WHY

CLIMBING THE CAUSALITY LADDER TO UNDERSTAND THE ENERGY DEMAND ON THE RESIDENTIAL SECTOR

# EU Policy Brief

## INTRODUCTION TO EUROPEAN CONTEXT AND RELEVANCE

Heating, cooling, lighting and appliance use in buildings account for around 40% of the EU's energy consumption and $CO_2$ emissions. Heating residential buildings is responsible for about 65% of energy consumption, revealing an untapped savings potential. To align with the EU's ambitious climate and energy goals, the buildings sector must achieve net-zero emissions by 2050, based on reducing its energy consumption, improving energy efficiency and utilising low or zero-carbon energy carriers. However, in many European countries, apart from decarbonising electricity, relatively little progress has been made towards these ends.

This Policy Brief presents key lessons from the WHY project to accelerate energy efficiency and decarbonise the residential sector across new and existing homes in the EU.

## WHY'S APPROACH AND RESULTS

The WHY project investigated these demand-side issues by integrating behavioural modelling and technical building-level modelling to create the WHY Toolkit, which integrates a causal model to improve our understanding of household behaviour with an improved household-level energy service model. The WHY Toolkit is soft-linked with the established PRIMES-Buildings energy system model to assess pathways and policies to decarbonise the buildings sector in the European Union by 2050. Through this approach, WHY developed an enhanced modelling methodology based on the consistent integration of improved representation of human behaviour and technical/engineering modelling into the large-scale PRIMES model. This can help energy planners and policymakers to develop efficient, equitable and sustainable policies to decarbonise the European building stock by 2050 alleviating potential regressive impacts, especially on low-income households (e.g. energy poverty).

## POLICY RECOMMENDATIONS

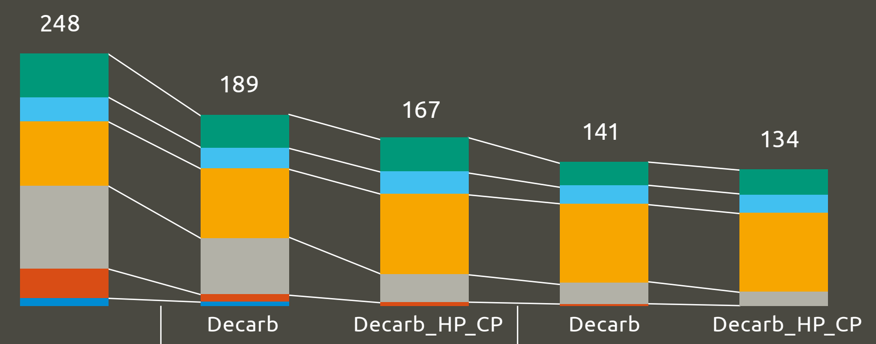
**Importance While the results captured during the WHY project display some key insights for the European energy future, it is also worth noting that the three years of the project were unprecedented with COVID-19, Russia's invasion of Ukraine and the preceding energy crisis. The structure of the policy brief spotlights how the WHY project results can contribute to relevant policies, while also looking at further policy recommendations that can enable the progress of the just energy transition in Europe and globally.**

**Relevance Our policy messages, based on the results of the WHY project, include guiding categories relevant to factors such as behavioural change, building-level technical change, pathways to net-zero buildings and/or a social impact assessment.**

# Policy message 1:

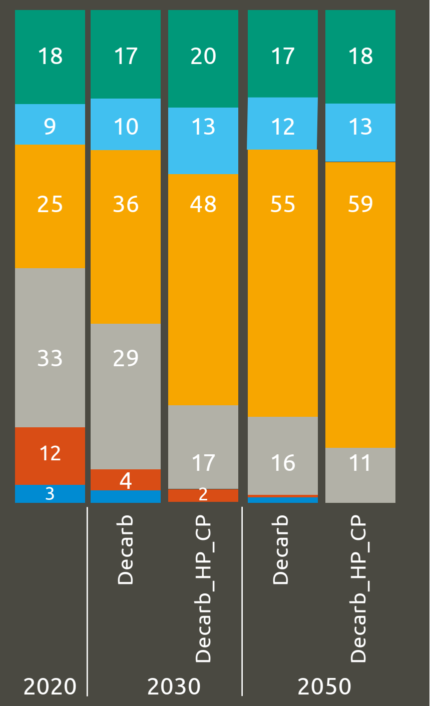
## Energy efficiency, combined with transitioning to low-carbon energy sources, is an essential enabler of the decarbonisation of buildings

### FINAL ENERGY DEMAND IN HOUSES (MTOE)




| | 2020 | 2030 Decarb | 2030 Decarb_HP_CP | 2050 Decarb | 2050 Decarb_HP_CP |
|---|---|---|---|---|---|
| Renewables | 44 | 32 | 34 | 24 | 24 |
| Heat | 22 | 19 | 22 | 16 | 17 |
| Electricity | 63 | 69 | 79 | 77 | 79 |
| Gas | 81 | 55 | 28 | 23 | 14 |
| Liquids | 29 | 8 | 4 | 0 | 0 |
| Solids | 8 | 5 | 0 | 1 | 0 |
| Total | 248 | 189 | 167 | 141 | 134 |

### SHARES IN %




Fuel mix and final energy consumption outlook in the Decarbonisation scenarios for EU27 in the residential sector.

The transformation of the EU buildings sector towards climate neutrality is based on two major pillars: accelerated energy efficiency and uptake of electrification, with heat pumps replacing fossil fuel use for heating.

To avoid further 'lock-in' to an inefficient, high-carbon pathway, new home constructions must not rely on energy-inefficient, fossil fuel-based technologies for heating such as heating stoves and boilers. However, this is not enough, as the required transformation must include the accelerated renovation of older existing buildings to improve their thermal insulation and reduce energy consumption. Overall, the final energy consumption of EU households declines by about 46% over 2020-2050 in a pathway towards net-zero emissions.

Although energy demand reduction is vital for enabling decarbonisation, it is critical that this is accompanied by a reduction in the carbon content of the energy consumption. In the decarbonisation scenarios developed in the WHY project, $CO_2$ emissions from buildings get close to zero by 2050. Most of this reduction occurs from replacing natural gas or heating oil with electric-powered heat pumps and non-fossil district heating. Low-carbon technologies are also more efficient than fossil fuel energy for heating, which, coupled with efficiency measures, such as improved insulation, leads to a reduction in energy demand in European homes.

**Policy recommendation**

Further provide and simplify consumer savings incentives to boost energy efficiency improvements and uptake of low-carbon energy heating appliances

## Policy message 2: Decarbonising European homes will require national governments to ensure clear and supportive policies to establish, monitor and enforce effective energy efficiency building regulations

Despite sharing a common energy policy framework (including the Energy Efficiency Directive and the Energy Performance of Buildings Directive) and set of minimum requirements, the stringency of building regulations across European countries – and the degree to which they are effectively monitored and enforced – varies substantially. This is in part due to variations in governance priorities and structures, as evidenced by the large variation of the energy efficiency of new domestic building envelopes across EU countries. Such variations in governance priorities and structures have affected the progress of new building performance and energy efficiency across the EU Member States.

To a greater extent, the countries in the EU need to significantly and timely invest in energy efficiency of residential building stocks, especially to renovate and retrofit building envelopes. The large financial resource mobilisation creates huge challenges for consumers, due to high-cost loans and relatively limited availability of financial resources for small projects. In addition, consumer behaviour in residential buildings is idiosyncratic, and often not rational, affecting the investment potential of energy efficient and low-carbon technologies. The latter options reduce energy bills but have high upfront costs and long payback periods.

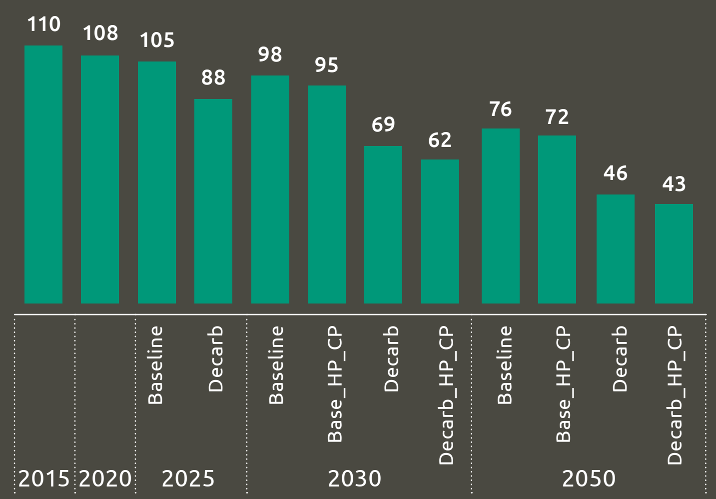
### Policy recommendation

Develop and monitor a continuous roadmap for enforcement to ensure the EU member states are on track to meet the 2030 building targets

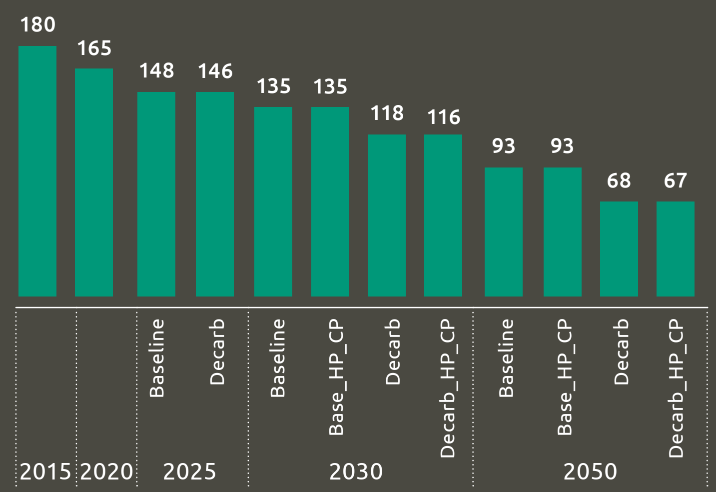
## Policy message 3:

## Energy and climate policies should consider the national circumstances to be effective and just

ENERGY CONSUMPTION IN HOUSES FOR HEATING AND COOLING, ON AVERAGE PER SURFACE UNIT IN GREECE (IN KWH/SQM)




ENERGY CONSUMPTION IN HOUSES FOR HEATING AND COOLING, ON AVERAGE PER SURFACE UNIT IN SWEDEN (IN KWH/SQM)




Energy consumption in houses for heating and cooling, on average per surface unit (in kWh/sqm) in Greece (left) and Sweden (right)

Given the vast diversity across EU countries, the results of two representative countries, Sweden and Greece, are analysed to zoom into behaviour change by examining how the different policy, climatic, socioeconomic and building construction contexts may impact the effectiveness of residential decarbonisation policies. From a policy perspective, a common EU-wide regulation does not necessarily have the same effect on different Member States and building types, as this will be impacted by the socioeconomic, climatic and behavioural factors.

Sweden and Greece are considered extreme but representative cases of the EU Member States in terms of climatic conditions but also socio-economic factors and technical features such as building stock and technologies used. Energy needs for heating in Sweden are much larger compared to Greece mostly due to longer and colder winters, but also due to higher income. The larger availability of finance implies that Swedish households can more easily perform renovation than Greek ones. However, the extension of ETS in buildings is more effective in Greece compared to Sweden, as Sweden's households are already largely equipped with heat pumps, whereas households in Greece use mostly oil and gas boilers.

Country differences largely influence the effectiveness of climate policies in the residential sector. In both EU Member States, the ambitious energy efficiency policies and the institutional measures included in decarbonisation scenarios significantly reduce energy consumption by 2050. For example, energy use for heating would decrease by 60% from 2020 levels due to accelerated renovation rates and stricter building codes. The impacts of price increases are higher in single-family households compared to multi-family ones, in line with behavioural literature, as the latter may be usually equipped with central heating systems that serve many dwellings in one building, creating difficulties in reaching an agreement on changing the central heating system with an individual one. Finally, in both countries low-income consumers spend a higher share of their income on their energy bills compared to high income, highlighting higher risks of energy poverty. Enhanced energy efficiency would decrease the share of income spent on energy purchases and increase household comfort, benefitting low-income classes most.

**Policy recommendation**

**Energy and climate policies should consider the national climatic, socioeconomic, building type and age circumstances to maximise their effectiveness**

## Policy message 4:

**By using smart redistributive policies, policymakers should ensure a just net zero transition reducing energy poverty and improving energy affordability for European households**


Enablers to further empower energy communities to alleviate energy poverty

When considering energy efficiency and net-zero energy targets in buildings, it is imperative to not only address the technical needs but to also ensure a just transition by examining distributional impacts for the most vulnerable consumers and households. While reforms of the Electricity Market Design and Energy Efficiency Directive are specifically defining energy poverty and reinforcing measures to protect vulnerable and energy poor households, further policy instruments can build upon this progress.

Carbon pricing is a key policy instrument to drive the transition but it tends to be regressive, putting a disproportionate cost burden on low-income households and increasing the risk of energy poverty. In this context, redistributive policies, such as lump-sum transfer to households or targeted support to low-income consumers through the Social Climate Fund, can reduce these regressive impacts and facilitate a rapid and equitable transition of all EU households, leaving no one behind.

In combination with the redistributive policies, further support for the energy communities framework to scale and succeed also gives vulnerable, energy poor households an active role in the energy transition. Energy communities can also help understand and explore the flexibility potential across different segments of the residential sector to stabilise the energy system – largely powered by renewables – during peak loads. Demand flexibility is highly relevant from the consumer and building level to the greater energy system, represented in energy system planning and modelling. Energy communities can play an active role in supporting the transition towards net zero by developing guides to engage vulnerable households and sharing best practices.

## Policy recommendation

Greater empowerment of energy communities can positively complement redistributive policies with active participation of energy poor

## Partners

- UNIVERSITY OF DEUSTO, Bilbao, Spain.
- 4WARD ENERGY RESEARCH GMBH, Graz, Austria.
- E3-MODELLING AE, Athens, Greece.
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