SCHOOL RENOVATION TO PASSIVE HOUSE STANDARD – A METHODICAL APPROACH AND A SUCCESS STORY

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ABSTRACT

The gloomy situation of current schools longs for a radical modification of the traditional methods of school renovations. The task for the owners, namely to get their school buildings "Fit for the Future" is a challenge and needs joint efforts within Europe. This paper presents a methodological approach on school building renovation developed among partners from the Eracobuild SCHOOLVENTCOOL project and external experts. The key focus was to find a way to break the cycle of traditionally applied and accustomed procedures that impede feasible and successful school renovations.

But any theory has to be proofed in practice. The Best Practice example of the school renovation of the "Nature Park School Zirbitzkogel-Grebenzen" (Austria) was realized by Arch. Gerhard Kopeinig showing the relevant success patterns. The story starts with an open project development that integrated the target users' just from the beginning and aimed at fostering the incorporation of the school into the region. A key focus was set on the implementation of prefabricated modules in order to reach the target of passive house standard for the major part of the building complex.

Résumé:

Passive house standard for school renovation is feasible and has already been realized in practice. Prefabrication offers a good basis for successful renovations but the success of the entire story depends on the commitment to follow the right strategy right from the beginning to the end.

1. STATUS QUO

Currently the pressure on the public sector is very high: on the one hand new buildings have to meet the standards of almost *zero energy buildings* by the end of 2018 (required by EPBD recast 2010/31/EU). On the other hand an Energy Efficiency Plan (COM, 2011) aims at an annual renovation rate of 3% of total floor area by 2014.The public sector shall set a good example and promote this rate by a binding renovation target. All over Europe both energy and education related developments require the transformation of our school building stock. However, the task for school building owners to renovate and adapt their building portfolios is challenging. From the technical point of view innovative technologies like prefabricated façade and roof modules, optimized building services (e.g.: ventilation systems) are available and already implemented in pilot projects – but these measures are rarely realized as common practice. Furthermore integrated design approaches or the integration of users are frequently used key words, but implemented too rarely. Mostly the focus of school building owners is set on the single school building trying to cope with technical and financial challenges. Renovation is usually characterized by limited resources and the implementation of the most necessary measures.

2. THE SCHOOL*VENT*COOL METHODOLOGY

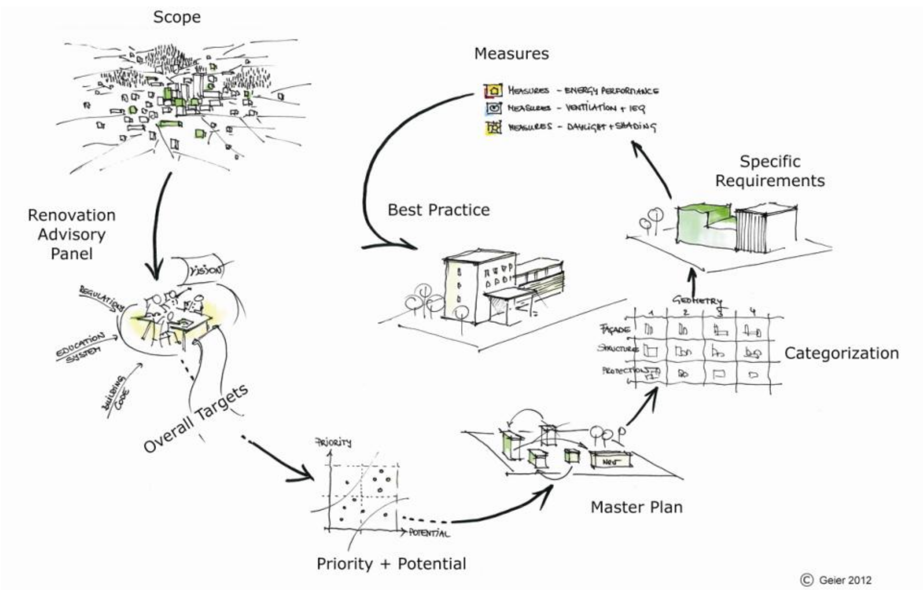


FIGURE 1: SCHOOL*VENT*COOL APRROACH (SOURCE: SCHOOL*VENT*COOL PROJECT)

Consequently a radical change in the traditional way is necessary. The SCHOOL*VENT*COOL project aimed at demonstrating this new solution: An interdisciplinary team consisting of architects, constructors, technicians, school administrators and many others studied various selected projects in international workshops in order to work out a standard approach for school renovations. This *Integrated Design Process* showed that the key issue was to break the cycle of the commonly applied and traditional procedures. The result was an open interdisciplinary discussion identifying challenges and solutions for the selected case studies. The analyses of strategy patterns lead to the final SCHOOL*VENT*COOL methodology.

The methodological approach

School buildings are part of a portfolio of buildings which in many EU member states administered by local municipalities or larger public or private school administrators. Successful renovation of school buildings cannot be performed without a scope and a sufficient overview and documentation on the entire held portfolio. This perspective helps to avoid measures and investments in a non-selective way.

Furthermore a school building portfolio is characterized by its own specific pre-settings arising from the existing building stock. This makes it difficult to provide one generally applicable solution. Moreover the appropriate approach is often a balance between different requirements, interests and preferences and is generally a compromise among several stakeholders, their interests and financial restrictions. Hence a core issue is to gain a multi-disciplinary perspective on a long-term basis. The “Big Picture” of the building portfolio should be designed in a way that focuses on the vision of education and the performance about 30-40 years ahead. Intensive discussions and the integration of panels with different fields of expertise faciltate long-sighted strategic planning for the entire portfolio and target-setting on the portfolio level. Hence the discussion is led on a general level for the entire portfolio instead of focusing on individual renovations and technical solutions. Such strategic development later avoids repetitive and boundless discussions on the level of the specific building.

In order to support strategic decision-making the SCHOOL*VENT*COOL project developed a methodological approach to identify priorities and potentials within a building portfolio. The proposal is based on the development of the Austrian criteria catalogue to assess the renovation potential of multi-familiy houses (www.hausderzukunft.at/results.html/id6337). A portfolio can never assess all buildings in detail on the overall level but a ranking of relevant criteria might help to identify which school buildings’ adaptation or renovation might be more viable than others. The result is shown in a matrix (Figure 2) where the potential of the buildings within the portfolio have to be assessed and compared to the needs in order to provide guidance on the chronological order and extent of renovation.

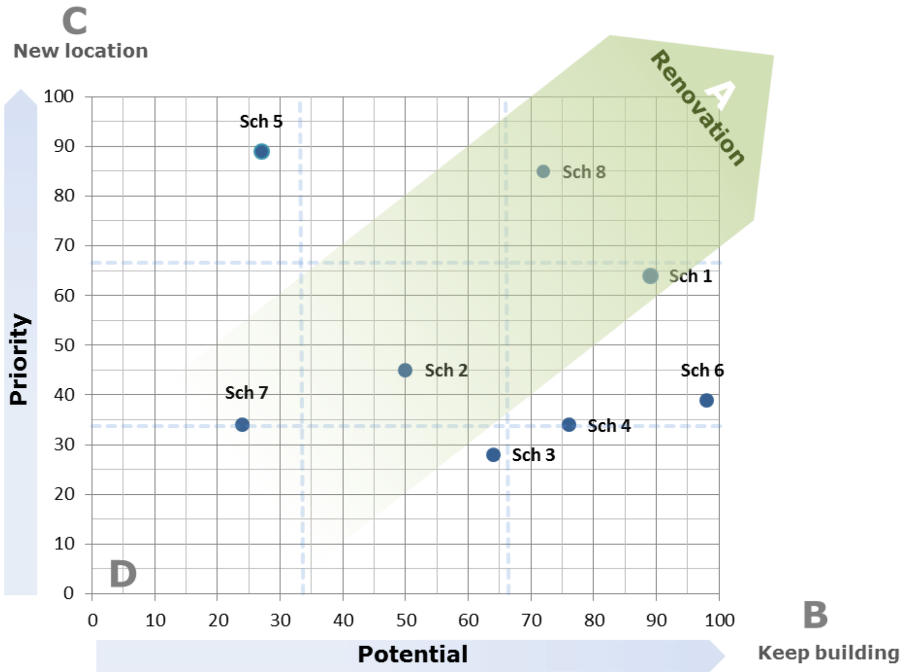


FIGURE 2: PRIORITY – POTENTIAL MATRIX SUPPORTS DECISION-MAKING WITHIN A BUILDING PORTFOLIO (EXEMPLARY VISUALIZATION).

Best Practice

The best way to prove theories is to show that they have already been realized. Although every project has its own specific approach – the pattern of the strategy and the subsequent success is similar. Hereinafter a school renovation that was realized as a demonstration project within the Austrian technology program "*e2020-Neue Energien"* (www.ffg.at/neue-energien-2020) is introduced in order to demonstrate that the patterns of successful school renovation are similar and feasible to be performed in practice.

3. BEST PRACTICE NATURE PARK SCHOOL GREBENZEN

Motivation

FIGURE 3: RENDERING

Main aims of the project:

- Improving the spatial structure and space connections by creating an attractive outside and attractive interiors; making the open space available for the pupils.
- Creating an energy-efficient building with minimal operating costs.
- Creating areas of high air quality and comfort.
- Fostering the use of local, renewable resources.
- Meeting all the required functions of the building complex as a secondary school, a place for after-school care, a public venue for meetings and events as well as sports facilities for clubs.
- The school building is also located in region with shrinking society. So there were to find answers how to manage this situation - by defining a school centre – to provide the families with all facilities.
- Giving the local companies a chance to make the job there. The region is well known for wooden construction, so the task was to use their knowledge and develop it, so the use of wooden elements for renovation became possible.

Situation before renovation

The existing building was a low-budget construction from the early 1970s as they can be found in large numbers across Austria. It showed reinforced concrete frames filled with bricks and single-glazed wooden windows. The heating costs were about 50.000 € per year on electricity.

It is the usual procedure in Austria to use around 15 cm of “EPS” in renovations in order to reach the low-energy standard (Fig. 4).

In Neumarkt, we aimed at renovating with prefabricated wooden elements (Fig. 5). This way, we wanted to be both quicker and more precise and, above all, to reach the passive house standard using renewable materials.

Why we – together with the client – decided to rebuild the school according to passive house standard with wooden elements was not only the wooden tradition and the short time of mounding or the air quality inside; it was much more also the calculation that we had the chance to reduce the installation costs for heating (even if we had to calculate 90 EUR/m^2 for comfort ventilation) and to minimize to running costs $^1/_{10}$ we had before. The government meanwhile also recognized that this is the future.

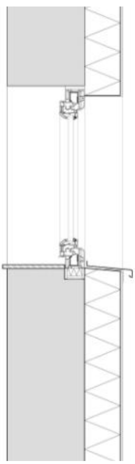


FIGURE 4: DETAIL WITH 15 cm “EPS”

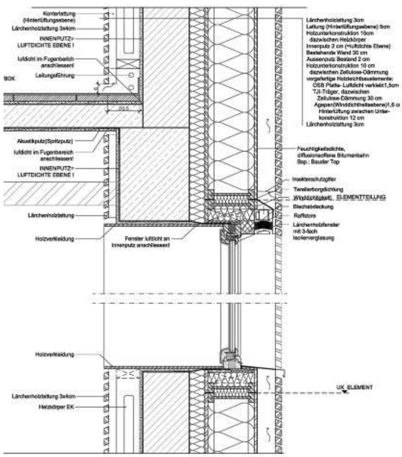


FIGURE 5: DETAIL WITH PREFABRICATED WOODEN ELEMENTS

Integrated design approach

The general project plan for the school was developed together with the municipality and other stakeholders (= definition of scope and advisory panel =

multidisciplinary project team). Mutually agreed general targets comprised using wood, reaching passive house standard, and creating a multifunctional centre in the region.

The success story of the renovation started with an open project development. It incorporated the intended users' right from the beginning. A basic aim was to closely integrate the school into the specific structure of the region: The school buildings host a secondary school, the public music school, rooms for clubs and event rooms for the municipality. At the same time, we explicitly focussed on the use of wood as a construction material from the region. A major part of the building complex was renovated with prefabricated wooden modules that were encased with a wood slat façade. The installation of a centralized ventilation system with 80 % heat recovery, external venetian blinds and a highly elaborate system for night ventilation were designed to guarantee a high indoor environmental quality.

The realized renovation

Measures (Prefab, NEH/ PH adapted to existing building situation)

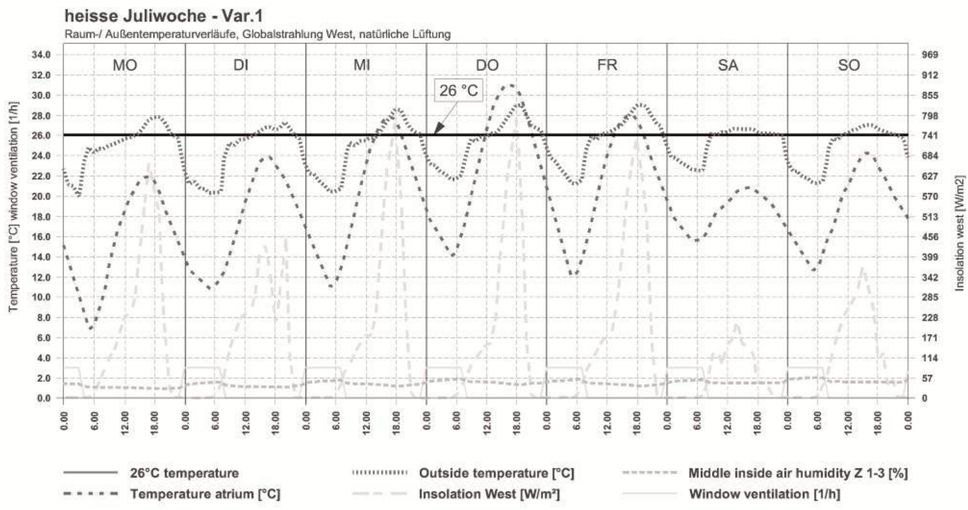
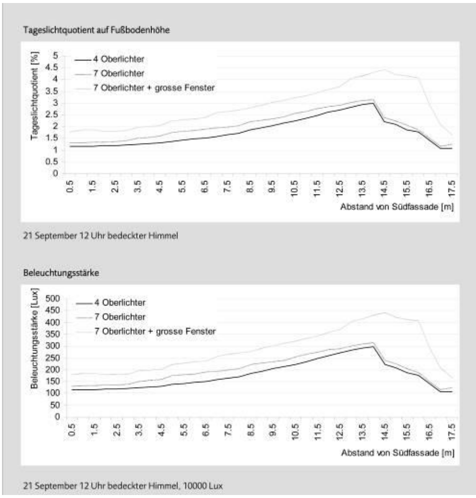


FIGURE 6: TEMPERATURE SIMULATION OF THE ENTRANCE ATRIUM

Renovation means planning in detail. First it is most important to know all the materials and constructions you have on the existing building. Second it is necessary to look very close on the system you design.

For example the entrance atrium was developed because we had too many square meters of classroom space. The official authorities wanted us to pull down one floor of the existing building. The solution we worked out in the end was to pull down one classroom per floor in order to gain an open study zone and the atrium. The façade of the atrium we opened was glazed and orientated to the west. The simulation (Fig. 6) we did on the space showed that if we used natural night ventilation we did not need any shading (lower costs, less service, easier cleaning), because the room did not get overheated (maximum 28 degrees Celsius in a hot July week).



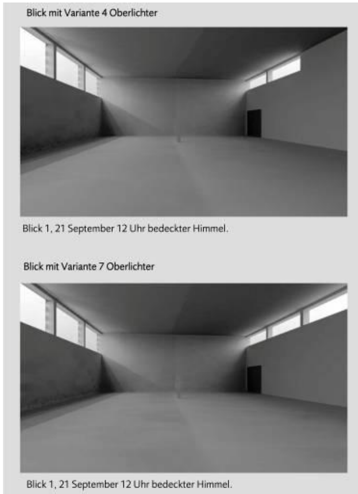


FIGURE 7: EXAMPLE FOR DAYLIGHT SIMULATION SIMULATION

FIGURE 8: EXAMPLE FOR DAYLIGHT

The second example was the sport and event hall of the school. Before renovation the windows on the north façade had the same size as on the south façade (Fig. 8). This caused serious problems in calculation (PHPP), because we were hardly able to meet the passive house standard due to the enormous thickness of insulation.

With the help of a daylight simulation we were able to show the client that the light inside the hall on a normal day in May was sufficient. We could thus reduce the window size on the north façade by 50% of their original size. This helped us to meet the passive house standard, reduced the building costs and the daylight situation was even better than before, because we used light materials.

Pictures of process of assembling and mounting

FIGURE 9: Existing building

FIGURE 10: Prefabricated elements

FIGURE 11: Prefabricated elements

FIGURE 12: PREFAB ELEMENTS

FIGURE 13: PREFAB ELEMENTS

FIGURE 14: CONSTRUCTION OF ROOF

The pictures above show the mounting of the wooden elements (Fig. 10 – 13). The prefabrication helped us in quality (production more precise in hall, without the influence of the weather), time (it was only possible to build 10 weeks in 2 years) and therefore also costs, because the companies developed a manufacturing system that made production more efficient.

One important point is to have a hall where you can store the pre-fabricated elements before mounting.

FIGURE 16: AFTER THE RENOVATION

FIGURE 17: SCHOOLYARD

FIGURE 18: FINISHED ATRIUM

FIGURE 19: WEST SIDE

FIGURE 20: CORRIDOR

FIGURE 21: NORTH EAST SIDE

FIGURE 15: SITE PLAN

Results

- Energy efficient redesign is economical (calculated over 30 years)
- The energy index will be reduced from 160 kWh/ m²a to 15 kWh /m²a
- A reduction of energy demand by factor 10 (which means $^{1}/_{10}$ of the following energy costs and $^{1}/_{10}$ of the previous CO_2 emission).

- A complete redesign of the School Center Neumarkt in Styria concerning sustainability, functionality, space, creativity for the school, the sport clubs and the region.

4. CONCLUSIONS AND OUTLOOK

Detailed conclusions/ Key patterns for the success of the project

In addition to their original purpose, school buildings may cover a variety of needs that arise within a specific school district as they are regularly vacant for extended periods of time. Besides incorporating a kindergarten or different types of schools, it makes sense to provide space for clubs or associations, for events and other cultural or leisure activities. More and more, the school becomes a core facility of the community. Hence the approach of the Nature Park School provides a good example for the situations of small towns but also for districts of a larger city or building portfolios.

Global conclusions

The discussion panels of the SCHOOL*VENT*COOL project agreed on the fact that all participating countries face similar challenges. It is a demanding task to transform school building portfolios in order to meet the needs and visions for the next 30-40 years. Joint efforts within Europe and an ongoing exchange of knowledge and experiences on transnational level will make it easier to overcome common patterns of renovation approaches and procedures. The perspective on single buildings and the focus on the best available technologies are necessary – but only after the strategic planning and basis for decision-making was done on the level of the building portfolio.

ACKNOWLEDGEMENTS

The SCHOOL*VENT*COOL-project was established in response to the ERA-NET Eracobuild joint call for research on Sustainable Renovation in 2010. The participation of each partner within the project is based on own national funding. The partners of the SCHOOL*VENT*COOL project are:

- AEE – Institute for Sustainable Technologies (AEE INTEC).
- Stad Antwerpen Stedelijk Onderwijs, Belgium.
- Passiefhuis-Platform vzw (PHP), Belgium.
- Technical University of Denmark, Building Physics and Services, DTU Civil Engineering (DTU- BPS), Denmark.

- Technical University of Denmark, International Centre for Indoor Environment and Energy (DTU- ICIEE), Denmark.
- Lucerne University of Applied Sciences and Arts, Engineering & Architecture. Competence Center Typology & Planning in Architecture (CCTP), Switzerland.
- University of Applied Sciences North Western Switzerland, Institute of Energy in Buildings (FHNW), Switzerland.

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