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REAL ESTATE IN A POST-PANDEMIC WORLD: HOW CAN POLICIES MAKE HOUSING MORE ENVIRONMENTALLY SUSTAINABLE AND AFFORDABLE?

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REAL ESTATE IN A POST-PANDEMIC WORLD: HOW CAN POLICIES MAKE HOUSING MORE ENVIRONMENTALLY SUSTAINABLE AND AFFORDABLE?

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Abstract

The real estate sector, including the residential and commercial market segments, is a heavy consumer of energy and, as a result, a sizeable source of emissions of greenhouse gases. This is primarily on account of the consumption of energy in heating and cooling systems, as well as in the use of domestic appliances. The construction, maintenance and thermal characteristics of buildings add to the sector's energy consumption. Based on a review of scholarly and policy-focused work, this paper argues that decarbonisation strategies to meet agreed climate change targets will need to incorporate policies targeted to the specificities of the real estate sector. They include addressing split incentives among owner-occupiers, landlords and renters (in the private and social housing markets) for investment in home improvements and energy retrofitting; raising the standards of energy performance for new and existing properties through labelling/certification and other means; and reducing the cost of finance for needed investments while broadening access to the underserved population.

Keywords: housing, decarbonisation, energy efficiency, real estate regulation.

JEL classification codes: Q58, Q48, R38, K25

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1. Introduction

The real estate sector, including the residential and commercial market segments, is a heavy user of energy. Buildings account for about 30 per cent of global final energy consumption and, as a result, the sector is a sizeable emitter of greenhouse gases, with about 15 per cent of energy-related CO_2 emissions (IEA, 2021a). In particular, in many countries the population is exposed to emissions of fine particulates, which are particularly detrimental to the health of residents (OECD, 2021a). The environmental footprint of the real estate sector is even heavier over the lifecycle of buildings, given the resource consumption related to construction, operations, maintenance and demolition. At the same time, the emissions associated with the real estate sector are priced lightly compared with other sectors and activities.

This combination of high but modestly priced emissions makes policies to enhance the environmental sustainability of the real estate sector, particularly in terms of improvements in the energy efficiency of buildings and electrification, an integral part of overall strategies to decarbonise economies and societies in pursuit of agreed climate change targets. Policies to decarbonise energy generation more generally will also help. In particular, many hurdles need to be overcome through policy action to unleash opportunities for home improvements and energy retrofitting of properties in a manner that solves the 'energy paradox' associated with the underutilisation of energy conservation technologies that are currently available and would otherwise make economic sense to be adopted (Gerarden et al., 2017). Lifecycle considerations are becoming increasingly important, as improvements in energy efficiency gradually shift attention to the carbon intensity of construction and demolition. First and foremost is the need to align incentives along the tenure spectrum — including owner-occupiers, landlords and renters in the market and non-market (social housing) segments — while at the same time securing financing for the needed investments, which are sizeable, particularly where energy efficiency performance is low, often where the stock of housing is old. In addition, there is a need to raise the energy efficiency standards of new buildings since demand for real estate will continue to increase, especially in emerging-market and developing countries, where populations are growing and standards are low. Indeed, floor area is expected to expand by about 75 per cent worldwide during 2020-50 (IEA, 2021a). For example, to reach net-zero emissions by 2050, annual capital investments in buildings worldwide will need to almost double from current levels to around USD 730 billion in 2050, primarily on account of energy retrofits, use of energy-efficient appliances, heat pumps and district heating systems (IEA, 2021a).

Dealing with 'split incentives' along the tenure spectrum and 'coverage gaps' in finance are important steps to make sure investments in energy retrofitting are made without putting additional upward pressure on house prices and rents that would aggravate affordability challenges. Indeed, in many advanced economies house prices have risen sharply over the last two to three decades, making quality homes unaffordable to large segments of the population (OECD, 2021a). At the same time, energy poverty already accounts for a large share of the population in many countries. This problem has been aggravated by the sharp increase in energy prices following the eruption of armed conflict in Ukraine in February 2022.

The 'split incentives' problem arises when the associated costs of energy retrofitting are not capitalised in rental or sale prices. For example, landlords have no incentive to invest to improve the energy efficiency of for-rental properties, which typically involves high upfront costs, if tenants enjoy the associated benefits in the form of lower energy costs and higher levels of comfort without a concomitant increase in rents. The 'coverage gap' problem arises from asymmetries of information between borrowers and lenders that increase the cost of capital and limit access to affordable financing from market sources. For example, banks cannot evaluate the effect of lower energy costs on credit quality if they do not have information on the energy performance of buildings or modelling capacity to use the information, where available, in their underwriting practices.

The residential market accounts for the lion's share of buildings and a large share of energy consumption in the real estate sector, making it of particular concern for policy.[1] Tenure structure is also more complex in the residential segment than in the commercial market, with greater potential for incentive mismatches and different choices related to lifestyle and behaviour that need to be taken into account in policy design. In the commercial real estate sector, by contrast, decisions on energy retrofitting tend to be based predominantly on cost and income generation considerations. Indeed, policy action that can lead to behavioural changes towards energy saving in general have the potential to complement efforts to decarbonise the real estate sector.

To shed light on these challenges, this paper reviews the scholarly literature and policy-oriented work with a focus on the interface between environmental sustainability and affordability.[2] It looks primarily at the difficulty of promoting energy efficiency given the different incentives to invest in home improvements and energy retrofitting along the tenure spectrum. It also looks at the specificities of the social housing segment, where energy efficiency tends to be low to begin with,

[1] This is not to say that the commercial market segment is not important. In fact, energy consumption is sizeable in the commercial end-use sector as well. In the United States, for example, the residential sector consumed over 21 quadrillion BTU in 2021 whereas consumption in the commercial segment amounted to about 17.4 quadrillion BTU (EIA, 2022).

[2] The review is based on searches through web-based tools of combinations of keywords for energy efficiency and housing or real estate. Selection of the relevant work to be considered was carried out based on relevance criteria, such as number of citations of the papers, the date of publication and the reputation of the publication outlet.

and policy design is marred by sustainability and affordability trade-offs. Moreover, the paper looks at the hurdles to develop energy efficiency financing instruments and the options available for policy in this area, including through the development of de-risking instruments associated with alternative underwriting mechanisms, as well as by improving the capacity of financial institutions to integrate these considerations in their credit assessment methodologies. These aspects are particularly important for policy; they have not been discussed extensively in previous surveys of the literature, including Solà et al. (2021), Gerarden et al. (2017), Markandya et al. (2015) and Ramos et al. (2015), and will be the focus of this review.

A few messages for policy emerge from the review of scholarly work. First, the real estate sector's environmental impact depends on its energy consumption and the carbon intensity of energy generation. Per capita energy consumption depends on per capita floor space, the thermal capacity of buildings, the use of heating/cooling systems and appliances by residents, as well as lighting and other energy uses. The carbon intensity of residential energy consumption is mainly driven by the energy mix to produce electricity but also by the technologies used to consume energy at home via appliances and heating/cooling equipment. Electrification, notably of water and space heating equipment, and energy efficiency improvements account for 70% of the buildings-related CO_2 emission reductions to reach carbon-neutrality by 2050 (IEA, 2021a). Construction activity is also very carbon-intense, and choices regarding construction materials and technologies affect the life-cycle energy use of the real estate sector. Buildings have a long life-cycle, and therefore differentiated decarbonisation approaches are needed for new units and the existing real estate stock.

Second, regulatory sticks are good complements to financial carrots. Energy performance labelling/certification for buildings are important regulatory tools. They are associated with rental or selling price premia for homeowners and vendors. Still, these regulations tend to focus on new buildings and properties for sale or rent, which excludes the bulk of the real estate stock. Extending regulations to the entire stock of properties while making disclosure of information on the energy performance of properties (throughout their lifecycle) compulsory would help to address this problem. Raising energy efficiency standards in building codes plays a key role in decarbonising new buildings, which complements efforts aimed at the existing stock of buildings. Moreover, financial incentives play an important role, including tax rebates and subsidies, but they place a financial burden on government budgets and tend to benefit the better-off, since upfront investments in home improvements and the acquisition of more efficient appliances tends to be high. Carbon pricing is yet another potential instrument, but it is underutilised in the energy end-user sectors, such as real estate.

Third, there is room for enhancing market-based financing for energy retrofitting by de-risking investments. This requires improving access to information on the energy performance of buildings, including through labelling/certification, as well as strengthening methodologies for incorporating this type of information in the underwriting practices of financial institutions. Improving taxonomies and disclosure standards for environmental, social and governance (ESG) investment more broadly would also help to reduce the cost of capital for lenders. Moreover, green mortgages and other innovations have a role to play, along with continued government support for borrowers who do not have access to finance from market sources, including through government-financed energy retrofitting investments in the social housing sector.

Fourth, related to the above is the need to deal with energy poverty. This requires tailoring financial support to the specific needs of low-income households, who are often renters. Therefore, the design of support programmes needs to deal with the twin challenges of delivering cost-effective energy efficiency gains for the underserved population while mitigating the disincentives that exist among landlords and tenants, including in the subsidised social housing segment. Support needs to deal with the financing of both home improvements and the upfront costs of acquiring energy-efficient appliances and using modern technologies, such as smart grids, which are useful information-based tools to shape energy conservation behaviour.

The paper is organised as follows. Section 2 presents a few indicators of the environmental impacts of the real estate sector, focusing on energy consumption, emissions and carbon pricing. Section 3 focuses on the 'split incentive' problems and discusses the empirical evidence reported in the scholarly literature, along with policy options. Section 4 draws attention to the pricing of emissions in the real estate sector. Section 5 focuses on energy poverty and the distributional implications of decarbonisation policies. Section 6 addresses the 'coverage gap' challenges in financing needed investment, associated empirical evidence and policy considerations. Section 7 concludes and points to avenues for further scholarly work.

2. The real estate sector: energy consumption and emissions

The real estate sector is a heavy energy user. Buildings account for about one-third of total energy consumption worldwide, along with industry and transport, essentially on account of the need for electricity for heating, cooling, lighting and use of domestic appliances (**Figure 1**). Energy consumption also depends on the thermal capacity of buildings, as well as habits and behaviour, making energy efficiency a crucial element of carbon abatement strategies for the real estate sector to meet agreed climate change targets. Moreover, there is considerable variation in the per capita energy consumption of buildings across countries, with higher readings in those countries located in higher latitudes, where winters are harsher.

As a result of its energy consumption, the real estate sector accounts for a large share of emissions of greenhouse gases. Buildings are responsible for about 15 percent of final consumption emissions of CO_2 worldwide, even though there is considerable variation across countries (**Figures 2and 3**). According to the IPCC (2014), when emissions from electricity and heat production are taken into account in the use of energy by sector of activity (indirect emissions), buildings (including residences) are responsible for close to one-fifth of emissions globally, followed by industry and Agriculture, Forestry and Other Land Use (AFOLU).

These numbers still underestimate the energy intensity of the real estate sector, because they exclude the energy use of the construction process itself and therefore do not consider the entire life cycle of buildings. Indeed, the real estate sector includes direct emissions from households' combustion of fossil fuels, indirect emissions from the production of the electricity used by households and district heating, which are both related to the operation/use of real estate, as well as embodied emissions related to the construction, maintenance and demolition of buildings. Most 'embodied carbon' in buildings comes from the production stage and, as such, unlike 'operational carbon', it cannot be mitigated during the working life of the building (UNEP, 2021). Empirical analysis also shows that on average across building types emissions come predominantly from operations, rather than manufacturing and construction (Seo and Hwang, 2001).

Exposure to fine particulates, which are particularly detrimental to residents' health, is particularly high in the residential sector (**Figure 4**). This is because many households around the world still use firewood for heating, especially in developing countries and emerging-markets economies, and in remote areas. To put these concentrations in perspective, the World Health Organisation ambient air quality guidelines currently stipulate an annual mean PM2.5 concentration limit of 5 $\mu g/m^3$, down from10 $\mu g/m^3$ in 2005.

Despite high emissions, the real estate sector is subject to low carbon pricing. The Effective Carbon Rates (ECRs) levied on heating for residential and commercial use vary considerably across countries (OECD, 2019; OECD, 2021b) (**Figure 5**).[3] Only a few countries price a majority of these emissions at EUR 30 per tonne of CO_2 or more while most hardly price them. This is because emission prices are low on average, even though they are higher for specific fuels, such as diesel and gasoline, and sectors, such as transport, which are heavy users of these fuels. Emission prices are lower for electricity, natural gas and biomass, which are the main sources of final energy consumption in the real estate sector.

3. Investing in energy retrofitting: incentive mismatches along the tenure spectrum

3.1 The split incentives problem

Improving the energy efficiency of the existing buildings will require considerable energy retrofitting. Currently, less than 1 per cent of buildings are retrofitted on average per year in the advanced economies, whereas achieving net zero by 2050 would require an average retrofit rate of about 2.5 per cent in 2030, or the equivalent of 10 million dwellings, according to the IEA projections (IEA, 2021a). However, investment is discouraged by a mismatch of incentives along the tenure spectrum, which ranges from owner-occupiers and landlords to renters in the market and non-market (social housing) segments. This variety of tenants is fraught with principal-agent problems that complicate policy design, especially given the diversity of tenure structures in OECD countries (**Figure 6**). A number of countries are characterised by a prevalence of homeowners without housing loans and relatively thin rental markets, whereas in other countries there is a large

[3] Effective carbon rates take account of fuel excise taxes, carbon taxes and tradable emissions permit prices.

share of renters and/or mortgage-holders. Policy therefore needs to be tailored to the specificity of these countries.

The mismatch of incentives for investment in energy retrofitting arises because the costs of home improvements are borne by homeowners (owner-occupiers or landlords), whereas the benefits in terms of higher levels of comfort and lower energy costs accrue to tenants. This is especially the case of rental contracts that do not allow for passing those costs on (in part or in full) in the form of higher rents. Incentive mismatches are compounded by the fact that homeowners tend to have a longer time horizon for investments in home improvements, especially given the high fixed costs of such investments, whereas tenants focus on the short-term benefits of home improvements, given their weaker attachment to rental properties (Kholodilin et al., 2017; Gerarden et al., 2017). These incentive mismatches are even more complex in the social housing sector, as discussed below, since constraints on rent increases and outright rent caps, as well as on transaction prices, make it difficult for improvement costs to be passed on to tenants or homebuyers (Chegut et al., 2016).

The incentive mismatch between homeowners and renters is borne out by the empirical evidence, as surveyed extensively by Solà et al. (2021) and Gerarden et al. (2017), among others. The analysis of Phillips (2012) indeed shows a lower willingness to pay for home improvements among renters than homeowners. Franke and Nadler (2019) reiterate these findings for Germany, showing that homeowners tend to be more familiar than renters with the energy performance of properties. Beyond Europe, Banfi et al. (2008) report different willingness to pay between homeowners and renters in the United States, making landlords in the residential for-rent market an important target group for designing energy efficiency programmes. Moreover, evidence for the United States also shows significant rent premia for energy-efficient properties, suggesting that the benefits for landlords of investment in energy-efficient technologies are large over and above the associated energy savings (Im et al., 2017). Most studies of owner-occupier dwellings indeed show that transaction prices rise with energy efficiency (Brounen and Kok, 2011; Cerin et al., 2014; Feige et al., 2013; Hyland et al., 2013; Taruttis and Weber, 2022).

3.2 Certification and other incentives

An important element in dealing with split incentives in this area is to make information on the energy performance of properties available through transparent and verifiable energy performance labelling or certification of properties. Labelling/certification facilitates comparison of energy performance among properties in situations of otherwise imperfect information that prevents price formation in a manner that rewards investment in improvements in, and maintenance of, the thermal characteristics of buildings. The labelling/certification of buildings is similar conceptually to the ratings applied to the energy performance of domestic appliances. The survey of the empirical literature conducted by Ramos et al. (2015) indeed confirms the potential of energy certification and labels. They report willingness-to-pay estimates of up to 20 percent in some cases, which is consistent with the reductions observed in energy use. This result applies to buildings, home appliances and vehicles, even though they are weaker for residential properties than for commercial buildings.

Several labelling/certification programmes are available around the world. For example, efforts in this area date back in the European Union to the Energy Performance of Buildings Directives (EPBD) of 2003 and 2010 (the "recast"), the Energy Efficiency Plan of 2011 and the Horizon 2020 energy efficiency stimulus package (Visscher et al., 2016). More recently, a revised EPBD proposal was launched in December 2021 introducing new energy performance standards, including minimum standards for existing buildings, zero-emission standards for new buildings from 2030, and new standards for data collection and dissemination. In the European Union programme, energy performance certification (EPC) requires a colour-letter energy efficiency (EE) rating for the energy performance of a building on a scale from A to G, where A is very efficient, and G is very inefficient. Implementation and effectiveness of the European certification system nevertheless vary across countries and regions depending on the characteristics of local housing markets. EPC has become increasingly rigorous over the years, even though it applies in most countries to new buildings and those for sale or rental, which excludes most buildings from mandatory certification and therefore poses challenges for the use of certification as an energy-saving tool for the stock of existing buildings.

Beyond the energy performance labelling/certification of properties, other programmes are in place in different parts of the world to encourage the reduction of operating costs of buildings, which leads to lower energy bills, loads on the electric grid and emissions from power generation. For example, in the United States, several utility-sponsored programmes at the regional and local levels provide rebates or incentives to homeowners who invest in more energy-efficient systems and technology (American Council for an Energy-Efficient Economy, 2016; Im et al., 2017). In other cases, incentives are provided through the guarantee of lower operating costs of selected products or buildings. The ENERGY-STAR labelling programme is the main such certification system in the United States. In Singapore, the Green Mark Certification programme is also well known (Davis, 2011; IEA, 2010).

Codes and standards are another class of instruments that can be considered (Solà et al., 2021; Markandya et al. 2015). These command and control instruments focus on improvements to the thermal characteristics of properties (residential or commercial) that can reduce energy consumption throughout the life-cycle of buildings, from pre-construction (design and planning) to the construction and occupation phases. Improvements can be made in landscape design, site selection, building plan and orientation, as well as internal space organisation. Building form, construction materials and envelope systems, in addition to integration of renewable energy sources, day lighting design strategies and mixed-mode ventilation systems are among the most common aspects in the case of office buildings according the survey of the literature carried out by Erebor et al. (2021). Indeed, many of these aspects are being incorporated in building codes and standards to encourage the use of energy efficiency design solutions, including bioclimatic design concepts and principles. These normative measures can increase the price premium for more energy efficient buildings, but they may also lead to higher construction and maintenance costs, as recognised in the survey of the literature conducted by Markandya et al. (2015).

3.3. Limitations of labelling/certification

Despite its potential, labelling/certification has several limitations. One is related to programme design, given the limited reach of regulations in most countries, including currently in the European Union. Labelling/certification is typically required for properties for sale or rental, which excludes the majority of properties in most countries. The Netherlands is among the very few countries where labelling/certification applies to all properties; energy-performance certification is also mandatory in France for multi-family properties, with implementation varying from 2024 to 2026 depending on the size of buildings. Indeed, analysis of the European Directives shows that compulsory use of EPCs in transactions, as well as the public display of the information, which was introduced in the 2010 “recast”, have strengthened the influence of certification on outcomes based on studies for Germany (Amecke, 2012); Spain (Ayala et al., 2016); Denmark (Jensen et al., 2016), Finland (Fuerst et al., 2016); Wales (Fuerst et al., 2016), and Ireland (Hyland et al., 2013), for example.

Also, there is often a lack of information about the rules and regulations themselves. This is shown by Franke and Nadler (2019) in the case of Germany, for example, suggesting that there is a need for further efforts to enhance the transparency of regulation and verification of compliance. Evidence from the European Directives, based on the seminal papers by Adjei et al. (2011), Broumen and Kok (2011) and Amecke (2012), also highlights the importance of disseminating information about energy performance, as well as building trust in labelling/certification systems and the information they provide. Adjei et al. (2011) reported high levels of awareness of EPCs, but low trust in the information on energy efficiency and limited impact on decision-making and price formation. Marmolejo-Duarte et al. (2020) also refer to poor reputation of the programme, in part due to weak monitoring and enforcement, when analysing the effectiveness of energy certification in Spain.

Another limitation concerns the economic incentives that can be created through energy performance labelling/certification. There is often a lack of awareness about the economic benefits of energy retrofitting along the tenure spectrum. Franke and Nadler (2019) indeed show in their work on Germany that renters are often unaware of the gains associated with home improvements in terms of lower energy bills, which is equivalent to a gain in disposable income if rents are not raised by the same amount. Residents also often lack a basic understanding of the links between the thermal characteristics of a dwelling and the set of appliances available in it (Hope and Booth, 2014). Moreover, Souza (2018) compares adoption rates among certified home appliances and finds heterogeneous incentives along the tenure spectrum. As in the case of energy labelling for buildings, homeowners typically have better energy-efficient appliances than renters. This is especially where landlords do not pay for utility bills, which provides limited incentives for them to invest in the energy efficiency of appliances in for-rent properties. The adoption gap between homeowners and renters is significantly narrower when utility bills are paid by landlords.

Energy performance labelling/certification may also have unintended effects on behaviour. For example, to the extent that the premia associated with energy efficiency encourage homeowners to invest in home improvements, they may face the incentive to keep investments at a minimum level needed to secure a move to a higher energy efficiency grade. Comerford et al. (2018) indeed find that the colour-letter grades embedded in the English Energy Performance Certificate programme provide an incentive for landlords to invest in energy efficiency. However, the incentive is stronger for homes close to the next colour grade rather than for the entire residential building stock. This finding suggests that energy labelling provides weak incentives for additional home improvements once a higher colour-letter grade is achieved. Another consideration is the moral hazard facing landlords of less energy-efficient properties to invest in retrofitting when disclosure of information on energy performance is not compulsory in rental markets. Fuerst and Warreen-Myers (2018) report evidence for Australia that voluntary disclosure of information on the energy performance of rental properties is more likely for better quality properties, which weakens the incentive for retrofitting the less energy-efficient properties.

Related to the above are other drivers of underinvestment that cannot be easily addressed through regulation and financial incentives. There are indeed complex behavioural responses by residents in relation to changes in the energy efficiency of buildings, as evidenced in the survey carried out by Harputlugil and de Wilde (2021). Renters are typically less informed about energy costs than landlords, typically resulting in higher energy expenditures for renters, all else equal, which strengthens the case for information campaigns, mandates to include energy certificates in the lease documentation or use of efficiency standards to improve market outcomes (Myers, 2020).

In addition, homeowners tend to overestimate the energy performance of their homes, which discourages investment in home improvements (Hope and Booth, 2014). They may also have a preference for the status quo, given uncertainty about technological improvements that may affect the return on investment in energy efficiency improvements (Markandya et al., 2015). Moreover, evidence also points to a lack of interest in the economic benefits of investment in energy efficiency improvements (Ambrose and McCarthy, 2019; Miu and Hawkes, 2020; Schueftan et al., 2021).

3.4. Life-cycle considerations

Decarbonisation strategies for the real estate sector need to consider the lifecycle of buildings, rather than focusing exclusively on the reduction of operational carbon, while ignoring embodied carbon. This is particularly important where construction activity is set to rise as a result of population growth, which calls for sustained increases in the stock of housing. It is also important to take a lifecyle perspective, because efforts to decarbonise the operation of buildings through improved energy efficiency actually increase the use of materials required for energy retrofitting and home improvements, which needs to be taken into account in policy initiatives. Moreover, as emphasis is placed on improving energy efficiency in the operation of buildings, there is a risk that carbon leaks to other phases of their lifecycle, increasing the importance of measures that can reduce embodied carbon in the real estate sector. Indeed, the review of lifecycle assessment case studies carried out by Roeck et al. (2020) shows that embodied carbon already accounts for the lion's share of emissions in highly energy efficient buildings.

However, comprehensive strategies including both operational and embodied carbon have yet to be developed in most countries. Policy discussions in the European Union are nevertheless encouraging in this regard, since the Renovation Wave strategy and the EPDR directive of the European Commission (discussed above) aim to make buildings less carbon-intensive over their lifecycle. Several policy initiatives targeting embodied carbon have indeed been taken in Europe over the last few years (Bionova 2018). At the national level, the Netherlands and France require new buildings to account for their embodied impacts through carbon content caps, as well as specific reporting and disclosure requirements. Assessment methodologies are also available in Belgium, Finland, Germany, Sweden and Switzerland (UNEP, 2021). The review of lifecycle assessments carried out by Pomponi and Moncaster (2018) nevertheless shows that there is considerable variation in assessment methodologies, which constrains comparability.

3.5 Insight for policy

In the light of this body of evidence, policy would do well to focus on a few key areas where potential remains for improving the design of energy performance labelling/certification programmes and strengthening economic incentives for energy retrofitting along the tenure spectrum. First, the coverage of labelling/certification rules and regulations could be extended to all properties and not only those for sale or rental. This would raise awareness about the benefits of investment, the links between the thermal characteristics of properties and energy consumption, and the economic benefits of investment in terms of lower energy bills and improvements in disposable income (as well as creditworthiness, as discussed below). It would also pave the way for more ambitious decarbonisation goals that would affect the entire real estate stock in the years to come.

Second, complementary efforts could be made to strengthen disclosure standards. This could be achieved by making labelling/certification compulsory for all properties and improving verification of compliance with the rules and regulations. This is particularly important in the rental market segment, because non-disclosure creates a moral hazard for landlords of sub-standard properties, who would have limited incentives to invest if the cost of energy retrofitting is not capitalised in rental or sale prices.

Third, policy would do well to strengthen the economic incentives for energy retrofitting. The design features mentioned above would help in this area, predominantly by raising awareness about the benefits of home improvements. Education campaigns would also contribute, especially if targeted at those least likely to be sensitive to the energy performance of properties, including renters. Indeed, given the different incentives facing owner-occupiers, landlords and renters, a case can be made for subsidising energy retrofitting for renters or landlords, rather than owner-occupiers, who are more knowledgeable about the economic benefits of investing in energy retrofitting and therefore face stronger incentives to invest. Of course, in the case of landlords, incentives to invest are stronger where the cost of energy is included in rents, which requires lower subsidies than in the case where landlords do not reap the benefits of enhanced energy efficiency in the form of lower utility bills.

Fourth, policy reform to broaden standards and regulations to cover the entire lifecycle of buildings would do well to start by tightening reporting requirements so that reliable data can be collected based on harmonised methodologies across environmental product declaration (EPD) issuers, jurisdictions (national and subnational), products and building types. This is essential for the comparability and coherence of carbon assessments and in turn the benchmarking of policies to decarbonise the real estate sector in line with state climate change goals (de Wolf et al., 2017). Making lifecycle carbon reporting compulsory would facilitate data collection and policy benchmarking, as well as raising awareness among the population about the importance of going beyond measures to contain the operational energy intensity of buildings.

Finally, there is a need to deal with energy efficiency standards for new buildings. The survey of the literature conducted by Markandya et al. (2015) suggests that these normative interventions tend to reduce energy consumption in residential buildings, albeit by less so than in the industrial sector. The latest European Directive aims to address this challenge by requiring stricter regulations for the decarbonisation of new buildings. This is important because of the long lifespan of buildings and structures, which implies that the standards embedded in building codes are locked in for several decades in the absence of requirements for regular home improvements for the existing building stock, and not only those properties for sale or rental. At the global level, however, two-thirds of countries still lacked mandatory building energy codes in 2020, and high-performance buildings, such as those with near-zero energy use, still make up less than 5 per cent of new construction (IEA, 2021b). Moving forward, this is particularly important because of the expected increase in demand for real estate, as mentioned above, especially in emerging-market and developing countries, with an attendant estimated increase in floor area by about 75 per cent worldwide during 2020-50 (IEA, 2021a), and where standards are typically low (Iwaro and Mwashs, 2010). Energy efficiency standards and regulation have a bearing on construction costs and administrative burdens on the supply of residential structures, making it important to take affordability considerations into account in policy design, as discussed below.

4. Beyond norms, regulations and financial incentives: the case of carbon pricing

4.1 Experience to date and empirical analysis

Energy performance labelling/certification regulations and financial incentives are powerful drivers of improvements in the energy efficiency of properties, despite the asymmetries discussed above in incentives across tenure types. However, other policy instruments, most notably the explicit pricing of emissions, could play a role by tightening the link between the cost of use of energy in buildings, on the one hand, and actual energy demand, on the other. As noted above, emissions are priced modestly in the real estate sector, because of the low carbon price of the fuels used most often to cool, heat and light buildings. Emphasis has also been typically placed on pricing emissions associated with energy production rather than its use or consumption. However, there is merit in pricing energy demand to the extent that consumers may reduce their energy consumption or choose to purchase energy from cleaner sources. This requires tracking power flows in transmission networks to identify the carbon content of end-users' power consumption. In any case, to the extent that there is complete coverage of the carbon tax among generators, production- or consumption-based pricing would yield equivalent effects on emissions (Chen et al., 2019).

Empirical evidence is mixed. The cross-country evidence provided by Thonipara et al. (2019) for the European Union indeed suggests that higher explicit carbon prices, beyond the implicit costs associated with rules and regulations, can lead to a reduction in the energy consumption of residential buildings. Nevertheless, empirical studies based on micro-econometric methods are limited in number (Green, 2021) and often point to contradictory findings. For example, the analysis carried out by Ott and Weber (2022) for Switzerland shows that the 2016 and 2018 carbon tax rate increases, which apply to fossil fuels used to produce heat and electricity, do not appear to have a discernible short-run impact between fossil fuel users and non-users. Heating consumption does seem to be affected more strongly by behaviour, such as preferences and habits over home temperatures and the availability of technologies allowing for temperature-setting.

Rather than dismissing the importance of the instrument, the authors suggest that other factors may be at play. They include a lack of salience from the tax, since tax increases may be swamped by market price volatility, as well as a lack of understanding of the tax among residents and limited ability to switch to alternative heating fuels and implement energy-efficient renovations. In any case, the meta-analysis of price elasticities of energy demand conducted by Labandeira et al. (2017) shows that these elasticities are rather low, especially in the short run and before behavioural responses trigger shifts in consumption. This is confirmed by more recent evidence by Pisu et al. (2022).

The sensitivity of energy use to price/tax signals also varies along the tenure spectrum. Weber and Gill (2016) focus on heating consumption in Germany and find higher elasticities for renters than homeowners. This is most probably due to the fact that tenants tend to consume more energy for heating per floor surface in their sample and therefore have more room to reduce consumption in response to higher taxes. Heterogeneous responses to price and tax signals suggest that other policy instruments may be needed to lead to durable reductions in consumption. This includes penalties, as suggested by Wang et al. (2022) based on programmes to foster the renovation of appliances.

4.2 Insight for policy

These findings suggest important differences in the effect of price and tax instruments on energy generators and end-users. Therefore, these instruments may have a stronger effect on emissions by shifting the energy mix for end-uses towards lower carbon-intensive alternatives rather than triggering behaviour changes among end-users themselves (Leibowicz et al., 2018). The literature remains inconclusive in this area, which underscores the need for further work on the use of carbon pricing among end-users in the real estate sector to encourage reductions in energy demand and/or improvements in the energy performance of properties.

Beyond carbon pricing, other price instruments can be considered to promote energy efficiency improvements in buildings, including taxes, subsidies and rebates. These instruments can address different market and behavioural failures that compound the split incentive problems associated with underinvestment in energy efficiency (Solà et al., 2021). However, empirical evidence is mixed on their effectiveness. For example, Villca-Pozo and Gonzales-Bustos (2019) suggest that property or income taxation are poor instruments to promote energy retrofitting in Spain, especially in the case of old buildings. As far as subsidies are concerned, Olsthoorn et al. (2017) show that factors, such as the time preference of benefit recipients, also matter. The survey conducted by Markandya et al. (2015) indeed shows that subsidies tend to result in the adoption of more energy efficient appliances, but they tend to costly to the government purse and subject to other limitations, including the scope for misuse of funds. In addition, there is the so-called "rebound effect" associated with the perverse incentive that a reduction in the price of an appliance results in consumers buying larger and more energy-using versions. Moreover, distributional considerations are important for the design of tax/subsidy incentives in this area, given the different take-up rates among social groups (Jacobsen, 2019; Markandya et al., 2015).

5. Energy poverty: a particularly challenging aspect of housing affordability

5.1 Who is most affected?

Energy costs are more burdensome on vulnerable social groups than their more affluent counterparts, making them more likely to face energy poverty. In the European Union, about one-fifth of households in the lowest quintile of the income distribution cannot afford to keep their homes adequately warm, nearly twice the rate for the middle class (**Figure 7)** This is all the more important in periods of sharp increases in energy prices. Indeed, Schaffrin and Reibling (2015) show that low-income households spend more on utilities than the better-off as a share of their income.

At the heart of the energy poverty challenge is the fact that energy demand varies considerably among social groups. This reflects their ability to cope with unexpected variation in energy costs, including through access to smart grid technologies, such as smart meters, in-home energy displays and home energy management systems, as well as social practices and behaviour regarding energy use, such as the time of day when appliances are used. Smale et al. (2017) show for the case of the Netherlands that household activities or practices contribute to peak demand, leading to higher energy costs that overburden low-income households more than their more affluent counterparts. Similarly, Faruqui and Sergici (2010) show for the United States that low-income households have a flatter daily energy consumption curve than better-off households, which suggests that they are less able to shift their energy demand in response to prices and financial incentives. At the same time, low-income households are more susceptible to extreme weather conditions, which is expected to become more prevalent as a result of climate change. These households are more likely to suffer from poor health related to respiratory and cardiac conditions, as well as psychological stress related to thermal discomfort and lifestyle cutbacks when faced with unaffordable energy costs.

There is a deficiency in the design of programmes to support those social groups most likely to suffer from energy poverty. In the United States, several energy assistance programmes are in place, but they focus on the provision of financial assistance to poor households for the payment of utility bills, rather than targeting energy efficiency itself through tax incentives and/or subsidies for the installation of new appliances or equipment. These programmes tend to have low take-up rates primarily because of the high upfront costs associated with the replacement of over-sized, obsolete and/or inefficient heating and cooling equipment, as well as inefficient household appliances and lighting (Drehobl and Ross, 2016; Im et al., 2017; Xu and Chen, 2019). This modality of financial support also tends to benefit the better-off, because they can better afford the upfront costs and have a broader array of home appliances than their lower-income counterparts. These problems are compounded by the renter-landlord incentive mismatch since most low-income households are renters. Indeed, Xu and Chen (2019) find for the United States that homeowners typically own more energy-efficient appliances, as well as lighting, heating and cooling systems than renters, and they also tend to use more energy demand management devices, such as adjustable or programmable thermostats. These gaps are also true between high- and low-income households.

5.2. Insight for policy

These empirical findings point to several options for policy. For example, there is a need for encouraging energy efficiency improvements among lower-income renters. This includes efforts to lower the cost barrier to the use of smart meters and adaptable technologies for low-income households. The policy interventions identified above to strengthen incentives for renters would go in this direction, especially to the extent that the specific needs of lower-income households could be addressed. Moreover, there is much scope for focusing on shifting energy demand patterns among lower-income households in a manner that could deliver higher savings. Xu and Chen (2019) argue that this involves social change, which can be encouraged by raising awareness about the associated benefits, not least in terms of energy savings, through, for example, community-based energy programmes for local multi-family housing communities. This calls for effective communication and trust-building between the local authorities and residents of social housing estates.

Policy would also do well to target the social housing sector. This is important because of the high concentration of low-income renters who would not be eligible for financial support for investment in energy retrofitting. Efforts to improve the energy efficiency of buildings, mentioned above, would go in this direction, but more could be done on the supply side, for example, by replacing obsolete appliances, where available, equipment and technologies with energy-efficient ones. On the demand side, policy options include making energy demand management devices, such as adjustable or programmable thermostats, available in social housing estates.[4] These interventions could be complemented by education and awareness-raising campaigns to allow residents to make the most of these technologies while also influencing behaviour towards the adoption of more energy-saving habits. Indeed, Ramos et al. (2015) show that these information-based instruments, specially smart meters, have great potential, even though they are costly and depend on the availability of digital technology to be implemented. Evidence on energy audits, which are more common in the industrial sector and tend to be costly and burdensome on the utility companies, is less clear-cut. Other “nudges”, such as the mandatory provision of information on average energy consumption in energy bills, are inexpensive and tend to have positive effects on behaviour.

6. Financing needed investments: addressing the ‘coverage gap’

6.1 The need for external financing

Energy retrofitting investments to accelerate the decarbonisation of the real estate sector are sizeable. The IEA estimates that annual capital investments in buildings worldwide to reach net-zero emissions by 2050 will need to almost double from current levels to around USD 730 billion in 2050 (IEA, 2021a). Annual energy retrofit rates would also need to more than double in the advanced economies by 2030 to achieve net zero by 2050. Going forward, innovative sources of finance will be essential for meeting a growing demand for energy efficiency investments that address the needs of homeowners, real estate investors and financial institutions.

[4] Solà et al. (2021) discuss in detail the potential and limitations of these information-based instruments in their survey of the empirical literature, even though their focus is not on low-income households.

External financing is particularly complex in the residential real estate sector for two specific reasons. One is that the upfront investment costs are particularly high for household budgets, and the amortisation timelines associated with the energy retrofitting of properties and the acquisition of energy-efficient appliances and equipment are particularly long. Both discourage private investment, especially by renters and landlords in the residential sector, given the split incentives discussed above. At the same time, financial institutions are discouraged from providing external financing because of considerable uncertainty about future energy prices, the energy savings associated with specific interventions, the energy performance of equipment and the regulatory framework. This complicates the estimation of cash flows associated with energy retrofitting investments.

Indeed, commercial mortgage underwriting practices currently do not fully account for energy risks for the duration of a loan; they are based on standard, rather than actual, average energy needs of a building. As a result, the effects of energy efficiency improvements on operating costs and credit quality are underestimated (Mathew et al., 2021). So are the risks related to fluctuations in energy costs. Such risks arise, for example, from increases in occupancy rates in the case of commercial properties and equipment degradation or sub-standard operation and maintenance of cooling/heating and lighting systems in the case of residential and commercial properties. Such risks affect the calculation of probabilities of default on loans and debt service coverage ratios. The evidence reported by An and Pivo (2017) for the LEED and ENERGY STAR certification programmes in the United States indeed shows that green buildings carry lower default risk, all else being equal.

Underwriting practices also suffer from methodological deficiencies. First and foremost, there is a lack of standardised methodologies for incorporating energy consumption-related risks and benefits of energy efficiency improvements in credit analysis. Even where engineering-based models are available, lenders typically lack the time and expertise to apply them in their credit assessment methodologies (Mathew et al., 2021). At the same time, a lack of common methodologies and standards for ESG investments, including on reporting and disclosure, prevents financial institutions from reaping the full benefits of green investments in terms of lower funding costs to finance energy efficiency projects.

Moreover, information gaps complicate the incorporation of energy standards into commercial mortgage underwriting. This includes in particular a shortage of data about the energy performance of buildings — an issue that is directly related to the discussion above about energy performance labelling/certification — as well as the credit history of borrowers (Koutsandreas et al., 2022). Household preferences also matter for external financing. For example, the choice experiment carried out by Schueftan et al. (2021) in Chile shows that financial instruments play the most important role in investment decisions by households, followed by the savings achieved by the retrofit. Householders also like to avoid long-term commitments by favouring a combination of personal savings and medium-term credits. In addition, uncertainty about technological change and the long-term evolution of energy prices, and the lumpiness of this type of investment create a preference for the status quo that discourages investment, even in the absence of market constraints, that is akin to an "option value" on investment in energy retrofitting (Gerarden et al., 2017).

Another complicating factor is related to the small scale of energy retrofitting investments, especially in the residential sector. Individual projects tend to be small, which increases transactions and administrative costs, especially in the absence of standardised methodologies and a lack of information about the energy performance of properties and the credit history of borrowers, as mentioned above. This makes the financing of energy efficiency improvements particularly costly, especially for small-scale interventions. For all these reasons, the cost of capital is among the main barriers to investment in energy retrofitting in the residential sector, according to the comparative analysis of alternative financing schemes carried out by Brown et al. (2019).

A final consideration is related to the development of green housing finance, which could broaden the range (and reduce the cost) of funding mechanisms for banks and financial institutions that provide loans for energy retroffiting and the financing of new real estate developments. Green housing finance is in its infancy, with green real estate bonds and mortgage-backed securities (MBS) representing only a small share of total issuances around the world. This is essentiually because of a fragmentation of green building rating systems and labels, spanning a range of environmental areas, such as water usage and waste management, which are related to decarbonisation efforts, as well as energy performance. Also, green labelling criteria related to energy performance and renewable generation are not always aligned with the objectives of net zero by 2050, with some rating systems incorporating lower levels of ambition.

From the perspective of borrowers, energy efficiency improvements can actually improve their creditworthiness. This is because the associated energy savings reduce borrowers' operating costs and therefore improve their disposable income, which contributes to improving their loan repayment capacity and reduces credit default risks (Karakosta et al., 2021). To the extent that these benefits are reflected in lower borrowing costs, there is an added benefit associated with the financing of energy improvement projects that would, in turn, further improve loan repayment capacity by borrowers and potentially funding costs for lenders through an improvement in the quality of their credit portfolio. This is indeed the principle behind green mortgages and other instruments that combine financing for home acquisition and real estate purchases more generally with associated improvements in the property's energy efficiency. For these initiatives to develop further, policy needs to deal with the lack of technical expertise by financial institutions and standardised methodologies for their evaluation, as well as the shortage of data about energy performance of buildings and the successful implementation of projects.

6.2 Insights for policy

Policy action could focus on reducing the otherwise high upfront costs of investment. Several options are available to this end. The review of alternative energy efficiency financing schemes carried out by Bertoldi et al. (2021) includes a variety of object-based financing (attached to the property) whereby investments can be paid back through utility bills or the tax system, for example. An example is on-bill schemes, which foresee investments by energy utility companies with the possible cooperation of financial institutions (Bianco and Sonvilla, 2021). The main advantage of these schemes is that they allow energy utility companies to switch part of the energy demand from fossil fuels, while energy retailers can sell energy efficiency as a service to users, regardless of their tenure type, hence reducing the incentive mismatches between renters and landlords.

Another modality of financing instruments focuses on de-risking through changes in underwriting mechanisms for loan qualification. Green banks and community development financial institutions have emerged as promising financing vehicles in this regard. These institutions often rely on public funds to leverage private financing to reduce the cost of capital for borrowers and, as a result, expand access to underserved populations (Krupa and Harvey, 2017; Ning et al., 2022). They are particularly well placed to close the financing ‘coverage gap’ for energy retrofitting for those residents, homeowners of not, who do not qualify for government-sponsored programmes, typically subsidised loans, and those who do not meet the credit standards or upfront collateral requirements for market-based loans. Indeed, this is the case of moderate-income households analysed by Leventis et al. (2017) and Forrester and Reames (2020) for the United States.

As for the financing needs of those who cannot access market-based financing, such as low-income households, direct government assistance remains the most common instrument. Means-tested aid to low-income households includes the Weatherization Assistance Program (WAP) in the United States, for example. Another option discussed above is to increase the supply of energy-efficient social housing. This is important because the social housing sector is large in a number of OECD countries (**Figure 8**). Chegut et al. (2016) look at the social housing segment and find a transaction price premium for a sample of Dutch properties with energy performance certificates (EPC), while controlling for building quality and other characteristics, such as thermal and insulation quality, as well as market conditions. Copiello (2015) also finds evidence of a rent premium in the case of an Italian case study of refurbishments that include energy efficiency improvements.[5]

Policy can do much to bolster the development of green housing finance. Priority areas for reform include the consolidation and clarification of standards, as well as the adoption of common methodologies and rating criteria. These are necessary steps towards making green real estate finance markets more liquid and reduce the cost of funding for banks and financial institutions.

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[5] All these initiatives are motivated by fairness and equity in access to energy efficiency financing. For example, the principle of 'just energy finance' underpins the transition to a low-carbon economy across the spectrum of energy uses and calls for a combination of affordability, good governance and energy resilience, among other principles (Hall et al., 2018).

7. Conclusions

Meeting agreed climate change targets requires considerable efforts to foster the energy transition of economies and societies away from fossil fuels. Expediting decarbonisation will be particularly difficult in the real estate sector, because it is a heavy consumer of energy throughout the lifecycle of buildings, and therefore a sizeable source of emissions of greenhouse gases. Also, buildings have a long lifespan, which requires strict codes and standards for new developments, as well as investments in energy efficiency upgrades and retrofits of older properties to bring them in line with evolving standards. Energy efficiency standards for new buildings are nevertheless often lacking, especially in those parts of the world where demand will rise faster due to population growth, such as emerging-market economies and developing countries, and for the residential market segment, which accounts for the bulk of the real estate sector. Lifecycle considerations also lack in policies and regulations. At the same time, there is a variety of tenure-holders often with misaligned incentives for investment, especially considering the high upfront costs of home improvements and difficulties for landlords to capitalise on those investments in rental and sale prices.

Policy action will be required on several fronts. They include addressing split incentives among owner-occupiers, landlords and renters (in the private and social housing markets), raising the standards of energy performance for new and existing properties through labelling/certification and other means, and reducing the cost of finance for needed investments while broadening access to the underserved population. Where market failures remain and the specific needs of the energy vulnerable social groups cannot be appropriately addressed through market-based interventions, a case can be made for subsidising at least in part the costs of investments to be financed from savings or borrowing. Direct investment and/or provision of energy-efficient social housing can do much in this regard. High energy-efficiency in the social housing sector is also likely to have a demonstration effect and/or put pressure towards at least comparable levels of energy performance in the rental market. Making sure that stricter energy efficiency and environmental standards do not aggravate affordability challenges will be particularly important, given the gradual increase in housing prices and rents in many countries over the last few decades.

Complementary interventions are needed in other areas too. They include, for example, support for innovation and the development of new, less energy-intensive construction technologies, as well as those that permit the use of buildings and structures as carbon sinks. Education programmes are also important, given that households are often unaware of the energy characteristics of their homes, the economic benefits of home improvements, the scope for improving energy demand management through changes in behaviour and practices, especially among the most energy vulnerable social groups.

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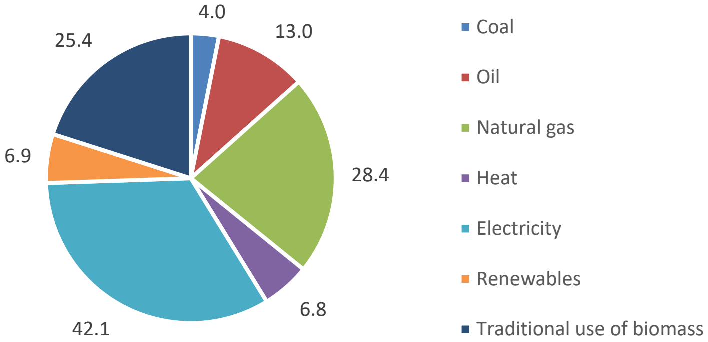
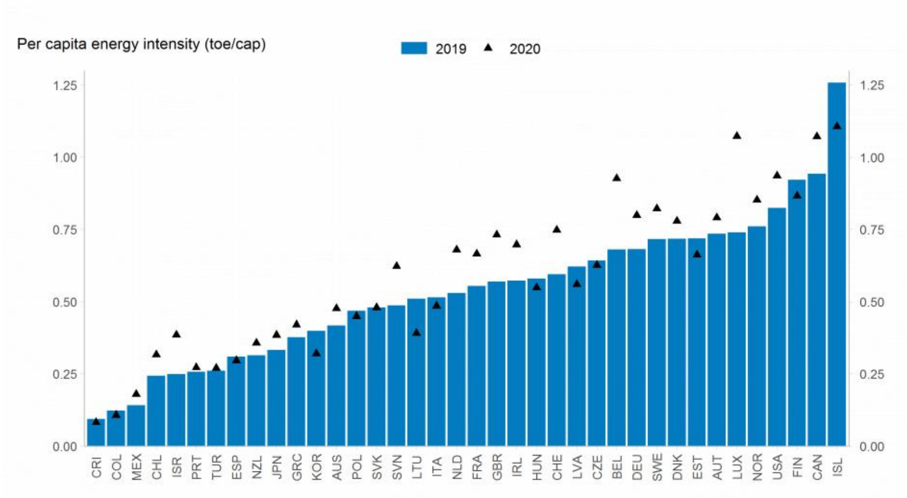
Figure 1. Real estate sector: Final energy consumption

Panel A. World energy consumption by source (in EJ, 2020)



Panel B. Energy consumption per capita (in tons of oil equivalent (toe), 2019 and 2020)

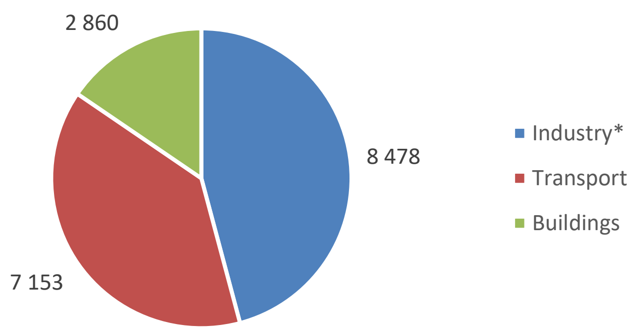


Note: In panel B, energy consumption includes space heating and cooling, water heating, cooking and appliances.

Source: IEA (2021a); Energy Efficiency Indicators, IEA, 2020 edition.

Figure 2. Final consumption emissions

(by sector, in Mt CO_2 equivalent, 2020)

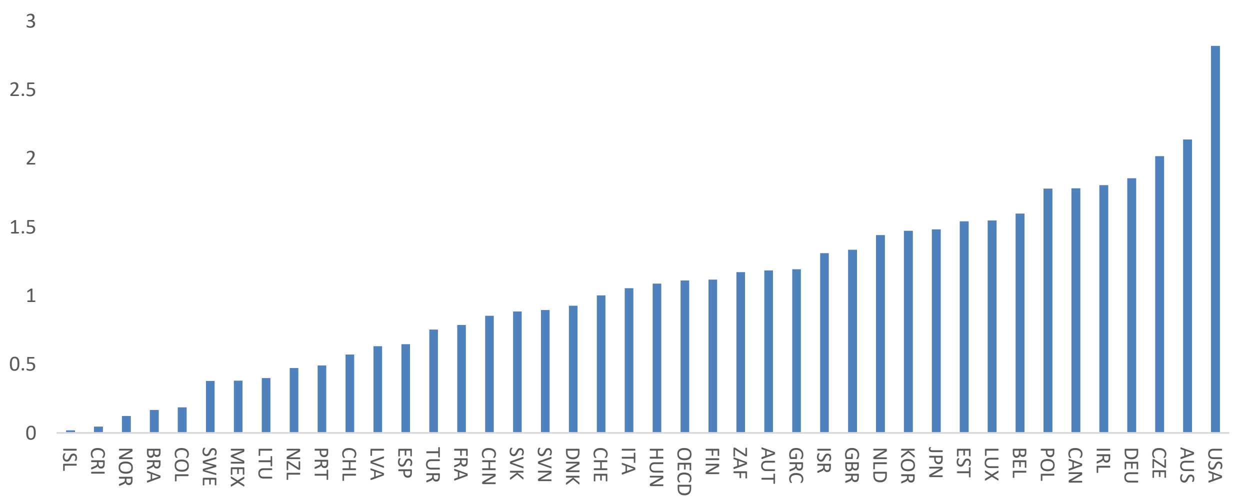


Note: (*) includes industrial process emissions.

Source: IEA (2021a).

Figure 3. Air pollutant emissions (residential sector)

(emissions from fuel combustion, including electricity and heat, in tons of CO_2 per capita, 2019)



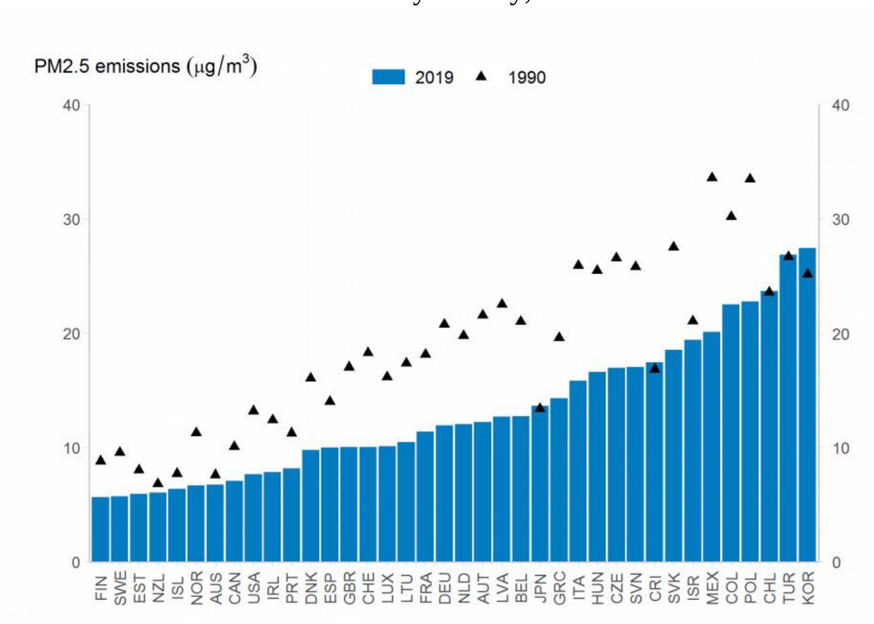
Note: In Panel A, the housing sector includes direct emissions as well as water, electricity, gas and other fuels. Industry includes all ISIC rev.4 classification activities from A to U except for H (transportation and storage), which is merged together with transportation.

Source: OECD Environnent Database.

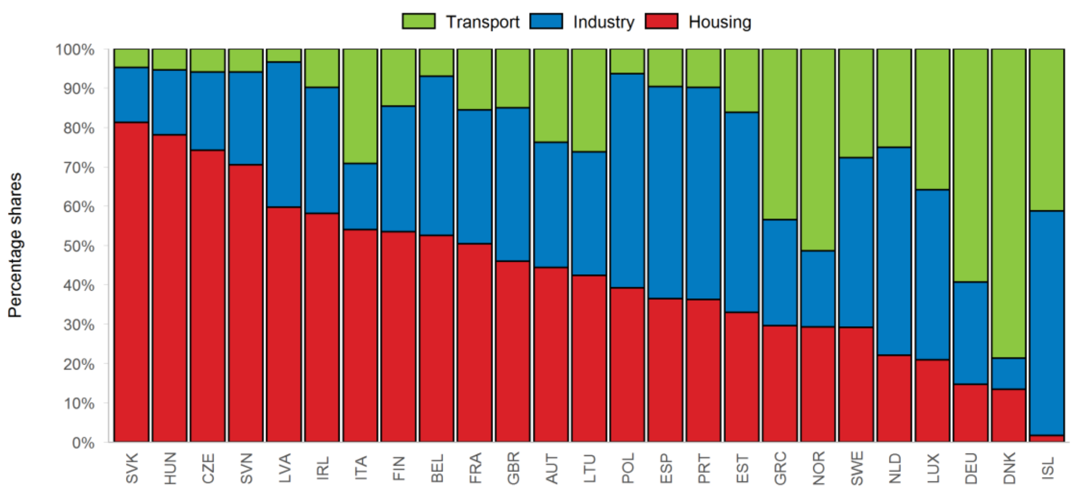
Figure 4. Exposure to air pollution in the residential sector

(PM2.5 emissions, in µg/m3, 2019 and 2020)

Panel A. Emissions by country, 1990 and 2019



Panel B. Emissions by sector (PM2.5 emissions, in %, 2019)

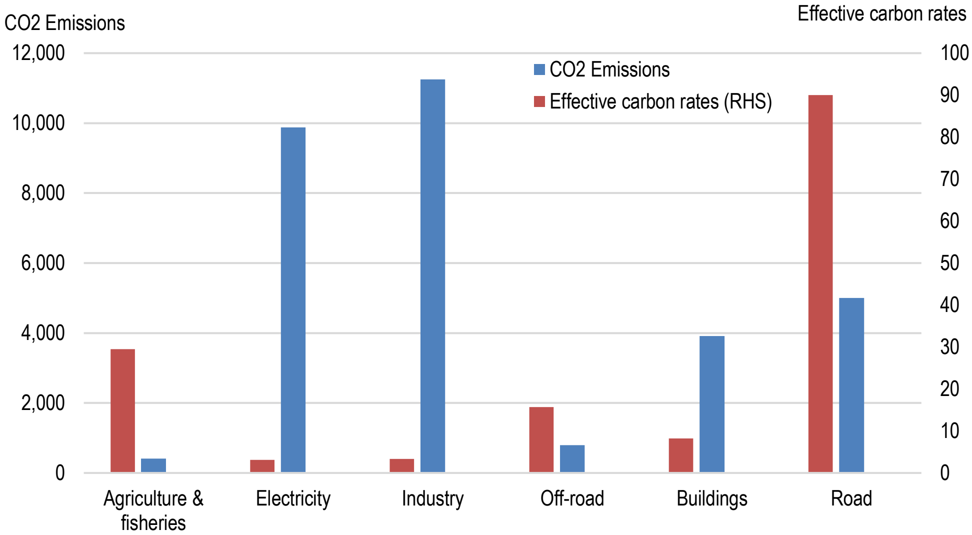


Note: Mean annual outdoor PM2.5 concentration weighted by population living in the relevant area, that is, the concentration level, expressed in microgram/m^3, to which a typical resident is exposed throughout a year.

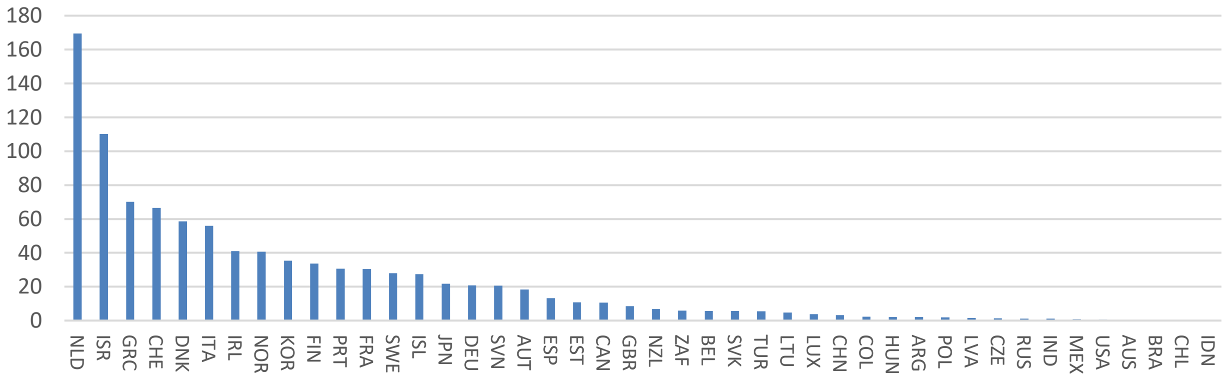
Source: Environmental risks and health, OECD Environment Database.

Figure 5. Emissions and carbon prices

Panel A. By sector (2018)



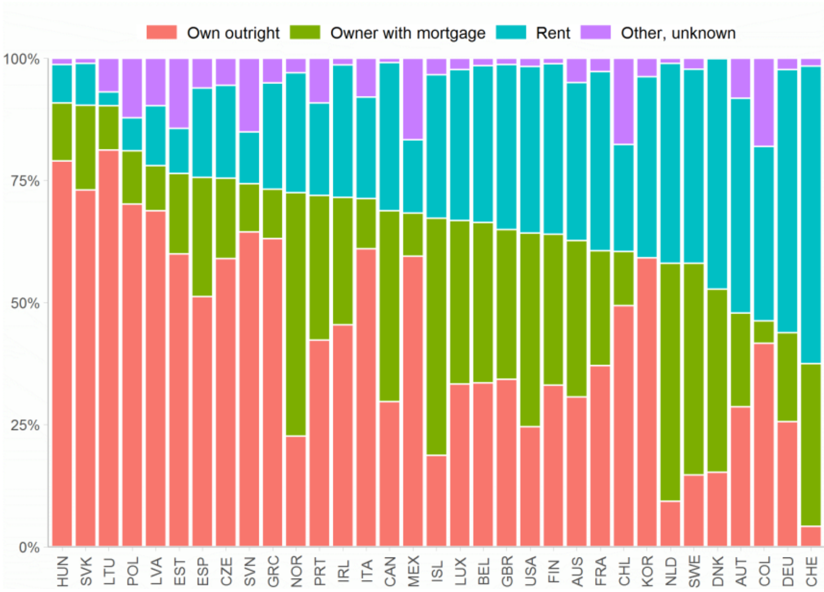
Panel B. By country (2018)



Note: Effective carbon rates are as of 1 July 2018. CO_2 emissions are calculated based on energy use data for 2016 from IEA (Extended World Energy Balances database), World Energy Statistics and Balances.

Source: OECD.

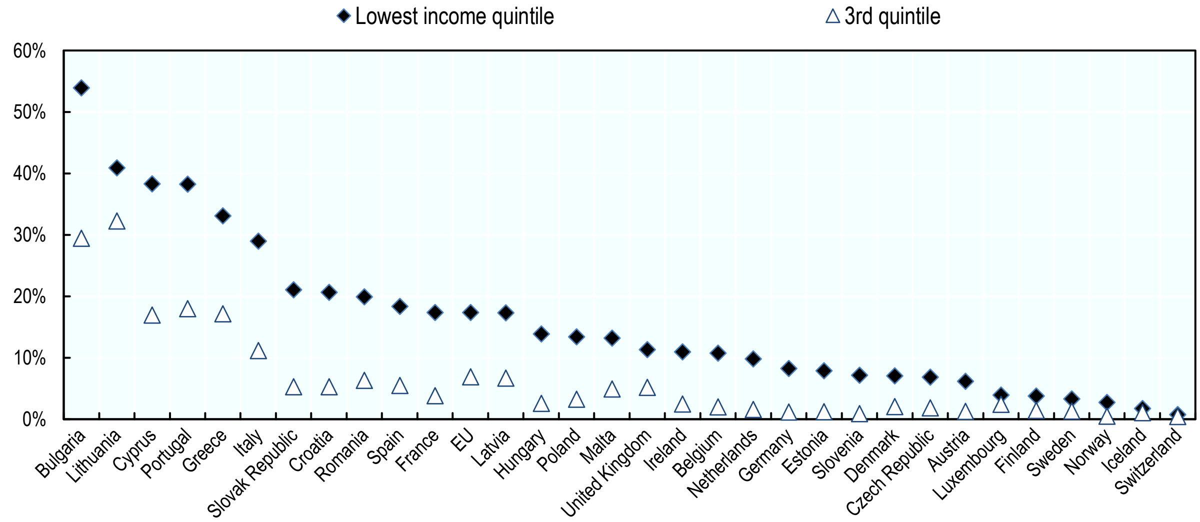
Figure 6. Tenure structure in OECD countries



Source: OECD Affordable Housing Database.

Figure 7. Energy poverty in OECD countries

Energy poverty incidence (in % of households, 2019 or latest year available)

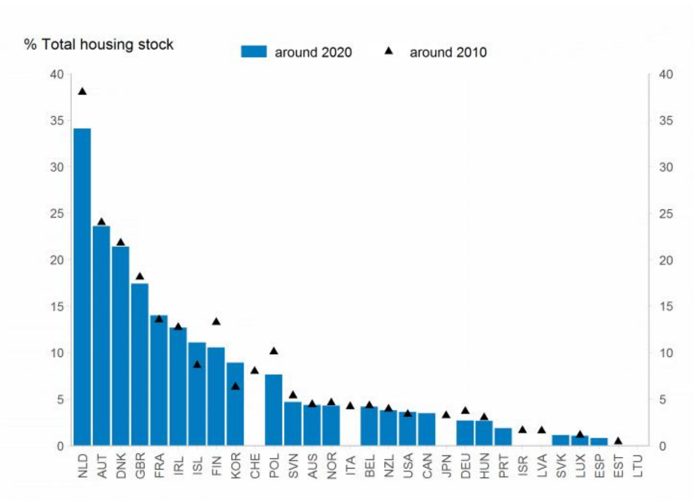


Note: Energy poverty is defined as the share of households that cannot afford to keep their dwelling adequately warm. The lowest and third quintiles refer to the distribution of household disposable income.

Source: OECD calculations based on European Survey on Income and Living Conditions (EU-SILC).

Figure 8. The social housing sector in OECD countries

(social rental dwellings, in % of the total housing stock, 2010 and 2020)



Source: OECD Affordable Social Housing database.