Advantages of Solid Construction: Differences to Timber Construction

Draft for members of
MASSIV MEIN HAUS e.V.
for your individual presentations
Do not distribute!

June 2007

Strong arguments in favour of solid houses

85% of residential buildings are solid constructions built with bricks or concrete

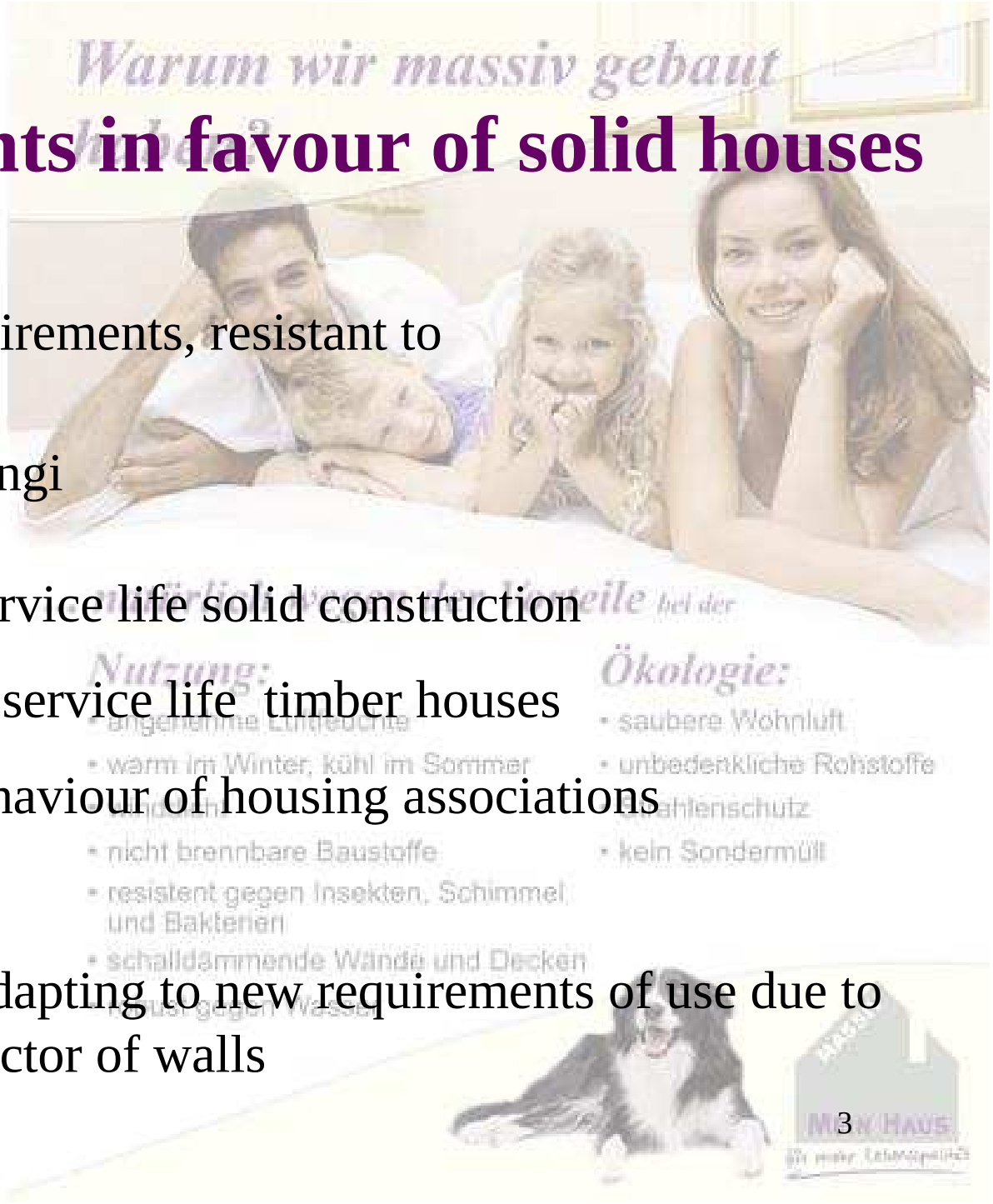
Germany has a lot of timber, so it would have been possible to use timber for construction much earlier if it were of any advantage

Solid construction reflects the climatic and geographical conditions in Central Europe :

- High moisture load
  $\Rightarrow$ service life
- Fast changes between warm and cold days
  $\Rightarrow$ indoor climate
- High-density housing
  $\Rightarrow$ fire protection

Flexibility offered a further development according to market requirements

Strong arguments in favour of solid houses



Service life

Low maintenance requirements, resistant to

- humidity
- rodents, bacteria, fungi

Experts: 80 years of service life solid construction

60 years of service life timber houses

See experience and behaviour of housing associations

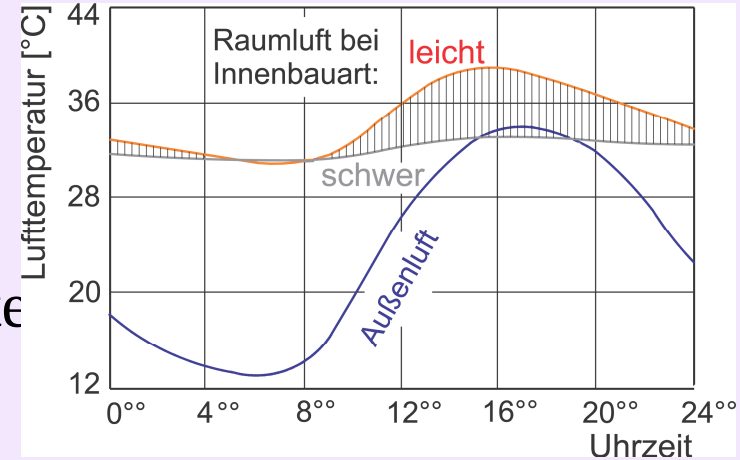
Alterations possible, adapting to new requirements of use due to a generally low load factor of walls

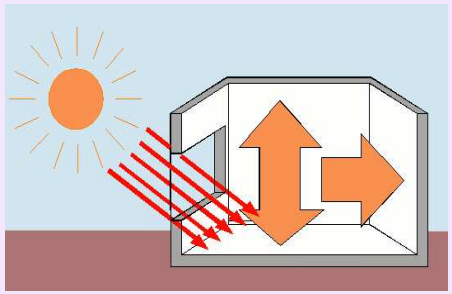
Balanced indoor climate

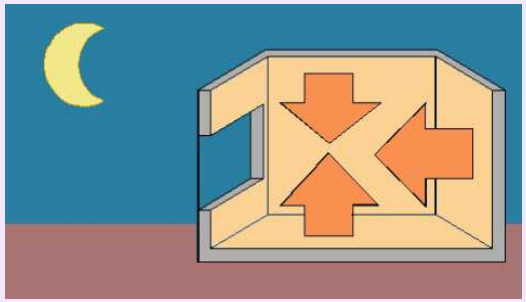
Heat retention due to heavy solid construction

Advantage in central European climate with frequent changes between

- warm and cold days
- between day and night
- avoids overheating
  provides a pleasant indoor climate
- reduces heating costs due to
  heat retention
  considered in 2002 Energy Saving Law







Balanced indoor climate

Advantage in central European climate

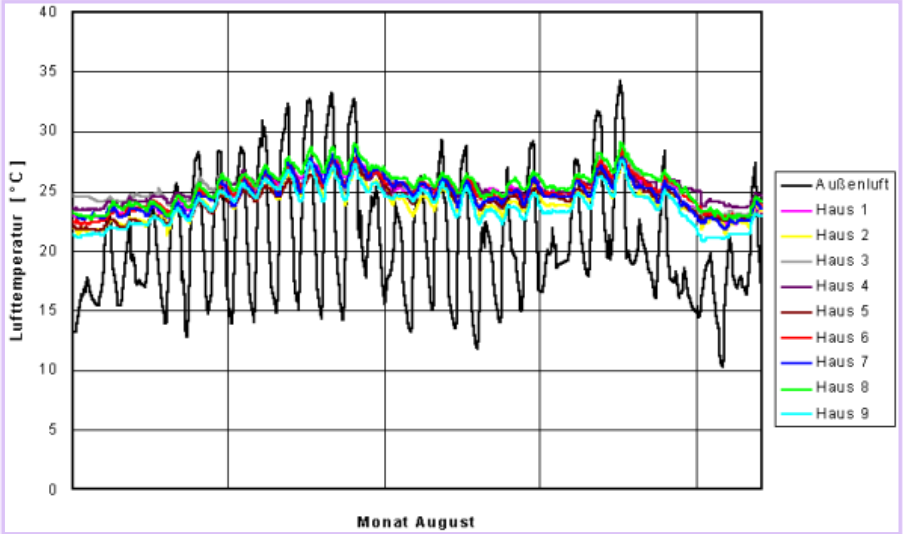
with frequent changes in outside temperatures

Example: terraced houses Bochum-Werne

Mean indoor air temperatures in August 1997

Even on days with outside air temperatures of up to 33°C

Maximum indoor temperatures about 5°C lower

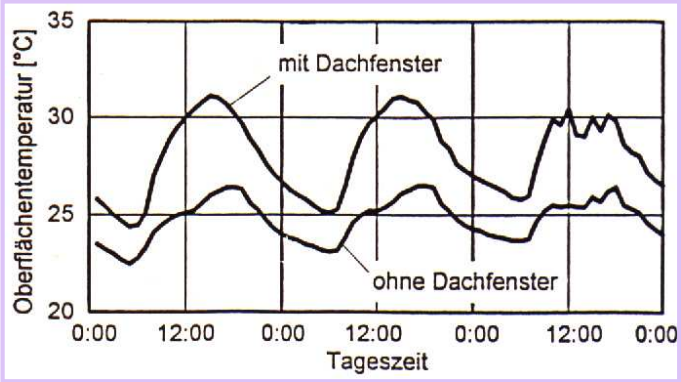


Balanced indoor climate

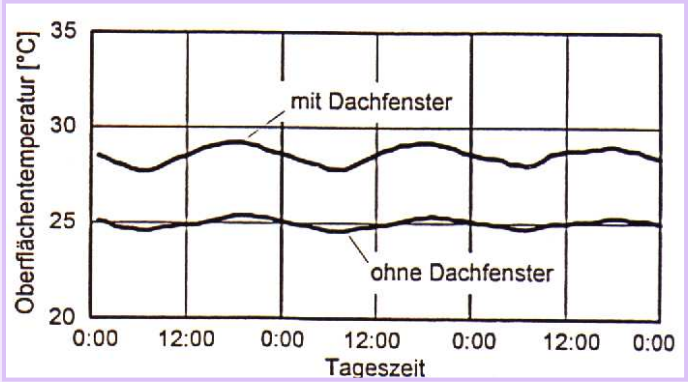
Example: solid roof

Comparing temperatures on surfaces facing the rooms
in midsummer

Roof in timber rafter construction



Modular concrete roof



(Source: „Bauphysik“ 21/1999 issue 3)

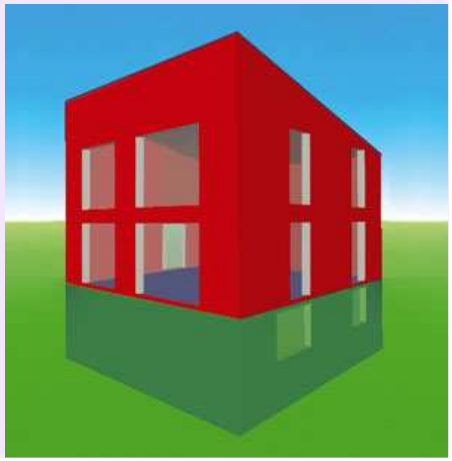
Advantages in summer and winter

Example of a KfW-40 house
Alware study, Brunswick

Heating energy demand of the solid house – despite the same insulation values – 427kW lower than in the timber house – i.e. more than 12%. The solid house also required a lower heating output. In the example shown the heating system of the timber house had to provide a maximum output of about 9.85kW. The solid house only required an output of 7.41kW. The heat retaining solid construction is particularly rewarding in case of extremely insulated KfW-40 and passive houses.

Frequency of overheating in the rooms facing to the south: solid house 7.1%, maximum temperature 29.2°C. Timber house: 19.2%, maximum temperature 33.1°C.

Unlike the solid house the timber house overheated during the heating period as well.



Amplitude damping and phase lag

Increase in line with

- mass
- heat insulation

Specific thermal capacity c

Heat content to increase the temperature

of 1kg of a material

by 1°C.

Material	c [J/(kg.K)]
Inorganic building and insulation materials	1000
Timber and wood-based materials	2100
Plant fibres and textile fibres	1300
Foamed plastics and plastics	1500
Aluminium	800
Other metals	400
Air (ρ = 1,25 kg/m^3)	1000
Water	4200

Heat retention during the heating period

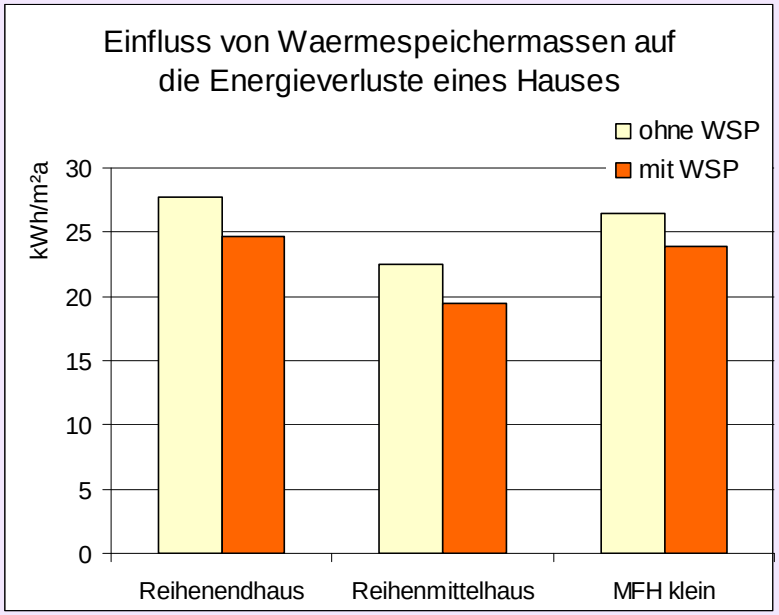
May be calculated acc. to the Energy Saving Law

Output coefficient of „heavy“ buildings is higher

See slides 7 and 11

Advantage in central European climate with frequently changing outside temperatures and sunny days

Example of the influence of heat retention (WSP), taken from Werner: *"Parameter study on the energetic variables influencing the heating energy requirements of buildings..."*



Heat retention during the heating period

Energy Saving Law:

Efficient heat retention c_{wirk}

Heat

penetrates the components with a time lag and is shielded by the insulation layers

$\Rightarrow$ only part of the thermal gain can be used

In case of exact calculations only calculate the layers at $\lambda \geq 0.1$ W/mK

- Layer thickness up to 10cm if bordering the indoor air on one side
- Layer thickness up to 20cm if bordering the indoor air on two sides

Simplified calculation

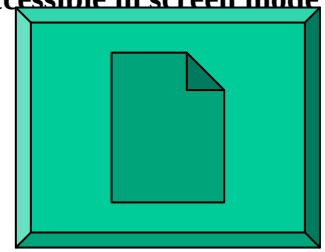
lightweight building: $c_{wirk} = 15$ Wh/m³K $\cdot V_e$

heavy building: $c_{wirk} = 50$ Wh/m³K $\cdot V_e$

Solid house and timber house

from an energetic and indoor climate point of view

(Accessible in screen mode only)

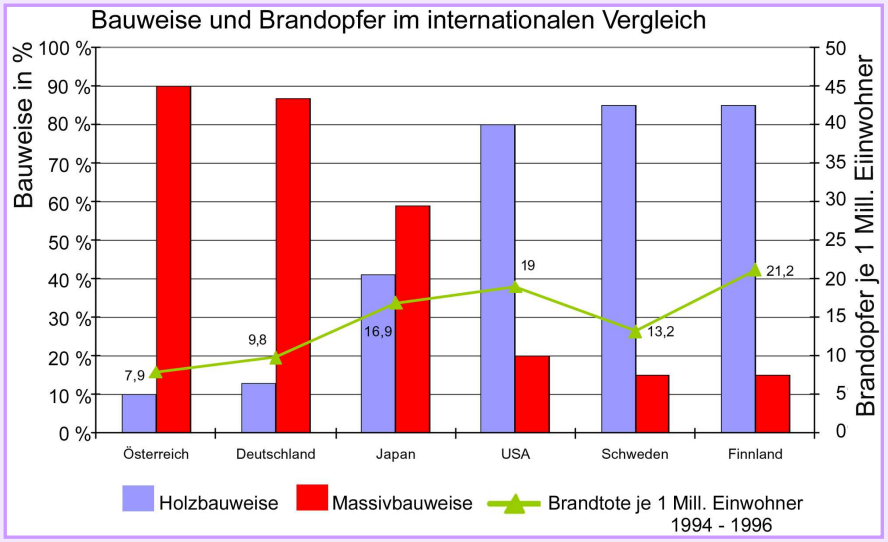


Fire protection

Masonry and concrete

- Are not flamable
- Do not contribute to the fire load
- Do not develop any toxic fumes
- Retard the spread of the fire
- Lower risk results in lower insurance premiums

The fire risk in our country is defined by the prevailing solid construction



Fire protection

- The construction authorities do not require compliance with any fire protection regulations in terms of the walls of detached single family homes (with one apartment)

- Solid houses are almost always rated as fire-risk category F 90

- Solid building materials made of bricks and concrete do not burn! German Construction Material Classification A (not flamable)

Fire protection

At night in particular the chances of escaping from a fire are improved by a solid house

- Opportunities of rescue teams to intervene
- In most cases the roof catches fire first
- Improved fire protection with solid roofs

Technical fire precautions as a sensible complementation

- Smoke detectors might fail
- Sprinklers might be triggered accidentally

(Accessible in screen mode only)

Burning houses in timber frame construction

Source:
http://www.fire-foto.com/holzhaeuser.htm

Burning multi-floor houses during construction London, 2006

Click here to download the Windows Media Player free of charge

Burning houses in timber frame construction

Fire protection – Risk of damage

The risk of damage of different construction methods is partially reflected by different insurance premiums (premiums may be doubled)

Comparability is often blurred; in case of the same premiums the reference (original value, current value, different deductibles) is changed

In case of a fire you are also liable for fire damage caused at your neighbour‘s!

Damage of neighbouring buildings is usually not covered by the fire insurance

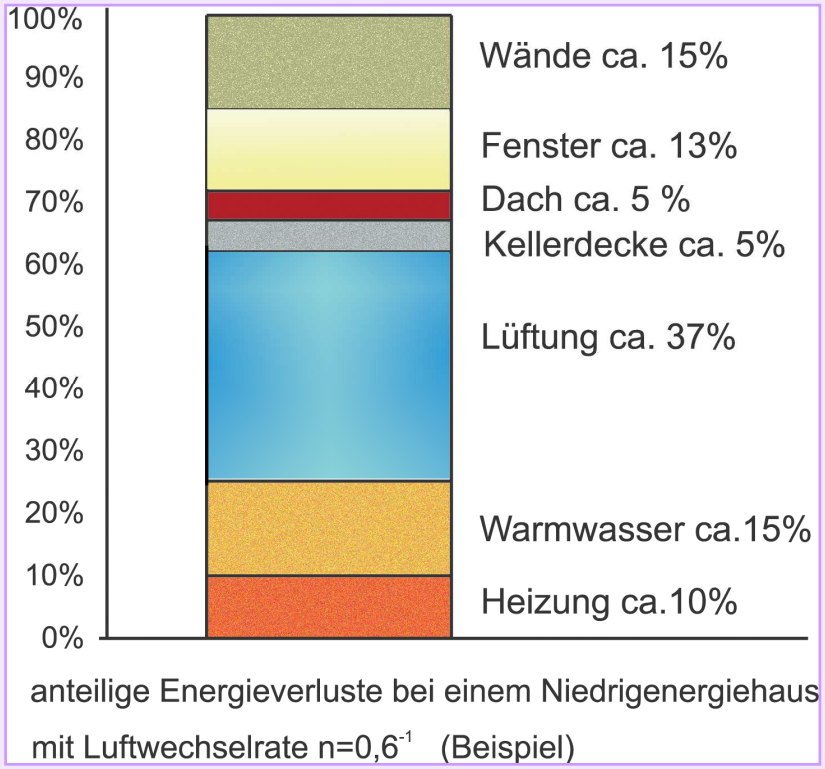
Thermal protection/low energy buildings

No major differenes between solid and timber construction

Identical features:

- roof
- windows
- cellar floor/cellar
- ventilation heat losses
- heat generation and water heating

Only the walls have a different structure

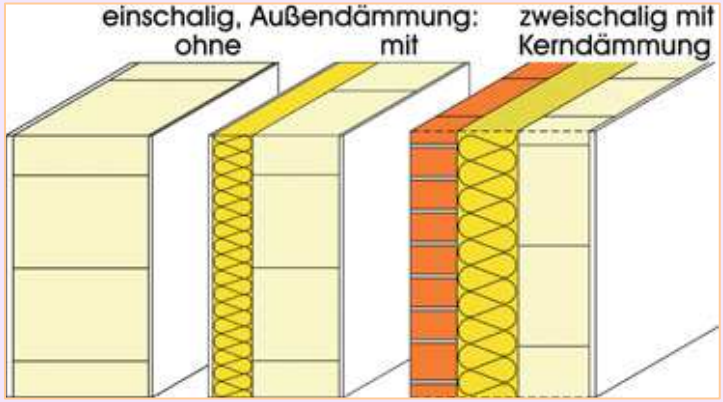


Thermal protection/low energy buildings

Exterior brick walls:

- Made of heat-insulating bricks
  lower heat conductivity than timber

  Solid wall at = 365mm
  with λ= 0.10 W/mK U= 0.25 Wm²/K
  with λ= 0.08 W/mK U= 0.21 Wm²/K
  softwood only λ= 0.13 W/mK



- With exterior insulation
  variable thickness of insulation material

- Two shells with core insulation
  shell distance limits thickness of insulation material thickness to 140mm

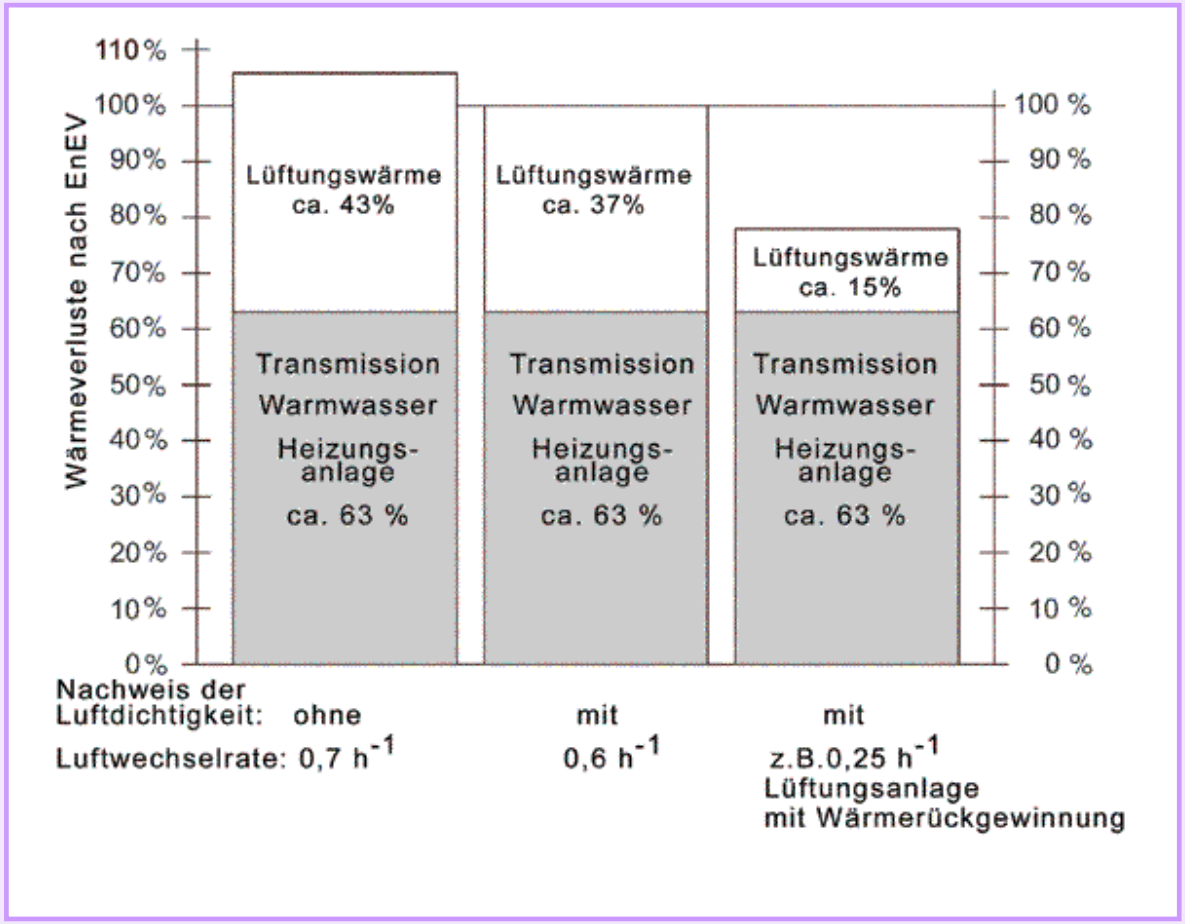
Planning scheme for low energy buildings

	Energieeinspar-verordnung 2002	Energiesparhaus 60 „3-Liter-Haus“	Energiesparhaus 40
Wärmebedarf	ca. 7 Liter Heizöl	ca. 3 - 4 Liter Heizöl	ca. 1,5 - 3 Liter Heizöl
Wand	U* ≤ 0,35 W/m²K	U* ≤ 0,30 W/m²K	U* ≤ 0,25 W/m²K U* ≤ 0,15 W/m²K (Passivhaus)
Fenster	U* ≤ 1,40 W/m²K	U* ≤ 1,10 W/m²K	U* ≤ 0,90 W/m²K
Dach	U* ≤ 0,25 W/m²K	U* ≤ 0,20 W/m²K	U* ≤ 0,15 W/m²K
Kellerwand u. -sohle	U* ≤ 0,40 W/m²K	U* ≤ 0,40 W/m²K	U* ≤ 0,35 W/m²K
Wärmebrücken	vermindert nach DIN 4108 Bbl. 2	optimiert	optimiert
Lüftung	geprüfte Luftdichtheit + Fensterlüftung	geprüfte Luftdichtheit + • Fensterlüftung oder • Lüftungsanlage, evtl. mit Wärmetauscher	geprüfte Luftdichtheit + Lüftungsanlage mit Wärmetauscher
Heizung (generell innerhalb der beheizten Gebäude-hülle)	Brennwert- oder Niedertemperaturkessel	Brennwertkessel oder Pelletheizung evtl. zusätzlich Solar-kollektoren	• Brennwertkessel • in Lüftungsanlage integrierte Elektroheizung • Wärmepumpe • Pelletheizung • zusätzlich Solarkollektoren
Warmwasserbereitung	integriert in Heizkessel	Solarkollektoren	Solarkollektoren
Hilfsstrom für Wärmeerzeugung	aus dem Netz	aus dem Netz oder Foto-voltaik	Fotovoltaik

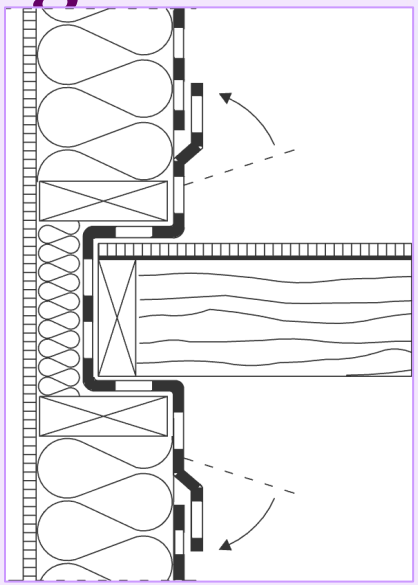
* Der Primärenergiebedarf - und damit die erford. U-Werte - hängen stark von der Anlagenaufwandszahl e_p ab.

Ventilation heat losses

How ventilation heat losses influence the primary energy demand of a single family home (example)



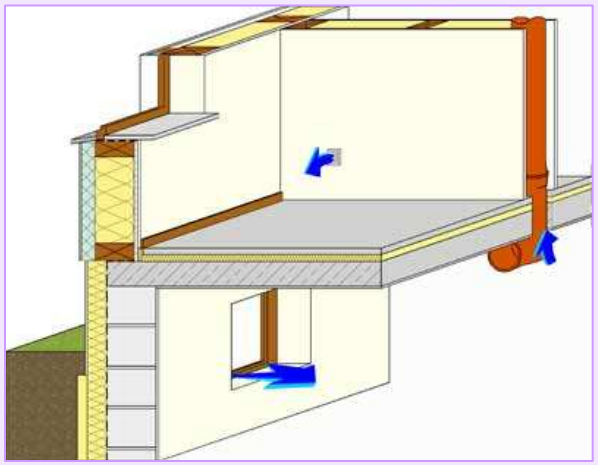
Solid components are wind tight due to interior plaster



See DIN 4108 – 7, August 2001

Other construction methods require foils and slabs

- **Higher sensitivity in terms of construction flaws**
- **Shocks**
- **Connections**
- **Penetrations**
- **Contracting and expanding of timber constructions**



Solid buildings provide good sound insulation

DIN 4109, “Sound insulation in building construction“ does not include any statutory requirements in terms of sound insulation inside a single family home or an apartment, but only regarding ***third-party*** working and living zones

Only reccomendations apply to the ***occupant‘s own*** working and living zones, often neglected

Solid walls and ceilings provide opportunities to retire, as

- Sound insulation of single-shell walls increases in line with the mass per unit area
- The bigger the mass, the better the sound insulation;
  it is difficult for sound waves to „jolt“ a solid wall
- Walls and ceilings made of bricks, mortar or concrete do not contract and expand, and there is no crackling noise

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Solid components provide good sound insulation

Sound insulation in the occupant‘s
living and working zone :

Ceilings and staircases are the main problem

Ceilings and walls made of bricks and concrete
provide good sound insulation

Do not make lightweight partitions too light

You may turn up the stereo in a solid building,
and children are allowed to rollick about

Solid buildings provide protection against street and air-traffic noise

Outdoor noise is rated in categories I to V, depending on the noise-insulation class

I = very quiet V = very noisy

Solid exterior walls meet the following requirements:

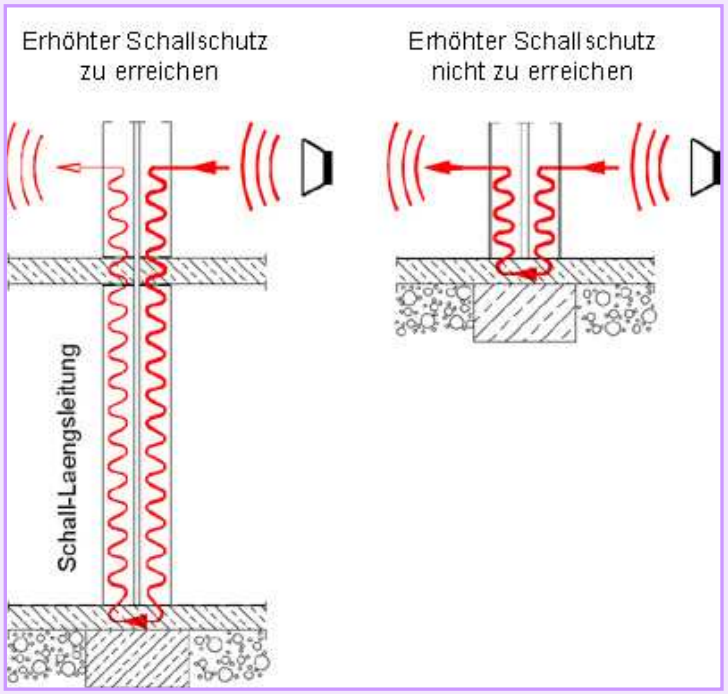
- At least noise-insulation class IV
- Usually noise-insulation class V

In a solid building

- Nobody on the road can hear what is spoken inside
- You may throw a party without disturbing your neighbours

Manufacturers of solid buildings should not offer any cellarless terraced or semi-detached houses!

It is hardly possible to provide good sound insulation without a cellar, even in case of cavity partition walls

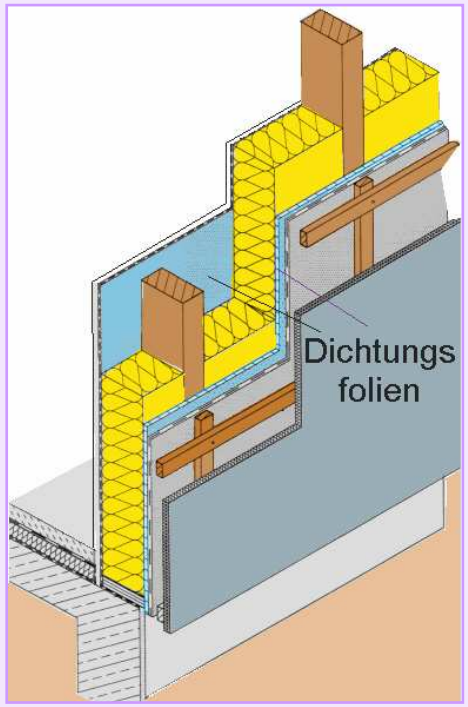


Argument: insensitive to water

Water load due to taking showers, laundry, bursting hoses

Solid walls made of mineral building materials

- Dry extensively and fast enough due to capillarity
- Provide a sound basis for sealing joints in moist rooms – longer service life as the components do not contract and expand



<u>Consequences of water in timber construction</u>

- Mould
- Poorer thermal insulation
- Exposed stability

Insurance against water damage

Only material damage will be covered

Insurance benefits for water damage
by far exceed the ones for fire damage

Insurance benefits for water damage
much higher for lightweight buildings

The differences are often hard to tell as
the references vary – replacement value,
current value or deductible

Solid buildings:
low maintenance cost

- Sturdy
- Insensitive to humidity
- Not useable biologically

Housing associations

use solid construction!

1988 report on structural damage

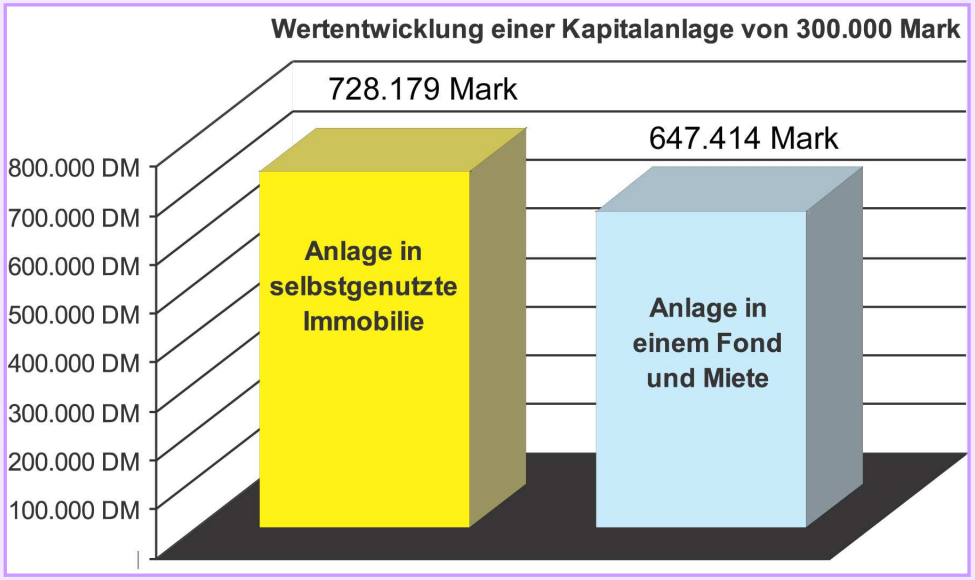
Lowest maintenance cost for masonry and concrete

Solid buildings: high resale value

- Low maintenance cost
- Long service life

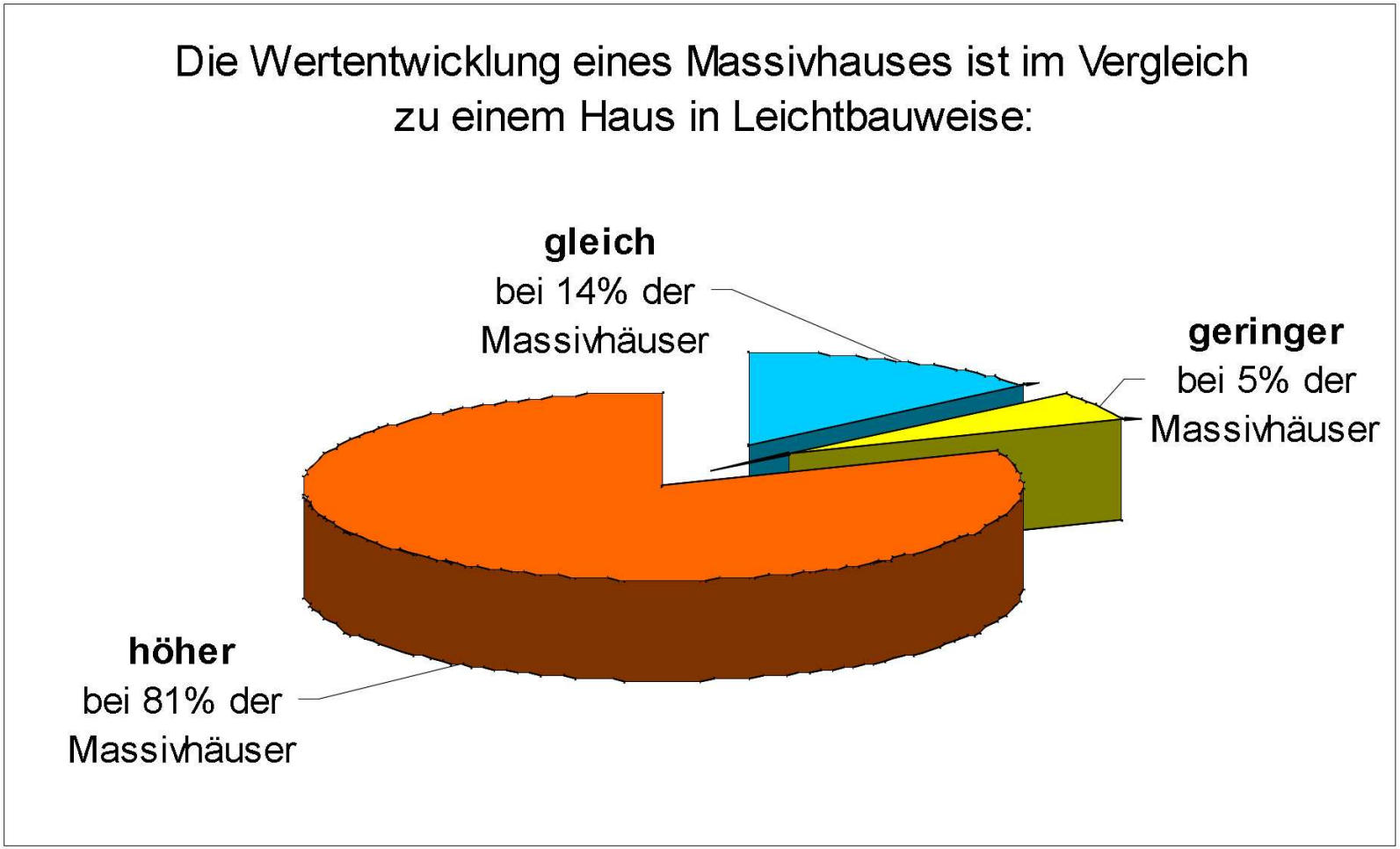
Contribution to

- Accumulation of capital and provision for old age
- Can be used right away - unlike financial investments
- Investment with value guaranteed



Solid buildings: high resale value

Study by DIA-Consulting from 2000



Healthy living:
mineral building materials guarantee

- A balanced indoor climate
- Good sound insulation
- No outgassing, no emission of fibres or dust, etc. by the materials
- Protection against switched mode radiation
- Radioactivity is at the level of the source materials of our surroundings, including sand, clay and lime; usually way below TLVs

  (See AUB documents)


ARBEITSGEMEINSCHAFT
UMWELTVERTRÄGLICHES
BAUPRODUKT E.V.

Urkunde

Deutschen POROTON GmbH
53639 Königswinter

POROTON-Wärmedämmziegel
POROTON-Wärmedämmhochlochziegel
POROTON-Hochlochziegel
POROTON-Schallschutzziegel

Building ecologically

Source materials include sand, gravel, clay, and limestone from our natural environment

Mineral building materials such as bricks, mortar and concrete :

- No long haulage distance, domestic production
- Depleted mines develop into valuable biotopes and recreation sites
- No hazardous waste after demolition

Major progress in recycling, e.g.

- Aggregates in brick production
- Substratum for road construction

Are timber houses more ecological?

Regenerative raw material, but

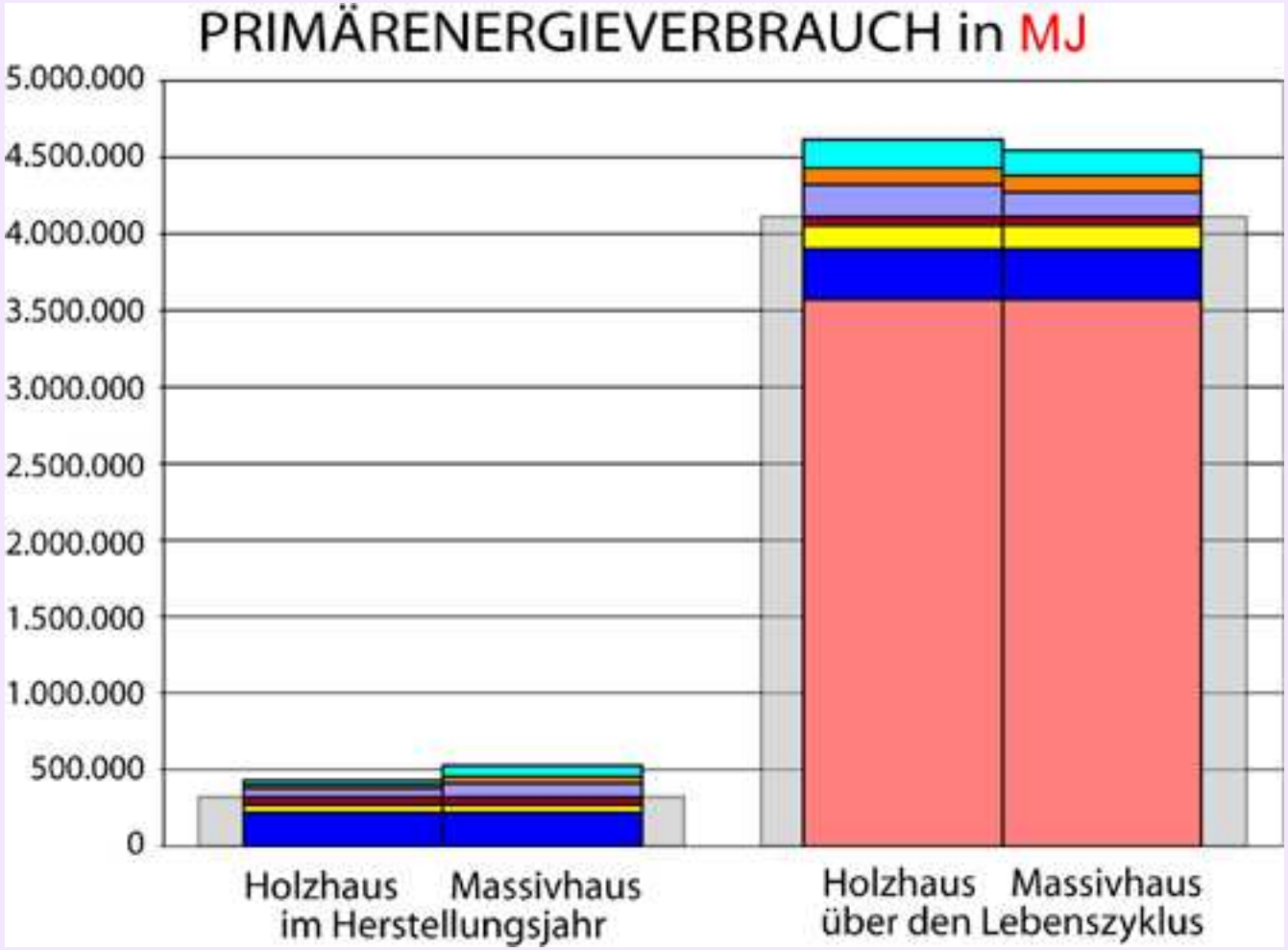
- The timber share is only 10-15%
- The rest consists of insulation material, chipboards, foils, etc.
- Wood preservatives in production and maintenance
- Hazardous waste for disposal
  or energy generation in waste incineration plants
- Sometimes long haulage distance from overseas
- It is hard to monitor the allegedly organic production abroad

A biased privilege is not justified!

See next slides!

Considering a service life of 80 years for solid and timber houses we see the same results in terms of

- Primary energy consumption
- Summer smog potential
- Greenhouse potential
- Acidification potential



Bei beiden Bauweisen

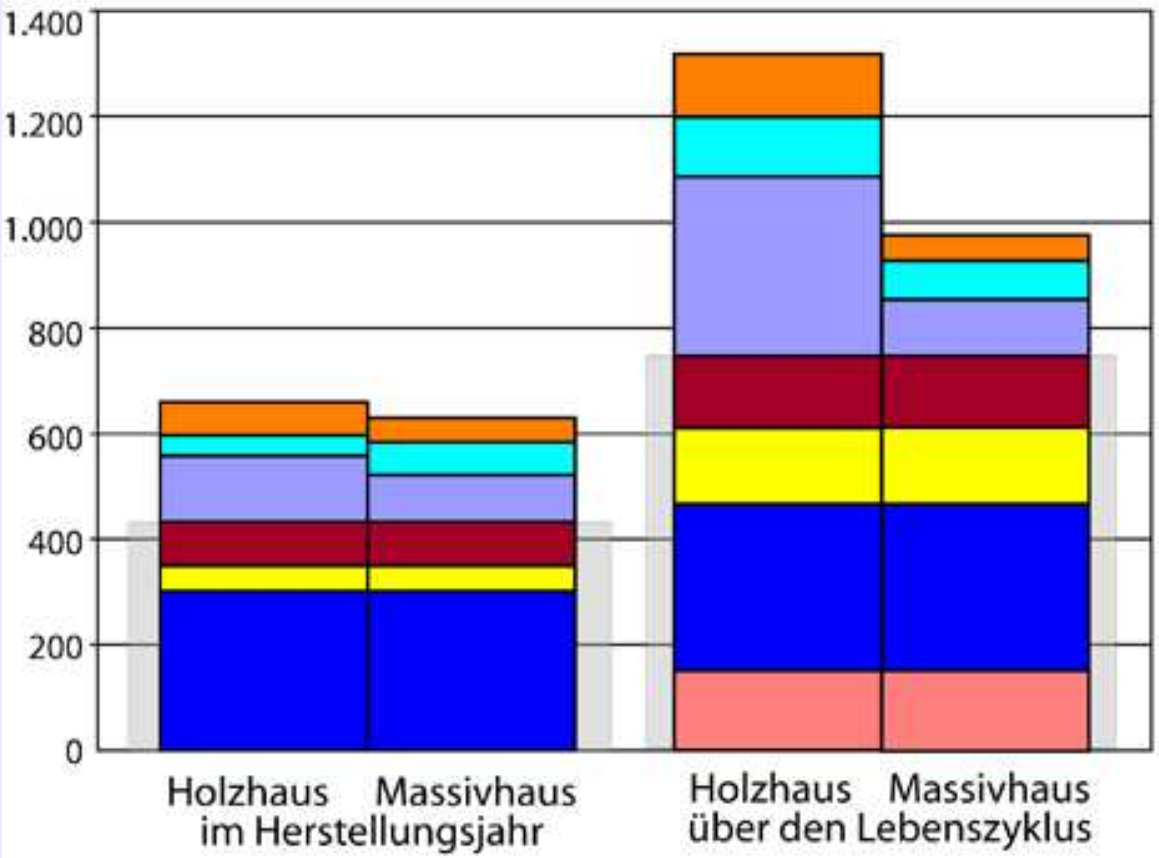
gleich sind:

- Dach
- Fenster und Türen
- Keller
- Heizung und Warmwasser

Unterschiede bei:

- Innenwänden
- Geschossdecken
- Außenwänden

SOMMERSMOGPOTENTIAL kgTOPP-Äquivalent



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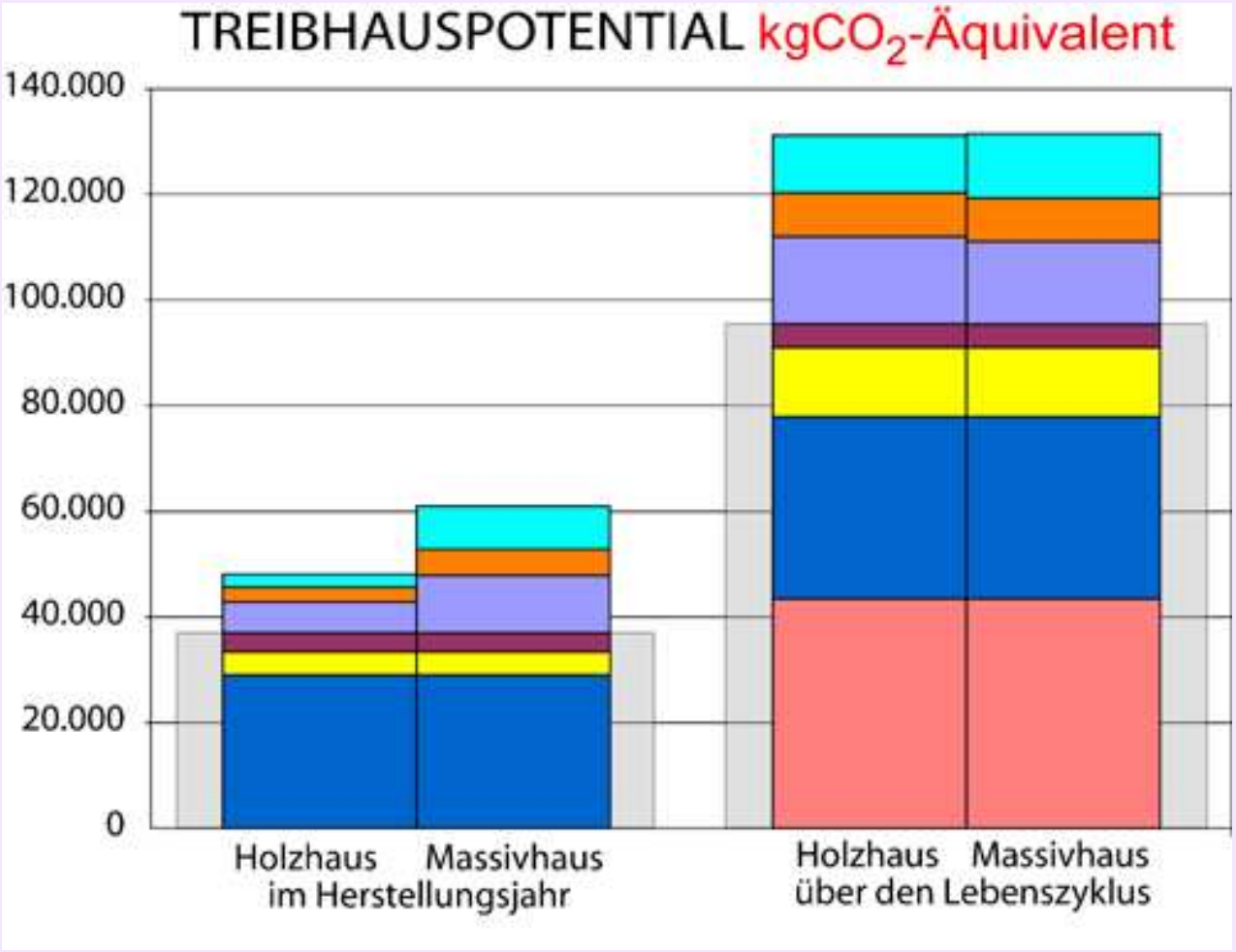

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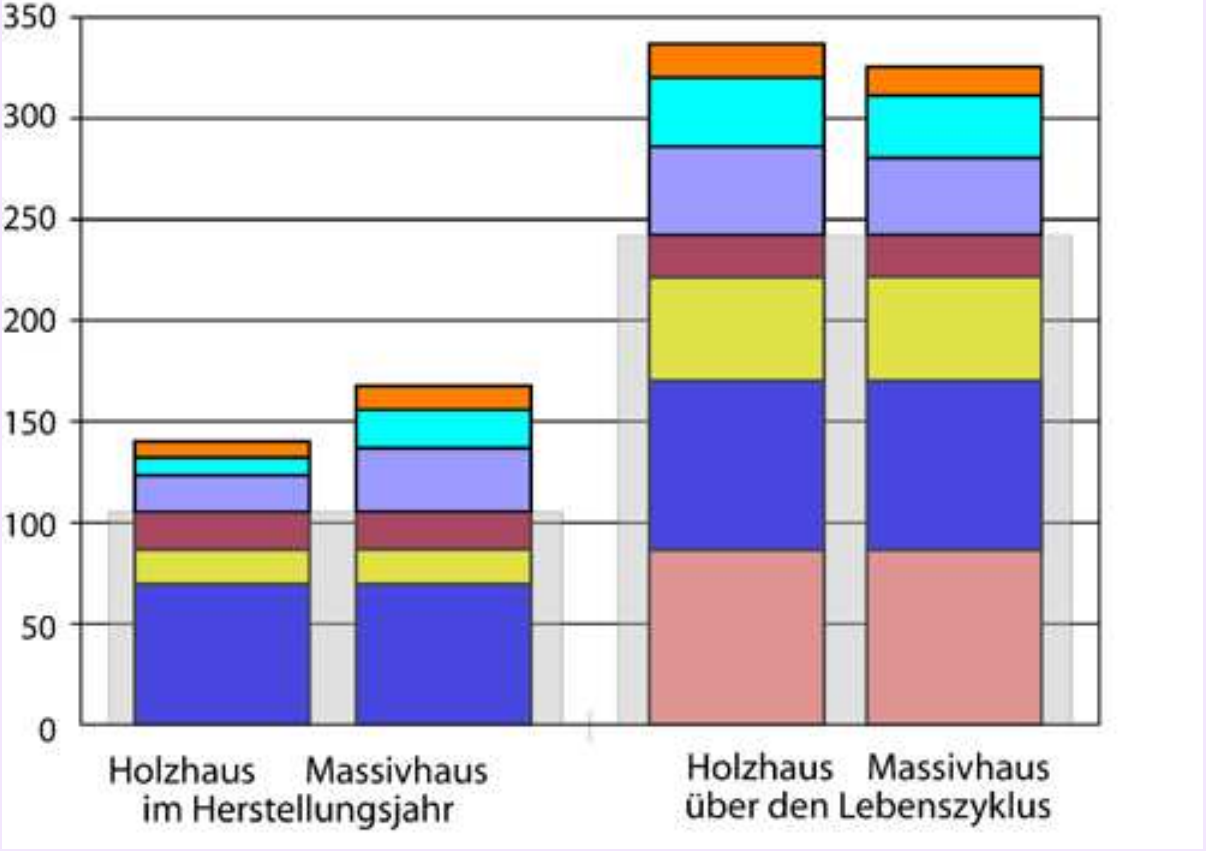
VERSAUERUNGSPOTENTIAL $kgSO_2$-Äquivalent



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Solid buildings

do not have to fear any type of cost comparison

Alternative tenders, construction in the mid 1990s

Ludwigshafen-Ruchheim

1. Tenderer solid construction 1,086.82€/m²
1. Tenderer timber construction 1,315.12€/m²

Council homes Lindau

1. Tenderer solid construction 815.52€/m²
1. Tenderer timber construction 909.09€/m²

Comparative calculation LBS-Systemhäuser
Arch. Dipl.-Ing. Sahner, Stuttgart:

Wooden post-and-beam structure is 5.6% more expensive than single-shell brick construction

Statement by Arch. Dipl.-Ing. Brenner, Ellwangen:
„At the end of the day a well-constructed timber house is no cheaper than my solid building.“

Solid buildings

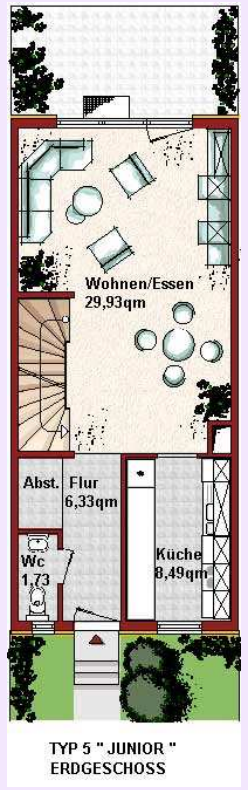
Alternative tenders

Terraced and semi-detached houses

Ludwigshafen-Ruchheim

1. Tenderer solid construction 1,096.32€/m²

1. Tenderer timber construction 1,315.12€/m²



Solid buildings

Alternative tenders

Council homes Lindau

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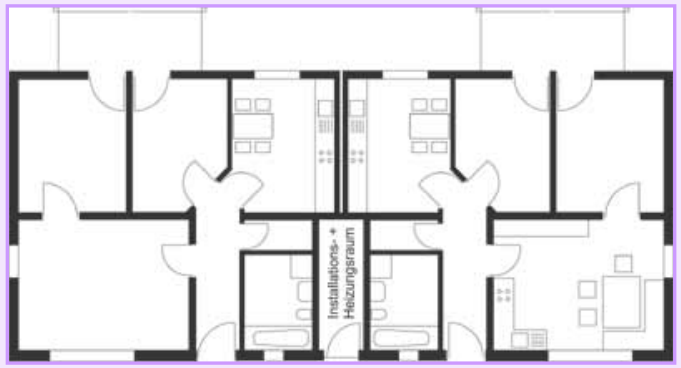

Comparative calculations

Comparative calculations *LBS-Systemhäuser*
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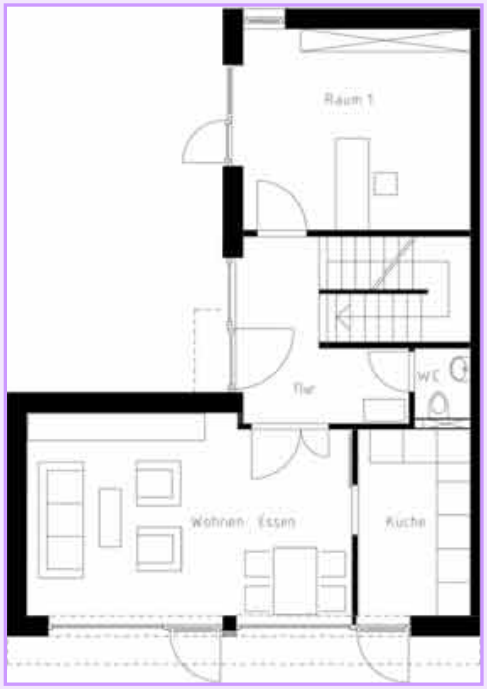

Comparative calculations

Comparative calculations

Dipl.-Ing. Bärbel Holzmann,

Mackenbach for *„Junge Häuser“*

Costs of chell construction

for bricks, porous concrete, lightweigl

concrete, lime sandstone:

between €869,997 and €88,562

for post-and-beam structure:

€105,594

Solid buildings

Competitive construction times

Short assembly period for prefabricated houses does not equal a short period between the closing the contract and handover

Rationalization measures have reduced the construction time of solid buildings considerably

5-day house project in Lower Bavaria