PROJECT SUMMARY
Housing renovation in several stages comprising:
- Building envelope
- Ventilation and heating system
- Smart control
Reduction of delivered energy: 55%

SPECIAL FEATURES
Improved ventilation system design

PLANNING AND DESIGN
Owner

OWNER
Dr. ing. Bjørn Jenssen Wachenfeldt

SFH Wachenfeldt in Orkanger in NO
BACKGROUND

Typical two-storey house in the neighbourhood, constructed in 1981-1982 with approx. 100/150 mm mineral wool in walls/roof, electric radiators, electric floor heating and wood stove. High energy consumption and poor comfort called for a relatively comprehensive renovation. The desires were:

1. A new office and a complete renovation of the laundry room, living room and kitchen to modern standards.
2. Improved energy performance
3. Improved indoor air quality and thermal comfort.

SUMMARY OF THE RENOVATION

• New roofing installed
• Balanced ventilation system with highly efficient heat recovery installed
• All windows replaced with triple glazed windows close to passive house standard (U value~0.8-1.0)
• 200 mm mineral wool added in the attic
• 50 mm insulation added on the inside of the west facade and bath/laundry room walls in the 1. floor
• 100/150 mm insulation added in new office
• High focus on improving air tightness
• New, highly efficient wood stove and heat pump installed, and all electric radiators removed
• Installation of smart control system (not carried out yet)
Living room after renovation. The transparent ventilation duct to the right provides fresh air to the office and one of the bedrooms in the base floor. A 5W LED lamp is installed within.

**CONSTRUCTION (Before renovation, assumed)**

**Floor construction**  
U-value: 0.7 W/(m²·K)  
Gravel 100 mm  
Expanded polystyrene (EPS) 50 mm  
Reinforced concrete 70 mm  
Linoleum 3 mm  
Total 223 mm

**Wall construction**  
U-value: 0.34 W/(m²·K)  
(interior to exterior)  
Wooden panels/pressed wallboards 15 mm  
Vapour barrier 1 mm  
Mineral wool 100 mm  
Wind barrier 1 mm  
Air 20 mm  
Wood panelling 22 mm  
Total 159 mm

**Attic floor (roof)**  
U-value: 0.34 W/(m²·K)  
(top down)  
Ventilated attic -  
Mineral wool 100-150 mm  
Vapour barrier 1 mm  
Air 20 mm  
Wooden ceiling plates 12 mm  
Total 133-183 mm

Tightening of the vapour barrier towards the attic.
**ENERGY PERFORMANCE**

The heat pump, together with the improved U-values, eliminates the need for the previously used electrical floor heating in the base floor and electric radiators in the living room and kitchen in the first floor. After renovation it is assumed that wood covers approximately 20% and the heat pump 80% of the space heating demand.

Calculated demand for total delivered energy/primary energy*:

**Before:** 286 kWh/m²/627 kWh/m²

**After:** 130 kWh/m²/260 kWh/m²

**Reduction:** ~55% / 59%

* Primary energy factor for electricity and wood logs: 2.35 and 0.10

Calculated energy use for space + water heating (delivered primary energy):

**Before:** 246 kWh/m²/533 kWh/m²

**After:** 90 kWh/m²/166 kWh/m²

**Reduction:** 63% / 69%

Calculations based on methodology from the Norwegian calculation standard NS3031:2007. The first year after renovation, the total energy demand (delivered energy) has shown to be about 100 kWh/m².

**BROCHURE AUTHORS**

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**Summary of U-values W/(m²·K)**

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attic floor</td>
<td>0.34</td>
<td>0.13</td>
</tr>
<tr>
<td>Walls</td>
<td>0.34</td>
<td>0.25</td>
</tr>
<tr>
<td>Windows</td>
<td>2.8</td>
<td>0.9</td>
</tr>
</tbody>
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**VENTILATION**

A balanced ventilation system with ~80% temperature efficiency was installed. Air is supplied to the office and each of the bedrooms in the base floor. From these rooms most of the ventilation air flows through the hall and staircase up to the living room and kitchen on the first floor, and further into the first floor bathroom where the main exhaust vent is placed. Since all ventilation air is supplied via bedrooms (and office) on the ground floor, unnecessary night ventilation of the living room is avoided.

A properly sized exhaust vent is also placed directly above the wood stove in the living room. This exhaust is controlled by a damper, which is opened when the wood stove otherwise would provide too much heat to the living room. This redistributes excess heat to the first floor via the heat exchanger.

Sleeves (white) are used for tightening between the vapour barrier and the ventilation ducts penetrating the attic floor before insulation is added. (The sleeve to the right is not mounted yet)