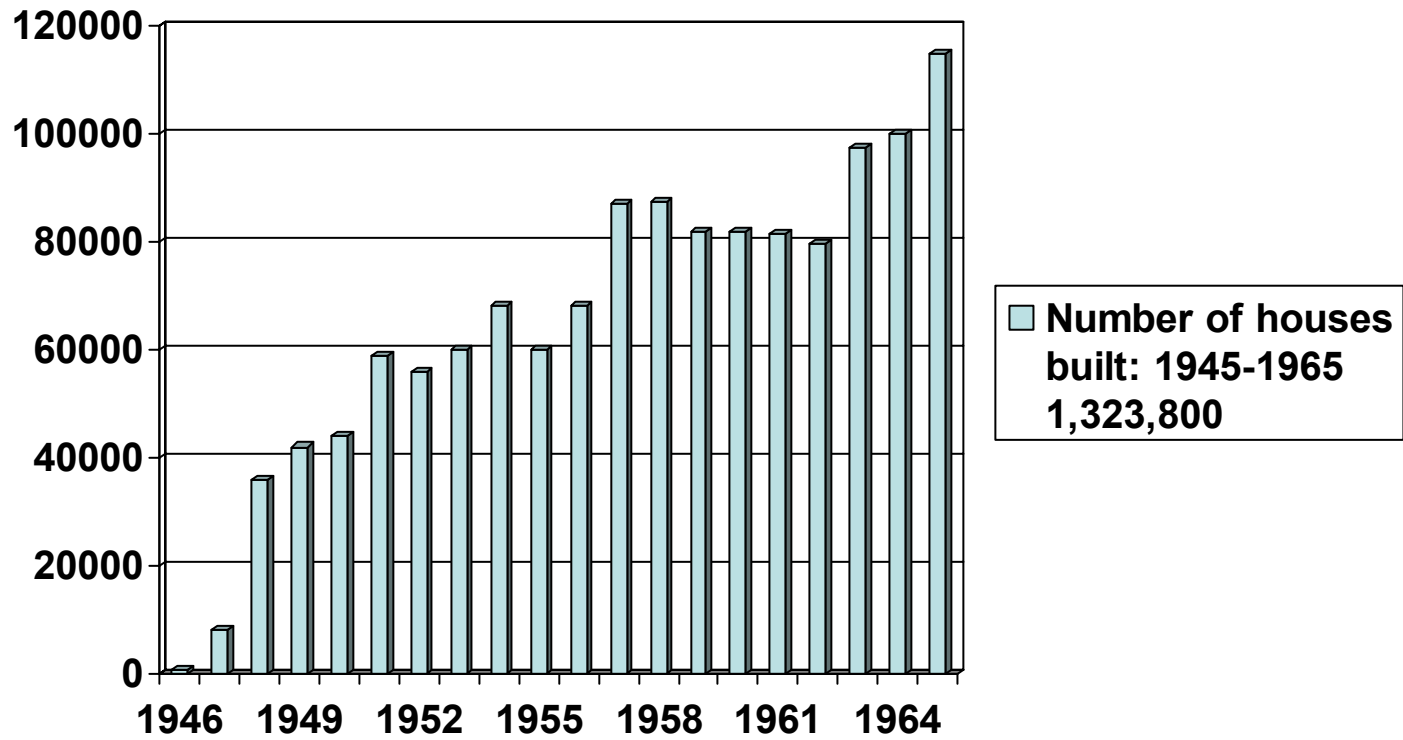


The Comprehensive Housing Renovation Approach

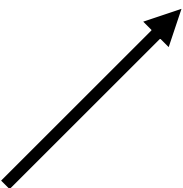
**Terrace housing
1945 – 1965**



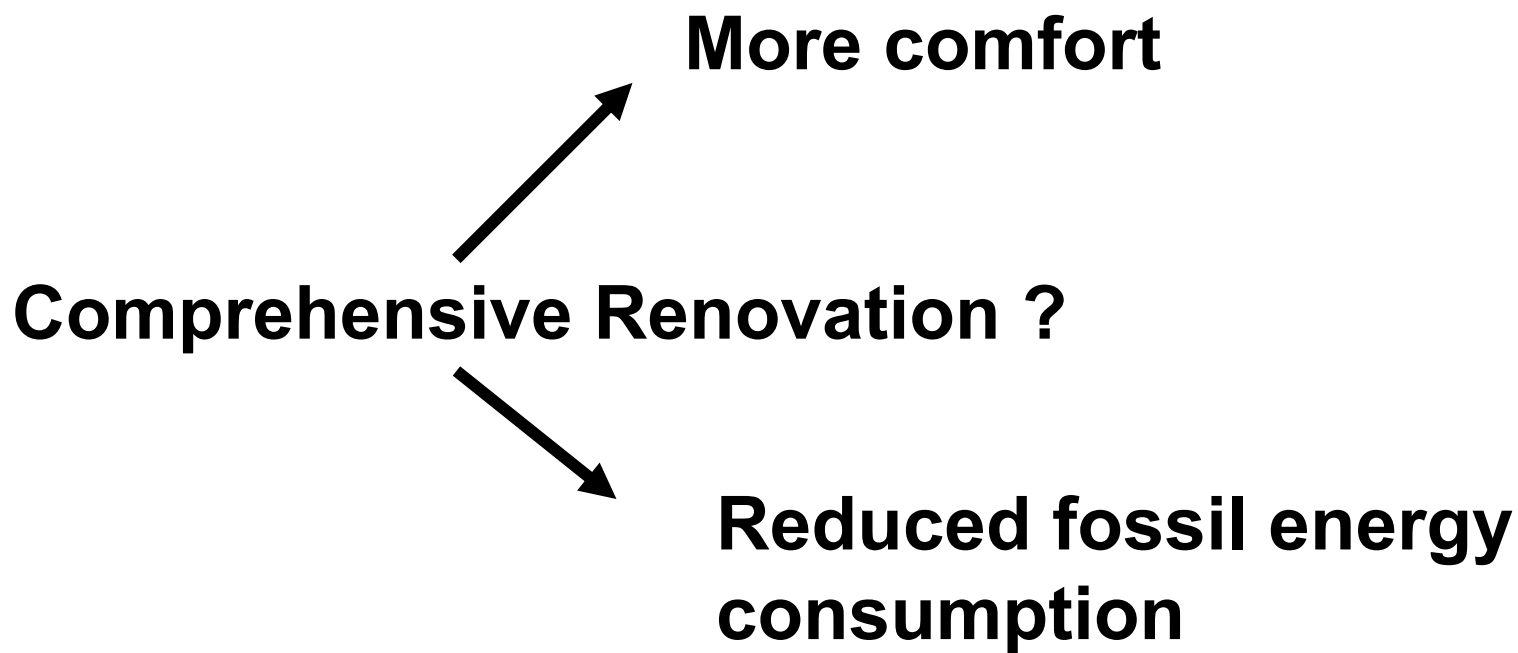


Comprehensive Renovation ?

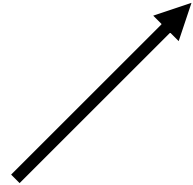
More comfort



Comprehensive Renovation ?

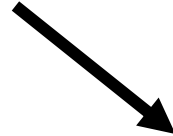


Comprehensive Renovation ?



More comfort

**More space
More possibilities
More equipment**



**Reduced fossil energy
consumption**

Comprehensive Renovation ?

More comfort

- More space
- More possibilities
- More equipment

Reduced fossil energy consumption

Heating 3000 m³ Natural gas

300 m³

Electricity 3500 kWh

1000 kWh

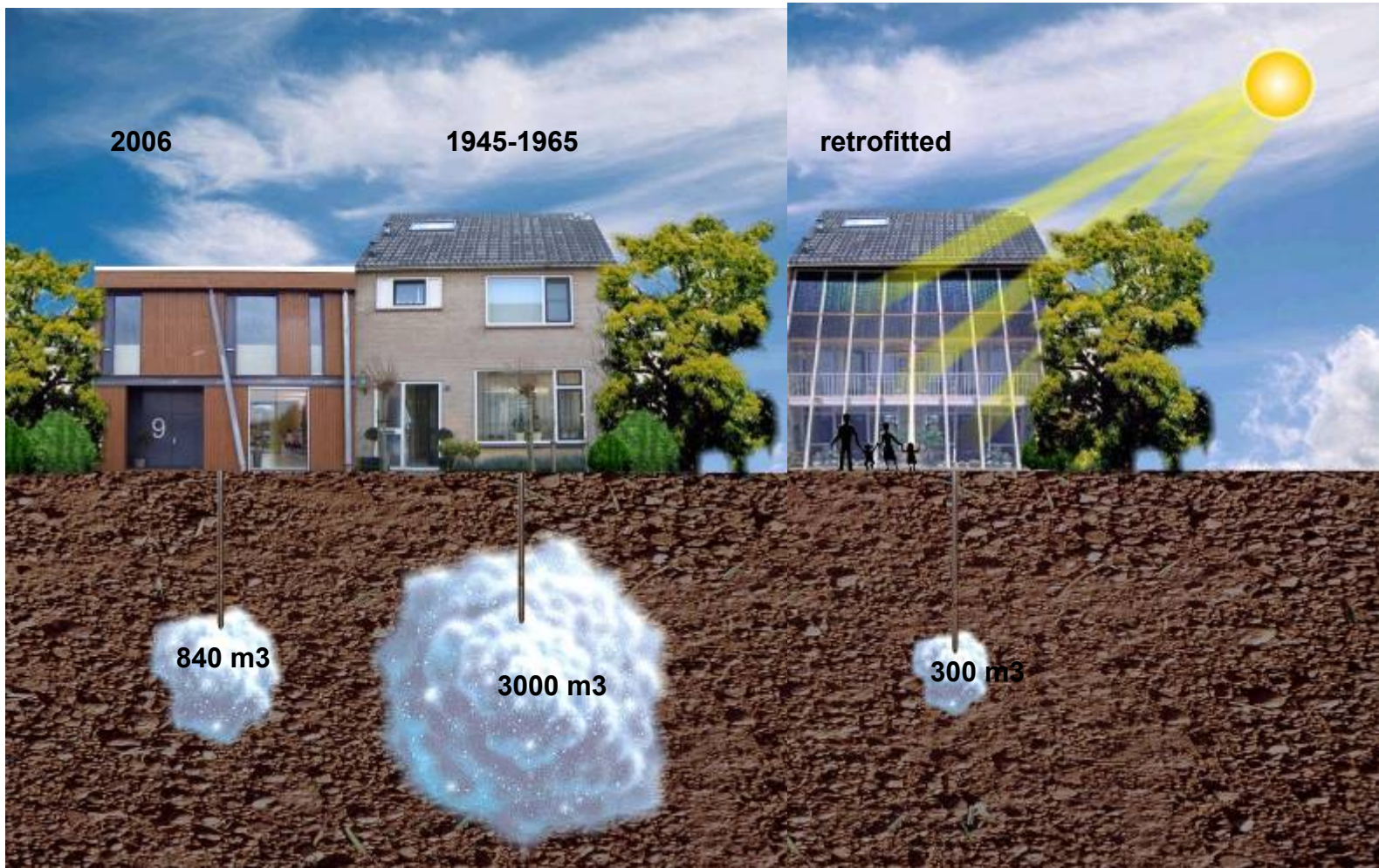
Heating 3000 m³
↓
300 m³

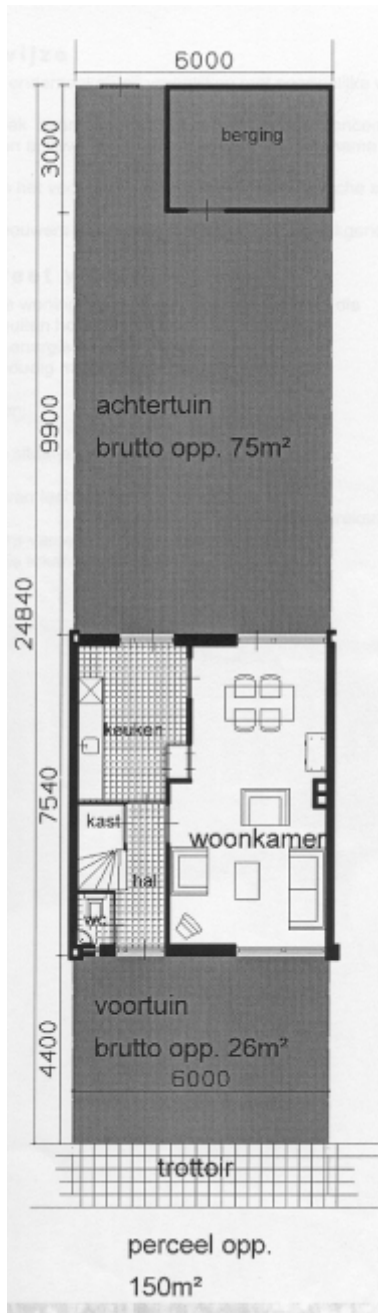
Electricity 3500 kWh
↓
1000 kWh

1 m³ natural gas ≈ 9.8 kWh

Average size 100 m²

$3000 \times 9.8 = 29400 \text{ kWh}$ @ 100 m² = **294 kWh /m² year** (Heating and Hot water)



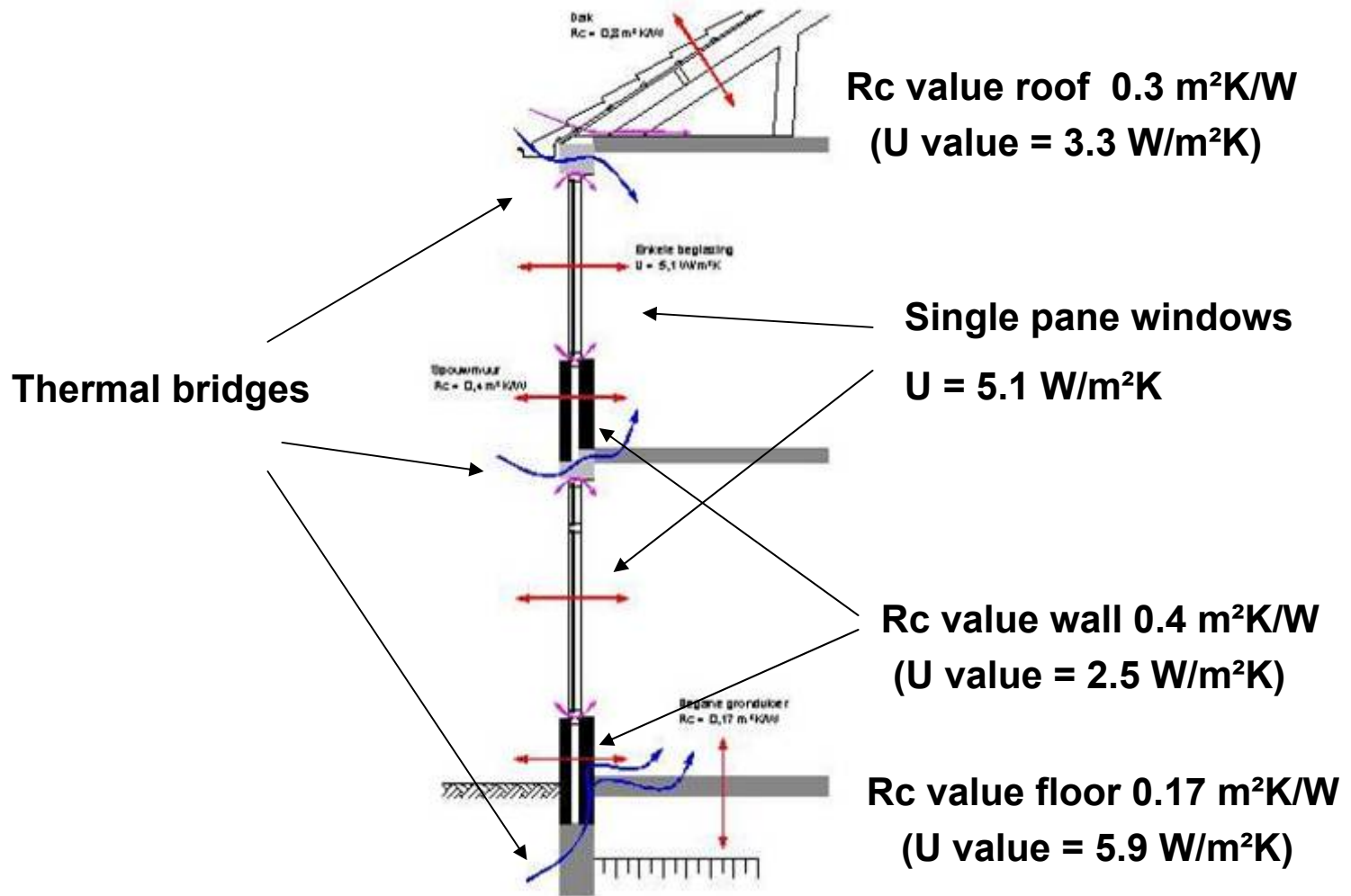


Storage 3x4 = 12 m2 (133 sq ft)

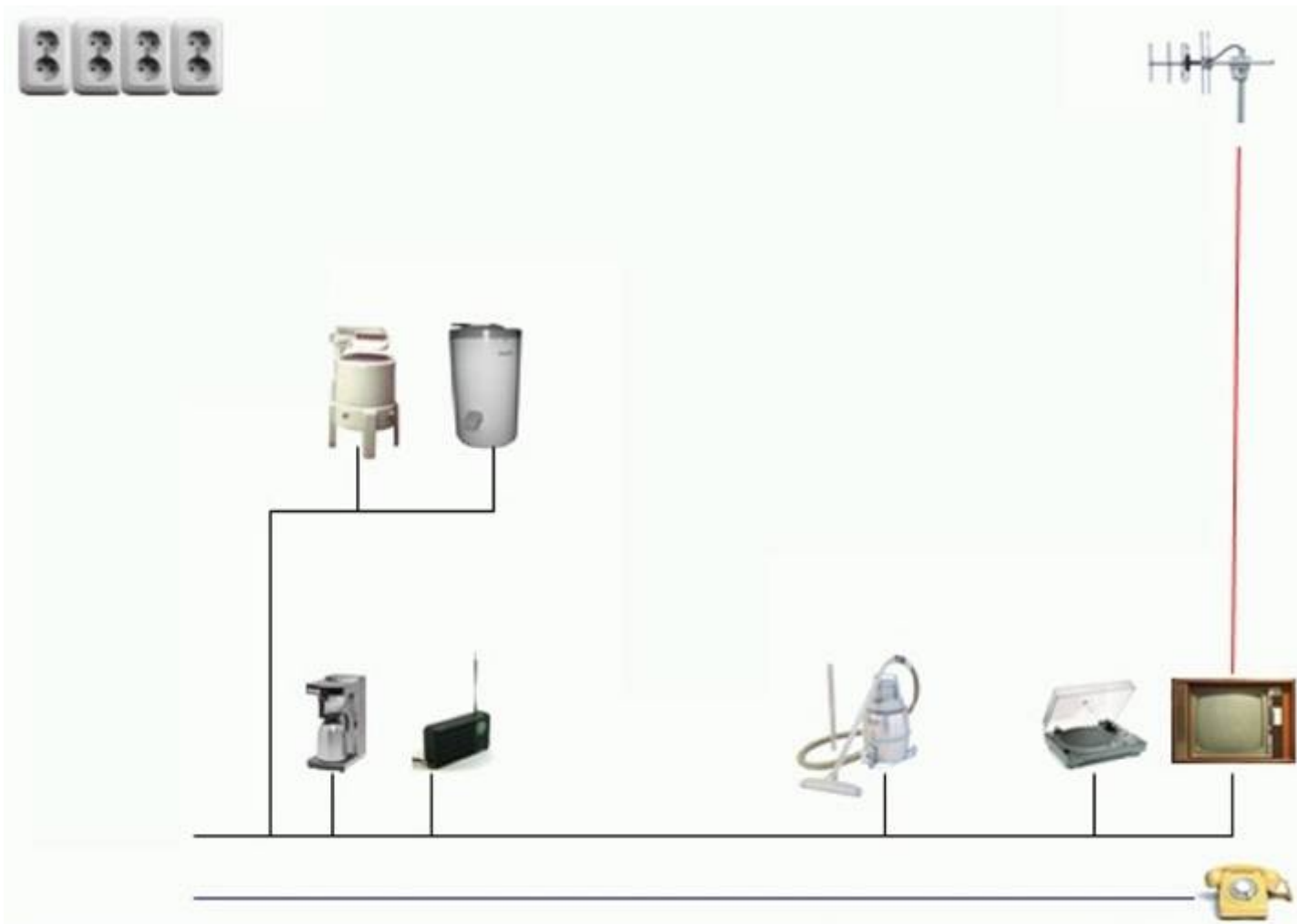
Backyard 6x10=60 m2 (670 sq ft)

Footprint 6 x 7.5 = 45 m2 (500 sq ft)

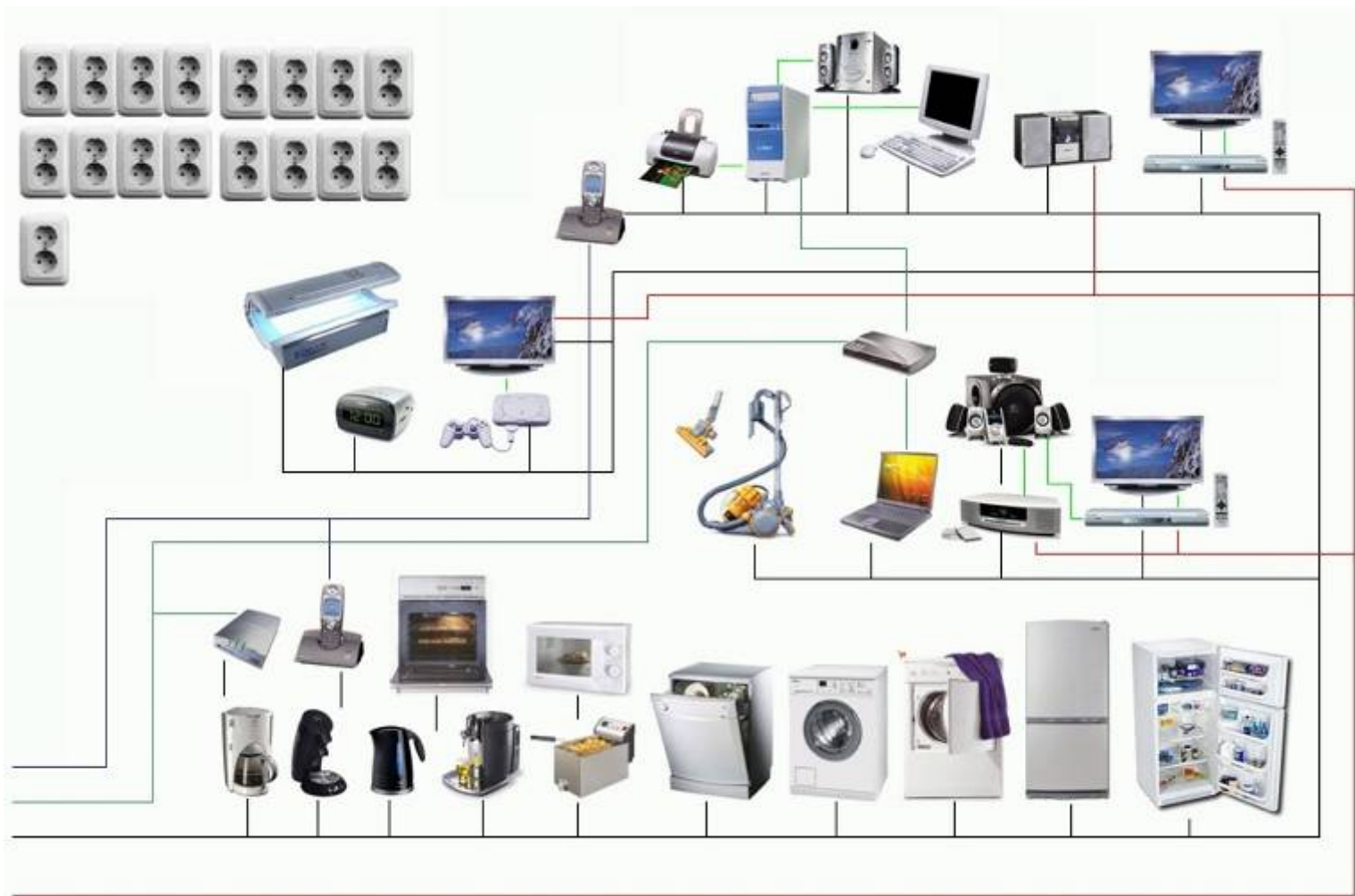
Total surface lot 150 m2 (1670 sq ft)



Characteristic vertical section Housing Built in 1945-1965 period



Electric equipment 1966



Electric equipment 2006





Building Sector is responsible for:

35 % total waste production

+

Cost of waste disposal:

€ 0.20 / kg

+

Cost of New building

€ 0.80 / kg

+

25 % of all road transportation is building related





Eindhoven 1950



Upgrading 2010 ?

Vitruvius (90 BC - 20 BC) a building must be:

Reliable

Safe

A thing of beauty



People want protection against Heat, Cold, Rain, Wind, Thieves and Curious other persons

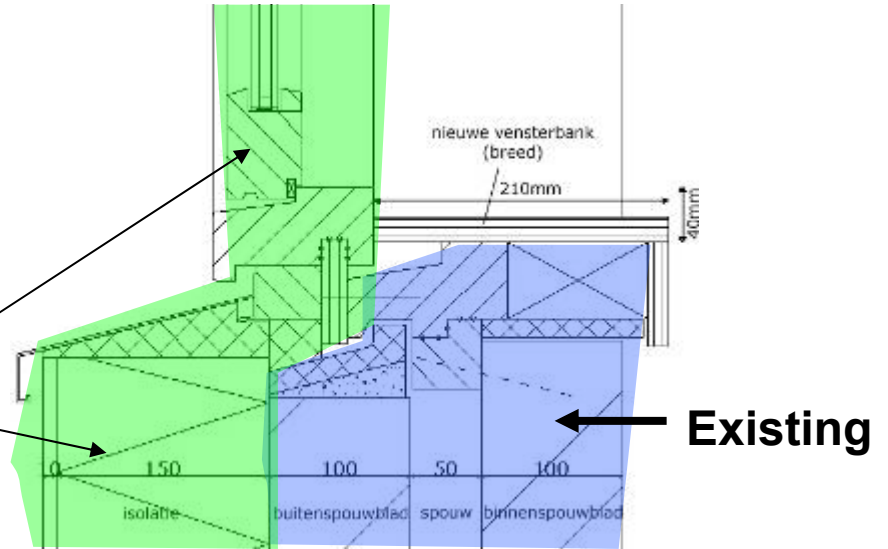
People want light and sun and order

People want places suitable for various activities like Cooking, working, sleeping and living.

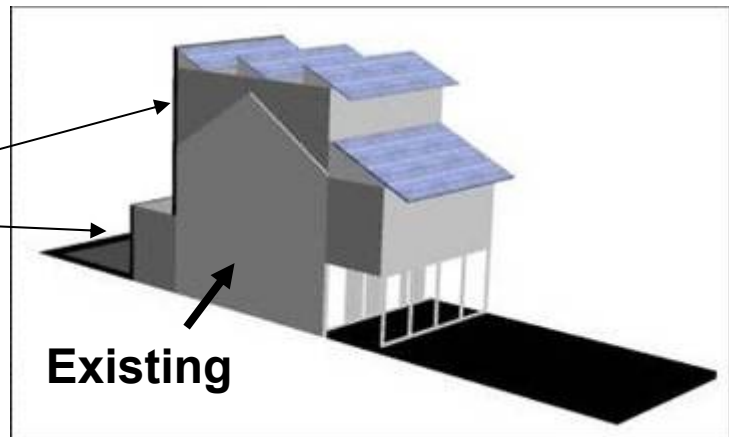
Le Corbusier (1887 – 1965)

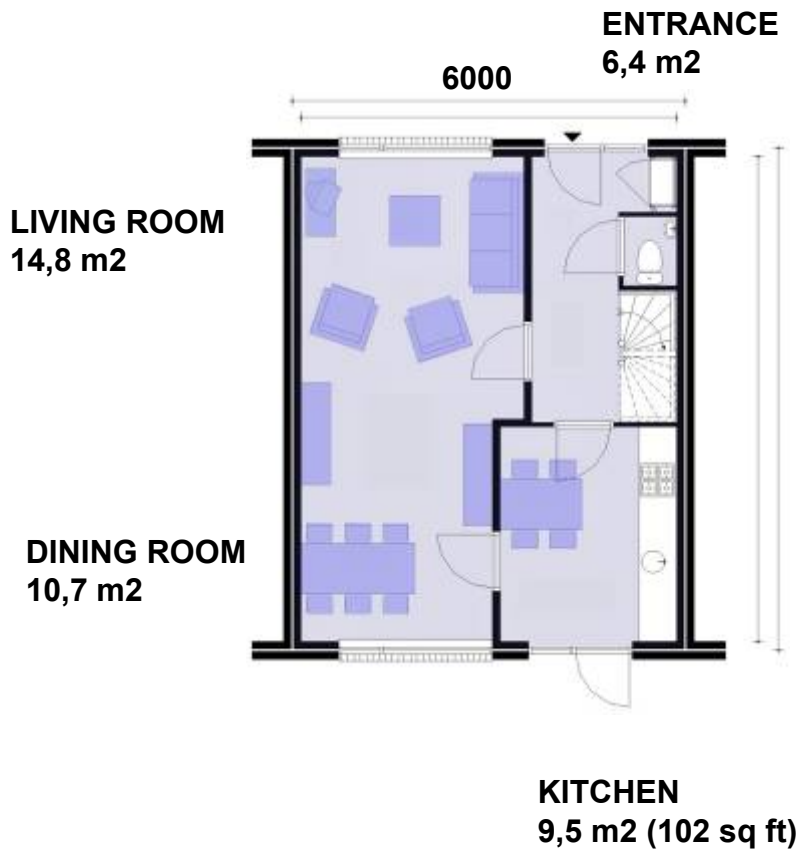
Adaption by:

Improvements



Additions



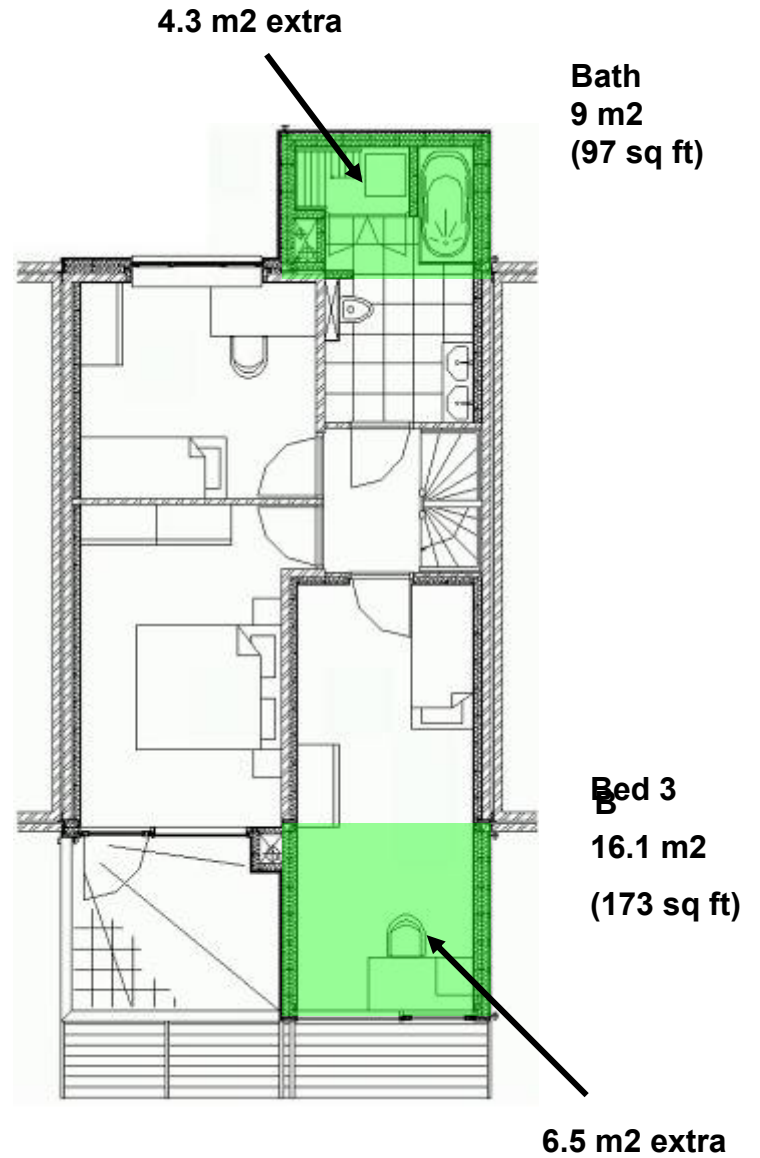


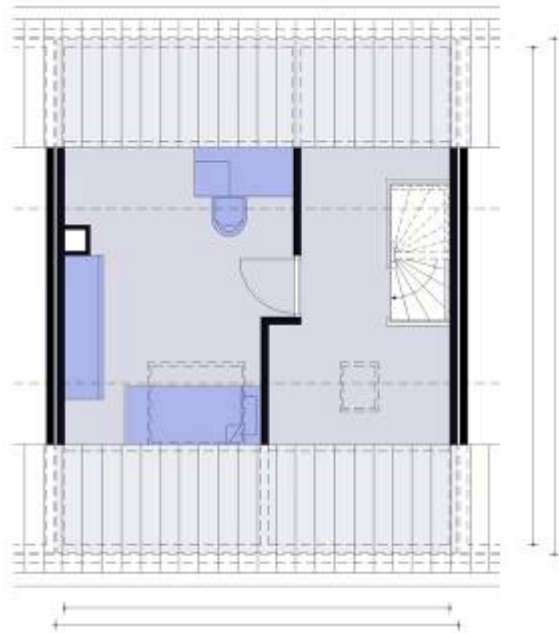
Ground floor layout



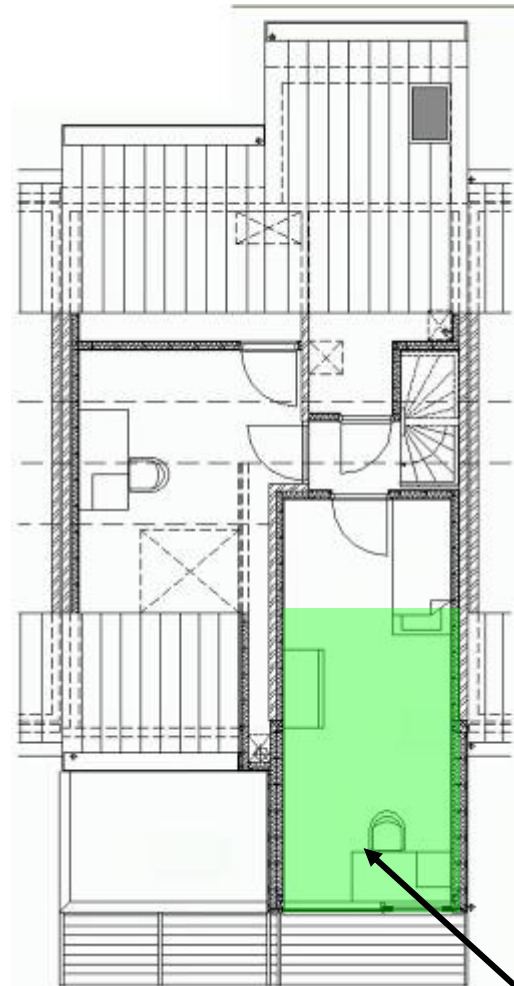


First Floor Layout



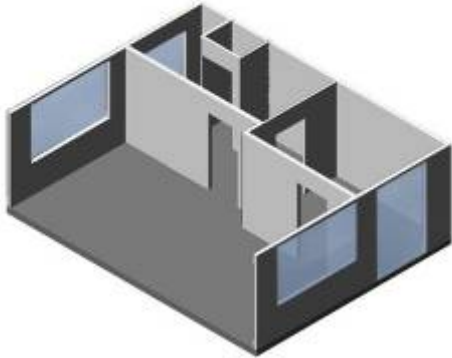
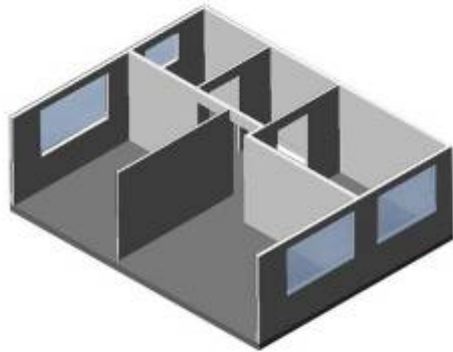
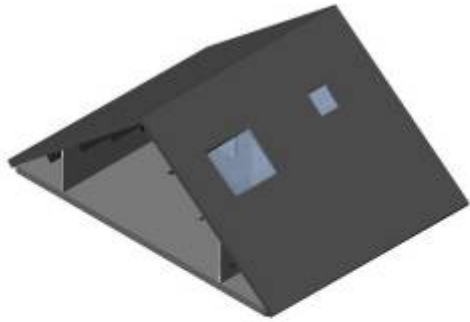


Second floor layout

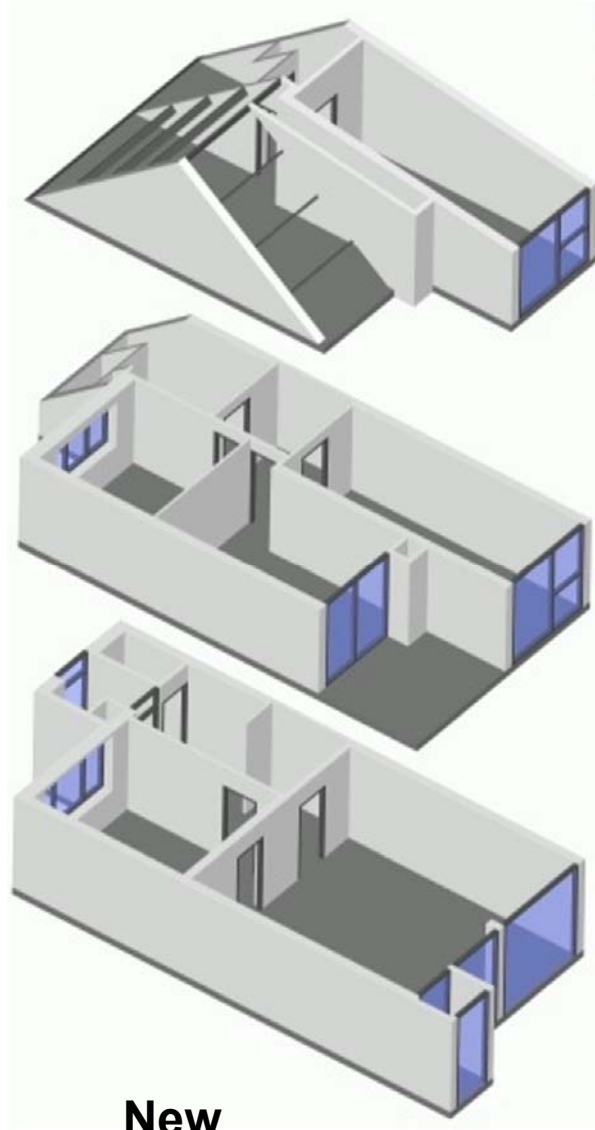


Bed 4
16.1 m²
(173 sq ft)

6.5 m² extra



Existing



New

Comprehensive renovation:

Thermal insulation and sun shading $R > 5.0 \text{ m}^2\text{K/W}$

Air tight structure

Enclosed porch

Heat recovery ventilation (**still problematic !**)

High performance windows $U < 1.0 \text{ W/m}^2\text{K}$

Use of orientation (passive solar energy)

Use of active solar energy (Thermal and PV)

Heat storage

Laundry drying space

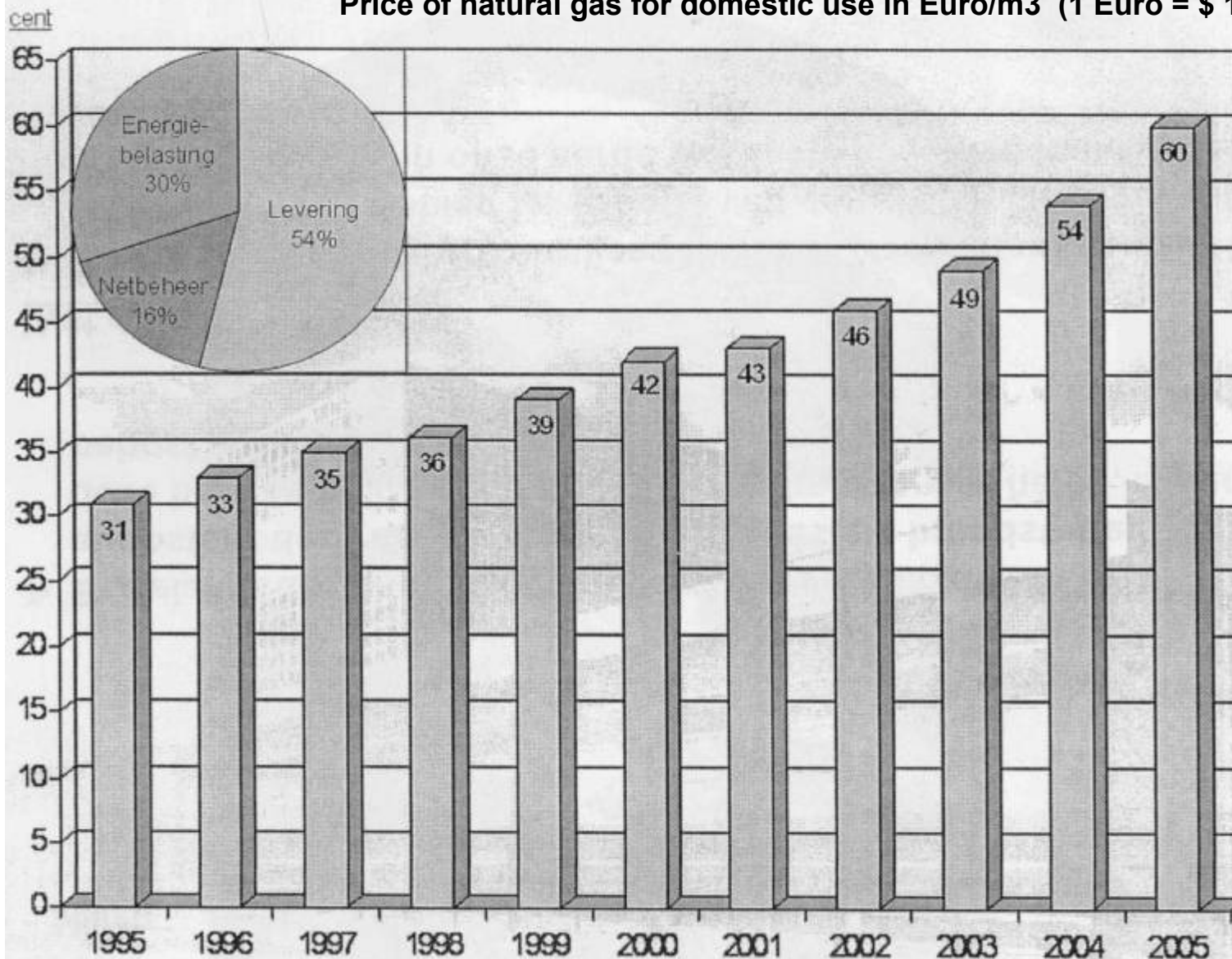
Special equipment (dishwasher and washing machine)

Gasprijs voor huishoudens per m³ (exclusief vastrecht)



Bron: NUON

Price of natural gas for domestic use in Euro/m³ (1 Euro = \$ 1.22)



Reduction heating cost and CO2 emissions

From 3000 m³ natural gas to 300 m³

Saves 2700 x € 0.60 = € 1620,- per year

1 m³ natural gas = 1.78 kg CO₂

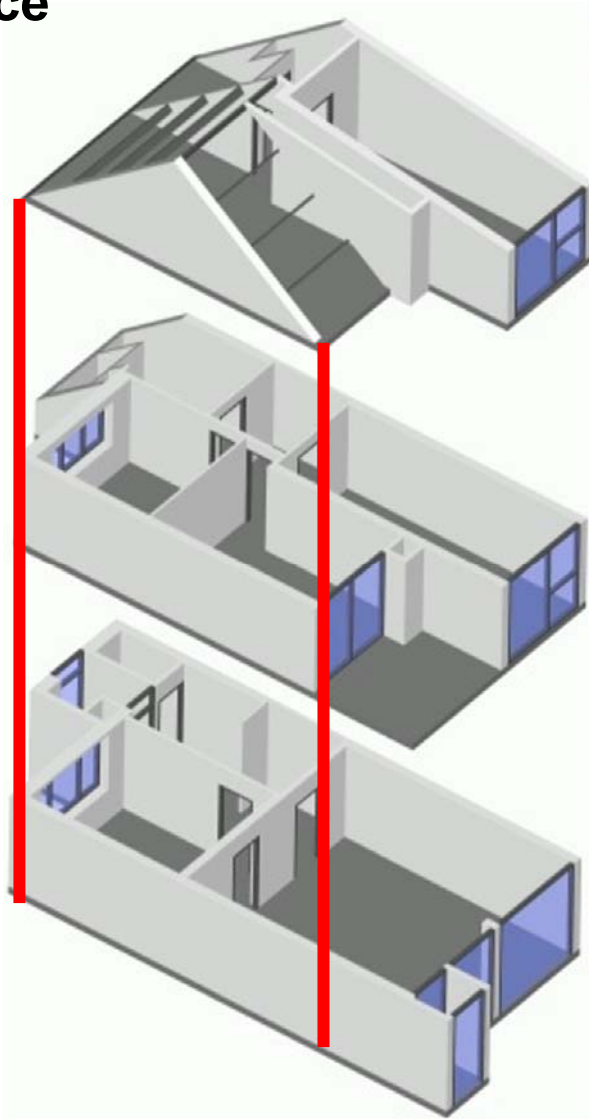
Saves 2700 x 1.78 = 4,806 kg CO₂

Total Dutch CO₂ emissions 239,000,000,000 kg

National Dutch goal of CO₂ savings: 20,000,000,000 kg (by 2010)

500,000 dwellings retrofitted = 2,403,000,000 kg CO₂ emissions prevented

Extra space



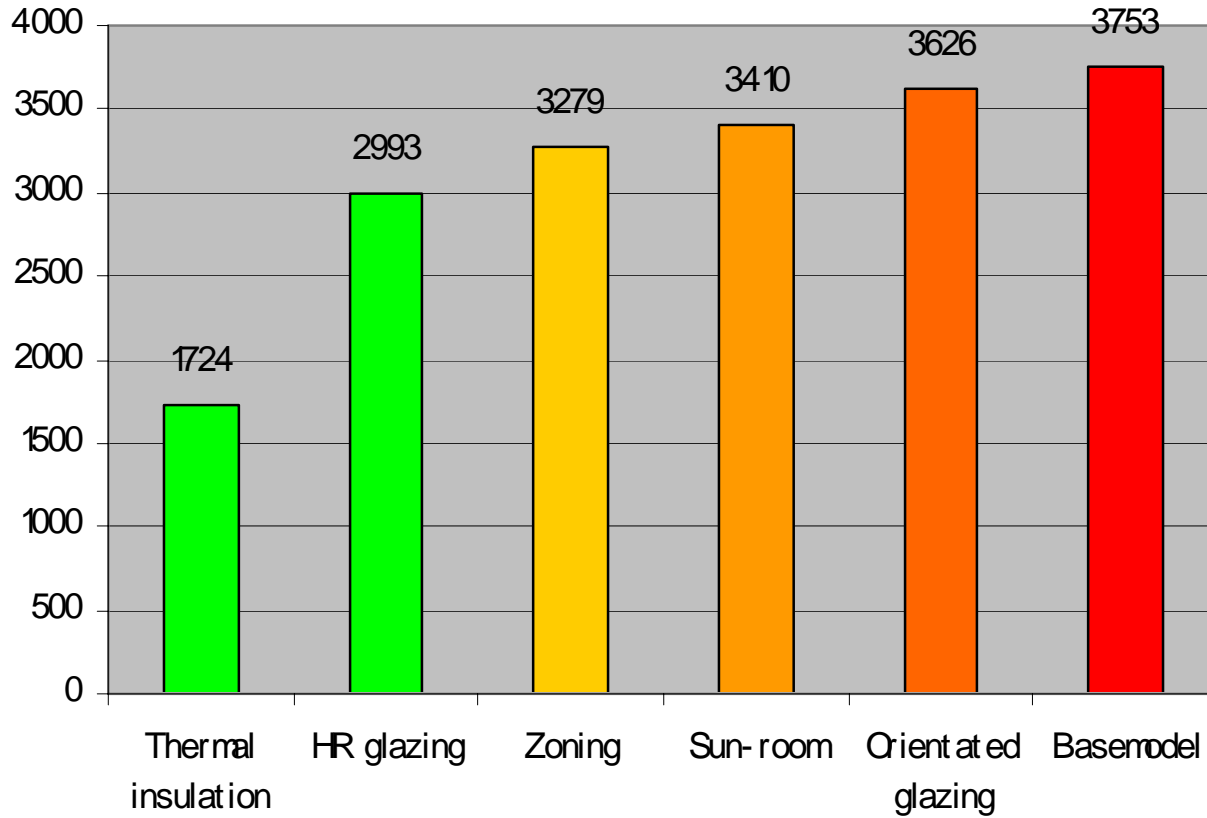
Second floor 6.5 m2 extra

First floor 10.8 m2 extra

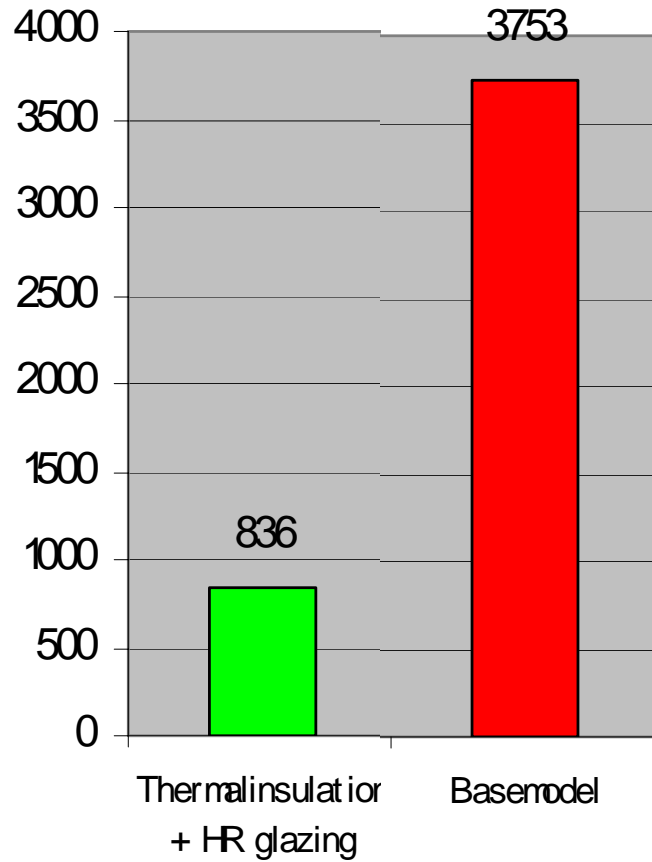
Ground floor 18.8 m2 extra

Existing surface 113 m2 + 36.1 (32%) = 149.1 m2 (1540 sq ft)

Natural gas consumption in m3 in relation to different solutions



R=5.0 m²K/W (200 mm)
Glazing U = 1.0 W/m²K



R=5.0 m²K/W (200 mm

Glazing U = 1.0 W/m²K

Conclusion:

With $R = 5.0 \text{ m}^2\text{K/W}$
and glazing with $U < 1.0 \text{ W/m}^2\text{K}$
and heat recovery ventilation with $> 50\%$ efficiency

Natural gas consumption will be reduced
from $3,753 \text{ m}^3$ to 375 m^3

Conclusion

Comprehensive housing renovation will bring:

More comfort, extra space reduced cost for the occupant

Reduction of waste and transportation

Reduced fossil energy consumption

Reduced CO2 emissions

