A new quality of living

Passive house retrofitting of an apartment building

Makartstraße Linz

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portrait of gap-solar

- The company is situated in the technology centre Perg/Austria

- History of gap-solar
  - foundation in May 2002
  - two great pilot- and demonstration passivehouses are buildt in general by gap-solar
  - with the manufacturing of facade panels (since 2004)
    - concentration on market
    - gives the chance to greater outlet

- Products
  - responsive building elements (solar panel, effect panel)
  - acoustic elements with honey-comb-design

- Organisation of market & production
  - market Germany, Luxembourg (with commercial agents)
  - market Switzerland by the company PAVATEX
  - market Scandinavia by the company barsmark (DK)
  - Home market Austria and the rest by gap-solar
  - production only in cooperation with partner companies
Overview

• Summary

• The project in detail
  – the situation of Makartstraße before and after renovation
  – aspects that should be reached by the renovation
  – renovation in detail

• The implemented responsive building elements in the project in detail
  – gap-solar panel
  – controlled single room ventilation with heat recovery
  – Windows with internal shading

• Pictures from manufacturing and the building-site
The building will meet the requirements of a passive house through prefabricated solar walls with gap solar facade-panels, reinforced insulation to the top floor and cellar ceiling, enlargement of existing balconies with integration into the thermal wrap as well as controlled room ventilation with single room ventilators with heat recovery.

It is an example for future oriented renovation of a building, i.e. partly high degree of prefabrication, therefore a short building time and high quality standards, makes only slight bothering of tenants possible.

The reduction of heat-energy from 179 kWh/m² living space to 14,4 kWh/m².a reduces the current heating costs for a flat of 59 m² living space from €40,80/month to € 4,73/month after modernization.

Improvement of living quality is made possible through an increase of sound protection and good ventilation by means of high quality single room ventilators without opening of windows.

It is one possibility to use responsive building elements in integrated building concepts by modern and future oriented overall shaping of „old objects“.

In the moment it is only a first step – many others should follow.
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History in pictures

before retrofitting

in the phase of planning

after the retrofitting
**The situation before renovation**

- the apartments are built in 1957/58
- 50 apartments in 5 floors without a lift
- 2,981,92 m² living space (incl. balcony)
- the walls are built general in scoria bricks (with bad static)
- ceilings in concrete with steel
- windows are changed individual (most of them in plastics)
- the situation of the object next to busy Makart Street did not allow a qualitative use of balconies due to enormous pollution and noise!
- a good infrastructure
Renovation in detail - the elements of renovation

Integration of gap-facade panels and low energy windows into prefabricated wall-elements
controlled room ventilation with heat recovery (single room)
enlargement of balconies with integration in thermal wrap by increasing the living space (317.43 m²)
new entrance doors to the apartments (insulation, noise, air tightness)
warm water production:
  instead of heat exchanger by gas ➔ heat exchanger by „Fernwärme“
sun- and light shading integrated into the windows
reinforce insulation of top floor and cellar ceiling
electricity installation new in stair rooms
new roofing
additional installation of lifts
change of the parking situation in connection with the pavement
gap-solar facade – functional principle

- “insulation by light” defines the function
- the solar honeycomb acts as a solar absorber
- at low position of the sun (winter) the solar load penetrates into the solar honeycomb and heats up
- a warm zone is created on the outside of the wall
- The temperature difference between living space and outside climate is practically neutralized
- at high position of the sun (summer) the honeycomb shades itself
- an additional mechanical sun-shading isn’t needed
Panel construction from outside to inside:
- ESG-float glass pane, 6-8 mm
- air gap (slightly ventilated), 31 mm
- solar comb, fire classification ÖNORM B1, 50 mm
- rear wall made of wood, 4 mm
- insulation (rock wool), 40 mm

maximum panel format: 1.250 x 3.050 mm
manufacturing tolerance: +/- 2 mm
high and oblong format possible

tone of the solar comb according to RAL
glass with or without structure

characteristics of heat:
$U_b$ (without additional insulation, only for the panel): 0.59 W/m²K
$g_{n,b}$: 0.11 – 0.13 (for dark tones)

soundproofing:
$R_w$ = 59 dB for a wooden framework-construction (16 cm)
$R_w$ = 67 dB for a vertically perforated brick-wall (38 cm), double sided plaster
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Integration of gap solar panel in a wooden construction

the gap-facade panel

will be integrated in the manufactory in the prefabricated wooden construction

➔ finished prefabricated wooden wall complete with windows and air flue for ventilation
The gap-facade panel II is a consequently continued development with a highly reduced frame construction and with identical function and performance than facade panel I.

Panel construction from outside to inside:

- ESG-float glass pane, 6-8 mm
- air gap (slightly ventilated), 27 mm
- solar comb, fire classification ÖNORM B1, 35 mm
- rear wall made of softwood fibreboard, 4 mm
- total construction thickness, 98 mm
- panel weight: 28 kg/m²

maximum panel format: 1.250 x 3.050 mm
manufacturing tolerance: +/- 2 mm
high and oblong format possible

tone of the solar comb according to RAL glass with or without structure

characteristics of heat:

$U_b$ (without additional insulation, only for the panel): 0.74 W/m²K
$g_{n,b}$: 0.13 – 0.15 (for dark tones)
integration into framework construction

gap facade panel I

gap facade panel II

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Effective U-values of the gap solar facade

Dämmstandard 1
Ständerdämmung 100 mm
Solarwabe 50 mm
Luftspalt 20 mm
Glas 5 mm
U-Wert = 0,285 W/m²K

Dämmstandard 2
Ständerdämmung 180 mm
Solarwabe 50 mm
Luftspalt 20 mm
Glas 5 mm
U-Wert = 0,183 W/m²K

Dämmstandard 3
Ständerdämmung 260 mm
Solarwabe 50 mm
Luftspalt 20 mm
Glas 5 mm
U-Wert = 0,135 W/m²K

100 mm
180 mm
260 mm
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. design with glass

- floatglass blank
- ornamente glass
- textured glass

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Form design with color

Practical every color is possible!
Determination of the heating capacity for the necessary hygienic air change:

necessary air change per person: 30 m³/h
interior air temperature: Tᵢ = 20°C
outdoor air temperature: Tₒ = −10°C
d.h. Δϑ = 30K; (P = 30m³/h. 0.33Wh/K/m³ . 30 K )

>>>>> heating capacity = 297 W

ditto at use of a ventilation device with heat recovery

assumption heat recovery of 75%

>>>>> heating capacity = 75 W

For ventilation devices with good heat recovery the residual heat capacity for the necessary hygienic air change could be covered by the thermal discharge of one person.
in every living room and bed room there is situated one ventilation device

3 steps of ventilation  15; 30 and 60 m³/h

changes of filter:  1-2/year

pollen filter alternative

heat recovery approx. 73 %

electrical power 4 - 12 Watt
(electricity consumption per heating period:  30 to 60 kWh)
localisation 40 cm below the ceiling

2-3 devices per apartment
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Ventilation with heat recovery – installation example

bore holes for couple of single room ventilation
Window (in passive house-quality) with integrated jalousie.
balconies: pictures – existence before and after

balcony (existence)

entrance (existence)
Balconies: enlargement + integration into the thermal wrap.

Balcony (new)

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the new facade encloses the balconies
and integrates them into the thermal wrapping
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facade measuring

- facade measuring per laser scanning and
- visualisation in 3d
Instead of the heat exchanger by the gas installation, the heat exchanger by „Fernwärme“ will be used for the making of warm water.

The existing heat exchanger by „Fernwärme“ will be still used for room heating (only reducing the temperature in the system!)

The existing radiators are completed with thermostats.
The heat-energy-consumption

reduction from 179 kWh/m² living space
to 14.4 kWh/m² (by PHPP).

The summary of saving is about of 455,000 kWh/a.

This gives a reduction of heating costs from
€ 14,150,—/a (existence) to € 1,273.50/a

and a reduction of the CO₂-emissions from 160 t/a to 14 t/a.

The saving- and reduction potential can be calculated –

but many other facts as …

....optical seeing, the using of renewable energy, sustainability, the high degree of prefabrication and therefore the high quality and short building time and only slight bothering of tenants ….

have to be calculated in a other way.
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. Heating costs for a flat of 59 m² living space

Heating costs before retrofitting   
ca. 0,69 Euro/m² month incl. VAT
= 40,80 Euro/month for 59,17 m²

Heating costs after retrofitting   
ca. 0,08 Euro/m² month incl. VAT
= 4,73 Euro/month for 59,17 m²

Reduction of heating costs:   
ca. 0,61 Euro/m² month incl. VAT
= 36,--/month for 59,17 m² living space
approx. 15 – 20 % of the gross costs
**Time table and financing**

**Termin**
- Begin of renovation: 24.08.2005
- Finish of retrofitting: 1. quarter 2006

**Financing**
- Building costs (all inclusive): 2,446,000,-- (787,--/m² WNFl)

**Reserves**
- Loan from apartment building funds, 25 years, 40 %AZ, country OÖ
- Upkeep and providence amount (so called „EVB“) actual € 1,39/m² living space/month
- Extra allowance from federal ministry „BMVIT“
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Pictures from manufactory
Pictures from the building-site
Pictures from the building-site
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Pictures from the building-site
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- Pictures from the building-site

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- Pictures from the building-site
Pictures from the building-site
Pictures from the building-site
Pictures from the building-site - retrofitting is finished.

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- Buildings in the solar-city – with gap solar panels

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13,5 kWh/m²a

7,3 kWh/m²a

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„The longest way begins with the first step.“
China Saying

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FOR YOUR INTEREST!