

# Feasibility study for improving Energy Efficiency in Historic Brick Public Buildings in Latvia

## Overview:

Historic brick buildings in Latvia, primarily pre-war public structures, remain significant energy consumers—accounting for around 30% of the building sector's total heat usage. Due to cultural heritage protection laws, external insulation is typically prohibited, and energy efficiency requirements are often voluntary unless they compromise heritage value.

## Key Insights:

Analysis of Latvian, EU, and Northern European practices reveals that while energy-saving potential exists, interventions must be carefully balanced with heritage preservation. Internal insulation, secondary glazing, window restoration, and HVAC modernization are among the most viable strategies.

## Technical Solutions:

- **Internal Insulation:**  
Natural materials like mineral wool or wood fiber boards can improve wall insulation by 50–70%, potentially saving 9–43% of heating energy. However, risks include moisture buildup, mold, reduced interior space, and high costs. Proper moisture modeling and ventilation are essential.
- **Secondary (Internal) Windows:**  
Installing internal glazing preserves the external façade while improving thermal performance (U-value from ~3.0 to 0.97 W/m<sup>2</sup>K), reducing window-related heat loss by up to 70%. Costs vary based on design and materials.
- **Window Restoration:**  
Renovating original wooden windows is preferred over replacement, offering 10–30% energy savings while maintaining historical authenticity. Replacements may harm the building's microclimate and heritage value.
- **Ventilation Modernization:**  
Heat recovery ventilation systems can reclaim 70–90% of exhaust heat, improving indoor air quality and reducing energy use by 20–40%. However, installation requires space and must be adapted to the building's permeability.
- **Heating System Upgrades:**  
Replacing outdated boilers with condensing boilers, heat pumps, or micro-cogeneration units can improve efficiency by 10–20%, especially when combined with renewable energy sources.
- **Digital Twin Technology:**  
IoT sensors and BIM models enable real-time monitoring and optimization of HVAC systems. This approach supports predictive maintenance and energy savings without invasive physical changes, preserving the building's integrity.

## Northern European Experience:

Projects like RIBuild show that internal insulation, when properly designed, can safely

deliver 15–20% energy savings. Experts emphasize the importance of moisture control and ventilation. External insulation is rarely permitted, and window replacement is discouraged due to its impact on heritage value.

#### **Expert Opinions:**

Latvian and Nordic experts agree that preserving façades is crucial. Simple measures like curtains and blinds should precede structural interventions. A balanced, step-by-step approach is recommended.

#### **Recommendations:**

- Develop national guidelines and financial tools tailored to heritage buildings.
- Encourage low-impact solutions (e.g., internal glazing, thermal curtains).
- Raise public awareness about preserving original materials.
- Promote integrated strategies combining technical, regulatory, and educational efforts.

### **Technological Solutions for Improving Energy Efficiency in Historic Buildings: Description, Advantages, and Drawbacks**

#### **Key Measures:**

##### **1. Internal Insulation:**

- Uses mineral wool or wood fiber boards on interior walls and ceilings.
- Can improve wall thermal insulation by 50–70%.
- Drawbacks: reduces indoor space, requires precise moisture calculations, risk of mold development, limits the building's thermal inertia, and can be expensive or difficult to implement.
- Mold risk is significant, especially without ventilation ducts and in moisture-prone areas.

##### **2. Secondary (Interior) Windows:**

- Additional windows are installed on the inside, preserving the historic façade.
- Improves window insulation from approximately 3.0 to 0.97 W/m<sup>2</sup>K, saving up to 60–70% of heat loss.
- Advantage – maintains the building's visual appearance, but costs depend on the chosen solution.

##### **3. Window Restoration and Replacement:**

- It is recommended to restore historic windows rather than replace them.
- Energy savings can be 10–30%, while new windows offer greater savings but may compromise heritage value and are more expensive.

##### **4. Modernization of Ventilation Systems:**

- Heat recovery ventilation can be introduced, recovering 70–90% of heat from exhaust air.
- Improves air quality and reduces moisture risks.
- Drawbacks: requires ducts and equipment that may affect the interior, and the system must be well-adapted to the building's airtightness.

**5. Modernization of Heating Systems:**

- Replacing old boilers with more efficient solutions (condensing boilers, heat pumps).
- Can improve efficiency by 10–20% and support the transition to renewable energy.

**6. Digital Twin for HVAC Systems:**

- Uses IoT sensors and BIM models to monitor and optimize building climate and energy in real time.
- Enables predictive maintenance and energy consumption reduction while preserving the microclimate of the historic building.
- Allows efficient energy control without major physical interventions.

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**Recommendations for Policymakers, Municipalities, and Building Owners:**

- Develop specific guidelines and financial incentives for energy efficiency in cultural heritage buildings.
- Ensure renovation plans consider both energy efficiency and heritage preservation.
- Provide dedicated funding and simplify bureaucracy in the restoration process.
- Promote building audits, training, and public awareness of best practices.
- Support the development of technologies using both traditional and modern materials.
- Include energy efficiency in regional plans and ensure access to restoration specialists.
- Building owners are advised to regularly monitor building conditions, implement small energy-saving interventions, and use efficient heating control solutions.

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This summary provides an overview of the main technological solutions for improving energy efficiency in historic buildings, their benefits, limitations, and recommendations for various stakeholders to balance energy savings with cultural heritage preservation.

