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Allianz Research

The great green renovation

The buildings sector transition pathway

Executive Summary

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- The EU's targets for reducing emissions are not ambitious enough to meet the Paris climate goals: Taking into account its "fair share", calculated by dividing the remaining carbon budget by its share of the global population, the EU needs to slash emissions by 65% by 2030 instead of the aspired 55% and achieve climate neutrality by 2040, 10 years earlier than currently planned. In this context, the buildings sector could play a key role: Buildings account for 40% of the EU's total energy consumption and 36% of energy-related greenhouse gas (GHG) emissions.
- There are two key levers to reduce emissions in the buildings sector: improving energy efficiency and switching to greener fuels. The former, energy savings, can be mainly achieved through renovations, reducing the energy demand by at least a quarter over the next decade. The latter implies thorough electrification: The electricity share is expected to climb from around 20% to 45% (residential buildings) and from 45% to 60% (service sector) in 2050. In the process, the share of natural gas in the energy consumption mix – today at 50% – will plunge to almost zero.
- Since up to 95% of existing buildings are likely to still be around in 2050, ramping up the renovation rate is essential. While around 16% of all of EU buildings undergo partial to full renovation per year, little to no attention is being paid to assessing and improving the energy performance of those buildings. As a result, the "real" renovation rate, weighted by effective energy savings, is close to 1% for residential buildings and close to 0.5% for non-residential buildings. The EU is aiming for a 2% energy-renovation rate to reduce GHG emissions from buildings, but we find that it needs a much more ambitious target of 3%.
- The actual investment needed for a ´deep energy renovation' (more than 60% of energy savings) varies between EU countries, ranging from EUR50 per m2 (residential projects in Spain) to EUR450 per m2 (non-residential projects in Sweden). But how much bang do you get for the buck? Energy savings of 1kWh per year were mostly realized at investments between EUR1-5; reducing CO2 emissions by 1kg per year was almost three times as expensive.
- Overall, the annual energy-renovation investment needs to achieve the EU goal of a 2% energy-renovation rate range between 0.2% and 0.8% of GDP in the EU countries, with an average of 0.5% of GDP. This amounts to EUR82bn per year in the EU or EUR95bn if the UK is included as well. However, the necessary 3% renovation rate would increase the energy investments needed by EUR47bn in the EU and UK per year. Against the backdrop of the EU's residential sector currently investing about EUR 200bn per year in energy renovations (though rather inefficient 'light' than efficient 'deep' energy renovations), these investment needs seem feasible if energy renovation becomes the first principle in renovation.


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Emission-reduction targets and pathways

The EU's '2030 Climate Target Plan' aims at slashing emissions in all sectors by a minimum of 55% by 2030 (compared to 1990), thus delivering the Fit for 55 (Ff55) target within the European Green Deal and implying a 60% GHG emission reduction for the buildings sector. However, looking at the bloc's "fair share"[1] in achieving the Paris climate goals, we find that emission-reductions of at least 65% would be necessary in all sectors by 2030. The EU would also need to achieve climate neutrality by 2040, 10 years earlier than planned in the Ff55. In this context, the buildings sector could play a key role: Buildings account for 40% (households: 26.3%, services: 13.7%) of the EU's total energy consumption and 36% of all energy-related GHG emissions.
The new REPowerEU Plan, introduced to accelerate energy sovereignty in the wake of war in Ukraine, could lay the foundations for the green transition of the buildings sector. Many of its measures address the diversification of energy supplies and propose energy savings through behavioral changes (e.g. less heating, speed limits). However, the key for long-term effects is the accelerated roll-out of renewable energy in buildings, which will be subsidized and demanded through various measures:

1 The 'fair share' is calculated by the dividing the remaining carbon budget by the EU's share of the global population. Current targets imply that the EU requires 10% of the available global carbon budget to limit the temperature rise to 1.5°C, while the EU represents only 5% of the world's population.

40%

buildings share in EU total energy consumption

- Boosting national fiscal measures to encourage energy savings, such as reduced VAT rates on energy-efficient heating systems, building insulation and appliances and products.
- Increasing the binding EU Energy Efficiency Target from 9% to 13% in 2030 vs. 2020.
- Implementing a solar rooftop initiative, with a phased-in legal obligation to install solar panels on new public and commercial buildings and new residential buildings.
- Doubling the rate of deployment of heat pumps, and measures to integrate geothermal and solar thermal energy in modernized district and communal heating systems.
- Extending buildings' Minimum Energy Performance Standards.
- Strengthening the national energy requirements of new buildings.
- Tightening national heating system requirements for existing buildings.
- Introducing national bans for boilers based on fossil fuels in existing and new buildings.
- Advancing the end of member states' subsidies for fossil fuel-based boilers from 2027 to 2025.

These measures address the two crucial focus areas for achieving GHG emission-reductions in the buildings sector: 1) improving energy efficiency and 2) switching to greener fuels.

Renovation will play a key role in improving energy efficiency. Heating and cooling account for 80% of the energy consumed in residential buildings, largely because they continue to rely on outdated technologies and appliances, as well as fossil fuels. Renewable heating and cooling accounted for only 22% of buildings' gross final energy consumption in 2019. Hence, one of the key focus areas is to slash the energy demand for heating and cooling by renovating the building envelope (e.g., insulation and windows) which is particularly important for older buildings that were constructed with lower energy-performance standards. In addition, the equipment fitted and used in the buildings also matter: Switching to electric heating systems, adopting renewable solutions such as solar systems, using better standardized and labelled energy-efficient equipment and smart home technologies (e.g., for controlling lightening and heating) can also play an important role in keeping energy demand in check.

If the EU is to achieve its original 2030 emission targets, significant final energy savings should be observed (Figure 1). The most pronounced savings would be in the residential sector, with the total energy consumption of buildings in the residential sector down by 24%, while heating and cooling savings would be around 31%.

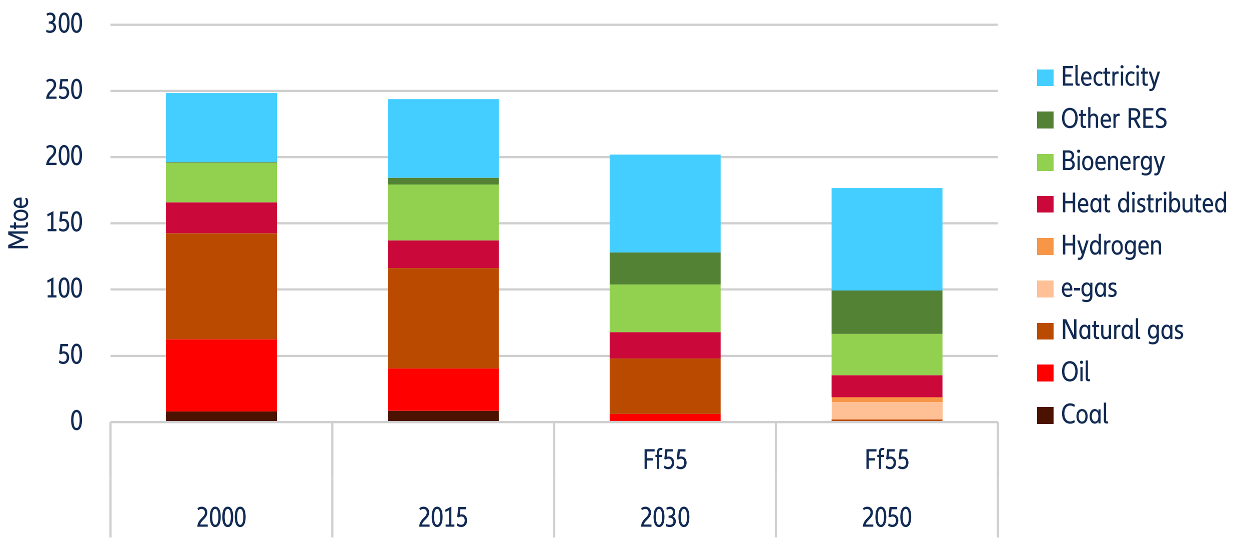
Figure 1: Evolution of the energy consumption in buildings in 2030 (compared to 2005)

Sources: EU Commission, Allianz Research

To green the fuel mix of buildings, a rapid growth of electricity consumption and decline in fossil fuels (especially natural gas) will be observed. For residential buildings, the electricity share is expected to increase to 36% by 2030 (+15pp), topping 45% by 2050 (Figure 2). In the services sector, the share of electricity will reach 50% by 2030 (+5pp) and to 60% by 2050 (Figure 3).

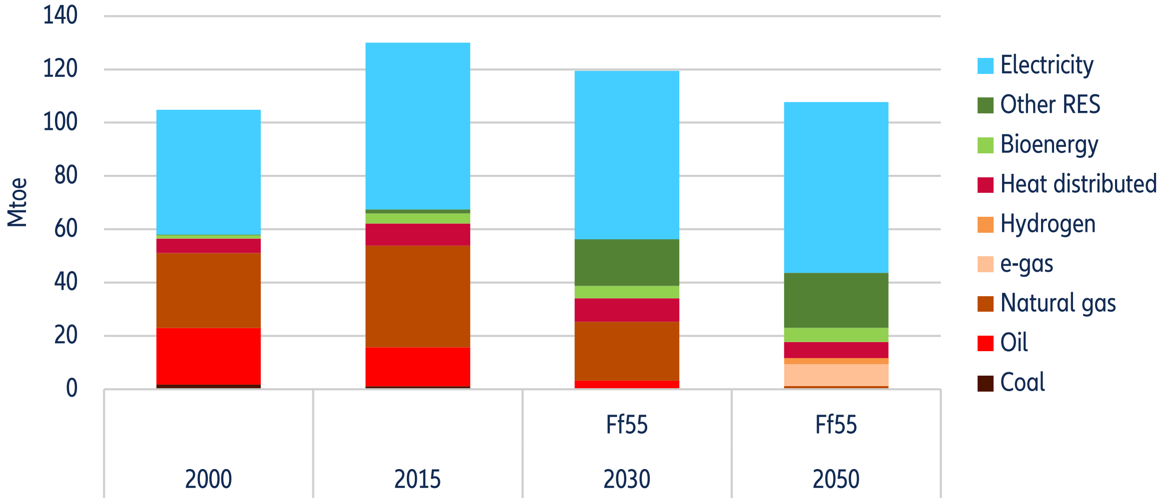
With the rise in electrification, coupled with overall declining energy demand, the consumption of other fuels (particularly fossil fuels) will continue to drop correspondingly as conventional heating technologies are phased out in favor of electricity-based heating systems (Figure 4).

Figure 2: Energy demand in residential buildings



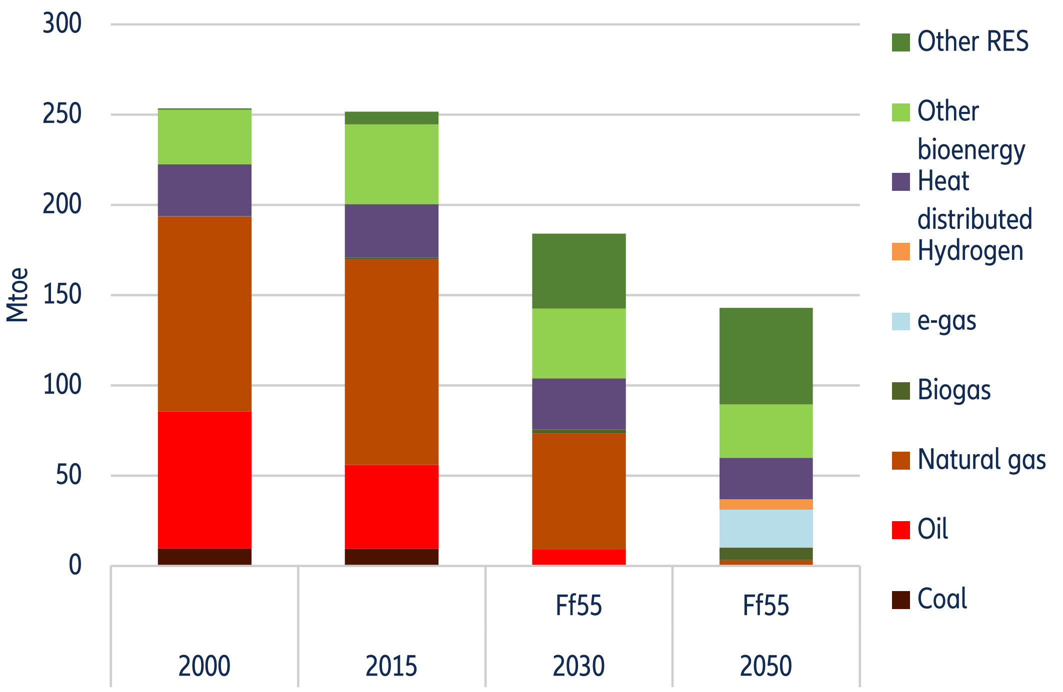
Sources: EU Commission, Allianz Research

Figure 3: Energy demand in services



Sources: EU Commission, Allianz Research

Figure 4: Non-electricity energy consumption in (residential and services) buildings



Sources: EU Commission, Allianz Research

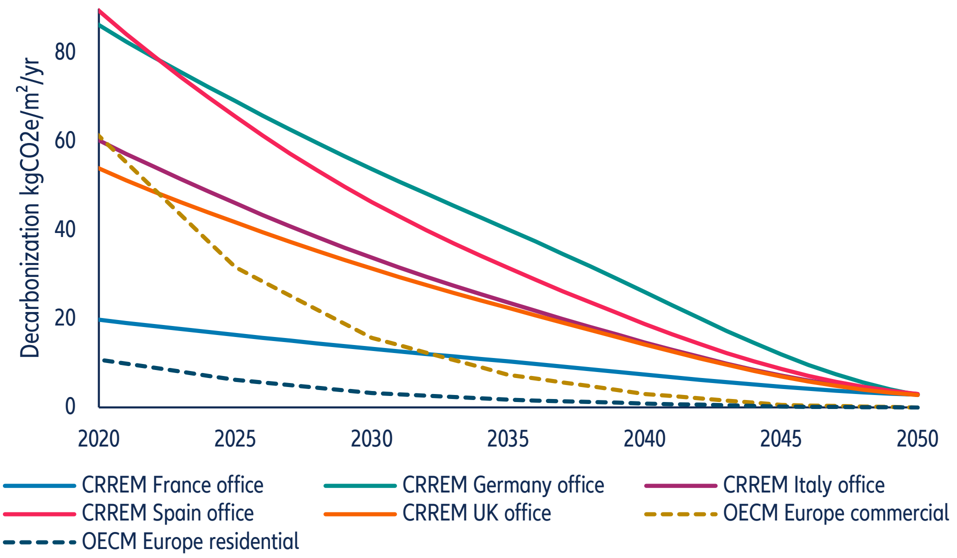
The required energy savings and the switch to renewables can by summarized by energy-reduction and decarbonization pathways. Figure 5 displays the popular and commonly used CRREM (Carbon Risk Real Estate Monitor) energy-intensity and emission-intensity pathways for office buildings and compares them to the pathways from the One Earth Climate Model (OECM) for commercial as well as residential buildings. The shown pathways claim to be consistent with keeping global warming below 1.5°C. While CRREM features pathways by country and OECM only a joint OECD Europe pathway, the development for energy intensity is reasonable similar. Interestingly, the pathway for residential buildings in OECM starts on a much lower intensity level and does not need to decline as fast as it converges to a similar absolute level in 2050 as the commercial energy intensity. The picture looks different for the emission intensity, though. While OECM and CRREM seem to start on similar average levels in 2020, the OECM emissions decline much faster and also converge to zero in 2050 while the CRREM emission-intensity pathways converge to just below 3kgCO2e/m2/yr. Where does this difference originate from? The simple answer is: from different assumptions as the CRREM pathways rely on rather outdated climate pathways. This only underlines the need to ramp up ambitions.

less than 1%

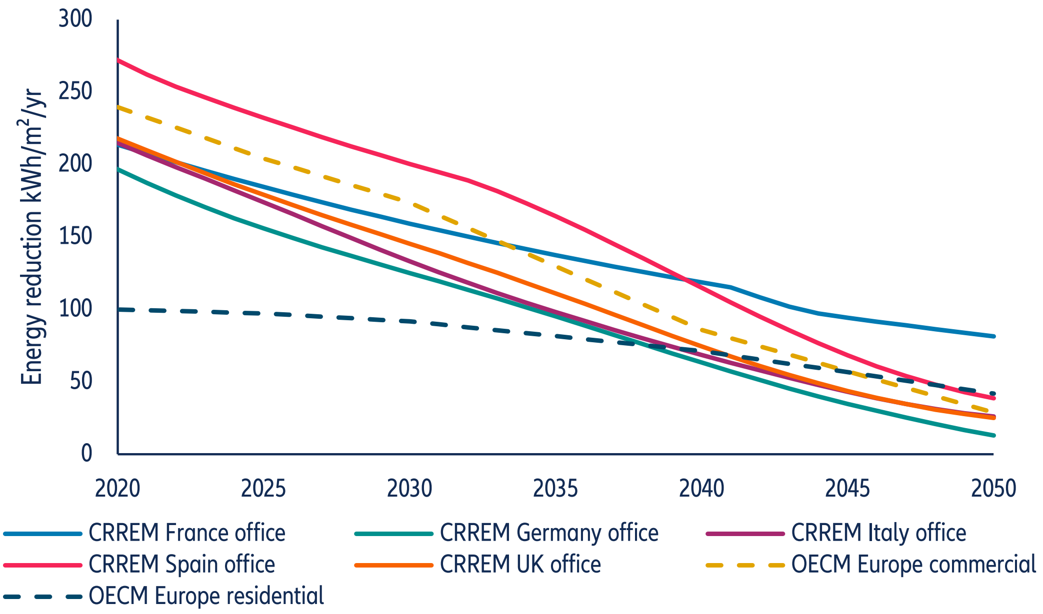
share of natural gas in the energy consumption mix of buildings

Figure 5: CRREM and OECM pathways

A Energy reduction



B decarbonization



Sources: CRREM, OECM, Allianz Research

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Build back better with building renovations

According to the EU Building Stock Observatory, the total building stock, comprising (residential) dwelling units and non-residential buildings, amounted to about 260mn units (in 2016-17)[2] . Around 85% of these, roughly 221mn units, were constructed before the beginning of the 21st century; up to half of the building stock even dates back to the pre-1960 era. Yet, up to 95% of these existing buildings are expected to still be around in 2050[3] .

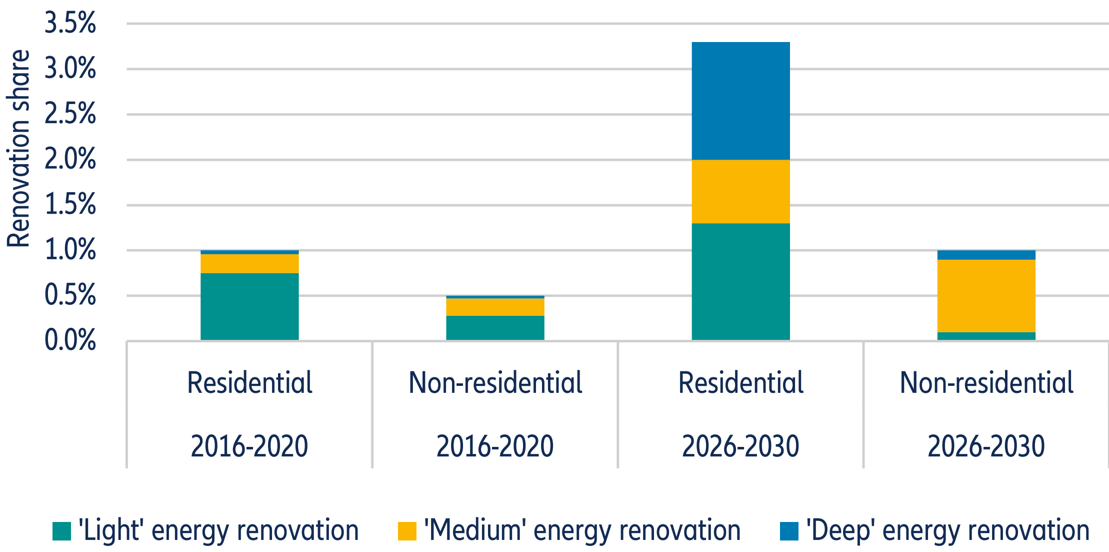
The Energy Performance of Buildings Directive (EPBD) already requires all new buildings from 2021 (public buildings from 2019) to be nearly zero-energy buildings (NZEB). However, every year, only close to 1% of the existing building stock is newly constructed. Taking this into consideration, renovating the older inefficient and energy-intensive buildings is the only way to achieve the Paris climate target of 1.5°C. With the energy performance certificates (EPCs) for buildings, introduced in 2002 (A=most efficient to G=least efficient), the EU established a tool to identify the most "attractive" renovation targets: Across the EU, 35% of buildings have an EPC rating between D and G. The proposed revision of the EPC suggests to define the G rating as the worst performing 15% of buildings, requiring their upgrade until 2027 for non-residential and 2030 for residential buildings.

2 Source: EU Buildings Database (2021)
3 Source: EU Renovation Wave Strategy (2021)

This would be a big step forward. Currently, around 16% of the EU's buildings undergo partial to full renovation per year. However, little to no attention is being paid to assessing and improving the energy performance of those buildings: While three quarters of renovations were energy-related, more than half of so-called 'energy renovations' are below the 3% energy-saving threshold for being considered as actual energy saving. Another one third consists of 'light energy renovations' with savings between 3% and 30% p.a.. Less than 10% resulted in 'medium energy savings' of 30%-60% and only around 2% in 'deep energy savings' larger than 60%. Consequently, weighted by effective energy saving, the annual energy renovation rate was estimated at close to 1% for residential buildings and close to 0.5% for non-residential buildings, according to the European Commission[4] (see Figure 6). These rates need to at least double to achieve the EU's climate targets.

4 Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU – Final Report (2019)

Figure 6: Development of weighted energy renovation rates (Type 1*) in buildings, by sector



*only renovation of the building shell (e.g., isolation)
Source: EU Commission, Allianz Research

Limits to energy efficiency

As the buildings sector is a major energy consumer, improving energy efficiency is a no brainer. But it should also be noted that despite implementing such measures, the result does not always guarantee energy conservation due to the rebound effect. The occurrence of such effects is identified when beneficial energy savings, as a result of improved energy efficiency, are counteracted with a rise in energy consumption of similar magnitude. (If the costs of energy do not vary greatly, there is a tendency that people will be tempted to utilize more energy when equipped with energy-efficient equipment since they pay the same price for more usage.)

The magnitude of the rebound effect (R) can be calculated as the percentage increase in energy consumption for every percentage increase in energy efficiency for a specified period of time.

- If R >100% => backfire (energy efficiency gains lead to an increase in energy consumption);
- If R=100% => full rebound;
- If 0%<R<100% => partial rebound;
- If R=0% => no rebound (actual energy savings match the predictions);
- If R is negative => super-conservation (energy-efficiency measures result in a larger drop in energy demand than expected).

Rebound effects (R>0%) could keep the EU from reaching its emission-reductions targets on time. A study on rebound effects for energy-efficiency measures in the EU's residential sector notes big differences between countries. In the first group (Bulgaria, Czechia, Estonia, Hungary, Italy, Romania, Slovenia, and Spain), a rebound of 100% or more is observed, which means that the measures usually resulted in a full rebound or even backfired. In the second group (Austria, Denmark, Croatia, Germany, Greece, Latvia, Lithuania, and Poland), a partial rebound effect is observed. Only four countries (Belgium, Finland, Ireland and Luxembourg) showed almost no rebound effects.

Photo by Bady Abbas on Unsplash

Investment needs to close the ambition gap

Renovations do not come without costs. An estimated 30mn building units are in the worst-performing energy label category 'G' and require renovations under EPBD. The EU budget has allocated up to EUR150bn to support and implement the upgrading of these buildings until 2030. As the EU's construction industry employs 18mn people and contributes to about 9% of total GDP, such a wave of renovations could potentially create 160,000 new jobs in the construction ecosystem.

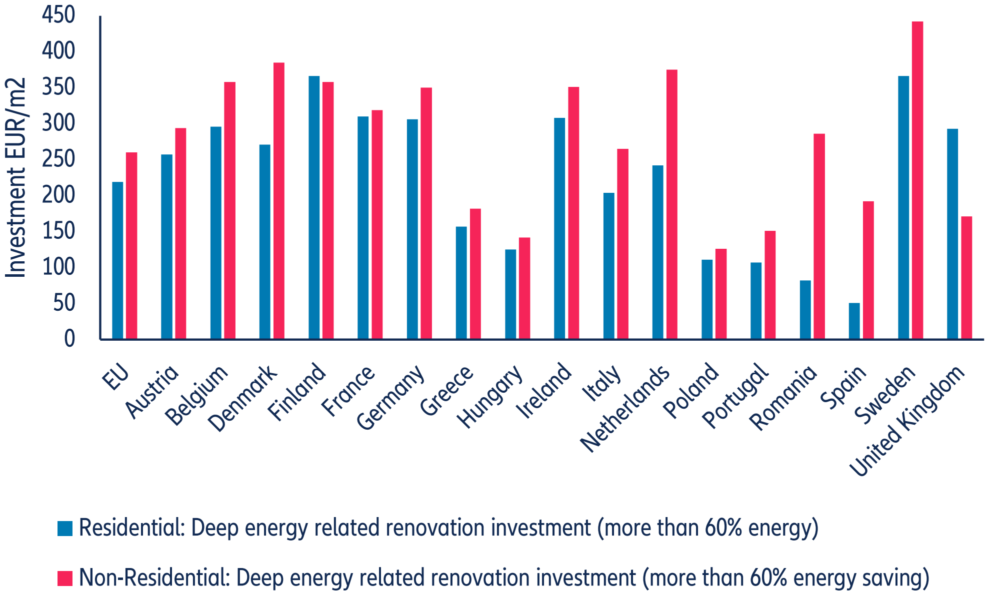
As shown in Figure 7, the actual renovation investment for a deep energy renovation (more than 60% energy saving) varies widely between EU countries. A large-scale analysis of actual renovation projects placed Spain among the cheapest (around EUR50 per m2 for residential projects) and Sweden among the most expensive countries (EUR450 per m2 for non-residential projects). With the exception of the UK, non-residential projects were still more expensive when normalized to square meter values.

But how much bang do you get for the buck? Figure 8 displays how many euros need to be spent to save 1kWh of energy or to mitigate 1kg of CO2, respectively. Naturally, these figures closely correlate to the investment costs per square meter, given the definition of the deep energy-renovation category (more than 60% energy saving) and the fact that consequently the actual observed energy savings and emission mitigations in that category do not vary dramatically by country. Energy savings of 1kWh per year were mostly realized at investments between EUR1-EUR5. Reducing CO2 emissions by 1kg per year was almost three times as expensive in all countries.

0.5%

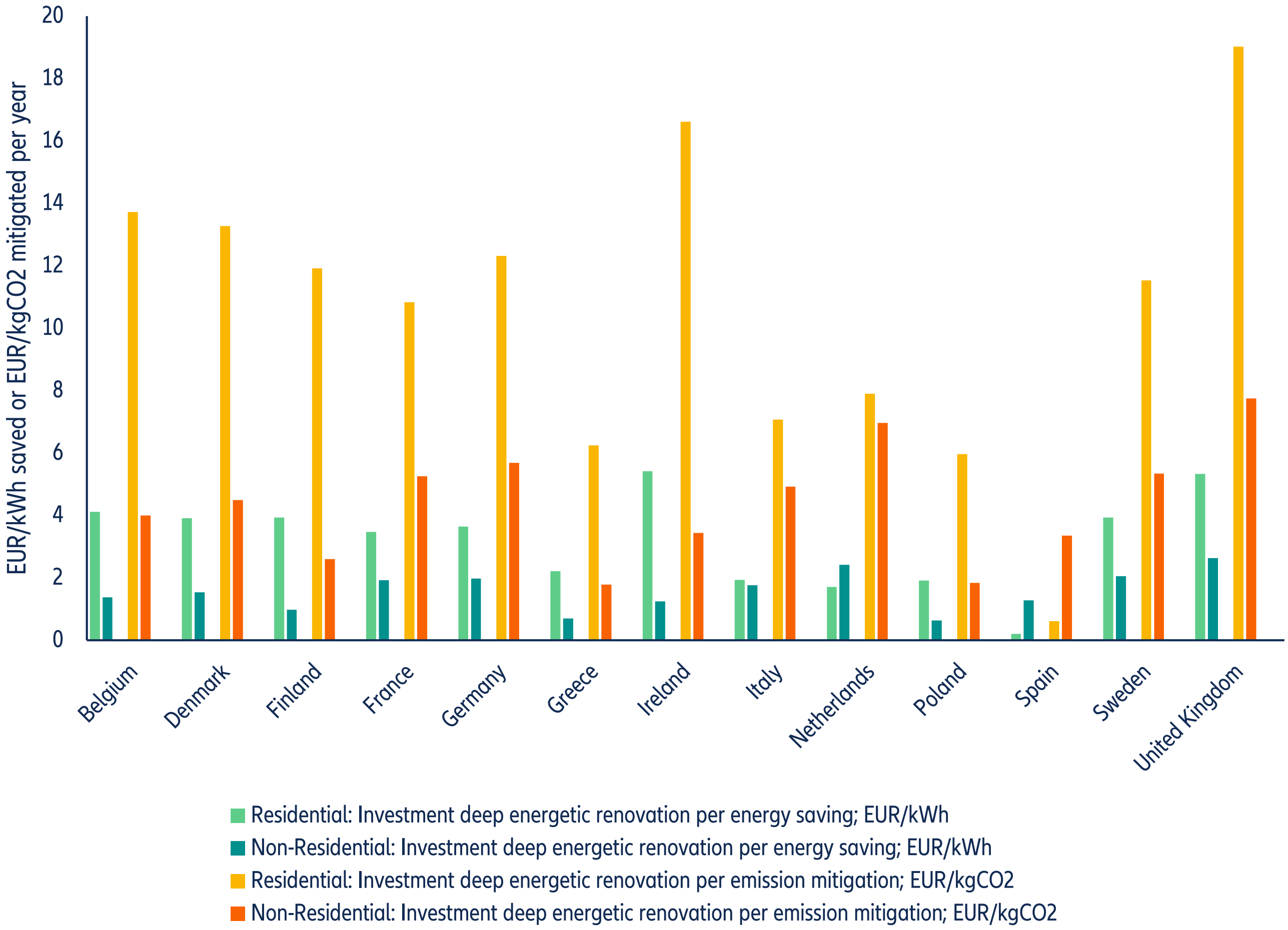
annual renervation-investments needs in percentage of GDP to achieve the EU goal of a 2% renovation energy rate

Figure 7: Investment needs for 'deep' energy-related renovation by country



Sources: EU Commission, Allianz Research

Figure 8: Investment needs per unit of energy saved or emissions mitigated

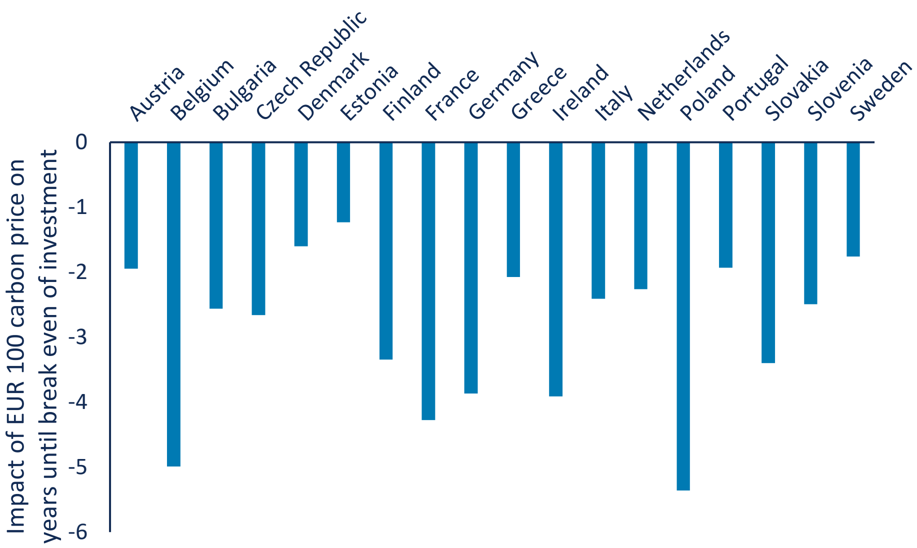


Sources: EU Commission, Allianz Research

Energy savings are per year and permanent (within the life cycle of the investment) and thus cumulate over time. Given the different investment needs for energy savings – and the varying consumption weighted energy costs for households, ranging from 5 cents per kWh in Hungary to 26 cents per kWh in Sweden – the time to recover the actual observed investments purely through energy savings differs widely in the EU, with an average of around 16 years (that excludes subsidies for energy renovations and the most recent rise in construction costs as well as in energy prices). Figure 9 displays the effect on the breakeven duration of deep energy investments if an additional carbon price of EUR100 would be passed through in the energy bills of consumers. For most countries, this would reduce the number of years to recover investments by 2 to 4 years, with the average in our sample lying at 3.3 years.

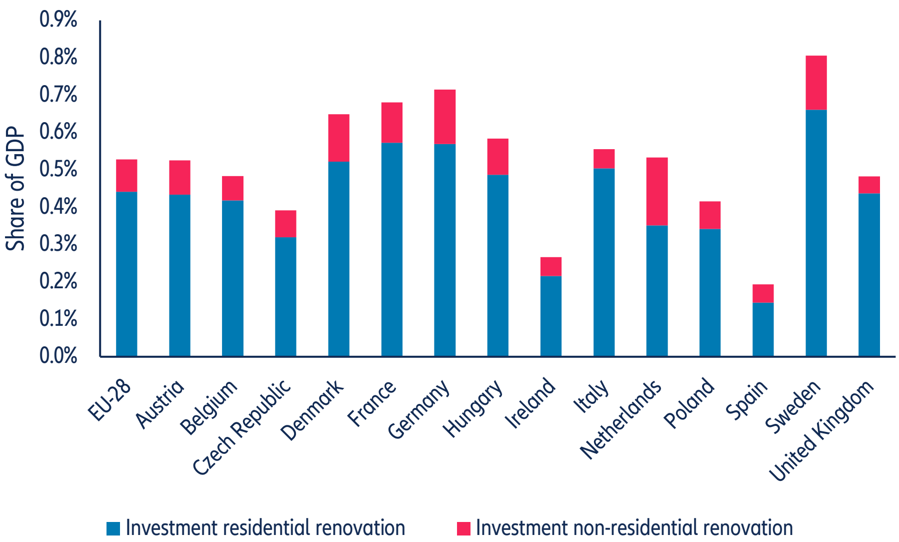
Figure 10 shows the annual energy-renovation investment needs to achieve the EU goal of a 2% energy-renovation rate. This estimate uses the aspired investment mix between light, medium and deep renovation (see Figure 6). About 82% of investments are supposed to flow into residential energy renovation. Investment needs vary between 0.2% and 0.8% of GDP, with an average of 0.5% of GDP. In total, this amounts to EUR82bn per year in the EU, or EUR95bn if the UK is included as well.

Figure 9: Effect of EUR 100 additional carbon price pass-through on break-even time of deep energy renovation



Sources: EU Commission, Allianz Research

Figure 10: Annual energy-renovation investments at 2% renovation rate and the planned EU renovation mix



Sources: EU Commission, Allianz Research

However, as discussed above, the EU's climate ambition is below its fair contribution to limiting global warming to 1.5°C. Furthermore, the invasion of the Ukraine made the energy transition even more urgent as the only viable path to energy sovereignty. In this context, the ambition should be ramped up to reducing the energy consumption at a rate of 3% per year.

Table 1 : Concrete measures by different ambition levels

All values per year	EU 2021	EU Ff55 pre-war	EU Ff55 post-war	3% renovation rate	Remark
Buildings renovated	1.75 mn	3.2 mn	3.5 mn	over 5 mn	Renovations with substantial energy savings. According to the (COM(2020) 662 final) communication by the European Commission, a 2% renovation rate accounts for 35 million buildings in 10 years.
Heat pumps installed	2.0 mn	1.0 mn	2.0 mn	over 5 mn	EU less ambitious than expected actual market development.
Solar rooftop installations	1.4 mn	1.2 mn	1.4 mn	over 5 mn	At an assumed 10kWp per installation. Low ambition by the EU as Germany alone plans to ramp up installation to over 1mn solar rooftops per year. Market peaked already at 1.4mn in 2011 and declined to below 0.3mn in 2014-2016.

Table 1 translates this "ideal" ambition into concrete action by comparing for the three key levers "buildings renovated", "heat pumps installed" and "solar rooftops installed" the current EU's ambitions with the current progress, as well as with the progress that should be reached for climate and energy sovereignty (i.e. a 3% energy renovation rate). Our analysis confirms previous findings and suggest that:[5]

- 5mn buildings per year need to undergo substantial energy renovations.
- 5mn heat pumps need to be installed, mainly for replacing fossil heating systems.
- 5mn solar rooftops need to be installed.

Although a clear acceleration compared to current targets, the new ambition is still feasible for a simple reason: The EU's overall targets do not seem particularly ambitious when compared with current market developments and policies announced by individual EU countries. In particular the deployment of heat pumps is seeing large growth rates. In addition, the German government's aim to add 11GW of solar rooftop capacity per year would already satisfy most of the EU target.

Energy renovations are typically triggered by other renovations, unexpected repairs, regular maintenance and inspections. Further important factors include budget becoming available or health issues requiring a modification of the premises. In the past, the most relevant aspects of residential energy renovation were not the energy savings, but the associated cost savings as well as making the home more comfortable and healthier. Thus, even within the current renovation budgets and capacities, the revised targets are achievable if the focus of renovation activities is consequently put on energy savings.

Concretely, the suggested 3% renovation rate or over 5mn energy-renovated units per year suggests an investment gap of EUR47bn in the EU-28 per year (i.e. total investment needs of EUR142bn per year). However, the EU's residential sector is already currently spending about EUR200bn per year in energy renovations, only mainly for rather inefficient 'light' ones, and EUR300bn for non-energy renovations. Another EUR200bn is being invested in renovating non-residential buildings. In this context, closing the investment gap should be possible if energy renovation becomes the first principle in renovation.

5 See for instance CAN Europe.

EUR 47bn

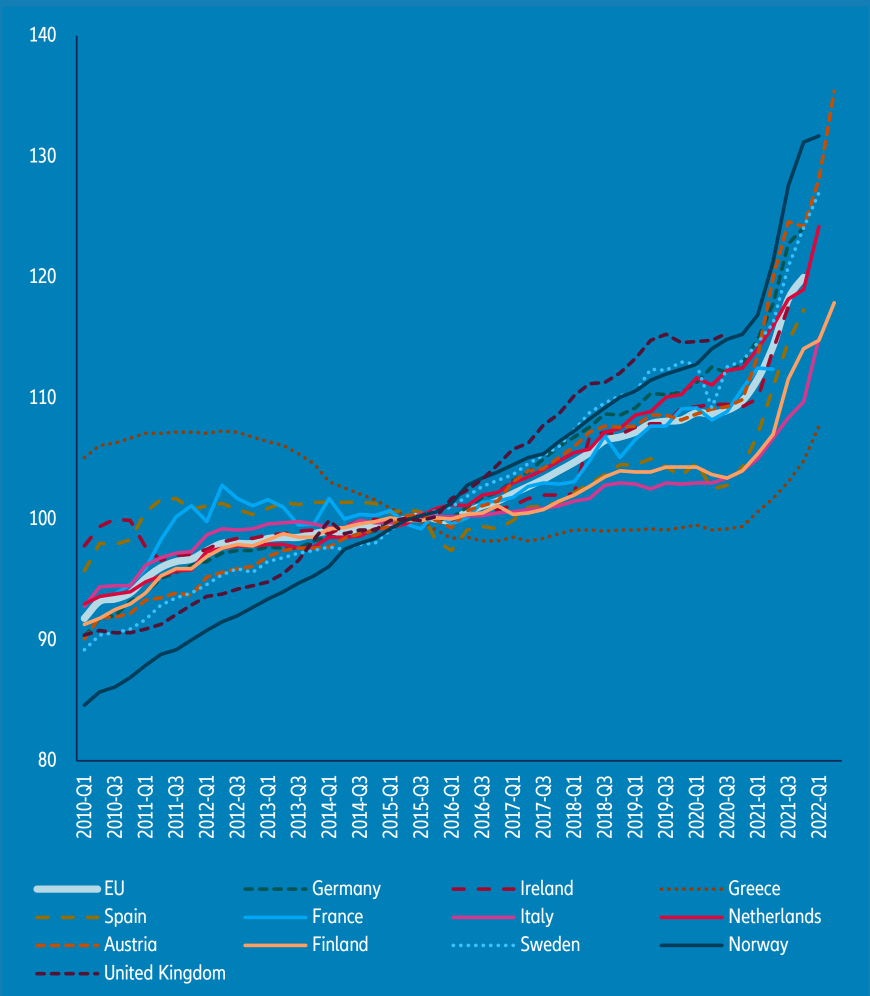
investment gap to renovate 5mn buildins per year instead of 3.5mn, pushing the energy-renovation rate to 3%

Roadblocks to energy renovation

Even if overall investment sums are not frightening, there are other roadblocks to the quick scale-up of energy-renovation activity. Many clients express uncertainty about what to expect from installers, with a high share of laymen (tenants, home owners) taking responsibility for quality control on the one hand and half of all installers across Europe reporting energy-efficiency measures being too complicated to install on the other. It does not help that incentives for renovations (be it economic or related to regulation or living quality) rarely account for the demand-side spilt into tenants, owner-occupiers and landlords and the supply-side division of labor between architects, main contractors and installers. Consequently, consumers, architects, contractors and installers across the board view financial and administrative barriers as being the main roadblocks for consumers.

For commercial clients, financing and savings are even stronger motivations than for residential clients. It is striking that a vast majority of consumers use their own capital to finance renovation works, suggesting that consumers don't undertake energy renovations unless they have sufficient own capital. This leads us back to the elephant in the room. Taking the construction costs for new residences as representative for renovations, Figure 11 displays the development of the construction cost index (CCI). Construction costs have been steadily rising over the years, with a notable +15% increase between 2010 and 2019. But this can hardly be compared to the price rally we have seen since the third quarter of 2021 due to the combined massive disruption in global supply chains and the energy price rush resulting from the Russian invasion of Ukraine. The Austrian CCI curve, close to the EU average between 2010 and 2019, currently indicates an expected +50% price increase for Q2 2022 vs. Q1 2010. On the positive side, energy-efficient buildings will help residents become less impacted by rising energy prices, and higher energy prices do not only increase construction prices but also lead to a quicker return on investment for renovation costs. The market for decarbonizing buildings will only become more attractive.

Figure 11: Construction cost index (CCI) – new residential buildings



Sources: Eurostat, Allianz Research

The full cycle view

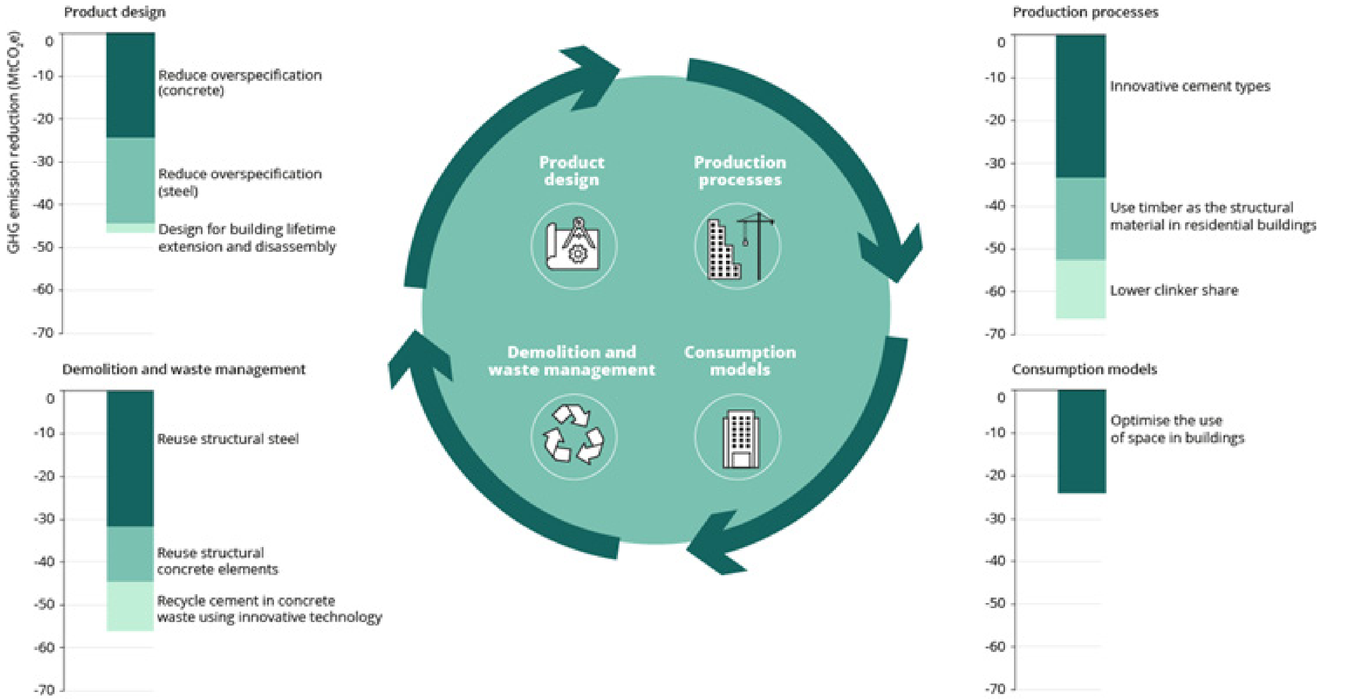
The end goal should be to transform all buildings into less carbon-intensive units, not only in their operational cycle but over their entire life cycle (encompassing the construction phase and the emission-intensive materials used therein, as well as the renovation and demolition phases). A briefing by the European Environment Agency (EEA, see appendix) suggests that by taking measures such as reducing concrete, cement and steel, materials-related GHG emissions can be cut by 61% over a building's life cycle stages until 2050. Main drivers are in the design phase the reduction of overspecification of concrete in building plans (-12%), in the production phase the use of innovative and alternative cement types (-16%), and in the demolition and waste management phase the re-use of structural steel (-15%). These three actions focus directly on making the flows of steel, cement and concrete more efficient, as these constitute the most emission-intensive materials used in the buildings sector. The European Commission does promote sustainable building materials and solutions and has a plan to focus on the sustainability performance of construction products within the revised Construction Products Regulation (CPR) expected to be released by 2023, charting a roadmap to 2050 for reducing whole life-cycle carbon emissions. Material recovery targets for construction and demolition waste (CDW) set in the EU legislation will also be reviewed by the EC by the end of 2024. In addition to construction materials, there is also a high uptake of insulation materials being used in renovations. Although they improve the energy efficiency of buildings, any potential trade-offs, such as the emissions generated in the creation of insulators, must also be factored in for a holistic picture of life-cycle emissions.

Finally, the carbon footprint of a building is not limited to zero on the lower end. Recent research has highlighted the role of buildings as potential carbon sinks[6] . Buildings could thus have negative net-emissions – if made from timber. A five-story residential building structured in laminated timber can store up to 180 kilos of carbon per square meter, three times more than in the above ground biomass of natural forests with high carbon density. According to the research, close to 700mn tons of carbon could be stored per year if 90% of new buildings worldwide were built in timber. However, the carbon accumulated in buildings over 30 years would sum up to less than one tenth of the overall amount of carbon stored above ground in forests worldwide, and 700mn tons seems small compared to the current amount of roughly 11,000mn tons of carbon (equalling almost 41,000mn tons of carbon dioxide) emitted per year.

6 E.g. Churkina, G. et al. (2020): Buildings as a global carbon sink.

Appendix

Cutting greenhouse gas emissions through circular economy actions in the buildings sector



Source: EEA

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