INDUSTRIAL RENOVATION: Insights & Best Practices

Apartment buildings' renovation with prefabricated timber frame elements

Serial renovation with prefabricated timber frame elements is a method of upgrading buildings using factory-made parts. These elements, which include insulation, external cladding, windows, and ventilation systems, are produced off-site, transported, and installed on the existing building facade.

On the following pages, we have compiled our learnings on innovative approaches to increase the energy efficiency of existing building stock, achieving approx. **50–60% energy savings** and **reducing renovation time by 50%.**

The collection has been compiled by the Estonian Woodhouse Association as part of the project LIFE IP BUILDEST.

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PREAMBLE

The **European Green Deal** aims for Europe to become the first climate-neutral continent by 2050. This includes reducing greenhouse gas emissions by at least **55% by 2030**, fostering sustainable economic growth, and enhancing social equity.

A key part of this effort is the **renovation** of old apartment buildings with poor energy performance, which consume 40% of the EU's energy and account for over one-third of emissions. Moreover, 80% of household energy is used for heating, cooling, and hot water.

To address these challenges, the European Green Deal's "Renovation Wave" aims to renovate **35 million buildings by 2030**, contributing to energy efficiency and carbon neutrality by 2050. (Energy) (European Commission). Currently, nearly 75% of buildings are energy-inefficient, and 85—95% of existing buildings will still be in use by 2050. Given this, **large-scale renovations** are urgently needed. However, with an annual renovation rate of just 1%, this progress is far too slow to meet the necessary targets and to achieve the transformation of the building sector.

To accelerate this process, adopting **industrial** and **serial renovation** solutions is essential. Prefabricated elements with versatile functionalities, such as insulation and energy generation, offer a scalable and cost-effective approach to upgrading the building stock. Supporting district-level renovations through industrial methods not only boosts the volume and speed of renovations but also reduces costs, enabling faster and more comprehensive decarbonization.

"By leveraging industrial solutions, the renovation process becomes faster, more efficient, and higher in quality, addressing both climate goals and modernizing the built environment for future generations."

Ivo Jaanisoo, Deputy Secretary General for Living Environment and Circular Economy at Ministry of Climate of Estonia

5 CHALLENGES TO DEAL WITH

1. **Financial Constraints**: Significant investments and financial incentives, such as loans, guarantees, and grants, are necessary.
2. **Technological Development**: Innovation in renovation technologies is needed to reduce costs and improve efficiency.
3. **Workforce and Capacity**: There is a need for a qualified workforce and expansion of renovation-related businesses.
4. **Policy and Regulation**: Effective measures and regulatory updates, including fire safety and building extensions, are essential to encourage renovations and support innovative solutions.
5. **Regional and Social Balance**: Balanced regional development and a focus on vulnerable households are essential to ensure that everyone in society can live in improved living conditions.

MEASURES

In Estonia, to enable large-scale **energy-efficient renovations,** a comprehensive set of measures have been established. By addressing financial, technical, and awareness challenges through innovative technologies, accessible funding, and collaboration, the **National Building Renovation Plan** fosters construction sector **innovation** and paves the way for **industrial-scale, factory-based renovations.**

Financial Tools

- **Grants for Renovation Projects** - direct financial support for apartment associations to cover part of renovation costs, focusing on energy efficiency improvements such as insulation, heating upgrades, and window replacement, as well as enhancing accessibility and safety for residents.
- **Renovation Loans** - low-interest loans for property owners and associations to fund large-scale renovations affordably.
- **Support for Pilot Projects and Innovation** - Funding projects that showcase innovative technologies like prefabricated elements builds confidence in modern renovation methods. Additionally, offering tax incentives for such projects encourages and accelerates innovation in renovation practices.

Promoting Advanced Technologies

- **Prefabrication Technologies** - encouraging and supporting the use of factory-produced building components for faster and more efficient renovations.
- **Digital Tools** - supporting to adoption of technologies like Building Information Modeling (BIM) for precise planning and execution.
- **Calculators** - developing user-friendly tools to help property owners estimate energy savings and returns on renovation investments.

Raising Awareness and Offering Guidance

- **Educational Campaigns** - public awareness initiatives to educate property owners on the benefits of energy-efficient renovations and share success stories from completed projects through marketing campaigns, seminars, and workshops.
- **Guidelines** - development of national Renovation Guide platform that guide property owners and apartment associations through the renovation process.
- **Community Engagement** - public meetings and forums where different stakeholders discuss challenges and solutions in energy-efficient renovations.

Cross-Sectoral Collaboration

- **Public-Private Partnerships** - joint initiatives that bring together different stakeholders from government and private sector to streamline jointly renovation projects on multiple level - technology, fire safety, moisture safety, renovation policy, procurement policy etc.
- **Research and Innovation Projects** - participating in programs that connect universities and research institutions with private companies to develop new technologies and methods.
- **Cross-Sector Demonstration Projects** - collaborative pilot projects involving multiple stakeholders from public and private sector to foster a shared understanding and accelerate the development of innovative renovation processes and technologies.

INDUSTRIAL RENOVATION

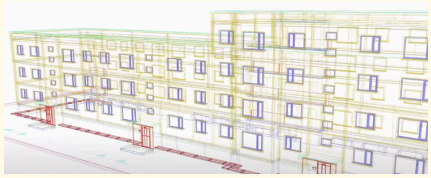
To enable large-scale, sustainable building renovation, Estonia has emerged as a front-runner in developing and implementing innovative **industrial renovation solutions**. By combining advanced technologies and cross-sector collaboration, Estonia has set a benchmark for industrial-scale renovation. This approach not only **accelerates renovation timelines** but also enhances **energy efficiency**, **reduces costs**, and **minimizes environmental impact.**

What is industrial renovation?

Estonia faces the challenge of renovating approximately 14,000 apartment buildings by 2050 to improve energy efficiency. Traditional on-site methods would take an estimated 100 years to complete this task. With only 25 years to achieve these targets, innovative solutions are essential.

Industrial renovation approach involves insulating the above-ground building envelope (walls and roof) using factory-produced lightweight wooden 2D elements. These prefabricated panels come with integrated insulation, windows, ventilation ducts, and pre-installed exterior cladding, making them suitable for **renovating apartment buildings of up to 9 stories.**

In addition to its primary benefits - accelerating the renovation process and improving quality by eliminating environmental impacts during construction - industrial renovation also supports the circular economy. The 2D panels are designed as durable and versatile components that could be repurposed as whole elements. For example, several panels that are initially used for insulating an apartment building could, after 50 years, be reused in the construction of a new structure, such as a residential buildings. This adaptability maximizes resource efficiency and further reduces the carbon footprint of the built environment.



Process description

Laserscanning - existing building is scanned in 3D using ground-based equipment and drones, producing a highly detailed 3D point cloud that captures the building's exact dimensions and features.

Modeling and design - detailed BIM model is generated from the 3D point cloud, allowing engineers to accurately analyze every deviation in the existing structure.

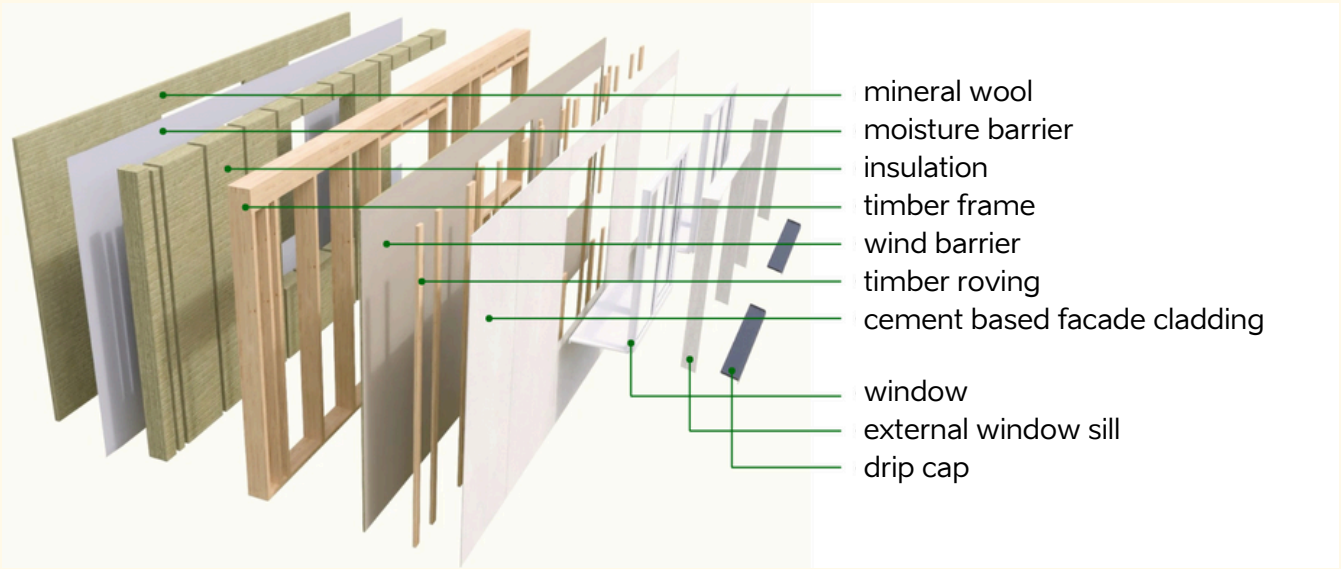
Production - high-quality prefabricated elements are produced in a controlled factory environment, ensuring precision, sustainability, and consistent quality.

Installation - prefabricated elements are transported to the site and installed quickly and efficiently, reducing disruption to occupants and significantly shortening the renovation timeline.

PREFABRICATED TIMBER FRAME ELEMENT

Prefabricated timber frame elements are **factory-produced components** designed for efficient and sustainable construction. These elements combine insulation, structural components, and external finishes in one system, enabling **quick on-site assembly.** Lightweight, durable, and environmentally friendly, timber frame elements are ideal for modern building and renovation projects, aligning with energy efficiency and circular economy goals.

Technical solution



Benefits of using timber frame solutions

- **Renewable and Sustainable Material** - timber is the only renewable natural building material, making it a sustainable and environmentally responsible choice.
- **Adaptability and Prefabrication** - timber is highly suited for factory production, where controlled conditions ensure precise prefabrication of elements with integrated insulation, structural components, and finishes. Factory production guarantees consistent product quality and streamlines the overall process, as well reduces on-site works, and minimizes material waste.
- **Lightweight and Efficient Logistics** - timber as a lightweight material, allows easier handling and reduces transportation needs. Fewer vehicles are required to transport timber elements, lowering in total fuel consumption and emissions while simplifying logistics.
- **Fire Safety Innovations** - timber construction is now safer than ever, thanks to advanced fireproofing techniques. In collaboration with the Rescue Board, renovation solutions have been developed to safely use timber frame facade elements for apartment buildings of nine stories or more, meeting high fire safety standards.
- **Circular Economy and Durability** - timber frame elements are recyclable and reusable, aligning with circular economy principles.
- **Modern Construction and Aesthetic Appeal** - timber frame elements enable innovative design possibilities, offering modern appearance that aligns with sustainable architectural trends.

Prefabricated timber elements represent a sustainable and efficient solution for **modernizing** and diversifying the built environment. By applying principles of **industrialized construction** and **modular design**, this method streamlines the building process, reduces waste, and ensures high-quality outcomes. It provides an innovative approach to urban regeneration, enabling adaptable, scalable solutions that enhance both the **functionality** and **aesthetic value** of residential areas.

PILOT PROJECTS

The first industrial renovation project in Estonia was completed in 2017, when Tallinn University of Technology upgraded its Akadeemia tee 5 dormitory to near-zero energy standards. This successful pilot was followed by the renovation of an apartment building in Saue (Kuuma 4) in 2019. These projects paved the way for a nationwide pilot led by KredEx, involving 19 apartment buildings.

TTÜ Student Dormitory: Served as a testbed for prefabrication technologies

The renovation of the TTÜ student dormitory at Akadeemia tee 5 in **2017 marked Estonia's first industrial renovation project.** This pilot aimed to explore the feasibility and efficiency of using prefabricated façade elements to upgrade Soviet-era buildings to near-zero energy standards. The dormitory was unoccupied during the renovation, allowing for uninterrupted implementation of the new methods.

Saue, Kuuma 4: Demonstrated significant energy savings and rapid renovation timelines

The renovation of an apartment building at Saue, Kuuma 4 in 2019 built on the successes and lessons of the TTÜ pilot, taking industrial renovation a step further. Unlike the dormitory project, this building was occupied during the renovation, adding a layer of complexity to the process by requiring minimal disruption to residents' daily lives.

As part of the DRIVE 0 project, this initiative also incorporated circular economy principles, and explored scalable solutions for broader application. The prefabricated façade elements used in the project were designed for durability and future reuse, ensuring that at the end of their lifecycle, they could be repurposed in new construction projects, such as row houses e.g.

Lessons learned

Both projects laid the groundwork for nationwide adoption of industrial renovation practices by:

- Demonstrating how factory-produced elements ensure **consistent quality** regardless of weather and significantly **accelerate the renovation process.**
- Confirming the method's **effectiveness** through substantial reductions in energy consumption.
- Highlighting the **reusability** and **repurposing** potential of prefabricated elements, supporting sustainable construction practices.

NATIONAL PILOT PROJECT

Estonian Business and Innovation Agency (EIS, former KredEx) Pilot Project: Scaling the Industrial Renovation Concept

The Estonian Business and Innovation Agency (EIS) pilot project aimed to validate and develop a scalable model for nationwide application of industrial renovation using prefabricated elements. Its primary objectives were to demonstrate the feasibility of this innovative renovation method and improve energy efficiency in apartment buildings.

The project was a collaborative effort involving the supervising Ministry, the Estonian Business and Innovation Agency, construction associations and companies, research institutions, and apartment associations. This multi-stakeholder approach enabled a comprehensive exploration and helped streamline the method.

Measure Description: EIS provided financial support and guidance to 19 apartment associations to implement the industrial renovation method. As part of the program, EIS covered 50% of the total renovation costs for housing associations that opted for prefabricated renovation solution.

Implementation of the measure

1. **Open Call for Participants** - apartment associations were invited to apply for the grant, with selection criteria based on their readiness to adopt prefabricated renovation methods.
2. **Standardized Requirements** - the program established clear guidelines and requirements for the design, production, and procurement process, ensuring quality throughout the projects.
3. **Collaborative Approach** - EIS facilitated coordination between housing associations, contractors, and design firms to address challenges and streamline the renovation process.

Results and Outcomes

- **Process Innovation** - the project refined prefabrication technologies, significantly improving installation speed and quality while making substantial contributions to product development and innovation in construction sector.
- **Market Competitiveness** - encouraged competition among construction companies to adopt and innovate within this method, fostering a more dynamic market.
- **Increased Demand** - raised awareness of industrial renovation among property owners and policymakers. Proven results, including reduced energy costs and faster renovation timelines, generated significant interest in expanding the approach nationwide.

The pilot project established a blueprint for the large-scale implementation of industrial renovation. Key achievements include:

Validating the potential of prefabricated elements, supporting material reuse and sustainability goals.

Developing guidelines and standards for industrial renovation processes, ensuring consistency and scalability.

Building capacity in the construction sector, ensuring more efficient execution of future projects.

The EIS pilot project not only demonstrated the practicality of industrial renovation but also paved the way for its adoption as a mainstream renovation practice in Estonia. By fostering innovation, enhancing market dynamics, and addressing key challenges, the project has significantly advanced Estonia's progress toward energy-efficient, sustainable, and scalable building renovation solutions.

RESULTS

Today in Estonia, 21 buildings have been insulated with prefabricated façade panels, with heating cost data from the first projects confirming the method's effectiveness. Industrial renovation has proven to be a viable, efficient, and sustainable solution for transforming apartment buildings into energy-efficient homes, setting a benchmark for modern renovation practices.

4 MEANINGFUL RESULTS FOR THE STATE

1. **Energy Efficiency Goals** - industrial renovation contributes significantly to achieving national energy efficiency targets by reducing the energy consumption of residential buildings by 50—60%.
2. **Reduced Carbon Emissions** - by renovating instead of demolishing buildings, industrial renovation significantly lowers greenhouse gas emissions in the construction sector.
3. **Economic Growth** - scaling industrial renovation drives growth in the construction sector, creates jobs, and fosters innovation in construction sector.
4. **Improved Housing Stock** - modernizing the country's aging apartment buildings enhances living standards, increases property values, and supports the long-term resilience of the housing sector.

11 MEANINGFUL RESULTS FOR RESIDENTS AND DEVELOPERS

1. **Year-Round Implementation –** as panels are manufactured in a controlled factory environment, it enables renovation work even during winter months
2. **Significantly Shortened Duration** - The industrial renovation approach allows the process to be completed up to twice as fast as traditional methods, elements can be installed with weeks.
3. **Reduced Revenue Loss:** Shorter renovation timelines mean less downtime for rental properties, faster project completion keeps rental income interruptions to a minimum.
4. **Favorable Financing Terms:** Renovating to a higher energy class can result in lower interest rates on loans, as energy-efficient buildings are less risky for lenders.
5. **Energy Savings** - heating energy consumption is reduced by an average of 50—60%.
6. **Indoor Climate** - integrated ventilation systems effectively regulates air quality and controls moisture, ensuring a healthier and safe living environment.
7. **Minimal Disruption** - installation is carried out without scaffolding, avoiding prolonged window coverage and residents can remain in their homes throughout the renovation process.
8. **Reduced Waste and Debris** - on-site debris is minimized due to efficient factory work, reducing overall waste and eliminating the need for temporary storage on-site.
9. **Enhanced Quality Control** - strict quality inspections during factory production and on-site installation ensures superior construction quality compared to traditional methods.
10. **Increased Property Value** - renovated buildings gain a contemporary look, with options to enclose loggias into heated spaces or add new balconies, improving both functionality and aesthetics. These improvements contribute to a significant rise in property value, making it a more attractive investment for both residents and potential buyers.
11. **Maintenance** - thanks to a highly durable and climate-proof outer layer, the need for maintenance is significantly reduced, leading to lower long-term costs. This makes future expenses for residents more predictable and helps avoid major unexpected investments.

FUTURE DEVELOPMENTS

The future of construction and urban design lies in innovation, adaptability, and sustainability. Projects below pave the way for scalable, efficient, and eco-friendly developments that not only enhance buildings but also transform the spaces and communities around them.

SOFTacademy

SOFTacademy aims to accelerate the renovation of prefabricated housing by developing an engagement model for municipalities and housing associations. The project will demonstrate this approach in Mustamäe, Tallinn, with the renovation of four apartment buildings and the redesign of the spaces between them using sustainable and circular economy principles. Guided by the New European Bauhaus concept, the project seeks to revitalize neighborhoods with eco-friendly solutions that enhance both buildings and public spaces.

Architectural researches

sLenderHood and sLenderFacade are pioneering research and design initiatives that explore innovative approaches to sustainable urban living and industrial renovation. **sLenderFacade** introduces Estonia's first modular renovation system, featuring prefabricated timber elements that integrate balconies, staircases, green spaces, and energy-producing surfaces. Situated in Tallinn's city center, this experimental prototype showcases mass-customizable building envelopes for scalable renovation solutions. **sLenderHood** expands on this concept by incorporating volumetric reconstruction and neighborhood-based design strategies, addressing energy efficiency, accessibility, urban farming, and public space improvements.

Together, these projects bridge architectural research and urban planning, demonstrating adaptable and environmentally responsible solutions for modernizing built environments.

Extensions with Modular Principles

Industrial renovation, guided by modular principles, opens up opportunities for both vertical and horizontal extensions of existing buildings. Lightweight and adaptable prefabricated timber elements make it feasible to add floors, install elevators, or create additional living spaces. These extensions maximize the use of existing urban space, **enhance accessibility**, and **increase the functionality** and value of older buildings.

By leveraging modular solutions, extensions can be efficiently integrated into the current structure with minimal disruption, contributing to sustainable development and modernized living environments.

CATALOGUE

We are at the dawn of a new era in construction, where renovation takes center stage, and innovation drives progress. Estonia's strong experience in this field has been supported by effective measures and a collaborative drive for innovation across sectors. This success would not have been possible without the contributions of national-level pilot projects, which have laid the foundation for scaling these practices nationally and internationally.

On this page, you will find examples of projects from the KredEx pilot program, as well as international projects carried out by Estonian woodhouse producers. These examples highlight innovative solutions, energy efficiency improvements, and the practical outcomes of collaboration between housing associations, contractors, and state support.

Apartment building with 30 apartments in Märjamaa, Estonia

Location: Rapla county, Estonia

Area: 2007 m2

Year: 2024

Producer: KMT Prefab OÜ

Apartment building with 60 apartments in Sindi, Estonia

Location: Pärnu county, Estonia

Area: 3624 m2

Year: 2024

Producer: KMT Prefab

4-storey apartment building in Tallinn, Estonia

Location: Pärnu mnt, Tallinn

Area: 1512 m2

Year: 2023

Producer: EstNor OÜ

4-storey apartment building in Tallinn, Estonia

Location: Lasnamäe, Tallinn

Area: 1463 m2

Year: 2023

Producer: EstNor OÜ

4-storey apartment building in Tallinn, Estonia

Location: Nisu street, Tallinn

Area: 2670 m2

Year: 2023

Producer: EstNor OÜ

3-storey apartment building in Kuressaare, Estonia

Location: Saare county, Estonia

Area: 1350 m2

Year: 2023

Producer: EstNor OÜ

CATALOGUE

4-storey apartment building in Tallinn, Estonia

Location: Kristiine, Tallinn

Area: 2614 m2

Year: 2023

Producer: EstNor OÜ

3-storey apartment building in Tallinn, Estonia

Location: Lasnamäe, Tallinn

Area: 1432 m2

Year: 2023

Producer: EstNor OÜ

4-storey apartment building in Tallinn, Estonia

Location: Riia mnt, Pärnu county

Area: 2341 m2

Year: 2023

Producer: EstNor OÜ

4-storey apartment building in Tartu, Estonia

Location: Turu street, Tartu

Area: 1720 m2

Year: 2023

Producer: EstNor OÜ

Apartment building with 60 apartments in Saue, Estonia

Location: Tule street, Saue

Area: 3931 m2

Year: 2023

Producer: EstNor OÜ

Apartment building with 30 apartments in Kehtna, Estonia

Location: Rapla county, Estonia

Area: 1911 m2

Year: 2024

Producer: EstNor OÜ

5-storey apartment building in Tartu, Estonia

Location: Anne street, Tartu

Area: 5680 m2

Year: 2023

Producer: EstNor OÜ

4-storey apartment building in Sindi, Estonia

Location: Kooli street, Pärnu county

Area: 1810 m2

Year: 2023

Producer: EstNor OÜ

Apartment building with 30 apartments in Kambja, Estonia

Location: Männi street, Tartu county

Area: 2311 m2

Year: 2024

Producer: KMT Prefab OÜ

CATALOGUE

Student dormitory with 80 apartments in Tallinn, Estonia

Location: Akadeemia tee, Tallinn

Area: 4324 m2

Year: 2017

Producer: Matek AS

3-storey apartment building in Saue, Estonia

Location: Kuuma street, Saue

Area: 2564 m2

Year: 2021

Producer: Timbeco Woodhouse OÜ

10 Apartment buildings in Tuttlingen, Germany

Location: Tuttlingen, Germany

Area: 380 m2/building

Year: 2023

Producer: KMT Prefab OÜ

Apartment building with 47 apartments in Germany

Location: Mönchengladbach

Area: 2441 m2

Year: 2022

Producer: Matek AS

5-storey apartment building in Tartu, Estonia

Location: Aardla street, Tartu, Estonia

Area: 4256 m2

Year: 2024

Producer: Welement AS

ESTONIAN COMPANIES WHO HAVE EXPERIENCES IN SERIAL RENOVATION

ESTNOR TIMBECO matek TIMBER FRAME HOUSES KMT PREFAB welement

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- Iliste, Elisa (2023), Basics of the energy efficiency assesment of residential areas based on the data of the building register
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