Image: Nussmüller Architekten

Knittelfeld, Austria - Vocational Training School

Non-intrusive and faster facade renovation for educational buildings – Knittelfeld

The EXCESS replication plans aim to identify suitable replication cases and provide a structured approach for replicating EXCESS PEB solutions. The replication plans include technical details and business models as well as regulatory and social aspects of specific replication cases. The Excess demo building in Graz uses a multifunctional facade element that includes integrated energy producing active elements (PV), insulation and activation elements for the use of existing facades as heat/cold storage and heat dissipation system.

The present replication plan outlines a replication case in the city of Knittelfeld, Styria. The building complex is a vocational training school including a boarding school and consists of three main buildings. It is managed by the Landesimmobilien-Gesellschaft Styria who manages a high number of similar public properties, many of them schools. The building is also a demo case of the national flagship project “RENVELOPE – Energy Adaptive Shell”, which is funded by the program Vorzeigeregion Energy – Green Energy Lab of the Austrian Climate and Energy Fund and the KPC (Kommunal Kredit Public Consulting).

The replication case does not include the energetic activation of the existing facades as the original EXCESS Demo in Graz but builds on the fundamental principals of serial refurbishment with active facade elements. The replication case realizes this by integrating innovative ventilation systems and PV within the newly installed building envelope, ensuring excellent indoor climate comfort for all three buildings while maintaining short renovation times, deep thermal renovation and overall low energy consumption of the active systems, coupled to the facade and roof integrated PV for on-site energy generation.

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1 Baseline assessment of the implementation environment

1.1 Building description

The school building was constructed in 1981-83 as a reinforced concrete skeleton construction and fanned out with bricks. It is structurally connected to the adjacent boarding school (2 buildings). In 2008-2009, the basement was converted into a workshop area and extended during this intervention. The heating supply of the school and the boarding school is provided by district heating. The heat is supplied exclusively via radiators. Thermostatic valves are available on most of the radiators. Domestic hot water is prepared in the sanitary facilities in the school building by means of electricity under the sink storage tanks. There are domestic hot water tanks for the boarding school. In the school building, the renovated workshop area in the basement and the dining hall in the north-west wing of the building have a mechanical supply and exhaust air system with heat recovery by means of a rotary heat exchanger. There is a photovoltaic system on the school grounds, which is used to partially cover the school's own electricity needs.

The heating demand of the buildings can be reduced from 675.240 kWh/a on average by around 80 % with targeted energy measures to approximately 135.048 kWh/a by the serial renovation package. The electricity demand from the higher-level grid can be reduced to 25% while increasing the locally produced electricity by installing about 300 m² of additional PV on the roof. Since the school building requires continuous high air quality, an innovative ventilation system is included in the facade panels as well.

Figure 1: View of the school building in Knittelfeld (left) and impression of a prefabricated facade element being installed (right). Source: Nussmüller Architekten

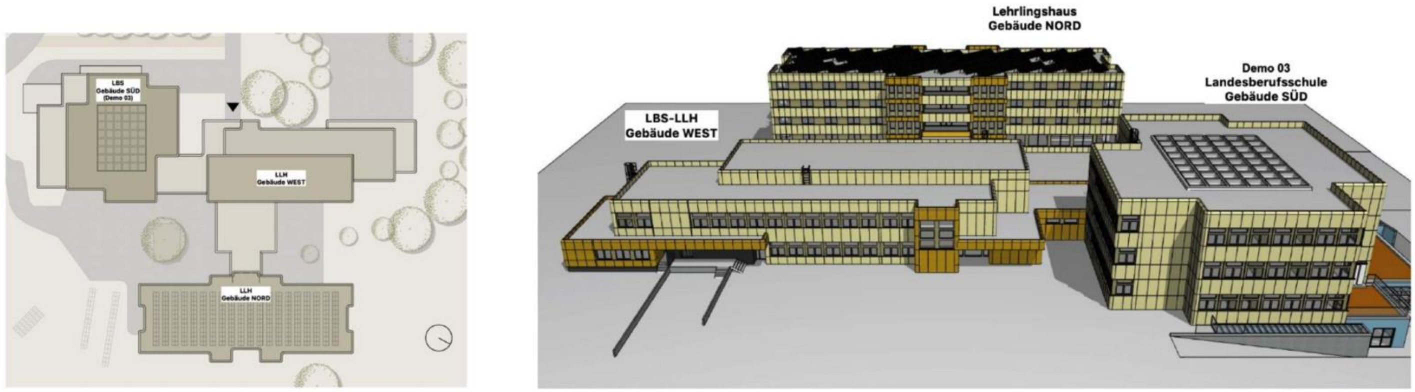

Figure 2: Top view (left) and 3D rendering (right) of the replication case buildings. Source: Nussmüller Architekten.

1.2 Regulatory aspects and public support schemes

The goal of the Austrian Federal Government is to achieve Austria's climate neutrality by 2040 at the latest. An important interim goal is to reduce greenhouse gas emissions by 3 million tonnes of CO2-eq by 2030. All sectors contribute to the complete decarbonisation of the energy system, with the building sector playing a central role. After all, about 27% of Austria's final energy consumption is used for the provision of space heating, hot water and cooling in buildings.

The Austrian government has set itself an ambitious goal in its government program: 100 percent of electricity is to be generated from renewable energies by 2030. This is an important step for the energy turnaround and on the way to climate neutrality. This requires a good legal framework; this will be created by the "Erneuerbare-Ausbau-Gesetz" (EAG, Renewable Expansion Act). The EAG creates new participation opportunities for citizens and companies.

Several regulatory aspects have to be considered in building renovation projects. In Austria, the implementation of the EPBD (Directive (EU) 2024/1275) is guided by the OIB Guideline 6 and is the responsibility of the provinces.

The Renewable Energy Act (Ökostromgesetz) in Austria sets the legal framework for renewable energy production, including provisions for collective self-consumption. This law includes regulations related to feed-in tariffs, grid access, and support mechanisms for renewable energy producers.

1.3 Social Dimension

The replication case buildings are owned by the Landesimmobilien-Gesellschaft Styria. The company is responsible for the maintenance and decarbonisation of a high number of public buildings throughout Styria, many of which are school buildings. The social dimension in this case is quite relevant as the owner serve as a core pillar of society in the form of education. Additionally it also provides a high-quality, renewable powered and inspiring environment to young generations that will carry this experience into their respective professions and serve as a multiplier for awareness about PEB and sustainable construction and building operation. The present replication case, therefore, has high upscaling and replication potential for Styria but also Austria as a whole, as similar institutions for public buildings exist in the other federal states. In that regard, serial refurbishment with prefabricated facade panels offers a unique combination key benefits to them that no other solution can offer.

Non-intrusive and faster renovation: The non-intrusive renovation process ensures that pupils, teachers and students in the boarding schools do not have to move out during renovation process, as well as a significant short renovation duration in general (3-4 weeks for the entire building). This even allows for **renovation cycles during the summer breaks** (9 weeks in Austria), reducing the impact of the renovation on the users to zero. For conventional processes, a building needs to be completely emptied to implement deep renovation, due to the necessary construction measures that affect the indoor spaces and issues with acceptance. Even for time periods where buildings are occupied, the serial refurbishment process offers the possibility of **deep renovation in a fully occupied and operational building**.

Higher quality of life/work after renovation: The renovation process will increase the level of comfort and, therefore, increase the wellbeing of inhabitants. Indoor Environmental Quality (EQ) addresses indoor air quality and thermal, visual, and acoustic comfort. This comfort has been shown to enhance productivity, decrease absenteeism, and improve the building's value. These comfort and well-being factors can of course be positively connected to indoor air quality and health of residents [3] [2]. Examples for health aspects which have proven to be influenced are respiratory illnesses, allergies, asthma and more. [6]. The planned installation of an innovative ventilation system within the buildings facade, including air temperature conditioning, showcases this benefit to its full extent.

2 Technical information

Key technologies installed

Besides about 40 cm thick mineral wool as thermal insulation, the prefabricated panels most importantly include active elements to implement an innovative ventilation system via the outside wall. The inlet air will also be preconditioned by heat exchangers connected to the central district heating system, allowing for an ideal indoor climate throughout the entire year. The facade elements will include almost all relevant piping for this measure, as well as new windows for all three buildings to complete the holistic refurbishment of the entire outer building.

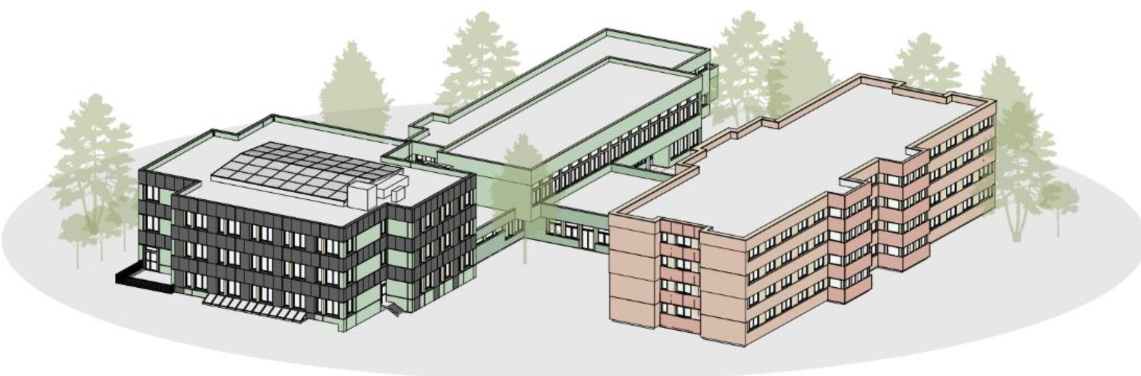

Figure 3: Rendering of the three buildings in Knittelfeld in their refurbished state with the school (left) and the two boarding school buildings (middle and right). Source: Nussmüller Architekten.

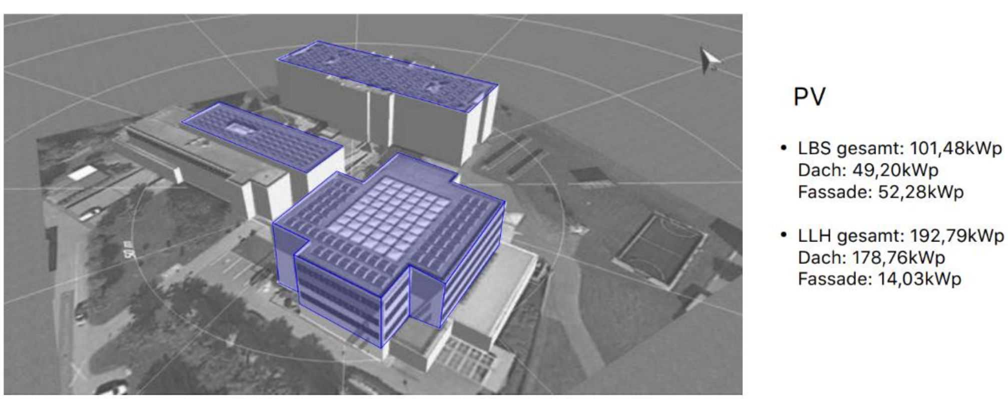

Figure 4: Satellite image from Google Earth with highlighted areas that are going to be used for PV, including power ratings. Source: Nussmüller Architekten.

3 Business model details and possible financing arrangements

Well suited financing schemes and business models are of central importance for a large-scale roll-out and replication of PEBs. The main benefits of PEBs stem from energy efficiency and the use of renewable energy sources. However, serial renovation with multifunctional facade elements lead to multiple additional benefits that can have an economic impact. The following list outlines relevant value propositions and revenue streams for the PEB renovation with multifunctional facade elements as realized in the Excess demo and the present replication case.

Lower heat energy demand: The deep renovation of the building significantly reduces (~80%) the heat energy demand and, therefore, heat energy cost.

Non-intrusive renovation process: One central benefit is the non-intrusiveness of the renovation process. This means that users do not have to move out during renovation process, as the multifunctional facade element is placed on the outside of the building. Renovation with multifunctional facade elements, therefore, saves the cost of relocation for users.

Speed of renovation: Another financial benefit of the serial renovation approach is the speed of renovation. As the facade elements are prefabricated, the renovation process onside is faster (around 50-60% time saved) compared to conventional renovation processes. This allows for a continued use of the school and boarding school buildings.

PV production: The renovation concept also contains a building-integrated PV module that leads to additional revenues from electricity feed into the grid.

This replication case could take advantage of all the previously mentioned benefits and revenues. The replication case is financed by the Landesimmobilien-Gesellschaft Styria through the conservation and improvement contribution fund, reserves and funding.

4 Possible PEB upgrade timeline

These buildings are in fact already fully under construction, with construction work having started in July 2024. The work is carried out by a general contractor with the goal of **finishing the entire school building in October 2024**. The other two will be undergoing the same renovation in summer 2025. After implementation, the building will be subjected to a scientific monitoring of at least one year, gathering data for optimization and further improvement of the deployed technical solutions.

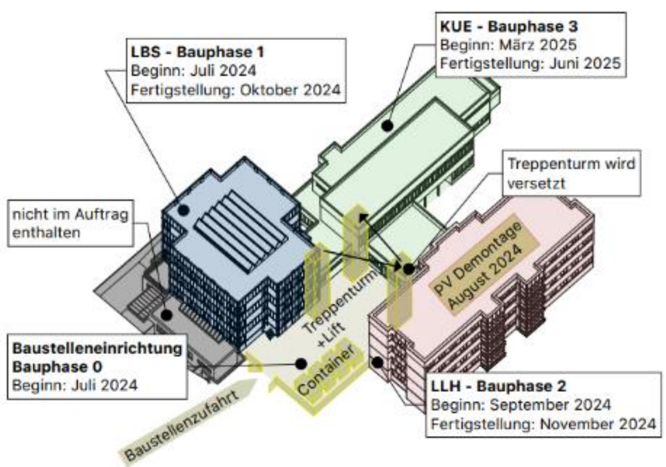

Figure 5: Schematic of the three buildings including the respective timelines for refurbishment. Source: Nussmüller Architekten.

5 Policy Recommendations

The multifunctional facade element fits best for renovation projects of buildings with construction year 1970 to 1990, as those buildings mostly have plain walls with low insulation levels.

Currently, there are no dedicated support schemes for serial renovation of buildings with multifunctional facade elements. There are also no support schemes available that target the holistic approach of PEBs but rather only separate support mechanisms for insulation and RES installation. Thus, new innovative support schemes for serial renovation to PEB standard could increase the replication potential. Since serial refurbishment can be carried out most effectively by general contractors, this reality also needs to be reflected in such funding schemes. Tendering for general contractors as opposed to tender for individual trades should be allowed. Renovation with multifunctional facade elements and heat pumps lead to a higher complexity of the buildings energy system, which requires highly skilled companies that could plan, build and operate the energy system. Therefore, important drivers for PEB replication can be facilitators, One-Stop-Shops or specialized integrators that help to overcome the intertwined barrier of the complex buildings energy system of PEBs.

Finally, more ambitious obligations (minimum performance requirements) and strict and effective transposition, implementation and enforcement of existing legislation could boost the replication of PEBs.