Single family house in Herselt BE

PROJECT SUMMARY
Retrofit of a century old country-house into a low energy house.

SPECIAL FEATURES
House meets Universal Design criteria.

ARCHITECT
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OWNER
Verbruggen-Jennes

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA – SHC Task 37
Advanced Housing Renovation with Solar & Conservation

Original state of the rural house

State of the building when bought in 1996

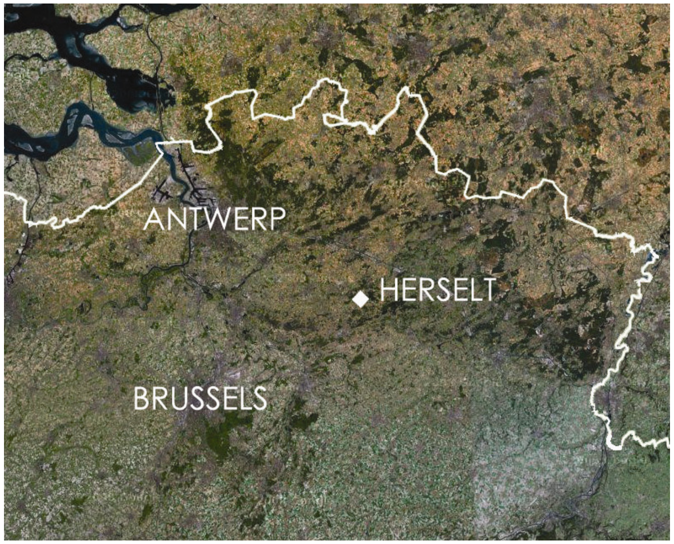
HISTORY

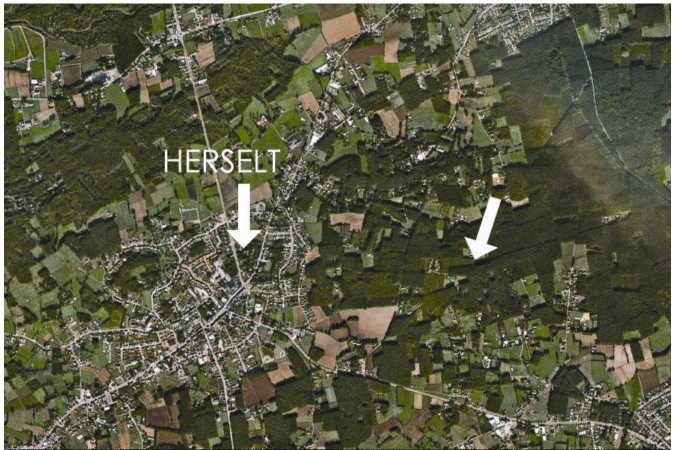
This house was originally of 30cm clay brick walls with a straw roof. After WWI the owners built a rectangle brick house. They lived in half the house, the other half was for animals and storage. Water was provided by an outside well. After WWII, the house was connected to the electrical grid. A bottled gas range and a coal/wood stove were added. Since the 1970's interest in such houses has grown. Depending on the location, the budget of the new owner and the urban planning laws, these houses are being renovated to meet current comfort demands.

This house was bought in 1996 while under reconstruction. In contrast to his predecessor, the new owner planned for a low-energy solar house. The retrofit started in 1996 but was delayed by urban planning disputes, finally bein completed by Christmas 2004. The long duration allowed for intense involvement of the owner with many adaptations compared to the initial plans.

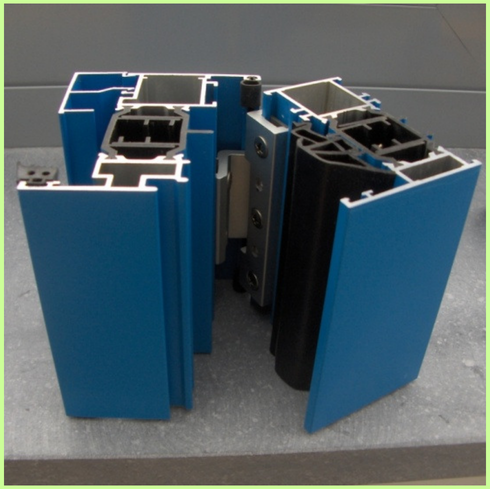
SITE

The house orientation and surroundings were the two most important reasons for purchase. The house is located in the middle of a green zone in Herselt in the south of the province of Antwerp. It has a favourable north-south orientation.





Aerial view of the city of Herselt, with location of the house.



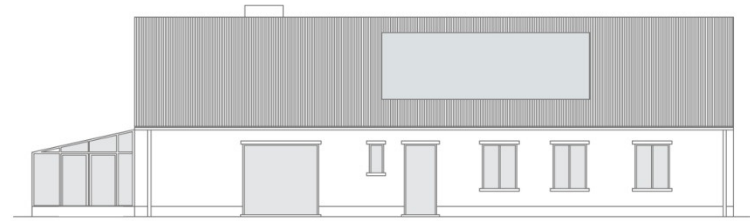
The window profiles

Photovoltaic panels on the roof of the garage

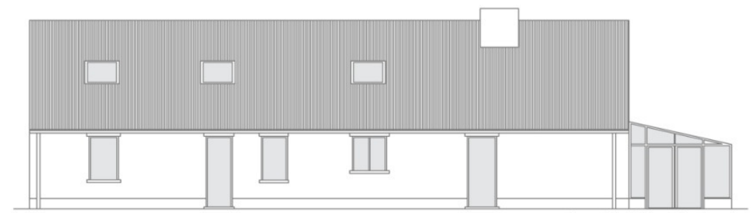
SUMMARY OF THE RENOVATION

- Foam glass was inserted in the old wall to make a thermal bridge free connection between new air cavity insulation and floor slab insulation.
- New brick facade was added on a new foundation, in front of the entirely preserved old brick construction with 12cm mineral wool in between.
- The roof was rebuilt.
- Aluminum windows and doors with high performance double glazing were installed.
- Electrical roller shutters for shading; additional insulation of the shutter casings were added.
- A new garage, with a cellar for cool storage of foods was added.
- Ambient energy and resources were harnessed.

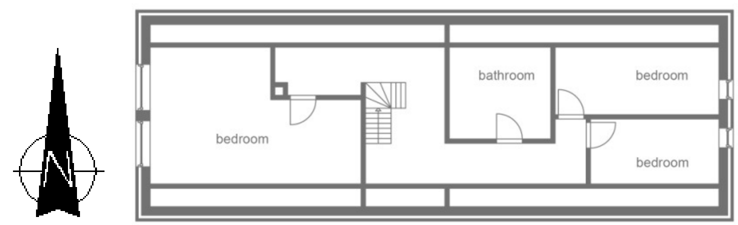
Legislation demanded that the size, height and external format (roof angle, window and door openings) of the construction were kept unchanged.



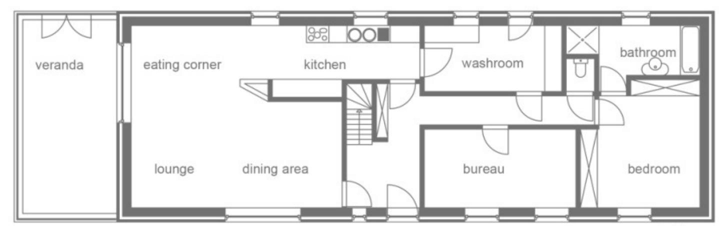
front of the house



back of the house



first floor



ground floor

The renovated house and new garage

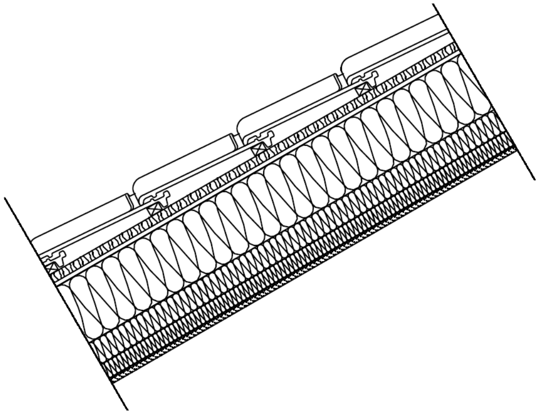
CONSTRUCTION

Roof construction

U-value: 0,18 W/(m²·K)

(top down)

Roof tiles	50 mm
Roof board	2.5 mm
Mineral wool	160 mm
Mineral wool and transverse beams	60 mm
Vapour barrier	-- mm
Mineral wool insulation	40 mm
Plaster	15 mm
Total	277.5 mm

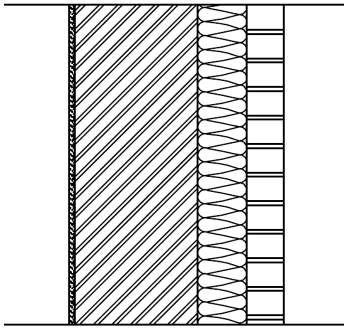


Wall construction

U-value: 0,26 W/(m²·K)

(interior to exterior)

Plaster	15 mm
Existing brick wall	300 mm
Mineral wool (8cm +4cm)	120 mm
Brick facade	90 mm
Total	525 mm

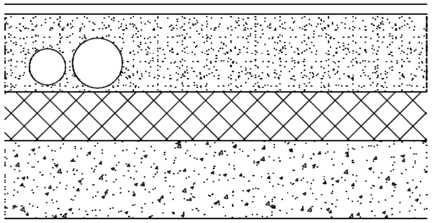


Ground floor

U-value: 0,35 W/(m²·K)

(top down)

Clay tiles	20 mm
Screed + ductwork	160mm
Polystyrene 2 x 5cm	100 mm
Concrete slab	160 mm
Total	600 mm



THERMAL BRIDGES

By adding a new roof construction and installing new windows, the connections to the adjoining building components could be designed to be thermal bridge free. The connection between the existing wall and the foundation on the other hand was a bigger problem. To solve this, a first layer of bricks was replaced by thermally insulated blocks, and a moisture resisting barrier was inserted. And, because of the insulation on the outside, and the new façade, the foundation had to be made broader. This was an opportunity to make the existing walls thermal bridge free by placing cellular glass behind the plinth in natural stone.
The use of electrical roller shutters formed another problem. Since no product on the market was sufficiently insulated, the owner added an extra layer of polystyrene panels around the roller housing.

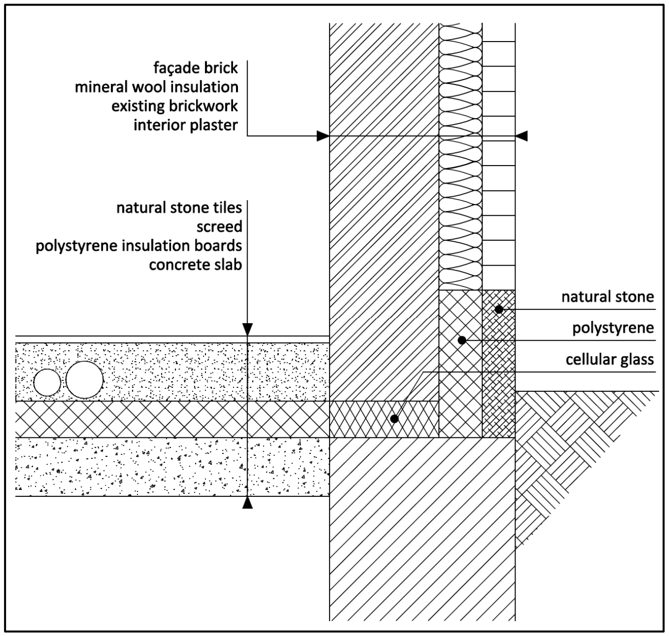
Thermal bridge free connection between flooring inside and outside

Reed field for water treatment.

SUSTAINABILITY

The house design respects the basic principles of universal design. Important elements of this design philosophy are flexibility, simplicity, accessibility.

- The bedroom and a bathroom are on the ground floor, allowing for future wheelchair access.
- A selection criterion for materials was sustainability and low maintenance.
- The elongated form of the house allowed for good natural light penetration. This was amplified by using glass doors. Only rooms needing privacy are provided with a normal, opaque door.



Detail of the foundation with cellular glass

Gastank

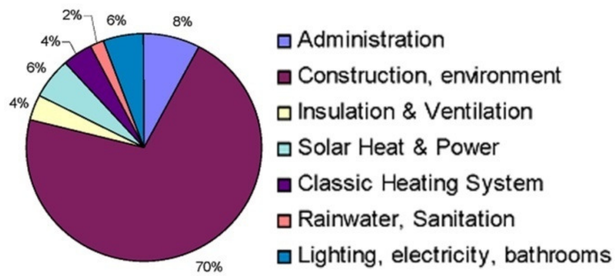
Garage with PV panels

COST ANALISYS

The retrofit was designed and monitored by the owner A consulting engineer provided technical support.

The construction and site works used 70% of the budget, partly due to the high quality of materials used. Most construction was done by the owner and his family, except for the heating system (4%) and solar heating and power (6%, net cost to the owner after capital subsidies).

About 12% of the costs are related to sustainable options (4% insulation and ventilation, +6% solar heat and power + 2% rainwater, sanitation). Administration (8%) covered lawyer's expenses to get the project approved.



Shares of main cost categories in construction budget

MEASURED COSTS AND BENEFITS

Due to efficient equipment and appliances, overall daylight access and careful control, the annual electricity consumption is less than 3000kWh, with more than 2000kWh being generated by PV. So, less than 1000kWh/year have to be purchased from the grid.

The project acheives a high degree of self-sufficiency: water sanitation (100%), water supply (50%), food storage (70%), laundry (80%). Heat is recovered from the forced ventilation.

For each MWh-PV fed into the net, the owner receives €150 .

Special tiles enable for rainwater absorption

The buffer tank, and the solar collectors installed on the roof

WATER CYCLE

Rainwater is collected in a $10m^3$ underground cistern to supply the WC, washing machine and water used in the garden. Waste water flows by gravity to a purification reed-field in the back of the garden.

Reed field for wastewater treatment

CONCLUSION

This retrofit was a true pilot project in energy performance, during a period when low energy in new construction was still considered futuristic. The thick insulation layer still required heating to be supplied, so as an experiment a solar heating system was installed on the roof.

The Belgian climate, with its extended periods of relatively low temperatures and cloudy skies, resulted inadequate solar heat production. So, in reality, the system provides mostly domestic hot water, while heating is provided by a wood stove.

The rural location of the project resulted in a very strict interpretation of the urban planning legislation. It was forbidden to change any dimensions at all, preventing the window sizes to be optimised for passive solar gains in winter. Still, the energy consumption of the house is low.

The energy measures were complemented by a thorough sustainable vision.

Mechanical ventilation with heat recovery

The garage before the renovation

Summary of U-values W/(m²·K)

	Before	After
Attic floor	0,76	0,18
Walls	3,14	0,26
Basement ceiling	2,2	0,35
Windows*	4,5	1,1

BUILDING SERVICES

Mechanical ventilation with 83% heat recovery

Back-up heating source: A wood stove in the living room provides the extra heating necessary, but sometimes causes room overheating.

Heating distribution: Floor heating on ground level, low temperature heating on first floor.

RENEWABLE ENERGY USE

- Solar flat plate collector: 22m²
  storage volume: 600l
- PV panels: 28m²

ENERGY PERFORMANCE

Space + water heating (primary energy)*
Before: 275 kWh/m²
After: 31,55 kWh/m²
Reduction: 88,5%
*Flemish implementation of EPBD

INFORMATION SOURCES

PHP vzw
Aviel Verbruggen refitting of a century old land-house to a low-energy house, *402 Int. J. Environmental Technology and Management*, Vol. 9, No. 4, 2008.

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