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OFFSITE CONSTRUCTION: A SOLUTION FOR AFFORDABLE HOUSING IN EUROPE

REDUCING COSTS, TIME AND CARBON

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Authors

Ivan Jankovic

Essam Elnagar

BPIE review and editing team

Ana Nanu

Oliver Rapf

Sibyl Steuwer

Graphic design

Publishing Bureau

Cover image source

Etex

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GLOSSARY

Circular economy (in construction): Approach that aims to keep materials and products in use for as long as possible through durability, repairability, reuse and recyclability, and reducing waste.

Circular Economy Action Plan: EU policy package that promotes more sustainable use of resources across key value chains, including construction and buildings.

Construction costs: All costs related to building a dwelling, including labour, materials, equipment, site preparation, and overheads, excluding land cost unless specified otherwise.

Embodied carbon: Greenhouse gas emissions from extraction of raw materials, manufacturing, transport, construction, maintenance, and end-of-life processing of building materials and components.

Energy Efficiency Directive (EED): EU directive that establishes a common framework to promote energy efficiency across the economy, including buildings, and to implement the energy-efficiency-first principle.

Energy Performance of Buildings Directive (EPBD): EU directive that sets the framework for improving the energy performance of buildings.

European Affordable Housing Plan: An EU Communication to boost affordable, sustainable housing supply and address rising housing costs.

European Strategy for Housing Construction: An EU policy framework designed to promote modern construction methods, simplify relevant regulations, and advance circular and low-carbon materials.

Financing costs: Costs arising from borrowing, i.e. interest and related charges.

Housing affordability: The degree to which housing costs can be met from household incomes without pushing households into housing cost overburden.

Housing costs: The regular payments a household makes to live in a home. These may include utility bills, mortgage payments, or property taxes.

Housing cost overburden: A situation where a household's total housing costs exceed 40% of its disposable income, indicating a high risk that housing is unaffordable for that household.

Housing cost overburden rate (HCOR): The percentage of people living in households where total housing costs are above 40% of disposable income.

Housing price: The amount of money paid to buy a dwelling, such as a flat or a house, at the moment of transaction.

Industrialised renovation: Using standardised, factory-made components or façade systems to upgrade existing buildings, improving performance and speed while limiting onsite disruption.

Modularisation: Designing and producing modules such as complete rooms or sections of a building, that are largely finished in the factory and then connected onsite.

Offsite construction: Construction approach where major building elements or modules are manufactured in a factory and then transported to the site for final assembly. Provided either via prefabricated (two-dimensional) building elements or (three-dimensional) modular construction.

Offsite renovation with ventilated façade: Renovation solution that uses prefabricated façade elements including insulation, substructure and cladding, installed onsite as an external building skin.

Onsite construction: Conventional approach in which most construction activities, including fabrication of structural elements and finishes, are carried out directly on the building site.

Operational energy use: Energy consumed during the use phase of a building (heating, cooling, hot water, lighting, appliances), which drives operational energy bills and associated emissions.

Prefabrication: Production of components such as wall panels, floor cassettes, or façade elements in a controlled factory environment before they are delivered and assembled on the construction site.

Sustainability: The reduction of whole life greenhouse gas emissions and construction waste across all life cycle stages.

Ventilated façade: External façade system with an air cavity between the cladding and the insulated wall.

Vertical extension: Addition of one or more new storeys on top of existing buildings, typically using lightweight offsite systems, to create extra dwellings without using additional land.

Whole-life carbon emissions: Total greenhouse gas emissions over a building's entire life cycle, combining both embodied carbon and operational emissions.

Zero-emission building (ZEB): Building standard under the EPBD that requires very high energy performance, very low operational energy demand, and the supply of remaining needs by renewable energy, leading to near-zero operational emissions.

Image source: Etex

EXECUTIVE SUMMARY

Across the European Union, housing supply has not kept pace with demand, increasing prices, including in France and Germany where deficits in new and social housing are visible. Construction costs, skills shortages, and reduced construction activity slow down delivery of new homes, while EU policies such as the Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive (EED), the Circular Economy Action Plan, and the European Strategy for Housing Construction require a faster transition to low-carbon, resource-efficient buildings.

Offsite construction methods, including prefabrication, modularisation, and industrialised renovation systems, offer a way to meet affordability and climate objectives at the same time. Evidence shows that compared to onsite construction, offsite methods provide significant benefits at both building and building stock level.

At building level, offsite construction improves cost competitiveness, shortens construction time, and enhances envelope performance, which reduces operational energy use and whole-life carbon emissions. When scaled to national and EU housing markets, these gains translate into lower per-unit housing prices, reduced housing cost overburden, and an ability to close housing demand gaps several years earlier than under conventional approaches.

The report finds that offsite vertical extension of existing apartment buildings can add new dwellings in dense urban areas without consuming additional land, contributing to easing housing shortages in France and Germany. Offsite renovation with ventilated façades further reduces energy use, improves acoustic and thermal comfort, and enhances durability and recyclability of building envelopes, supporting EPBD and circular economy objectives while lowering energy bills for occupants.

Offsite construction can substantially reduce residential housing prices per square metre, with potential reductions of 30% in France and 22% in Germany for new buildings. In case of offsite vertical extension, residential housing prices may decrease by approximately 20% in France and 14% in Germany.

Achieved reductions would directly improve affordability for households purchasing newly built homes. If all new housing is delivered offsite, housing cost overburden rate among new homeowners would drop from 7% to 0.5% in France and from 12% to 2.6% in Germany.

By reducing construction costs, offsite construction could support affordability for low-income renters and lower cost-based social rents by around 12%.

Offsite construction can accelerate delivery of urgently needed social housing, potentially closing Europe's gap of 13 million units around five years earlier than with conventional onsite methods.

In environmental terms, offsite methods can cut whole-life carbon emissions by roughly 15% to 50% and reduce construction waste generation by about 20% to 90%.

Vertical extension of existing apartment buildings using offsite techniques could further provide an additional 15% to 21% of identified housing needs across the EU depending on national context.

To unlock this potential, EU and national policies need to recognise offsite construction in EPBD and EED implementation, direct affordable housing finance towards projects using industrialised solutions, and use public procurement and product policy to create stable demand for low-carbon, offsite approaches. Aligning regulatory frameworks, financing instruments, and technical guidance with industrialised construction can accelerate delivery of affordable, low-carbon housing in France, Germany, and the EU.

Image source: Etex

INTRODUCTION

Across the European Union, housing has become increasingly unaffordable as supply fails to keep pace with strong demand for both social and conventional housing. Social housing shortages in many Member States mean that low-income households are particularly exposed to these pressures. Construction costs, skills shortages, and a resulting decline in building permits have put pressure on the construction industry, slowing down the pace at which new homes can be delivered. Consequently, house prices have risen faster than incomes, making access to adequate housing increasingly difficult. In addition to a European focus, this study examines the situation in France and Germany more closely, which together account for a large share of the EU housing stock but still face a shortage of new homes and social housing.

At the same time, the European Union needs to accelerate action to meet its environmental commitments and align the building sector with its climate goals. The EPBD and revised EED require Member States to drive down the carbon footprint of the building stock and accelerate renovation. The Circular Economy Action Plan calls for construction to embrace more durable, repairable, and recyclable building systems. The European Strategy for Housing Construction identifies offsite construction as a priority lever to boost productivity and increase housing supply, asking for immediate investment in innovative technologies. These policy drivers converge on a common imperative: housing must become more affordable whilst simultaneously becoming more sustainable. The challenge is no longer choosing between cost reduction and climate policy objectives but rather achieving both.

Offsite construction methods, which encompass prefabrication, modularisation, and other forms of industrialised construction and renovation, offer a potential pathway to meet these dual objectives. Evidence from across Europe and beyond shows that compared to onsite construction, offsite construction can deliver time savings, reduce labour costs, and lower material consumption through optimised design. By shortening project duration, reducing onsite waste, improving quality control, and enabling the systematic design of components for future reuse, offsite construction is expected to lower the cost of delivering housing whilst simultaneously reducing embodied and operational carbon emissions.

Yet despite these documented benefits, offsite construction remains marginally used in most EU Member States. Only a small fraction of new residential buildings is constructed offsite. [1] Barriers ranging from regulatory fragmentation across Member States to financing challenges, cultural resistance, and skills gaps have prevented the technology from scaling at the pace needed to address the housing crisis. The question is no longer whether offsite construction can work, but rather how to deploy it at sufficient scale to meaningfully improve housing affordability, renovation rates and sustainability across the EU.

This report examines how offsite construction can contribute to more affordable housing at building and housing market levels in the EU, with particular focus on France and Germany. The analysis covers three complementary topics. First, it assesses how offsite construction methods affect the speed of delivering new housing, lower labour and financing expenses, improve building quality, improve sustainability, and reduce site disturbance and footprint. Second, it evaluates how renovation systems with ventilated façades installed onsite can improve environmental performance and indoor comfort. Third, it examines how vertical extension of existing apartment buildings, when combined with offsite methods, can help address housing shortages. Across all topics, where applicable, the report quantifies benefits at building level and translates these into housing market impacts such as reduced housing costs, increase in housing affordability and the reduction of housing cost overburden across the EU, lower social housing rents, and meeting demand for social and residential housing in general.

The report proceeds as follows. The Methodology section describes the analytical framework and presents some important clarifications. The following section explains the building level benefits of offsite construction including vertical extensions and ventilated façades. Subsequent sections take these benefits to national housing markets and quantify their large-scale impacts. After introducing relevant methodologies, these sections address topics such as improved housing affordability, reduced rents in social housing, the potential for offsite methods to accelerate delivery of social housing and addressing overall housing shortages. A final section on recommendations outlines how EU and national policies can steer financing, procurement, and regulations to enable offsite construction to scale at the pace needed to address the housing crisis whilst meeting climate objectives.

Image source: Etex

METHODOLOGY

REPORT SCOPE

The scope of the study covers three topics relevant for offsite construction and the impacts these may have at building or building stock level in France, Germany, and the EU in general. A brief overview of the topics and impacts can be found in **Table 1**.

Construction is examined at building level in terms of cost competitiveness, quality improvements, time savings and sustainability. These building-level findings are then scaled up to assess their implications for housing affordability and the reduction of social housing shortages in France, Germany and the EU.

Throughout the report, construction refers to the construction of entirely new buildings, therefore excluding vertical extension that is analysed separately.

Vertical extension is analysed with the same set of building level criteria: cost, quality, time and sustainability, but the stock level focus is narrower and concentrates on how rooftop additions can help address general housing shortages in France and Germany.

Regarding ventilated façades, the study concentrates on building level performance only, addressing reduced energy use, better acoustic performance, improved indoor comfort, higher durability and recyclability. The analysis is carried out for the EU rather than for individual Member States.

TABLE 1: REPORT TOPICS AND ANALYSED IMPACTS

Research topic	Benefits of offsite construction (building level)	Regions covered	Offsite construction impacts (building stock level)
Construction (excluding vertical extension)	• Cost competitiveness • Higher quality • Time savings • Lower financing costs • Sustainability	DE FR EU	• Affordability • Social housing rents • Social housing shortage
Vertical extension	• Cost competitiveness • Higher quality • Time savings • Lower financing costs • Sustainability	DE FR	• Housing shortage • Housing price
Ventilated façades	• Reduced energy use • Acoustic performance • Improved indoor comfort • Improved durability • Sustainability = recyclability	EU	• Not analysed

USEFUL DEFINITIONS

For this report, offsite construction means that major building elements or modules are manufactured in a factory and then transported to the site for assembly, while in onsite construction most activities, including fabrication and finishes, take place directly on the building site.

At the same time, sustainability is defined as the reduction of whole life greenhouse gas emissions and construction-related waste for new housing, considering all life cycle stages from product manufacturing to end-of-life. Wherever possible, sustainability of offsite versus onsite construction is based on embodied and operational carbon, material efficiency, or waste generation and recovery, to name a few.

ANALYTICAL STEPS

The workflow underpinning the analysis is explained in **Figure 1**. The analysis is based on three steps moving from gathering evidence on offsite and onsite construction approaches to housing market impacts that can be achieved when switching from onsite to offsite construction.

The first step collected quantitative and qualitative information about onsite and offsite construction, including costs, time, quality and sustainability indicators for different building uses and countries. Comparative analysis, as the second step, structured this evidence into a systematic comparison of onsite versus offsite construction, mostly using a common cost structure and harmonised impact metrics so that the comparison can be completed across regions. The third and final step focuses on impact, translating the building level differences from the comparative analysis into conclusions about how wider deployment of offsite construction could affect EU construction markets, in particular by influencing housing affordability and the speed at which housing shortages can be addressed.

FIGURE 1: ANALYTICAL STEPS

BENEFITS OF OFFSITE CONSTRUCTION

This section explains and quantifies the benefits of offsite construction, through the construction of new buildings and vertical extension, at building level. The impacts of these benefits on EU and national building stocks and housing markets are examined in subsequent sections of the report.

TIME SAVINGS

Time savings are one of the most visible advantages when switching from onsite to offsite construction. Numerous empirical studies and industry reports show that modular and other offsite methods typically reduce overall project duration by around one third, with best practice cases reporting time reductions between 30 and 50% compared to conventional, onsite construction. [1] [2]

One of the main reasons for these gains is that the work on the foundations and on the building structure no longer happens in sequence: while the site is prepared and utilities are installed, modules or large elements are produced in a factory, so that assembly on site becomes a short, predictable phase rather than one of the main bottlenecks of the project.

The factory environment also removes many of the delays that slow down onsite projects. Production lines operate with standardised modules and under controlled conditions, largely independent of weather, which avoids the stoppages and resequencing possible when multiple subcontractors are employed onsite.

As a result, offsite projects experience fewer schedule overruns and a much higher rate of on time completion than traditional construction, which translates into earlier handover. For residential projects, this means that new dwellings can come on the market months earlier, accelerating the response to shortages on social and conventional housing.

Time savings may lead to two important benefits: lower labour costs and lower financing expenses. The following sections explain these two in more detail.

LOWER LABOUR EXPENSES

Offsite construction may reduce labour costs not only by offering time savings but also by shifting work into efficient factories and changing the skill mix required on site.

Time savings explained above directly cut the number of labour hours needed on site and the period during which supervision and other time-dependent costs must be paid. In addition, shorter schedules may also reduce exposure to weather-related stoppages and coordination delays, so fewer paid hours are lost to non-productive waiting time.

With offsite construction, most complex work moves into the factory, where it can be done by a smaller and generally lower-cost workforce than in traditional construction. Some estimates suggest that transitioning to off-site manufacturing can reduce project labour costs by up to 25%, and that savings are greater when high-value activities such as electrical, plumbing, and HVAC installation are also migrated off-site. [3]

LOWER FINANCING EXPENSES

Shorter construction times in off-site projects translate directly into lower financing costs and, ultimately, lower housing prices. Since offsite methods typically shorten project timelines by 30–50%, construction loans are outstanding for a shorter period and own resources tied up for fewer months. A shorter construction phase and faster sales reduce the total amount of interest paid on development debt and allow investors to start collecting rental income earlier.

In this study, the above effect is captured by modelling the share of financing expense in the total price of a dwelling under onsite and offsite approach. In case of onsite construction, interest expense contributes around 7%[1] of the final dwelling price. In the offsite scenario, shorter site works and faster sales bring the share of financing in the total price down to 3%.

HIGHER QUALITY BUILDINGS

Offsite construction does not only change where buildings are produced. It also changes how quality is managed along the whole value chain. Evidence shows that factory-based production leads to more consistent workmanship, fewer defects and significantly less rework than traditional on-site construction. Components are manufactured in a controlled environment using standardised processes, repeated tasks and systematic inspections, leading to higher quality of construction and buildings than what is typically achieved onsite.

One of the main benefits is reduction in claims once the homes are sold and used. Factory quality control identifies problems before elements leave the plant and reduces the risk of moisture-related damage, thermal bridges, or finishing defects that otherwise may generate warranty claims. These translate into fewer post-completion interventions and lower expenditure on follow up repairs. In financial terms, the developer can operate with a smaller claims reserve and a lower allowance for defect-related contingencies in the project budget, because the expected number and cost of claims decrease. This improvement in risk profile supports more competitive pricing for end users.

In the context of this study, higher quality is reflected in a lower risk claim reserve embedded in the price of offsite constructed housing. The typical claim reserve in case of onsite construction can be estimated with 5% of total housing price, while in case of offsite construction the same value is estimated to drop to 3%. This reduction in claims reserve contributes to more affordable housing without compromising performance. [4] [5] [6]

IMPROVED SUSTAINABILITY

Benefits of offsite construction regarding sustainability can be explained by focusing on reduced carbon emissions and lower waste generation.

WHOLE LIFE CARBON EMISSIONS

Off-site construction can materially improve the carbon performance of new housing by lowering both embodied and operational carbon emissions over the building life cycle. Life cycle assessment studies comparing modular and conventional homes typically report that modular construction can achieve between 15 and 50% lower emissions than equivalent on-site projects. [7] [8] [9]

PRODUCT STAGE

Offsite manufacturing supports sustainability by avoiding unnecessary material use, reducing material quantities through optimised design and enabling higher reuse. Standardised components, design for manufacture and assembly [40] and precision cutting[2] allow structural mass and finishes to be trimmed to what is strictly needed, while unused material can be reintroduced into other elements or recycled, instead of being discarded. Case studies show upfront embodied carbon reductions of roughly 20–45% for optimised modular structures compared with onsite construction. [10] [11]

TRANSPORT AND CONSTRUCTION

Although responsible for a small fraction of life cycle carbon emissions, GHG reductions from transportation should not be neglected. Traditional onsite construction relies on frequent small deliveries of materials, equipment and workers. On the other hand, offsite construction may consolidate these into fewer, optimised shipments of panels or modules, with most small items delivered once to the factory rather than repeatedly to dispersed sites. This may reduce the number of truck movements and heavy machinery hours, lowering fuel consumption and associated emissions from transport and logistics. [9] [10] [11]

Construction site activities are a significant source of direct emissions from machinery, generators and energy intensive processes. Prefabrication shortens the time that sites are active resulting in less need for wet trades, fewer high energy curing processes and less equipment idle time on site. Faster and more efficient construction translates to reductions in energy use from lighting, welfare facilities, generators and tools. Construction site emissions from offsite projects can cut emissions from energy use by around 30%, which further reduces GHG emissions and local air pollution during construction. [9] [10] [11]

OPERATION STAGE

In whole life carbon assessments for buildings, emissions from the operating stage are typically one of the major hotspots, often exceeded only by emissions embodied in products and materials. Compared with onsite construction, off-site construction can deliver more consistent quality of construction and help buildings achieve the required energy performance, thereby supporting national and EU targets for the energy and carbon performance of buildings.

1 Assuming corporate borrowing cost of 4% per annum, as reported by ECB.
2 For example, through precise CNC cutting.

For example, factory assembled envelopes may achieve tighter tolerance, better thermal continuity and more consistent airtightness. By helping building systems perform much closer to their design specifications, these measures can reduce heating and cooling loads, as well as GHG emissions over the building lifetime. [10] [11]

REUSE

Offsite construction can also reduce life cycle GHG emissions at the end-of-life stage by making buildings easier to dismantle and materials easier to recover. Offsite construction naturally supports the use of design for disassembly [41] and selective deconstruction [43] because buildings are assemblies of standardised, factory-made modules and components. Modular logic allows building elements to be disconnected and reused at the end of their service instead of being demolished as mixed waste. Empirical studies show that with modular and prefabricated buildings, life cycle greenhouse gas emissions can be reduced by roughly 10–50% compared with conventional onsite construction. [12]

WASTE REDUCTION

When elements cannot be reused, their prefabrication with standardised form and known material composition make separation and recycling more efficient, which reduces emissions from waste processing and decreases the share of waste sent to landfill. Existing studies report waste reductions ranging from 20 to 90%, depending on project type and level of industrialisation. In detailed case studies of a single-family dwelling and a school building, modular construction reduced total waste weight by up to 83% and lowered waste-management costs by nearly 50%.

These findings indicate that shifting from conventional onsite processes to modular fabrication can substantially reduce the material footprint of construction, supporting both circular-economy and low-carbon objectives in the built environment. [13]

Finally, prefabrication may also improve traceability of materials and facilitate documentation for future recovery, which further supports high recovery rates at the end of life. Easier deconstruction and more compact material streams may also reduce the number of truck movements and the operation time of demolition equipment, lowering fuel consumption and associated GHG emissions in waste transport and handling.

REDUCED SITE DISTURBANCE AND FOOTPRINT

Because most of the work is carried out in a factory, shorter presence on site means less construction noise, dust, and peak-hours activity, which reduces disturbance for residents who live and work close to the site. Offsite methods also require fewer deliveries of construction materials and components and less heavy equipment traffic. This leads to fewer temporary road closures and reduced traffic around the site, as well as lower local air pollution and improved traffic safety.

Reduction in overall site footprint, and therefore more space available for parking or pedestrian circulation, is another benefit. Thanks to materials and components that arrive ready for installation, the area needed for material storage or cutting is smaller than in the case of traditional construction sites.

VERTICAL EXTENSION BENEFITS

While vertical extensions benefit from the general advantages of offsite methods, this section focuses on the specific gains achieved by adding floors to existing buildings.

RESOLVING LAND SCARCITY

Vertical extensions add housing without relying on greenfield or virgin land, which may be particularly relevant in dense urban areas where land for new construction is scarce or expensive. They support compact-city strategies that aim to curb urban sprawl by building up instead of out and by making more intensive use of the existing building stock.

USING THE EXISTING INFRASTRUCTURE

In such contexts, vertical extensions use the existing public transport, schools, services, and other infrastructure, which also brings benefits through avoiding public spending in new supportive infrastructure and increased sustainable mobility patterns. In addition, vertical extensions may very well complement other densification measures such as repurposing of underused buildings and can contribute to preserving open space and periurban agricultural land.

FINANCING RENOVATION

By adding new, often higher-value rooftop apartments or extra floors, vertical extension projects can generate income for the building owners that may be used to renovate the existing building. This mechanism can help housing companies and owners overcome upfront investment barriers, since part of the renovation cost is effectively cross-subsidised by the additional dwellings created on top of the existing structure. This approach can be particularly attractive for multifamily buildings in well-located urban areas, where demand for new apartments is strong and where energy renovation needs are often high.

BENEFITS OF RENOVATION WITH A VENTILATED FAÇADE[3]

A ventilated façade is a multilayered external wall system that creates a continuous air cavity between the façade cladding and the building's insulated structural wall. The cavity allows air to circulate vertically through stack effect, enabling several advantages in thermal performance. The typical components of a ventilated façade are a load bearing wall, exterior insulation layer, ventilated air cavity, and exterior cladding (façade skin).

Ventilated façades may be compatible with offsite construction if their components are produced offsite and attached onsite either to the structure of a new building (e.g. to a floor slab) or to a load-bearing wall of an existing building. [14]

REDUCED ENERGY USE

Ventilated façade systems may reduce energy demand through several mechanisms. During summer periods the ventilated cavity absorbs much of the incident solar radiation on the external layer warming up the air in the cavity. Warm air is then extracted through buoyancy-driven and wind-driven ventilation, which continuously removes the heat flux towards the interior and moderates cooling needs. During winter, enhanced thermal resistance provided by the air layer is of special importance. When the façade openings are well controlled, this additional resistance improves the overall thermal performance of the envelope and limits winter heat losses. Finally, in transitional seasons such as spring and autumn, ventilated façades help moderate indoor conditions by reducing day–night temperature swings. During the day, the façade limits excessive heat gains to the interior, while at night, its cavity helps the building to keep a portion of the heat accumulated during the day, contributing to a more stable indoor temperature profile. [15]

Several case studies and research papers show positive impacts of ventilated façades. Ventilated façades can significantly enhance the thermal performance of buildings by moderating heat transfer through the envelope. Evidence from simulation and field studies shows that **cooling loads or heat gains can be reduced by 20–65%, while winter heating demand may decrease by 10–20%**[4]. [16] [17]

ACOUSTIC PERFORMANCE

Ventilated façades may improve acoustic comfort mainly through combining mass–air–mass layers with non-homogeneous construction and the use of different materials. This configuration enhances the attenuation of a broad range of sound frequencies, thereby contributing to improved indoor acoustic comfort. [18]

The assembly of inner structural wall, insulation, ventilated air gap, and outer cladding creates an acoustic buffer that can reduce external noise levels by roughly 9–12 dB[5] compared with the original wall. In relative terms, typical measurements indicate a substantial reduction in noise pollution of around 25%. [15] [18]

IMPROVED INDOOR COMFORT

In addition to energy benefits, ventilated façades contribute to improved indoor thermal comfort by enhancing **temperature uniformity, lowering interior surface temperatures, and improving occupants' thermal sensation**. As a result, they represent an effective passive-design strategy for advancing low-carbon and high-comfort building envelopes in renovation and construction projects. [16]

For instance, by dissipating excess heat, a ventilated façade may have a direct effect on indoor operative temperatures. Model results suggest that, relative to a standard façade, ventilated façades may provide around 4% lower maximum and higher minimum operative temperatures, while, due to the shading effect of the external layer, the air temperature within the ventilated façade cavity may be reduced by around 8 to 10 °C. [19] [20]

3 Equitone by Etex
4 When ventilation openings are seasonally adjusted or combined with heat-recovery elements.
5 Depending on cladding type and insulation thickness.

Field studies using thermal comfort metrics indicate that ventilated façades can lead to noticeable improvements in occupants' thermal sensation, particularly in winter. Simulations show that these façades may shift occupied periods from moderate (Category III) to normal (Category II) comfort levels,[6] highlighting their effectiveness in maintaining a more comfortable indoor environment. [19]

BUILT TO LAST

Ventilated façades offer a range of sustainability advantages that extend well beyond the construction phase. Their design ensures long service life, durability, and ease of maintenance, allowing individual components to be repaired or replaced without dismantling the entire system.

By placing a ventilated, rainscreen cladding outside the insulation and structural wall, ventilated façades shield the load-bearing wall and insulation from direct rain, UV radiation, and thermal shocks, which significantly reduces façade pathologies over time. Sources aimed at practitioners state that rear-ventilated façades typically achieve a longer service life because the main weathering affects only the outer cladding, while the substructure and insulation remain dry and protected, provided that periodic inspections are carried out. [21] [22] [23]

Ventilated façades are designed as demountable layer systems: individual panels or profiles can be removed and replaced without major demolition, which simplifies local repairs, upgrades, and access for inspections. These benefits typically lead to less frequent need for checking render, joints, and sealants and to less intrusive and labour-intensive repairs. [21] [23] [24]

READY TO BE RECYCLED

Ventilated façades compatible with offsite construction reduce material use over time, limit waste generation, and lower the need for repeated interventions across the building's life cycle.

In the production phase, conventional façades may exhibit lower environmental impacts, reflecting simpler build-up and a reduced number of components. By contrast, ventilated façades often make greater use of recyclable materials such as aluminium and wood. In addition, ventilated façades, although heavier and more complex than conventional ones, can be delivered as prefabricated elements, thereby limiting onsite waste.

From a circularity perspective, ventilated façades are advantageous because their mechanically fixed cladding, substructure, and insulation can be dismantled separately at end of life. This facilitates cleaner material recovery, supports higher recycling rates, and reduces mixed construction waste compared with composite façade systems.

Life cycle assessments of façade systems note that ventilated façades, particularly those using metal or fibre-cement cladding, can be designed for easier separation and recycling, which supports circularity through longer service life and more recyclable end-of-life scenarios. [21] [25]

Analysis of several Environmental Product Declarations for ventilated façades manufactured in the EU indicates these systems achieve substantially better end-of-life recyclability compared to conventional façade types. Specifically, results for scope D impacts show that the reduction in CO_2-equivalent emissions per square metre can be several times higher than for some conventional products.

6 Thermal comfort was evaluated using the four indoor environment categories (EN 16798 1:2019). Category I stands for high expectations for sensitive occupants, Category II suits new or renovated buildings with normal expectations, Category III applies to existing structures with moderate acceptability, and Category IV covers other cases.

IMPACTS OF OFFSITE CONSTRUCTION AND VERTICAL EXTENSION

REDUCING HOUSING PRICE

This section analyses whether, and by how much, offsite construction, either via construction of new buildings or vertical extension, can reduce the housing price of new apartments or houses in France, Germany and the EU. It examines both the potential reductions and the absolute levels of housing prices.

METHODOLOGY

For this report, housing price of an apartment or a house consists of:

- **Construction cost**, broken down into a) labour and b) materials and energy, explaining how the total cost is impacted by productivity improvements and savings in materials and energy
- In case of vertical extension, **roof rights** are treated as a separate item to capture the value of using or acquiring rooftop space
- **Claims reserve** is included to account for potential defects, delays or contractual disputes that may arise during construction and that typically materialise after completion
- **Financing costs** reflect interest on capital employed during the development period
- **Other costs** capture remaining project expenditures such as design, permitting or marketing

The cost of land is not considered when determining the housing price of new buildings. In the case of vertical extensions, however, the cost of using the roof, referred to here as roof rights, is included in the final housing price.

These elements add up to the housing price paid by the house or apartment buyer. For this report, this price provides the reference for assessing the impact of offsite construction on overall house/ apartment costs and related housing affordability. Regarding the same analysis at the EU level, the strong diversity of national housing markets needs to be considered. Since in some Member States, average purchase prices per square metre are up to four times higher than in others, a single EU-wide reference price would not be meaningful. Therefore, the EU level analysis is based on housing price ranges rather than single values. In other words, the report explains how the range of possible housing prices shifts once offsite construction is introduced.

Also, because of this variability, the EU analysis does not reconstruct a detailed cost structure or quantify how individual cost components such as labour, materials or financing costs would change with offsite construction. Instead, it focuses directly on the expected change in the final housing price per square metre when offsite methods are adopted.

The following sections show the results of the BPIE research and analysis of data collected from various sources including reports, websites and databases. All sources used in this section have been listed in the section *Sources used for analysis on reduced housing price.*

FRANCE AND GERMANY

NEW RESIDENTIAL BUILDINGS

Comparing the housing price structure of new residential buildings under onsite and offsite construction shows that offsite delivery can substantially reduce the final purchase price per square metre of floor area[7] for houses and apartments. Overall, when using offsite instead of onsite construction, the purchase price of new houses and apartments (without land) is about 30% lower in France and 22% lower in Germany. Absolute change in housing prices can be found in **Table 2**.

7 In case of new apartments and houses, the price of land is not considered.

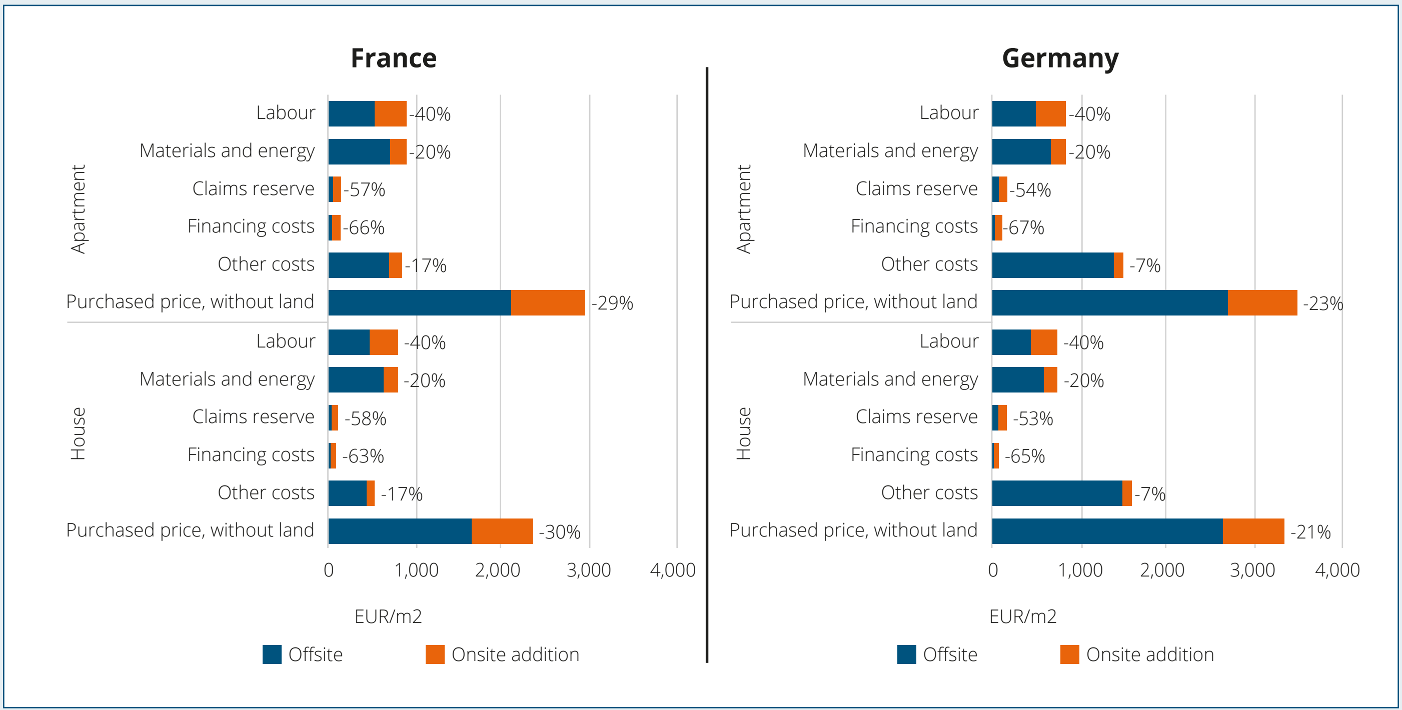
TABLE 2: HOUSING PRICE (PER M²) PER CONSTRUCTION APPROACH[8]

Country	Building use	Price per m²	
		Onsite construction	Offsite construction
France	House	2,350	1,650
	Apartment	2,950	2,100
Germany	House	3,350	2,650
	Apartment	3,500	2,710

In both countries, offsite construction reduces labour costs by 40%, reflecting lower person hours required to deliver the same floor area. In addition, material and energy costs are reduced by 20%. When merged, these imply weighted decline in total construction costs by around 30%, equivalent to roughly 500 EUR per m². Since higher build quality and shorter construction times lower expected post-completion claims and interest during construction, claim reserves in both countries are reduced by about 55% and financing costs by about 65%. Although higher in relative reduction, absolute reduction from these items is lower due to their low absolute contributions to total price.

A more detailed overview of how offsite construction reduces housing prices in France and Germany can be found in **Figure 2**.

FIGURE 2: OFFSITE CONSTRUCTION AND HOUSING PRICES IN FRANCE AND GERMANY



8 BPIE calculation.

VERTICAL EXTENSION

The impact of offsite construction on housing prices through vertical extension was analysed by focusing on several main dimensions: construction time, roof rights, claims reserve, financing costs, and other costs.

Overall, the figures show that offsite vertical extension reduces the cost of creating additional floor area on top of existing apartment buildings. The resulting decrease in housing prices reaches about 20% in France and 14% in Germany.

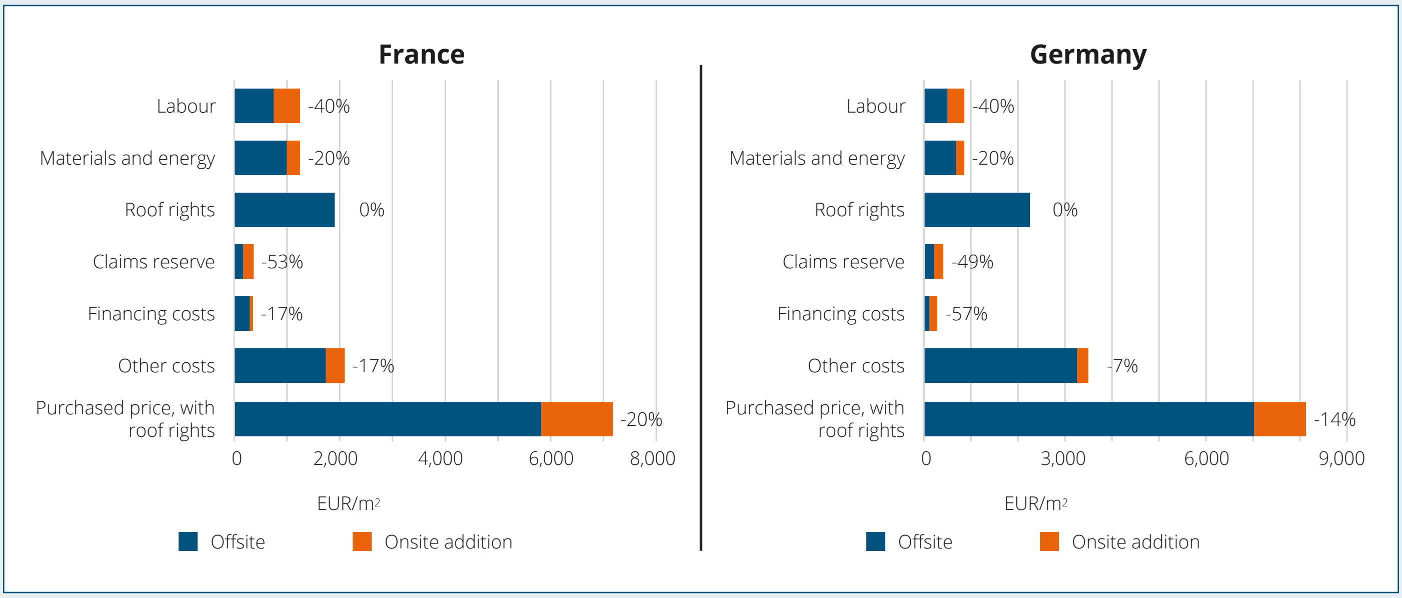
Percentage reductions, together with the matching absolute housing prices, are presented in **Table 3**.

Furthermore, the cost comparison decomposes total housing price into several categories. Detailed overview of these categories and how they are affected by offsite construction can be found in **Figure 3**.

TABLE 3: HOUSING PRICE (PER M²) OF VERTICAL EXTENSION, PER CONSTRUCTION APPROACH

Country	Building use	Price per m²	
		Onsite construction	Offsite construction
France	Apartment added	7,160	5,820
Germany	Apartment added	8,130	7,030

FIGURE 3: OFFSITE CONSTRUCTION AND VERTICAL EXTENSION HOUSING PRICES IN FRANCE AND GERMANY



Similar to new residential buildings, labour costs in offsite vertical extension fall by 40%, while material and energy costs decline by 20%. This effect reduces total construction costs by around 740 EUR per m² of floor area in France, and by around 510 EUR per m² of floor area in Germany.

Claim reserves in both countries drop by around 50%, reflecting the expectation that higher construction quality in offsite projects will lead to fewer defects. At the same time, shorter construction periods reduce financing costs, since loans are required for a shorter time. These risk-related savings reduce the final housing price even further, as they come on top of the price reductions already achieved through lower construction costs. By contrast, some items, such as roof rights, remain unchanged because they are not affected by the chosen construction method.

EU LEVEL[9]

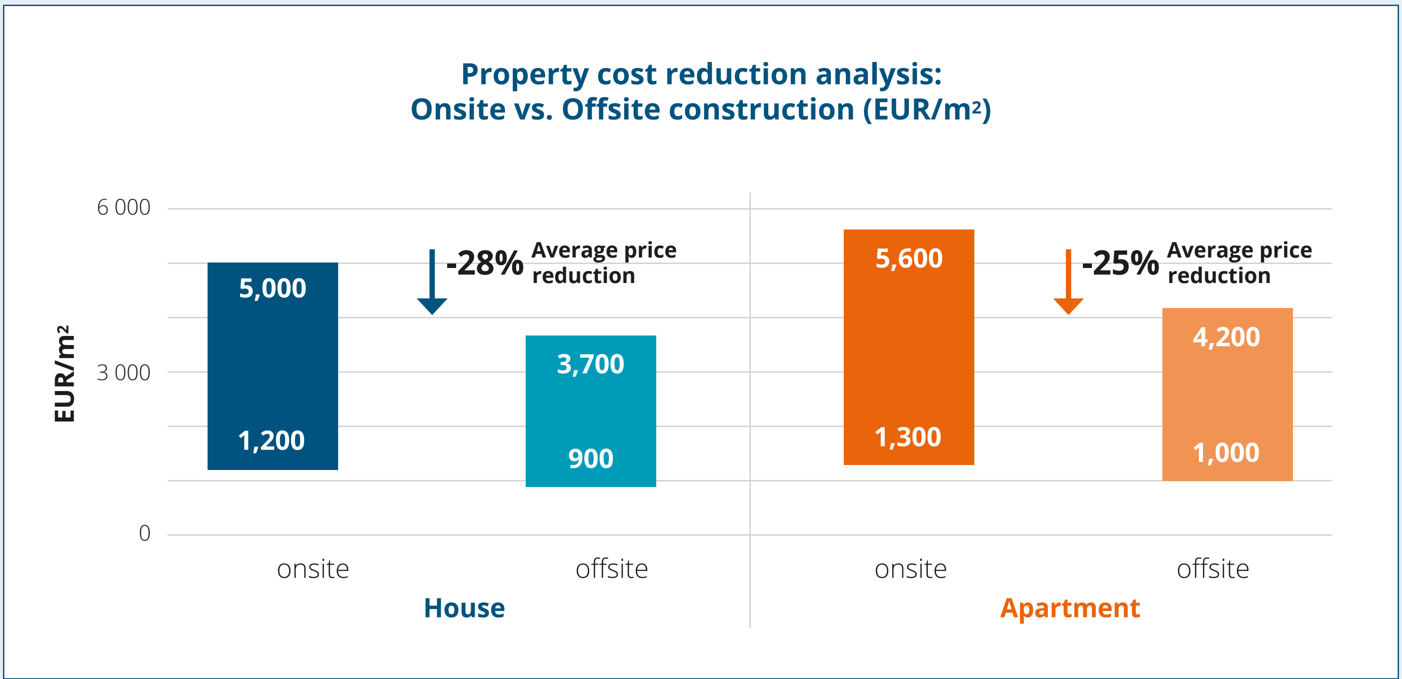
NEW RESIDENTIAL BUILDINGS

At EU level, offsite construction reduces the entire range of purchase prices for new dwellings, both for houses and apartments. Details of this change can be found in **Figure 4**.

For houses, onsite housing price[10] range from around 1,200 EUR per m² at the lower end to about 5,000 EUR per m² at the upper end. Under offsite construction, this range shifts downward to roughly 900–3,700 EUR per m², corresponding to a reduction in average purchase price range of around 28%.

In case of apartments, onsite prices range from about 1,300 EUR per m² at the bottom of the distribution to roughly 5,600 EUR per m² at the top. With offsite construction, the range moves down to approximately 1,000–4,200 EUR per m², reducing the average apartment price by around 25%.

FIGURE 4: RANGE OF PURCHASE PRICES IN THE EU



9 Due to limited availability of relevant data, the impact of offsite construction on housing prices through vertical extension was not analysed at EU level.
10 Excluding land, as explained in the methodology section.

IMPROVING AFFORDABILITY

The affordability assessment analyses how buying an off-site instead of an on-site constructed house or apartment can affect housing costs. In the ideal case, reducing housing costs and their share in a household's disposable income would improve the affordability of housing within the population buying new homes.

METHODOLOGY

AFFORDABILITY DEFINITION

For the study, affordability is directly related to **housing cost overburden rate.** Eurostat defines housing cost overburden rate as the percentage of the population living in households where the total housing costs represent more than 40 % of disposable income.[11] [43]

Building on the housing cost overburden concept, affordable home[12] means a home where housing costs are lower than 40% of the disposable income.

Current housing cost overburden rates in France, Germany, and EU, as provided by Eurostat, can be found in **Table 4**. [44]

EXAMINED POPULATION

Potential improvements in affordability due to reduced housing costs are examined within the population buying newly built homes. The population buying new homes, together with those who either do not look for new homes or buy homes in existing buildings, make the total population of a country.

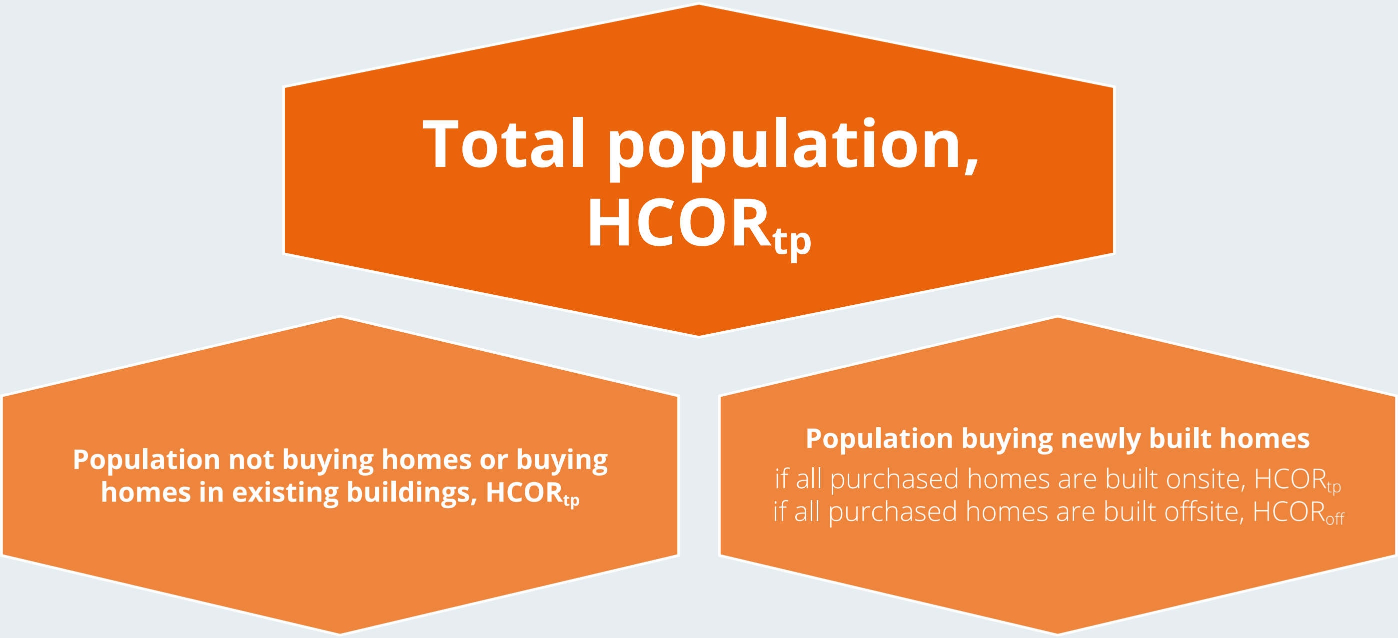
Each group is associated with a specific housing cost overburden rate. The housing cost overburden rate of the total population ($HCOR_{tp}$) corresponds to the value typically reported by Eurostat. It is assumed that the housing cost overburden rate of the population not looking for new homes or replacing them with existing homes is also equal to $HCOR_{tp}$.

TABLE 4: HOUSING COST OVERBURDEN RATES ACROSS THE EU

Region	Population buying newly built homes	
	Housing cost overburden rate if all new homes are built onsite[13]	Housing cost overburden rate if all new homes are built offsite
France	7%	0.5%
Germany	12%	2.6%
Sample of 9 EU countries	3.8%–28.9%	0.1%–10.6%
EU	8.2%	1.6%

11 Housing costs and disposable income are calculated 'net' of housing allowances.
12 Apartment or family house (single-family or multi-family)
13 Equals the housing cost overburden rate applicable to the entire population.

FIGURE 5: EXAMINED POPULATION AND THEIR HCOR



For people buying newly built homes, the housing cost overburden rate before the purchase equals $HCOR_{tp}$. The housing cost overburden rate after the purchase depends on the housing price, i.e., the price of the purchased house.

If all new housing is built onsite, the housing cost overburden rate is assumed to remain equal to $HCOR_{tp}$, i.e., there are no improvements in affordability. If all new housing is built offsite, reduced housing price due to offsite construction should cause the housing cost overburden rate to decrease to $HCOR_{off}$. The rest of this section explains how, starting from reduced housing prices, one can determine $HCOR_{off}$.

Explained population grouping and HCOR for different groups is visualised in **Figure 5**.

IMPACT ASSESSMENT

Analysing how reduced housing prices affect the $HCOR_{off}$ starts with examining the composition of housing costs,[14] i.e. regular payments a household makes to live in a home. Housing costs considered here include:

- Utility costs, such as water, electricity, gas, and heating
- Cost of capital employed, which here will equal mortgage repayments (net of any tax relief)
- Rental payments gross of housing benefits, in the case of tenants
- Other costs, such as insurance, regular maintenance and repairs, or taxes

It is assumed that reduced housing prices affect the $HCOR_{off}$ only through the cost of capital employed, which is here approximated with monthly instalments for a housing loan used to finance the purchase. The effect of a reduced housing price on housing cost through utility bills, rental payments, repairs, taxes and other housing cost components, is neglected.

To examine the effect of reduced debt service, the analysis assumes:

- Floor area of 37 m^2 per person[15]
- Annual interest rate of 4%, and
- Housing loan maturity of 20 years

QUANTIFYING THE IMPACT

The affordability assessment is based on two main sources obtained from Eurostat:

1. National statistics on income distribution [45]
2. National statistics on housing cost overburden [44]

Using the two sources, it is possible to define an income benchmark that separates the population living in affordable and non-affordable housing in each country. Assuming that people living in non-affordable housing belong to the low-income

14 Housing costs should be distinguished from housing price. Please refer to the glossary for more details.
15 EU average

area,[16] the benchmark is defined as the household income below which one can find population living in households with total housing costs above 40 % of disposable income.

An example of income distribution and the income benchmark can be found in Figure 6. The area marked in blue corresponds to household incomes lower than the benchmark income and represents around 12% of the total population, which equals the housing cost overburden rate for Germany.

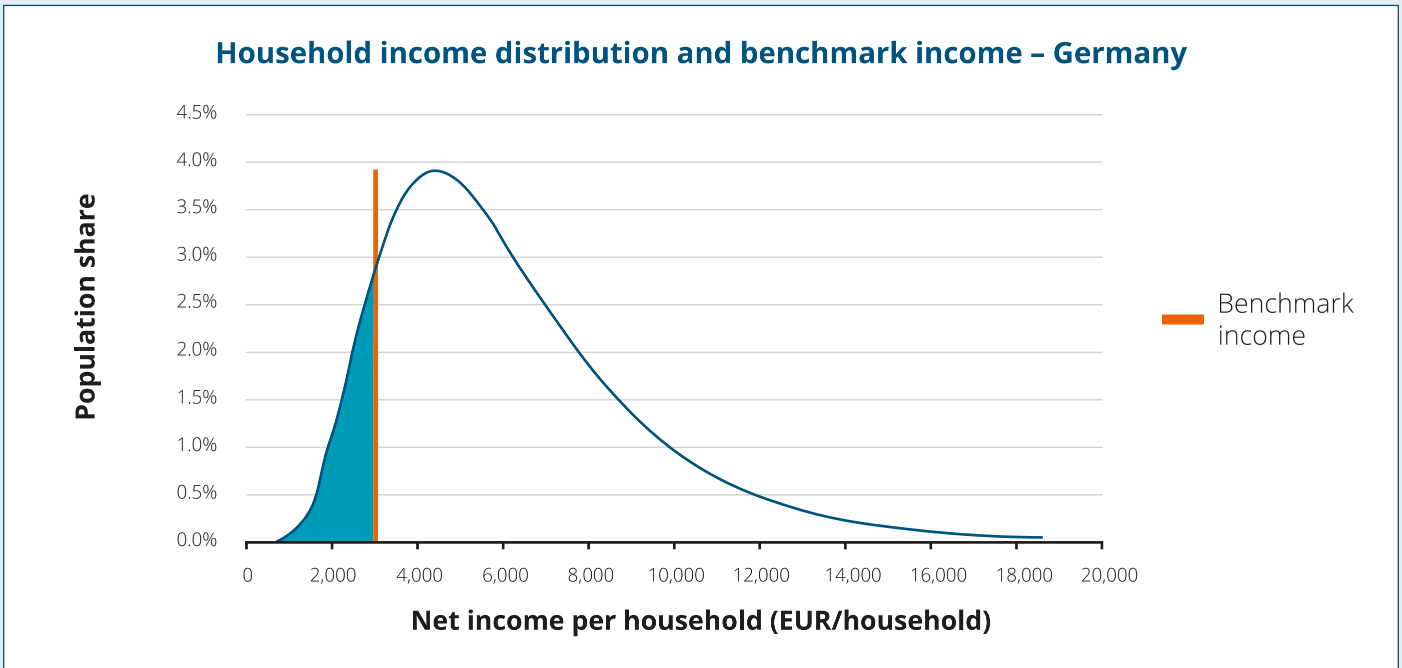
Ideally, any reduction in housing costs, while keeping household income constant, decreases the housing cost overburden rate. Referring to Figure 6, if housing price, and therefore debt service and housing costs are reduced, the benchmark income would move to the left[17] and reduce the share of population living in unaffordable housing. This is exactly how reducing housing price with offsite construction improves the affordability within the population buying newly built homes.

Please note that housing price reductions bring benefits to households across all income groups. However, it is primarily among low-income households where these reductions can lower the share of housing costs below 40% of total income,[18] and therefore contribute to improving the housing overburden costs and affordability for people buying newly built homes.

The approach and the results presented in this section apply to the whole population, irrespective of income levels. While it is recognised that housing purchase may be problematic for the lowest-income population, the results presented below remain valid for understanding the potential of offsite construction and how, when hypothetically deployed at large scale, it can reduce housing cost overburden rates. To fill this potential gap, a separate section of this report examines how offsite construction can also benefit the lowest-income population by lowering cost-based social rents in several EU countries.

When estimating the effect of new offsite housing on the national housing cost overburden rate, it is assumed that the current housing demand will be fully met over a 15 year period from 2026 to 2040. The resulting reduction in the housing cost overburden rate over this period is then presented in the results.

FIGURE 6: INCOME DISTRIBUTION AND BENCHMARK INCOME EXAMPLE



16 i.e., instead of being spread across different income levels.
17 Please note it is the benchmark income, not household income, that is decreased. Household income, as mentioned before, remains intact.
18 This means that housing costs in middle- and high-income households are assumed to already account for less than 40% of their total income.

RESULTS

FRANCE

In France, a household that chooses an off-site rather than an onsite constructed new home can cut its monthly housing costs by up to 300 EUR. At population level, this would reduce the share of new homeowners living in unaffordable housing from about 7% to around 0.5%.

Figure 7 shows the projected trend in the housing cost overburden rate under the assumption that today's unmet housing demand is fully satisfied over the next 15 years.

GERMANY

Compared to buying an onsite constructed home, buying an offsite constructed home in Germany can lower monthly housing costs by around 285 EUR per household, mainly through reduced financing costs.

Given Germany's income distribution, if all households seeking a new home buy dwellings built offsite, the share of new homeowners that remain exposed to unaffordable housing would fall from around 12% to about 2.6%. Assuming that current housing demand can be satisfied within the following 15 years, a drop in housing cost overburden rate would follow the trend explained in **Figure 8**.

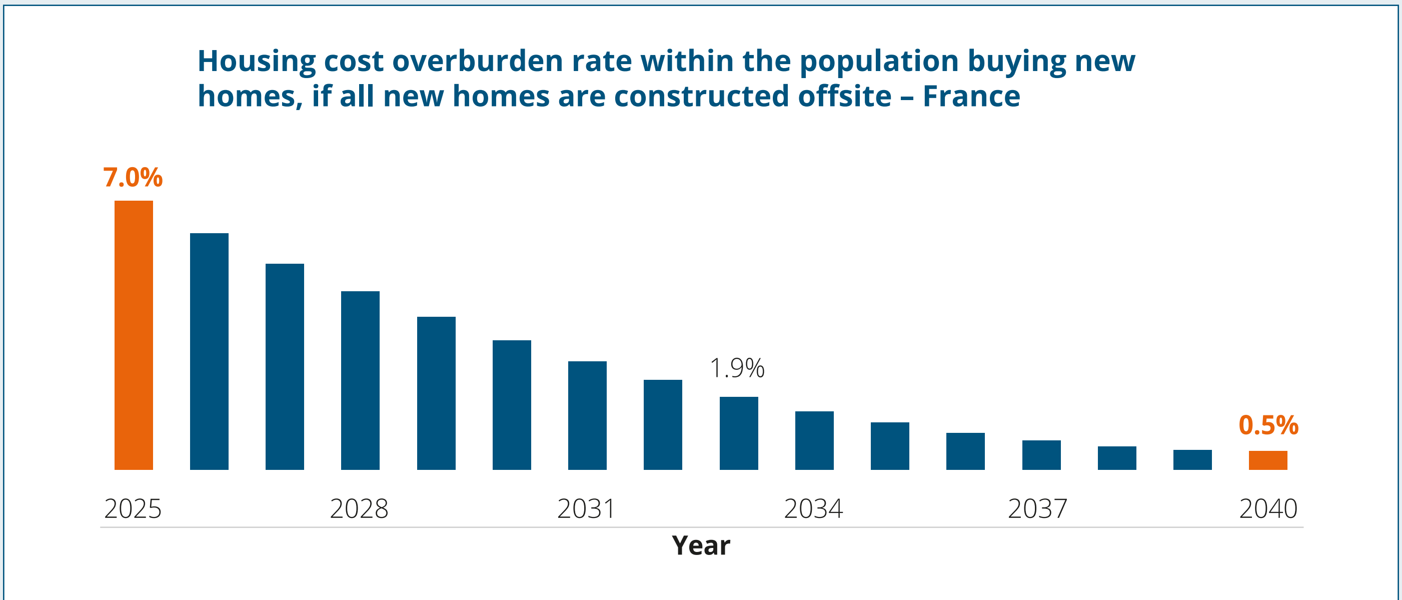
EU

The effect of offsite construction on affordability at EU level is assessed by analysing nine EU countries: Austria, France, Germany, Greece, Hungary, Italy, Netherlands, Slovenia, and Spain.[19] Applying the same approach from above to each of these countries, the research shows that, within the population looking for new housing, housing cost overburden rate in analysed countries will be more than 63% lower after buying offsite instead of onsite buildings.

For example, in Greece, the housing cost overburden rate among new homeowners could fall from 28.9% to 10.6%, meaning that the number of households living in unaffordable homes after buying offsite instead of on-site would drop by roughly 63%. At the other end of the spectrum, Hungary emerges as the top performer in the sample, where the housing cost overburden rate for new homeowners could fall from 9.0% to just 0.1%, practically eliminating unaffordable housing within this group.

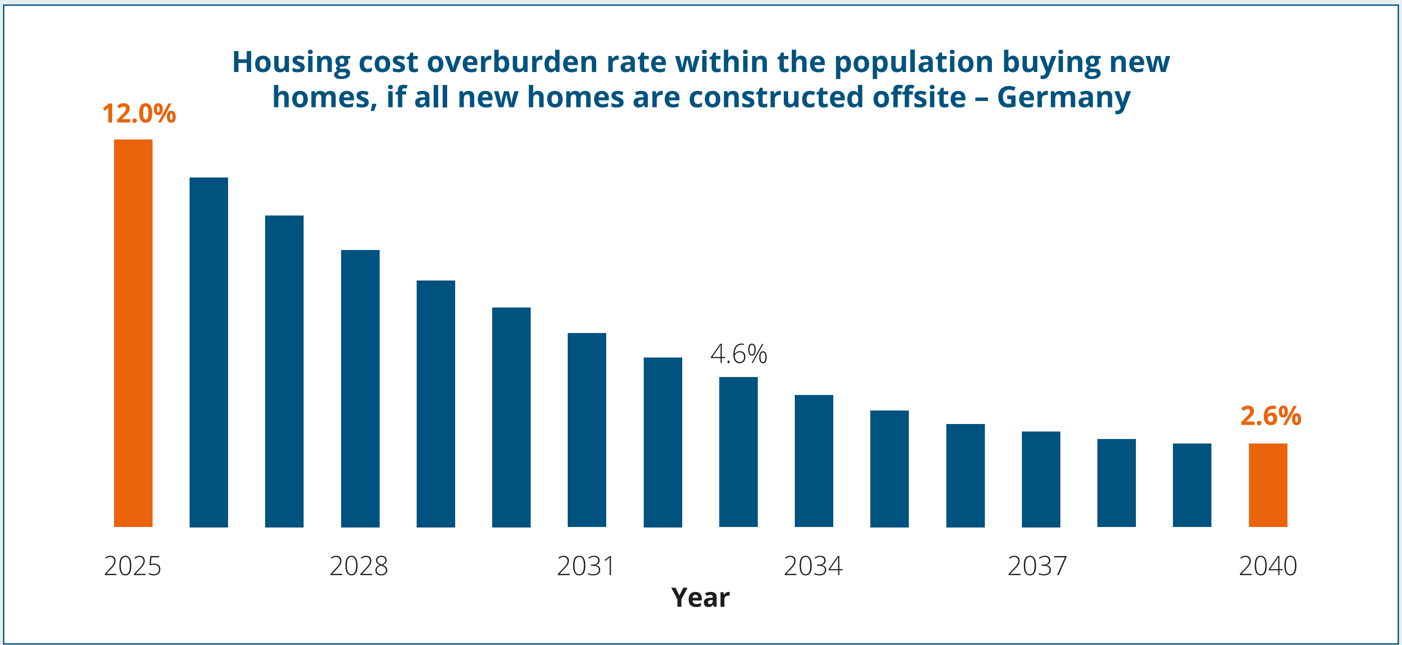
Taken together, the results from the nine analysed EU Member States show that shifting new housing supply from onsite to offsite could significantly reduce the housing cost overburden rate. Using the sample of nine Member States, the relative reduction in housing cost overburden rate for new homeowners may average around 80%. Given the current EU average housing cost overburden rate of 8.2%, expanding offsite housing supply could reduce this rate to roughly 1.6% among new homeowners.

FIGURE 7: OFFSITE CONSTRUCTION REDUCING HOUSING COST OVERBURDEN RATE IN FRANCE



19 The selection is based on data availability.

FIGURE 8: OFFSITE CONSTRUCTION REDUCING HOUSING COST OVERBURDEN RATE IN GERMANY



LOWERING SOCIAL HOUSING RENTS

Most low-income households in Europe may not be able to afford a newly built home and will remain tenants either in social housing or on the private rental market. In this wider context, the potential of offsite construction goes beyond helping individual buyers of new apartments (explained above) and could support lowering social housing rents.

The potential of offsite construction is particularly visible in the case of cost-based social rental housing. This approach to defining social rents, successfully used in several EU countries,[20] sets rents so that they cover the real costs of provision, such as repayment of loans or maintenance, without generating profit. When combined with a cost-based rent formula, offsite construction and its lower costs may reduce social rents by lowering the construction cost needing to be recovered through rents.

Nine cost-based social housing case studies from Austria, Denmark, and Finland are used to illustrate this mechanism and the effect of offsite construction on social rents. In all cases, recovery of construction cost appears as a distinct rent component. Replacing conventional with offsite social housing and therefore reducing construction costs by around 25%,[21] would reduce social rents in the case studies by roughly 12%.[22] Individual rent reductions would stay between about 7% and 14%[23] per case study, depending on the initial cost structure and financing terms. [26]

This clearly illustrates the advantage of offsite construction for affordable housing aimed at low-income groups. As shown, offsite methods can achieve rent reductions for moderate- and low-income households in social housing, which translates into a lower housing cost overburden and more room in household budgets. If adopted at scale, these reductions may also help lower housing cost overburden rates in the wider population.

The topic is extended to the following section that explains how offsite construction can answer the demand for social housing in the EU.

20 Such as Austria, Czechia, Denmark, Estonia, Finland, France, or Slovenia.
21 As explained in this report, for example in the section on reduced housing price.
22 Own calculations based on [26]
23 Own calculations based on [26]

ANSWERING SOCIAL HOUSING DEMAND[24]

METHODOLOGY

The purpose of social housing demand analysis is to illustrate if, and to what extent, off-site construction can accelerate the reduction of social housing shortages compared to conventional on-site delivery.

The underlying data on social housing shortage come from the 2025 State of Housing in Europe report [27], which provides country-level estimates of social housing units required and, where available, indicative horizon years by which these gaps would need to be covered.

For each project country and EU, the analysis starts with estimating the stock of social housing units needed. Keeping in mind possible annual construction flow through onsite (business-as-usual construction approach) and offsite (advanced and faster approach to construction methods), it was possible to estimate the year in which social housing shortage would be satisfied under both approaches.

FRANCE

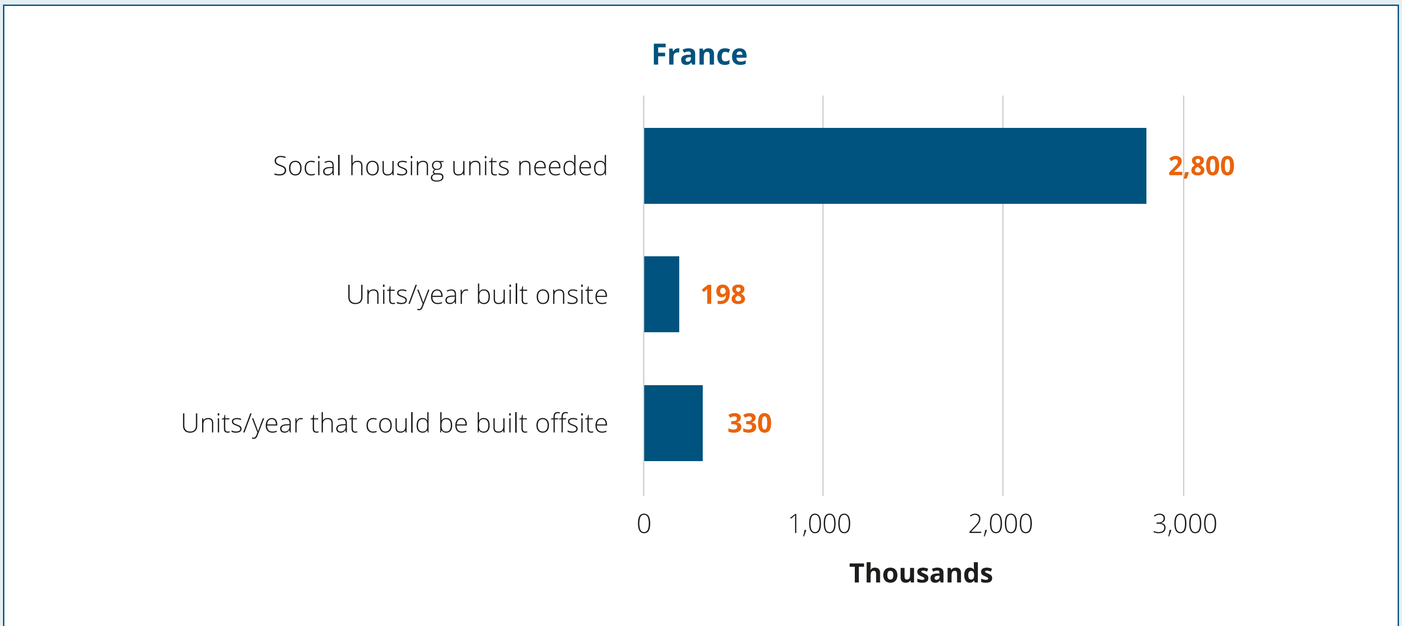
France has one of Europe's largest social housing stocks, with nearly six million units currently available nationwide. [29] However, this supply remains insufficient to address growing demand that equals around 2.8 million pending social housing applications. Estimates indicate that around 198,000 new social homes are required each year to meet current and future needs, maintain affordability, and prevent further social housing shortages. [27]

France currently produces around 198,000 new social units each year, a volume that remains comparable to Germany's social housing output. By shifting towards offsite and modular construction, France could accelerate the rollout of social housing in a similar fashion. With construction time cut by roughly 40%, these methods could increase annual social housing delivery to around 330,000 units rather than 198,000. This higher pace would enable France to close its social housing gap seven years sooner and reach the necessary stock by about 2033 instead of 2040.

GERMANY

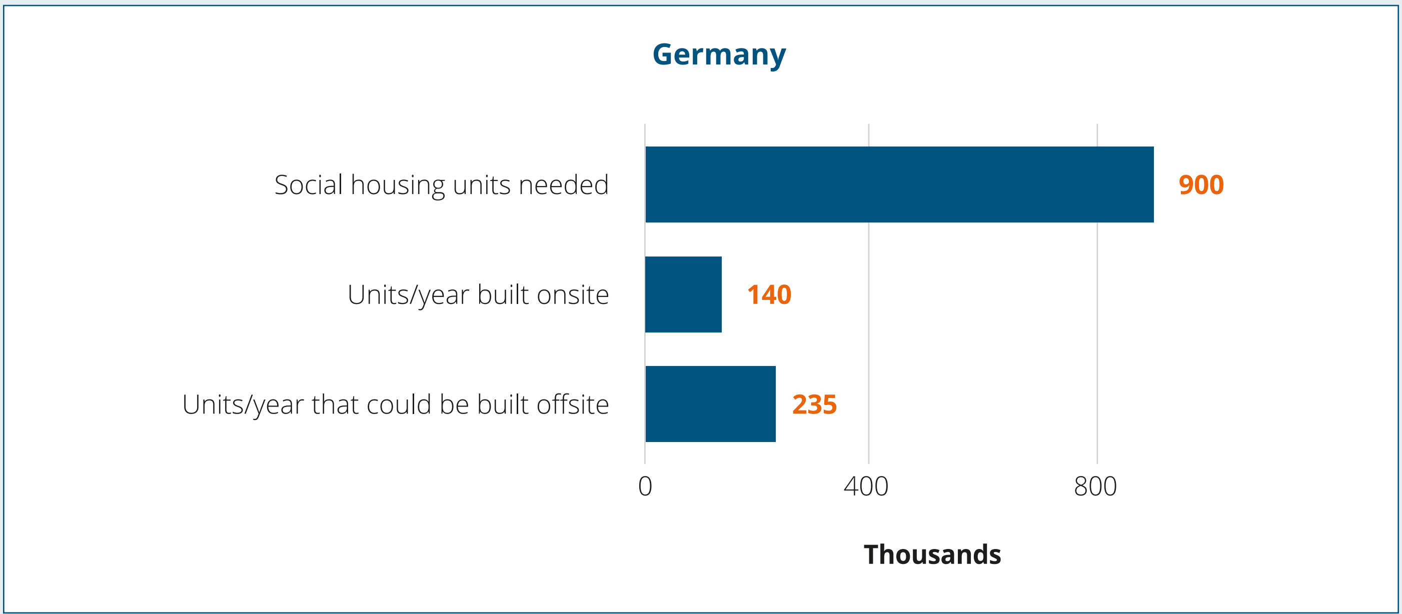
According to recent assessments, Germany's current stock of approximately 1.1 million social housing units is insufficient to meet growing demand. Housing experts and industry associations are therefore calling for a significant expansion of the sector through the construction of around 900,000 additional social housing units. Achieving this objective would raise the total number of social housing units in Germany to about 2 million. [28] To meet this goal and stabilise the housing market, Germany would need to deliver approximately 140,000 new social housing units each year. [27]

FIGURE 9: SOCIAL HOUSING DEMAND IN FRANCE AND THE EFFECT OF OFFSITE CONSTRUCTION



24 Although overlaps between the two topics are possible, social housing is analysed separately from affordability.

FIGURE 10: SOCIAL HOUSING DEMAND IN GERMANY AND THE EFFECT OF OFFSITE CONSTRUCTION



Offsite and modular approaches can significantly accelerate the delivery of new social housing in Germany. If building time is reduced by around 40%, offsite construction would make it possible to deliver 235,000 rather than 140,000 social dwellings per year. This would bring the country to the required level of social housing by roughly 2029 instead of around 2032 and thus close the existing gap several years earlier.

EU LEVEL

Across the European Union, there are significant shortfalls in social housing. Observing the needs in the biggest EU housing markets, such as France and Germany, but also some smaller ones including the Netherlands, Sweden, Czechia, and Portugal, one can estimate that current social housing needs at EU level will require the construction of approximately 13 million additional units.[25]

Meeting Europe's estimated need for social housing before 2035 would require the construction of approximately 1.4 million units per year. Such effort would represent one of the most significant housing investment challenges in the EU, particularly considering the recent slowdown in construction activity.

However, the adoption of offsite and modular construction methods could substantially accelerate delivery. By reducing construction time by around 40%, these industrialised approaches could enable the EU to meet its housing needs five years earlier, potentially achieving the required capacity by 2030.

MEETING HOUSING DEMAND WITH VERTICAL EXTENSION[26]

METHODOLOGY

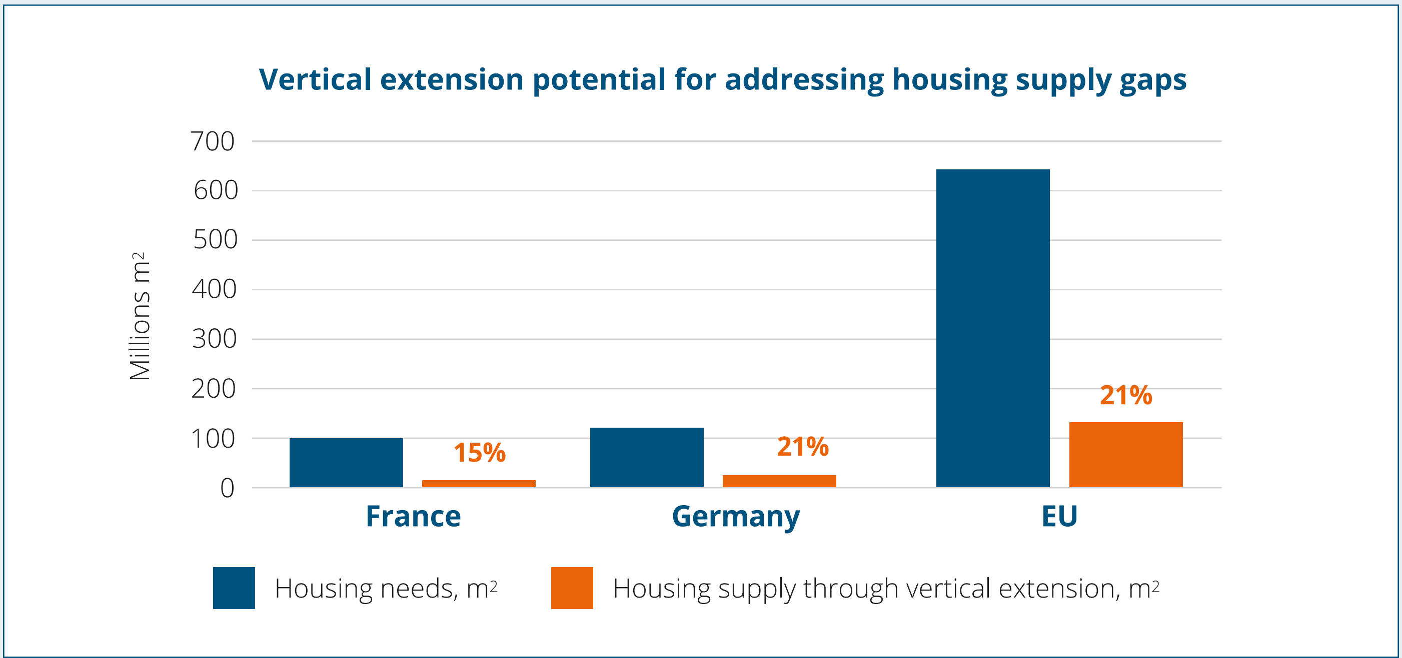
By investigating the impact of vertical extension, the report analyses how vertical extension of apartment buildings can be used to answer aggregate housing needs in France, Germany and the EU.

The starting point is an estimate of EU needs for additional dwellings equivalent to around 4% of the current residential building stock, which is converted into floor area using national estimates of total residential floor space. [30]

The research continues by defining the number of apartment buildings in each project region that may be available for vertical extension. This is obtained by combining information on national building stock with research results on average share of apartment buildings suitable for vertical extension. The number of square metres potentially provided by vertical extension

25 Own calculation based on [27].
26 In meeting housing demand, increasing emphasis has recently been placed on better use of the existing buildings. For details on the potential of conversion, splitting and sharing of buildings for housing provision, please see BPIE report on Sufficiency in the building sector for the whole life carbon roadmap.

FIGURE 11: VERTICAL EXTENSION POTENTIAL FOR ADDRESSING HOUSING SUPPLY GAPS



is obtained drawing on statistics regarding the amount of floor area typically added when extending individual buildings across the EU.

An important source for these steps, especially for national building stock statistics, is the EU Building Stock Observatory. [29]

Building on the above, the analysis derives the total area of new apartments that could in principle be built via vertical extensions. By dividing the identified extension potential by housing needs, the share of housing demand that could be met through vertical extensions is developed.

RESULTS

The analysis presented here is grounded in two key empirical research findings.

First, research of the Lyon urban area showed that approximately 13% of its apartment buildings would be suitable for vertical extension. This share should reflect the buildings' foundation capacity, sufficient structural reserves, and compliance with local building codes permitting such modifications.

Second, research of vertical extension potentials in Lyon and Germany proved that, when an apartment building is successfully vertically extended, it typically may generate around 130 square metres of additional floor area. This figure should account for variations in building typologies, architectural configurations, and construction standards across different EU countries. [31] [32]

Building on the methodology explained above, **Figure 11** compares total housing needs with the potential housing supply that could be created through vertical extensions in France, Germany and the EU.

For Germany and the EU aggregate, vertical extensions could in principle deliver new dwellings equivalent to approximately 21% of identified housing needs. In France, the relative potential is somewhat lower, at around 15% of needs.

While vertical extension alone cannot address the EU's housing shortage, it represents a meaningful and readily available source of additional residential floor space. Vertical extension can make a substantial contribution to easing housing pressures in Germany and across the EU, and a moderate but still significant contribution in France.

RELEVANT POLICIES AND INCENTIVES

Across the EU, the combination of rapidly rising house prices, stagnating supply and persistent social housing shortages is now recognised as a structural social and economic crisis, which the **European Affordable Housing Plan** explicitly frames as a threat to cohesion, competitiveness and equal opportunities. The Plan estimates that more than two million new homes per year are needed, requiring about 650,000 additional units annually and around 150 billion EUR in extra investment, and it identifies high construction costs, skills shortages, innovation gaps and excessive red tape as key drivers of the supply shortfall. [33]

The quantitative analysis in this report directly addresses these drivers by showing how offsite construction can reduce construction costs, shorten delivery times and ease capacity constraints in the EU as a whole, and in France and Germany. At the same time, the Affordable Housing Plan stresses that new housing must be affordable, energy-efficient and built with the lowest possible carbon footprint, combining affordability and sustainability objectives. The report answers this by demonstrating that offsite construction can simultaneously lower purchase prices for new dwellings, reduce whole life carbon and improve building quality, thereby helping the Plan's four pillars on boosting supply, mobilising investment, enabling reforms and supporting the most affected to be implemented in practice.

In parallel, the **EPBD and the EED** put energy efficiency at the centre of EU building policy and require Member States to transform their building stocks with minimum energy performance standards, national building renovation plans, one-stop shops and financial incentives that support zero-emission buildings and deep renovation. At the same time, the **Circular Economy Action Plan** calls for construction and building value chains that are more durable, recyclable and resource efficient. The report answers these expectations by showing that offsite construction and renovation solutions, including ventilated façades, can deliver more consistent energy performance, cut operational and embodied emissions, reduce construction and demolition waste and support design for disassembly. In this way, they help implement EPBD provisions on energy performance, renovation and whole life greenhouse gas reductions and support the EED's energy-efficiency-first principle in the buildings sector. They also contribute to the Circular Economy Action Plan's ambition to make construction and buildings a frontrunner of circular, low carbon industrialisation.

The **European Strategy for Housing Construction** positions offsite and modular construction as a priority lever to overcome the construction sector's innovation deficit, which limits productivity, housing supply, and climate progress. It highlights that industrialised methods offer "the clearest potential for ramping up housing supply rapidly" through factory-based production that cuts errors, accelerates delivery, and supports circularity. Offsite construction can also help address inflated housing prices and unpredictable planning, including volatile material costs and supply chain disruptions. To unlock this potential, the Strategy calls for immediate action including investment in innovative materials and technologies and regulatory simplification to remove cross border barriers. It also emphasises the importance of recycled and low carbon products and reminds us that these offsite construction benefits are addressed and promoted by other legislative instruments as well, such as the new Construction Products Regulation and the EPBD.

Within this framework, the report demonstrates that, across the EU, offsite construction can lower construction costs, accelerate delivery, improve quality, reduce whole life carbon and construction waste, and significantly enhance housing affordability, especially for lower-income households buying new homes. The policy challenge is therefore not whether offsite construction is relevant for EU housing and climate objectives, but how existing and emerging instruments can be steered to enable its deployment at scale. [33] [34] [35] [36]

CONCLUSIONS AND RECOMMENDATIONS

OFFSITE CONSTRUCTION AND EU HOUSING POLICY

Quantitative analysis presented in this report shows that substituting onsite with offsite construction can reduce purchase prices of apartments and houses (excluding land) by around 30% in France and 22% in Germany, and by around one quarter in EU as a whole. When applied to vertical extension, offsite construction reduces the cost of creating additional floor area on top of existing apartment buildings, with housing prices decreasing by approximately 20% in France and 14% in Germany. Such reductions take place mainly through lower labour and material costs, reduced claims reserves and lower financing expenses. By lowering the cost of delivering each square metre of new housing and shortening construction times by about one third to one half, offsite construction directly addresses several supply-side bottlenecks identified in the Plan, including high building costs, long project lead times and limited capacity to respond quickly to changing demand.

The report further shows that, for households buying newly built homes, the adoption of offsite methods can dramatically reduce the housing cost overburden rate, thus improving affordability for a large share of the population overburdened with housing costs.[27] In France, replacing onsite with offsite construction for all new homes could lower the overburden rate among new homeowners from 7% to 0.5%, while in Germany the equivalent rate could fall from about 12% to 2.6%. Defining accurate EU values may be challenging but it is expected that relative reduction in overburdened population[28] at EU level would be close to 80%, in view of the relative reduction rates in France (93%) and Germany (78%).

For social housing, the combination of shorter construction times and industrialised delivery could allow France and Germany to close their estimated social housing gaps several years earlier than under conventional building methods. At EU level, offsite construction may bring forward the date at which social housing needs of around 13 million units are met by about five years.

Regarding housing needs across the EU, vertical extension of apartment buildings may represent a meaningful strategy to address this pressing shortage. The potential to deliver new dwellings with vertical extension is equivalent to approximately 15% of identified needs in France and 21% in Germany and the EU.

ALIGNMENT WITH EPBD, EED AND CIRCULAR ECONOMY OBJECTIVES

The EPBD positions the building stock at the centre of the EU decarbonisation agenda and requires Member States to act accordingly. For example, the Member States are required to develop National Building Renovation Plans, introduce minimum energy performance standards, expand energy performance certificates and renovation passports, and provide financial incentives that prioritise deep renovation and zero-emission buildings.

The analysis presented in this report shows that offsite construction and renovation systems, including ventilated façades produced offsite, support Member States in meeting EPBD targets. Such support comes from offsite construction delivering more consistent quality of envelopes, better airtightness and more predictable energy performance, therefore reducing operational energy use and emissions over the building life cycle.

At the same time, the EED establishes a common framework to remove barriers to energy efficiency and to implement the energy-efficiency-first principle across all sectors, including buildings, underlining that higher efficiency reduces energy bills, strengthens energy security and contributes to climate neutrality.

27 Population that currently spends more than 40% of disposable income on housing
28 Based on a sample of nine EU countries

From a life-cycle perspective, the review of empirical evidence confirms that, through lower material use, more efficient production, reduced waste and increased recyclability, modular and prefabricated construction can cut whole life carbon emissions by roughly 15–50%. This aligns closely with the Circular Economy Action Plan's focus on construction and buildings as a priority value chain, where the Plan seeks to promote more durable, repairable and recyclable products, increase the use of secondary materials and reduce waste. Offsite construction benefits align also with emerging guidance on the global warming potential of buildings under the EPBD,[29] which requires staged introduction of life cycle assessment-based indicators for new buildings from 2028 and 2030.

In short, offsite construction offers a concrete pathway to implement EU objectives on energy efficiency and circularity while simultaneously easing housing affordability pressures.

POLICY RECOMMENDATIONS

The analysis of offsite construction benefits at building and housing-market level, combined with the evolving EU policy framework, points to several areas where EU and national policies could explicitly promote offsite construction to support affordable, low-carbon housing in France, Germany and EU.

Policy recommendations supporting offsite construction are listed below and intended to apply equally to new buildings and to renovation of the existing building stock, wherever possible.

RECOGNISING OFFSITE CONSTRUCTION AND RENOVATION IN EPBD AND EED IMPLEMENTATION

National implementation of the EPBD and EED should recognise industrialised and offsite construction as a priority delivery mechanism for zero-emission buildings and deep renovation, especially in the social and affordable housing segments. Member States could reflect this by referencing offsite construction and renovation systems in National Building Renovation Plans, including offsite solutions in technical guidance for renovation passports and minimum energy performance standards, and ensuring that one-stop shops provide dedicated information and technical assistance on industrialised solutions for both new buildings and renovation.

DIRECTING HOUSING FINANCE TOWARDS OFFSITE SOLUTIONS

Financial incentives and funding streams that will be mobilised under the European Affordable Housing Plan should be designed to reward the use of offsite construction where it delivers lower costs, faster delivery and improved performance. This may include directing EU and national funding for affordable and social housing towards programmes that use offsite methods or integrating offsite construction into the design of state aid schemes for social and affordable housing. Another suggestion would be to link housing finance to performance criteria such as reduced per-unit costs or shorter time to completion, which modular and industrialised projects are well placed to meet.

USING PUBLIC PROCUREMENT TO CREATE DEMAND FOR OFFSITE CONSTRUCTION

Public procurement and product policy should be used more systematically to create stable demand for offsite solutions in housing, in line with the Circular Economy Action Plan and the revision of EU Green Public Procurement criteria for buildings. Public authorities at EU, national and local levels could incorporate criteria on whole life carbon, circularity and resource efficiency into procurement for social and affordable housing, for example by giving weight to lower embodied carbon or high recyclability in tender evaluations. In addition, requiring evidence of cost and time savings may provide additional support for the uptake of offsite solutions.

Several Member States have already started to use public procurement and industrial policy to scale up offsite construction and can offer valuable best practices on this topic. Ireland's housing plan, for instance, introduces standardised design and Design & Build procurement for publicly funded housing, while the United Kingdom has issued system-wide guidance that helps make modern methods the default option for many public projects.

CAPACITY BUILDING AND SHARING GOOD PRACTICES

The actions proposed under the European Affordable Housing Plan, such as the multi-level governance mutual learning programme on housing, should be used to disseminate best practice and build capacity on offsite construction across Member States. France and Germany, where housing pressures and potential gains are high, could be the front runners in this field. Collecting and sharing case studies on modular and offsite programmes in social and affordable housing would convene national and local authorities, project developers and industry to reduce perceived risks and accelerate learning and support the development

29 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401275

of standardised designs and fast-track permitting approaches tailored to industrialised housing.

ADAPTING REGULATORY FRAMEWORKS FOR OFFSITE AND VERTICAL EXTENSION

Ensure that planning and regulatory frameworks enable the use of offsite construction and vertical extension. For example, urban planning and zoning rules, e.g., on height and urban density limits, or law rules on co-ownership of apartment buildings, should resolve or at least reduce legal and technical barriers that may prevent vertical additions in urban areas. Also, permitting and approval procedures, e.g. building permits for new construction, should be streamlined for standardised modular designs and include fast-track or simplified procedures, which would exploit the full potential of offsite construction to improve housing affordability and reduce social housing shortages.

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