

RENEW SCHOOL

**Sustainable school buildings in Europe
with prefabricated timber elements**

EXAMPLES AND EXPERIENCES



CONTENT

Foreword.....	3
Introduction.....	4
Building physics	5
Examples and experiencies	
■ Musik-NMS and PTS Schwanenstadt.....	12
■ Søreide Skole.....	16
■ Neue Mittelschule Rainbach.....	20
■ Heusden-Zolder Education School	24
■ Volksschule St. Leonhard bei Siebenbrunn.....	28
■ Scuola Media Alessandro Volta.....	32
■ Talenteschule Doren	36
■ Berufskolleg Detmold	40
■ Naturparkmittelschule Neumarkt	44
■ Europaschule Rostock.....	46
Technical Summary	52
Financing and cooperation models	54
Imprint	58
Picture Credits	59



FOREWORD



Renovated school buildings provide the best possible learning conditions for our children and they are energy efficient as well. It is in the public's interest to renovate school buildings to make them fit for the future.

Worldwide a high share of buildings require refurbishments and schools are no exception. There is a national and international demand for new concepts and technologies for the deep renovation of (school) buildings.

This best-practice brochure was created within the EU project RENEW SCHOOL in order to present outstanding school renovation projects that have been realised in Austria and Europe. This demonstrates the availability of knowledge for qualitative refurbishment. Consequently, the next step is the broad application. As technology leaders Austrian companies are highly sought-after partners at home as well as abroad.

My department is engaged in research for energy efficient and sustainable building and refurbishment within the R&D programme "City of Tomorrow". In 2006 the first school renovation to passive house standard was funded. The breakthrough of technological developments was supported especially in research areas highly relevant for the renovation of school buildings: light and lighting, air quality, innovative building materials and production technologies.

The foresight of principals, owners as well as of many other stakeholders is essential in order to start sustainable projects. Therefore, I hope that this brochure not only provides an overview of innovative school projects throughout Europe, but also inspires national projects to sustainability and energy efficiency. With this in mind I wish you a stimulating and interesting read.

A handwritten signature in black ink, appearing to read "Jörg Leichtfried". The signature is fluid and cursive, with a large initial "J" and "L".

Jörg Leichtfried

Austrian Federal Minister of Transport, Innovation and Technology



THE MOTIVATION FOR THIS BROCHURE

Schools are places of public interest. Therefore, not only the education system but also the state of the buildings themselves carry an important message to the public. In this brochure we want to show that major changes in school architecture are becoming visible. Today there are school buildings with high indoor air- and daylight quality, where prefabricated timber elements were used to build or retrofit rapidly and obtain high-level results regarding energy and environment.

Moreover, renewable sources contribute to the energy supply of the school. These schools have an identity, and provide for an appropriate environment to learn and work with success.

The examples in this brochure are chosen in order to promote high quality construction methods for schools.

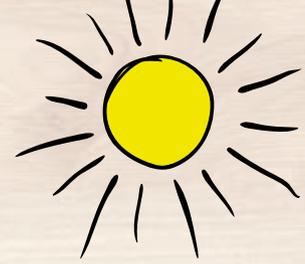
They are characterized by their implementation of the following goals:

- Improvement of the building envelope with prefabricated insulated timber elements
- Improvement of the indoor air quality and the comfort in the classrooms through ventilation systems and daylight use with intelligent protection from excess sun light, glare and heat
- Increase of the use of renewable energy sources

Each of the 10 school buildings described in this brochure has been analysed in the EU-project RENEW SCHOOL in order to learn from it. Each of it is commendable in its own way.



RENEW SCHOOL



LIGHT

We need light in order to see.

Light comes from the sun and sky, and it can be created artificially from electricity. The illumination of a surface is given in Lux [lx], and in school it should be at least 300 lx. Illumination can be measured by smartphone applications (e.g. Lux Meter).

Even though artificial light and sunlight both allow us to see, their spectra have different effects on our organisms. Using sunlight is not only energy-efficient, but also good for our health. Depending on the characteristics of the glass, windows allow light as well as heat (short-length heat waves) to enter. Moreover, they allow for visual contact with the environment. On the other hand, too much sunlight may cause glare and lead to overheating. When planning to build or retrofit a school, the use of sunlight and artificial light should be considered.

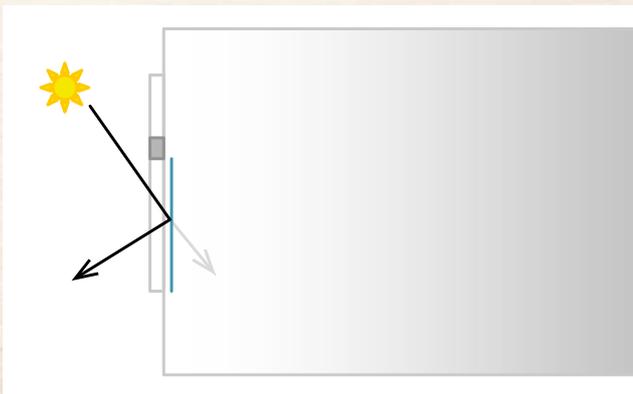
Depending on window orientation and glazing, a shading system might be necessary to prevent glare and/or overheating.

To improve the lighting situation in the school, designers should consider window size and room depth.

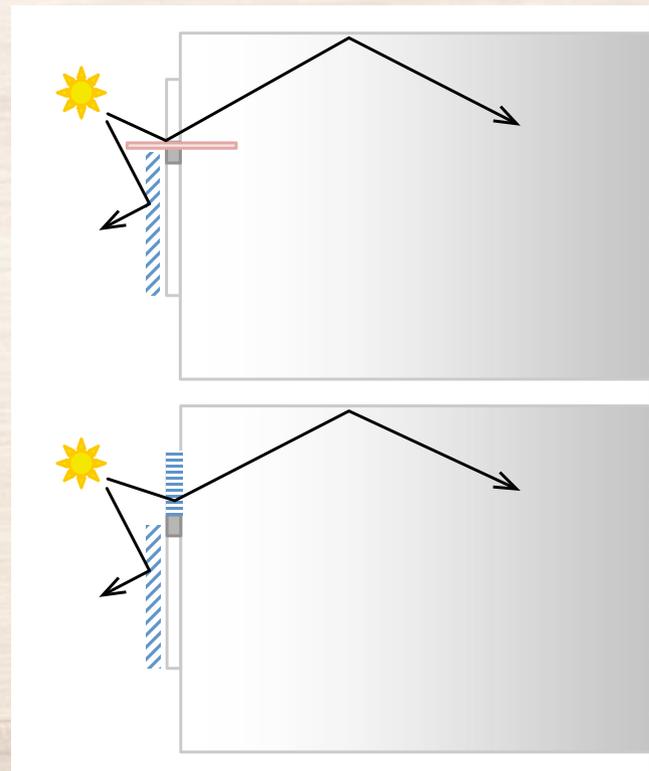
Measures that can improve daylighting include

- Light shelves
- Semi-transparent textile blinds
- Venetian blinds
- Bright colors on ceiling and walls
- Energetically optimized skylights

Find out more about the daylighting solutions on the page of the European solar shading organization <http://es-so.com/> and in the school examples.



Prevention of glare



Light guiding systems



WATER

It is important to take care of humidity.

Some water vapour in the air is good to keep mucous membranes humid and school users healthy. On cold and dry winter days, a too high ventilation rate might result in very dry indoor air, with bad effects on the users' health. **On the other hand, water molecules can condense on cold surfaces and in building materials, leading to mould and decomposition.**

Wood is an organic material, and thus sensitive to water. Therefore, it is important to prevent water from condensing in wooden structures. Ventilated facades can help here, as well as using steam barrier materials.

Your designer will find a good way to protect prefabricated wooden elements from humidity, considering the local climate, and the state of the existent building.



COOL

In summer, buildings can heat up (quite a bit).

On average, outside temperatures have risen by 0,85°C in the last 130 years. This may not seem much, but some regions are experiencing increasingly hot and dry summers. Overheating is an issue almost everywhere in Europe, and even more pressing when schools are to be used in summer. But depending on the local climate schools can overheat also in spring, making concentration and learning seem impossible while our thoughts drift off towards the swimming pool. Protection from overheating is therefore very important.

But where does the heat in school buildings come from?

There are several heat sources, the most important ones are

- Electric devices like lights, computers and projectors
- Human bodies, which produce about 70 W each, depending on activity and size

- Solar heat by radiation through windows
- Solar heat by hot air from outside entering the building

Since there are many sources, overheating can be addressed by different measures

- avoid unnecessary use of electric devices
- reduce solar heat input by shading or planting trees in the courtyard
- use cool nights to cool down the building through night ventilation.

Using simulations or just testing different methods will show if the temperatures can be kept in the comfort ranges (like those defined in EN 15251).



AIR

Air is essential to human life.

We produce and exhale CO₂ as we live, think and learn. Dust, evaporation from furniture and exhalation products like CO₂ stress our organism and make us less efficient. Therefore, a decent indoor air quality, that is level I or II as defined in EN 13779, should be maintained.

For each person, about 20 to 30 m³ of indoor air should be exchanged by fresh outdoor air per hour. This amounts to around 675 m³ per hour for a class of 25 pupils and 2 teachers!

There are various possibilities to ensure this air exchange:

- Natural ventilation, for example by allowing air to move in or out through windows and doors.
- Mechanical ventilation, with fans.
- Hybrid ventilation, a mix between a) and b)

The VENTILATION CONCEPT helps to ensure that air exchange is feasible and sufficient.

How much air has to be exchanged?

Who will be responsible for the air exchange?

With natural ventilation, how often and for how long should windows be opened?

These are questions to be answered in the ventilation concept. It has to be ready before starting with the design for a renovation or new building. In the hands of an architect or a ventilation planner it will help to ensure a good air quality. In case of a renovation, the caretaker or the users of the house should be included in the creation of the ventilation concept. Air quality in existing buildings can easily be measured with a CO₂ sensor. Free calculation tools available online can help estimate how much air can be exchanged through window openings. Check out Sommluft at <https://passipedia.org/planning/tools>

Consider mechanical ventilation due to

■ Heat loss

With warm indoor air moving outside, the heat in the air is lost, too. This can amount to around 200 kWh or 17 liters of heating oil per person and year in a climate like Graz, Austria. Mechanical ventilation systems allow recovering 75% or more.

■ Outdoor air quality

Filters in the mechanical ventilation systems keep out pollutants over a certain grain size.

■ Noise

Your school may be in a noisy surrounding. Mechanical ventilation does not let in noise like windows do. Sound absorbers reduce noise produced in the ventilation unit.

Mechanical ventilation can come in different forms, most of them are well suited for school buildings. Your ventilation or HVAC planner can inform you on how you can reach a good air quality in your school.

Find more information on different options in the school descriptions.

$$Q = V \Delta T c$$

Q ... heat loss

V ... exchanged air volume

ΔT ... Temperature difference between inside and outside

c ... heat capacity of air

(0,32 Wh/m³K is a typical value for Austria)

Calculation of losses due to air exchange



HEAT

Sitting close to a cold wall or window can make us feel very uncomfortable.

Many currently existing schools have been built in the sixties, seventies and eighties of the twentieth century. In this period, energy saving was not considered as very important. We encounter walls with high heat transmission losses, often made out of armoured steel without any heat insulation.

It follows that energy losses by transmission are high. In cold periods, this means high energy consumption for heating as well as cold walls.

When walls and windows are cool, the air temperature has to be even higher in order to make us feel comfortable.

The solution of course is to insulate walls and roofs, and replace windows. This will reduce energy consumption and at the same time improve comfort, making schools a better place to learn and work.

PREFABRICATED WOODEN ELEMENTS

A school should not only feel nice but also look good!

It is even better, if the new outer skin does not need a lot of maintenance. And if it was possible to intensively use the summer break for renovation ... and not even relocate classes... It is possible to reach all that using prefabricated wooden elements.

- Before starting prefabrication, the existing facade is measured accurately
- Prefabrication means that facade elements are prepared in factories, thus reducing the renovation time on-site
- Prefabricated elements come in high quality, since they do not suffer from weather conditions at the building site

The main advantage of using wood in renovation is its relatively low weight and high resilience. If the building is short of space, another level can be added in wood construction. Especially in countries with forests, wood is a sustainable construction material.

Find out on the next pages how prefabricated wooden elements have been used in school buildings to increase energy efficiency and maintain a high comfort. To go deeper into the subject look for the "School's technological signpost" on the page of RENEW SCHOOL www.renew-school.eu



EXAMPLES AND EXPERIENCES



Musik-NMS and PTS Schwanenstadt

SCHWANENSTADT / UPPER AUSTRIA

The school building is situated in the centre of Upper Austria and was renovated and enlarged already in 2007. It houses two schools: The secondary modern school offers education up to the 8th school year with special attention also to music, while the 'polytechnic school' accompanies pupils in their last obligatory school year and supports them in choosing their future professional development. In total, about 350 pupils attend the two schools.

The motivations for the retrofit were structural damages in the buildings as well as the overall poor energetic quality. The gymnasium was renovated as well, but unlike the rest of the building it was not equipped with mechanical ventilation featuring heat recovery. Already in 2002 the planning started, and an agreement was achieved with the regional government on

the financial support for the project. But then the planning team was completely changed by the city government and Architect Plöderl and his team was put in charge with planning the first school renovation to reach passive house standard in Austria. Now 10 years have passed since the renovation with prefabricated timber elements was concluded and the building is still in a very good state, evidently innovative even if in the meantime further steps have been taken in construction technology. The building now hosts 16 classrooms, the administration, a gymnasium and a number of functionalized rooms like a refectory.





We are glad that we have chosen to renovate in passive house standard. It allows us to achieve not only a huge reduction in CO₂ emissions, but also enormous savings in heating energy and of course heating costs. Part of the renovation work was done during school time; the extension was built in the summer holidays.

Karl Staudinger, mayor of Schwanenstadt





New Building or Renovation:

Renovation and extension

School type:

Secondary modern school and polytechnic school

Age classes: 5 (aged 10 to 15)

Function: School building with rooms for crafts, gymnasium and refectory

Motivation: defects in the construction and low comfort

Gross Floor Area (GFA): 6835 m²

Heating consumption: 14 kWh/m²_{GFA}.a (previously 145)

Electricity consumption: 15 kWh/m²_{GFA}.a

Final energy consumption: 43 kWh/m²_{GFA}.a

Number of pupils: Around 350

Year of construction/renovation: 1973/2007

AWARDS/CERTIFICATES

- Upper Austrian Prize for Timber Construction 2007
- Energy Globe Upper Austria 2007

SPECIFIC CHALLENGES AND LESSONS LEARNED

Appointing a main constructor for the renovation did not bring about the expected advantages: Some of the planned measures were not realized in the renovation process and had to be implemented later on.

The functionality of the building is still very good 10 years after the renovation.

FINANCING

Around 75% of the total project volume was covered by the government of Upper Austria, 4% of the financing came from the Austrian Climate and Energy Fund. The remaining 21% was paid for by the municipality with a grant. The support by the government of Upper Austria was very high, because 90% of the students come from neighbouring municipalities and only 10% from Schwanenstadt.

Project volume: 10,4 million euro

Main contractor: NEUE HEIMAT Oberösterreich
Gemeinnützige Wohnungs- und Siedlungs-GesmbH (of public use)

Building owner: Municipality of Schwanenstadt

Construction period: May 2006 – August 2007 (16 months)

BUILDING SERVICES

Decentralized, mechanical ventilation for each room regulated by CO₂ sensors, with heat recovery and the possibility for night ventilation. A central pellets heating boiler (110 kW) – regulated by outdoor temperature – and a buffer storage – holding 1860 liters – feed radiators and provide part of the domestic hot water. In addition there are some decentralized electric boilers for hot water. The electric power is generated by photovoltaic elements integrated in the facade (6,7 kW peak power).

FACADE CONSTRUCTION

Prefabricated timber elements were filled on the building site with up to 58 cm of cellulose insulation material and mounted on the outer walls made of reinforced concrete. The construction is protected on the outside by a ventilated timber cover. In this way, the U-value of previously 2,5 W/m²K was reduced to 0,11 W/m²K. The windows framed by wood and aluminium feature Persian blinds, which can be used to steer sunlight far into the rooms.

CONTACTS

Architecture:

DI Heinz Plöderl, PAUAT Architekten ZTGmbH, Atelier Wels
Bernardingasse 14, 4600 Wels
E-Post: h.ploederl@pau.at

Municipality:

Mayor Karl Staudinger
Stadtplatz 54, 4690 Schwanenstadt
E-Post: stadttamt@schwanenstadt.ooe.gv.at

School:

Principal Martina Decker
Mühlfeldstraße 1, 4690 Schwanenstadt
E-Post: nms2.schwanenstadt@eduhi.at



**passive
house for
active
students**



Søreide Skole

BERGEN / NORWAY



The primary school is located close to Bergen in Norway. It was built in 2013 because the old school building was getting way too small and is used by up to 600 pupils.

It is almost entirely made from wood and a model project of «Time for timber» in the national programme “Cities of the Future”.

The classrooms are grouped to form three units, where each of these units offers an additional common room to be used by everyone. The school promotes gentle mobility like walking and riding bicycles.





This building affects you as soon as you enter the door. It is light and airy and feels warm due to the wooden walls. I observe adults and children lower their shoulders and relax.

Atle Myking, principal of Søreide school



**New building or renovation:**

new construction

Construction year: 2013

School type: Primary school

Age classes: 7 (aged 7 to 13)

Function: School building with multi-functional room, kitchen; external use for workshops, events etc.

Motivation: Requirement of space

Gross Floor Area (GFA): 8300 m²

Electricity consumption: 50 kWh/m²_{GFA}.a

Heat consumption in addition to internal and solar gains as well as heat recovery in ventilation:

about 15 kWh/m²_{GFA}.a

Number of pupils: up to 600

Construction time:

April 2012 – December 2013 (18 months)

AWARDS/CERTIFICATES

- The building was nominated for “This year’s timber construction 2013” and was, along with three other projects, highlighted for the innovative use of timber.
- The project has followed a BREEAM NOR classification and has achieved a certificate for the standard “Very Good”.
- Pilot project in the “Cities for the Future Program”

SPECIFIC CHALLENGES AND LESSONS LEARNED

Due to prefabrication the construction period was so short that it was not necessary to build a canopy for the building site. The school is a good example for a winning cooperation between planning and skilled crafts. In order to guarantee a high quality the manufacturers undertook a specific training.

FINANCING

Project volume: around 25 million euro

Financed by public–private partnership: The school was built by Skanska Norway, which also holds the ownership for 25 years. It is leased by the community and passes into the communities’ ownership after 25 years. The project was supported by “Time for Timber” (Tid for Tre – Bergen) in the “Cities of the Future” programme (Framtidens byer).

One of the goals was to reduce cradle to grave CO₂ emissions to 50% of the maximum allowed values. The additional costs to reach this goal are 5% of total costs.

Timber constructions: Sotra Takstol AS

BUILDING SERVICES

Central mechanical ventilation with a heat recovery factor of 81% and a maximum of 0,42 W per [m³/h] of power use. Also, the heat generation system is centralized, it offers heat for space heating, domestic hot water and to preheat inhale air. As heat source, a solar thermal facility is used in combination with a heat pump. The system is designed to cover 30% of total heat demand by on-site generation.

CONSTRUCTION

The building mainly consists of timber, some parts are made in concrete. The roof is made from timber, just like the interior and the facade cover.

CONTACTS**Architecture:**

Asplan Viak, Christian Irgens

E-post: christian.irgens@asplanviak.no

Developer:

Skanska Norge

Håvard Tjore

E-post: havard.tjore@skanska.no

Jorunn Grøntveit

E-post: jorunn.grontveit@skanska.no

School:

Nordeidåsen 5, 5251 Søreidgrend, Norway

E-post: soreide.skole@bergen.kommune.no



Tid for Tre
TIME FOR TIMBER



Neue Mittelschule Rainbach

RAINBACH IM MÜHLKREIS / UPPER AUSTRIA

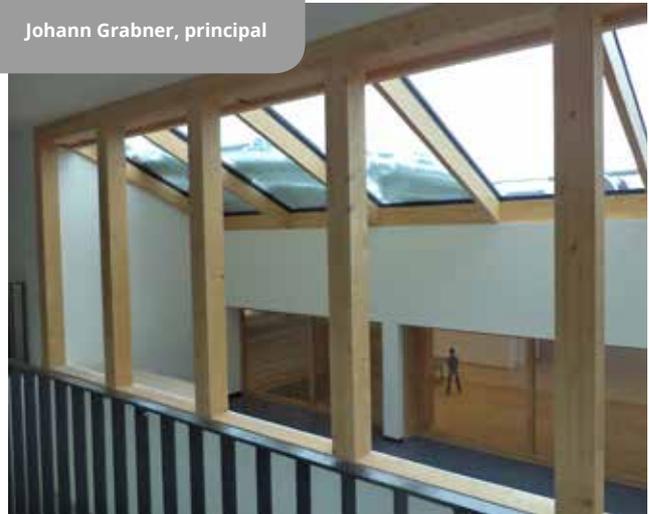
The secondary school is located in the Mühlviertel in Upper Austria. The building was renovated in 2013 and now provides space for about 120 pupils. The main motivation for the renovation was the extremely bad structural condition of the building. The pre-design phase took a very long time. Already in 2001 the decision was made to renovate the building, then 2010 the design team was replaced. Timber elements were used for the facades as well as the resulting new cultural hall. The building now includes 6 classrooms, the administration, special rooms like work rooms and the boiler room. Furthermore, rooms for the care attendants and the refectory are included.





“
The bright, light-flooded rooms allow for well-being.
The transformation of the school from a large energy
consumer to an energy generating „powerhouse“
(photovoltaic) makes the building a „flagship project
of the energy revolution“ .

Johann Grabner, principal





New building or renovation:

Renovation and extension

School type: Secondary school

Age classes: 4 (aged 10 to 14)

Function: School building, refectory, event area

Motivation: Structural damages and massive comfort deficiencies

Gross Floor Area (GFA): 3243 m²

Heating demand: 13,6 kWh/m²_{GFA}·a (before 139,5)

Electricity demand: ca. 15,5 kWh/m²_{GFA}·a

Final energy demand: 55,6 kWh/m²_{GFA}·a

Number of pupils: around 120

Construction time: 1973/2013

AWARDS/CERTIFICATES

- energy star 2014
- klimaaktiv gold certificate – object of the month 4/2015
- best practice renovation of the Climate and Energy Fund

SPECIFIC CHALLENGES AND LESSONS LEARNED

- The communication in the design team and the optimization in the operation phase went very well
- Great commitment of the construction management, the architect team, the principal, the school caretaker and the mayor

FINANCING

About 82% of the costs were covered by the State of Upper Austria; about 8% were funded by the Climate and Energy Fund for best practice renovation. The remaining 10% were allocated by the municipality of Rainbach.

Project costs: 7,4 million euro

Main contractor: Verein zur Förderung der Infrastruktur der Marktgemeinde Rainbach & CoKG

Architects: Ingrid Domenig-Meisinger, Albert P. Böhm

Building owner: Municipality of Rainbach

Construction time: May 2013 – September 2013 (5 months)

BUILDING SERVICES

Centralized mechanical ventilation system with heat recovery, heating of the supply air, night ventilation function and control based on the CO₂ concentration.

Wood chips central heating (boiler output 150 kW) and 20 m² solar thermal collectors feed a heat storage tank (2300 liter), which supplies the floor heating and the radiators; There is an outside temperature control. A gas boiler (50 kW) is installed in case of malfunction of the wood chips boiler.

Hot water is delivered only to places where it is needed for cleaning, showers and kitchen.

Electricity generation: 250 m² PV system on the roof with an output of 50 kWp.

The lighting is daylight-driven.

FACADE CONSTRUCTION

Prefabricated timber elements with 30 cm mineral wool insulation in a rear-ventilated timber frame construction with white fiber cement panels on the exterior were mounted on the existing reinforced concrete wall (including 6 cm mineral wool for level control). This way the U-value of the wall can be reduced from 2,3 W/m²K to 0,11 W/m²K. The wood-aluminium windows are equipped with daylight-deflecting outside blinds.

CONTACTS

Architecture:

ARCH + MORE, Haseneck 7, 4048 Puchenau/Linz

E-post: domenig@archmore.cc

Albert P. BÖHM, Stelzhamerstraße 10/II, 4020 Linz

E-post: office@architekt-boehm.at

Developer:

Verein zur Förderung der Infrastruktur

der Marktgemeinde Rainbach, Mayor Friedrich Stockinger

Pragerstraße 5, 4261 Rainbach i.M.

E-post: buergermeister@rainbach-muehlnkreis.ooe.gv.at

School:

Principal Johann Grabner, Schulstraße 16, 4261 Rainbach i.M.

E-post: s406092@lrs.eduhi.at



 **from energy devourer
to powerhouse**

Heusden-Zolder Adult Education School

HEUSDEN-ZOLDER / BELGIUM

The school is used as an adult education school by CVO De Verdieping. The new school building replaced an existing one on another site. The new school was built as an extension of an old mine building.

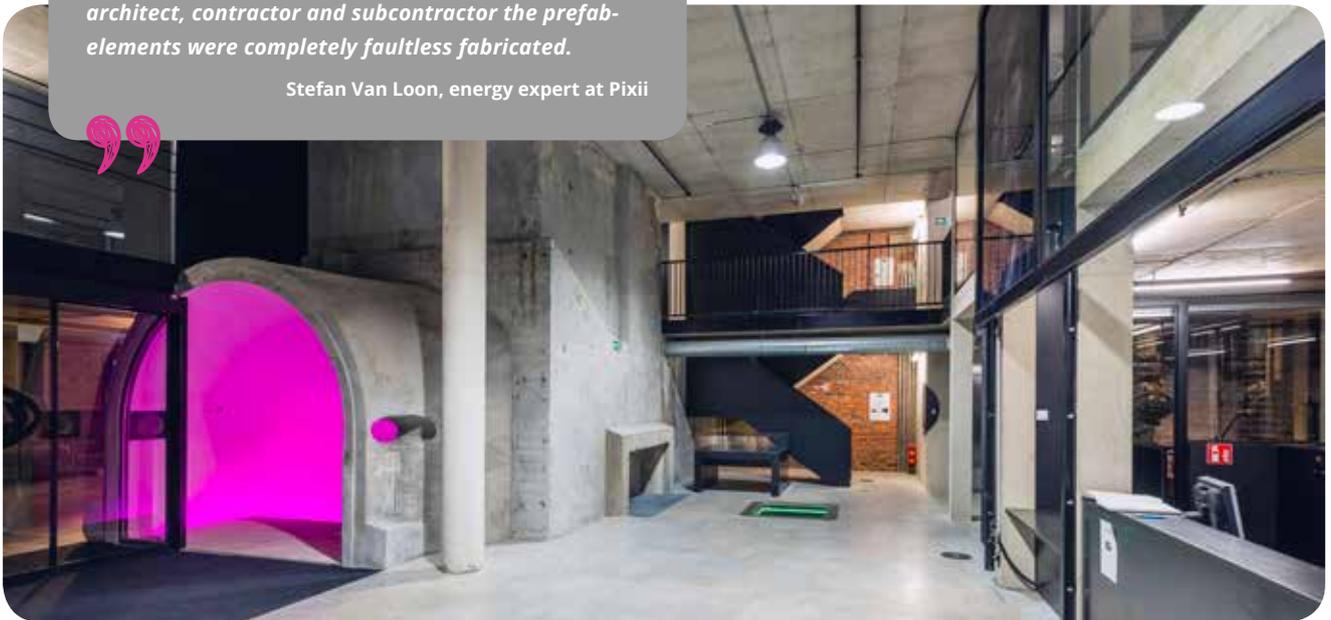
It was built in 2013-2014 and has been in use since February 2015. The main energy related targets were valuable energy savings and a healthy indoor climate with high comfort. Monitoring data are gathered during the first 2 years of operation.





“ Thanks to a very detailed design of the building envelope and sharing knowledge between the architect, contractor and subcontractor the prefab-elements were completely faultless fabricated.

Stefan Van Loon, energy expert at Pixii





Renovation or New Building:

New building (extension)

School type: Adult school

Age classes: From 18

Function: Educational building with administration, kitchen and dining rooms

Motivation for building:

Lack of space – need of extension

Gross floor area (GFA): 5637 m²

Heating consumption: 13 kWh/m²_{GFA}.a

Electricity consumption: 29,2 kWh/m²_{GFA}.a

Final energy consumption: 28,5 kWh/m²_{GFA}.a

Number of students: around 400

AWARDS/CERTIFICATES

Passive-house school certification

SPECIFIC CHALLENGES AND LESSONS LEARNED

A more detailed design is an absolute must before starting the construction phase. A “passive” airtightness value of 0,6/h for the building envelope is a reachable goal. Good communication between the main contractor, producer of prefab-elements, window-producers, and the producer of the cladding system made of corten steel resulted in a zero-error project. There was less than 1% difference between planned costs and realised costs, thanks to well-done calculation + optimization + continuously verification!

FINANCING

Project volume: 19,4 million euro

21% of the costs were covered by the European Regional Development Fund, 55% came from regional departments for school infrastructure and cultural heritage. The remainder was financed by the province of Limburg and Limburg Sterk Merk.

General contractor: Houben nv + Vanderstraeten nv

Architecture and Planning: The building was designed by TV AAQ, which is a temporary association between different architects and engineers.

TV AAQ = ARAT Architecten, AXIS ingenieurs and Q-BUS Architectenbureau.

Building owner: Municipality of Heusden-Zolder

Construction time: 11/2012–12/2014 (25 months)

BUILDING SERVICES

Each of the 4 floors has two CO₂-controlled balanced mechanical ventilation systems with heat and moisture recovery. A daylight controlled lighting with absence detection is installed, and there are blinds outside the east- and west- oriented windows. Every classroom has its own (small) heat pump which heats or cools the room. These small heat pumps emit their heat to a ring duct system. This way energy can be transported between different classrooms. For example from warm cooking classes to colder north oriented classrooms. An additional central heat pump system controls the need for heating and cooling on a global building level. Heat can be easily distributed from warm zones to cold zones if requested. A PV system is mounted on the roof. 25 % of the final energy demand is covered by renewable energy.

CONSTRUCTION

The prefabricated facade elements consist of plasterboard, an insulated installation cavity, OSB, insulated wooden beam structure, wooden-fibreboard, air cavity and a cladding of corten steel on the outside. A new concrete structure was built. During the construction time of the new concrete structure the prefab elements were prepared off-site. U-value after renovation: 0,14 W/m²K.

CONTACTS

Architecture:

Q-BUS Architectenbureau – Luc Nizet and Karolien Sas

E-post: info@q-bus.net

ARAT Architecten – Philip Baelus, Katrien Vervoort

Building Services Planner:

AXIS ingenieurs – Wout Reynaert

School:

CVO De Verdieping

Schachtplein 1, 3550 Heusden-Zolder

E-post: info@cvoeverdieping.be

Air Factory and Adult Education



Volksschule St. Leonhard bei Siebenbrunn

ST. LEONHARD / ARNOLDSTEIN / CARINTHIA / AUSTRIA



The primary school is located in the municipality of Arnoldstein in Carinthia and was renovated in 2010. It now provides space for about 100 pupils.

The main motivation for the renovation was the poor energy performance and the bad structural condition. Already in 2005 a new sports hall was constructed next to the school building. The school was evaluated in 2007, the decision to renovate to passive house standard was made soon after.

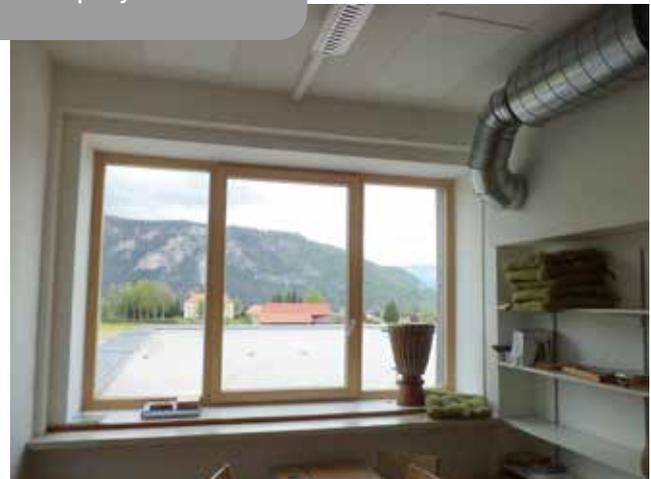
For the facades of the existing primary school and of the newly constructed kindergarten prefabricated timber elements were used. The building now includes 8 classrooms and 3 rooms for the kindergarten as well as the administration and refectory.





Imagine your child going to a passive house kindergarten and then to a passive house school, and every day seeing the photovoltaic modules on the roof. What object will this child build as an adult, when faced with the choice?

Kurt Bürger, consultant for environment and energy,
municipality of Arnoldstein





New building or renovation:

Renovation

School type: Primary school

Age classes: 4 (aged 6 to 10)

Function: School building

Motivation: Low comfort and poor energy performance

Gross Floor Area (GFA): 1791 m²

Heating demand: 8 kWh/m²_{GFA}·a (before 133)

Electricity consumption: 20 kWh/m²_{GFA}·a

Final energy demand: 44 kWh/m²_{GFA}·a

Number of pupils: Around 100 (without kindergarten)

Construction time: 1964/2010

AWARDS/CERTIFICATES

- PHI-certificate
- klimaaktiv bronze
- Isover Energy Efficiency Award 2011
- Energy Globe Carinthia 2011

SPECIFIC CHALLENGES AND LESSONS LEARNED

Before the construction started, a meeting was held with all executing companies in order to guarantee the compliance with the passive house standard. This led to a high quality of the construction work.

FINANCING

The Carinthian school building fund financed about 65% of the retrofit, the Austrian Research Promotion Agency financed about 15%. The remaining 20% was allocated from the municipality of Arnoldstein by the UIAG.

Projekt costs: 1,7 million euro

Main contractor:

Umwelt und Innovation Arnoldstein GmbH (UIAG)

Architect: Gerhard Kopeinig

Building owner: Municipality Arnoldstein

Construction time: May 2010 – September 2010 (5 months)

BUILDING SERVICES

Centralized mechanical ventilation system with heat recovery, separate brine system for frost protection, night ventilation function and control based on the CO₂ concentration.

Wood pellets central heating (boiler output 65 kW) with outside temperature control and heat storage tank (960 liter) which supplies the floor heating and the radiators.

A 300 liter tank feeds circulation ducts that provide **hot water** at specific tapping points.

Electricity generation: PV system on the roof with an output of 5 kWp

FACADE CONSTRUCTION

Prefabricated timber elements were filled with 30 cm cellulose insulation on-site and mounted on the existing reinforced concrete wall. On the exterior a rear-ventilated timber formwork was mounted. This way, the U-value of the wall could be reduced from 2,5 W/m²K to 0,09 W/m²K.

The wood-aluminium windows are equipped with daylight-deflecting outside blinds.

CONTACTS

Architecture:

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Developer and main contractor:

Umwelt und Innovation Arnoldstein GmbH (UIAG)

Karl-Heinz Gradsak

Gemeindeplatz 4, 9601 Arnoldstein

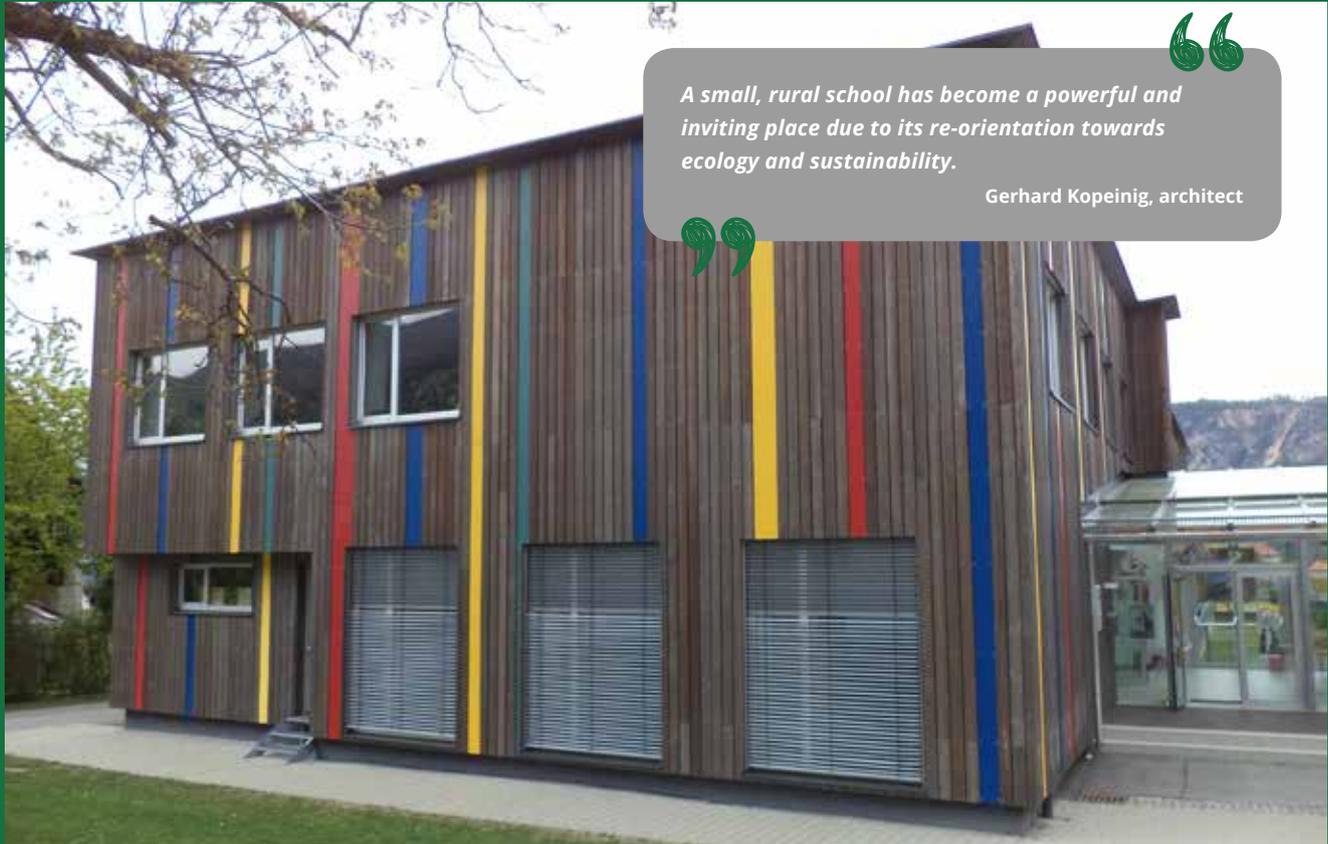
E-post: karl-heinz.gradsak@ktn.gde.at

Primary School:

Principal Gabriele Raup

St. Leonhard bei Siebenbrünn 11, 9587 Riegersdorf

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A small, rural school has become a powerful and inviting place due to its re-orientation towards ecology and sustainability.

Gerhard Kopeinig, architect



Scuola Media Alessandro Volta

COLOGNO MONZESE NEAR MILANO / ITALY

Supported by the programmes „safe schools, beautiful schools“, which aims at improving the buildings resistance to earth quakes.

The secondary school A. Volta at Cologno Monzese close to Milan was retrofitted in 2015. It is currently used by around 483 pupils of sixth to eighth grade. The goal of the renovation was to reduce the heating demand and improve indoor air quality. Another important goal was to stabilize the building in order to make it save in case of earthquakes.

In addition to being modern, the Volta school is now also beautiful, and beauty, just like culture, stimulates the cognitive capacity. Energy efficiency, innovation, safety of the structure and attention to aesthetics are the key words that led the planning and realization.

Angelo Rocchi,
mayor of Cologno Monzese





It is important to supply our children school buildings that are efficient and – I would add – also beautiful.

Dania Perego,
municipal councillor of Cologno Monzese



Safe school

SEISMIC SECURITY

Walls and structural elements have been enforced at strategic positions, in order to allow them to absorb vibrations. Moreover, metal plates have been added to strengthen the joints of columns and beams. Prefabricated elements made of wood also increase seismic security: Wood can absorb vibrations, and can thus be used in combination with steel.





Retrofit or new building: Renovation

School type: Middle School

Age classes: 3 (aged 10 to 14)

Motivation for the Retrofit:

Reducing the impact on the environment, improving indoor air quality, enhancing security in case of seismic events

Gross floor area (GFA): 3400 m²

The transmission value of the outer walls was reduced from 1,64 W/(m²K) to 0,11 W/(m²K)

Reduction in energy demand due to this measure:

About 45 kWh/m²_{GFA,a}

Number of pupils: now 483 (up to 600 possible)

Year of construction, year of retrofit: 1977, 2015–2016

SPECIFIC CHALLENGES AND LESSONS LEARNED

Ventilation: To improve indoor air quality, windows have been planned such that they can be easily used for ventilation. Moreover, the pupils have been trained one month long in the project Air@School to provide for a decent air quality by adequate window opening. In two classrooms CO₂-sensors show when ventilation is necessary. The training activity was conducted by the association Energia di Classe (www.energiadiclasse.com) in cooperation of eERG research group del Politecnico di Milano (www.eerg.it), in the framework of the RENEW SCHOOL project.

Protection from Overheating: External movable solar blinds have been installed to prevent overheating and glare.

FINANCING

Project volume: about 1 million euro

The renovation has been financed by the community, with support from regional funds and the national programme „Safe Schools, beautiful Schools“ (scuole sicure, scuole belle).

The technical office of the community has made the planning and supervision of the works.

Direction of structural works: PROGETTO VIPI – Milano

Construction company: GANDELLI Legnami

BUILDING SERVICES

Radiators, gas central heating.

The warm drinking water provided in the building is produced in a central unit.

CONSTRUCTION

The building was covered by wall elements made from glulam and filled with mineral wool. The facade is ventilated, the outer cover elements are made of resin bound wood or paper fibers with a weatherproof coating. In this case, the thermal envelope has been added layer after layer on the existing building.

CONTACTS

Architecture:

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Geom. Luca Martinelli

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School:

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An example of how light prefabricated elements can be used to modernize a school building in reasonable time, compatible with educational activities, and getting optimal results with a thermal insulation.

Lorenzo Iachellini, main planner



Talenteschule Doren

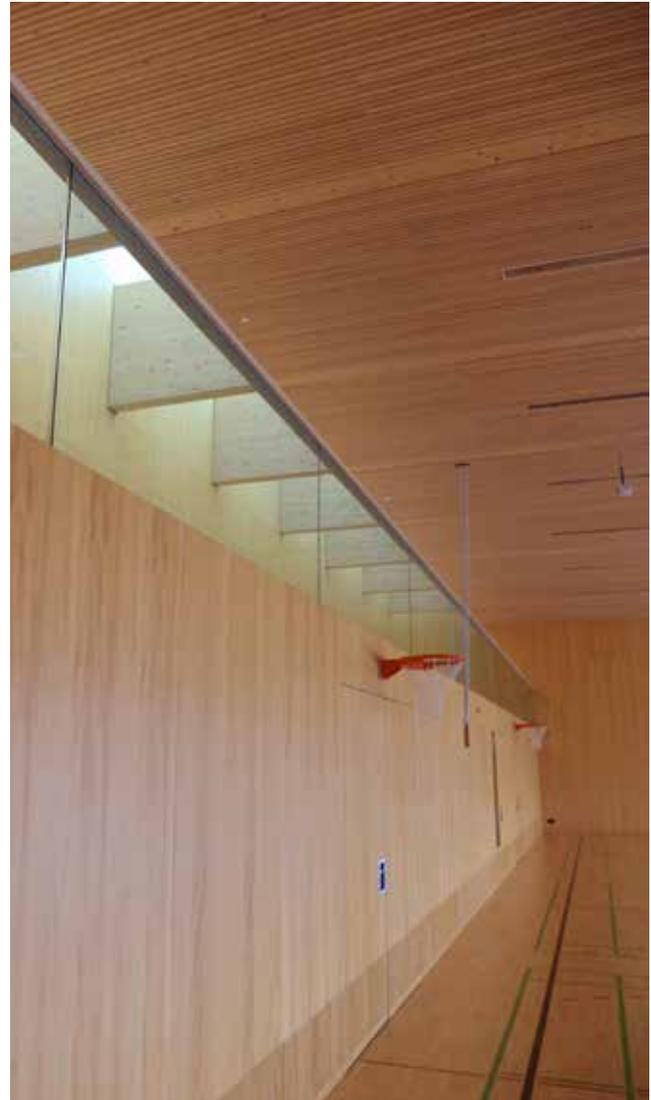
DOREN IN BREGENZERWALD / AUSTRIA

The comprehensive secondary school for about 180 students is located in Bregenzwald. The renovation was concluded in 2012. Motivation for the renovation was the bad condition of the building and lack of functionality.

From 2006 on renovation was being considered. Then, in 2010, the municipal council decided to do the renovation. Soon afterwards the new pedagogic concept of Learning Landscapes (short: LeLa) emerged and was finally realized within the renovation.

Major parts of the facade and the new gymnasium were renovated or built with timber frame constructions. The building houses four LeLa areas, which are used by 2 or 3 classes each. Each area offers also ample common rooms with flexible furniture.

For the teachers of the basic school subjects, i.e. mathematics, German and English, conference rooms with learning materials and PC work stations are provided.





The constructive and appreciating way of communicating in the planning team is essential for a successful realization of projects. This is especially the case in school renovations.

Markus Thurnher, architect



**New building or renovation:**

Renovation and new gymnasium

School type: Comprehensive secondary school

Age classes: 4 (aged 10 to 14)

Function: School, hall for events, gymnasium

Motivation: Structural damage and leaky components

Gross Floor Area (GFA): 4879 m²

Heating demand: 26 kWh/m²_{GFA}·a (vorher 84)

Electricity demand: ca. 21 kWh/m²_{GFA}·a

Final energy demand: 84 kWh/m²_{GFA}·a

Number of pupils: Etwa 180

Year of construction/renovation: 1974/2011–12

AWARDS/CERTIFICATES

- Timber construction award Vorarlberg 2013
- 7. Vorarlberger Hypo-Bauherrenpreis 2015
- Best practice renovation by the Austrian Climate and Energy Fund

CHALLENGES AND LESSONS LEARNT

Consulting the local Municipality association as well as environmental association in tender/procurement matters proved to very helpful. The commitment by the mayor and the construction site management as well as the early involvement of the planning team lead to high quality.

FINANCING

Project volume: 9,8 million euro

40% of the costs were covered by the regional government Vorarlberg, 6% came from the Climate and Energy Fund that supports best practice renovations. The rest was financed by the interested municipalities.

Main contractor:

Gemeinde Doren Immobilienverwaltungs GmbH & Co KEG

Coordination: Schmelzenbach Baumanagement GmbH

Building Owner: Municipality of Doren

Construction time: May 2011 – September 2012 (17 months)

BUILDING SERVICES

Central mechanical ventilation, controlled by CO₂ sensors, with heat recovery, additional air heating and possibility for night ventilation.

Central heating with wood chips (220 kW) and two buffer storage tanks of 3500 liters each. Heat emission by floor heating or radiators, regulated on the basis of outdoor temperature.

The existing oil boiler with 200 kW as reserve.

Domestic hot water is carried by circulation ducts over storage tanks of 300 liters into each LeLa area. Electric power is generated by photovoltaic elements on the roof (99 kWp, 550 m²). On a yearly basis, the generated energy of about 100 MWh covers the electric energy demand of the building!

FACADE CONSTRUCTION

Prefabricated timber elements with insulation boards of 24 cm, made from wooden fibers, behind a ventilated timber frame construction were mounted on the existing wall of concrete and bricks. This way, the U-value of about 0,79/0,49 W/m²K is reduced to 0,15–0,17 W/m²K.

Heat protection windows with frames from wood and aluminum are shaded by venetian blinds, controlled automatically by light sensors.

CONTACTS**Architecture:**

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Fink Thurnher Architekten

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Developer:

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School:

Principal Robert Österle

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E-post: direktion@hsdo.snv.at



Retrospectively the renovation of the secondary school of Doren can be considered a full success. Particularly the users (students and teachers) are enthusiastic about the pleasant and comfortable atmosphere.

Guido Flatz, mayor of Doren



Berufskolleg Detmold

DETMOLD / GERMANY



The renovation to plus energy school was concluded in 2016. The school center, formed by „Felix-Fechenbach-Berufskolleg“ and „Dietrich-Bonhoeffer-Berufskolleg“ is used by about 3600 pupils and students.

The new building is a demonstration project in the national program for energy efficient schools.

The campus consists of 3 bar-shaped buildings, built in the years 1954 to 1962.

The buildings were maintained and extended, and have been redesigned to create an innovative look. Prefabricated timber elements were produced on the basis of a 3D-scan of the building and were mounted on the existing masonry.



The old school building.



The previously present „odour of old building“, which one often encounters in schools, has been completely replaced by fragrances of timber and other natural materials and of course by a lot of fresh air.

Harald Semke, architect





New building or renovation:

Renovation to plus energy school

School type: Vocational college

Age classes: 14 years and older

Function: Vocational college offering specific engineering studies like electrical, information, wood, metal and supply engineering, complemented by studies on nutrition, health care and welfare.

Motivation for the renovation:

Deficits in the energetic situation as well as visibly in need of repair, changes wanted in the interior design

Gross Floor Area (GFA): 14300 m²

Heating consumption: 27 kWh/m²_{GFA}·a

Electricity consumption: 16,4 kWh/m²_{GFA}·a

Final energy consumption: 58,5 kWh/m²_{GFA}·a

Number of pupils: up to 3600

Year of construction/renovation:

between 1954 and 1962/2014–16

AWARDS/CERTIFICATES

- Winner at the ideas competition “School 2030 – Learning with energy” in the category “master plan in renovation and innovative lighting system”

SPECIFIC CHALLENGES AND LESSONS LEARNED

Fast, smooth and cost-efficient renovation due to prefabricated timber elements. The insulation material made of cellulose can be blown in to form an ideal bond between old wall and timber element.

FINANCING

Project volume: about 10,7 million euro

The administrative county of Lippe pays for renovation. Support comes from the German federal ministry for economic affairs and energy. The administrative county of Lippe covered 69% of the renovation costs. Support came from the German federal ministry for economic affairs and energy, paying 31%.

Main contractor: Brüggemann Holzbau GmbH & Co. KG und Krebbers GmbH & Co. KG

Architect: pape oder semke ARCHITEKTURBÜRO

Building owner: Kreis Lippe

Construction time: 01/2014–03/2016 (27 months)

BUILDING SERVICES

A hybrid ventilation concept provides the appropriate ventilation of the classrooms. Generally, decentralized ventilation units are used in combination with natural ventilation by opening windows. The heat recovery factor of the mechanical ventilation units is around 85%.

District heating is used for room-heating and domestic hot water, just like before the retrofit. Existing radiators were kept and are now operated at a lower temperature. Heat comes primarily from a cogeneration plant.

To reach an energy surplus an integrated solar roof made of monocrystalline solar cells was installed. The photovoltaic plant reaches 352 kWp with a total area of 2.768 m².

CONSTRUCTION

Prefabricated timber elements have been used on facade, roof and top floor ceiling.

The timber frame construction parts were delivered to the building site without windows and plastering and mounted on the existing walls. Then the cellulose insulation material was blown in. The outer walls now reach a U-value of 0,11 W/m²K.

CONTACTS

Architecture:

pape oder semke ARCHITEKTURBÜRO

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The pleasant characters of outdoor and indoor spaces merge, while natural building materials like timber and lime determine the friendly and bright rooms and reflect daylight from outside to the inside.

Harald Semke, architect



Naturparkmittelschule Neumarkt

NEUMARKT IN STYRIA / AUSTRIA

The secondary school is located in Neumarkt/Styria in the natural preserve Zirbitzkogel-Grebenzen. The building provides space for about 220 pupils and is part of the school centre which consists of 4 building parts: For 2 buildings individual renovation measures were carried out, for the other two parts (C and D) a high-performance renovation was finished in 2011.

The main motivation for the renovation was the very bad structural condition of the building and an upcoming consolidation of the secondary schools.

In 2005 it was decided to renovate the building and a first evaluation of the design team was performed. The facade of one of the four building parts of the school centre Neumarkt (building C) was renovated with prefabricated timber elements. The building includes classrooms, administration and special rooms. The existing cultural hall, which provides space for more than 600 people, was also renovated in passive house quality.

The old school building.





It was one of the most precious challenges of my hitherto work life to renovate this centre for education and events in a sustainable way and to reach a high quality without having to relocate the students. In this way we could give back some self-consciousness for the element „wood“ to the people living in the area.

Gerhard Kopeinig, architect





New building or renovation: Renovation
School type: Secondary school
Age classes: 4 (aged 10 to 15)
Function: School building, afternoon care
Motivation: Structural damages, comfort deficiencies and school consolidation
Gross Floor Area (GFA) Building C: 2.800 m²
Heating consumption: 10,4 kWh/m²_{GFA,a} (before 160)
Electricity consumption (ventilation): 5 kWh/m²_{GFA,a}
Final energy consumption: ca. 55 kWh/m²_{GFA,a}
Number of pupils: About 220
Year of construction/renovation: 1975–78/2009–11

AWARDS/CERTIFICATES

- ZT-Award 2009, appreciation award “energy optimised retrofit”

FAZIT/LESSONS LEARNED

In 2009 all executing companies were instructed to avoid thermal bridges and to construct airtight. Furthermore there have been discussions on specific solutions before starting the renovation works. Great commitment by the construction management and the design team led to success. The monitoring in the first year of operation was very useful to detect for example the high electricity consumption of the night ventilation in summer, which could be countered. Disadvantage: if the money would not have come from research funds, no one would have paid for it.

FINANCING

About 53% of the costs were covered by the State of Styria; about 7% were funded by the Climate and Energy Fund. The remaining 40% were allocated from the municipality Neumarkt and the 7 additional enrolled municipalities.

Project costs: 7 million euro (entire school centre)

Main contractor: Marktgemeinde Neumarkt in Steiermark
Schulerrichtungs- u. Sanierungs KG

Project management: Ing. Elisabeth Löcker

Building owner: Municipality of Neumarkt



Construction time of building C:

May 2010 – September 2010 (4 months)

BUILDING SERVICES

Centralized mechanical ventilation system with heat recovery, brine-system for frost protection, heating of the supply air, night ventilation function and control based on the CO₂ concentration. The nearby biomass local heating supplies the radiators, an outside temperature control exists.

Hot water: decentralized small electric boilers

FACADE CONSTRUCTION

Prefabricated timber elements with 30 cm cellulose insulation in a rear-ventilated timber frame construction with larch formwork on the exterior were mounted on the existing reinforced concrete wall (including 10 cm mineral wool and cellulose insulation for level control). In this way the U-value can be reduced from about 2,5 W/m²K to 0,13 W/m²K. The wooden windows are equipped with irradiation-driven exterior blinds, which deflect daylight in its upper part.

CONTACTS

Architecture:

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School:

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**Centre
for the
whole
Region**



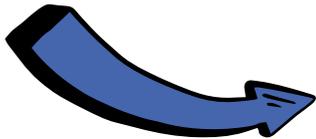
Europaschule Rostock

ROSTOCK / GERMANY

The first buildings of the secondary school in Reutershagen in Rostock were constructed in the years 1960/61. The school now consists of three parts, which are connected and arranged around a central covered schoolyard, called "school street". Two of these buildings are newly built; the third one has been renovated.

An important point of the architectural concept of the Plusenergy - renovation was to obtain a compact structure, which allows the assignment of functions with a reduced part of circulation areas. Moreover, the structure of the main building was to be preserved as much as possible.

The „school street“ connecting the buildings is not actively heated. It divides the new complex into climate zones. Transparent walls form the surfaces between old and new buildings.



**Study
with
energy**



All passive and active measures in the plus-energy concept are part of the overall design. They affect the architecture of the building and make it distinctive. The daily contact allows students, parents and teachers to live and understand the effect of energy sources and energy sinks.

Martin Wollensak, architect



The old school building.





New building or renovation:

Renovation and new building

School type: primary & secondary school

Age classes: 1.–4. grade (primary school, aged 6 to 10) and 5.–12. grade (aged 11 to 18)

Function: School

Motivation: Redundant space, and need for adjustments in energy behavior and design; Due to a decline in population and thus a reduced number of pupils the two buildings were not fully used any more. Aim of the renovation was thus to add a primary school at the same location.

Gross Floor Area (GFA): 8400 m²

Heating demand: 45 kWh/m²_{GFA}·a

Electricity demand: 9,5 kWh/m²_{GFA}·a
(for ventilation, lighting, auxiliary energy)

Final energy demand: 61,7 kWh/m²_{GFA}·a

Number of pupils:

830 (primary school ca. 300, secondary school ca. 530)

Year of construction/renovation: 1960/61 / 2008–2015

AWARDS/CERTIFICATES

- Winner at the ideas competition “School 2030 – Study With Energy” in the category “Global concept for Renovation”

CHALLENGES AND LESSONS LEARNED

The buffer area called school street is well accepted by the students as a living zone. One of the reasons for that is certainly the presence of various seats and accommodations which have been carefully designed and arranged.

FINANCING

Project volume: 10,2 million euro

The project was supported with 4,8 million € by the German federal ministry for economic affairs and technology and with 1,45 million € by the regional ministry for energy, infrastructure and development in a program for climate protection.

Main contractor: KOE Rostock

Building Owner: Hansestadt Rostock

Building time: 08/2008–10/2015 (in two stages)

BUILDING SERVICES

Since district heating in Rostock requires little primary energy, the school continues using heat from the local district network. The heat distribution has been redesigned to meet the now much lower demand. Classrooms are heated with a combination of two systems: The basic load is covered by thermal activation of the skirting boards, to reach room temperatures up to 17°C. In case of additional need, the ceiling can be activated as well, to reach 21°C. In the winter, the classrooms are ventilated by 4 central ventilation units, which deliver incoming air through textile ducts. The exhaust air is then led into the “school street” to heat it. Special valves are used between classrooms and “school street” to stick to fire protection rules. Waste air is then taken from the school street and used to heat up fresh air in the rotating heat exchangers of the central ventilation units. To produce renewable energy, two wind generators with each 2,3 kW have been installed, as well as monocrystalline photovoltaic modules on the shed roofs and as sun protection on the southern facade.

CONSTRUCTION

New building: Prefabricated timber elements: gypsum board, insulated installation layer, timber frame construction with mineral wool (24 cm). The cover panels and windows were mounted on the building site.

Old building: plastered solid bricks (36,5 cm) and prefabricated timber elements like above, covered by timber formwork.

CONTACTS

Architecture:

IGEL-Institut für Gebäude-, Energie- und Lichtplanung,
Hochschule Wismar

Prof. Dipl.-Ing. Martin Wollensak

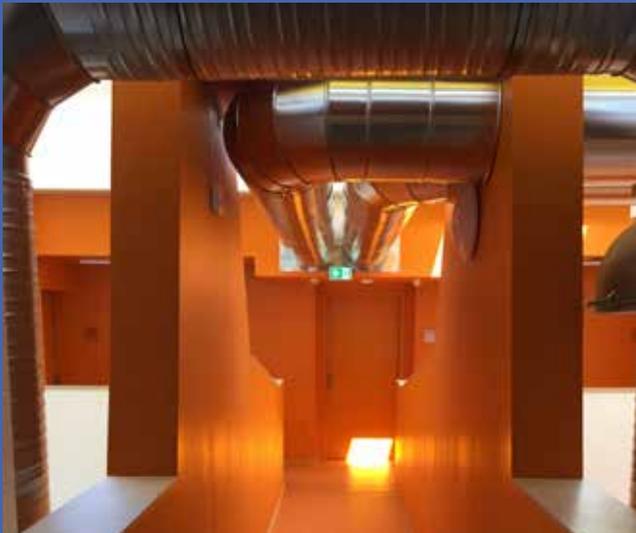
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In the winter, the classrooms are ventilated by 4 central ventilation units, which deliver incoming air through textile ducts. The exhaust air is then led into the “school street” to heat it. Special valves are used between classrooms and “school street” to comply with fire protection rules. Waste air is then taken from the school street and used to heat up fresh air in the rotating heat exchangers of the central ventilation units.



TECHNICAL SUMMARY

Best Practice School	GFA / heating demand	Energy carrier or energy generation	Ventilation
Søreide Skole/NO New Building (2013)	8300/5,6	Heat pump, solar thermal and direct electric heat	Mechanical ventilation with heat recovery and active heating of inlet air
Heusden-Zolder/BE New Building and Renovation (2014)	5637/13	Decentralized heat pumps complemented by a central one, photovoltaic modules (PV) to cover 25% of electricity demand	8 CO ₂ -controlled mechanical ventilation systems with heat recovery and night ventilation
Berufskolleg Detmold/GE Renovation (2015)	14300/21	District heat with a high share of cogeneration and biomass (>50%), 2768 m ² PV (352 kWp) on the roof	CO ₂ -controlled decentralized (over facade) and central mechanical ventilation with heat recovery and night ventilation
Europaschule Rostock/GE Renovation and Extension (2015)	8400/45	District heating, 2 wind generators (each 2,3 kW) and PV (120 kWp) on the roof and 20 kWp on the facade	4 CO ₂ -controlled mechanical ventilation systems with heat recovery and night ventilation
Talenteschule Doren/AT Renovation (2012)	4879/26	Wood chips heating and 550 m ² PV (99 kWp) on the roof	CO ₂ -controlled mechanical ventilation systems with heat recovery and night ventilation
Neue Mittelschule Rainbach/AT Renovation (2013)	3243/14	Wood chips heating, solar thermal installation, an 250 m ² PV (50 kWp) on the roof	CO ₂ -controlled mechanical ventilation systems with heat recovery and night ventilation
Naturparkschule Neumarkt/AT Renovation (2011)	2800/10	Biomass-district heating and PV on the roof of the district heating station	CO ₂ -controlled mechanical ventilation systems with heat recovery and free night cooling
Volksschule St. Leonhard bei Siebenbrunn Arnoldstein/AT Renovation (2010)	1791/8	Pellets heating and PV (5 kWp) on the roof	CO ₂ -controlled mechanical ventilation systems with heat recovery
Schwänenstadt/AT Renovation (2007)	6835/14	Pellets heating and PV (6,7 kWp) on the facade	Decentralized mechanical ventilation with heat recovery for each classroom
Scuola Media Alessandro Volta/IT Renovation (2015)	3400/n.a.	Gas boiler	Manual window ventilation, Air quality is measured and displayed in classrooms by CO ₂ -measuring units

GFA = gross floor area in m², heating demand is given in kWh/m²_{GFA}·a

Sun shading / day lighting	Prefabrication	Financing	Cooperation model	Project volume [million €]
Focus on glare protection, glimmer free light	Partly prefab timber frame for facades and roof	PPP, Partly supported by „Cities of the Future“ (5%),	Public Private Partnership (PPP): after 25 years the municipality will own the building	25
Only on windows facing east/west: persian blinds, controlled by daylight and presence sensors.	Prefab isolated timber frame construction for facades	EU 21%, region 55% (cultural heritage 16%, school infrastructure 37%, tourism 2%), province 24%	PPP – municipality has engaged a main contractor	19,4
Persian Blinds, daylight controlled	Prefab timber elements, on-site filled with zellulose insulation, cover mounted on-site	Regional gov 69%, central gov (Bund) 31%	Municipality is the owner of the school and contracted the timber constructor, building services engineers etc.	10,7*
Persian Blinds and PV modules for shading	Partly prefab timber frame construction	Regional gov 14%, central gov 47%, Rostock remaining 39%	Municipality is the owner of the school and directly engaged timber constructor, building services engineers etc.	10,2*
Daylight controlled and daylight guiding Persian blinds	Partly prefab timber frame construction, covered on-site	Regional gov 40%, central gov 6%, municipalities 54%	KG owned by municipality engages the companies involved	9,8*
Daylight controlled and daylight guiding Persian blinds	Partly prefab timber frame construction, covered on-site	Regional gov 82%, central gov 8%, municipality 10%	KG owned by municipality engages the companies involved	7,4*
Daylight controlled and daylight guiding Persian blinds	Partly prefab timber frame construction, covered on-site	regional gov 53%, central gov 17%, remainders by the municipality	KG owned by municipality engages the companies involved	7*
Manually controllable blinds between panes and daylight guiding Persian blinds	Vertical prefab timber element, cellulose isolation blown in on-site	65% regional school building fonds, central gov 15%, municipality 20%	UIAG, owned by municipality engages and manages the companies involved	1,7
Daylight controlled and daylight guiding Persian blinds	Vertical prefab timber element, cellulose isolation blown in on-site	60% regional gov, central gov 4%, 36% municipality	Main constructor was asked to engage all other involved companies	10,4*
Skylights, Persian blinds	Partly prefab timber elements, covered on-site	Financing by municipality, support from regional and central government (fund for safe schools)	Municipality is school owner and engaged the involved companies	1

* Total costs of deep renovation including other parts like gymnasium

FINANCING AND COOPERATION MODELS

Before starting the deep renovation of a school, it makes sense for all major school owners like towns or regional real estate owners, to make a master plan for the whole portfolio of educational buildings. The result should be that the schools best connected to public infrastructure and those with the highest demand of renovation, e.g. due to structural defects, are renovated first. Other locations which are not needed anymore, can be sold with profit to help finance the more important ones. This approach guarantees a reasonable use of budget, and quality criteria, like e.g. a high indoor air quality, can and should be previously defined in the master plan.

Experiences on Financing

For best practice renovations in Austria that have undergone a deep thermal energetic renovation the following holds true: The funds usually come from three different national sources; in none of the analysed cases funds from the EU were used.

More than 50% of the financing comes from the interested regional government and about 5 to 10 % from the federal government via special funds of the Climate and Energy Fund like the one specifically targeting best practice renovations. The remaining 10 to 45% are covered by the municipality or other neighbouring municipalities that send children to the school. The part the municipalities covers is mostly paid for using low-priced loans of local or regional banks, with interest rates of 0,5 to 1,2%.

The payback period varies from a few to up to 20 years. Only few municipalities in Austria – but they exist – are able to finance the renovation with their own resources. Funds from regional governments normally come via different administration units, like the department for education or for special demands.

An example for an efficient funding tool achieving good results is the fund for school buildings in Carinthia, where all support comes from one hand. While school renovations with prefabricated timber facades are concluded after a short construction time, financial support for the renovation is usually given to the municipalities not at once but over a longer period of time.

These financial details as well as processing a large project with construction companies and the complex regulatory framework make the deep renovation of a school a major challenge for everyone involved in a community. Financial and organisational obstacles are the main barriers on the way to a deep renovation. They can be overcome with the help of professional consultancy and support that municipalities are offered, e.g. from an association like the Vorarlberger Umweltverband.

Without such professional help, and if none of the individual people involved have experience in school renovations, in the worst case these barriers lead to purely cosmetic interventions.



Factors for successful financing

Summarizing the experiences made up to now one can say:

- It makes sense to use various financial sources (both public and private).
- Check if the burden of financing can be alleviated via interest-subsidized loans or input tax reduction.
- Financing using EU funds or sources (e.g. EFRE, EIB) is more complex but should be considered in the case of larger projects.
- Investigate the possibility of covering part of the costs by means of contracting with energy service companies (ESCO), e.g. by contracting energy savings or allowing the company to use facades or roofs to generate energy from renewable sources.
- Use help to organize the tendering
- Prefabricated timber elements help saving on relocation costs and make it easier to adhere to budgeted construction costs. Moreover they can be more convenient in case the renovation of a number of buildings is tendered at the same time.
- And do not forget: There are examples, like those shown in the brochure, from which one can and should learn!

Experiences on Cooperation

In order to achieve the best practice school renovations in Austria mentioned above, in some cases limited partnerships have been founded, or existing ones used again, in order to use the benefit from input tax reduction. In other cases main contractors were put in charge of renovation. Only in a few cases the whole renovation process was conducted by the municipality or town itself, or via a public-private partnership.

Mayors, principals and caretakers were included comprehensively in the process, and were often the driver of the projects. It is important to understand that a **deep renovation process** of a school often **takes at least 5 years** – from the first inventory taking or the municipalities' decision to renovate to the comple-

tion. If you add the optimization phase of the building after project conclusion then at least 7 years are to be estimated.

If innovations like prefabricated timber elements, ventilation concepts including summer comfort, day-light optimisation or the connection of architecture and education are to be considered, then it is highly recommended to include – as soon as possible – experts with experiences in the planning process. This will save costs in the long term.

Generally in the Austrian best practice projects the team of architects, planners of building services and construction experts have reached an agreement on the details and quality assurance – as shown in the example of the cooperation network in Figure 1.

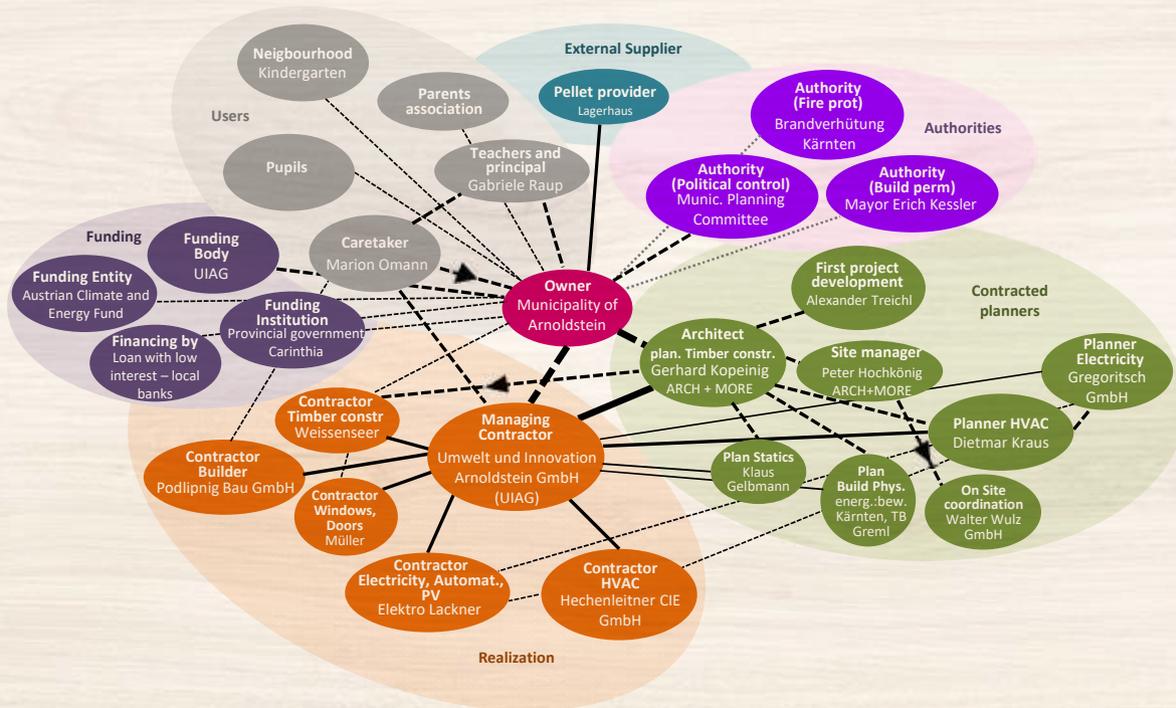


Abb. 1: Cooperation-Network for the deep renovation of the primary school in St. Leonhard at Siebenbrunn / Municipality of Arnoldstein, Carinthia / Austria (Source: AEE INTEC)

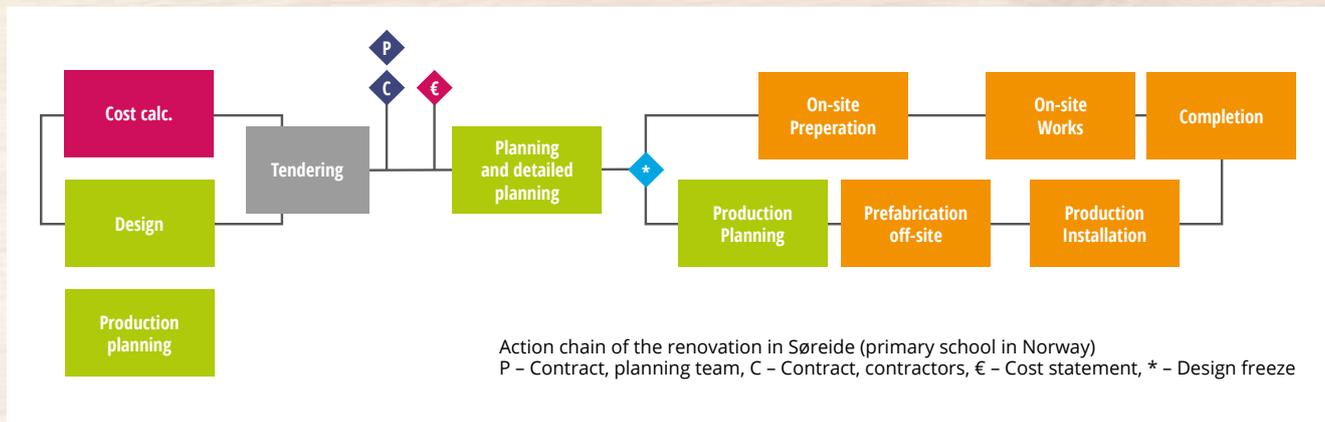


Figure 2: The best offer for the renovation of the primary school of Sørreide in Norway based on the cooperation of the main contractor with the architects team. Contract conclusion (see “P” and “C”) was followed by an extensive design phase “Planning and detailed planning”, in which prefabricated elements and other solutions were optimized by architects, engineers and operating companies. (Source: Asplan Viak /NO)

Factors for successful cooperation

In summary, the following criteria were found to lead to a successful cooperation in the renovation process:

- Definition of the goal in an early stadium, even before the tendering, helps optimizing costs and processes.
- Engagement of the project coordinator and focused use of planning software e.g. BIM in the planning phase.
- Target-oriented and transparent communication between designers, engineers and executing contractors can be helpful, e.g. organizing face-to-face meetings reduces the probability of misunderstandings and increases trust.
- Early integration of future users into the planning process improves acceptance of measures and motivation.
- Management of information and documentation, to assure quality and a permanent information exchange over the whole project life-time.
- Offer incentives (financial or other) to designers and executors/builders involved to create a common interest in obtaining the best result. Spread benefits but also risks to improve the cooperation between designers and operators.
- An interesting cooperation model was realized in Germany in the years around 2000. The “Bauteam” or cooperative planning concept allows for high quality at low construction costs. Find information on that at: <http://www.renew-school.eu/en/the-german-bauteam-cooperative-planning-approaches-for-high-quality-and-low-cost-construction/>
- Tendering which promotes CO₂-saving and sustainable use of resources also encourages use of prefabrication and timber elements. An example for that is the construction of the best-practice school Sørreide/Norway (Figure 2).
- A precise and understandable documentation should be handed to the users. This will facilitate maintenance as well as supervision and interventions, and is necessary to be able to benefit from the high-quality renovation.
- Tendering should be used to identify those contractors that will be able to create innovative solutions at low life-cycle costs through good cooperation in the team.

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