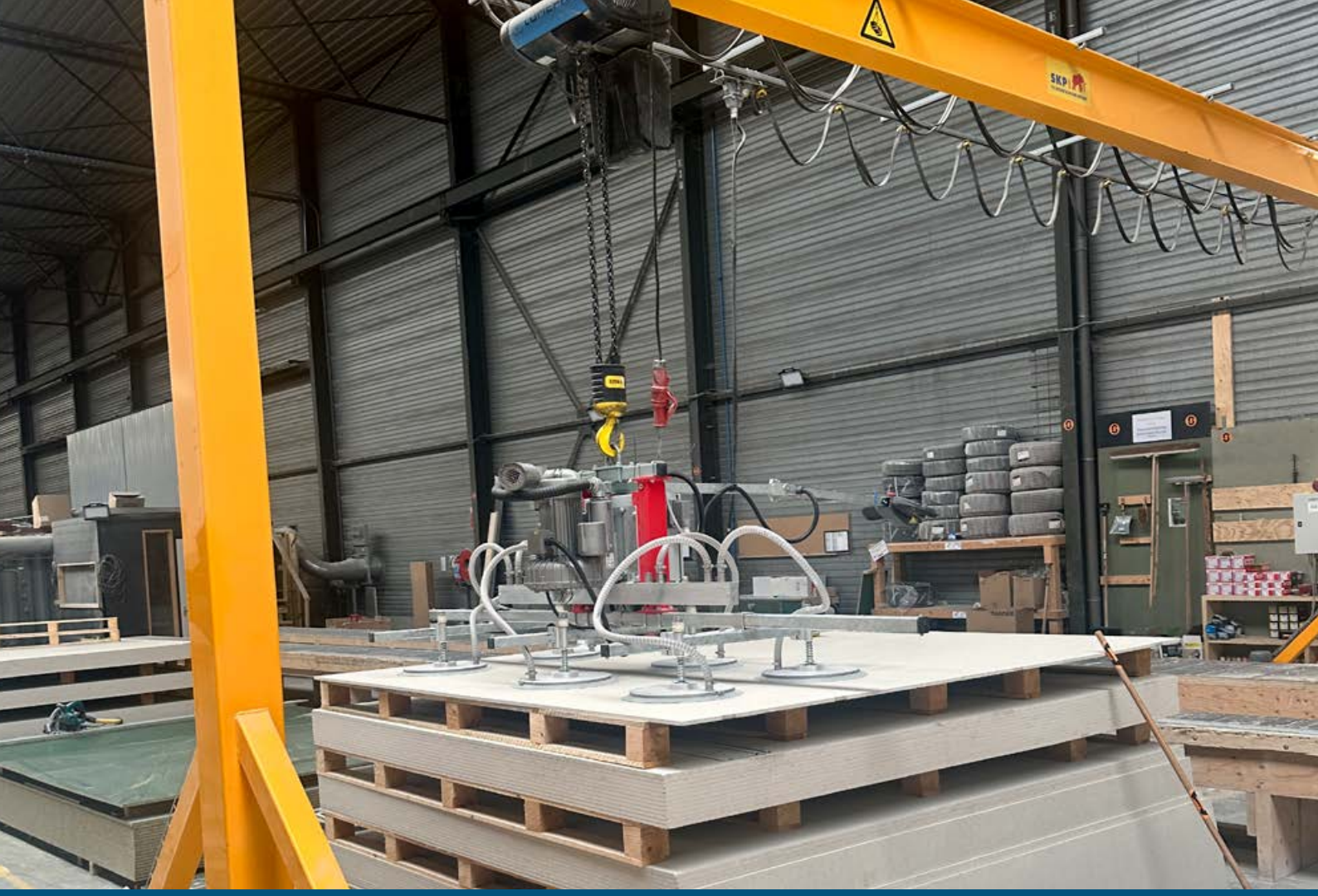


Topic Group: Construction and Architecture

COST CONTROL IN SUSTAINABLE HOUSING

EFL EUROPEAN FEDERATION FOR LIVING

INTRODUCTION

The Construction and Architecture topic group convened this year in Belgium, hosted by EFL member housing association 'Dimensa' from Gent (B). The three-day meeting, meticulously organized by Sven van de Vijver, Head of "Innovation, Quality, and Sustainability" at Dimensa, ran from April 3rd to 5th, 2024. Fabien Lasserre (Vilogia) and Thorsten Schulte (Gewobag), providing the French and German perspectives respectively, offered indispensable support as topic group leaders.

Around 20 participants from EFL member organizations Dimensa (Belgium), Vilogia (France), Intervilvoordse (Belgium), Gewobag (Germany), Cluid (Ireland), Polylogis (France), IWO (Germany), and Afpols (France) attended the meeting. Joost Nieuwenhuijzen represented EFL.

This year the topic group met to discuss a major point for social housing companies in the European context : How to handle the costs of construction and renovation. This meeting was divided in 3 parts.
During the first day, due to the location in Brussels, we focused on the legal framework and the European institutions and EU projects for the building sector.

Then, in the 2nd day, we explored one medium-term solution to handle the cost of construction : developing new solutions to increase productivity and therefore reduce the cost (offsite building, 3D printing,…).

The last day was dedicated of a comparison of the different economical contexts in Europe and a presentation of some cost control solutions already developed by EFL Social housing Companies and Universities.

Sven van de Vijver, Dimensa
Fabien Lasserre, Vilogia
Thorsten Schulte, Gewobag
Joost Nieuwenhuijzen, European Federation for Living

INTRODUCTION TO 3D PRINTING AND MODULAR CONSTRUCTION

THE POTENTIAL OF 3D PRINTED BUILDINGS FOR RESIDENTIAL USE

3D printed buildings represent a groundbreaking advancement in residential construction, offering a blend of innovation, efficiency, and sustainability. This cutting-edge technology involves using large-scale 3D printers to create building components layer by layer from materials such as concrete, polymers, or composites. One of the primary benefits of 3D printing in construction is the significant reduction in construction time and labor costs. Homes that would traditionally take months to build can now be completed in a matter of days, thanks to the precision and speed of 3D printing technology. Additionally, this method allows for the creation of complex architectural designs that would be difficult or prohibitively expensive to achieve with traditional building techniques. 3D printed homes also have the potential to greatly reduce construction waste, as the process uses only the exact amount of material needed for each project. Moreover, the versatility of 3D printing enables the use of eco-friendly materials, further enhancing the sustainability of residential buildings. As technology continues to advance, 3D printed homes are likely to become more prevalent, offering a viable solution to housing shortages and the need for affordable, high-quality residences. The future of residential construction is poised to be transformed by the widespread adoption of 3D printing, providing innovative, efficient, and sustainable housing options.

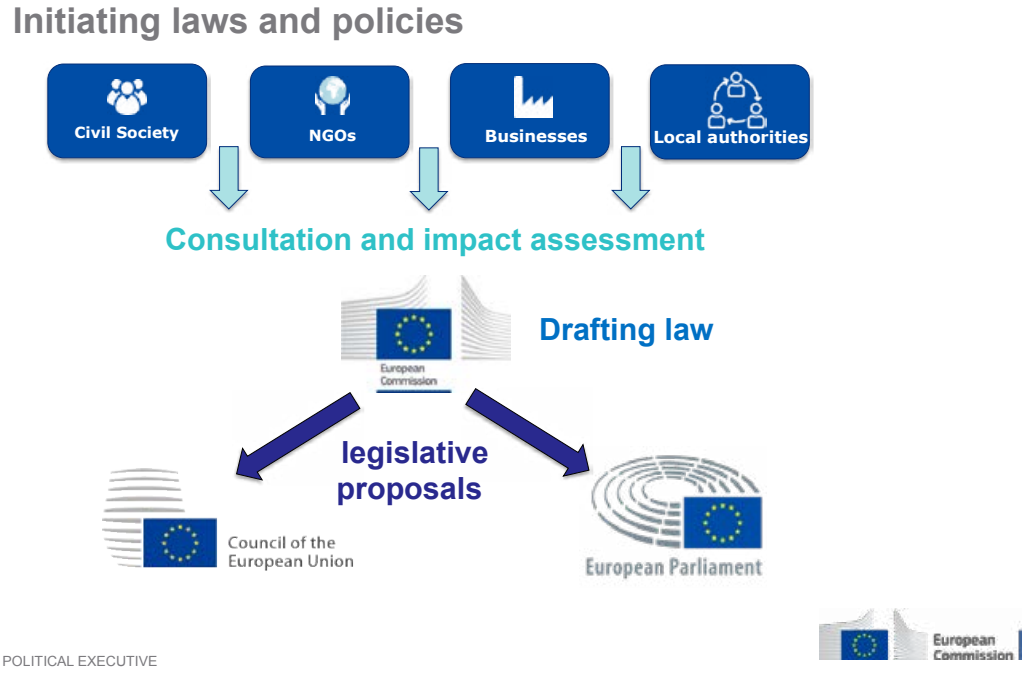
THE SIGNIFICANCE OF MODULAR CONSTRUCTION AND ITS FUTURE

Modular construction, which involves the prefabrication of building sections off-site followed by their subsequent assembly on-site, is transforming the construction industry in profound ways; this method offers a myriad of benefits over traditional construction approaches, including significantly reduced construction times, notable cost savings, and enhanced quality control. By shifting a substantial portion of the construction process to a controlled factory environment, the risk of delays caused by adverse weather conditions is substantially minimized, and stringent quality checks can be consistently applied, ensuring superior craftsmanship. Moreover, modular construction is environmentally advantageous, generating less waste and facilitating the reuse of materials, which aligns perfectly with the increasing global emphasis on sustainability. As urbanization continues to escalate at an unprecedented pace and the demand for affordable, high-quality housing soars, modular construction is poised to become an integral solution; advancements in technology, such as Building Information Modeling (BIM) and automation, are further augmenting the efficiency and precision of modular construction, heralding a future where this method becomes the norm. The inherent flexibility and scalability of modular construction render it ideal for a diverse array of projects, encompassing everything from residential buildings to hospitals and educational institutions, suggesting its widespread adoption in the foreseeable future.

DAY 1: EUROPEAN VISIONS AND INSTITUTIONS IN BRUSSELS

The *European Parliament* and the *European Commission* stand as the principal European institutions. The Parliament, directly elected by European citizens, serves as the EU's democratic platform. Currently encompassing 27 member states with a collective population of 447 million, the European Commission wields considerable influence, with each member country represented by a commissioner. This executive body of the EU significantly shapes the formulation of new laws and regulations.

Of particular significance to EFL and its members is the Commission's initiative to establish the New European Bauhaus (NEB). Spearheaded by Ursula von der Leyen, Chairperson of the Commission, the NEB endeavours to democratize Europe's Green Deal, focusing on inclusive and sustainable development with an emphasis on aesthetics. Central to NEB projects are the core values of sustainability, inclusiveness, and quality aesthetics, underpinned by citizen participation and multi-level engagement.



NEW EUROPEAN BAUHAUS

The NEB Movement count a number of achievements to date:

- The NEB serves as a pivotal force for transformative change on the ground.
- The NEB community has burgeoned, boasting over 1000 entities.
- National Contact Points have been established to coordinate NEB implementation efforts at a national level across all EU Member States.
- NEB projects span every EU Member State and extend to numerous countries within and beyond Euro-

pe.
- Over EUR 250 million in funding from various EU Programs have been earmarked to bolster NEB projects.

EXAMPLES OF EU FUNDING AND ACTIONS TO SUPPORT THE NEB

1) Six NEB Demonstrators under Horizon Europe: These projects yield diverse outcomes that can be adapted and replicated across Europe and beyond, addressing themes such as building renovation, circularity, arts, cultural heritage, education, smart cities, urban, and rural regeneration.
2) NEB Demonstrators under Cohesion Policy Affordable Housing Initiative (AHI) under the Single Market program: These initiatives represent a new wave of NEB demonstrators under cohesion policy, focusing on constructing and renovating with *circularity* and *carbon neutrality in* mind, preserving and transforming cultural heritage, adapting buildings for affordable housing solutions, and revitalizing urban spaces. The initiative provides tailored project support for affordable/social housing renovation at the district level, benefiting social and affordable housing providers, SMEs, and cities seeking inclusive and exemplary renovation solutions.

EB GUIDELINES AND TOOLS

- The *NEB Compass*: A guiding framework for decision and project-makers seeking to apply NEB principles and criteria to their activities.
- The *NEB Toolbox:* Practical tools, workshops, and exemplary cases facilitating co-design and effective implementation of NEB values.
- The *NEB Matrix Scoring System and Guidance*: Designed for public authorities interested in launching dedicated NEB calls, providing a structured approach to project evaluation and implementation.

DAY 2: KAMP C: A HUB FOR INNOVATION AND EDUCATION

On the second day of the gathering, participants embarked on a study visit to Kamp C, the Flanders Centre for Innovation and Sustainable Construction. Nestled in the Province of Antwerp, Kamp C serves as a dynamic site where groundbreaking construction techniques are explored and trialled. Its mission centres on fostering *knowledge exchange* among the construction sector, academic institutions, and clients, with a keen focus on sustainability. Key pillars of sustainable construction, as viewed by Kamp C, encompass *Space, Energy, Biodiversity, Water, Materials, and Affordability*.

Beyond its role as an innovation hub, Kamp C also functions as an educational institution for the next generation. It offers courses on sustainability tailored to teenagers and students, delving into modular construction and 3D printing. Notably, a striking feature on the site is a fully 3D printed building, boasting impressive specifications:

- Built on February 25th, 2020
- Stands at 8.43 meters tall
- Comprises 556 layers of 1.5 cm each
- Printed within a remarkable 10-day timeframe
- Utilizes the world's largest printer, measuring 10x10x10 meters
- Marks a pioneering achievement as the first multiple-floor building printed on-site globally.

UNDERSTANDING 3D CONCRETE PRINTING

In the realm of construction, 3D printing has emerged as a transformative technology, capable of producing large-scale elements ranging from buildings and walls to statues. With a focus on printing mortar (concrete), this technique enables prefabrication directly on-site, revolutionizing traditional construction methods.

The 3D printed building at Kamp C offers a tangible glimpse into this innovative approach. Constructed layer by layer using concrete, these buildings boast versatile designs while integrating insulation seamlessly into the walls, eliminating the need for external insulation. Moreover, the construction process minimizes manual labor, leveraging automated processes controlled by cameras for efficient execution.

CIRCULAR CONSTRUCTION

Circular construction stands as a burgeoning trend in the building industry, complementing traditional sustainability efforts with a focus on reusing materials from existing buildings. By maximizing the reusability of components and products, as well as prolonging the lifespan of buildings, circularity aims to minimize waste and reduce reliance on virgin resources. Intelligent architecture, tailored for adaptability to future needs, exemplifies this approach, facilitating seamless transitions between different functions.
In the field of circular construction, *innovative tendering strategies* emerge as crucial levers for driving sustainable practices. By prioritizing quality design, project management, circularity, embodied carbon, and

cost-effectiveness, these strategies incentivize contractors to embrace circular and modular construction techniques.

Circular 'tendering' is another element of the circular construction cycle. Increasingly 'Design and Construction Teams' are used as a way for early planning, both with the designers and in an early phase also with the constructor. This is different than 'classical' tendering, where first a few rounds of tenders for the designs are performed , followed by a tendering process for the construction. Mismatch between design and construction, with higher level of errors, are normal.

AWARD CRITERIA INCLUDE:

1. quality design
   a. quality architecture
   b. quality materials
2. project management
3. circularity
4. embodied carbon
5. price (maximum level)
   a. construction cost
   b. maintenance cost (technical issues).

Circular and modular construction play an important role in managing the construction costs of housing.

KEY SUCCESS FACTORS INCLUDE:

1. define a leading strategy
2. don't be too ambitious in a first project
3. use "Design&Build": fixed price, timing, quality
4. discover the market
5. create a buzz (linked-in)
6. (organise information sessions)
7. use other than mainstream channels
8. learn and share lessons learned

OFFSITE & MODULAR CONSTRUCTION

Driven by the demand for affordable housing and the imperative for controlled production, offsite and modular construction methods gain traction, particularly in the social housing sector. Pioneering (Belgium) companies like Van Roey and Skilpod specialize in designing and constructing fully finished modular homes in factories, streamlining the assembly process on-site. Embracing digital technologies such as *Building Information Modelling* (BIM), these companies revolutionize the construction market by delivering customizable, sustainable housing solutions efficiently.

Skilpod, in particular, aims to disrupt the modular construction market by offering a diverse range of off-site-produced housing solutions, from single-family homes to apartment complexes. Leveraging a digital system for design and production, Skilpod's innovative approach promises to address the pressing need for quality, affordable housing while advancing sustainable construction practices.

DAY 3: NATIONAL PRACTICES RELATED TO ENERGY AMBITIONS AND POLICIES

On the third day, the present EFL members shared the national ambitions for energy reduction in the building sector, including both the policies for new construction as well as renovations. With a large challenge for social housing providers in particular, the focus needs increasingly to swift from ambitious projects, to ways to reduce the costs of construction due to insufficient financial means to realise the governmental ambitions (as laid down by the Paris Agreement, the European Green Deal and subsequent national policies).

COST MECHANISMS IN SOCIAL HOUSING IN FLANDERS, BELGIUM

GENERAL OVERVIEW SOCIAL HOUSING:
Flanders boasts approximately 165,000 social dwellings, accounting for 7% of the total building stock in the region. These dwellings are managed by 41 local Social Housing Organizations (SHOs), with an average portfolio size ranging from 2,000 to 3,000 dwellings each. The social housing sector is tightly regulated, with an average rent of €341/month in 2023, significantly lower than the average rent in the private rental sector, which stood at €853/month in the same year.
Notably, the social rented sector primarily serves vulnerable tenants.

FINANCIAL MODEL IN FLANDERS
The financial framework in Flanders operates on a cost model basis. Loans for new construction and renovations are facilitated by a public bank through the organization 'Wonen in Vlaanderen' (Living in Flanders). These loans span a 30-year term with a fixed 1% interest rate, but 82% amortisation after this term. Furthermore, subsidies are available for infrastructure development and climate initiatives. Deficit guarantees in the

exploitation phase are managed through the 'Gewestelijke Sociale Correctie' fund.

RENT MODEL
The rent calculation is based on market value prediction using a dataset of housing characteristics such as location, year of construction, building type, size, amenities, and condition. Income and family situation, as well as the condition and energy performance of the dwelling, further influence rent adjustments. The rent is determined as 1/60 of the net taxable income, with minimum and maximum values applied.

COST CONTROL
To ensure cost control, a maximum cost limitation is imposed on projects financed with loans at a 1% interest rate. This maximum cost calculation incorporates various parameters, including cost per square meter, complexity factors, additional facilities, renewable energy installations, and indexation based on construction cost indices. Projects exceeding the maximum cost threshold are subject to loans with market interest rates for the excess amount.

OTHER INSTRUMENT
Various tender procedures are employed to support social housing organizations, including framework contracts, Design & Build (D&B) arrangements, and modular unit competitions. Additionally, calls for innovation target projects related to circularity, building techniques, green infrastructure, and mobility, with short-term subsidies and long-term integration strategies in place.

CONTEXT IN FRANCE: BUILDING COST AND ENERGY PERFORMANCE GOALS

France has set ambitious energy performance targets for new construction projects, with increasing emphasis on reducing concrete usage in favour of wood. Construction costs have surged by 40% between 2015 and 2024, significantly outpacing the growth in rental rates (13,4% in same period). Additionally, governmental obligations for energy performance improvements have become increasingly stringent, leading to a disparity between renovation costs and allowed expenses under subsidy schemes.

GOVERNMENTAL AMBITIONS IN FRANCE

To reduce CO2 emissions from the housing stock, the French government mandates landlords to upgrade energy labels for rental properties, with stringent timelines for compliance. By 2050, 80% of all homes must achieve labels A or B, further emphasizing the importance of energy efficiency in the housing sector.

CONTEXT IN FRANCE: BUILDING COSTS AND ENERGY PERFORMANCE GOALS

NEW CONSTRUCTION PROJECTS
France has set ambitious targets for energy performance in new construction projects, enshrined in law. In 2024, the focus was on a mix of 10% wood and 90% concrete. However, by 2031, the goals aim for a significant shift towards sustainability, with targets set at 70% wood and 30% concrete.

ENERGY LABELLING REGULATIONS
The evolution of energy labelling regulations (RE) underscores France's commitment to sustainable construction practices. The label system is used to push the transformation of the housing stock to the higher

labels and reduce concrete as building material.

- RE2020: Energy Label B, with 100% reliance on concrete.
- RE2025: Energy Label B, with a transition towards 90% concrete.
- RE2028: Energy Label B, with a further reduction to 50% concrete.
- RE2031: Energy Label B, aiming for only 30% reliance on concrete.
- RE2032: Introduction of new regulations focusing on water, mobility, soil, biodiversity, and achieving Energy Label A status.

CONSTRUCTION COSTS

Between 2015 and 2024, construction costs in France experienced a significant surge, increasing from approximately €1300/m2 (excluding VAT and design fees) to around €1800/m2. This represents a staggering 40% rise, translating to an average annual increase of 4.5%. In contrast, rents during the same period saw a comparatively modest uptick of 13.5%, equating to around 1.3% per year. This discrepancy underscores the financial strain faced by social housing providers and highlights the need to bridge the widening gap between construction costs and rental income.

RENOVATION COSTS

The disparity between renovation costs and government-mandated guidelines is another pressing issue. In 2015, the average renovation cost per dwelling stood at €75,000. However, by 2023, the maximum allowed renovation costs plummeted to €45,000—a drastic 40% decrease. This reduction occurred against the backdrop of a 40% increase in construction costs, further exacerbating the financial challenges faced by housing providers. Moreover, stringent energy performance goals set by the government add an additional layer of complexity to renovation endeavours.

ENERGY PERFORMANCE GOALS

France boasts some of the strictest energy performance goals in Europe, reflecting its commitment to environmental sustainability. As of 2023, the distribution of energy performance labels among French housing stock (social and private) paints a vivid picture:

- F+G: 5.2 million homes
- E: 6.7 million homes
- D: 9.8 million homes
- C: 5.5 million homes

These figures underscore the urgent need for concerted efforts to improve energy efficiency and reduce carbon emissions across the housing sector.

RETURNS/RENTS

Rental income in France is regulated by the State and the national Bank (Caisse Des Dépôts), with rates ranging from 6 to 9.5 €/m2 for tenants across income brackets. Other financial opportunities include subsidies for energy performance improvements from local authorities and incentives such as White Certificates for achieving energy efficiency targets, both contributing to the overall sustainability of social housing developments.

THE GERMAN CONTEXT: BUILDING COST AND ENERGY PERFORMANCE GOALS

BUILDING COST FOR NEW CONSTRUCTION PROJECTS

Germany adheres to the GEG Gebäudeenergiegesetz, the Building Energy Law, revised as of 1/1/24, with ambitious targets including:

- Achieving a 65% renewable energy target to promote the transition to climate-friendly heating systems and reduce reliance on fossil fuels, aiming for a complete phase-out by 2045.
- Further reducing primary energy consumption for heating, hot water, ventilation, and cooling to not exceed 55% of the corresponding reference building.
- Maintaining existing requirements (U-value) for the building envelope while introducing alternative methods for calculating permissible greenhouse gases (CO2) to ensure compliance.

Average Cost/m2:

- Conventional construction: €2,000 to €2,400 gross/m2 of living space.
- Wood/Hybrid construction: €2,400 to €4,200.

BUILDING COSTS FOR RENOVATION PROJECTS

Renovation projects align with the GEG Gebäudeenergiegesetz, with key provisions including:

- Imposing new replacement and retrofitting obligations for existing buildings, such as replacing certain heating systems and insulating pipes in unheated rooms.
- Introducing new standards for primary energy consumption when renovating building envelopes, allowing for a 150% higher consumption compared to new constructions.
- Implementing new standards for heating systems based on local requirements, applicable from 2026 in major cities and 2028 in all municipalities.

Average Cost/m2:

- €2,200 to €2,600 gross/m2 of living space, inclusive of planning, GEG-compliant energy efficiency measures, and general refurbishment including bathrooms.

RETURNS VIA RENTAL INCOME

Rental income is subject to local legislation, with examples including the Berliner Modell der kooperativen Baulandentwicklung and Sozialgerechte Bodennutzung (SoBoN) in Munich. Public housing associations often have additional obligations specified in agreements with local governments, such as offering a percentage of affordable and low- to mid-income housing units as mandated by building permits. Subsidized financing for income-regulated housing is also available through local institutions.

OTHER FINANCIAL OPPORTUNITIES TO ENHANCE RETURNS:

- Developing commercial projects such as short-term accommodations, nursing facilities, and student housing.
- Providing utilities such as electricity, heating, and mobility services to diversify revenue streams and increase returns.

CONCLUSION

Advancing Sustainable Housing Through Cost Control and Innovation. In our exploration of cost control mechanisms and sustainable housing practices across Europe, it is evident that the construction and architecture sector is undergoing transformative change driven by ambitious goals and innovative strategies. From Belgium to France and Germany, stakeholders are embracing new paradigms to address the pressing challenges of affordability, energy efficiency, and environmental sustainability.

KEY INSIGHTS

1. European Collaborations and Initiatives: The establishment of the New European Bauhaus (NEB) stands as a testament to Europe's commitment to inclusive and sustainable development. Through collaborative efforts and targeted funding, NEB projects are catalysing transformative change at local and regional levels, fostering innovation and citizen engagement.
2. Innovative Construction Techniques: Groundbreaking approaches such as 3D concrete printing and modular construction are revolutionizing traditional building methods. Sites like Kamp C in Belgium serve as living laboratories for experimentation and education, showcasing the potential of technology-driven solutions to address housing needs sustainably.
3. Circular Construction Practices: Circularity emerges as a driving force in the construction industry, promoting resource efficiency and waste reduction. By prioritizing reusability and longevity, circular construction models offer a pathway to mitigate environmental impact while ensuring economic viability.
4. Cost Control Strategies: Robust financial models and tendering procedures are essential for ensuring the affordability and feasibility of sustainable housing projects. From loan structures with fixed interest rates to innovative procurement strategies, stakeholders are leveraging diverse mechanisms to optimize costs and maximize returns.
5. Policy and Regulatory Frameworks: Governments play a pivotal role in shaping the trajectory of sustainable housing through supportive policies and stringent energy performance standards. By incentivizing energy-efficient renovations and fostering collaboration between public and private stakeholders, policymakers can drive systemic change and accelerate the transition to a greener built environment.

FUTURE DIRECTIONS

As we navigate the complex landscape of sustainable housing, collaboration and innovation will remain very important. That is also the main goal of EFL. By harnessing the collective expertise of stakeholders and embracing emerging technologies, we can unlock new opportunities for affordable, energy-efficient housing while advancing broader sustainability goals.
Moving forward, it is imperative to continue fostering cross-border partnerships, investing in research and development, and advocating for policy frameworks that prioritize sustainability and social equity and a sound financial framework. By working together, we can build a future where everyone has access to safe, affordable, and environmentally responsible housing, laying the foundation for a more resilient and inclusive society.

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