia	100
Finland	113
Estonia	144
Cyprus	146
Luxembourg	148

Country	Losses per unit GDP in % 1999-2018 (average Rank)
Romania	55
Bulgaria	57
Slovenia	61
Croatia	66
Czech Republic	70
Austria	71
Portugal	75
Denmark	81
Latvia	84
Germany	85
Lithuania	97
France	98
Hungary	101
Slovak Republic	105
Greece	106
Poland	107
Ireland	108
Italy	110
Spain	115
Sweden	127
Belgium	134
Cyprus	140
Netherlands	142
Norway	146
Estonia	149
Luxembourg	158

Source: *Global Risk Index 2020 (Germanwatch, 2020)*

Table A5: Main public initiatives supporting buildings' energy renovation in EU member states

Member State	Sectors covered	Measure Type			Number of measures	Notable Examples
		Grants/ Subsidies	Loans/Soft Loans	Tax Exemption/ Reduction		
AUSTRIA (AT)	Residential				4	1) Residential building subsidy("Wohnbauförderung") 2) Austrian Federal Government's Renovation Drive ("Sanierungsscheck")
	Commercial				2	
	Public				2	
BELGIUM (BE)	Residential				11	1) Green loans for energy efficiency investments by households (Brussels) 2) Property Tax Reduction (Flanders) 3) Financial incentives for RUE investments in buildings (Wallonia)
	Commercial				4	
	Public				4	
BULGARIA (BG)	Residential				4	1) National Energy Efficiency Program for Multifamily Residential Buildings renovation 2) Residential Energy Efficiency Credit Line REECL
	Commercial				2	
	Public				1	
CROATIA (HR)	Residential				3	1) Programme of energy renovation of commercial non-residential buildings 2014-2020 (B.4) 2) Programme of energy renovation of multifamily housing
	Commercial				1	
	Public				1	
CYPRUS (CY)	Residential				3	1) Grant scheme "Save & Upgrade" for residential sector
	Commercial				1	
	Public					
CZECH REPUBLIC (CZ)	Residential				5	1) Operational Programme Environment (2014-2020): Sustainable Use of Energy Sources 2) New Green Savings Programme 2014-2020
	Commercial				4	
	Public				2	
DENMARK (DK)	Residential				2	1) Green BoligJobordning household employment scheme
	Commercial				1	
	Public				1	
ESTONIA (EE)	Residential				1	1) Reconstruction of private residences and apartment buildings
	Commercial					
	Public					
FINLAND (FI)	Residential				2	1) Energy Grants for Residential Buildings/Housing Finance and Development Centre of Finland
	Commercial					
	Public					
FRANCE (FR)	Residential				6	1) Energy Transition Tax Credit (CITE) 2) Social Housing eco-loan 3) Energy Saving Certificates
	Commercial				3	
	Public				4	
GERMANY (DE)	Residential				4	1) CO2-Gebäudesanierungsprogramm 2) Market Incentive Programme for Renewable Energies (MAP) 4) Energy Incentive Programme (APEE)
	Commercial				4	
	Public				4	
GREECE (EL)	Residential				1	1) "Saving at home" Programme 2) Energy savings in Local Self-Governments
	Commercial					
	Public				1	
HUNGARY (HU)	Residential				4	1) Warmth at Home Programme (WAH) (funded from carbon credits) 2) Energy Efficiency subsidies for public and local governmental buildings
	Commercial				1	
	Public				2	
IRELAND (IE)	Residential				5	1) Better Energy Homes (Residential Retrofit) 2) Warmer Homes Scheme (Low Income Housing Programme)
	Commercial					
	Public					

Evaluation of the potential interest/ need of EE mortgages among EU members

Member State	Sectors covered	Measure Type				Number of measures	Notable Examples
		Grants/ Subsidies	Loans/ Soft Loans	Tax Exemption/ Reduction			
ITALY (IT)	Residential					5	1) Ecobonus 2017 tax deduction scheme 2) Renewable Energy for Heating and Cooling and Small Interventions Increasing Energy Efficiency Support Scheme (Conto Termico 2.0)
	Commercial					3	
	Public					4	
LATVIA (LV)	Residential					2	1) Energy efficiency improvement in residential buildings 2) Energy efficiency improvement in public buildings 3) Energy efficiency in manufacturing industry
	Commercial					2	
	Public					4	
LITHUANIA (LT)	Residential					3	1) Programme for the renovation/upgrading of multi-apartment buildings 2) Programme for Improving Energy Efficiency in Public Buildings
	Commercial					2	
	Public					1	
LUXEMBOURG (LU)	Residential					4	1) Promotion of energy renovation of residential buildings 2) Klimabank loans
	Commercial					1	
	Public					1	
MALTA (MT)	Residential					1	1) Financing Schemes and instruments and fiscal incentives
	Commercial						
	Public						
NETHERLANDS (NL)	Residential					5	1) Subsidy schemes (IRE, MEI, UKR, Clean and Efficient Demonstration Projects) 2) Energy Investment Allowance (EIA)
	Commercial					3	
	Public						
POLAND (PL)	Residential					3	1) Subsidised loans for the construction of energy efficient houses 2) Operational Programme Infrastructure and Environment 2014-2020
	Commercial						
	Public					1	
PORTUGAL (PT)	Residential					6	1) Energy Efficiency National Fund 2) 1 Direito
	Commercial					3	
	Public					3	
ROMANIA (RO)	Residential					2	1) National Programme for Improvement of Energy Performance in Apartment Blocks
	Commercial						
	Public						
SLOVAKIA (SK)	Residential					7	1) State Housing Development Fund 2) SloVSEFF II and III (for renovation of multifamily buildings)
	Commercial					1	
	Public					1	
SLOVENIA (SI)	Residential					3	1) Financial incentives for energy-efficient renovation and sustainable construction of residential buildings 2) Financial incentives for the energy efficient heating systems in residential and Commercial buildings
	Commercial					2	
	Public					1	
SPAIN (ES)	Residential					3	1) PAREER programme 2) PIMA SOL programme
	Commercial					1	
	Public					2	
SWEDEN (SE)	Residential					2	1) EU financial support for energy efficiency in buildings 2) Aid for improvement and increases in energy efficiency of rental accommodation
	Commercial					1	
	Public					1	
UNITED KINGDOM (UK)	Residential					7	1) Energy Efficiency Loan Scheme (SALIX) 2) Energy Company Obligation (ECO)
	Commercial					1	
	Public					1	

Source: Economidou et al. (2019)

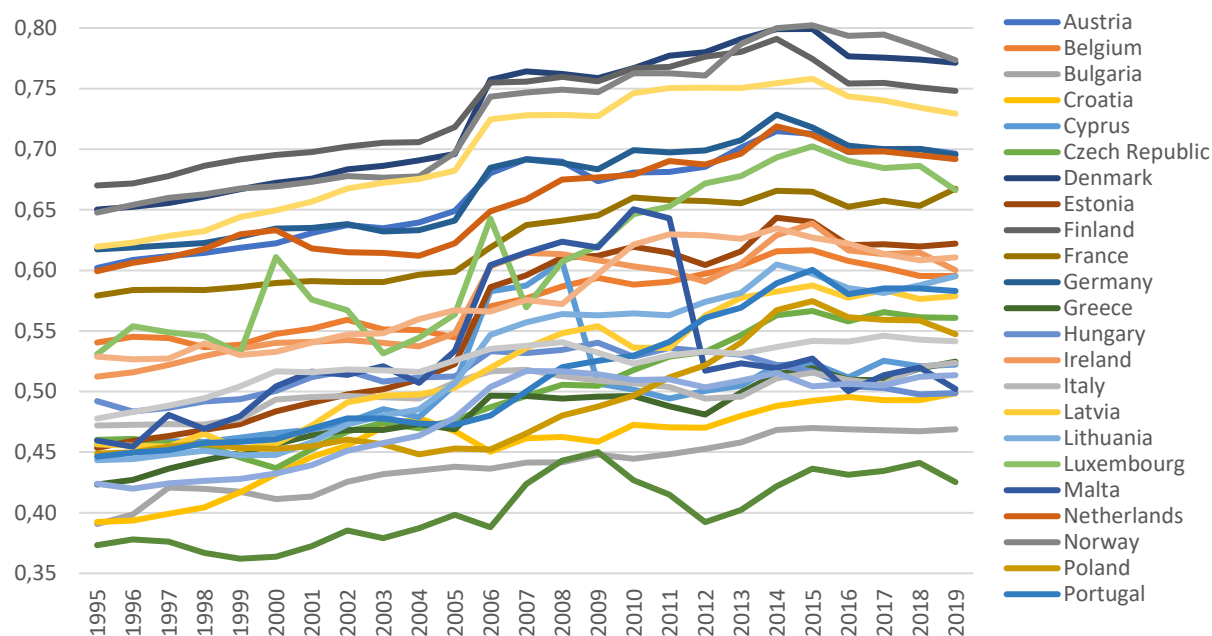
Table A6: Private schemes supporting buildings' energy renovation in EU member states

MSs	Type	Name of scheme	Timing
IT	Commercial loans on energy efficiency	Condominium Financing ("Finanziamento Condominio")	Since 2019
HR		Green Housing Loans by Zagrebacka Bank	n/a
BE		Belifus housing retrofit programme	Since 2018
*Mult		EBRD Sustainable Energy Financing Facilities schemes	Since 2006
PL		Financing energy efficiency by BOŚ commercial bank	Since 2012
UK	Energy Efficiency Mortgages	Eon-BNP Paribas green mortgage product	Since 2018
*Mult		Green home ("Casa Ta Verde"), Raiffeisen bank	Since 2018
SE		Nordea Green Mortgages	Since 2018
DE		MünchenerHyp sustainability loans	Since 2015
DE	Crowdfunding and energy cooperatives	Bettervest	Since 2013
*Mult		CitizenEnergy	Since 2014
DE		Econeers	Since 2013
ES		Fundeen	Since 2017
UK	Specialised funds	Mayor's London Energy Efficiency Fund	Since 2018
LV		Latvian Baltic Energy Efficiency Facility	Since 2016
*Mult		SUSI Energy Efficiency Fund	Since 2009
UK	Energy efficiency insurance	HSB Engineering Insurance	Since 2014
DE		Energie Einspar Protect (EEP) KlimaProtect	n/a
*Mult		Energy Savings Insurance	Since 2015

*Mult: Multiple countries

Source: Economidou et al. (2019)

Figure A3: EU countries political readiness – ND- GAIN Country Index, Readiness component (1995- 2019)



Source: ND-GAIN Country Index (2021)

Table A7: Energy saving rate in residential, 2019 comparatively to 2000 (from lowest to highest)

Country	Energy saving rate in households (2019)
Italy	10
Hungary	13
Bulgaria	18
Estonia	18
Finland	18
Malta	18
Czechia	22
Lithuania	23
Croatia	24
Denmark	24
Poland	24
Greece	28
Austria	30
Germany	30
Cyprus	31
France	32
Spain	32
Belgium	33
Sweden	33
Slovakia	34
United Kingdom	34
Luxembourg	38
Portugal	38
Latvia	40
Netherlands	40
Ireland	42
Slovenia	42
Romania	43

Source: ODYSSEE-MURE (2022)

Table A8: EU Households' Energy Expenditure and homes age structure

Country	Households' Energy Expenditure and homes age structure				Score (out of 4)
	More than 70% of houses built before 1981	Households' Energy consumption (toe/dw)	Electricity prices (Purchasing Power standard (PPS) per 100 kWh)	Gas prices (Purchasing Power standard (PPS) per 100 kWh)	
Austria		X			1
Belgium	X	X	X		3
Bulgaria				X	1
Croatia		X			1
Cyprus					
Czech Rep.		X	X	X	3
Denmark	X	X		X	3
Estonia					
Finland					
France		X		X	2
Germany	X	X	X		3
Greece		X			1
Hungary	X	X			2
Ireland		X			1
Italy	X	X	X	X	4
Latvia					
Lithuania					
Luxembourg		X			1
Malta					
Netherlands				X	1
Poland			X	X	2
Portugal			X	X	2
Romania	X		X	X	3
Slovak Rep.	X				1
Slovenia		X		X	2
Spain			X	X	2
Sweden	X				1
UK[1]	X	X			2

Source: Authors' compilation (Hypostat (2021), ODYSSEE-MURE (2021), Eurostat (2021))

Table A9: EU members climate vulnerability scores

Country	Climate Vulnerability		Score (out of 2)
	Climate Risk Index (up to rank 80) 2018	ND-GAIN Country Index, vulnerability component (av. Score above 30 (1995-2019))	
Austria	X		1
Belgium	X	X	2
Bulgaria	X	X	2
Croatia	X	X	2
Cyprus		X	1
Czech Rep.			
Denmark		X	1
Estonia		X	1
Finland			
France	X		1
Germany	X		1
Greece	X	X	2
Hungary	X	X	2
Ireland		X	1
Italy	X	X	2
Latvia		X	1
Lithuania		X	1
Luxembourg			
Malta		X	1
Netherlands	X	X	2
Poland	X	X	2
Portugal	X	X	2
Romania	X	X	2
Slovak Rep.		X	1
Slovenia	X	X	2
Spain	X		1
Sweden			
UK	X		1

Source: Authors' compilation (Global Risk Index 2020 (Germanwatch, 2020), ND-GAIN Country Index (2021))

Table A10: EU members EE progress and political readiness

Country	Implemented EE domestic initiatives and political readiness			
	Lowest Number of Existing EE initiatives for buildings (public and private schemes)	Energy saving rate in households (2019) below 25	Lowest ND- GAIN Country Index, Readiness component	Score out of 4
Austria	X			1
Belgium			X	1
Bulgaria	X	X	XX	4
Croatia	X	X	XX	4
Cyprus	XX		X	3
Czech Rep.		X	X	2
Denmark	XX	X		3
Estonia	XX	X	X	4
Finland	XX	X		3
France				
Germany				
Greece	XX		XX	4
Hungary	X	X	X	3
Ireland	X		X	2
Italy		X	X	2
Latvia	X		X	2
Lithuania	X	X	X	3
Luxembourg	X			1
Malta	XX	X	X	4
Netherlands	X			1
Poland	X	X	XX	4
Portugal			X	1
Romania	XX		XX	4
Slovak Rep.	X		XX	3
Slovenia	X		X	2
Spain			X	1
Sweden	X			1
UK				

Source : Authors' compilation (Economidou et al. (2019), ODYSSEE-MURE (2022), ND-GAIN Country Index (2021))