Energy efficiency in buildings and new technologies

Czech-Austrian Winter/Summer School

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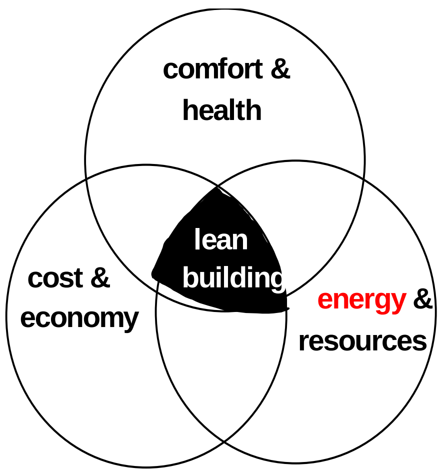
Whole life optimised building =>



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Gebäudebestand in Österreich

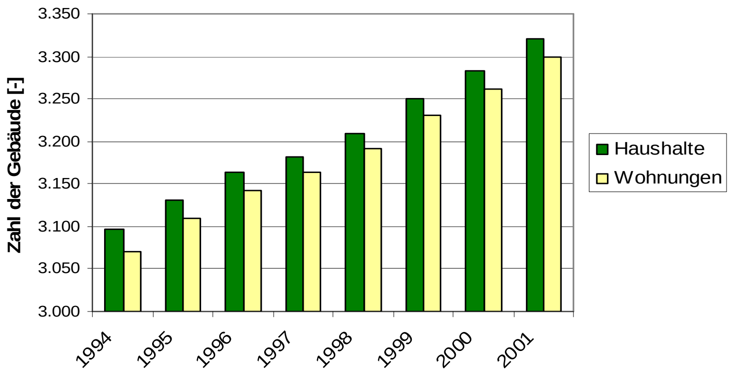

Abbildung: Entwicklung des Gebäudebestandes in Österreich, Quelle: www.statistik.austria.at, 15.03.2005

Quelle: Statistik Austria, (2004)

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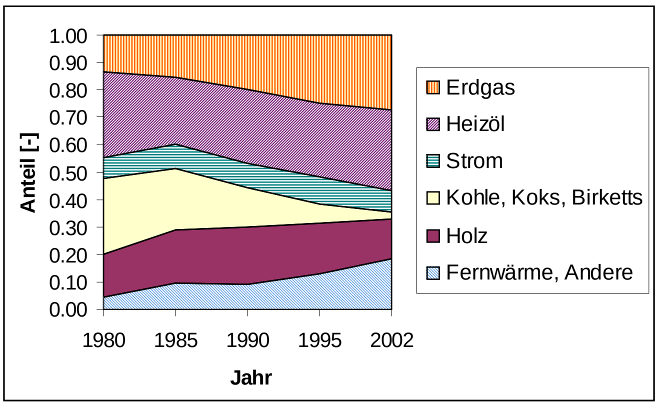
Energy carriers in Austrian households



Quelle: Statistik Austria, (2005)

Heating values and specific CO_2-emissions of fossil fuels

Energy carrier	Lower heating value	CO_2-emissions (related to lower heating value)
Hard coal	8,14 kWh/kg	0,350 kg/kWh
Lignite	2,68 kWh/kg	0,410 kg/kWh
Ignite briquetts	5,35 kWh/kg	0,380 kg/kWh
Coke	7,50 kWh/kg	0,420 kg/kWh
Heavy duty oil	10,61 kWh/l	0,290 kg/kWh
Oil „extra light“	10,08 kWh/l	0,270 kg/kWh
Natural gas	10,00 kWh/m3	0,200 kg/kWh

Energy balance of a building over its lifetime

Construction

Maintenance

Energy consumption

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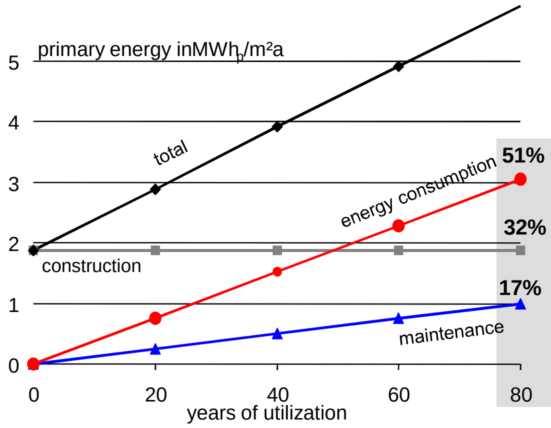
Life Cycle Energy

embodied energy 1,9 MWh/m²



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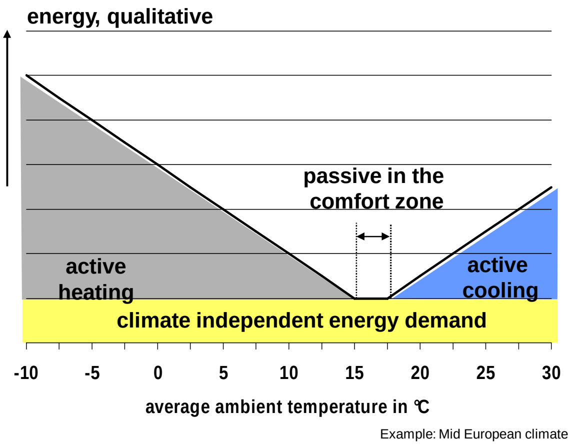
Current Buildings

Energy for:
- heating
- cooling
- ventilation
- lighting
- utilization



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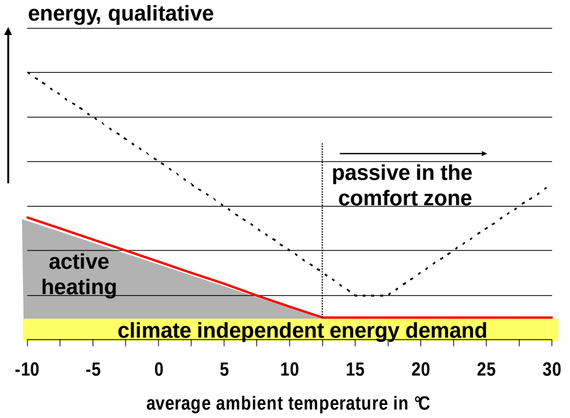
Lean Buildings

Energy for:
- heating
- cooling
- ventilation
- lighting
- utilization



Example: Mid European climate

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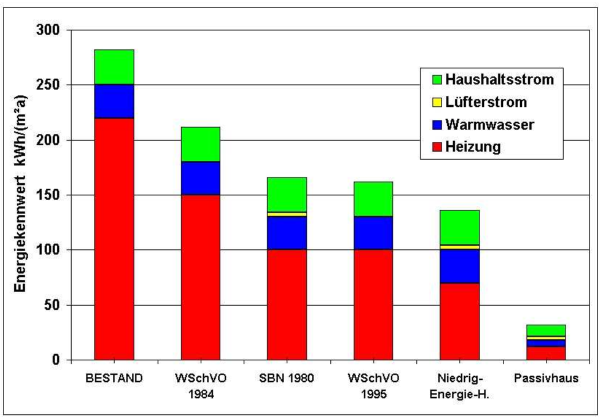
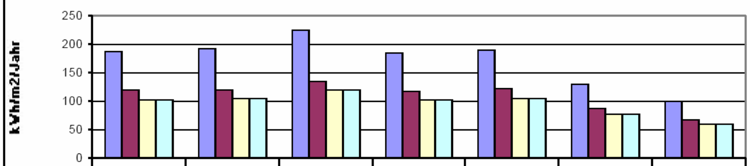
Energy demand of buildings



Specific space heating energy demand of single (SFH) and multi family buildings (MFH-K : small, MFH-G big) in decpendenc of year of errection in Austria

Raumheizungskennzahlen nach Baualtersklassen und Haustypen (nutzenergiebezogen)



	vor 1919	1919 - 1945	1945 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	ab 1991
EFH	188	193	226	186	191	130	99
MFH-K	121	121	136	118	122	88	67
MFH-G	103	106	120	103	104	78	60
NWG	103	106	120	103	104	78	60

Quelle: Jungmeier, et al. (1996)

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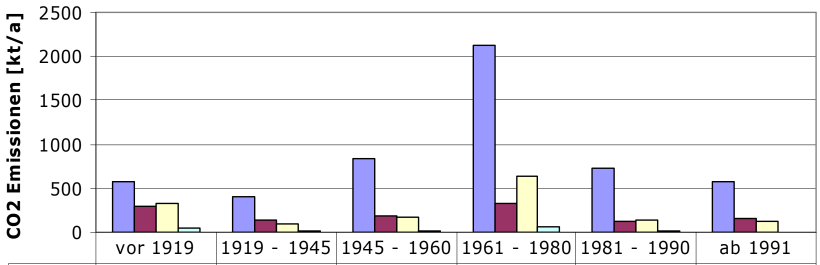
CO_2-emissions from space heating of appartements in Austria



	vor 1919	1919 - 1945	1945 - 1960	1961 - 1980	1981 - 1990	ab 1991
EFH	580	408	841	2 134	732	575
MFH-K	293	144	179	333	128	148
MFH-G	321	94	177	636	140	118
NWG	49	11	22	55	16	7

Quelle: eigene Berechnung

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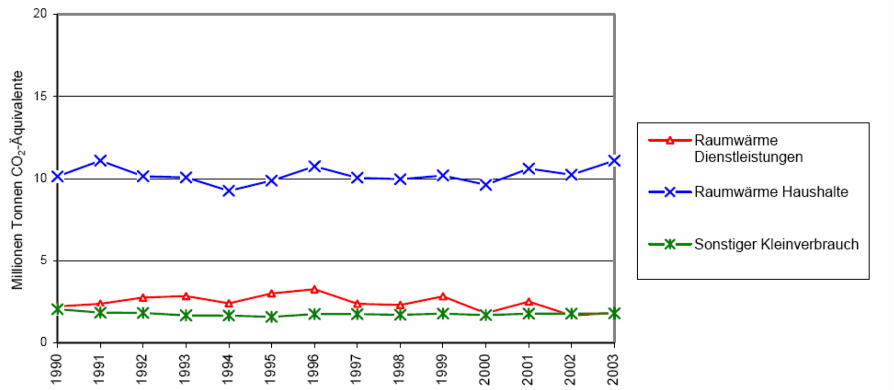
CO$_2$-equivalent emissions from the residential sector (Raumwärme Haushalte) and other small



Quelle: BMLFUW (2005)

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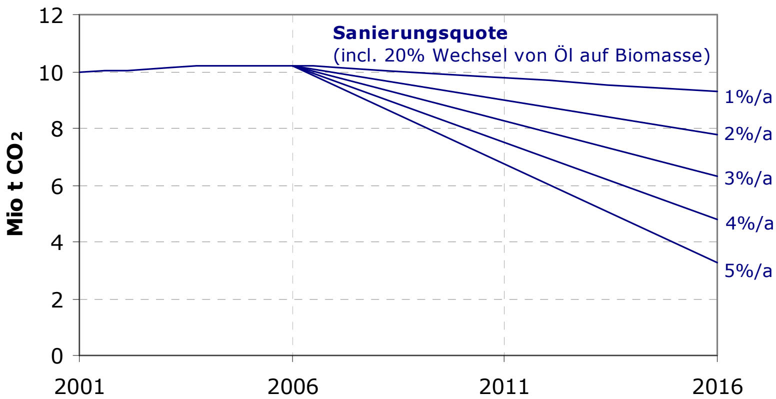
Trendscenario of thermal renovation and fuel switch of all Austrian dwellings (basic data from Statistik Austria, 2001)



Quelle: eigene Berechnung

Steps of integrated building design für low energy demand

Boundary conditions
(Size, orientation, number of persons, climatic indoor conditions,
Costs (errection and operation), etc.)

↓

Energetical optimization of the building itself
(measures at the building)

↓

Simple and efficient heating, ventilation, cooling system

↓

Ecologically benign heat and cold production
(renewable energy carriers)

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Energetical System Building

Building behaviour
- Active thermal mass
- Passive solar energy use

User behaviour
- Ventilation
- Internal Heat gains
- Indoor air set temperature
- Shading

Control
- Indoor air temperature controlled (centralized, decentralized)
- Outdoor air temperature dependend (centralized)
- Analog - digital
- Irradiation controlled
- Positioning of sensors

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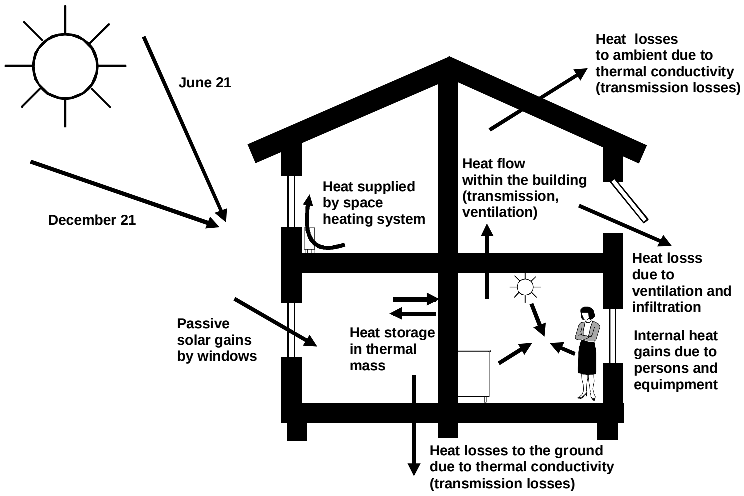
Energetical System Building



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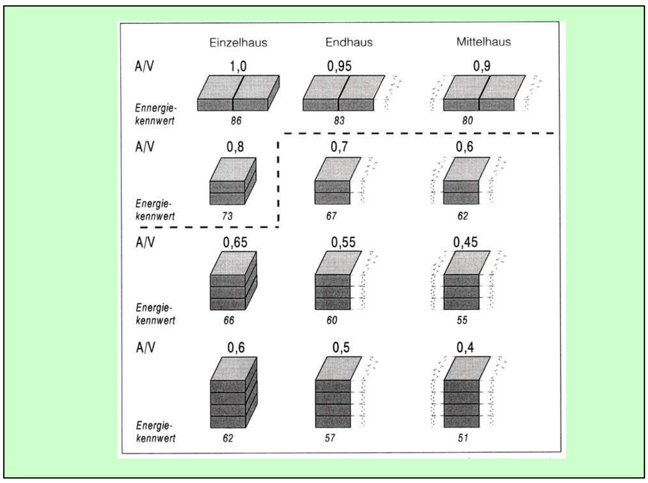
Building Shape: Ratio of A/V for differetn shapes



Quelle: Feist, W., 1998, Das Niedrigenergiehaus

Heat transfer coefficient for transmission heat losses

$$U = \frac{\dot{Q}}{A \cdot \Delta T} \; (=k) \qquad [W/(m^2K)]$$

mit A... Heat transfer surface $[m^2]$

$\dot{Q}$... Transferred heat $[W]$

ΔT... Forcing temperature difference $[K]$

$\dot{q} = \frac{\dot{Q}}{A} = U \cdot \Delta T$ .... specific heat flow $[W/m^2]$

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Heat conduction through a wall

$$\frac{1}{U} = \frac{1}{\alpha_i} + \sum_n \frac{s_n}{\lambda_n} + \frac{1}{\alpha_a}$$

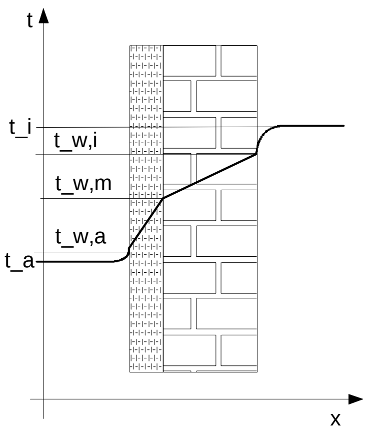
$$R = R_i + \sum_n R_n + R_a$$

mit α… heat transfer coeffcient $[W/(m^2\,K)]$

λ_n… thermal conductivity $[W/(m\,K)]$

s_n… thickness of layer $[m]$

R… thermal resistance $[(m^2\,K)/W]$



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Maximum U-values (W/m²K) Austria (2007)

Bauteil	U-Wert [W/m²K]
WÄNDE gegen Außenluft	0,35
Kleinflächige WÄNDE gegen Außenluft (z.B. bei Gaupen), die 2% der Wände des gesamten Gebäudes gegen Außenluft nicht überschreiten, sofern die ÖNORM B 8110-2 (Kondensatfreiheit) eingehalten wird.	0,70
TRENNWÄNDE zwischen Wohn- oder Betriebseinheiten	0,90
WÄNDE gegen unbeheizte, frostfrei zu haltende Gebäudeteile (ausgenommen Dachräume)	0,60
WÄNDE gegen unbeheizte oder nicht ausgebaute Dachräume	0,35
WÄNDE gegen andere Bauwerke an Grundstücks- bzw. Bauplatzgrenzen	0,50
ERDBERÜHRTE WÄNDE UND FUSSBÖDEN	0,40
FENSTER, FENSTERTÜREN, VERGLASTE oder UNVERGLASTE TÜREN (bezogen auf Prüfnormmaß) und sonstige vertikale TRANSPARENTE BAUTEILE gegen unbeheizte Gebäudeteile	2,50
FENSTER und FENSTERTÜREN in Wohngebäuden gegen Außenluft (bezogen auf Prüfnormmaß)	1,40
Sonstige FENSTER, FENSTERTÜREN und vertikale TRANSPARENTE BAUTEILE gegen Außenluft, VERGLASTE oder UNVERGLASTE AUSSENTÜREN (bezogen auf Prüfnormmaß)	1,70
DACHFLÄCHENFENSTER gegen Außenluft	1,70
Sonstige TRANSPARENTE BAUTEILE horizontal oder in Schrägen gegen Außenluft	2,00
DECKEN gegen Außenluft, gegen Dachräume (durchlüftet oder ungedämmt) und über Durchfahrten sowie DACHSCHRÄGEN gegen Außenluft	0,20
INNENDECKEN gegen unbeheizte Gebäudeteile	0,40
INNENDECKEN gegen getrennte Wohn- und Betriebseinheiten	0,90

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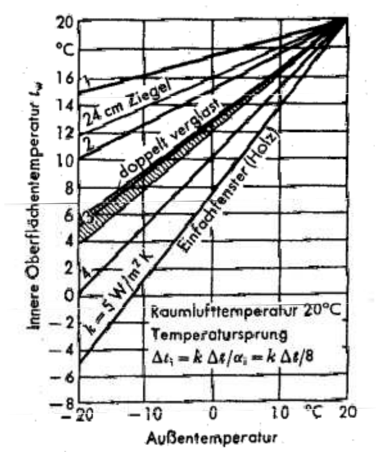
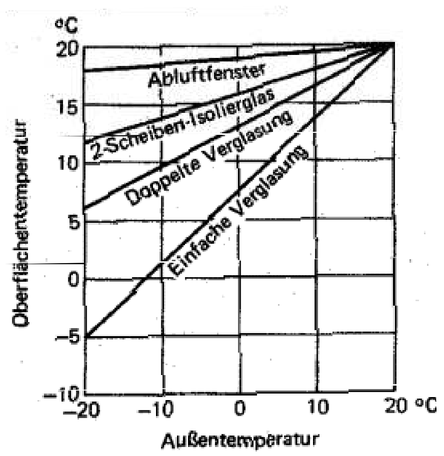
Room air temperature – temperature of surrounding surfaces ⇔ thermal comfort





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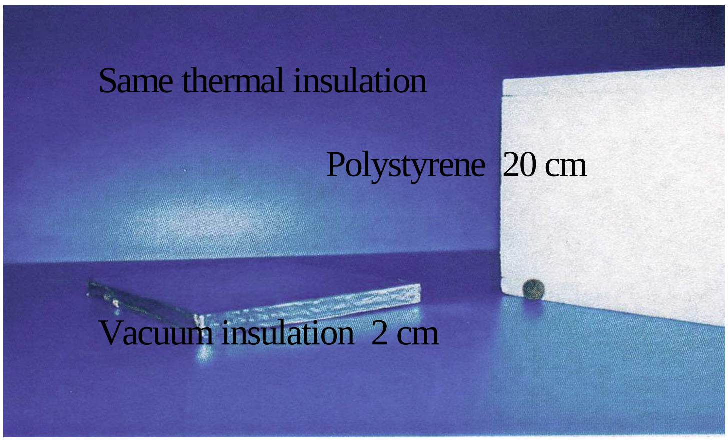

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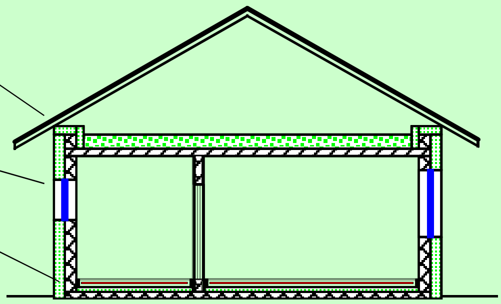
Avoiding thermal bridges

Problematic zones:

- **Connection of roof**
- **Windows**
- **Floor e.g. cellar ceiling**
- **Balkonies**



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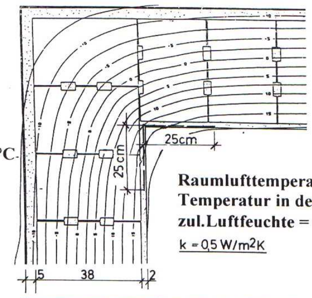
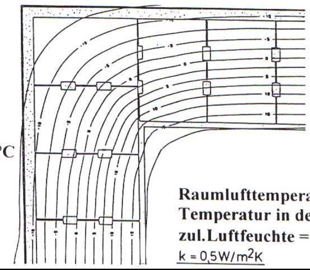
Course of temperature in an edge



$t_{ne} = -15°C$

mit Streckmetall
Standard 26*62/2/3

Raumlufttemperatur $t_i = 20°C$
Temperatur in der Kante $t_{oi} = 14.2°C$
zul.Luftfeuchte = $\varphi_i = 69\%$
$k = 0{,}5\ W/m^2K$



$t_{ne} = -15°C$

ohne Streckmetall

Raumlufttemperatur $t_i = 20°C$
Temperatur in der Kante $t_{oi} = 12.9°C$
zul.Luftfeuchte = $\varphi_i = 63.7\%$
$k = 0{,}5\ W/m^2K$

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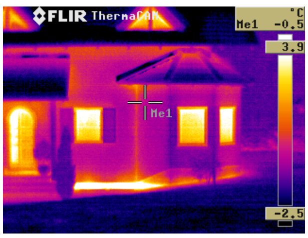
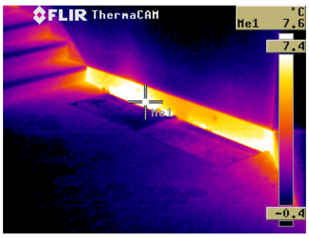
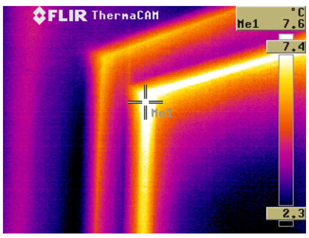
Thermal bridges, Thermographie



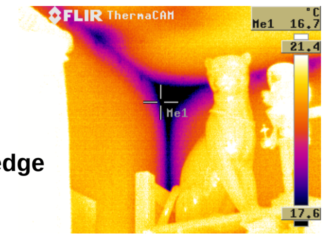


Ground floor to cellar,



Window

interior edge



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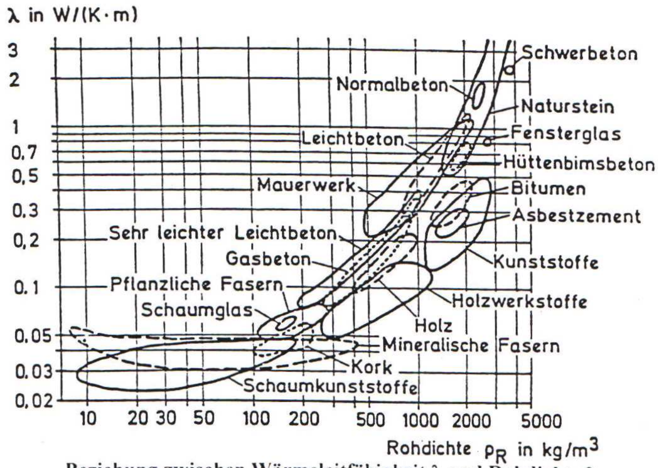
Material: Thermal conductivity λ and density ρ



Beziehung zwischen Wärmeleitfähigkeit λ und Rohdichte ϱ_R

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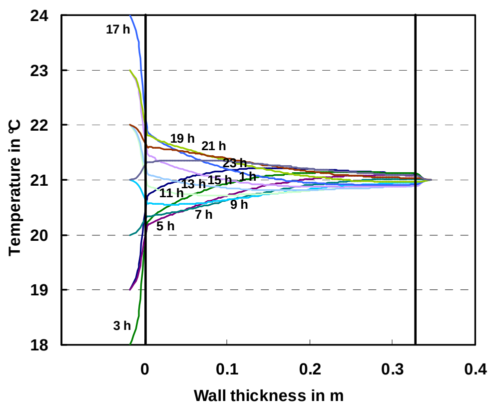
Principal of active thermal mass

$$\dot{q} = -\lambda \frac{\partial T}{\partial x} \qquad \frac{\partial \dot{q}}{\partial x} = -\lambda \frac{\partial^2 T}{\partial x^2} = \rho_{Sp} \, c_p \frac{\partial T}{dt}$$



Needs room air temperature shifts

Stored and released heat : 0.076 kWh/(m² d).

Significant temperature change up to a depth of ca. 10 cm (concrete wall)

It is not useful to make this wall thicker

Thermal mass means AREA not DEPTH

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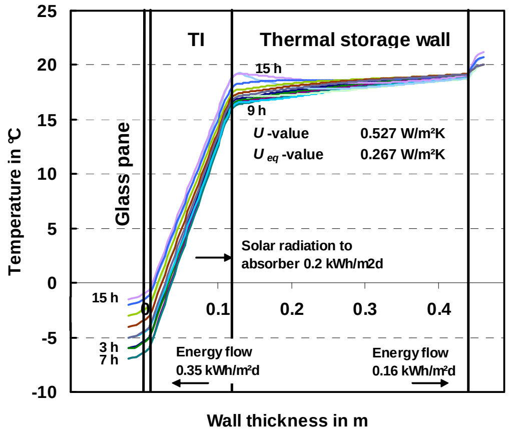
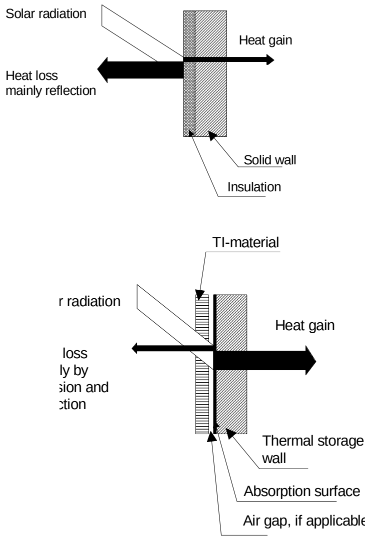
Transparent Insulation





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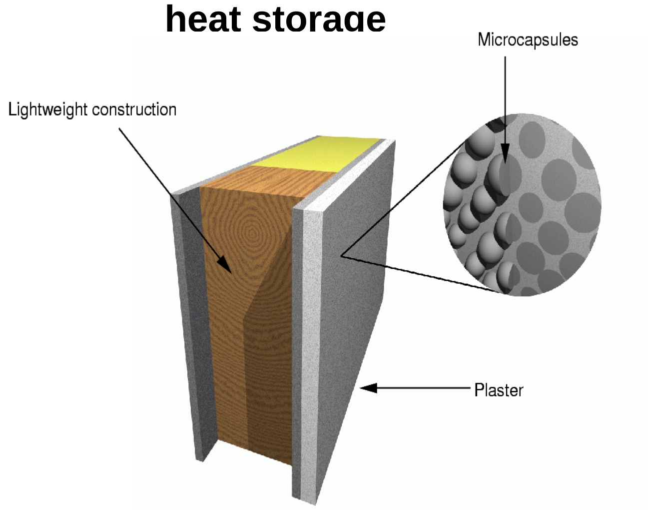
Micro-encapsulated phase change material, heat storage



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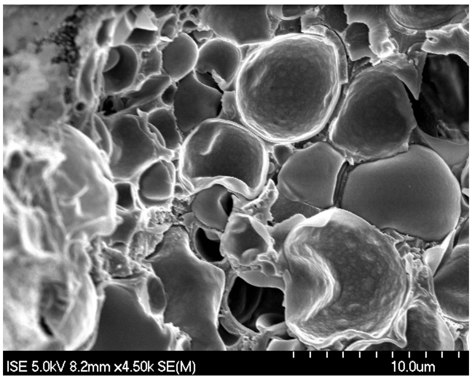
Micro encapsulated phase change materials

- Organic phase change materials
- PMMA-capsule (BASF), ~20 µm
- Integration into plaster, gipsum, concrete
- Increase of the thermal mass in a small temperature range
- Reduction of temperature peaks in summer time
- No active air conditioning



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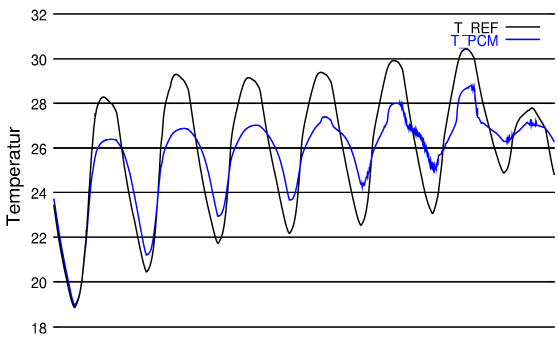
Application of PCMs on inner walls

Temperature behaviour of a test and a reference cell in comparison



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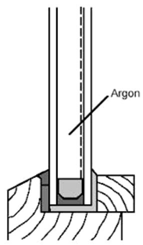
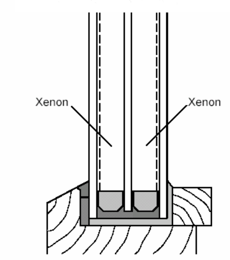
Energy transmitttance through windows

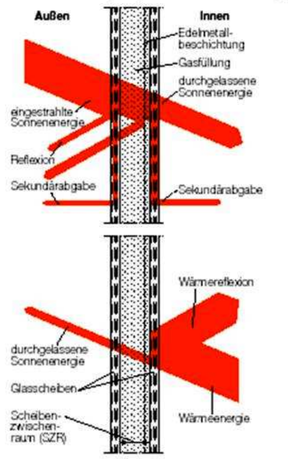


k_V = 1,3 W/(m² K)
k_F = 1,4 W/(m² K)
g_F = 0,62
$k_{eq,F,Nord}$ = 0,81 W/(m² K)
$k_{eq,F,Ost/West}$ = 0,38 W/(m² K)
$k_{eq,F,Süd}$ = -0,09 W/(m² K)



k_V = 0,40 W/(m² K)
k_F = 0,67 W/(m² K)
g_F = 0,42
$k_{eq,F,Nord}$ = 0,27 W/(m² K)
$k_{eq,F,Ost/West}$ = -0,02 W/(m² K)
$k_{eq,F,Süd}$ = -0,34 W/(m² K)

Bild 3.7: Wärmedurchgang durch ein Fenster mit Wärmeschutzglas (schematische Darstellung)



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Energy transmittance (g) and heat transfer coefficient (U) for different glazings

	Diffuse *g*-value	*U*-value glazing in W/(m² K)
Insulating glazing (4 + 16 + 4 mm, air)	0.65	3.00
Thermal insulation double-glazing (4 + 14 + 4 mm, argon)	0.60	1.30
Thermal insulation double-glazing (4 + 14 + 4 mm, xenon)	0.58	0.90
Thermal insulation triple-glazing with argon filling	0.44	0.80
Thermal insulation triple-glazing with krypton filling	0.44	0.70
Thermal insulation triple-glazing with xenon filling	0.42	0.40
10 cm plastic capillaries, one cover pane	0.67	0.90
10 cm plastic honeycombs, one cover pane	0.71	0.90
10 cm glass capillaries, two panes	0.65	0.97
2.4 cm granular aerogel, two panes filled with air	0.50	0.90
2 cm evacuated (100 mbar) aerogel plate, two panes	0.60	0.50

The diffuse *g*-values were measured for a poor in iron 4 mm front pane, whereas for the *U-value*s an average sample temperature of 10 °C has been assumed.

$$U_{eq} = U_W - S_F\, g$$

S_F = 0,95 north, 1,65 east/west, 2,4 south

Diffuse g-value ($g_{diffuse}$), U-value of the window (U_w) and equivalent U-values (U_{eq}) corresponding to different glazing types (see /3-5/)

	$g_{diffuse}$	U_w	U_{eq} (south) in W/(m^2 K)	U_{eq} (east/west)	U_{eq} (north)
Simple glazing	0.87	5.8	3.7	4.4	5.0
Double-glazing (air 4 + 12 + 4 mm)	0.78	2.9	1.0	1.6	2.2
Double-glazing with thermal insulation and argon filling (6 + 15 + 6 mm)	0.60	1.5	0.1	0.5	0.9
Triple-glazing with thermal insulation and krypton filling (4 + 8 + 4 + 8 + 4 mm)	0.48	0.9	-0.3	0.1	0.4
Triple-glazing with thermal insulation and xenon filling (4 + 16 + 4 + 16 + 4 mm)	0.46	0.6	-0.5	-0.2	0.2

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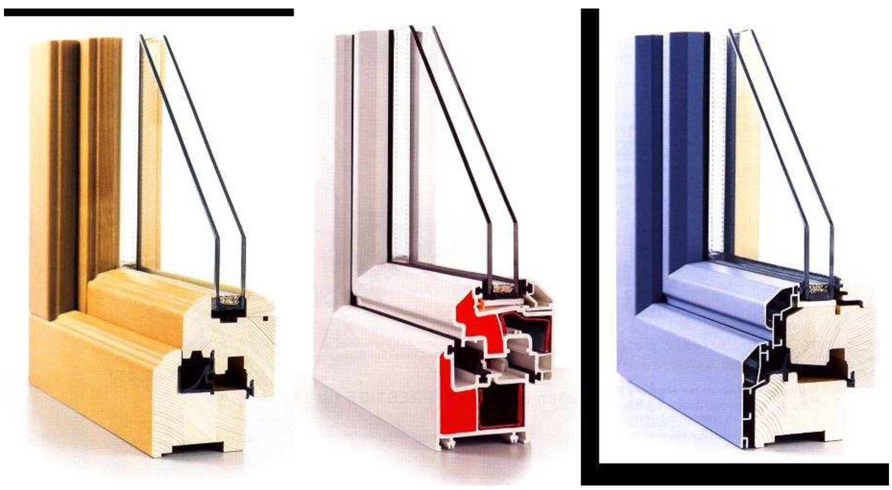
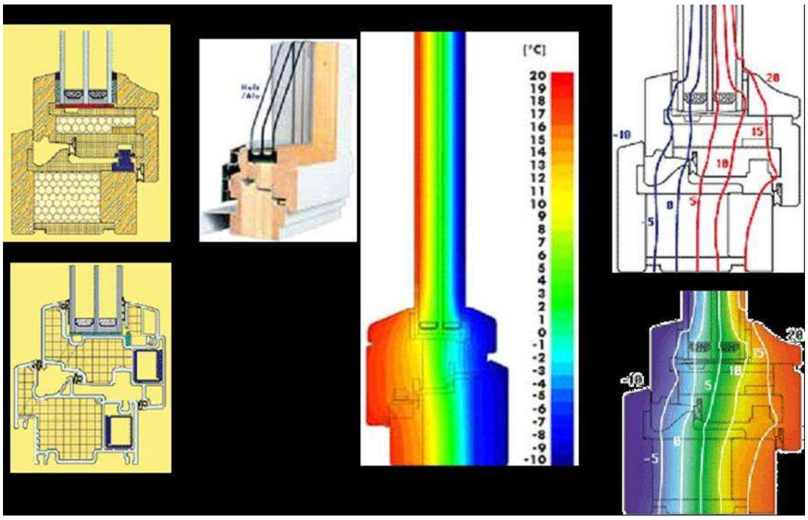
2-panes windows



3-pane low U windows



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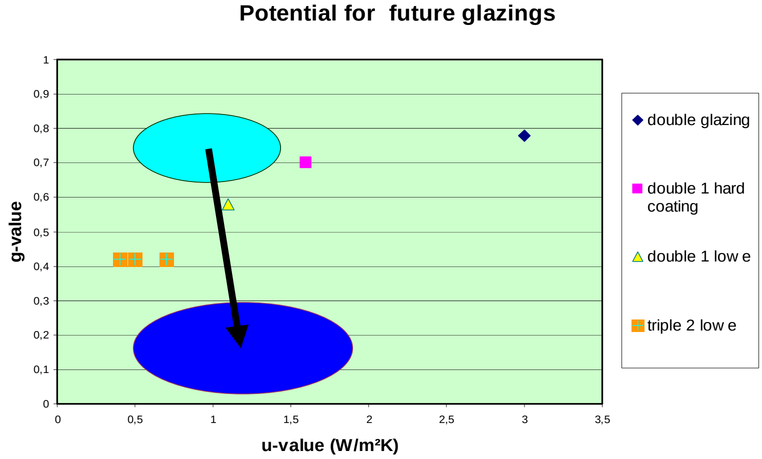

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Switchable glazings

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Factors influencing the solar transmittance of windows

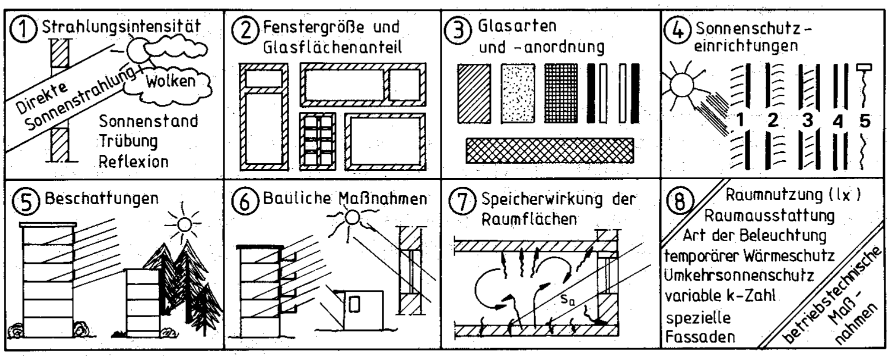

Abb. 7.24 Einflußgrößen auf Sonnenwärme durch Fenster

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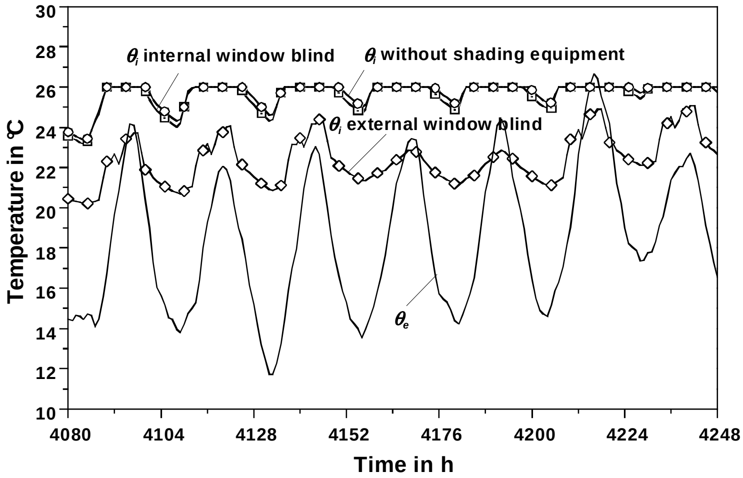
Shading by internal and external window blinds (θ_e ambient temperature, θ_i room temperature)



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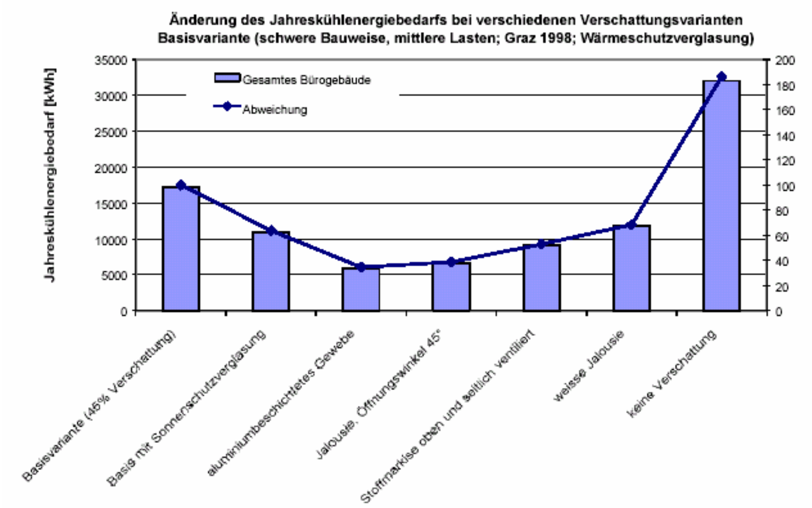
Cooling energy demand for different shading strategies in an office building



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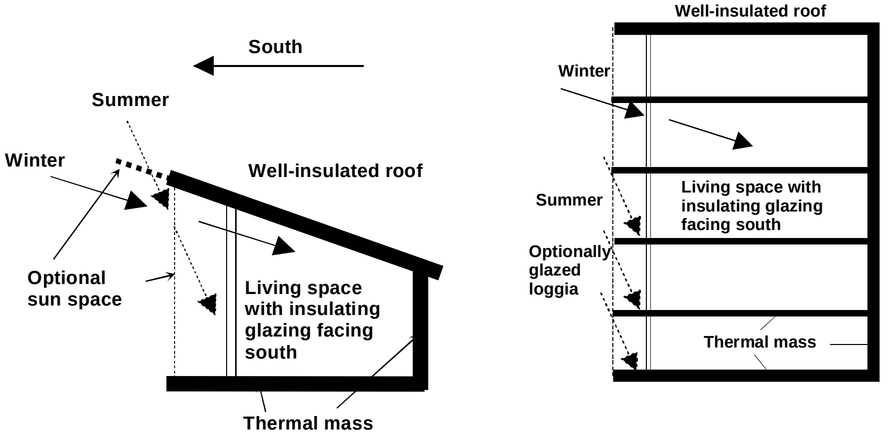
Shading of transparent building surfaces by roof overhangs (left: one family home, right: multiple families home)



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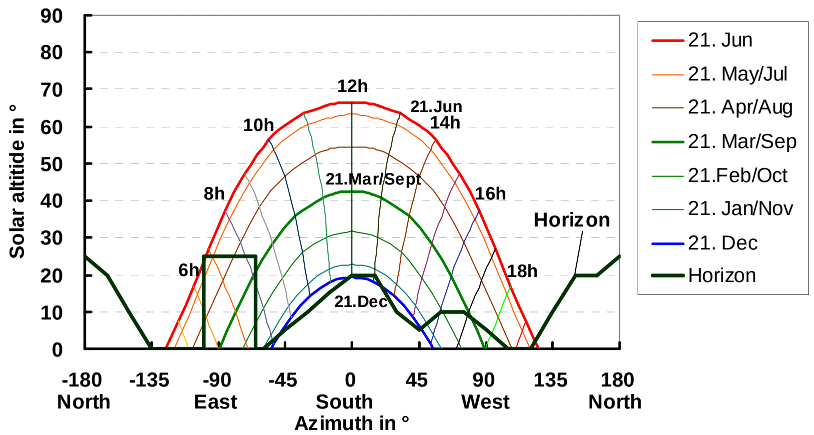
Solar position plot



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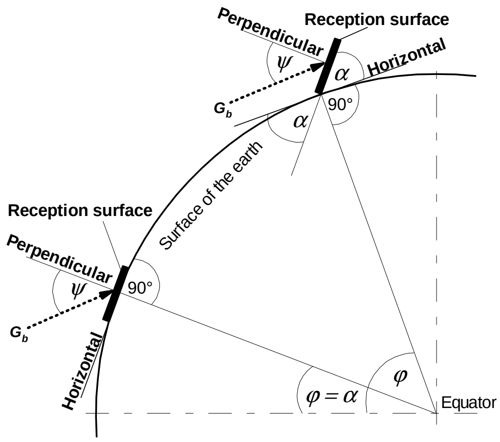
Geometrical interrelationship of solar radiation incident on tilted surfaces



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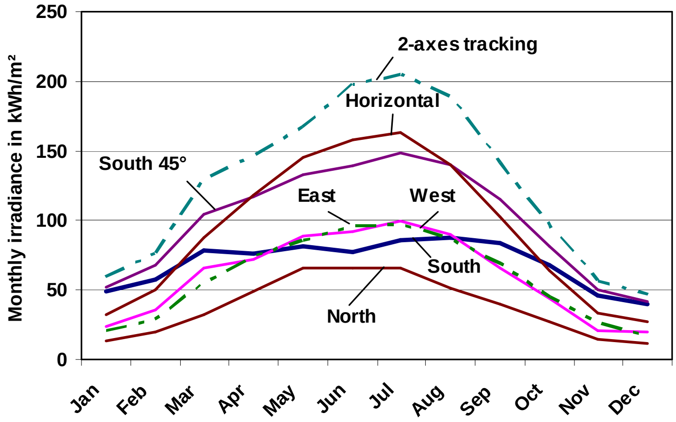
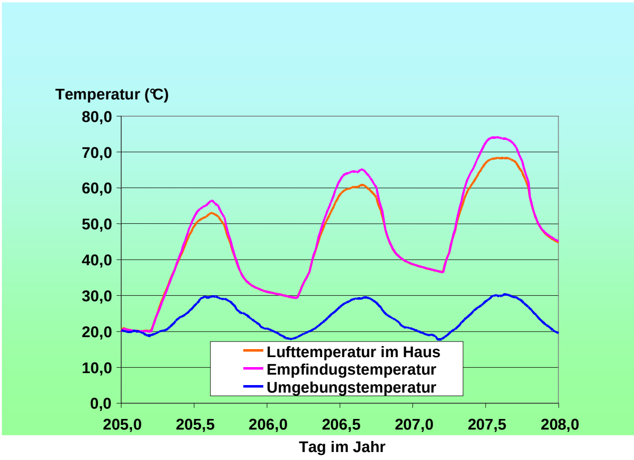
Global radiation incident on surfaces with various alignments in Central Europe (climate Graz/Austria, 47° latitude)



Summer Overheating in an office building (simulated)



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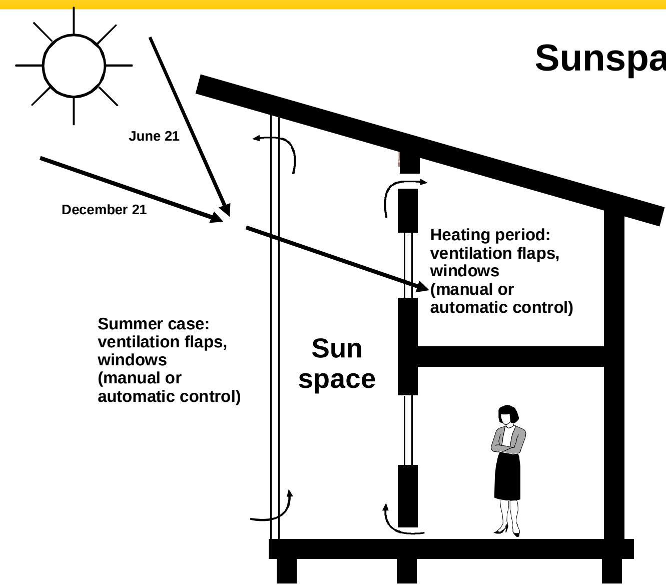
Sunspaces



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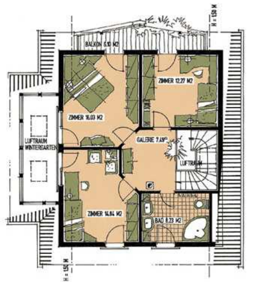
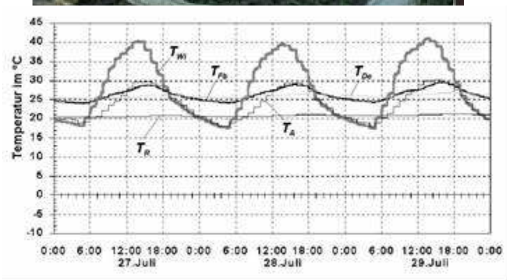
Sunspace





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Low-energy lean multi family building

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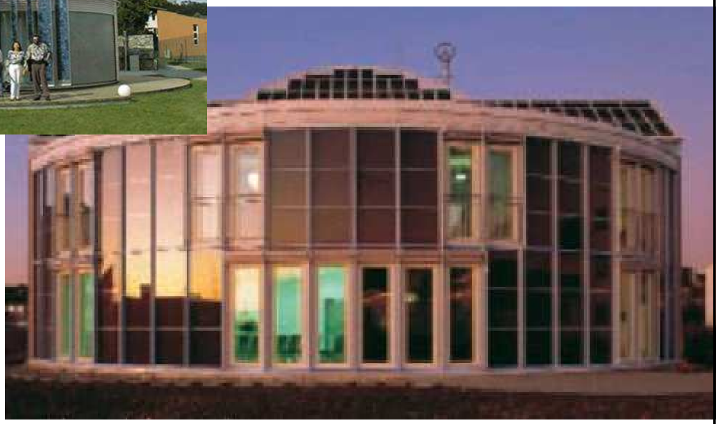
Solar houses



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„Passive row houses“

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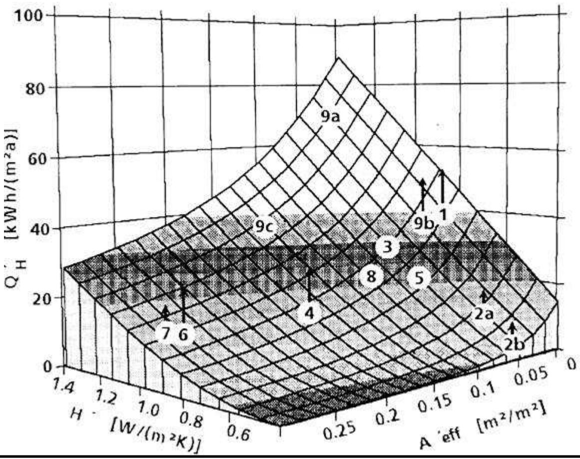
„Solarhouses" – „Passivhouses"

Gebäudekennfeld für ein Gebäude mittelschwerer Bauart und einigen realisierten Gebäuden: 7: Solarhaus Freiburg, 2: Passivhaus Kranichstein (a: Endhaus, b: Mittelhaus), Q´H: spezifischer Heizenergiebedarf (Voss, 1997)



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EU Directive on the overall energy performance of buildings (EPBD) and its effect on the planning of buildings

Directive 2002/91/EG of the European Parliament and the Commission

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Motivation for Directive (16.12.2002)

- Reduction of the energy demand and the CO2 emission of buildings (space heating and hot tap water amounts to 40% of the total end-use energy demand in Europe)
- Value of buildings not (only) because of the location but also because of the energy demand and the operating costs
- European harmonization of standards for calculation and evaluation (certificates) of energy demand of buildings
- Reduction of emissions by constant maintenance of boilers and air-conditioning systems

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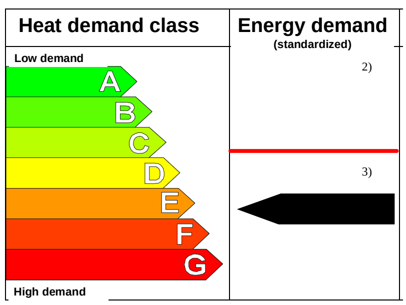
Content of the Directive

- Development of the calculation method (energy demand of heating (EN 13790), cooling (new), lightning (new) and losses of the production- and distribution systems (new)
- Fixing of average, minimum and maximum energy demand of buildings by the national governments
- Development of energy certificates for buildings



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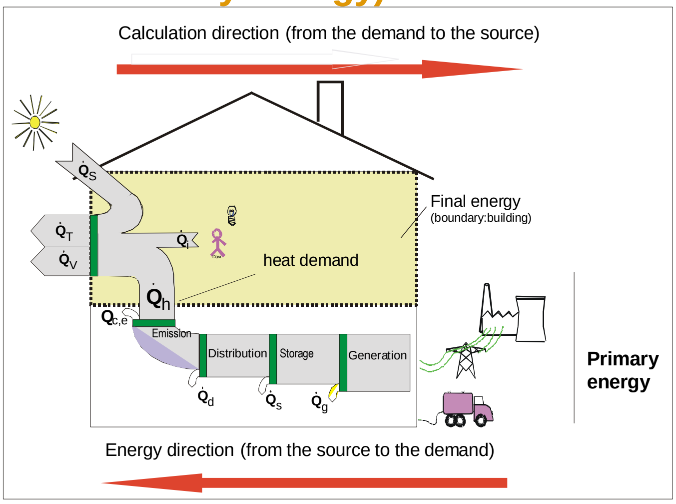
Calculation of Final, End-Use (and Primary Energy) Demand



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Possibilities of energetical limits in the building sector

-U-Values of the components in W/m²K

-LEK- Value of the building envelope in [-]

-Useful energie demand in kWh/m²a

-End-use energy demand in kWh/m²a

-primaryenergy demand in kWh/m²a

- CO_2 – key figure $kgCO_2/m^2a$

Content of the Directive

- Application for all new and refurbished buildings
  - Private houses: new buildings, (partly)selling, renovation
  - Public buildings: right after the directive comes into force
- Increasing the use of renewable energy sources, combined heat and power plants (CHP) and heat pumps if economically feasible

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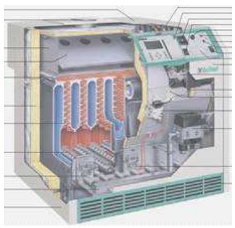
Content of the Directive

- Regularly inspections of boilers (>100 kW every 2 / 4(gas) years; <20 kW every 15 years)
- Regularly inspection of air-conditioning systems
- Inspection by independent specialists
- Set into force by

!!! January 4th 2006 !!!



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Three Levels of Energy-Demand Evaluation

- **Level A**
  Calculation of End-Use Energy demand
  (predefined user behaviourm, Asset Rating)
- **Level B**
  Measurement of End-Use Energy demand
  (actual user behaviour, Operational Rating)
- **Level C**
  Estimation of End-Use Energy demand using statistical values for different types, architectures and ages of buildings

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Status of the EPBD development (CEN)

- Mandate to CEN (October 2003) for developing calculation systems
- Affected Technical Committees (TCs)
  - CEN/TC 89 Thermal performance of buildings and building components
  - CEN/TC 156 Ventilation for buildings
  - CEN/TC 169 Light and lighting
  - CEN/TC 228 Heating systems in buildings
  - CEN/TC 247 Building Automation, Controls and Building Management
- Till this time big activities in the standardization bodies

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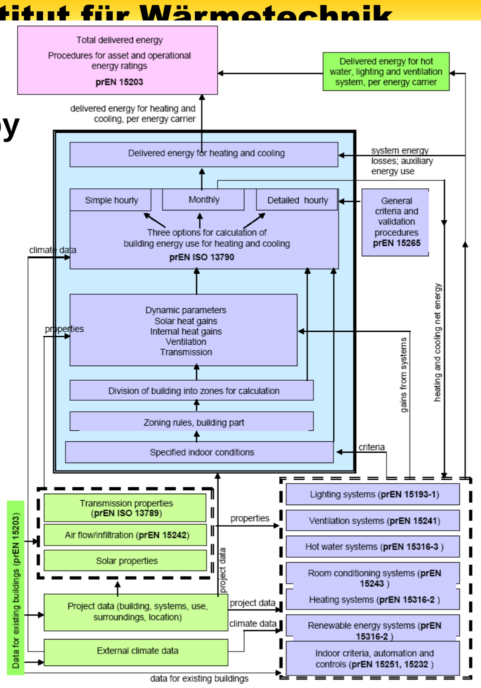
Standards affectd by the EPBD *(41 standards)*



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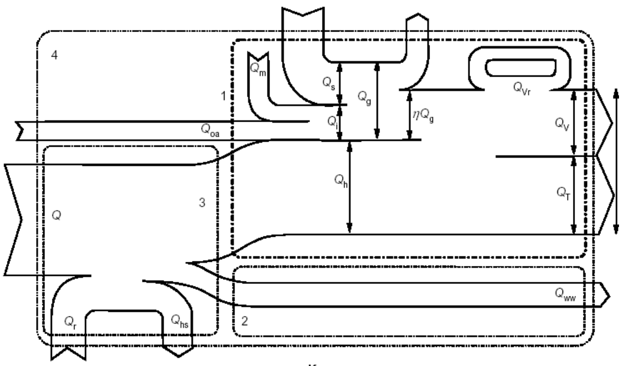
Energy Flow in Buildings by En ISO 13790



Key

Q energy use for heating
Q_{oa} heat from other appliances
Q_r recovered energy
Q_{hs} losses from the heating system
Q_m metabolic heat
Q_s passive solar gains
Q_i internal gains
Q_g total gains
ηQ_g useful gains

Q_h heat use
Q_V ventilation heat loss
Q_{Vr} ventilation heat recovery
Q_T transmission heat loss
Q_{ww} heat for hot water preparation
Q_L total heat loss

1 boundary of the heated zone
2 boundary of the hot water system
3 boundary of the heating plant
4 boundary of the building

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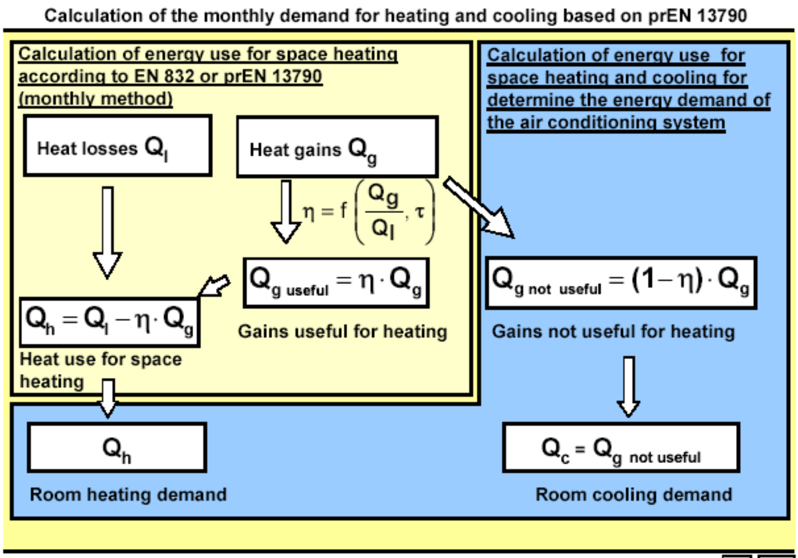

Prof. Dr. L. Rouvel
Extraordinarius für Elektrische Gebäudeenergietechnik

Stand: 12.01.04

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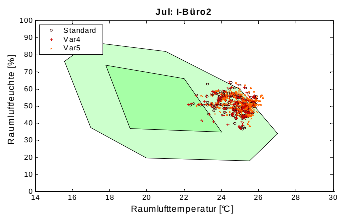
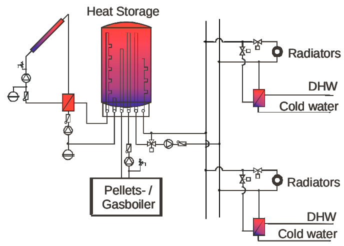
What can‘t be done with the calculation via EPBD

- Heating / cooling load



- Statistic about over-temperature



- Detailed effects of complex hydraulics and controls

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Energy Certificate Berlaymont Gebäude

Year of errection: 1967 (renovated from 1995 to 2004)

Useful area: 241.515 m²

Persons: over 3000 Persons per day

Heating: 3 Gas burners with a total capacity of 7.800 [kW]

Cooling: 4 Compression cooling machines with a total cooling capacity of 8.900 [kW]

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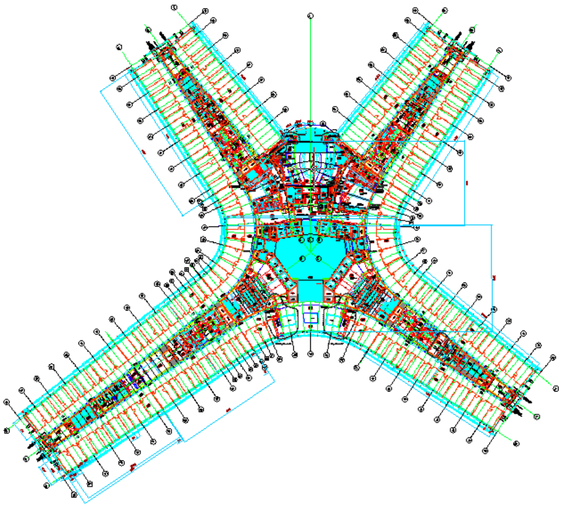
Energy Certificate Berlaymont Gebäude



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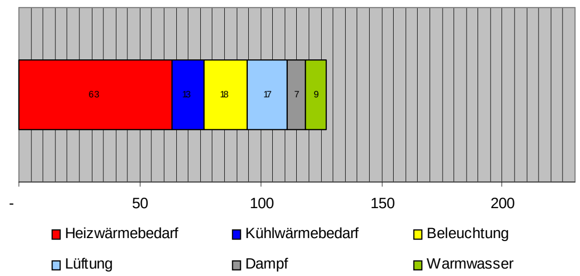
Results useful energy, example Berlaymont, Brüssel

Nutzenergie:

Heizwärmebedarf	63	[kWh/(m².a)]
Kühlwärmebedarf	13	[kWh/(m².a)]
Beleuchtung	18	[kWh/(m².a)]
Luftförderung	17	[kWh/(m².a)]
Dampf	7	[kWh/(m².a)]
Warmwasser	9	[kWh/(m².a)]

Summe	127	[kWh/(m².a)]

spezifischer Nutzenergiebedarf [kWh/(m².a)]



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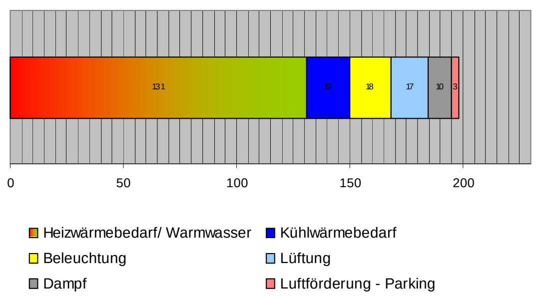
Results end use energy, example Berlaymont, Brüssel

Endenergie:

Heizwärmebedarf und Warmwasser	131	[kWh/(m².a)]
Kühlwärmebedarf	19	[kWh/(m².a)]
Beleuchtung	18	[kWh/(m².a)]
Luftförderung	17	[kWh/(m².a)]
Dampf	10	[kWh/(m².a)]
Luftförderung - Parking	3	[kWh/(m².a)]

Summe	198	[kWh/(m².a)]

spezifischer Endenergiebedarf [kWh/(m².a)]



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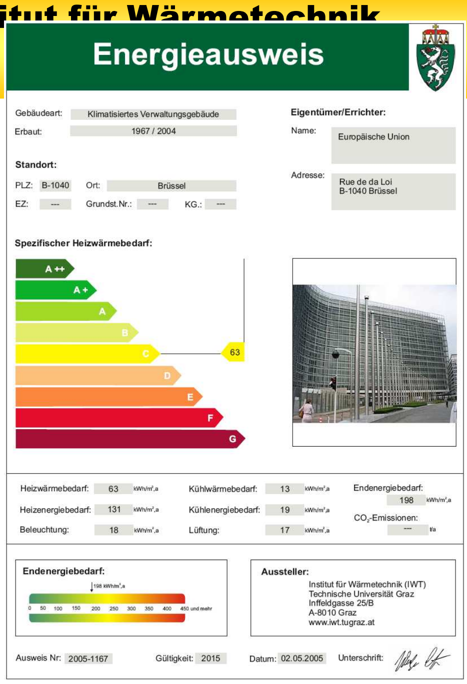
Energy certificate Berlaymont Building – Styria



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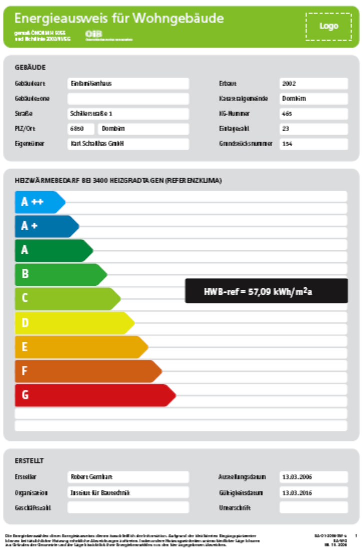
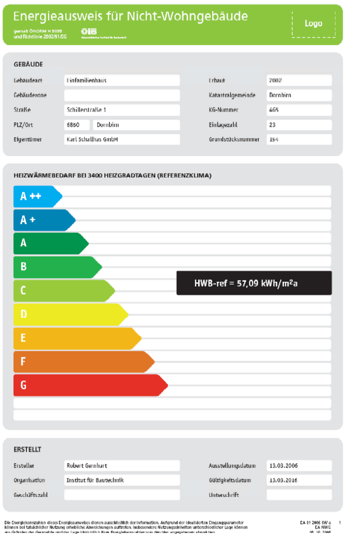
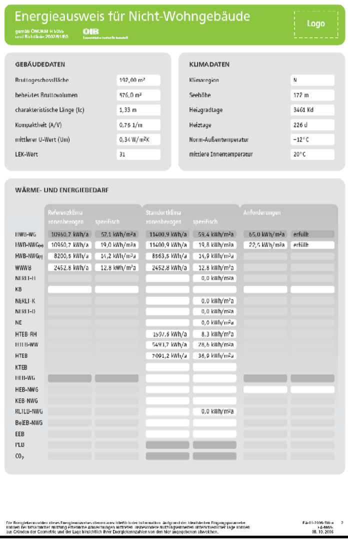
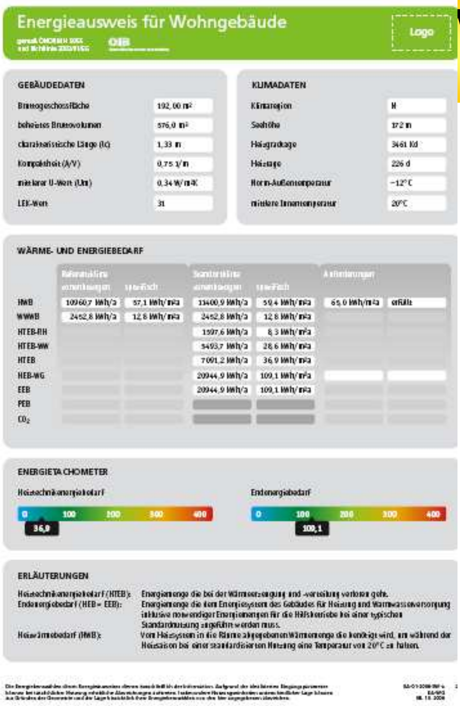
Energieausweis Wohngebäude



Energieausweis Nichtwohngebäude







Energieausweis für Wohngebäude

Logo

GEBÄUDEDATEN

Bruttogeschossfläche	192,00 m²
beheiztes Bruttovolumen	576,0 m³
charakteristische Länge (lc)	1,33 m
Kompaktheit (A/V)	0,75 1/m
mittlerer U-Wert (Um)	0,34 W/m²K
LEK-Wert	31

KLIMADATEN

Klimaregion	N
Seehöhe	172 m
Heizgradtage	3461 Kd
Heiztage	226 d
Norm-Außentemperatur	−12°C
mittlere Innentemperatur	20°C

WÄRME- UND ENERGIEBEDARF

	Referenzklima zonenbezogen	spezifisch	Standortklima zonenbezogen	spezifisch	Anforderungen	
HWB	10960,7 kWh/a	57,1 kWh/m²a	11400,9 kWh/a	59,4 kWh/m²a	65,0 kWh/m²a	erfüllt
WWWB	2452,8 kWh/a	12,8 kWh/m²a	2452,8 kWh/a	12,8 kWh/m²a		
HTEB-RH			1597,6 kWh/a	8,3 kWh/m²a		
HTEB-WW			5493,7 kWh/a	28,6 kWh/m²a		
HTEB			7091,2 kWh/a	36,9 kWh/m²a		
HEB-WG			20944,9 kWh/a	109,1 kWh/m²a		
EEB			20944,9 kWh/a	109,1 kWh/m²a		
PEB						
CO_2						

ENERGIETACHOMETER

Heiztechnikenergiebedarf: 0 – 100 – 200 – 300 – 400; 36,9

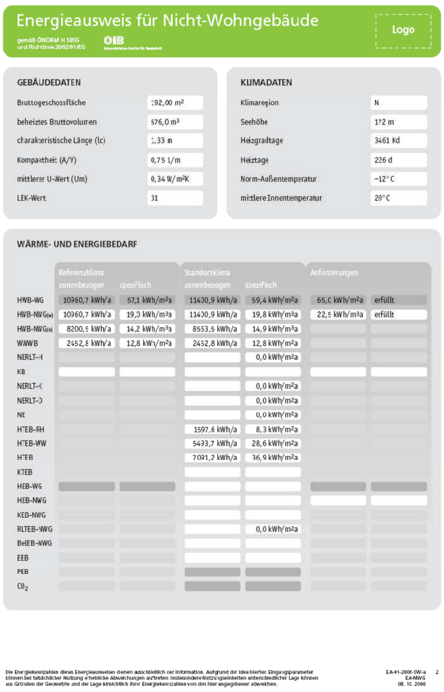
Endenergiebedarf: 0 – 100 – 200 – 300 – 400; 109,1

ERLÄUTERUNGEN

Heiztechnikenergiebedarf (HTEB): Energiemenge die bei der Wärmeerzeugung und -verteilung verloren geht.

Endenergiebedarf (HEB = EEB): Energiemenge die dem Energiesystem des Gebäudes für Heizung und Warmwasserversorgung inklusive notwendiger Energiemengen für die Hilfsbetriebe bei einer typischen Standardnutzung zugeführt werden muss.

Heizwärmebedarf (HWB): Vom Heizsystem in die Räume abgegebenen Wärmemenge die benötigt wird, um während der Heizsaison bei einer standardisierten Nutzung eine Temperatur von 20°C zu halten.



Energieausweis für Nicht-Wohngebäude

gemäß ÖNORM H 5055 und Richtlinie 2002/91/EG

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GEBÄUDEDATEN

Bruttogeschossfläche	192,00 m²
beheiztes Bruttovolumen	576,0 m³
charakteristische Länge (lc)	1,33 m
Kompaktheit (A/V)	0,75 1/m
mittlerer U-Wert (Um)	0,34 W/m²K
LEK-Wert	31

KLIMADATEN

Klimaregion	N
Seehöhe	172 m
Heizgradtage	3461 Kd
Heiztage	226 d
Norm-Außentemperatur	−12°C
mittlere Innentemperatur	20°C

WÄRME- UND ENERGIEBEDARF

	Referenzklima zonenbezogen	spezifisch	Standortklima zonenbezogen	spezifisch	Anforderungen	
HWB-WG	10960,7 kWh/a	57,1 kWh/m²a	11400,9 kWh/a	59,4 kWh/m²a	65,0 kWh/m²a	erfüllt
HWB-NWG(w)	10960,7 kWh/a	19,0 kWh/m³a	11400,9 kWh/a	19,8 kWh/m³a	22,5 kWh/m³a	erfüllt
HWB-NWG(n)	8200,5 kWh/a	14,2 kWh/m³a	8553,5 kWh/a	14,9 kWh/m³a		
WWWB	2452,8 kWh/a	12,8 kWh/m²a	2452,8 kWh/a	12,8 kWh/m²a		
NERLT-H				0,0 kWh/m²a		
KB						
NERLT-K				0,0 kWh/m²a		
NERLT-D				0,0 kWh/m²a		
NE				0,0 kWh/m²a		
HTEB-RH			1597,6 kWh/a	8,3 kWh/m²a		
HTEB-WW			5493,7 kWh/a	28,6 kWh/m²a		
HTEB			7091,2 kWh/a	36,9 kWh/m²a		
KTEB						
HEB-WG						
HEB-NWG						
KEB-NWG						
RLTEB-NWG				0,0 kWh/m²a		
BelEB-NWG						
EEB						
PEB						
CO_2						

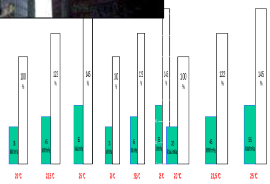
Die Energiekennzahlen dieses Energieausweises dienen ausschließlich der Information. Aufgrund der idealisierten Eingangsparameter können bei tatsächlicher Nutzung erhebliche Abweichungen auftreten. Insbesondere Nutzungseinheiten unterschiedlicher Lage können aus Gründen der Geometrie und der Lage hinsichtlich ihrer Energiekennzahlen von den hier angegebenen abweichen.

EA-01-2006-SW-a 2
EA-NWG
08. 10. 2006

What can't be done with the calculation via EPBD

- Effect of complex calculations (big sunspaces, double skin facades)

- Consideration of user-behaviour (window-ventilation, attendance, internal loads …)



Space heating energy for varying indoor air temperature in a Passive house

- Worst/best case scenarios regarding climate

Effects of the EPBD on the Design Process of Buildings

- Energy demand for heating and cooling will be relevant already in architectural competitions.
- As the first sketch of the architect fixes about 40 % of the energy demand of the building, integrated design approaches (architect, civil engineer, mechanical engineer...) will become relevant
- Building codes and subsidy schemes will use the EPBD certificates.
- Detailed questions to the building still need dynamic building simulation.

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Further upcoming EU-regulations

- **Draft Standardization Mandate to CEN, “Development of horizontal standardized methods for the assessment of the integrated environmental performance of buildings” (into force presumably 12/2007)**

- **Directive on energy end-use efficiency and energy services (into force presumably 6/2006).
(1 % increase of end-use energy efficiency per year)**

- **Thematic strategy for urban environment (sustainable building) (KOM(2004)60, 11.02.2004**

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Biomass

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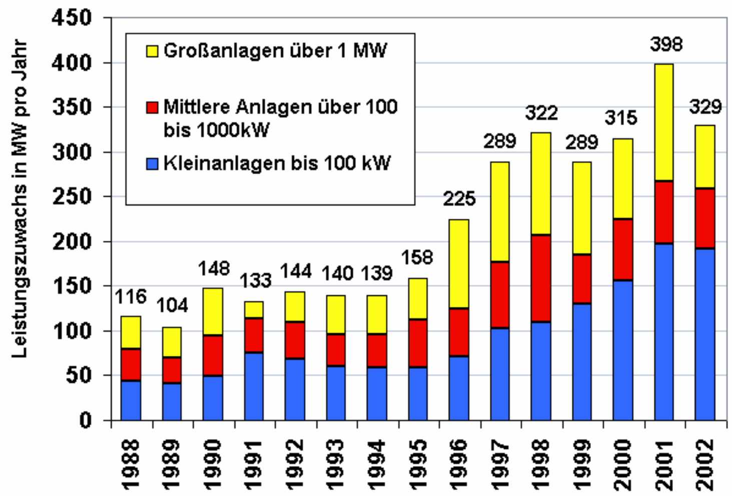
Jährlicher Leistungszuwachs bei Hackschnitzelanlagen (1998 - 2002)



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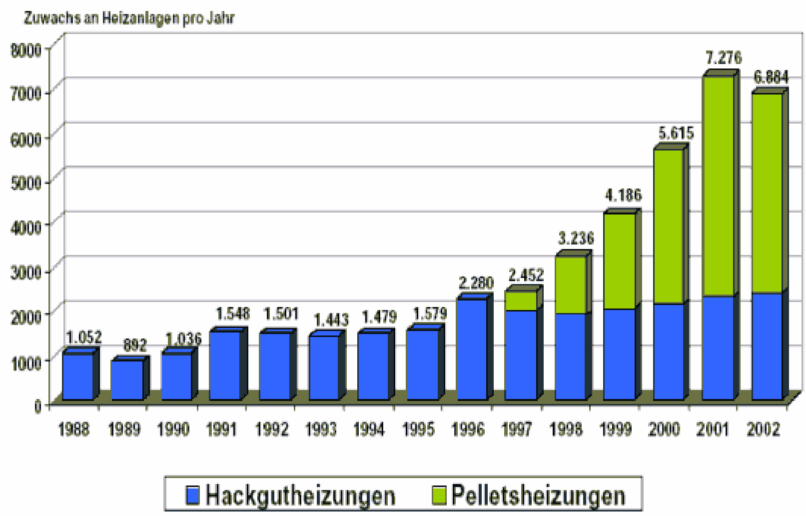
Yearly increase of biomass heating systems in Austria



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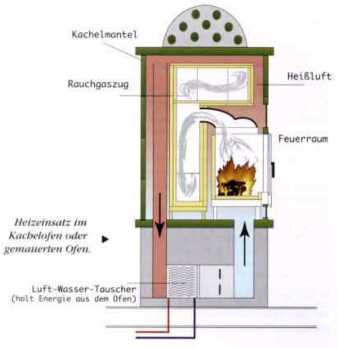
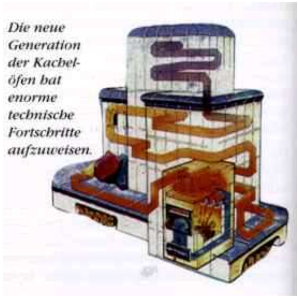
„Kachelofen“





- Positioning that several rooms can be heated, with water HX inside a coupling to a water heating system can be done
- Efficiency about 60-70 %
- High startup emissions (cold burning chamber)

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“Kaminofen”

- Positioning that several rooms can be heated, with water HX inside a coupling to a water heating system can be done
- Efficiency about 60-70 %
- High startup emissions (cold burning chamber)

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Log wood burner with downward flame

- Logs and ash is transported autmomatically downwards
- Logs are dries before burned
- Burning chamber is NOT cooled

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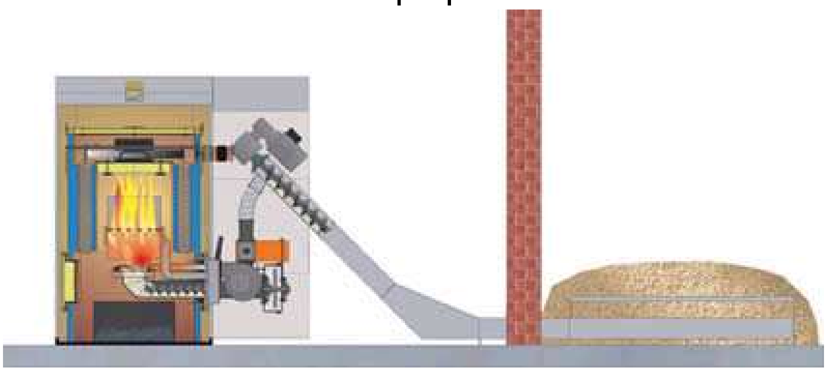
Automatic wood chips/pellets burner



- Similar maintenance a soil or gas burners
- Similar emissions as oil burner
- Slightly higher investment than oil burner
- Biomass store has to be reached yb the blowing tube of the truck

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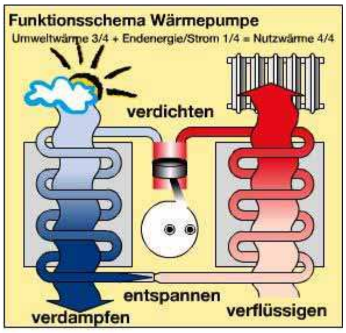
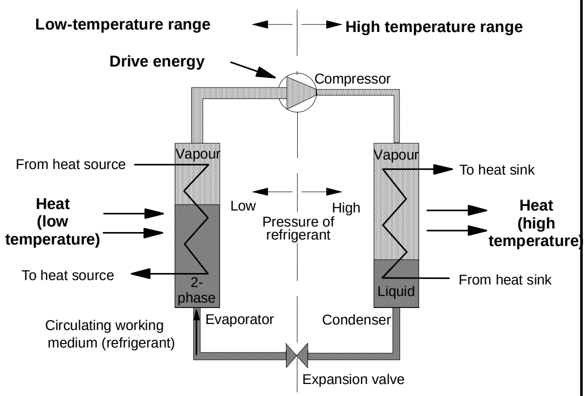
Heat pumps





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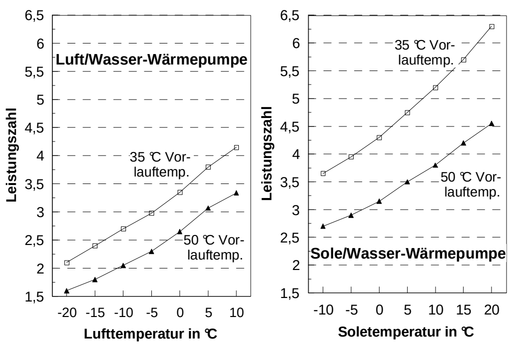
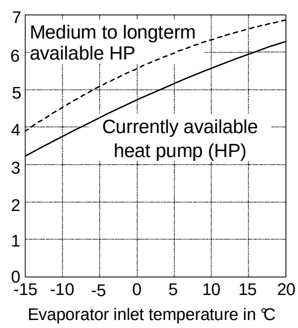
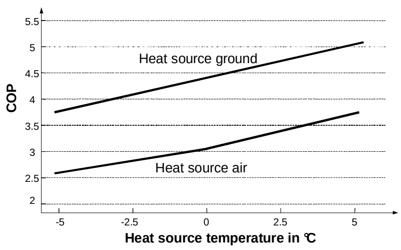
Heat pump COP and boundary conditions





Quelle: Kaltschmitt, Streicher, Wiese, 2006



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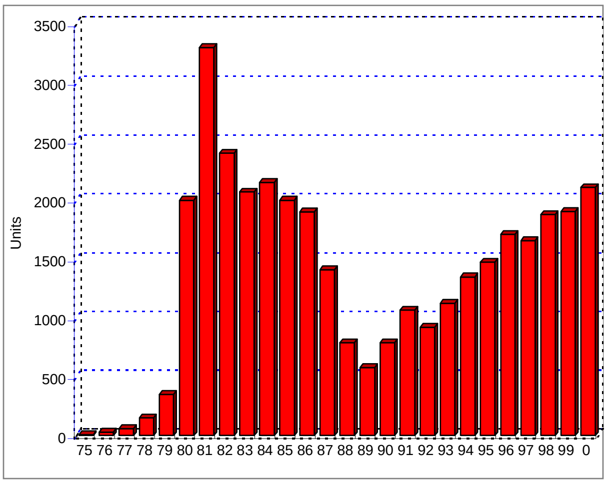
Space heating heat pumps in Austria



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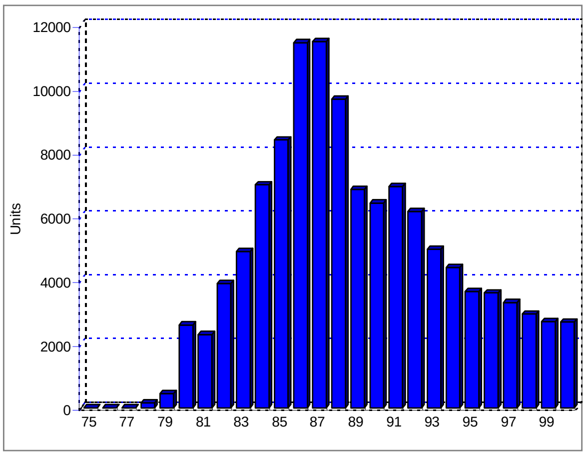
Domestic hot water heat pumps in Austria



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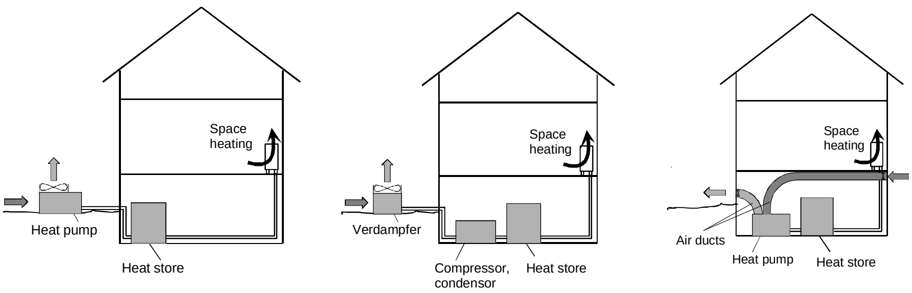
Ambient air as heat source



Quelle: Kaltschmitt, Streicher, Wiese, 2006

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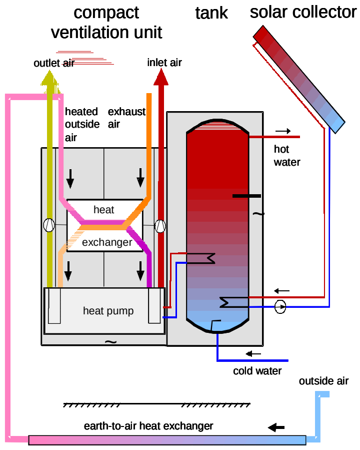
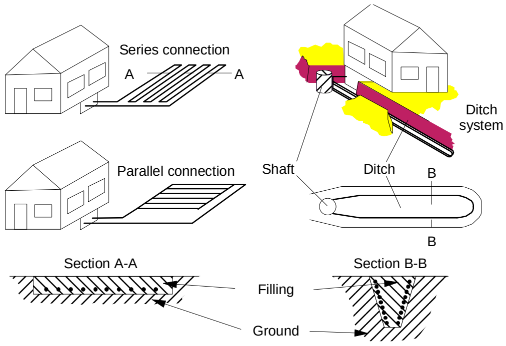
Compact heating and domestic hot water unit

- air-to-air heat recovery
- exhaust air heat pump
- storage
- solar collector
- earth-to-air heat exchanger



Source: Fraunhofer-Institut für Solare Energiesysteme ISE, 2000

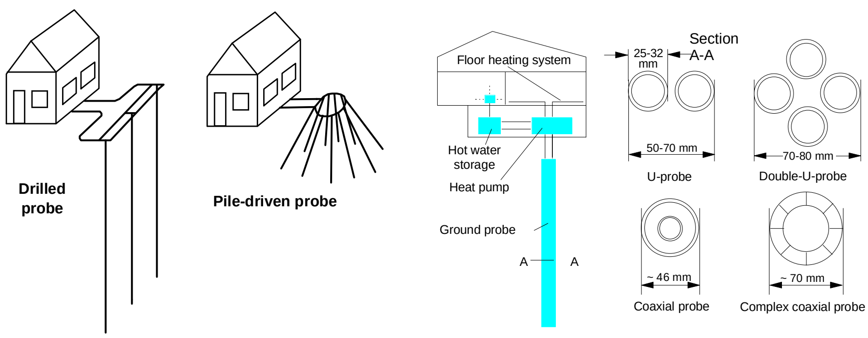
Ground as heat source



Type of soil	Withdrawn heat capacity
Dry, sandy soil	10 – 15 W/m^2
Humid, sandy soil	15 – 20 W/m^2
Dry loamy soil	20 – 25 W/m^2
Humid loamy soil	25 – 30 W/m^2
Water saturated sand/gravel	30 – 40 W/m^2

Quelle: Kaltschmitt, Streicher, Wiese, 2006, VDI 4640

Ground as heat source



Quelle: Kaltschmitt, Streicher, Wiese, 2006

	1 800 h/a	2 400 h/a
General guidelines		
Bad subsoil (dry lose rocks)	25 W/m	20 W/m
Solid rock subsoil, water-saturated lose rock	60 W/m	50 W/m
Solid rock with high heat conductivity	84 W/m	70 W/m
Individual soils		
Gravel, sand, dry	< 25 W/m	< 20 W/m
Gravel, sand, carrying water	65 – 80 W/m	55 – 65 W/m
Gravel, sand, strong groundwater flow, for small systems.	80 – 100 W/m	80 – 100 W/m
Clay, loam, moist	35 – 50 W/m	30 – 40 W/m
Limestone (solid)	55 – 70 W/m	45 – 60 W/m
Sandstone	65 – 80 W/m	55 – 65 W/m
Acidic magmatites (e. g. granite)	65 – 85 W/m	55 – 70 W/m
Alkaline magmatites (e. g. basalt)	40 – 65 W/m	35 – 55 W/m
Gneiss	70 – 85 W/m	60 – 70 W/m

The requirement for using the table: only heat withdrawal (heating incl. hot water) takes place; length of the individual ground probes between 40 and 100 m; smallest space between two ground probes would be a minimum of 5 m for ground probe lengths of 40 to 50 m or at least 6 m for ground probes with lengths of over 50 to 100 m. Suitable ground probes are double-U probes with an individual tube diameter of 25 or 32 mm or coaxial probes with at least a diameter of 60 mm. The values given above can fluctuate considerably, depending on rock formations such as crevasses, foliation and weathering.

Quelle: Kaltschmitt, Streicher, Wiese, 2006, VDI 4640

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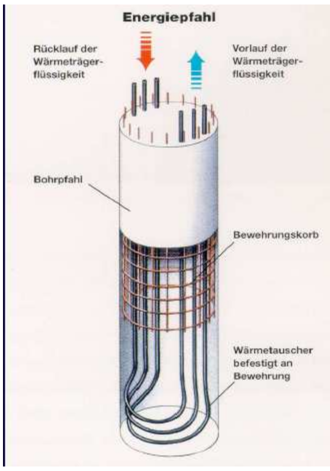
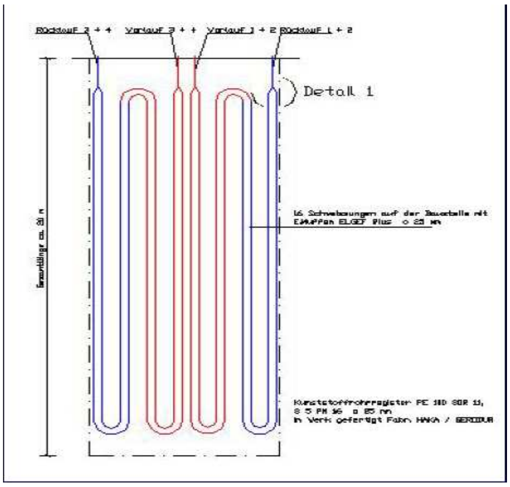
Energy poles





Quelle: Sauerwein, Bilfinger Berger,

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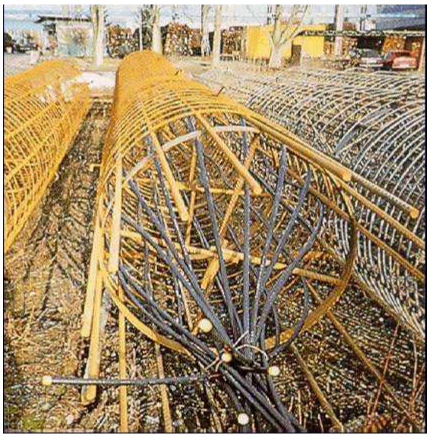
Vorgefertigter Bewehrungskorb



Energy poles

Verteilerstation Energiepfähle

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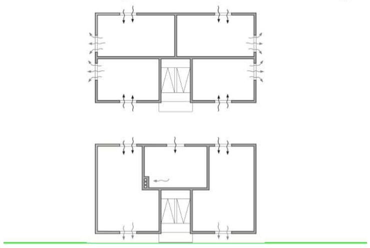
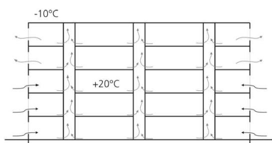
Natural ventilation

Natürliche Luftströmung durch Gebäude

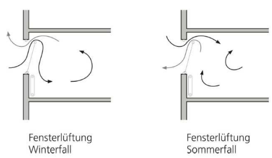
Querlüftung bei natürlicher Lüftung



Schachtwirkung durch thermischen Auftrieb



Natürliche Lüftung Sommer/Winter



Quelle: Bohne, Skript techn. Gebäudeausrüstung, UNI-Hannover

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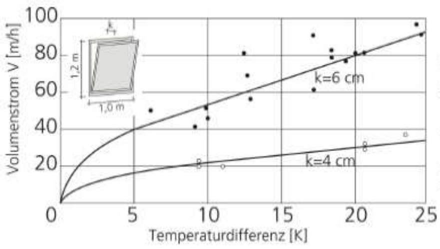
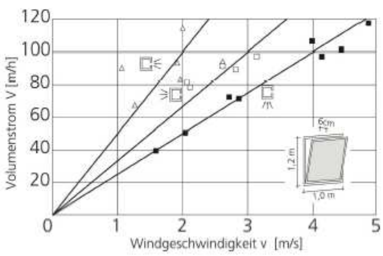
Natural ventilation

Luftaustausch bei natürlicher Lüftung durch Temperaturdifferenz und Windgeschwindigkeit





Quelle: Bohne, Skript techn. Gebäudeausrüstung, UNI-Hannover

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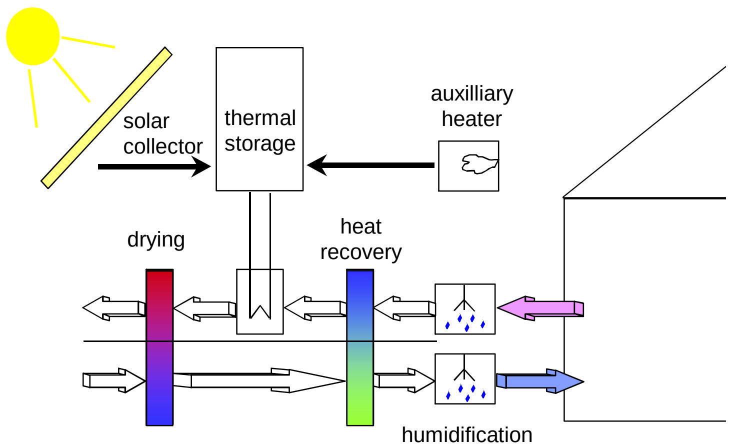
Solar dessicant cooling



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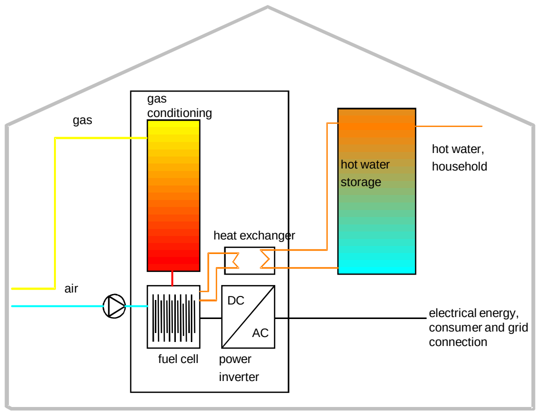
Domestic fuel cell system



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New control strategies

Higher efficiency

Total energy supply concepts

Integration into the grids

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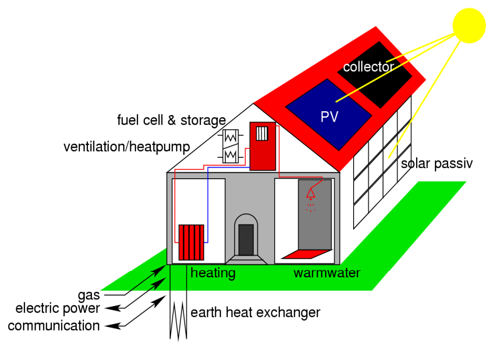
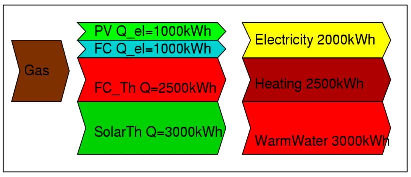
Concept of the domestic supply with fuel cells





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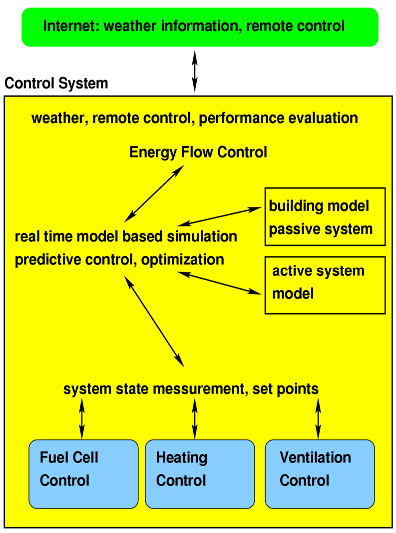
Control strategy



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Summary

New materials enable new systems

New systems enable new energy concepts for buildings

New control stategies enable an optimized energy supply

Always under consideration of comfort and health, cost and economy and available resources