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the time gap between high upfront costs and long-term payback from renovation works deter consumers from investing in energy renovation.

To address these challenges, the EU has introduced a policy toolkit that includes strengthened price signals against fossil-fuel heating through emissions trading, and setting energy-consumption reduction targets in the Energy Performance Building Directive (EPBD).

EU countries must take the EPBD targets seriously and implement policies to accelerate building retro ts and the adoption of clean heating. If they don't, there is a risk that EU climate targets will not be met, and the costs for households of subjecting domestic heating to emissions trading could be almost twice the higher costs seen during the 2022 energy crisis.

We estimate that achieving the EPBD's energy savings targets requires lling an investment gap of about €150 billion per year up to 2030. is is a daunting but feasible goal. By leveraging energy savings from electri cation and retro tting to reduce renovation costs, the investment gap could be more than halved. Additionally, e ective use of EU funds and emissions trading revenues will further shrink the gap.

A mix of grants, preferential loans and obligations is needed, as no single policy will speed up energy renovations. Prioritising grants for the worst-performing buildings, often occupied by vulnerable consumers, will yield climate bene ts and bene ts in terms of improved air quality, health, productivity, energy security and lower future government outlays to alleviate energy poverty. Traditional public subsidies have not successfully engaged the banking sector, which now must help to foster private-public nancing mechanisms. Countries also need to adjust relative energy prices for heating through taxation and subsidies, and expand one-stop-shops to streamline the renovation process for consumers.

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1 Introduction

e heating and cooling of buildings using fossil fuels is responsible for 13 percent of European Union emissions (EEA, 2023a). Electricity use in buildings accounts for another 14 percent. While new buildings are designed increasingly to be nearly-zero or zero emission, three-quarters of the existing EU building stock is energy ine cient (European Parliament, 2024). Building renovations can cut heating bills by up to 85 percent (Abdoos *a* , 2024).

e EU energy performance of buildings directive (EPBD, EU/2024/1275), updated in 2024, sets targets for such energy savings for 2030 and 2033. However, we estimate that meet-with the rate for non-residential buildings at only 0.6 percent (Bredahl *a* , 2024)[3]. Deep renovations – resulting in energy savings of 60 percent or more (European Commission, 2019) – were done for only 0.2 percent of residential and 0.3 percent of the non-residential building stock.

Figure 1: Fossil-fuel use in heating and cooling in residential and non-residential sectors, emissions reductions, 1990-2022, Mt/CO2eq

Source: Bruegel based on EEA and UNFCCC. Note: Emissions from agriculture, forestry and fishing related buildings are excluded.

A 2020 European Commission strategy, known as the Renovation Wave, aimed to double energy renovation rates, promote deep energy renovations and renovate 35 million building units by 2030. More energy e cient buildings will be important to integrate additional electricity demand smoothly into power grids. Without e ciency improvements, meeting current heating demand in the EU through electricity would increase electricity demand in winter months by at least a third[4], with even greater electricity generation capacity required for unfavourable cloudy and non-windy weeks.

ere is unfortunately no good data on rates of energy renovation in the EU. Literature and institutional documents typically refer to the 1 percent rate estimated from 2012-2016 data (European Commission, 2019). ere is also no standardised de nition of the renovation rate. Some datasets and studies have helped provide a clearer picture, but use the same data as a basis for their analyses[5]. It is therefore not possible to assess thoroughly the latest trends in building energy e ciency, nor to gauge the impacts of the COVID-19 pandemic and the subsequent economic-ub

Figure 2: Percentage change per country in fossil-fuel emissions from building heating and cooling, 2005-2021

Source: Bruegel based on UNFCCC and EU Buildings Stock Observatory. Note: The 2030 milestone of -68 percent compared to 2005 corresponds to the -60 percent compared to the 2015 level set in the PRIMES model's MIX scenario, the leading model employed by the

otherwise be wasted. Maximising decarbonised district heating in dense urban areas can cut costs and provide exibility to electricity networks (Brugger *a*, 2023). ere are no speci c EU targets on district heating, yet it has vast potential.

3 The lack of an attractive investment case

Decisions to deploy clean energy solutions or insulate buildings are made by companies and households, but the rate of deployment has been undermined by weak economic incentives. Most EU governments have not implemented policies to change this situation.

Weak investment has ve main reasons. First, energy renovations require high upfront costs and o er returns over the long term, making them less appealing to households and small and medium-sized companies, which discount future income more heavily than governments or large companies[9]. Second, unlike electricity, fossil-fuel prices for heating do not re ect the cost of their carbon emissions, and EU energy taxation favours fossil fuels, an issue only partly addressed by ETS2. ird, many households, especially poorer households, and small businesses lack access to funds for renovations and face borrowing di culties. Fourth, a third of EU residents live in rented accommodation, where tenants pay energy bills but landlords are responsible for renovations, creating split incentives. Lastly, information barriers, construction-related inconvenience and administrative complexities add non-monetary costs to renovation projects.

3.1 The long wait for economic returns

For energy renovations, discount rates – the rate at which future cash ows are valued today – are generally assessed between 7 percent and 36 percent (Andersen *a*, 2020)[10]. Low-income households are typically more uncertain about the future, leading them to discount future savings more than high-income households (Samwick, 1997).

is lack of a viable investment case because of high discount rates is a major barrier to energy renovations. Table 1 outlines a modelling exercise estimating the net present value of deep renovations for a German household living in an apartment or a single-family house relying on either gas, oil or coal heating (in brackets), for four scenarios with di erent energy prices. e net present value is computed by subtracting the costs of a deep renovation[11] from the discounted value of the resulting future energy savings for 30 years. Cells in green show that the present value of the investment is positive for all fuel types; cells in grey show that the present value is positive only for some fuels; and cells in red show that the present value is negative for all fuels. Given retail energy prices at the time of writing and a carbon price of €60 per tonne[12] (scenario 1), there is no economic case for such an investment for households currently relying on gas and oil boilers, notwithstanding public support[13]. e investment

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On average, in the EU, electricity excise duties exceed gas taxes more than twofold (Figure 4). Progress in the use of renewables for heating buildings has been stagnant, largely relying on biomass. The current taxation framework does not align with EU climate and energy objectives (Renewable Energy Directive, (EU) 2023/2413) and fails to incentivise investments in clean technology.

Figure 4: Composition of electricity and gas prices for households in the EU, eurocents/KWh, May 2024

Source: Bruegel based on Eurostat and Household Energy Price Index by VaasaETT. Note: Because of the greater efficiency of electrical appliances, particularly heat pumps, significantly less electricity is needed than gas to deliver the same energy services.

3.3 Lack of upfront capital and borrowing constraints

Renovating a property to improve its energy performance can require an investment comparable to a household's annual income. A 2023 German survey found that 41 percent of homeowners cited financial constraints as the main barrier to energy upgrades, rising to 68 percent among low-income households compared to 29 percent of high-income households (Romer and Salzgeber, 2023). Low-income households struggle to borrow for renovation because of negative creditworthiness assessments by banks. Their risk profiles significantly influence loan approval and interest rates (Biere-Arenas *et al*, 2021).

3.4 Split incentives

Landlords make energy-renovation decisions, while tenants consume and pay for the energy. Even when controlling for income and other characteristics, renters are significantly less likely to make energy-efficiency investments, while owner-occupied dwellings are much more likely to have energy-enhancing properties, such as ceiling insulation (Gerarden *et al*, 2017). Additionally, owners and tenants of apartments often cannot undertake significant energy-ef-

Box 1: Hits and misses in energy-efficient renovation support schemes

- Italy's 'Superbonus' scheme offers a 110 percent tax credit as an incentive for energy-efficient renovation. So far, the public costs have far exceeded expectations – it was estimated to cost €35 billion over 15 years but has cost €120 billion (6 percent of Italian GDP) in less than four years, raising Italy's debt and contributing to a breach of EU fiscal rules[15].
  - Because the tax credit covered renovation costs fully, households had no incentive to negotiate prices, leading to significant cost spikes.
  - Only 4 percent of Italian buildings (about 500,000 buildings) have undergone renovations under the scheme (Arcano *a* , 2024).
  - The programme has favoured wealthier households (Ciminelli and Schwellnus, 2024) but has been narrowed to focus on low-income families, with an expected reduction in uptake (UpB, 2023). The programme is set to end in 2026.

- Germany approved a bill to phase out new fossil fuel domestic boilers by 2024 but faced backlash because of long waiting times for replacement subsidies and a cut in subsidies in early 2023, making even the cheapest heat pumps more expensive than gas boilers (Dempster and Huckstep, 2024). Lack of skilled fitters and insufficient electricity supply for heat pumps also caused problems[16]. The scheme actually led to the share of fossil gas and oil heating systems rising, and the boiler ban deadline was pushed to 2028, making it likely that Germany will miss its 2030 climate targets[17].

- France's *c -P à Ta Z* (éco-PTZ) programme ran from 2009 to 2023, offering interest-free loans for energy-efficiency upgrades of primary residences built before 1990. In 2015, the government's €40 million investment mobilised €480 million in private investment[18]. This approach showed the potential for cutting emissions by using limited public money to leverage private finance.
  - Zero-interest renovation loans boosted renovation rates in the programme's first two years (Dastgerdi *a* , 2022).
  - Take-up was higher among high-income households, who are more likely to own property and be willing to take on debt. Low-income households saw less significant efficiency gains from renovations.

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4 Europe’s new carbon price is a revolutionary step

In May 2023, EU countries agreed to introduce a second emissions trading scheme (ETS2). is will put a price on emissions from direct fuel combustion, including gas and oil boilers in private homes, and fuel combustion in road transport[19]. Taking e ect in 2027, ETS2 will require upstream fossil-fuel suppliers to surrender carbon certi cates equivalent to the emissions generated by consumers of their fuels. ese suppliers are expected to pass through the cost of certi cates in the form of higher fuel prices.

Carbon pricing could impact energy bills signi cantly, making it more attractive to renovate buildings by adjusting relative prices. e extent of this impact will depend on the prevailing market price for carbon permits, which is in uenced by supply and demand dynamics.

e European Commission has suggested that from 2027 to 2030, e orts will be made to keep the ETS2 price below €45 per tonne of CO2[20] (in 2020 prices, or €60 in 2027 prices)[21]. Although the market will determine prices, a reserve will be established to manage price volatility by releasing more carbon allowances if prices rise too quickly or too high. e reserve will hold 600 million allowances, or 18 percent of the ETS2 emissions cap between 2027 and 2030. European Commission (2021) estimates suggest the price could range between €48 and €80 if the EU plan to cut emissions by 55 percent by 2030 compared to 1990 is fully implemented. However, if countries do not act to decarbonise ETS2 sectors more quickly, prices could skyrocket to between €200 and €300 (Fotiou *a* , 2024; Müller and Nesselhauf, 2023), indicating that the allowanceiaaotBm2(men)(u)TJ/T1_3 ;.9 (v)2.9intimoes eqesain558.5276 Tm[(in(d)1 (yn)

The introduction of ETS2 will help in decarbonising buildings. However, it could lead to very high carbon prices, undermining its social and political acceptability and jeopardising both building decarbonisation policies and the European Green Deal more generally.

Implementing the decarbonisation and energy efficiency in buildings legislation is fundamental because it will directly tackle high energy prices. EU laws on emissions reductions in non-ETS sectors, renewable energy and energy efficiency, alongside the EPBD, set targets and standards that incentivise energy efficiency, increase the use of renewable energy and provide technical support for renovation. Collectively, these policies should lower energy bills, stabilise costs and improve living conditions, particularly benefiting households struggling with high energy prices.

5 Missing money: the need for more investment

5.1 The investment gap

We estimated that, from 2024 to 2030, meeting the EPBD targets will requires annual investments of €297 billion (for details see the online annex)[22]. Reaching this target requires doubling renovation rates from the current 1 percent. The overall (public and private) investment gap would therefore be €149 billion per year.

Two European instruments fill some of this gap. First, the Recovery and Resilience Facility, the EU's post-COVID-19 economic recovery fund, is estimated to provide €12 billion annually until 2027. Second, if half of the ETS2 revenues are reinvested in energy renovations[23], an additional €28 billion could be made available from 2027. This leaves an annual investment gap of €137 billion up to 2027, and €121 billion thereafter, or approximately 0.7 percent of EU GDP. A substantially larger sum is currently spent on building renovations – though not necessarily aimed at cutting emissions (for example, extensions). In most countries with available data, the

Figure 7: Additional annual investment needs for energy renovations, € billions and % of GDP

Source: Bruegel. Note: See the online annex for a detailed explanation.

5.2 EU financing

The Recovery and Resilience Facility has increased funding for energy-efficient improvements, providing €73 billion for 2021-2027 (Baccianti, 2023, in which figures are in current prices). This is the first European policy instrument with such a significant volume of funding dedicated to buildings energy efficiency and renovation. However, the overall impact of this funding on energy renovations remains unclear.

The EU budget, the European Regional Development Fund, the Cohesion Fund, and the Just Transition Fund contribute to these efforts (Ivanova *et al*, 2023). Funding for building renovations and energy-efficiency projects was slightly increased in the most recent EU budget for 2021-2027, totalling around €17 billion (Baccianti, 2023). This amount is not included in our calculation of the investment gap as it does not represent a significant change from previous periods.

5.3 New funding: ETS and ETS2 revenues and the Social Climate Fund

Carbon prices have increased significantly in recent years and revenues from auctioning carbon allowances rose from €5 billion in 2017 to €30 billion in 2022 (EEA, 2023b). Over the past decade, EU countries reported allocating 76 percent of these revenues to climate, renewable energy and energy-efficiency initiatives. This increased stream of public revenues and its claimed allocation to energy efficiency raises hopes for increased funding for energy renovations in the future. However, reporting and accountability on the use of these revenues are considered poor, with several counties categorising compensation for high carbon prices given to industrial firms as climate action (WWF, 2022; Branner *et al*, 2022). Reporting and accountability shortcomings make it difficult to gauge the role that ETS revenues could play in fostering energy renovations.

Auctioning of ETS2 allowances will also generate substantial revenues, ranging from €42 billion annually at a carbon price of €45 to €187 billion annually at a carbon price of €200. A

6 Policy options, trade-offs and recommendations

Annual investments in renovating European buildings need to increase by around € 149 billion or 1 percent of EU GDP. The challenge for policymakers is to ensure that the additional annual €149 billion investment in building renovation happens, that it happens in a way that society deems fair and that it does not threaten fiscal stability. This is particularly challenging when governments currently face borrowing costs at their highest level since 2008. The EU's fiscal rules framework also restricts the ability of countries with high debt (above 60 percent of GDP) to invest (Darvas *et al*, 2024).

Traditionally, for supporting building renovation, European countries have relied on grants and tax incentives, soft loans and regulations (EIB, 2020; Bertoldi *et al*, 2021). Four-fifths of 2021-2027 EU budget funding for energy efficiency and renovations comes in the form of grants (Ivanova *et al*, 2023). In the previous EU funding cycle (2014-2020) the European Scientific Advisory Board for Climate Change found that the cost-effectiveness of EU spending on energy efficiency in buildings was low because of inadequate targeting of investments through grants that crowded out private investment that would probably have happened anyway (Bredahl *et al*, 2024).

The magnitude of the challenge means a wide range of policies should be employed to cut buildings-related emissions. A portfolio of measures will help mitigate the impact of policy trade-offs. For example, with zero-interest green loans, a trade-off exists between maximising cost-effectiveness and ensuring distributional fairness, because such loans are primarily taken up by richer households. Maximising cost-effectiveness often involves targeting policies at wealthier households, which are more able to invest, while ensuring fairness would require focusing on poorer households[25].

Another trade-off is simplicity versus complexity. Simple policies, such as bans on fossil-fuel boilers, are easy to understand and communicate but may fail to allocate resources efficiently and can create backlash. Policymakers must address such issues, especially when using ETS2 revenues, which should be allocated effectively and equitably.

Frontload investment support for the vulnerable to limit future compensation spending

For low-income countries, the Social Climate Fund (SCF) will likely suffice to both fully compensate vulnerable households[26] for the carbon price and support investment in fuel-switching (Braungardt *et al*, 2022). However, if countries do not decarbonise at the pace they have committed to, and the carbon price is not contained, the capped SCF funding will not be enough to cover increased costs for vulnerable households in major countries including Germany, France and Italy (Braungardt *et al*, 2022).

A fine balance must be struck between compensation measures and encouraging investment in decarbonisation solutions. If progress in energy renovations does not gain pace, the ETS2 price shock might be similar to that experienced during the energy crisis, during which €540 billion were earmarked to compensate consumers (Sgaravatti *et al*, 2023). This is equivalent to providing 35 million households with €15,000 each, or covering more than half of our overall estimated investment gap for energy renovations up to 2030.

Governments should frontload investment support for vulnerable consumers to

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encourage energy renovations and reduce the need for compensation after ETS2 takes effect. Accelerating energy renovations in advance will help contain the ETS2 carbon price. Compensation measures must preserve the price-incentive to renovate. Typically, this involves using lump-sum transfers, rather than reducing consumer fossil-fuel prices.

Reduced energy demand also reduces the EU's dependency on energy imports and improves resilience against economic shocks, which is critical given that 40 percent of the energy used for heating homes comes from natural gas (European Parliament, 2024), making the residential sector Europe's biggest gas consumer.

The social benefits of targeted intervention

Untargeted and poorly designed policies can be fiscally unsustainable, lead to renovation works that would have happened anyway and provide little return on investment to the state. Financial support needs to be targeted by income level and building type. The worst-performing buildings are prime candidates for grants and tax incentives because of their high energy and emissions-saving potential, offering a bigger return on investment compared to more energy-efficient buildings (European Commission, 2021). Renovating these buildings could significantly reduce the ETS2 carbon price. We estimated that deeply renovating 10 percent of the worst-performing buildings would cut total buildings-related emissions by 20 percent and lower ETS2 emissions by 8 percent[27].

Targeting support at the least energy-efficient buildings addresses fairness considerations and is politically justifiable. Low-income households typically occupy these buildings, and renovating them could reduce heating bills – which in Germany are up to 30 percent of the earnings of low-income households (Behr *et al*, 2024). Targeting these buildings would help alleviate energy poverty, which currently affects 50 million Europeans and leads to public health costs of €167 billion annually – from heating with smoky fuels, for example (Ahrendt *et al*, 2016). Accelerating energy renovations could lift seven million Europeans out of energy poverty each year (ITRE, 2017), progressively reducing the need for public support to help vulnerable households with energy bills.

The EPBD's broad definition of residential worst-performing buildings (43 percent of the building stock) allows for tailored policies suited for different local needs. For example, central and eastern European countries have large shares of multi-apartment blocks built from the 1960s to the 1980s. While these buildings are energy-inefficient, in terms of energy per square meter, they perform better than energy-inefficient single-family houses because they have proportionally fewer outer walls and smaller unit sizes (Gerőházi *et al*, 2023). However, renovating communist-era panel buildings could be a more cost-efficient strategy than single-family houses because of their high population density and the potential for standardised, scalable renovation projects.

An important issue for the worst-performing and multi-apartment buildings is the impact on rental prices. Half of EU households below 60 percent of the median income are tenants, compared to only 30 percent overall. Landlords may put up rents after energy renovations, forcing vulnerable households to move and reducing the positive social impacts of energy renovations. Therefore, controls on rental prices need to be attached to access to generous state subsidies. Similarly, to create incentives for energy renovation, the costs of the ETS2 carbon price might be shared between tenants and landlords. The higher the emissions per square meter, the greater the share of the costs that should be borne by landlords.

Change relative fuel prices and reduce price uncertainty

Only a third of the retail electricity price paid by households and small enterprises reflects acburden, similar to education and public health funding.

Uncertainty around future fossil fuel and electricity prices also complicates the optimisation problem for investors. Governments have extensive experience designing tools to hedge against price volatility for renewable energy providers, such as contracts for difference. Similar schemes could be implemented for deep energy renovations, involving energy utilities or new competitors as aggregators. Governments or public development banks could hedge future energy price risks by guaranteeing fixed payments to households based on defined electricity, fossil fuel and carbon prices (McWilliams and Zachmann, 2021). If fossil fuel or carbon prices are lower than expected (reducing the savings for investing households), governments would provide an annual payment. If not, nothing would happen.

Little progress has been made in phasing out fossil-fuel subsidies in the EU. The current policy framework, including the more than two-decades-old Energy Taxation Directive (2003/96/EC) and EU state aid regulations, permits subsidies for fossil gas and oil. Between 2015 and 2021, fossil-fuel subsidies remained stable at around €50 billion per year, but in 2022, they more than doubled to €120 billion as governments shielded consumers from the energy crisis. Only eight EU countries[28] have set dates for phasing out subsidies for fossil-fuel heating in buildings, or have restrictions on installing new fossil fuel-based heating systems. Fossil-fuel subsidies distort competition, hinder the energy transition and can lead to long-term emission lock-ins. As energy commodity prices have fallen, governments should shift subsidies from fossil fuels to clean technologies and electricity. It is critical to phase out these (households or rms) a certain level of energy savings. Payments are linked to actual energy savings achieved, and the company compensates the client for any shortfall (Bertoldi *a* , 2021a). ese contracts often involve a mix of funding sources, including revolving funds from the energy service company, the client, local and national subsidies and third parties. ese types of contracts have already been used across Europe for large industrial sites, public administration buildings, large multifamily apartment buildings and social housing (Bertoldi *a* , 2021a). Public funding to scale up energy-performance contracts can reduce the need for upfront capital, reduce borrowing costs and link renovations to actual energy-e ciency gains.

Policies such as these can alleviate consumer concerns about future energy savings and technical assistance for buildings energy-efficiency investments. However, with less than €300 million awarded, mobilising an estimated €9.5 billion over 15 years, the impact has been limited[31].

Other policy options are energy-efficiency obligations and mortgage portfolio standards. These are more stringent types of regulation that force the market to move towards improved energy performance. Energy-efficiency obligations target utility companies, forcing them to promote energy efficiency savings to their consumers. Mortgage portfolio standards require lenders and financial funds to gradually increase the energy performance of their real-estate portfolios (Bertoldi *et al*, 2021). The EPBD rightly encourages greater use of mortgage portfolio standards at national level.

One-stop shops to simplify energy renovations and collect data

One-stop shops (OSS) are private or public entities that act as points of reference for companies and citizens willing to make energy-efficiency investments. OSS serve as intermediaries between final customers and the entire supply chain for energy renovations, providing administrative, financial and legal support, while monitoring renovation progress and delivery.

OSS can also help pool projects, creating an investment case for contractors that would be lacking for projects in isolation[32] (Bertoldi *et al*, 2021b). This function of matching demand and supply can be particularly useful to create public-private partnerships.

OSS can also help fill data gaps by collecting information on prices, types of renovations and efficiency gains post-renovation. For example, OSS could help expand the adoption and improve the quality of energy-performance certificates (EPCs), the main tool at EU level to certify a building's energy efficiency rating, grading building from A (best performing) to G (worst performing). While useful, EPCs have been criticised for inaccuracy, often because of self-reporting and unreliable energy audits (European Commission, 2021). EPCs often provide ratings based on the physical assets of buildings or real energy consumption, but fail to give an actual representation of energy performance in kilowatt hours per square metre (Jenkins *et al*, 2017). As a result, EPCs sometimes fail to inform households about the energy efficiency of their homes, leading many to mistakenly believe renovations are unnecessary (Römer and Salzgeber, 2023).

More broadly, the lack of useful data on buildings is alarming and should be addressed as a priority[33]. Detailed information on heating systems across local communities can help local authorities make informed decisions on which heating systems to promote and whether district heating is a viable option.

7 Conclusions

Bridging the investment gap in buildings energy renovations in the EU to meet the 2030 EPBD target requires national governments to roll-out cost-effective policy tools, shielding vulnerable consumers from the high upfront costs, leveraging future energy savings, lowering administrative burdens, correcting relative energy prices and crowding-in private capital.

Even for the worst-performing buildings, for which governments will need to allocate the biggest share of public support (estimated at 60 percent), leveraging future energy savings

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can close the remaining investment gap. This can be done by blending subsidies with pay-as-you-save or energy-performance contracts. For other private buildings, preferential loans, tax incentives and energy-efficient mortgages can be used. Doing this would lower the new public finance needed to €50 billion per year (Table 3). Finally, deploying one-stop-shops, mortgage portfolio standards, energy efficiency obligations, revolving funds and contracts for difference have the potential to greatly speed up energy renovations.

Table 3: estimated investment gap and suggested relevant instruments by type of building

Target Group	Annual investment gap	New public finance needed (per year)	Secondary characteristic	Type of instrument
Residential worst-performing buildings	€42 billion	€25 billion (assuming 60% from the state)	Single-family houses	- Grants and subsidies blended with pay-as-you-save finance
			Large multi-apartment buildings	- Grants and subsidies blended with energy performance contracts or energy service agreements
Non-residential worst-performing buildings	€73 billion	€17 billion (assuming 23% from the state)	Private buildings	- Preferential loans - Tax incentives
			Public buildings	- Energy performance contracts - Energy service agreements
Other residential buildings	€34 billion	€8 billion (assuming 23% from the state)	All	- Preferential loans - Energy efficient mortgages - Pay-as-you-save - Tax incentives
All buildings			All	- One stop shops - Mortgage portfolio standards - Energy efficiency obligations - Revolving funds - Energy performance contracts - Energy carriers contracts for difference

Source: Bruegel.

However, even if public funds and ETS2 revenues - estimated at €30 billion/year for energy renovations – are deployed most efficiently, a gap of €20 billion per year persists. EU institutions should therefore leave enough margin for fiscal manoeuvre for EU countries to make the required investments.

References

Abdoos M., A. Alireza, A. Shahee and R. Zahedi (2024) 'Reducing the energy consumption of buildings by implementing insulation scenarios and using renewable energies', *E I a c* 7(18)

Gerőházi, É., E. Somogyi and H. Szemző (2023) *C Ta d Ac E P M a* (Deliverable 1.3), ComAct Project, Metropolitan Research

ITRE (2017) *E P*, Study for the ITRE Committee, European Parliament

Ivanova V., M. Jones, A. Joyce, A. Psatha and C. Simpson (2023) 2021-2027 *C P c S E E c c a d B d R a*, E3G and Renovate Europe

Jenkins, D., A. Peacock and S. Simpson (2017) 'Investigating the consistency and quality of EPC ratings and assessments', *E* 138: 480–89

Jiménez-Navarro J. P., K. Kavvadias and G. omassen (2019) *D ca b EU H a S c*, JRC Technical Reports, European Commission

Macfarlane, L. and M. Mazzucato (2023) 'Mission-Oriented Development Banks: e Case of KfW and BNDES', *W Pa* 2023/13, UCL Institute for Innovation and Public Purpose

Mahlstein, K., C. McDaniel, S. Schropp and M. Tsigas (2022) 'Estimating the economic e ects of sanctions on Russia: An Allied trade embargo', *W d Ec*, 45(11): 3344–83

McWilliams, B., S. Tagliapietra and C. Trasi (2024) 'European clean tech tracker', Bruegel dataset, rst published 28 March 2021

McWilliams, B. and G. Zachmann (2021) 'Commercialisation contracts: European support for low-carbon technology deployment', *P c C b* 15/2021, Bruegel

Müller, S. and L. Nesselhauf (2023) Der CO2-Preis Für Gebäude Und Verkehr, Agora Energiewende

Römer, D. and J. Salzgeber (2023) *K W E T a Ba 2023 E T a Ca b N d Ac a d F a c a P b*, KfW

Samwick, A. (1997) 'Discount Rate Heterogeneity and Social Security Reform', *W Pa* 6219, National Bureau of Economic Research

Sgaravatti, G. (2024) 'Electricity tari s dashboard', Bruegel dataset, 16 May

Sgaravatti, G., S. Tagliapietra, C. 2.1 (anctions)ons h 287 (1.625 -i, G)25.1 ga, C. 2.1 8nn. SamwictRy-2.3 . S ip5