

Multi-family building at Stauffacherstrasse in Bern, Switzerland

Modular and fully equipped pre-wall units for bathrooms considerably simplify and noticeably accelerate the renovation of old buildings. The pre-wall units incorporate a decentralised hot water tank with a high-performance vacuum insulation, a low-power heat pump and an intelligent control system.

Key facts

Building

Location	<i>Bern, Switzerland</i>
Construction	<i>2018 (renovation)</i>
Heat distribution	<i>in building</i>
Heated area	<i>30 apartments each 40 m² living area</i>
Level of insulation	<i>renovated building</i>

Heat pump and source

Number of DHWHP	<i>30 units</i>
Number of heating HP	<i>1 unit centralized for space heating of building</i>
Installed capacity COP (A7/W45)	<i>400 W (per unit) 3.1</i>
Operation mode	<i>waste heat recovery</i>
Heat source	<i>exhaust air</i>
Brand and type	<i>THERMOS Swissframe AG</i>
Refrigerant	<i>R134a</i>
Sound level	<i>< 40 dB</i>

Domestic hot water

Type of system	<i>pre-wall installation in each apartment</i>
Max. Temperature	<i>60 °C</i>
Circulation system	<i>no</i>
Legionella measures	<i>thermal according to SIA 385/2 regulation (60 °C for min. 1 h per day)</i>
Storage size	<i>about 100 L</i>
# of storage tanks	<i>1 in each apartment</i>
Storage heat losses	<i>vacuum insulation panels enable low passive losses</i>
Temperature control	<i>yes</i>

Other information

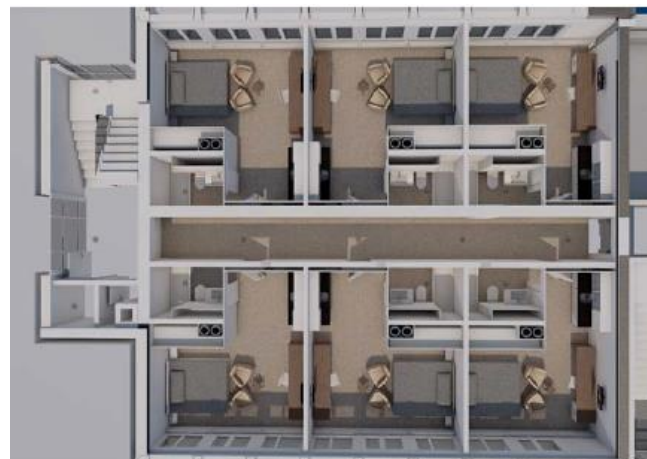
Electric energy consumption per year	<i>about 1'100 kWh/a for 3 persons</i>
Investments costs	<i>unknown</i>
PV installation	<i>yes</i>
Solar thermal	<i>none</i>



Multi-family building at the Stauffacherstrasse 60 in Bern, Switzerland.

Swissrenova AG has renovated the multi-family building in the Stauffacherstrasse 60 in Bern (incl. PV system). By December 2018, a restaurant and 30 service apartments for rent (one-room apartments for 1 to 2 persons) have been created in the five-story building.

Swissframe AG delivered the plug & play pre-wall units THERMOS for the bathrooms. The pre-wall units have a comfort ventilation with an intelligent heat recovery system from Zehnder Group AG. In addition, there is a small hot water tank with high-performance insulation, which, together with a low-power heat pump, can more than adequately cover the heat requirements of a 3-person household. A smart controller monitors and controls the entire system and optimizes the residential unit's own needs using solar electric power.



Floor with 6 of the 30 service apartments in the multi-family building.

In order to document the optimization of the hot water network with the new building technology with measurement data, the Swiss Federal Office of Energy (SFOE) supported the installation of extensive measurement technology in five of the 30 bathrooms (apartments in a downward line). The field test runs from 2018 to 2020 and aims to achieve a comprehensive technical, economic and social assessment of the newly developed pretext units. Of particular interest is the system's energy balance compared to conventional systems. The renovation of a bathroom is shortened considerably for the customer and can be done by two plumbers alone.



LOW-POWER HEAT PUMP FOR HOT WATER PRODUCTION

Exhaust air leaving the apartment serves as a heat source for the small-scale heat pump. The heat pump extracts the remaining energy from the exhaust air by evaporating the refrigerant. In the compressor, the heart of the heat pump, the recovered energy is thermally upgraded with the supplied solar electric power, so that it is available again as useful energy in the condenser. In the condenser, which is placed in the boiler, the refrigerant can release the upgraded energy in the form of heat to the storage medium, which heats up as a result. The heat pump achieves a heating capacity of between 250 and 400 W depending on the temperature of the heat sink. The heat pump is able to heat the storage medium in a day from 20 to 60 °C. Special attention has been paid to the noise emission (< 40 dB) of the heat pump, as it can affect or disrupt the comfort of the customer, since the system works in the living areas. The heat pump is invisible to the customer when the comfort ventilation unit is running.

HIGH PERFORMANCE INSULATION FOR THE ENERGY STORAGE

Despite the high functionality, the pre-wall unit should not require more space than other common sanitary installations. Since the comfort ventilation unit is the only component that is integrated into the pre-wall unit as a finished product, the dimensions of the pre-wall unit have been adapted to this component. The storage tank therefore had to be specially adapted to the pre-wall unit. The amount of energy that can be stored in the boiler depends on the specific properties (= constant) of the storage medium and the volume (= variable) that is available to the storage medium in the boiler. In order to be able to achieve as much volume as possible, a cubic instead of the usual cylindrical storage tank was developed. The volume of the storage tank was limited to 100 L, which meant that the entire wall unit has a depth of only 0.3 m.

Two heat exchangers are placed in the boiler. These are the condenser, which supplies the storage medium with energy and heats it up, and the fresh water heat exchanger, which in turn extracts the energy from the boiler and provides it as hot water at the tapping points. In order to keep the energy loss of the storage tank over its surface as low as possible and to be able to meet all SIA criteria (Swiss Society of Engineers and Architects), the storage tank was covered with high-performance vacuum insulation panels (VIP) as insulation. With a panel with a wall thickness of 10 mm, the SIA limit of 1.05 kWh of heat loss per day can already be met. With a 20 mm thick insulation layer, even the more stringent SIA target of 0.75 kWh per day can be achieved.

ADVANTAGES OF THE PRIME UNIT

An important advantage of decentralized hot water supply is that each apartment is «self-sufficient». In other words, if the central heating system fails, all connected parties are affected. Decentralization eliminates this problem. The heat pump of the pre-wall unit THERMOS was designed in such a way that it works practically all day to generate the required hot water. Due to the low number of starts, less wear occurs in the compressor, which has a positive effect on the lifetime of the heat pump.

PROJECT MANAGEMENT

The Bern University of Applied Sciences (BFH) is responsible for the overall project management, technical planning and analysis of the monitoring data. The sensors for the measurements are evaluated together with the partner universities, University of Applied Sciences Rapperswil (HSR), Interstate University of Applied Sciences Buchs (NTB), and the project partner smart-me AG. The detailed measurement is limited to five systems (apartments of a downward stretch over five floors in the tower towards the northwest), whereby the standard operating data are recorded for the remaining 25 bathrooms. The partner universities plan and accompany the detailed measurement and optimize the management if possible.

LITERATURE

Swissframe AG, THERMOS Product Information: <https://www.swissframe.ch/produkte/thermos>

NTB Buchs, Institute for Energy Systems (IES), Projekt Homepage with all published information: <https://www.ntb.ch/projekt/kompakte-dezentrale-warmwasserbereitstellung-aus-fortluft-und-solarstrom/#page-4>

Bertsch, Stefan S. & Büchel, Elias (2017). [Idee, Projekt und Produkt - Kompakte und dezentrale Warmwasserbereitstellung](#), bauRUNDSCHAU, 2017, 2, 34–38.

Hunziker, Douglas Urena, Bärtschi, Joël, Muntwyler, Urs, Ruesch, Florian & Büchel, Elias (2018). [Dezentrale Warmwasserbereitstellung aus Fortluft im Badezimmer ein BFE Demonstrationsprojekt](#), 20. Status-Seminar «Forschen für den Bau im Kontext von Energie und Umwelt», 6./7. Sept. 2018, Zürich.

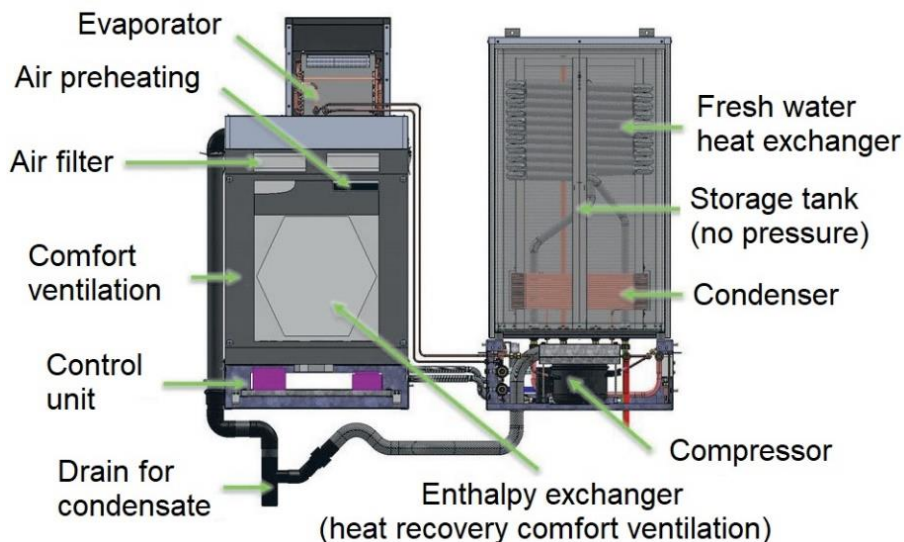
Ruesch, Florian, Persdorf, Patrick Persdorf, Hunziker, Douglas, Büchel, Elias & Haller, Michel (2018). [Decentralized DHW production from exhaust air in the bathroom prewall](#), EuroSun 2018 Conference, September 2018, Rapperswil.

Büchel, Elias, Bertsch, Stefan, Persdorf, Patrick, Urena, Douglas, Muntwyler, Urs, Weber, Roger (2016). [Kompakte, dezentrale Warmwasserbereitstellung aus Fortluft und Solarstrom \(KoDeWa\)](#), 19. Status-Seminar «Forschen für den Bau im Kontext von Energie und Umwelt», 8./9. Sept. 2016, Zürich.

Technical details

The pre-wall unit THERMOS offers the following advantages:

- Three times more efficient compared to a conventional electric boiler
- Decentralised hot water tanks do not require long heating networks and heating systems, especially in multi-family houses.
- The passive energy losses of the distribution networks are eliminated.
- Time discrepancy between energy production and demand of the renewable energy sources plays only a subordinate role, since the solar power produced can be used directly to supply the tank with energy or hot water again during the day.
- Hot water consumption can be effectively billed according to the consumer.



Components of the pre-wall unit THERMOS.

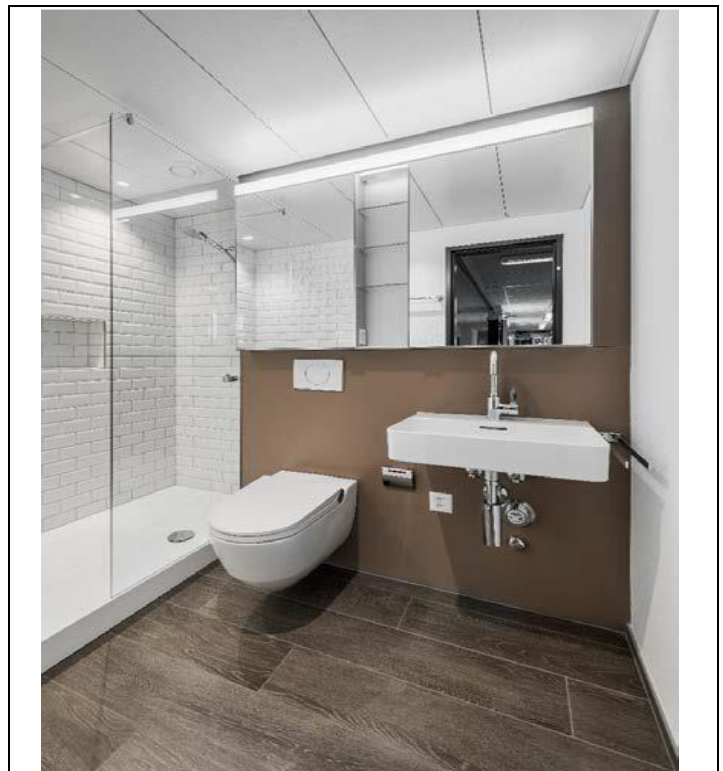
Description of the technical concept

The pre-wall unit THERMOS has been fully developed and patented by Swissframe AG. The introductory phase in the market and the communication of the technical properties is intensified parallel to the P&D project. In the case of energy-efficient new buildings and especially when refurbishing objects with decentralized electric boilers, the aim is to spread and increase the level of awareness of the product.

A measurement campaign to validate the technology maturity in the real environment was prepared. The opening of the five-story building including restaurant and 30 service apartments for rent started in December 2018. After recording a first measurement period from 2018 to 2020, the evaluation and analysis of the data begins.

By comparing the measurements from Stauffacherstrasse 60 and those from the climatic chamber of the NTB, conclusions can be drawn about further optimization potential on the pretext unit. The energetic analyzes are compared with conventional reference systems. The determined simultaneity factors must be supported by the field test.

User surveys are used to raise questions about personal behavior and the acceptance of the system.



*Renovated bathroom with pre-wall unit THERMOS.
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