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Residential Retrofit Review

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Executive Summary

This report conducts a desk-based analysis of the residential sector between Ireland and a purposive selection of several comparable European economies. The report focuses on three main strands: (1) Profiling the energy efficiency of the residential building stock, (2) identifying residential energy efficiency policies and (3) exploring evidence on policy effectiveness and opportunities for further progress. The review encompassed policy and academic literature.

The report finds that Ireland demonstrates many elements of successful residential retrofit policy. It has a broad range of policies designed to overcome the various barriers associated with residential retrofit including financial support, information and awareness and efforts to ease the burden of engaging with retrofit. All of this is nested within overarching EU policy targets. Many of these supports have been recently revised and although early results on retrofit are promising, sustained success is required.

The commentary surrounding wider - and deeper - retrofit adoption cannot be disentangled from the barriers limiting adoption. This research explores additional factors which hinder further progress, aside from the primary barrier of the current economic landscape of continued inflation, supply chain limitations and uncertainty. The report identifies several areas for continued improvement in terms of labelling and standardisation to support informed decision-making.

Consideration of wholesale change must consider the need for a just transition that avoids placing insurmountable barriers on homeowners looking to make positive change. The optimal allocation of scarce public resources is a common issue best addressed through research, innovation and carefully calibrated pilot studies to support evidence-based decision making. The full report presents several insights based on an international review.

Profile

Ireland was compared with the following European countries based on the residential sector profile: Belgium, Finland, Germany and the Netherlands. Comparatively, Ireland features a relatively higher share of the population in rural areas and standalone houses. Although Ireland ranks high in terms of energy use per household, comparisons of heating energy use and floor space suggest Ireland is more in line with EU peers when considered on a per square metre basis. This suggests that major change is possible through adoption by fewer households. Analysis suggests that Ireland is among the EU leaders in terms of residential energy savings this century, illustrating great capacity for positive change.

Progress

Ireland has demonstrated strong recent progress in retrofit uptake. In Q1 2023, there were 9,946 upgrades completed, an increase of 172% over the same period in 2022. Although the number of retrofits is outpacing the annual target, there remains a disconnect between action and policy intent, especially regarding the target of 500,000 upgrades to BER B2 by 2030 and heat pump installation targets. Continued success will be required, which can be supported through recently revised grant supports. An important pillar of European policy is to improve energy efficiency among the worst performing dwellings. It is promising to see the Fully Funded Homes Energy Grant prioritise energy inefficient dwellings and accept applications from homeowners who previously received supports under the scheme. If successful, these policies will allow every type of household to join the energy efficiency movement.

Policy

The review found that EU policy plays an important role in driving high impact national policy. This is evident for regulations surrounding building energy performance, minimum energy performance standards and energy efficiency certificates. Other high impact policies include financial incentives and information campaigns. Several European policies that are deemed high impact are related to retrofit or technology adoption, which is supported by financial backing, information and standards. The review underlines the essential role of government in promoting retrofit scheme success across the entire ecosystem of stakeholders.

A systematic review of European retrofit policy instruments identifies the essential role of government interventions, specific environmental targets and the need for a mix of policy instruments to achieve change (Zhang et al., 2021). Comparative evidence from Finland finds that international differences in building standards contribute to significant differences in dwelling energy use (Hu et al., 2022b).

Barriers

There are several barriers identified in this study that serve to limit adoption, with the complexity of the retrofit decision featuring most prominently. Evidence suggests that policy should seek to foster matching between energy counselling services and homeowners (Murto et al., 2019). This is illustrated by how optimal retrofit strategies need to be tailored for each building type and age cohort (de Oliveira Fernandes et al., 2021) and how considerable effort is required by homeowners to identify the optimal upgrade (Murto et al., 2019). Evidence from Ireland suggests that homeowners often fail to select the optimal retrofit combination for their dwelling, underlining the need for consultation supports (Mac Uidhir et al., 2020).

Research across Europe explored several behavioural barriers to retrofit adoption. Specifically, access to capital and attitudes towards debt aversion may influence adoption (Schleich et al., 2021). Evidence recommends improved targeting of supports, such as low-interest loan programmes targeted at younger homeowners with lower income and less formal education.

The identified barrier of the need for tailored retrofit solutions and expert advice looks to be an opportunity in Ireland where the recent introduction of the 'One Stop Shop' model, paired with a more comprehensive home energy assessment seeks to better inform Irish households.

Opportunities

There are many opportunities to foster greater adoption of energy efficiency, with accurate data collection proving central to this effort. The installation of smart meters to support data collection, improvements to the Energy Performance Certificate and a streamlined retrofit process all have potential.

The need for real data is underpinned by evidence showing how actual energy use often deviates from the level of the Energy Performance Certificate (Coyne and Denny, 2021; Cozza et al., 2020; Sunikka-Blank and Galvin, 2012). Evidence suggests that Energy Performance Certificates should be more comparable across EU Member States and include real energy consumption data and measures of air quality and dwelling comfort (Simpson et al., 2020).

Another opportunity is to foster modest energy efficiency improvement from a wider base with a more gradual progression pathway. Research from Germany identifies an increasing marginal cost of improving energy efficiency for more efficient dwellings (Galvin, 2023). This suggested that retrofitting more dwellings to a more modest efficiency standard would better balance the marginal cost of CO_2 abatement with current carbon prices and limited public funds. This connects with earlier evidence from Germany that advocates for gradual improvements in energy efficiency to allow more households to make appropriate and affordable upgrades over time (2014).

Finally, evidence from the Netherlands shows that traditional retrofit measures (heating system, insulation) have a substantial impact and are considered an easy win (van der Bent et al., 2021). Scenario analysis from the Netherlands finds insulation to be a significant, "no-regret" element of any retrofit strategy – especially for older properties (de Oliveira Fernandes et al., 2021). Finally, other research illustrates the influential role of non-profit housing associations support positive change at scale (van der Bent et al., 2021).

There are several opportunities for further research identified by this research. One major area is draft EU policy that seeks to mandate a minimum energy efficiency level prior to sale or lease of a property. Further research is required to understand the wider consequences of this proposal from a just transition and equity perspective. Additional evidence on Ireland-specific issues such as the high proportion of standalone rural dwellings that are oil-dependent is required to identify steps to achieve the change required.

1 Introduction

This report conducts a comparative analysis of the residential sector of Ireland and a purposive selection of European economies. This research seeks to understand best practice from suitable comparators with a view towards understanding differences in (1) the energy efficiency of the residential building stock, (2) retrofit policies and (3) ideas to overcome barriers faced in the Irish setting.

This work is motivated by a lower-than-expected improvement in residential energy efficiency in Ireland. Specifically, the National Residential Retrofit Plan aims to upgrade 120,000 dwellings retrofitted to BER B2 (or cost optimal equivalent) by 2025 and 500,000 by 2030 (Government of Ireland, 2022). The 2022 CCAC Annual Review (CCAC, 2022) found that this level of adoption is not occurring at sufficient pace, posing a risk for achieving targets. This research is informed by areas identified by the Irish Climate Change Advisory Council (CCAC) Annual Report (CCAC, 2022) relating to the residential sector (Table 1).

Table 1 – Summary of CCAC Recommendations

Sector	Summary of CCAC recommendations
Electricity Demand	A demand side strategy is urgently required, including enablers for demand side flexibility in residential demand.
	Support installation of smart meters and provision of data and suitable tariffs to move demand away from peak times.
Built Environment	Prioritise support for retrofit and zero carbon heating towards: i) households in receipt of fuel allowance ii) the worst performing buildings - powered by coal and peat
	Significantly increase the target for the Local Authority Retrofit Programme.
	Realise significant savings from 'simple' retrofit measures for the worst performing households.
	Mandate the installation of solar PV panels on all new builds to reduce energy price exposure and reduce peak demand.
	Develop an Action Plan for increasing use of zero-carbon district heating – which could supply up to 50% of residential heat.
	Support deployments of heat pump economy (supply chain, skills, assessment, awareness) to support rural homes, including free technical assessment grants.

Source: Climate Change Advisory Council (2022)

The Central Statistics Office provides insight into recent trends in Irish residential energy efficiency (Central Statistics Office, 2023). It notes that the vast majority of dwellings built since 2015 are Building Energy Rating (BER) A-rated, with electric heating present in 87% of new builds from 2020-2023. As a result, the challenge of eradicating fossil fuel heating systems concentrates on older dwellings. The same analysis also highlights the benefits associated with retrofit by comparing houses with multiple BERs over time (Central Statistics Office, 2023). This scale of change underlines the important role of regulations and standards on driving positive change that will be felt for the lifetime of the building.

At present, a complete view of building energy efficiency is not possible due to many dwellings not having a BER. National analysis weighs the BER database (n=1,084,203) with the 2016 Census of Population (n=1,553,656). It shows there would be fewer A-rated dwellings and more F- and G-rated properties in the full population. The divergence between national building efficiency and what is recorded is expected to skew towards more efficient properties – as new builds and grant-supported retrofits require a BER (Central Statistics Office, 2023).

1.1 Report scope and structure

The methodology underlying this report includes a desk-based review of peer-reviewed academic studies and policy-relevant literature for a purposive selection of relevant EU comparison countries based on their residential sector characteristics. The objective of this study is to understand residential energy efficiency and policy effectiveness with a focus on lessons applicable to Ireland. It adopts a positivist perspective (Bryman, 2012), focusing on empirical evidence and policies exploring the topic.

Analysis relies on the most recently available comparable year. For example, comparisons based on the nationally representative EU Survey of Income and Living Conditions (EU-SILC) are based on 2021 data (Eurostat, 2023a). Certain comparisons of energy use and policies are obtained from the ODYSSEE-MURE (ODYSSEE-MURE, 2023a) platform. ODYSSEE-MURE is a decision-support tool for evaluating energy efficiency policy across the EU (ODYSSEE-MURE, 2023a). It features data for 28 countries from national energy efficiency agencies.

The first step of this report is to identify suitable comparison countries to Ireland through a review of key metrics, focusing on recent features of the European housing. Although there is no one perfect comparison, this report uses a basket of relevant comparators to highlight best practices in similar settings. The following countries were chosen for comparison: Belgium, Finland, Germany, Netherlands.

Section 2 details the profile and energy efficiency of the residential sector to identify suitable comparators (Section 2.1). Following this, it compares energy consumption and overall energy efficiency (Section 2.2). Section 3 provides a summary of recent residential energy efficiency policy at the EU (Section 3.1) and Irish (Section 3.2) levels. This is followed by a comparison of high impact policy across comparator countries (Section 3.3).

Section 4 features analysis of academic literature regarding residential retrofit policies. It presents evidence on some of the hallmarks of effective policy (Section 4.1), before detailing many of the barriers associated with retrofit identified in comparator countries (Section 4.2). It concludes with a broader discussion on how labelling could be improved to support wider adoption (Section 4.3). Section 5 provides a brief discussion on some of the headline findings from throughout the report.

2 Profile and efficiency of residential building stock

This section provides a European comparison of the residential sector. It first details the profile and efficiency of the residential building stock based on EU-SILC data (Section 2.1). From this, Belgium, Finland, Germany and the Netherlands are identified as suitable comparators. The second part of this chapter provides a comparison of energy use and heating in the residential section based on national-level data (Section 2.2). A previous report prepared for the CCAC focuses on the Irish residential sector, with a chapter dedicated to the historical change in the Irish dwelling stock and associated with retrofit (Coyne et al., 2022).

2.1 Residential sector profile

2.1.1 Ownership and tenancy

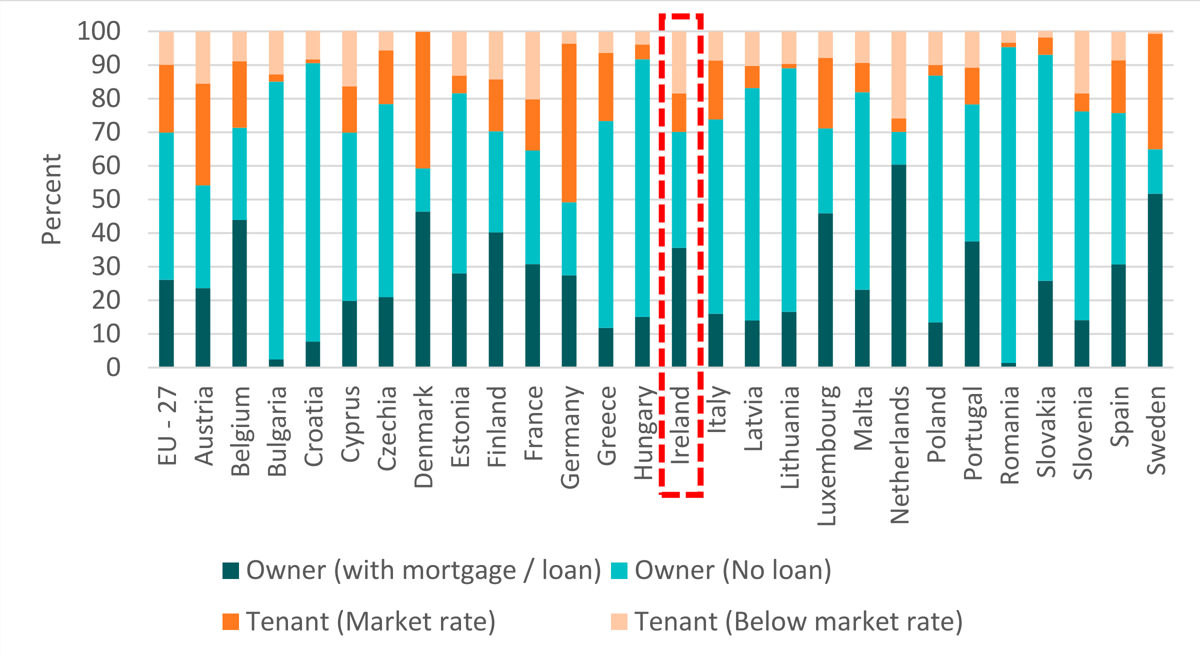
A comparison of home ownership rates (Table 2) provides an indicator of the scope for achieving change. This is particularly true for tenants (who are not in position to improve the dwelling), landlords (who may not always be incentivised to upgrade energy efficiency for their tenants) and homeowners. Figure A illustrates differences in ownership and tenancy rates across the EU-27 countries.

Table 2 – Comparison countries

Country	Home ownership rate	Tenancy Rate	Fuel Poverty Rate
Ireland	70.1	29.9	3.2
Belgium	71.3	28.7	3.5
Finland	70.3	29.7	1.3
Germany	49.1	50.9	3.3
Netherlands	70.1	29.9	2.4
EU-27 Average	69.9	30	6.9

Source: Author's analysis based on EU-SILC data from 2021 Eurostat (2023).

Figure A - EU Dwelling stock ownership and tenancy status



Source: Author's analysis using Eurostat (2023) EU-SILC data from 2021.

Table 3 notes that Ireland has a rate of ownership in line with the EU average and ranked 20th out of 27 EU countries. This is broadly in line with countries such as Belgium (71.3%), Finland (70.30%) and the Netherlands (70.1%), with Germany reporting the lowest ownership rate in the EU-27 at 49.1%.

Table 3 – Ownership and Tenancy Percentage Comparison

	Ireland	EU-27	Rank EU-27
Owner	**70.10**	**69.90**	**20**
With mortgage	35.60	26.10	8
No mortgage	34.50	43.80	18
Tenant	**29.90**	**30.00**	**7**
Market rate	11.40	20.20	14
Below market rate	18.50	9.80	4

Source: Author's analysis based on EU-SILC data from 2021 Eurostat (2023).

For Ireland, 35.60% of homes are owned with a mortgage. This ranks 8th highest in the EU, above the EU average of 26.10%. For homes owned *without* a mortgage, Ireland ranks below the EU-27 average of 43.80% with a value of 34.50%, ranked 18th highest in Europe.

Ireland has just under a third of dwellings (29.90%) being occupied by tenants, which is the 7th highest rate in the EU but in line with the EU average (30%). Of this group, there is a large split in the proportion that rent below (18.50%) and at market rates (11.40%). This difference may speak to wider features of the Irish rental market, but the high proportion of tenancy suggests that upgrading the efficiency of such dwellings may prove more challenging than elsewhere. The tenancy rate of 29.90% is comparable to EU countries including the Netherlands (29.90%), Finland (29.70%), Luxembourg (28.90%) and Belgium (28.70%).

It bears repeating that there are potentially opposing forces that may influence willingness to renovate for owner-occupiers. On the one hand, homeowners should be able to secure access to finance and upgrade their dwelling if they wish. Conversely, homeowners with no mortgage might tend to be older occupants with little incentive to invest in energy efficiency with a long payback period. By extension, homeowners with a mortgage might have limited interest in obtaining further financing towards improving energy efficiency. Tenants often bear the running cost of an energy inefficient dwelling and are the end-user that experiences fuel poverty. Barriers to improving energy efficiency for this cohort include a limited capacity of the tenant to make upgrades and the lack of incentive and interest on the part of landlords to upgrade energy efficiency if it does not make commercial sense.

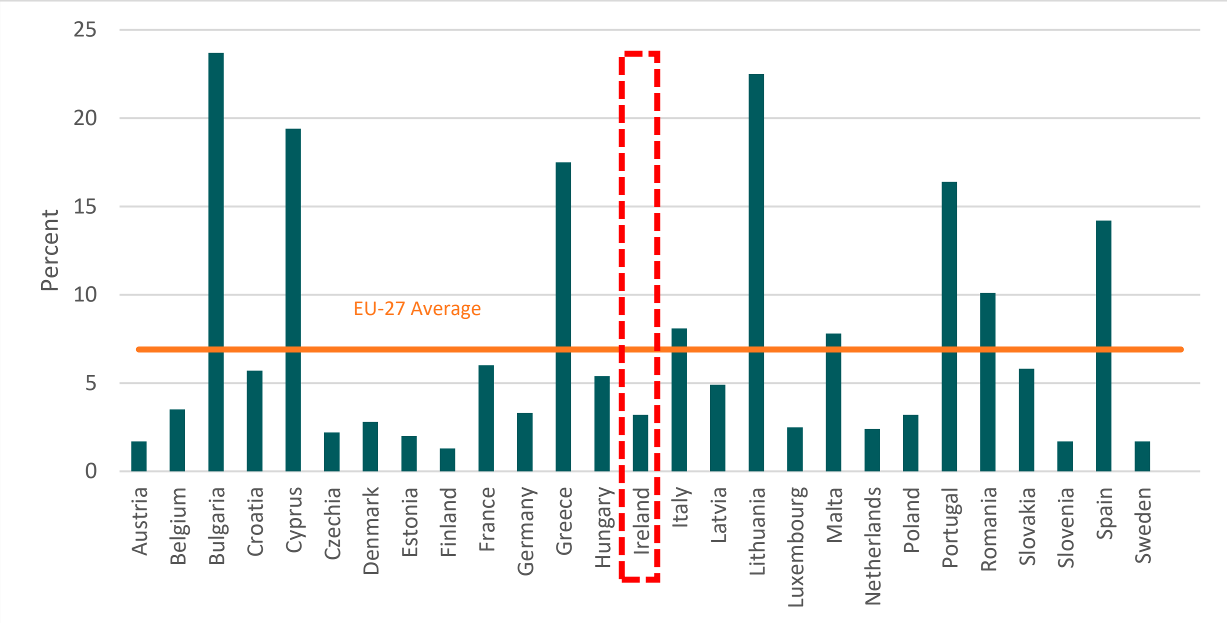
2.1.2 Fuel poverty

Another suitable comparison is through reported levels of fuel poverty, based on EU-SILC data (Eurostat, 2023b). Fuel poverty is an important measure of wellbeing that depends on several physical and behavioural factors including the energy efficiency of the dwelling, the cost of energy and temperatures. The specific question reflects the proportion of respondents that go without heating due to lack of money.

As measured by this metric, 6.9% of the surveyed EU population in 2021 could not afford to keep their home adequately warm (Figure B) (Eurostat, 2023b). Ireland has a lower fuel poverty rate of 3.2%, ranking 17th highest out of the EU-27 countries. This rate is comparable to countries such as Germany (3.30%), Poland (3.20%), Denmark (2.80%) and the Netherlands (2.40%). Finland is the best performer in this category, with a fuel poverty rate of 1.30%.

It is important to note that measures of fuel poverty can vary based on the criteria. For example, recent estimates for Ireland suggest the number can be far higher when calculated based on households spending more than 10% of net income on energy (Barrett et al., 2022).

Figure B - EU Fuel poverty rates



Source: Author's analysis based on EU-SILC data from 2021 Eurostat (2023).

2.1.3 Population distribution

Another important aspect of the residential sector is the location of citizens – both geographically and by dwelling type. EU-SILC data reports the proportion of population in each region (Table 4, Figure C) to provide context on regional disparities. Eurostat data distinguishes between citizens located in i) cities, ii) towns and suburbs and iii) rural areas.

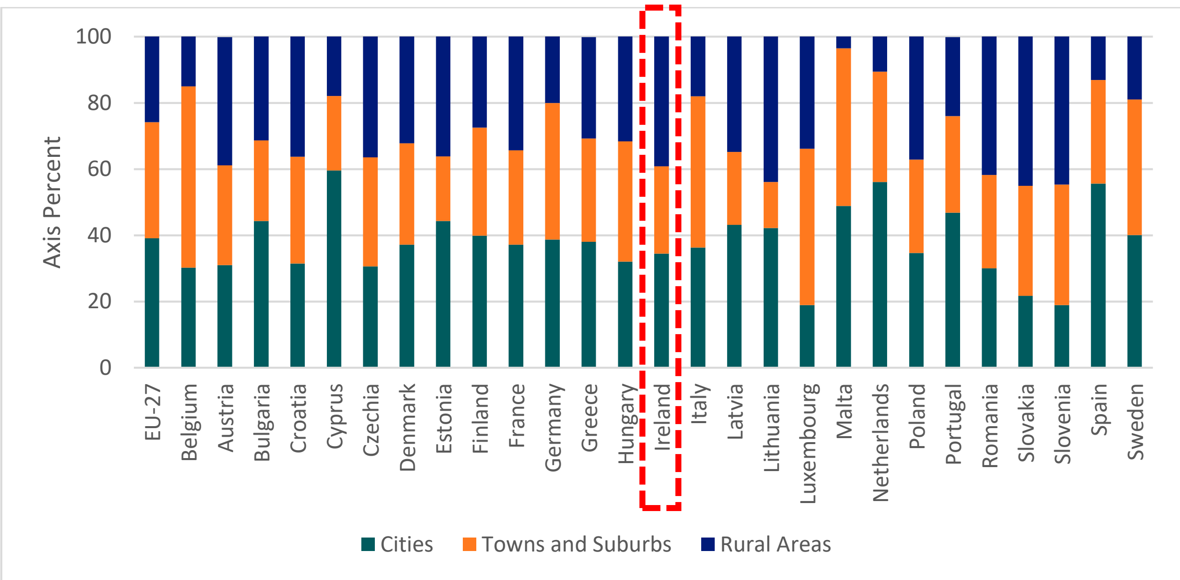
Table 4 – Comparison countries – Population by Location (%)

Country	Cities	Towns and Suburbs	Rural Areas
Ireland	34.5	26.3	39.2
Belgium	30.2	54.8	15
Finland	39.9	32.6	27.5
Germany	38.7	41.3	20.1
Netherlands	56.1	33.3	10.6
EU-27 Average	39.1	35.1	25.9

Source: Author's analysis based on EU-SILC data from 2021 Eurostat (2023).

In 2021, the EU-27 average included 39.10% of people in cities, with 35.10% in towns and 25.90% of people in rural areas. By comparison, Ireland has 34.50% of its population based in cities, (18th highest), 26.30% in towns (22nd highest) and 39.20% in rural areas (5th highest). The rural concentration in Ireland is quite unique in the European context and speaks to the size of the country and legacy regional differences. By comparison, Belgium ranks 1st in the proportion of population in towns and suburbs (54.80%) and the Netherlands ranks 2nd in terms of dwellings in cities (56.10%).

Figure C - EU Population by location



Source: Author's analysis using Eurostat (2023) EU-SILC data from 2021.

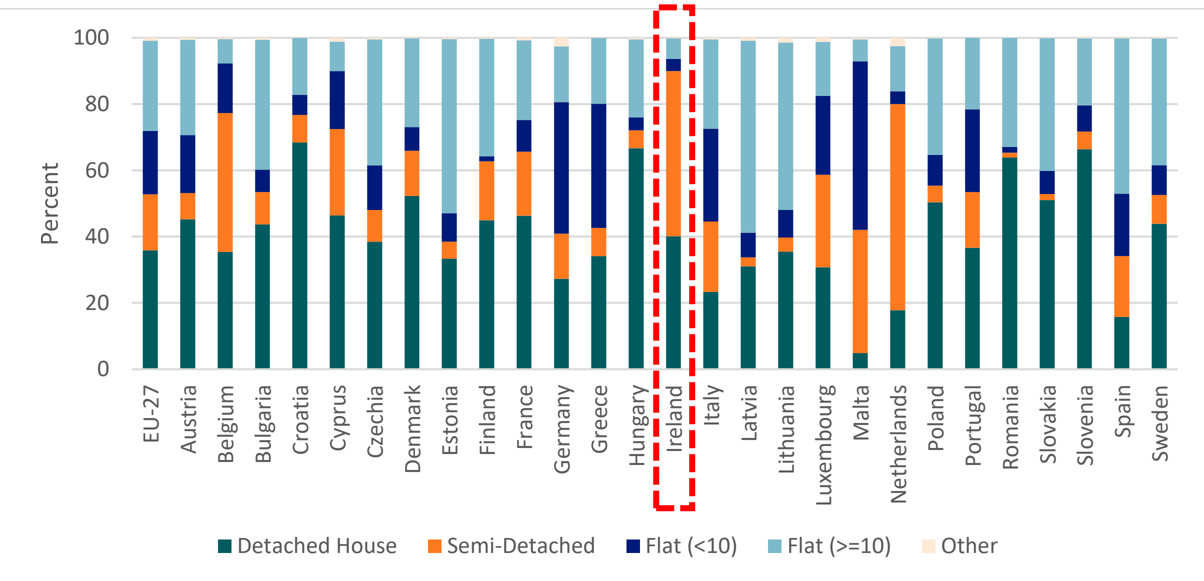
Another important comparison is the profile of the dwelling stock. EU-SILC data captures the proportion of the population in each house type (Table 5, Figure D). A more direct comparison of the number of houses features in Section 2.2. Ireland is an outlier in terms of dwelling type with a high proportion of detached (40.10%) and semi-detached (49.90%) dwellings. The Netherlands and Belgium are the most comparable in terms of proportion of houses. This is particularly important considering the differing retrofit needs by dwelling type and the relationship between dwelling size and retrofit cost.

Table 5 – Comparison countries – Population by Dwelling Type (%)

Country	Houses	Flats	Other	Detached House	Semi-Detached House	Flat (<10)	Flat (10+)
Ireland	90.00	9.80	0.10	40.10	49.90	3.60	6.20
Belgium	77.30	22.30	0.40	35.40	41.90	15.00	7.30
Finland	62.70	37.00	0.30	45.00	17.70	1.60	35.40
Germany	40.90	56.40	2.70	27.30	13.60	39.70	16.80
Netherlands	80.00	17.50	2.50	17.80	62.20	3.90	13.60
EU-27 Average	52.80	46.30	0.90	35.90	16.90	19.10	27.20

Source: Author's analysis based on EU-SILC data from 2021 Eurostat (2023).

Figure D - EU Population by house type



Source: Author's analysis using Eurostat (2023) EU-SILC data from 2021.

2.2 Consumption and heating

Section 2.1 compares the profile of the residential market, including more socioeconomic variables using EU-level survey data. This section focuses on aggregate energy use for the residential sector, using the Odyssee database to compare trends in energy use and efficiency (ODYSSEE-MURE, 2023a). Analysis is performed on the basis of i) energy consumption per dwelling, ii) heating consumption per dwelling and iii) overall energy savings this century.

Where feasible, Odyssee distinguishes between 'Normal Climate' and 'European Average Climate'. 'Normal Climate' omits influence of a cold winter for residential space heating, while 'EU Average Climate' adjusts space heating to the EU average on the basis of relative heating degree days. This serves to advantage colder climates such as Finland.

Table 6 suggests that Ireland is among the better performers in the EU in terms of final energy consumption for the residential sector, ranking 16th highest with energy consumption of 3.03 million tonnes of oil equivalent (Mtoe). However, this comparison is largely indicative of the significant differences in the size of the occupied dwelling stock.

Table 6 – Final energy consumption – Residential Sector

Country	Climate Corrected (Mtoe)	EU-27 Rank	# Dwellings (thousand)
Ireland	3.03	16	1,789.86
Belgium	8.29	8	4,904.22
Finland	5.02	13	2,941.29
Germany	59.01	1	39,111.75
Netherlands	9.63	6	7,469.36
EU-27	253.16		189,265.24

Source: Author's analysis adapted from Odyssee for 2019 (ODYSSEE-MURE, 2023a). Notes: in million tonnes of oil equivalent (Mtoe). 'Normal climate' omits influence of cold winter for residential space heating.

A more appropriate comparison of energy consumption per dwelling (Table 7) suggests that Irish dwellings are among the largest energy users in the EU. Ireland ranks 7th highest in the EU-27 in terms of energy consumption per dwelling based on a normal climate calculation (Column 2). The Irish average value of 1.58 tonnes of oil equivalent per dwelling exceeds the EU-27 average (1.33 toe), is comparable to Belgium (1.61 toe/dwelling) and much greater than Germany (1.48 toe/dwelling) and the Netherlands (1.28 toe/dwelling).

An alternative measure calculated to account for the EU average climate (Column 4) advantages colder regions such as Finland, who have a much lower average consumption when based on EU average climate (1.71 to 1.21 toe/dwelling). On this basis, Ireland has a slightly higher value (1.69 toe/dwelling), ranking 5th highest in the EU-27.

Table 7 – Energy consumption per dwelling

Country	Normal Climate (toe/dwelling)	EU-27 Rank	Europe Average Climate (toe/dwelling)	EU-27 Rank
Ireland	1.58	7	1.69	5
Belgium	1.61	6	1.80	4
Finland	1.71	2	1.21	18
Germany	1.48	14	1.50	13
Netherlands	1.28	18	1.42	16
EU-27 Average	1.33		1.31	

Source: Author's analysis adapted from Odyssee for 2019 (ODYSSEE-MURE, 2023a). Notes: Average values for permanently occupied dwellings. Units in tonnes of oil equivalent (toe) per dwelling. 'Normal climate' omits influence of cold winter for residential space heating. 'EU Average Climate' adjusts space heating to the EU average based on relative heating degree days.

When focusing on residential energy used for heating (Table 8), Ireland ranks 7th highest in the EU (Column 1). On a per metre squared (m^2) basis (Column 3), Ireland ranks 17th highest (8.91 kilogramme of oil equivalent per m^2), lower than the EU-27 average (9.47 koe/m^2). This suggests that Irish dwellings are larger than EU comparators, so analysis based on floor area is more appropriate. This result is consistent when calculated based on 'Normal Climate' (Column 3) or 'Europe Average Climate' (Column 5).

Table 8 – Heating usage per dwelling

Country	Heating Per Dwelling (toe)	EU-27 Rank	Per m_2 Normal Climate (koe / m_2)	EU-27 Rank	Per m_2 Europe Average Climate	EU-27 Rank
Ireland	1.07	7	8.91	17	9.93	16
Belgium	1.2	4	N/A	N/A	N/A	N/A
Finland	1.04	T-9	10.20	14	5.75	22
Germany	1.04	T-9	11.30	10	11.48	11
Netherlands	0.87	14	7.34	19	8.50	19
EU-27 Average	0.85		9.47		9.47	

Source: Author's analysis adapted from Odyssee for 2019 (ODYSSEE-MURE, 2023a). Notes: Values for permanently occupied dwellings. Units in tonnes of oil equivalent (toe) per dwelling and kilogram of oil equivalent (koe) per square metre. 'Normal climate' omits influence of cold winter for residential space heating. 'EU Average Climate' adjusts space heating to the EU average based on relative heating degree days.

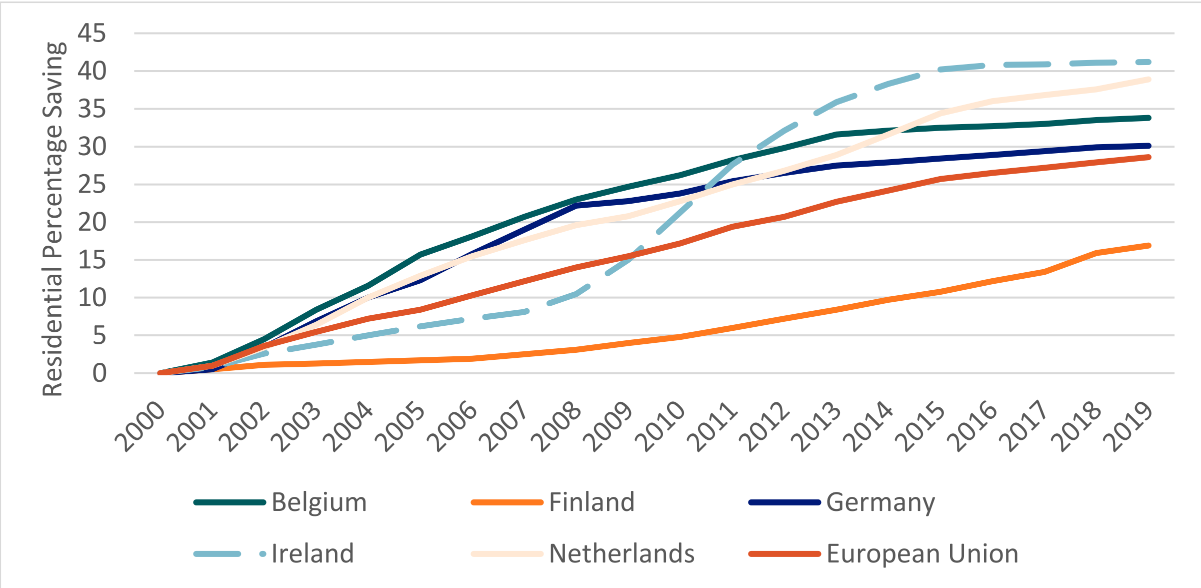
Lastly, Odyssee provide a benchmark of energy saving rate for the residential sector since 2000 (Table 9, Figure E). This rate is based on a weighted average approach of unit consumption trends for 11 residential end-uses (classed under space heating, water heating and electrical uses for cooking, lighting and large appliances). Ireland has made substantial progress in the rate of energy saving at 41.2% since 2000, 3rd highest in the EU-27. This is well above the average improvement of 28.6% over the same period.

Table 9 – Residential Energy Saving Rate since 2000

Country	2019 Rate %	EU-27 Rank
Ireland	41.2	3
Belgium	33.8	10
Finland	16.9	25
Germany	30.1	13
Netherlands	38.9	6
EU-27	28.6	

Source: Author's analysis adapted from Odyssee database for 2019 (ODYSSEE-MURE, 2023a). Notes: Energy saving rate is a weighted average of residential consumption by end use. Aggregated for heating (unit consumption per m^2 at normal climate), water heating (unit consumption per dwelling) and electricity use.

Figure E – Residential Energy Saving (Since 2000)



Source: Author's analysis using ODYSSEE data from 2020.

2.3 Summary

This section identifies trends in dwelling ownership, fuel poverty, the location and type of dwellings across Europe. It suggests that Ireland is among the EU leaders in terms of residential energy savings (Table 9), which demonstrates a great capacity for positive change. Results suggest that Ireland ranks high in terms of energy use per household across the EU (Table 7). However, comparisons of heating energy use and floor space (Table 8) suggest Ireland is more in line with EU peers. The lower number of households suggests that uptake of retrofit in Ireland is required from fewer households to achieve a relatively bigger change than would be required elsewhere.

3 Residential Energy Efficiency Policy

This section analyses residential energy efficiency policies, with particular focus on retrofit. It begins with a summary of the latest EU policy on energy efficient buildings (Section 3.1). After this, it details recent updates to retrofit policy in Ireland (Section 3.2) and seeks to identify the indicators for high impact household energy efficiency policies (Section 3.2).

3.1 Recent EU residential policy

Buildings are a focus of European policies designed to improve quality of life, alleviate energy poverty and provide multiple benefits for health and comfort (European Commission, 2021a). The 'Clean energy for all Europeans' package (European Commission, 2019a) builds on the Energy Performance of Buildings Directive (EPBD) (European Commission, 2018) and the Energy Efficiency Directive (European Parliament, 2018). In 2020, the European Green Deal (European Commission, 2019b) advocated for a 'renovation wave' to at least double the annual energy renovation rate of buildings by 2030 while fostering deeper renovation.

The latest EPBD aims to achieve a fully decarbonised building stock by 2050 (European Commission, 2021b). Importantly, it includes targeted financing paired with policies to combat energy poverty (European Commission, 2021a). It seeks to achieve a 60% reduction in emissions by 2030 in the buildings sector (relative to 2015) with the following changes:

- Energy performance standards to trigger renovation of worst performing buildings
- Develop new building standards with vision for zero-emission future
- Enhanced long-term renovation strategies
- Increased reliability, quality and digitalisation of Energy Performance Certificates with performance classes based on a common criteria
- Define deep renovation and introduce building renovation passports
- Modernise building systems for greater energy systems

Source: (European Commission, 2021a)

Draft EU EPBD policy (European Parliament, 2023) seeks to mandate a minimum energy efficiency level prior to sale or lease of a property. A minimum standard such as this would likely serve as an effective albeit blunt tool in improving the least efficient dwellings (Zhang et al., 2021). Further research is required to understand the wider consequences of this proposal from a just transition perspective.

Heat pumps are expected to play a crucial role in residential decarbonisation across Europe through the impending EU Heat Pump Action Plan due to launch at the end of 2023 (European Commission, 2023a). This policy is informed by the European Green Deal and the RePowerEU plan to increase renewables investment (European Commission, 2022) and reduce dependence on fossil fuel imports. A key ambition of the policy is to double the deployment rate of heat pump installation, with an additional 10 million units by 2027 targeted (European Commission, 2023a). As Ireland has limited district heating networks, progress in this space will likely target fossil fuelled standalone dwellings. The shape of EU supports in this regard will need to account for some of the unique features in Ireland, including a geographically dispersed dwelling stock, with a large share of standalone dwellings.

3.2 Retrofit in Ireland

This section details recent progress in retrofit interest across Ireland. In Q1 2023, there were 15,600 grant applications, a 76% rise on the same period in 2022. In terms of tangible progress, 9,946 upgrades were completed in Q1 2023, an increase of 172% on the same period in 2022 (SEAI, 2023). Out of the 9,946 upgrades, 3,304 homes (33%) were upgraded to BER B2 standard or higher. Conversely, two thirds of upgrades were not to the BER B2 standard, which may cause some concern. SEAI cite supply chain constraints hindering wider adoption (SEAI, 2023).

Although the total number of retrofits and heat pump installations in Q1 2023 is outpacing the annual target, the 2022 National Retrofit Plan targets 83,000 homes upgraded to BER B2 standard by 2025, with 88% of those upgrades involving a heat pump (Government of Ireland, 2022). A lack of sufficient BER B2 upgrades to date threatens the 2030 BER B2 (500,000) and heat pump installation (400,000) targets, where accelerated action will be required.

The latest residential grants include an individual upgrade process, a 'one stop shop' providing end-to-end support and fully funded energy upgrades for vulnerable households (Table 10). The one stop shop service provides a fully managed solution from the initial home assessment through the final BER assessment post-upgrade. It is designed to ease barriers related to information asymmetry, financing and installation.

SEAI conducted a deep retrofit pilot project (SEAI, 2018), requiring all participating homes to adopt air-source heat pumps with mechanical ventilation. Over two thirds of homes completed were approved to have solar PV installed. The average capital cost to upgrade from average BER F to average BER A3 is €60,814. However, costs are likely to vary due to factors including house type, size, age, existing BER and works done. Finally, the report found a strong correlation in cost (per m^2) and pre-works BER for detached homes than for semi-detached.

Table 10 – Irish retrofit grant supports

Measures	Description
Individual Energy Upgrade ('Better Energy Homes ')	Capital grants to householders for the implementation of specific energy efficiency measures. Attic and wall insulation, heating controls, with efficient boilers, solar
One Stop Shop Service	Managed home assessment and retrofit with a sole provider. Grants, measures and financing structure to achieve BER B2 standard.
Fully Funded Energy Upgrades ('Warmer Homes Scheme')	Fully funded energy upgrades to homeowners who receive certain welfare payments. Since 2022, targeting worst performing properties. Insulation and other measures. Heating system occasionally recommended.
Deep retrofit pilot programme	Investigate the challenges and opportunities of performing deep retrofits on residential dwellings. Lessons will inform support towards large scale deep retrofit of buildings in Ireland.

Source: SEAI (https://www.seai.ie/grants/home-energy-grants/)

The latest grant provides for a full home assessment which is more advanced than a BER rating alone. It also includes a technical report on dwelling energy efficiency, details on upgrades needed to reach BER B2 standard, heat pump technical assessment, estimate of the costs of the recommended energy upgrades. The recently revised fully funded homes energy grant (previously the Warmer Homes Scheme) seeks to target the worst performing properties, by prioritising homes that were built and occupied before 1993 and have a pre-works BER of E, F or G. For the first time, applications will be accepted from qualifying homeowners who previously received supports under the scheme, but who could still benefit from even deeper measures. Both of these revisions reflect European policy ambition for deeper retrofit of the least efficient dwellings (European Commission, 2021a).

3.3 Comparison of household energy efficiency policy

This section compares a selection of household energy efficiency policies across the EU. It is based largely on the data featured in the MURE database submitted by member states (ODYSSEE-MURE, 2023b). The data includes details on the country, type of policy, an impact rating and details on the type of policy (Appendix A provides a complete list for comparators).

Analysis of the 93 active household policies across Ireland and comparator countries (Table 11) finds the most common policies are financial (25), mandatory standards (21) and information/training (20). The overall trend in is consistent across countries – except for financial policies in Finland (1). The observation for Finland may be rooted in the unique collaboration on voluntary energy efficiency agreements between government and industry (Energy Efficiency Agreement, 2023).

Table 11 – Overview of household energy efficiency policies

Category	Belgium	Finland	Germany	Ireland	Netherlands	Total
Financial	4	1	9	5	6	25
Mandatory standards	2	4	4	7	4	21
Information/training	5	7	1	5	2	20
Mandatory information	1	2	2	1	2	8
Fiscal	2	1	1		2	6
General programme					4	4
Mandatory standards, information	3					3
Others		1		1		2
Mandatory standards, Others			1			1
Financial, Information/training					1	1
Financial, Mandatory standards			1			1
Mandatory information & standards	1					1
Total	18	16	19	19	21	93

Source: Author's analysis of active policies on MURE as of 31/05/2023 (ODYSSEE-MURE, 2023b).

MURE classify 'high impact' policies by applying 12 criteria (six high priority, six low priority) to define policy success (Table 12) using a quantitative evaluation to assign a score to each, ranging from 1 (worst) to 5 (best) (ODYSSEE-MURE, 2023b).

Table 12 – MURE criteria for successful policy

High Priority Criteria	Low Priority Criteria
High impact / high number of applicants	Policy transferability between countries
Cost efficiency for the implementor / required administrative support	Linkage between other measures and policy packages
Potential for market transformation, promotion of energy service market	Historical success of the measure and detail on impact
Suitability to overcome barriers for energy efficiency	Avoidance of negative side-effects
Ease and stability of re-financing	Support of positive side-effects
Persistency of savings induced by measure	Ease of acceptance by stakeholders

Source: MURE Database (ODYSSEE-MURE, 2023b).

In terms of 'successful' national policies with high impact (Table 13), EU policy plays a prominent role especially for regulations surrounding building energy performance, minimum energy performance standards and energy efficiency certificates. Other high impact policies include financial incentives and information campaigns. Appendix A features a list of household energy efficiency policies across comparator countries detailed by MURE.

Table 13 – Summary of 'Successful' Policy Measures

Title	Type	Average score (out of 5)
IRELAND		
EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Irish Response to the Energy Performance of Buildings Directive	Mandatory information - Energy efficiency certificates	3.4*
EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Building regulations 2011	Mandatory standards - Standards for buildings, Energy Performance Standards	3.6*
Better Energy Homes (Residential Retrofit)	Financial - Subsidies for building renovation	3.8
BELGIUM		
EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for residential buildings	Mandatory standards for buildings (thermal insulation, Energy Performance, Periodic mandatory inspection of boilers Mandatory information - Certificates	3.2*
Wallonia - Financial incentives for RUE investments in buildings	Financial - Subsidies - Subsidies for new construction / energy efficiency / renewable / energy audit / heating	3.3
FINLAND		
Energy Efficiency Agreement of the Property and Building Sector - Rental Action Plan	Others - Negotiated/Voluntary agreements	3.9
Promotion of heat pumps	Information/training	3.9
Building regulations for new buildings	Mandatory standards - Standards for buildings - Energy Performance Standards	3.7*
Energy efficiency agreements for oil-heated buildings (Höylä IV)	Information/training - Informative campaigns	3.8
GERMANY		
EU-related: Energy Performance of Buildings (Directive 2010/31/EU) - Energy Savings Ordinance (Energieeinsparverordnung - EnEV)	Mandatory standards - Standards for buildings - Energy Performance Standards / Mandatory information	3.3*
EU-related: Ecodesign Directive for Energy-using Products (Directive 2005/32/EC) - Energiebetriebene-Produkte-Gesetz - EBPG	Mandatory standards - Standards for electrical appliances - Minimum efficiency standards for electrical appliances	3.7*
KfW Programme "Energy-efficient Refurbishment" (Energieeffizientes Sanieren)	Financial - Other financial instruments - soft loans / & Grant	3.9
Energy Advice for low-income households (Stromsparcheck)	Financial - Subsidies - Subsidies for other energy efficiency/renewable investments	3.9
Market Incentive Programme for Renewable Energies in Heat Market (Marktanreizprogramm für erneuerbare Energien im Wärmemarkt– MAP)	Financial - Soft loans Financial - Subsidies - Subsidies for efficient/renewable heating technologies	3.1
NETHERLANDS		
Energy Performance Standards (Energie Prestatie Norm, EPN)	Mandatory standards - Standards for buildings - Energy Performance Standards	3.8*
Covenant energy savings rent sector	Market-based Instruments - Technology	3.6

Source: Author's analysis of MURE 'Successful' policies - past and ongoing (ODYSSEE-MURE, 2023b). See: https://www.measures.odyssee-mure.eu/successful-efficiency-measures-tool.html#/results Note: * denotes an EU-related policy identified by MURE. Appendix A includes a broader list of ongoing policies.

Table 13 details several high impact, non-EU policies designed to achieve change across comparators, some of which are detailed here. In Finland, Energy Efficiency Agreements (Energy Efficiency Agreement, 2023) build on a legacy of voluntary agreements since the 1990s to conserve energy and improve energy efficiency. The ambition is to achieve a level of voluntary change comparable to standards, while maintaining flexible implementation. The **Rental Action Plan** in Finland is designed to spur efficiency among the Finnish Association of Building Owners and Construction Clients (Energy Efficiency Agreements, 2016a). It targets a 4% energy savings by 2020 and a 7.5% target for 2025. A key element of the policy is annual reporting of measures and savings. Members also seek to increase resident awareness of the importance of improving the energy efficiency (Energy Efficiency Agreements, 2016b). It also requires members to consider energy targets when tendering property maintenance services.

Separately, the **Höylä IV** policy in Finland seeks to spur voluntary introduction of renewable energy into currently oil-heated properties in a way that is economical and provides positive environmental impacts (Energy Efficiency Agreements, 2016c). By 2025, it seeks to have renewable energy present in at least 50% of oil-heated properties. Action areas include 1) inspection of boilers, 2) upgrading of old oil-heating systems, 3) promotion of advanced oil-heating systems, 4) promoting use of renewable energy in oil-heated properties and 5) improving overall building energy efficiency.

In Germany, KfW is a federal level bank dedicated to improving economic, social and environmental conditions (KfW, 2023a). The **Energy-efficient Refurbishment** programme provides federal funding for efficient buildings, including promotional loans and financing (up to €150,000) per residential unit for renovation and purchase (KfW, 2023b). It also provides a repayment subsidy (5% to 45%) to help lower the repayable amount, with the rebate increasing for achieving a higher efficiency. It also provides promotional loans for the adoption of renewable energy.

Another federal German resource is the MAP, which provides grant subsidy for installation of efficient and renewable heating systems (BMWK, 2023). The typical subsidy for heat pump or biomass is up to 35%, with this increasing to 45% where an old oil heating system is replaced. It also offers a lower subsidy for upgrades to gas hybrid heating systems with a renewable share of 25% - this is often through the inclusion of solar thermal energy. Since 2000, more than 1.8 million investments have been funded with support from MAP.

Other comparator countries have similar financing and subsidy schemes. In Belgium, the Wallonia region has a similar suite of subsidies to foster energy efficiency, including a zero-interest loan and a range of subsidies to promote savings across heating systems and insulation measures (Wallonie Énergie SPW, 2023).

3.4 Summary

This chapter summarised select headline policies in effect across the EU, Ireland and comparator countries for the residential sector. One key observation is that EU policy plays a prominent role in driving high impact national policy. This is evident for regulations surrounding building energy performance, minimum energy performance standards, and energy efficiency certificates. Other high impact policies include financial incentives and information campaigns.

An overview of high impact policies from comparator countries underlines the importance of EU targets being reflected through national priorities. Financial incentives such as subsidies and low-cost loans are catalysts for positive change. A somewhat unique observation is from Finland, where a culture of voluntary agreement seeks to achieve the required level of change in a more flexible manner to set standards, with discretion as to how the change is achieved. A critical requisite for achieving change is the ability to monitor energy use and report change.

In Ireland, recent updates to the suite of retrofit offerings seek to overcome some of the long-standing barriers towards retrofit adoption. The presence of a ‘One Stop Shop’ seeks to alleviate financial and information asymmetries for households looking to engage with retrofit. Although recent data on the number of retrofit installations are promising, sustained success is required. Concerns around the depth of retrofit, the rollout of grant-supported heat pump installations and concerns surrounding draft EU policy mandating a minimum BER standard for property sales are identified as potential concerns.

4 Policy effectiveness and barriers

This section explores relevant academic evidence on the effectiveness of retrofit. It first details factors supporting policy effectiveness such as the role of government, agreed targets and standards, and tailored solutions (Section 4.1). This is followed by analysis of some of the main barriers hindering change (Section 4.2). The chapter concludes with analysis surrounding the need for accurate labelling to support informed decisions (Section 4.3). A previous report prepared for the CCAC focuses on the Irish residential sector, with a chapter dedicated to the multiple benefits associated with retrofit (Coyne et al., 2022).

4.1 Policy effectiveness

Zhang et al. (2021) underline the essential role of government for successful implementation of retrofit policy. Zhang et al. (2021) studied 165 retrofit policy instruments for existing residential buildings across 11 countries. It classes policies by one of four designations (direction and command, assessment and disclosure, research and service and financial incentives). It found that in Europe, the most common financial incentive is a direct capital grant for retrofit works, followed by rebates for energy-efficient equipment and tax credits.

Zhang et al. (2021) identify specific environmental targets as a main driver of retrofit policy, with more retrofit schemes where clear targets are available. Another important insight was the need for a mix of policy instruments, often to improve stakeholder awareness. Finally, the authors propose one ambitious solution to the landlord-tenant problem is to impose restrictions on the rental and sale of energy inefficient housing (Zhang et al., 2021).

In Finland, research (Hu et al., 2022b) comparing energy use for a sample of high energy efficient multi-family dwellings in Finland and America finds that differences in the building codes contribute to lower energy use observed in Finnish dwellings, with an average energy use almost half of the US value. This work underlines the important role of building standards.

Additional policy focus on retrofit planning and regulations can provide support. As an example, major cities are considering an increased role for retrofit as a consideration for redevelopment. This has been suggested for London as part of the 2040 London City Plan. This Plan proposes to always consider retrofit and whole-life carbon emissions as a redevelopment option for major scheme developments (Spocchia, 2023).

Research in the Netherlands (de Oliveira Fernandes et al., 2021) models common building archetypes with a variety of scenarios. Analysis finds insulation to be a significant, "no-regret" element of any retrofit strategy – especially for older properties. They also find that effective retrofit measures should target both heating and electricity-generation. Importantly, their analysis identifies some of the complexity for decision-makers as optimal retrofit strategies need to be tailored for each building type and age cohort (de Oliveira Fernandes et al., 2021).

Other research studying non-profit housing associations (van der Bent et al., 2021) shows that traditional measures (heating system, insulation) have a substantial impact. More innovative solutions (including solar PV, heat pump, biomass) account for a smaller proportion (15.6%) of savings, with high future potential. A further 15.6% of the overall improvement observed is due to changes in the dwelling stock (new build + acquired, sale + demolished) (van der Bent et al., 2021). This work identifies the role of dwelling stock renewal and the potential for non-profit housing associations to improve average sectoral energy efficiency.

Earlier work by Galvin & Sunikka-Blank (2013) note that potential for 'economically viable' retrofit – where renovations must repay their cost through the savings produced - is not as large as intended (in this case an 80% reduction in CO_2 emissions by 2050). They advocate for a decoupling of the criteria for economically viable retrofits away from a stated policy target. An additional recommendation is to highlight reasons for renovating to economically viable levels and to consider approaches towards household behavioural change.

Recent research from Germany (Galvin, 2023) identifies increasing marginal costs for improving energy efficiency in more efficient dwellings (Galvin, 2023). It suggests that retrofitting more dwellings to a more modest efficiency standard would better balance the marginal cost of CO_2 abatement with current carbon prices and limited public funds.

4.2 Barriers

Zhang et al. (2021) classify the barriers to uptake by one of four categories: awareness and information issues, technical issues, financial issues and management / other (Zhang et al., 2021). It highlights the need for real building energy performance data, identifying a suitable rating system, gradual upgrade pathways, and a role for contractors to assist homeowners with the complex rebate process. This section provides an overview of academic research exploring the myriad barriers facing retrofit and energy efficiency policy.

In Germany, a synthesis of the long-standing issues hindering wider retrofit identifies policy solutions (Galvin, 2014). It notes that overly strict technical regulations often result in additional layers of bureaucracy. Solutions proposed include whether a change in the CO_2 reduction target (of 80%, in this case) is appropriate for housing given its centrality as a human need (compared to transport or air travel).

Galvin (2014) also advocates for stepwise reductions to adopt significant measures that would reduce energy consumption while being economically viable and clearly affordable. Finally, it suggests that retrofits could occur in many households where it is appropriate and affordable – even if it does not technically pay back for itself in fuel savings (a criteria in Germany). This connects with the secondary benefits of retrofit including increased thermal comfort, protection from fluctuations in energy prices and increased property value (Galvin, 2014).

Schleich et al. (2021) has explored how capital and attitudes towards debt aversion may play a role in the adoption of retrofit measures in European households (Schleich et al., 2021). It conducts a demographically representative survey across a selection of European households. It suggests that respondents who are more debt averse are less likely to adopt retrofit measures. This is especially true for debt-averse households with poor access to capital. It recommends that low-interest loan programmes should be targeted at younger homeowners with lower income and less formal education (Schleich et al., 2021).

Research from Finland has explored the barriers facing deep energy retrofit (Murto et al., 2019). Qualitative results echo concerns on the complexity of deep retrofit and how adopters must expend considerable effort to understand market offerings and identify their optimal system. It suggests that domestic policy should foster matching between potential adopters and energy counselling services (Murto et al., 2019). More recent analysis has modelled differences in retrofit cost variance for samples of Finnish and American dwellings (Hu et al., 2022a). It found that the Finnish energy retrofit projects has a distribution of costs similar to conventional renovation projects. It also found that the two most significant cost drivers were non-energy related cost items and the building envelope. This suggests that the heating and ventilation system itself is not the primary cost driver in renovations (Hu et al., 2022a).

In the Netherlands, research has explored the presence of cognitive biases in the retrofit decision facing homeowners (Ebrahimigharehbaghi et al., 2022). It finds evidence for reference dependence, loss aversion and diminishing sensitivity across different target groups. Unsurprisingly, households with the highest average income and house values exhibited the highest investment in retrofit measures. An interesting observation is that promoting the cost and loss reduction of energy retrofits can be more effective than promoting retrofits by their advantages and benefits (Ebrahimigharehbaghi et al., 2022).

Research in the Irish context has studied pathways to improve energy savings from retrofit (Mac Uidhir et al., 2020). It applies a simulation model to nine common building archetypes in Ireland to examine the most popular retrofit combinations and the change on expected energy performance. An interesting finding from this paper is the idea of retrofit choice autonomy and the most popular retrofit choices often fail to maximise potential efficiency gain. These untapped benefits are concentrated in the least efficient homes. This highlights the need for a bespoke retrofit scheme which provides more informed choices that consider the pre-existing condition of the building (Mac Uidhir et al., 2020).

4.3 Labelling

An important part of understanding residential energy use us the need for accurate data at a high resolution. In practice, there are a several Energy Performance Certificate (EPC) schemes across the EU that provide a point-in-time indicator of dwelling energy efficiency for a subset of the population. Although EPCs can help reduce information asymmetries, there are often substantial differences between an EPC and actual energy use.

In Ireland, research has shown significant differences between actual energy use and the level of the EPC (Coyne and Denny, 2021). Other research has found evidence of a similar Energy Performance Gap in Switzerland (Cozza et al., 2020) and for social housing in the Netherlands (Majcen et al., 2013). The lack of focus on measuring actual household consumption is evident in policies that target dwelling energy efficiency standards because it is easier to quantify and not subject to occupant behaviour. In Germany, Sunikka-Blank & Galvin (2012) find that occupants consume roughly 30% less heating energy than indicated by their EPC. They also find evidence that low-energy dwellings tend to engage in rebound, consuming more energy than expected by the EPC after receiving a retrofit. Although not the most accurate measure, comparison of building fabric (instead of actual energy use) is the best available measure.

Li et al. (2019) review the range of EPCs across Europe to identify improvements. It is motivated by evidence that EPCs can have a positive impact on property investments and returns on rents. It finds that some form of EPC has been implemented in every EU member state, with most countries establishing an EPC database. Li et al. (2019) advise that future EPCs should rely on Building Information Modelling (BIM) technology and include measures of perceived comfort and air quality. Other research has noted how leveraging actual energy use and temperature data could be utilised future EPC design (Simpson et al., 2020).

The latest EPBD seeks to develop a more comparable EPC (European Commission, 2023b). Furthermore, revised platforms such as the Building Stock Observatory (Arcipowska et al., 2016) seek to improve transparency on the EU building stock (European Commission, 2023c). A significant upgrade of the platform is anticipated later in 2023.

4.4 Summary

There is a diverse literature on the topic of residential energy efficiency, ranging from studies of policy effectiveness and exploration of the myriad factors limiting further progress. Based on the exploration of literature in this report, it identifies some of the main benefits and barriers from comparator countries. This will be revisited in the final chapter.

In terms of the keys for success, appropriate EU and national policy plays a key role. Whether in setting specific targets in terms of adoption or emissions reductions or minimum standards for buildings. Success relies on a mix of targets, set by the agents with the capacity to deliver change at scale. Research has noted the benefit of relatively easy wins such as insulation, the role for housing associations to deliver change at scale and the need for matching to connect the right households with the right upgrades.

Aside from the purely financial barriers to achieving retrofit, this report identifies additional barriers including the appropriateness of certain policy targets, the opportunity for encouraging incremental upgrades and the need for real data to support informed decision-making. Other barriers such as the suboptimal choice of retrofit measures and behavioural features such as debt aversion are also shown to play a role.

5 Discussion

This report presents a desk-based analysis of the residential sector between Ireland and a purposive selection of several comparable European economies. This section provides key takeaways across three main strands: (1) Profiling the energy efficiency of the residential building stock, (2) identifying residential energy efficiency policies and (3) exploring evidence on policy effectiveness and opportunities for further progress. The areas explored in this study are connected to areas identified by the Irish Climate Change Advisory Council Annual Report (CCAC, 2022) relating to the residential sector. The research identified several promising areas of progress and some further areas for examination (Table 14, column 3).

Table 14 – Summary of CCAC (2022) advice and insights

Sector	Summary of CCAC advice	Insight
Electricity Demand	A demand side strategy is urgently required, including enablers for demand side flexibility in residential demand.	Understand actual energy consumption and savings rather than a BER-based target.
	Support installation of smart meters and provision of data and suitable tariffs to move demand away from peak times.	
Built Environment	Prioritise support for retrofit and zero carbon heating towards: i) households in receipt of fuel allowance ii) the worst performing buildings - powered by coal and peat	"Fully Funded Energy Upgrades" prioritises pre-1993 homes with BER of E, F and G.
	Significantly increase the target for the Local Authority Retrofit Programme.	Group actions can deliver change at scale.
	Realise significant savings from 'simple' retrofit measures for the worst performing households.	Irish policy targeting deeper retrofit to BER B2 standard may hinder gradual improvements.
	Mandate the installation of solar PV panels on all new builds to reduce energy price exposure and reduce peak demand.	
	Develop an Action Plan for increasing use of zero-carbon district heating – which could supply up to 50% of residential heat.	
	Support deployments of heat pump economy (supply chain, skills, assessment, awareness) to support rural homes, including free technical assessment grants.	Support heat pumps given high proportion of rural standalone oil heated dwellings.

Source: Author's analysis and Climate Change Advisory Council (2022)

Profile

Ireland was compared with relevant European countries based on the profile of the residential sector: Belgium, Finland, Germany and the Netherlands. Although Ireland ranks high in terms of energy use per household, comparisons of energy use suggest Ireland is more in line with EU peers when considered on a per square metre basis. The relatively higher share of the population in rural areas and larger standalone houses suggests that greater change is possible through adoption by fewer Irish households compared to European peers.

Benefits

The review identified the critical role of EU energy efficiency policy in high impact national policies. This is evident for regulations surrounding building energy performance, minimum energy performance standards and energy efficiency certificates. As a result, Ireland features many elements of successful residential retrofit policy. There have been revisions to retrofit supports to ease the burden of engaging with retrofit, improved data collection through smart meter rollout and prioritised grant support for the least energy efficient dwellings.

Analysis of high impact residential energy efficiency policies at European level found that EU policy plays an important role in driving high impact national policy. This is evident for regulations surrounding building energy performance, minimum energy performance standards and energy efficiency certificates. Other high impact policies include financial incentives and information campaigns.

Barriers

A substantial literature exists on the barriers towards greater uptake of retrofit. This review identified several barriers. One major barrier considers the increasing marginal cost for improving energy efficiency for more efficient dwellings. This suggests that policy targets for emissions reduction could be more modest to support adoption by dwellings with lower energy efficiency. Evidence also suggests that a threshold dwelling energy performance standard (such as the BER B2) may be prohibitively high for some dwellings to feasibly reach, which may deter this cohort of houses from making any energy efficiency upgrades. A more equitable view could support homes seeking to make more gradual change.

Other barriers identified include the need for EU-level harmonisation in building energy performance certificates, that could be improved with real data and important measures, such as air quality and dwelling comfort. Finally, this work identified the need for tailored retrofit solutions and expert advice as dwellings face different optimal upgrade pathways and homeowners often choose a suboptimal combination of measures when they do upgrade. In the Irish case, the 'One Stop Shop' model, paired with a more comprehensive home energy assessment seek to alleviate some of the complexity facing Irish households.

Concluding remarks

This report provides a timely update on effective policies and pathways to unlock continued gains in residential energy use. It is important to view progress as a spectrum. Lower-than-expected progress towards longer-term targets should not deter stakeholders from continuing to push for positive change. This sentiment is best articulated in Finland, where "even small measures have a great effect when added up" (Energy Efficiency Agreement, 2023). This attitude is essential for supporting continued progress in the green transition and the residential sector, where change is often required at the household level.

Prior research offered a comprehensive review of the Irish residential sector, identifying several important considerations (Coyne et al., 2022). It noted that the need for a multi-fuel future, the importance of matching suitable technologies with end-users, accounting for the behaviours of homeowners and the barriers they may face. Residential policy should also account for the multiple benefits of energy efficiency and the important resource constraints facing the sector (Coyne et al., 2022). Recent developments in Ireland have sought to address information asymmetries and financing constraints.

Evidence suggests that the national BER B2 and heat pump targets could be missed. Future research should explore the suitability of the BER B2 target (versus an equivalent for low-efficiency homes) and the heat pump target. The former is important to consider the potential for a wider, more modest improvement in dwelling energy efficiency to reach the desired level of change in a more inclusive manner. Future study of the heat pump target (and factors influencing adoption) is especially important given the profile of the Irish dwelling stock.

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7 Appendix A – Database of Household Policies

Table 15 – Database of ongoing household energy policies

Code	Title	Type	Impact	Starting Year	Ending Year
Belgium					
HOU-BE0426	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Federal government - Transposition of recast Ecodesign directive 2009/125/EC	Mandatory standards	High	2010	
HOU-BE0417	Flanders - Reduction in property tax and gift tax for energy-efficient residential buildings	Fiscal	Low	2009	
HOU-BE0418	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Brussels - Act structurally on the demand through progressive reinforcement of the requirements of the EPB regulations in the residential sector	Mandatory standards, Mandatory information	High	2008	
HOU-BE0428	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Wallonia - Thermal regulation for buildings	Mandatory standards, Mandatory information	High	2008	
HOU-BE0419	Brussels - Develop and promote exemplary buildings (with virtually zero consumption and of high environmental quality)	Financial	High	2007	
HOU-BE0425	Brussels – Green loans for energy efficiency investments by households	Financial	Low	2007	
HOU-BE0420	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for residential buildings	Mandatory standards, Mandatory information	High	2006	

HOU-BE0424	Wallonia - Public service obligation - gas and electricity invoices (household sector)	Information/training	Low	2006	
HOU-BE0427	Federal government - Energy guzzlers web tool	Information/training	Low	2006	
HOU-BE0421	Wallonia - Financial incentives for RUE investments in buildings	Financial	High	2005	
HOU-BE0410	Brussels - Energy grant for households	Financial	Medium	2003	
HOU-BE0423	Wallonia - Training and information on rational use of energy (household sector)	Information/training	Low	2002	
HOU-BE0411	Federal government - Reduced VAT for renovation of old buildings	Fiscal	Low	2000	
HOU-BE0422	Brussels - Act structurally on the supply by stimulating the sustainable building sector (household sector)	Information/training	Low	2000	
HOU-BE0413	EU-related: Energy Labelling of Household Appliances (Directive 92/75/EC) - Federal Government - Labels on electrical household appliances	Mandatory information	High	1998	
HOU-BE0412	EU-related: Performance of Heat Generators for Space Heating/Hot Water (Directive 92/42/EEC) - Federal government - Minimum efficiency requirements for new central heating boilers (household sector)	Mandatory information, Mandatory standards	Low	1998	
HOU-BE0416	Brussels - Assist households proactively with regard to energy and eco-construction to improve the quality and energy comfort of their residence	Information/training	High	1996	
HOU-BE0414	K-level thermal regulations of residential buildings (in use prior to the EPB directive)	Mandatory standards	High	1985	2009
Finland					
HOU-FI3960	Regulations for nearly-zero energy buildings	Mandatory standards	Medium	2018	
HOU-FI0581	Energy efficiency agreements for oil-heated buildings (Höylä IV)	Information/training	High	2017	2025
HOU-FI0586	Energy Efficiency Agreement of the Property and Building Sector - Rental Property Action Plan	Others	Medium	2017	2025

HOU-FI0592	Decree on improving the energy performance of buildings undergoing renovation or alteration	Mandatory standards	High	2013	
HOU-FI0591	Decree on water measurement instruments	Mandatory standards	Medium	2011	
HOU-FI0593	Full roll-out of smart meters for electricity in 2013	Information/training	Medium	2009	
HOU-FI0590	Act on energy efficiency certificates for buildings (dwellings)	Mandatory information	Low	2008	
HOU-FI0583	Information measures instead of mandatory inspections for household boilers	Information/training	Low	2007	
HOU-FI0575	Window Energy Rating System	Information/training	High	2006	
HOU-FI0580	Energy Efficient Home Campaign	Information/training	Low	2005	
HOU-FI0577	Subsidies for energy efficiency in buildings	Financial	High	2003	2023
HOU-FI0578	Energy Audit Model for Residential Buildings	Mandatory information	Low	2003	
HOU-FI0582	Household tax credit	Fiscal	Low	2001	
HOU-FI0588	Promotion of heat pumps	Information/training	High	2000	
HOU-FI0584	National theme week for second grade pupils	Information/training	Low	1996	
HOU-FI4212	Building regulations for new buildings	Mandatory standards	High	1976	
Germany					
HOU-DE4397	Federal funding for efficient heating networks (Bundesförderung für effiziente Wärmenetze - BEW)	Financial, Mandatory standards	Low	2022	
HOU-DE3993	Funding of Serial Renovation Work (Förderung der Seriellen Sanierung)	Financial	High	2021	
HOU-DE3992	Federal subsidy for efficient buildings (Bundesförderung für effiziente Gebäude (BEG))	Financial	High	2021	
HOU-DE3991	Tax incentives for energy efficient building refurbishment (Steuerliche Förderung der energetischen Gebäudesanierung)	Fiscal	High	2020	2030
HOU-DE4003	Replacement of small storage tanks (Austausch von Kleinspeichern)	Financial	Low	2020	

HOU-DE4000	Further development of the Innovation Program Future Building (Fortentwicklung des Innovationsprogramms Zukunft Bau)	Financial	Low	2020
HOU-DE0641	National efficiency label for old heating systems (Nationales Effizienzlabel für Heizungsaltanlagen)	Mandatory standards	High	2016
HOU-DE0642	Heating Check (Heizungscheck)	Financial	Low	2016
HOU-DE0640	Upgrading the CO2 Building Renovation Programme (Weiterentwicklung, Verstetigung und Aufstockung des CO 2 - Gebäudesanierungsprogramms bis 2018 - inkl. Einführung des Förderstandards Effizienzhaus Plus)	Financial	High	2015
HOU-DE0644	Energy Efficiency Strategy for Buildings	Mandatory standards	Low	2015
HOU-DE4158	Smart Metering based on the EU Directive for the internal electricity market 2009/72/EC (Smart Metering basierend auf EU-Richtlinie für den Elektrizitätsbinnenmarkt 2009/72/EG)	Information/training	Medium	2010
HOU-DE0672	Energy Advice for low-income households (Stromsparcheck)	Financial	Low	2009
HOU-DE0661	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy certificates for buildings (Energieausweise für Gebäude)	Mandatory information	Low	2008
HOU-DE0668	EU-related: Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - (Energiebetriebene-Produkte-Gesetz - EBPG)	Mandatory standards, Others	High	2005
HOU-DE0667	EU-related: Energy Consumption Labelling Ordinance - Directive for Labelling of Energy-related Products (Energieverbrauchskennzeichnungsverordnung, EnVKG)	Mandatory information	High	1998
HOU-DE0647	Small-Scale Combustion Plant Ordinance (Kleinfeuerungsanlagenverordnung)	Mandatory standards	Low	1993
HOU-DE0670	Energy Consultancy for Residential Buildings - EBW (Energieberatung Wohngebäude - EBW)	Financial	Low	1991
HOU-DE0645	Ordinance on Heat Consumption Metering (Verordnung über Heizkostenabrechnung)	Mandatory standards	High	1981

HOU-DE0658	Energy Consultancy and Energy Checks of the Federation of German Consumer Organisations (Energieberatung und Energie-Checks der Verbraucherzentralen Bundesverband (vzbv)	Financial	Low	1978	
Ireland					
HOU-IE4407	Home Energy Saving Kit	Information/training	Low	2019	
HOU-IE0714	Smart Metering	Information/training	High	2016	2020
HOU-IE0724	EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Irish response to the recast EPBD	Mandatory standards	Low	2013	
HOU-IE0721	EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Building regulations 2011	Mandatory standards	High	2011	
HOU-IE0723	Better Energy Homes (Residential Retrofit)	Financial	High	2011	
HOU-IE0712	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Energy Efficient Lighting	Mandatory standards	High	2009	
HOU-IE0717	Condensing Boilers - Minimum Boiler Efficiency	Mandatory standards	High	2008	
HOU-IE0706	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Irish Response to the Energy Performance of Buildings Directive	Mandatory information	High	2007	2013
HOU-IE0711	Best Practice Design for Social Housing	Information/training	Medium	2007	
HOU-IE0713	Boiler Efficiency Information Campaign	Information/training	Low	2007	
HOU-IE0709	Power of One -Information Campaign	Information/training	Medium	2006	
HOU-IE0705	Warmer Home Scheme (Low Income Housing Strategy)	Financial	Medium	2002	
HOU-IE0719	Energy efficient communities through spacial and planning policies	Others	Medium	2002	
HOU-IE0703	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Energy Efficiency Requirements For Household Electric Refrigerators, Freezers and Combinations Thereof, implementing EU Directive 96/57/EC	Mandatory standards	Medium	1999	

HOU-IE0708	EU-related: Performance of Heat Generators for Space Heating/Hot Water (Directive 92/42/EEC) - Minimum Efficiency Standards for Boilers	Mandatory standards	Medium	1995	
HOU-IE0718	EU-related: Revised Directive for Labelling of Energy-related Products (Directive 2010/30/EU) - Mandatory labelling of electrical appliances	Mandatory standards	Low	1995	
HOU-IE0704	Programme “Energy Action” in Dublin	Financial	Low	1988	
HOU-IE0725	Deep Retrofit Pilot Scheme	Financial	Low		
HOU-IE0726	Social Housing Upgrades	Financial	Low		
Netherlands					
HOU-NL4104	Revolving fund heat (Warmtefonds)	Financial	Medium	2020	2030
HOU-NL4014	"Starter motor"-approach for renovating houses rental sector	General programme	Medium	2020	2023
HOU-NL4348	Stimulation scheme natural gas free rental housing (SAH)	Financial	Medium	2020	2023
HOU-NL4010	Digital Platform	Information/training	Low	2020	
HOU-NL4347	Municipal heat transition visions (TVW)	General programme	Low	2020	2030
HOU-NL4105	Sustainability scheme Reduction Landlord charges for Housing Associations (RVV)	Financial	Medium	2019	
HOU-NL4009	Climatecampaign 'Everybody acts'	Information/training	Low	2019	
HOU-NL4432	Subsidy scheme Reduction Energy Use Dwellings (RRE(W))	Financial	Low	2019	
HOU-NL0843	Block by Block approach (Blok voor Blok)	General programme	Low	2019	2030
HOU-NL4102	Programme and large scale pilots on natural-gas-free neighbourhoods	General programme	Medium	2018	
HOU-NL0850	Investment Subsidy for Sustainable Energy (Investeringssubsidie Duurzame Energie (ISDE))	Financial	Medium	2016	2030
HOU-NL4433	Energy Performance Fee Bill (EPV)	Mandatory standards	Low	2016	
HOU-NL0833	Heat distribution law (warmtewet)	Mandatory standards	Low	2014	
HOU-NL0844	Introduction Smart Meters (Uitrol slimme meters)	Financial, Information/training	Low	2012	

HOU-NL0835	Change in the Home Valuation System (Aanpassing woningwaarderingsstelsel)	Mandatory standards	High	2011
HOU-NL4011	Extending mortgage options for energy saving measures	Financial	Low	2011
HOU-NL0842	Reduced VAT rate on labour costs for insulation and glass and for maintenance an renovation of residential buildings (Verlaagd BTW tarief)	Fiscal	Medium	2009
HOU-NL0829	EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Energy performance certificate for buildings/ Energy label for houses (Energieprestatie Certificaat Gebouwen/Energielabel woningen)	Mandatory information	Low	2008
HOU-NL4101	Net metering (salderen) and VAT refund on solar panels	Fiscal	Medium	2004
HOU-NL0854	The Building Decree (2002, 2012 onwards) (Bouwbesluit, 2002 en vanaf 2012)	Mandatory standards	High	2002
HOU-NL0826	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Energy labels on appliances (Energielabels voor apparaten)	Mandatory information	Medium	1996

Source: Author's analysis adapted from MURE Database (ODYSSEE-MURE, 2023b).