Low Energy Buildings and Renewable Energy Use

Czech-Austrian Winter/Summer School

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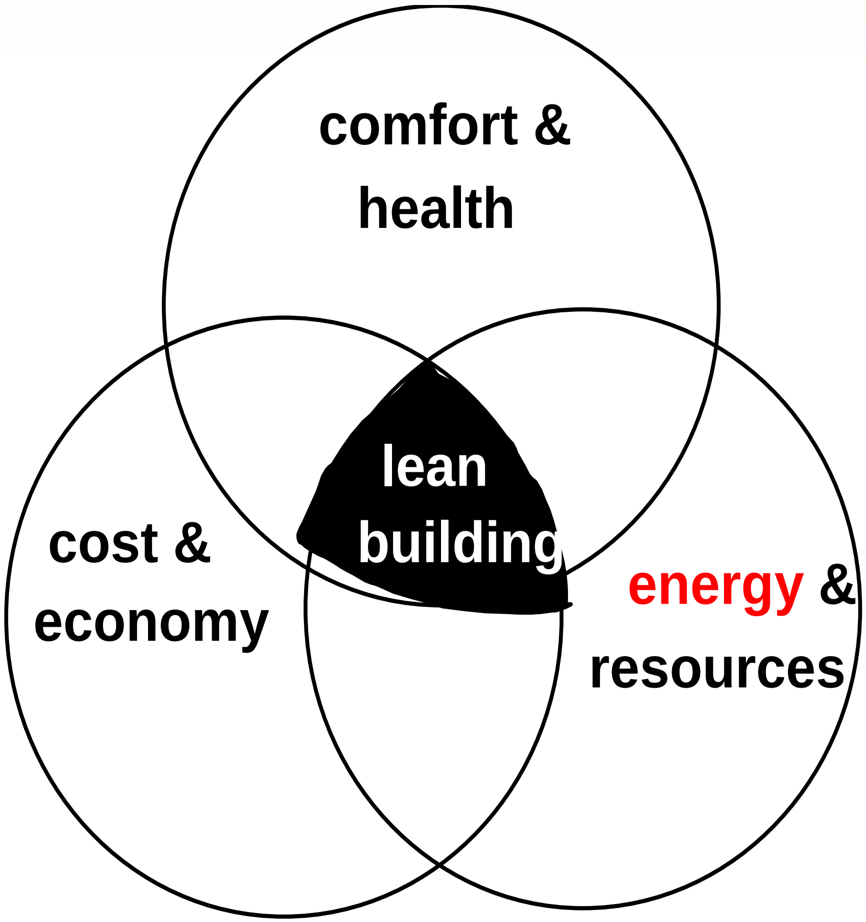
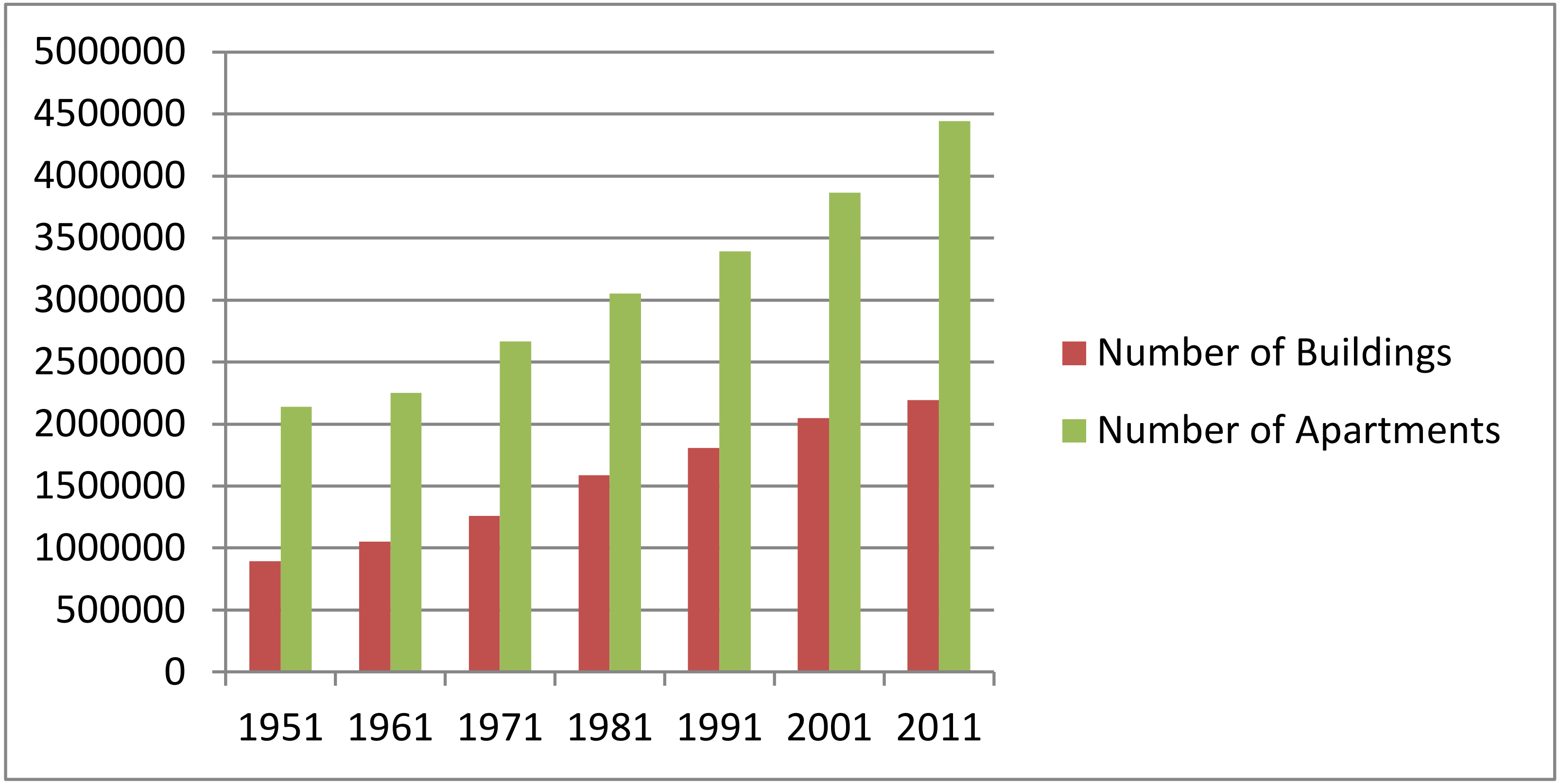
Whole life optimised building

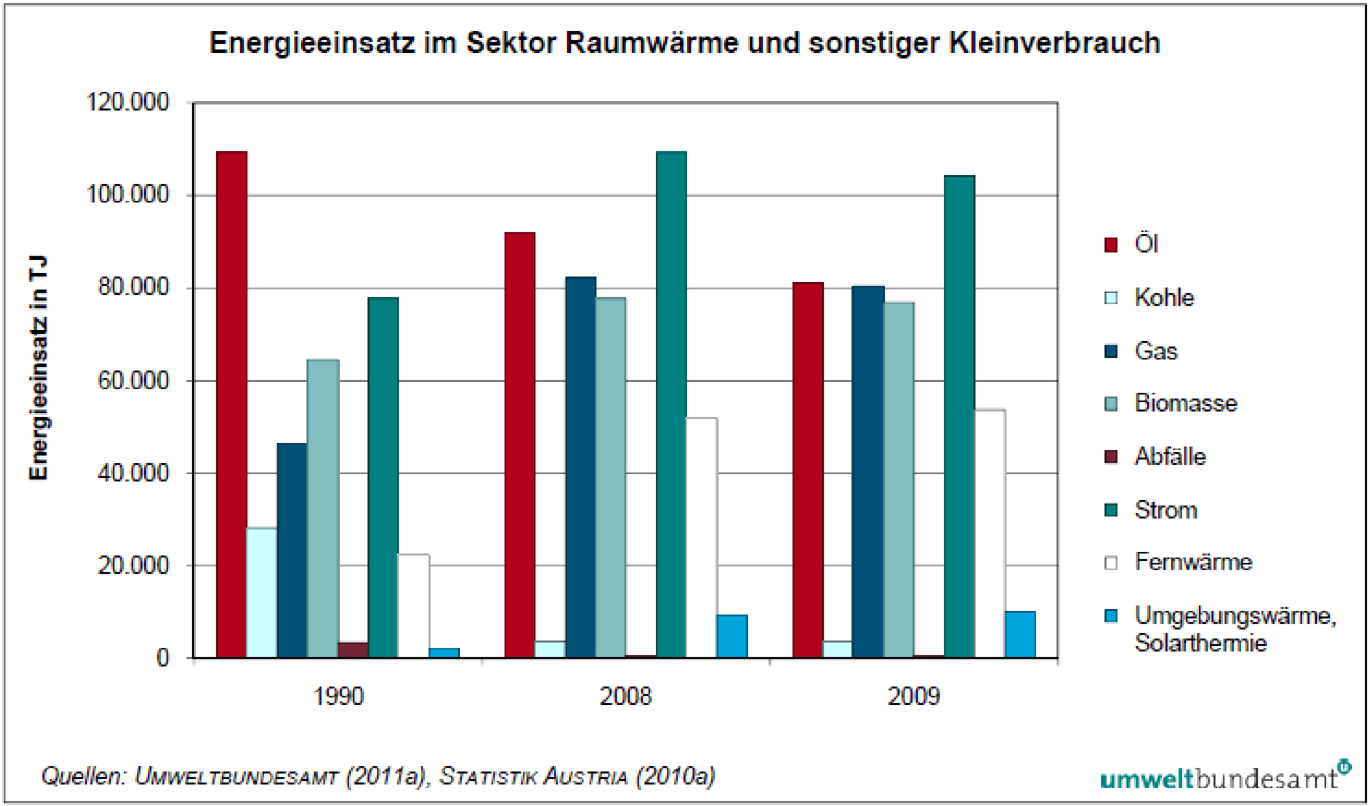
=>



Gebäudebestand in Österreich

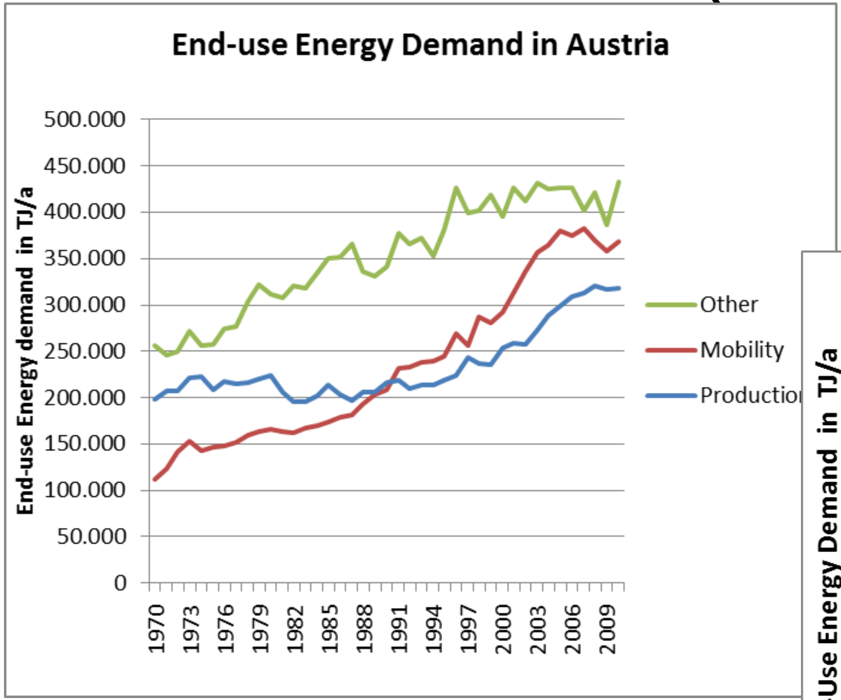


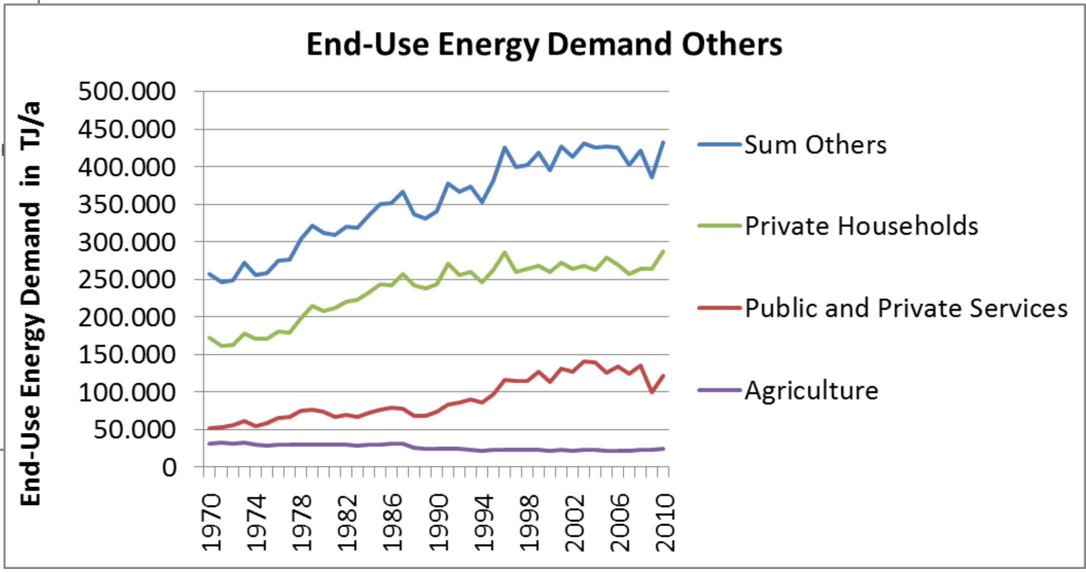
Energy carriers in Austrian households



Quelle: Statistik Austria, (2005)

Energy use energy demand (EE) of the sector „others“ and out of this households (Haushalte)

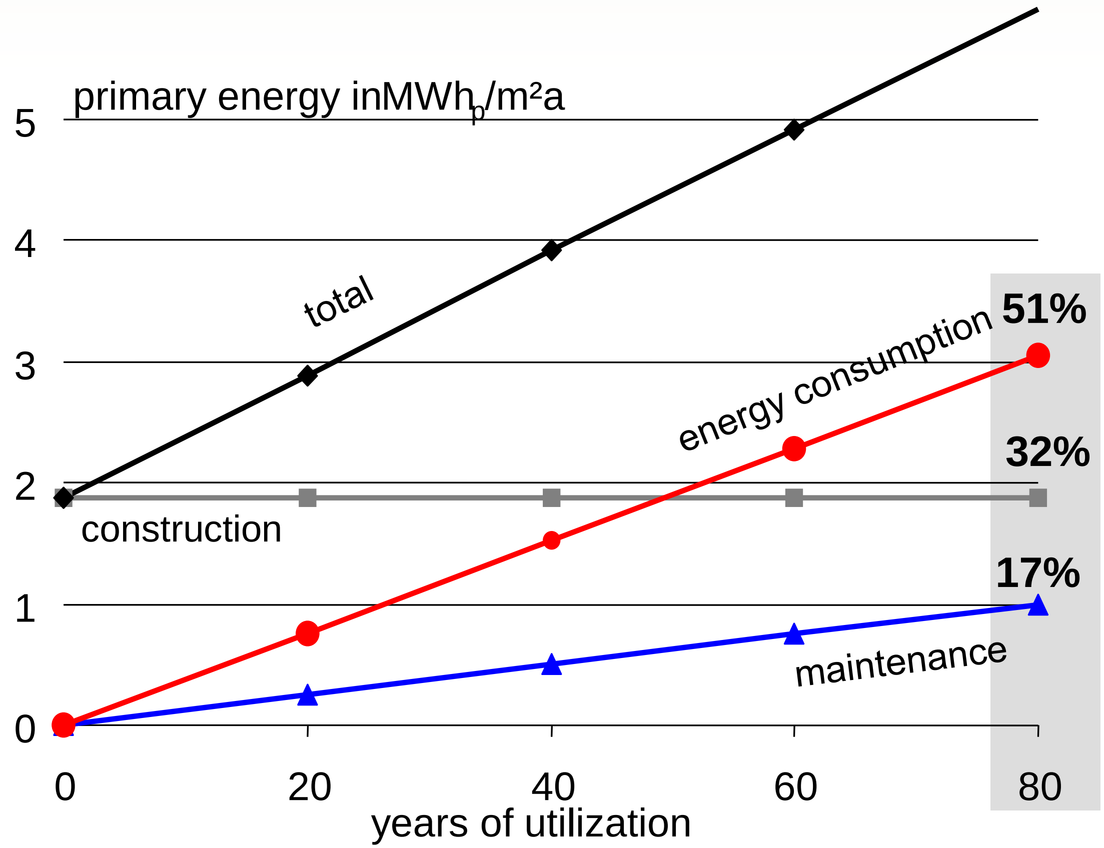




Source : Statistik Austria, superwebquest 2012

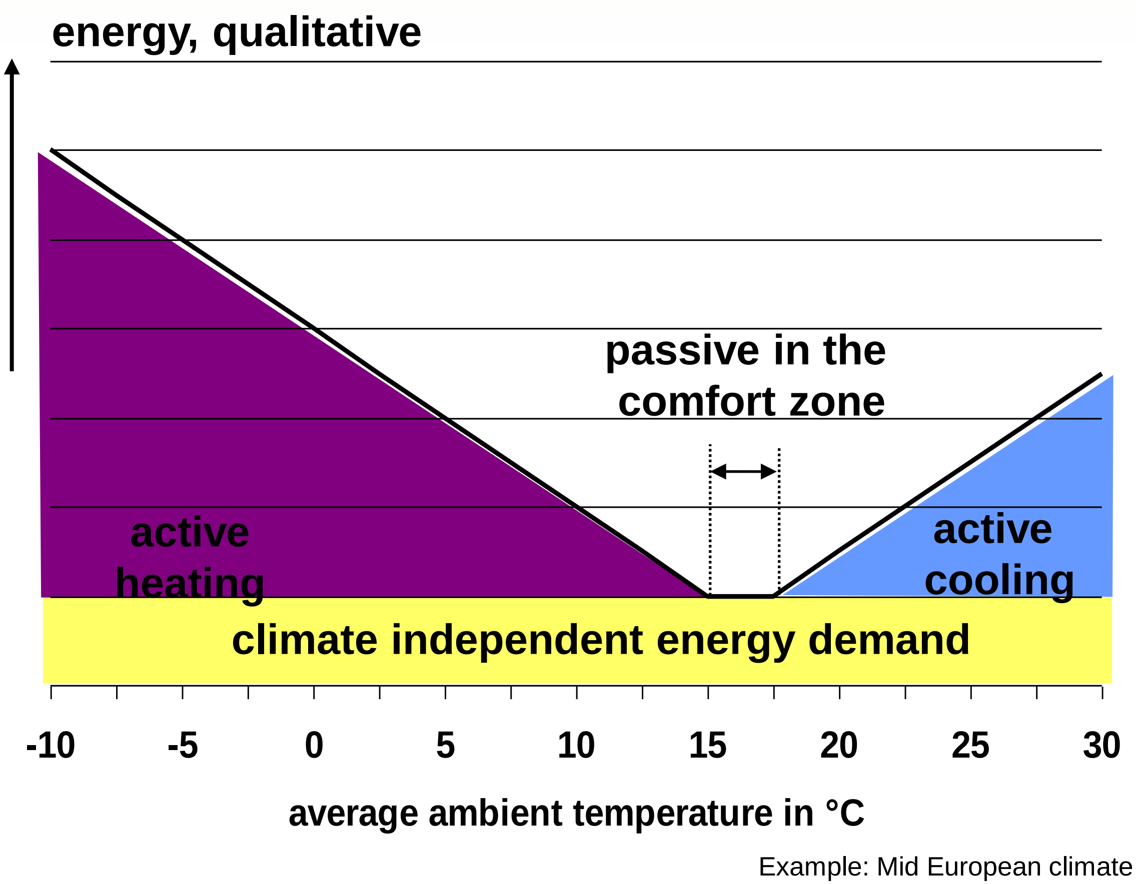
Life Cycle Energy

embodied energy 1,9 MWh/m²



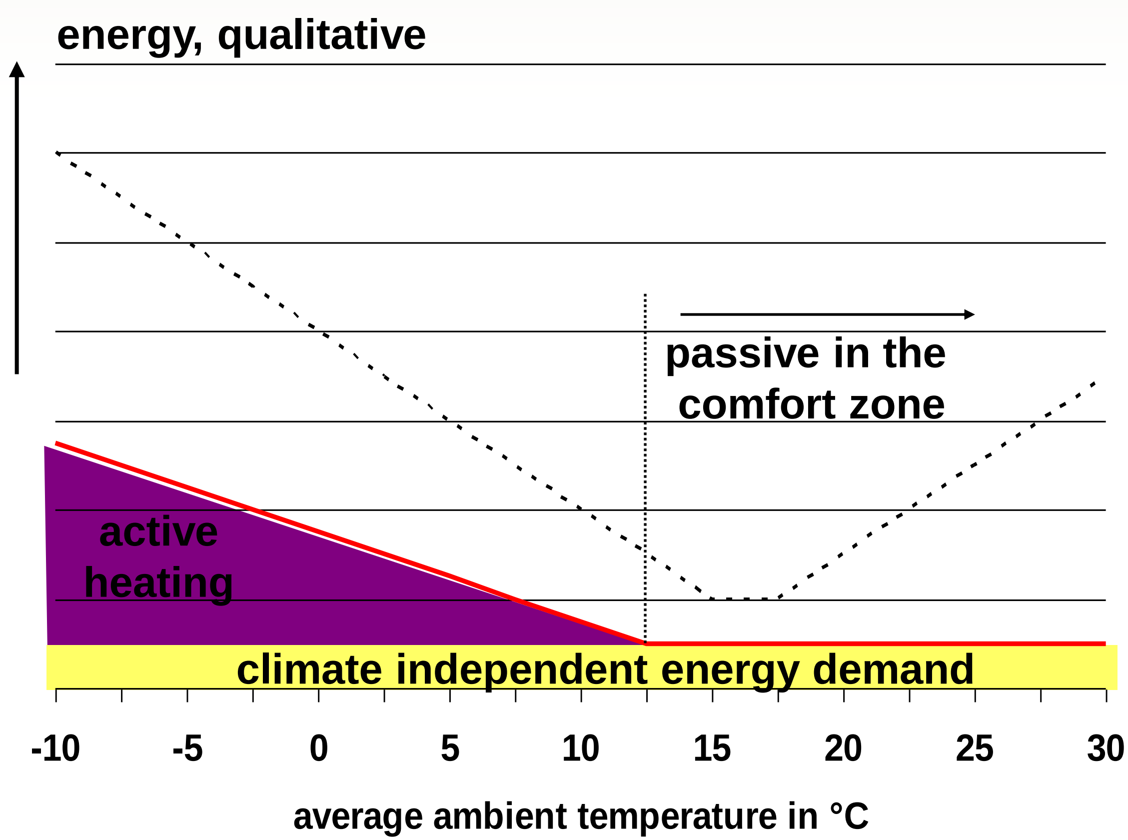
Current Buildings

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



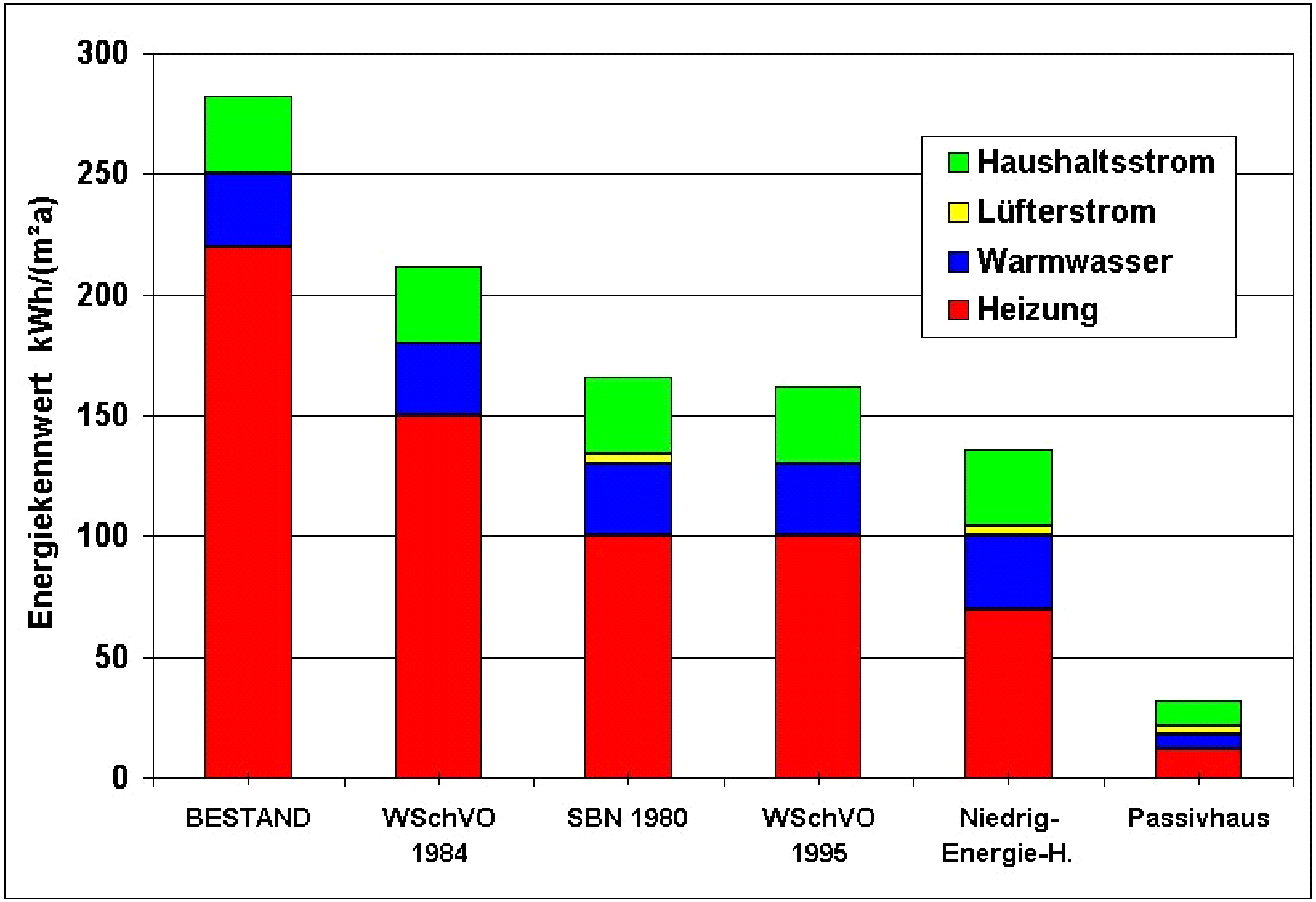
Lean Buildings

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

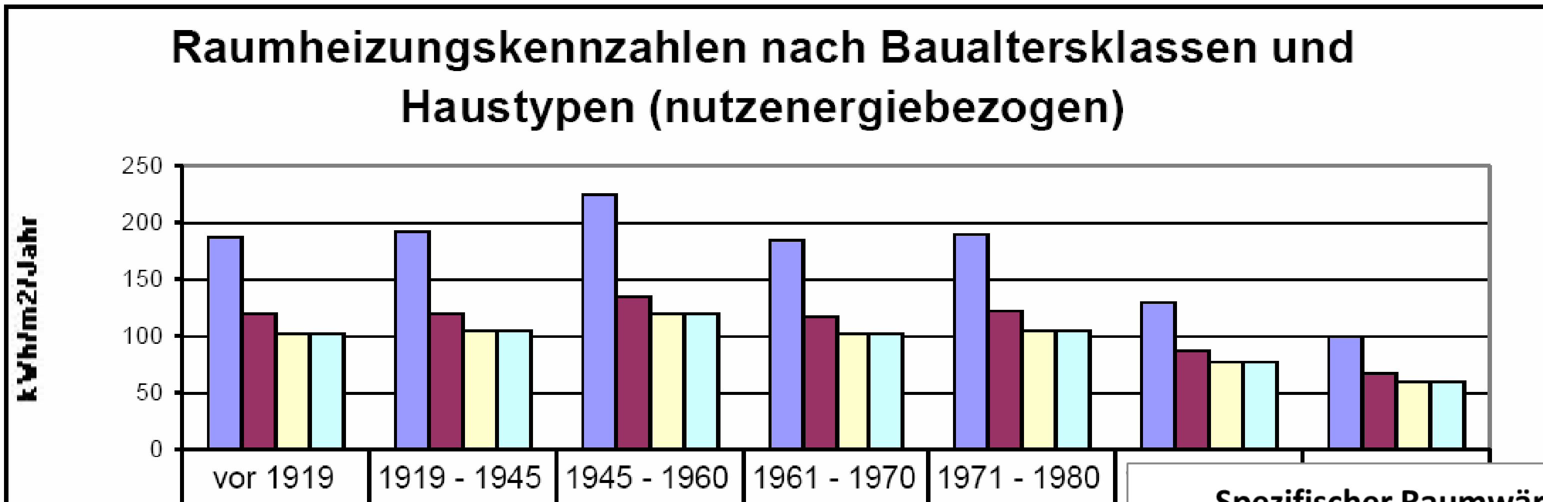


Example: Mid European climate

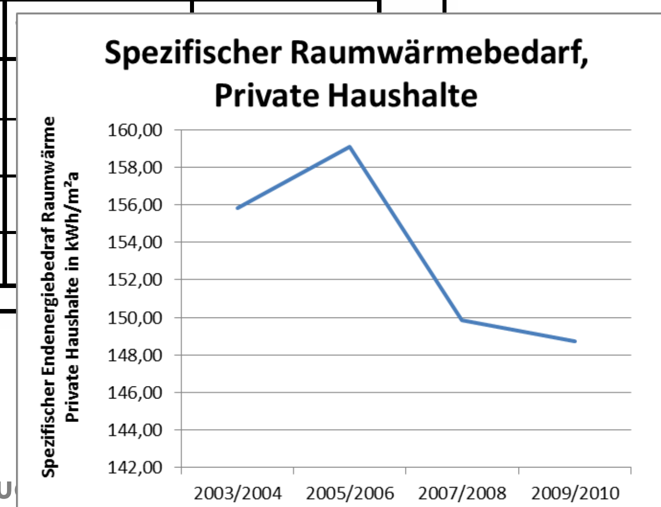
Energy demand of buildings



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



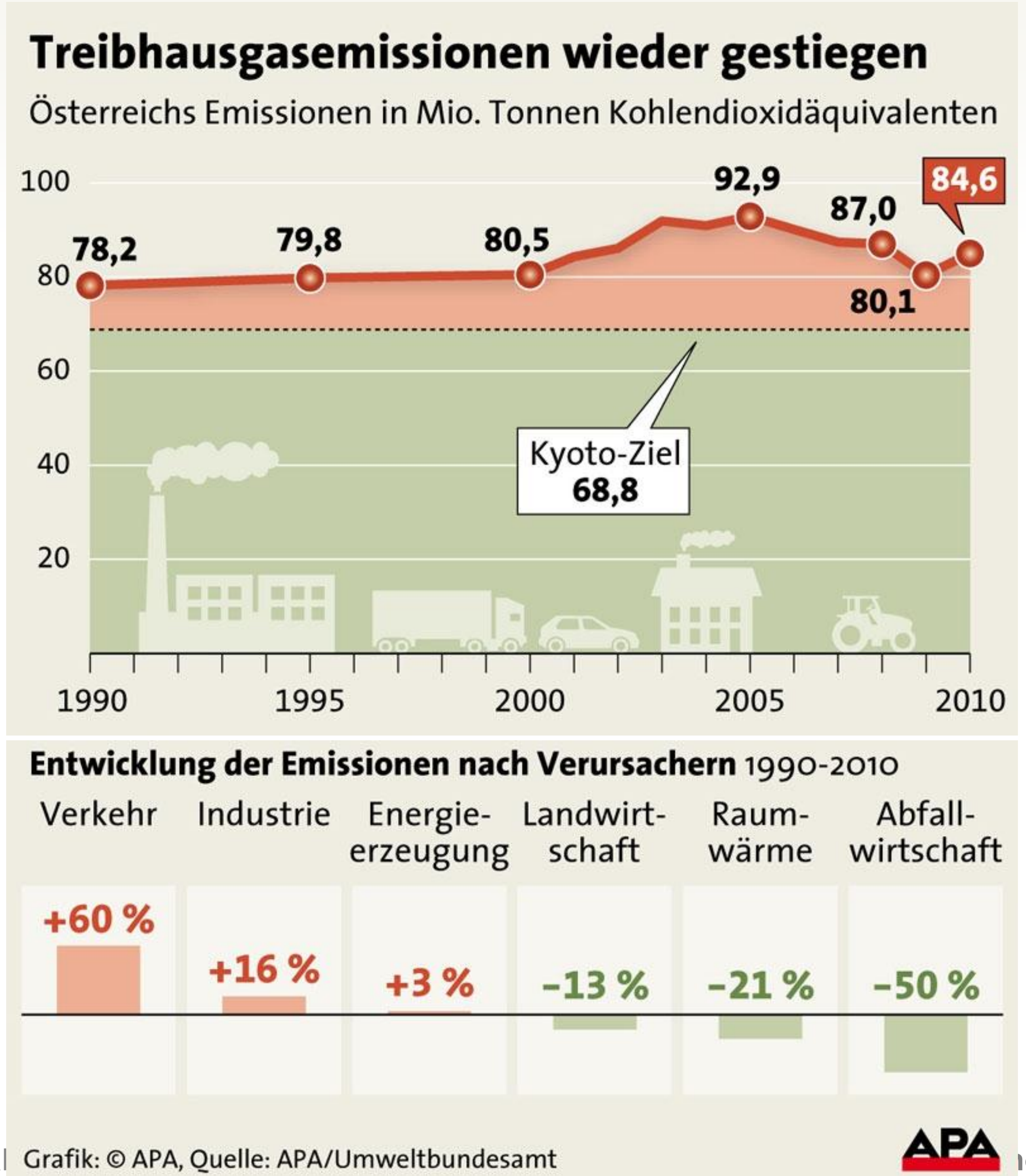
	vor 1919	1919 - 1945	1945 - 1960	1961 - 1970	1971 - 1980
EFH	188	193	226	186	191
MFH-K	121	121	136	118	122
MFH-G	103	106	120	103	104
NWG	103	106	120	103	104



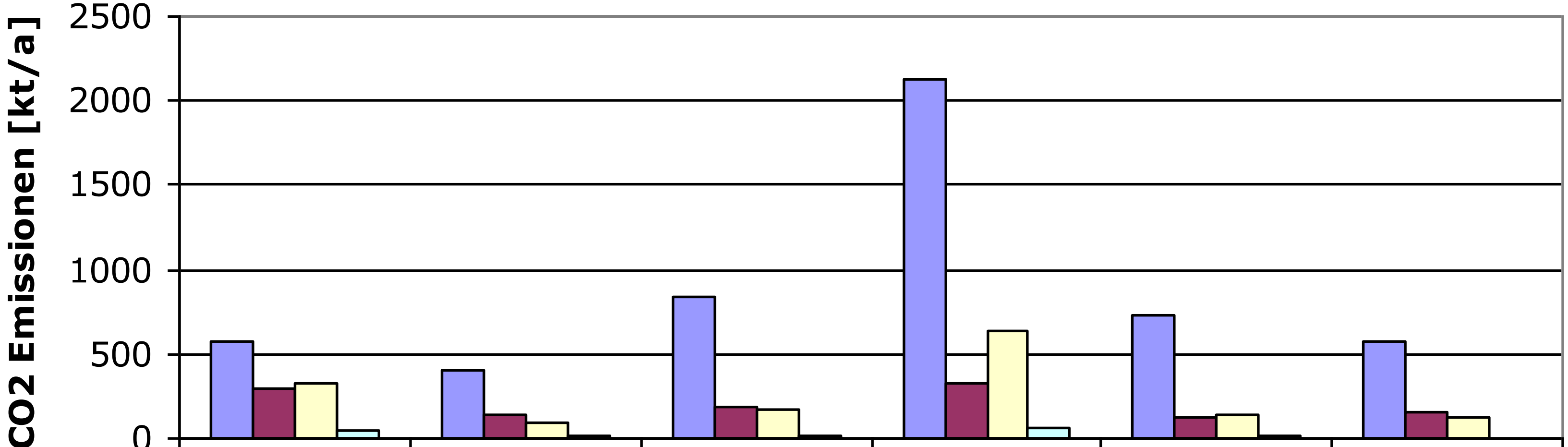
Quelle: Jungmeier, et al. (1996)

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


Treibhausgasemissionen wieder gestiegen
Österreichs Emissionen in Mio. Tonnen Kohlendioxidäquivalenten
100
80
60
40
20
78,2
79,8
80,5
92,9
87,0
84,6
80,1
Kyoto-Ziel
68,8
1990
1995
2000
2005
2010
Entwicklung der Emissionen nach Verursachern 1990-2010
Verkehr
Industrie
Energie-erzeugung
Landwirt-schaft
Raum-wärme
Abfall-wirtschaft
+60 %
+16 %
+3 %
-13 %
-21 %
-50 %
Grafik: © APA, Quelle: APA/Umweltbundesamt
APA

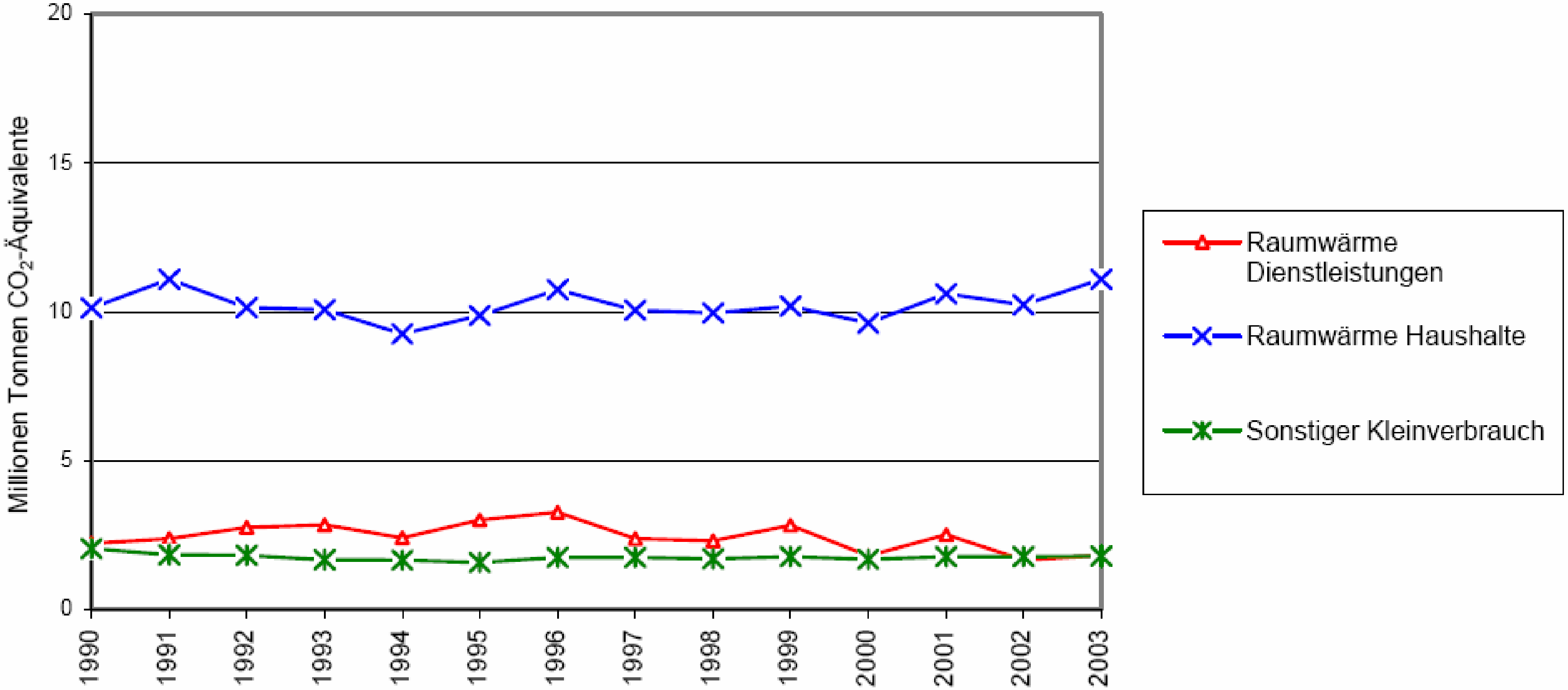
CO_2-emissions from space heating of appartements in Austria



	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

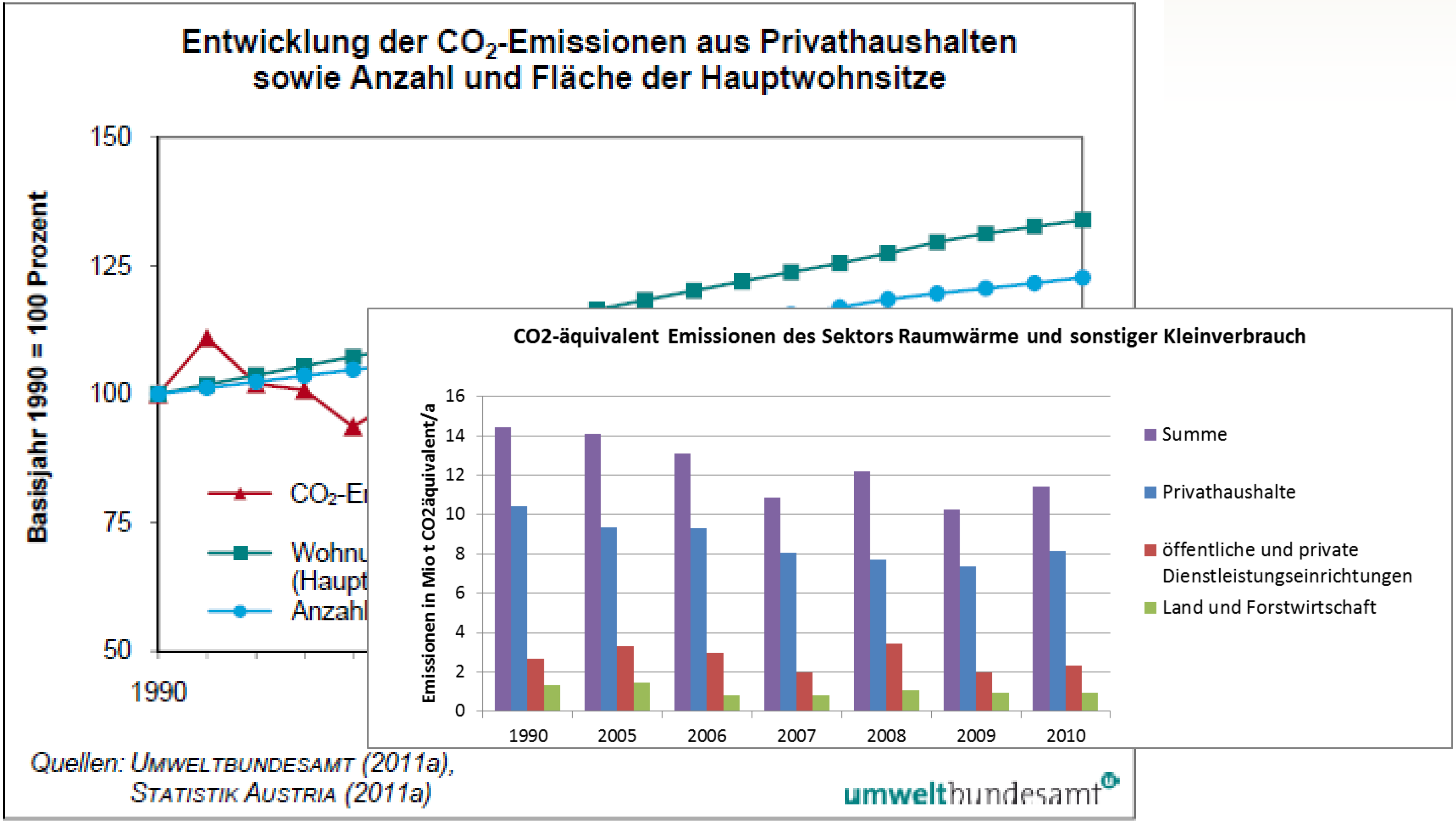
Quelle: eigene Berechnung

CO_2-equivalent emissions from the residential sector (Raumwärme Haushalte) and other small use in Austria

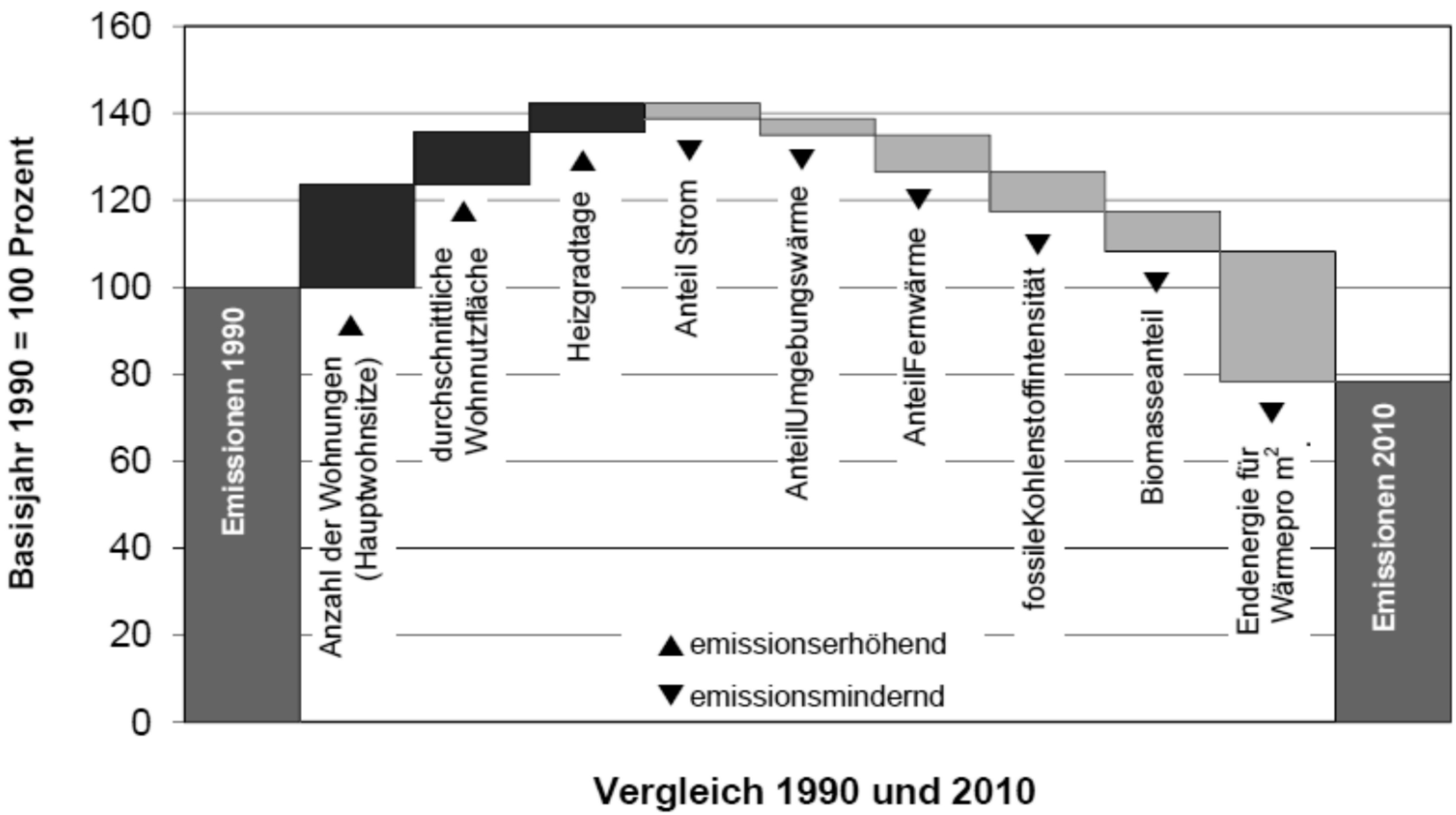


Quelle: BMLFUW (2005)

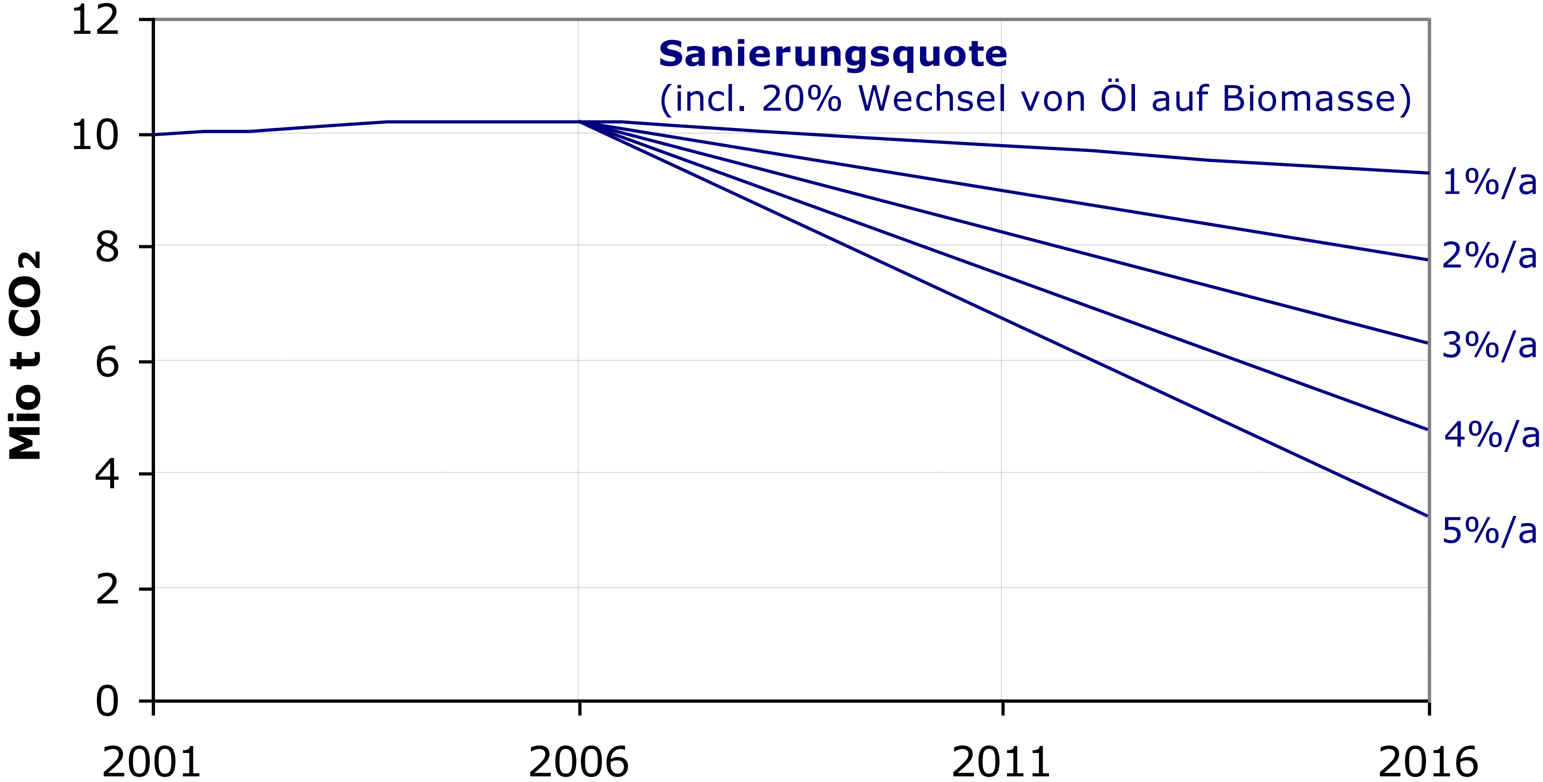
CO_2-emissions from the residential sector (Raumwärme Haushalte) in Austria



CO_2-emissions from the residential sector (Raumwärme Haushalte) in Austria



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)

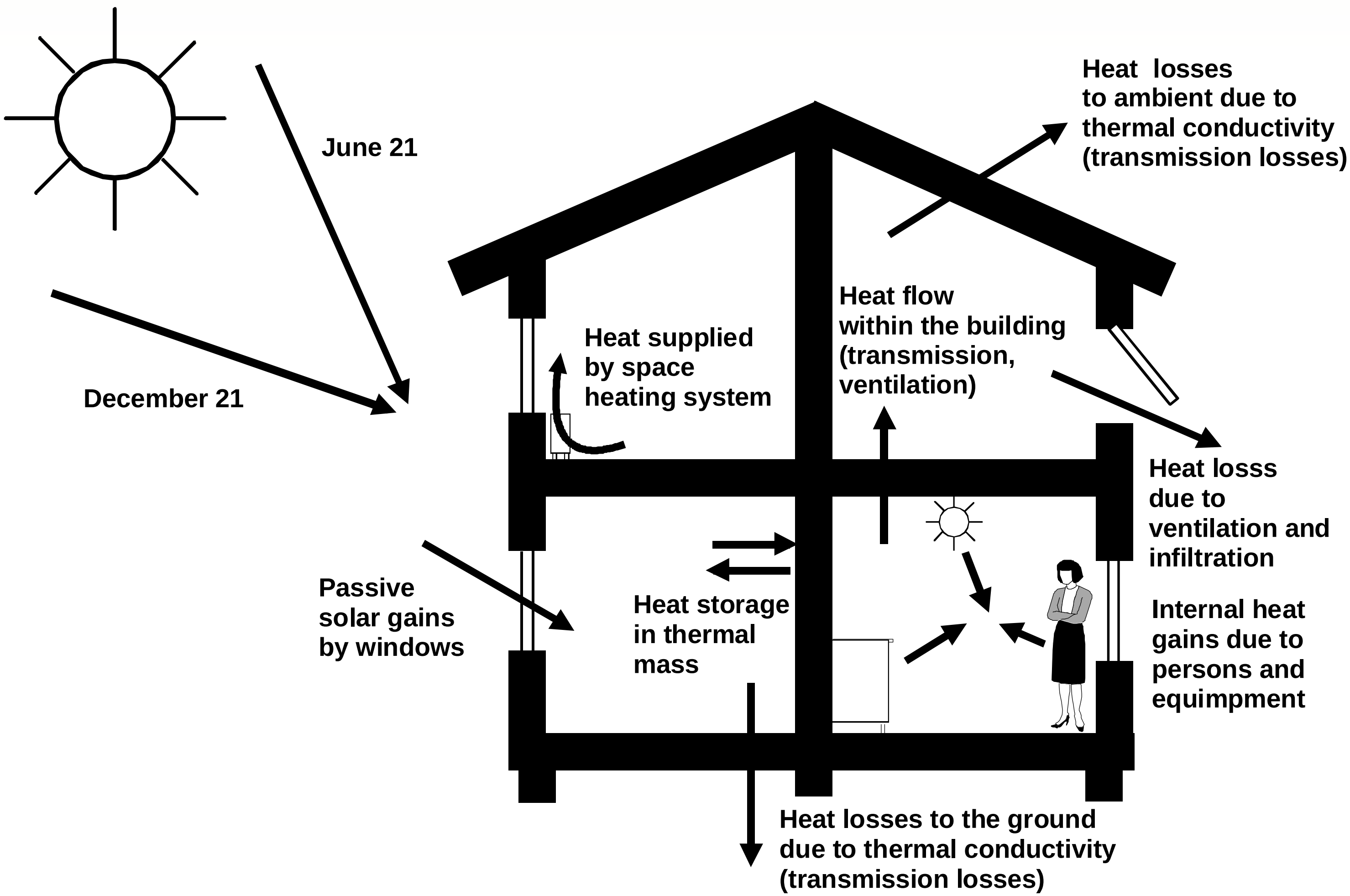
Energetical System Building

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

Energetical System Building



Heat transfer coefficient for transmission heat losses

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

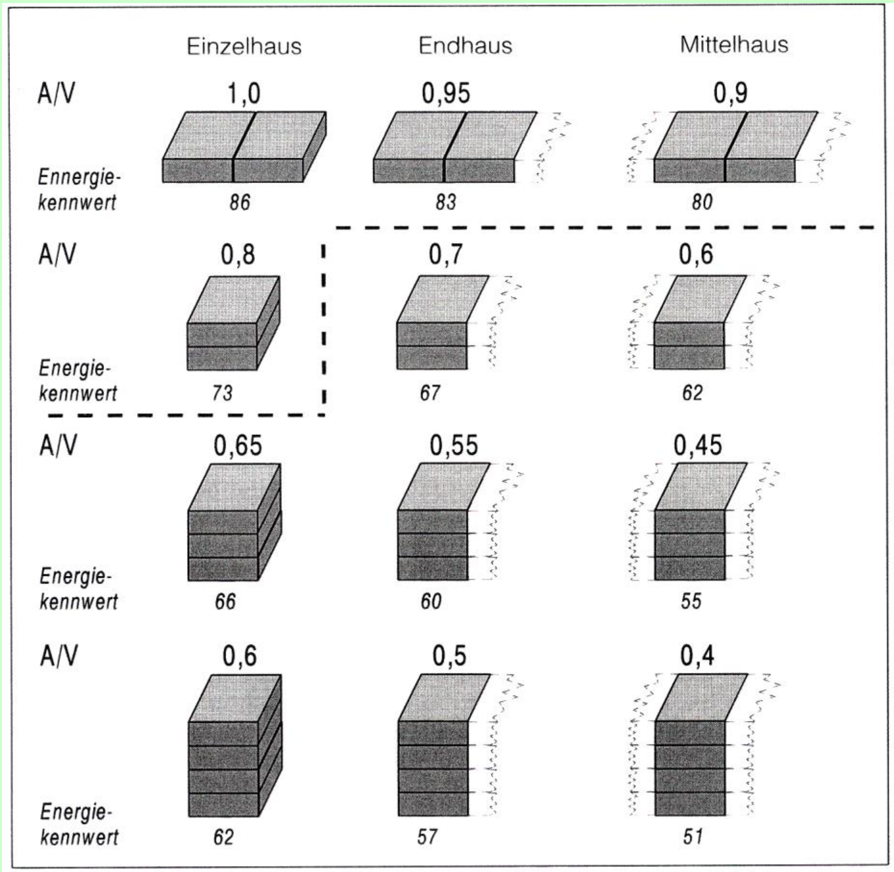
mit A... Heat transfer surface $[m^2]$

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

ΔT... Forcing temperature difference [K]

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

Building Shape: Ratio of A/V for different shapes

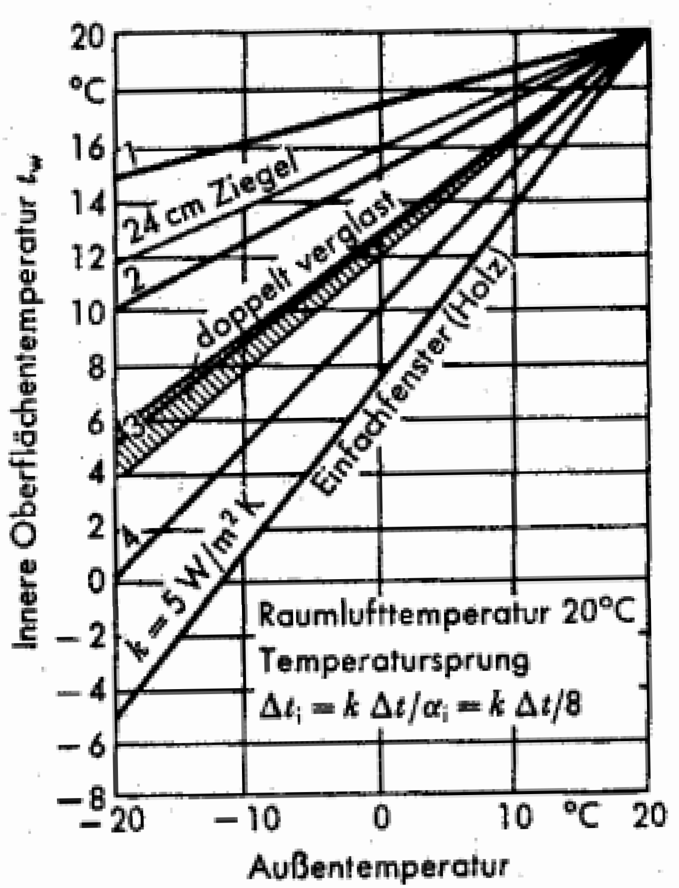


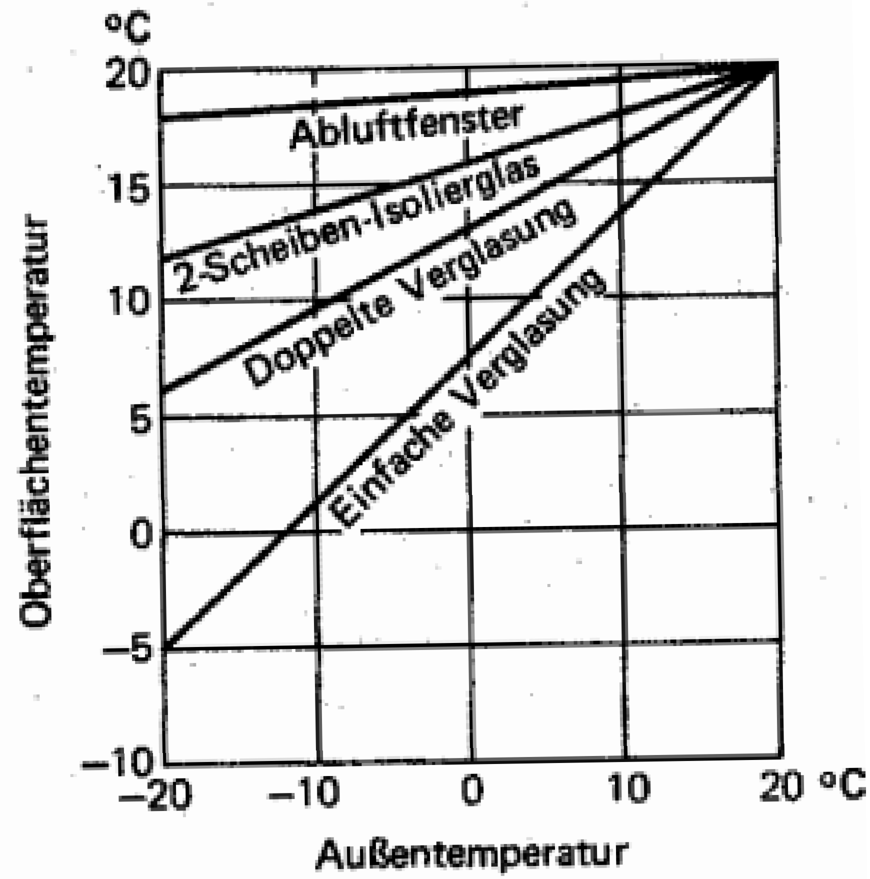
Quelle: Feist, W., 1998, Das Niedrigenergiehaus

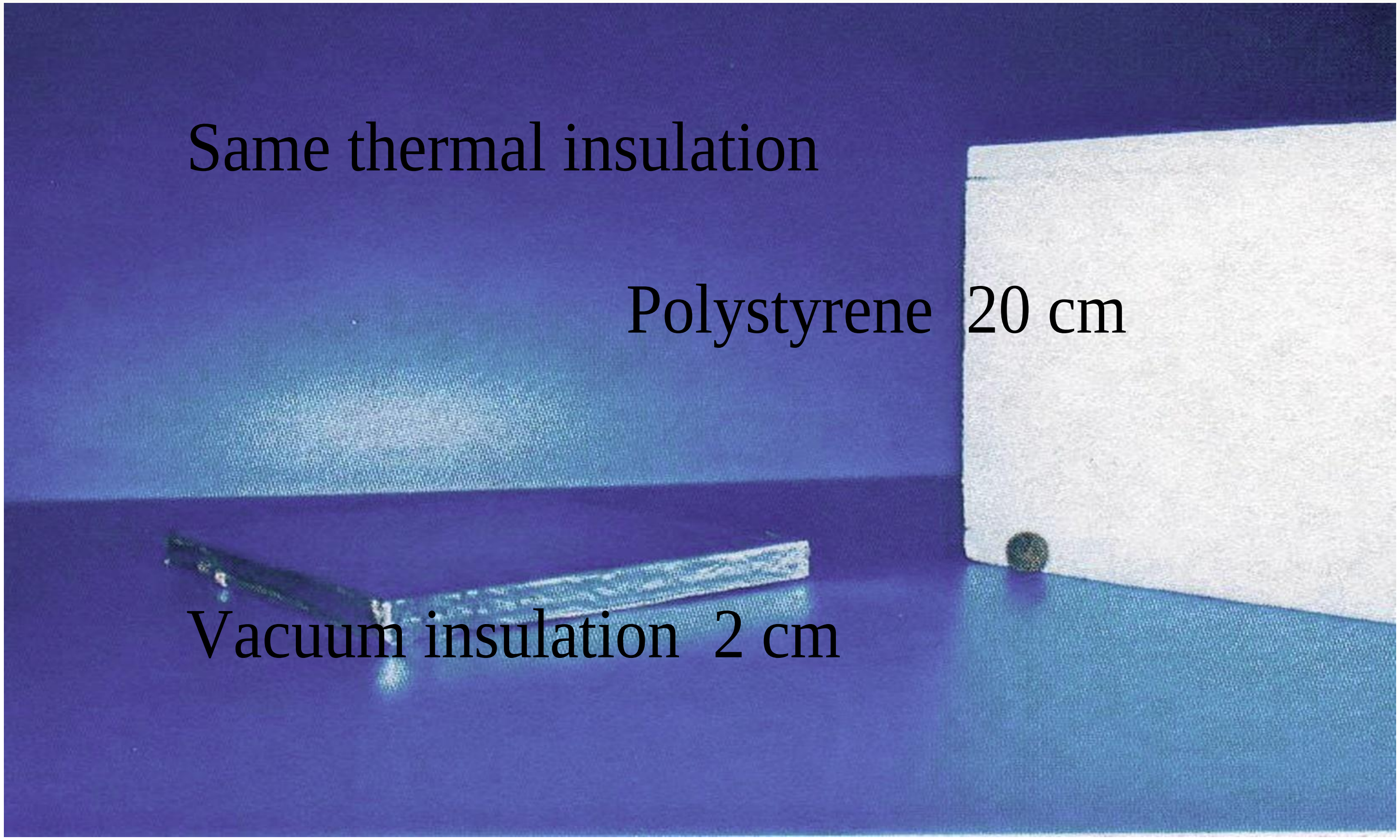
Maximum U-values (W/m²K) Austria (2007)

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

Room air temperature – temperature of surrounding surfaces ⇔ thermal comfort



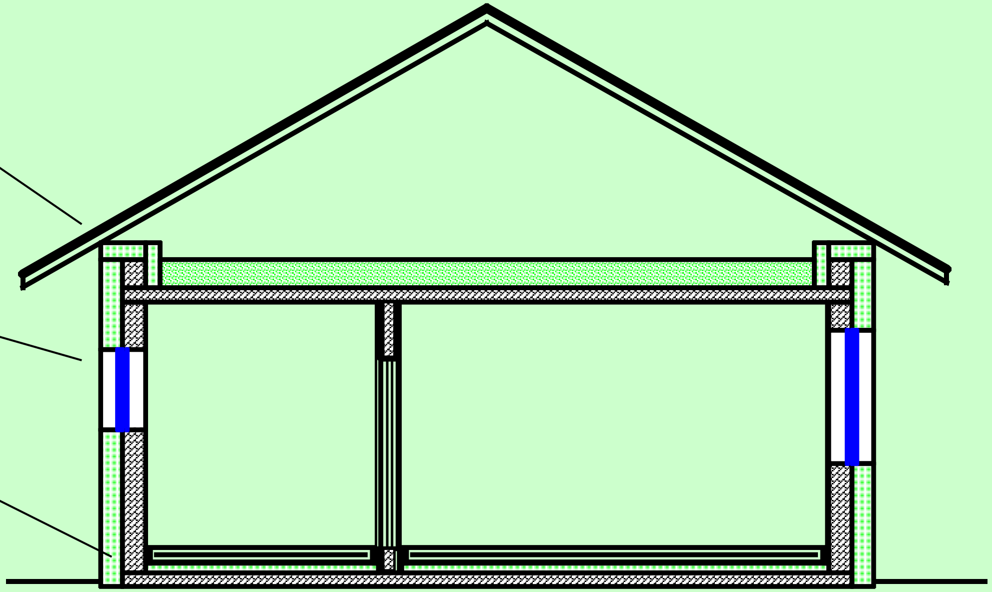



Same thermal insulation
Polystyrene 20 cm
Vacuum insulation 2 cm

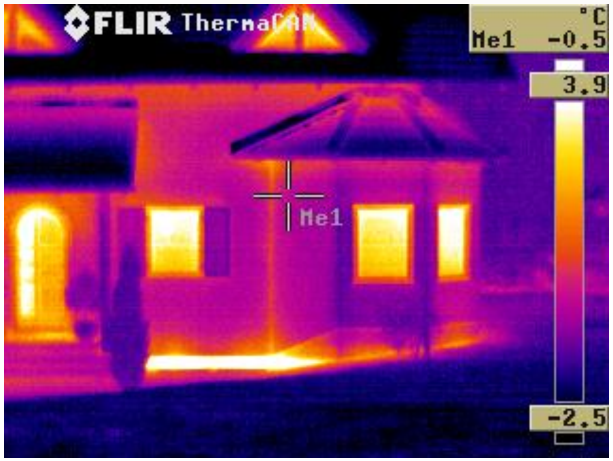
Avoiding thermal bridges

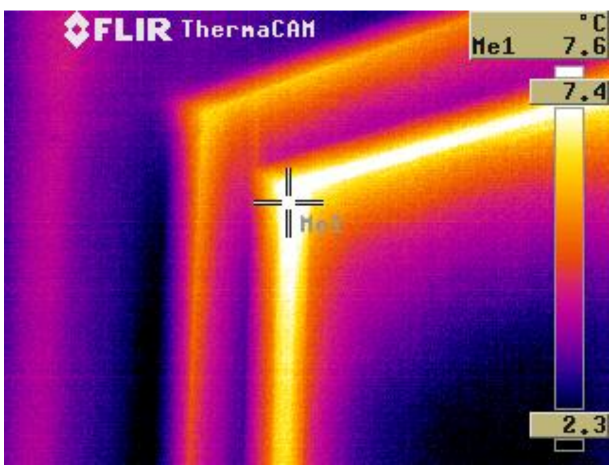
Problematic zones:

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



Thermal bridges, Thermographie

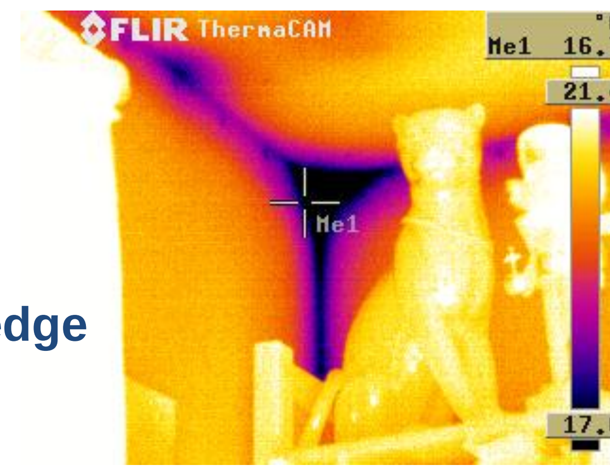




Ground floor to cellar,

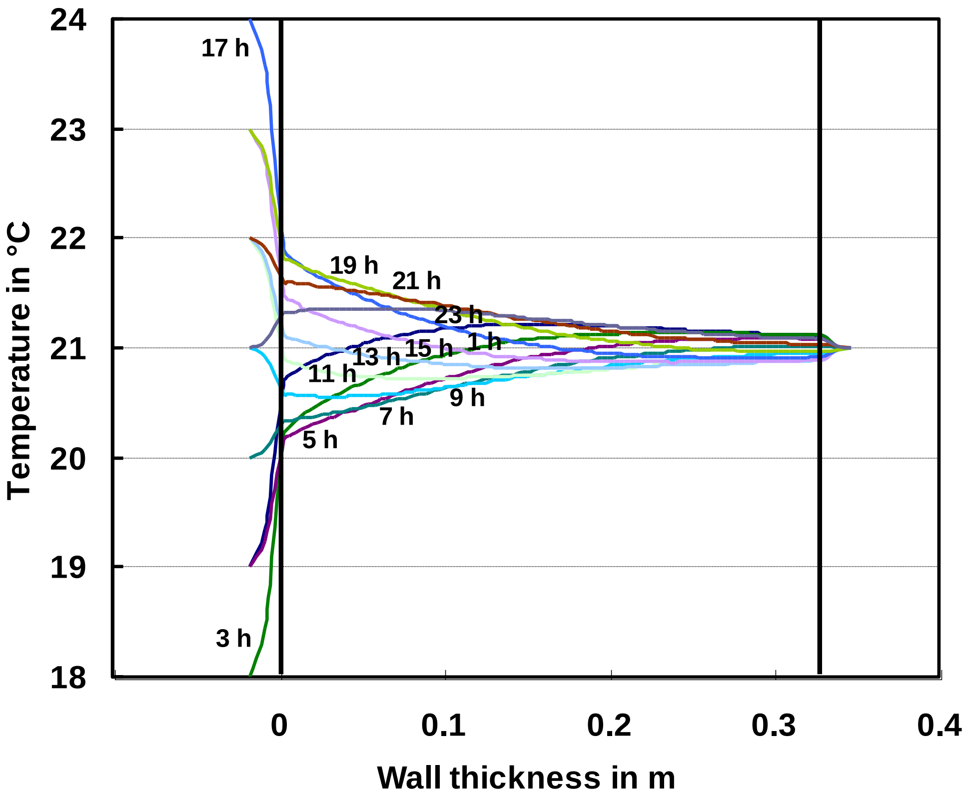
Window

interior edge



Principle 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

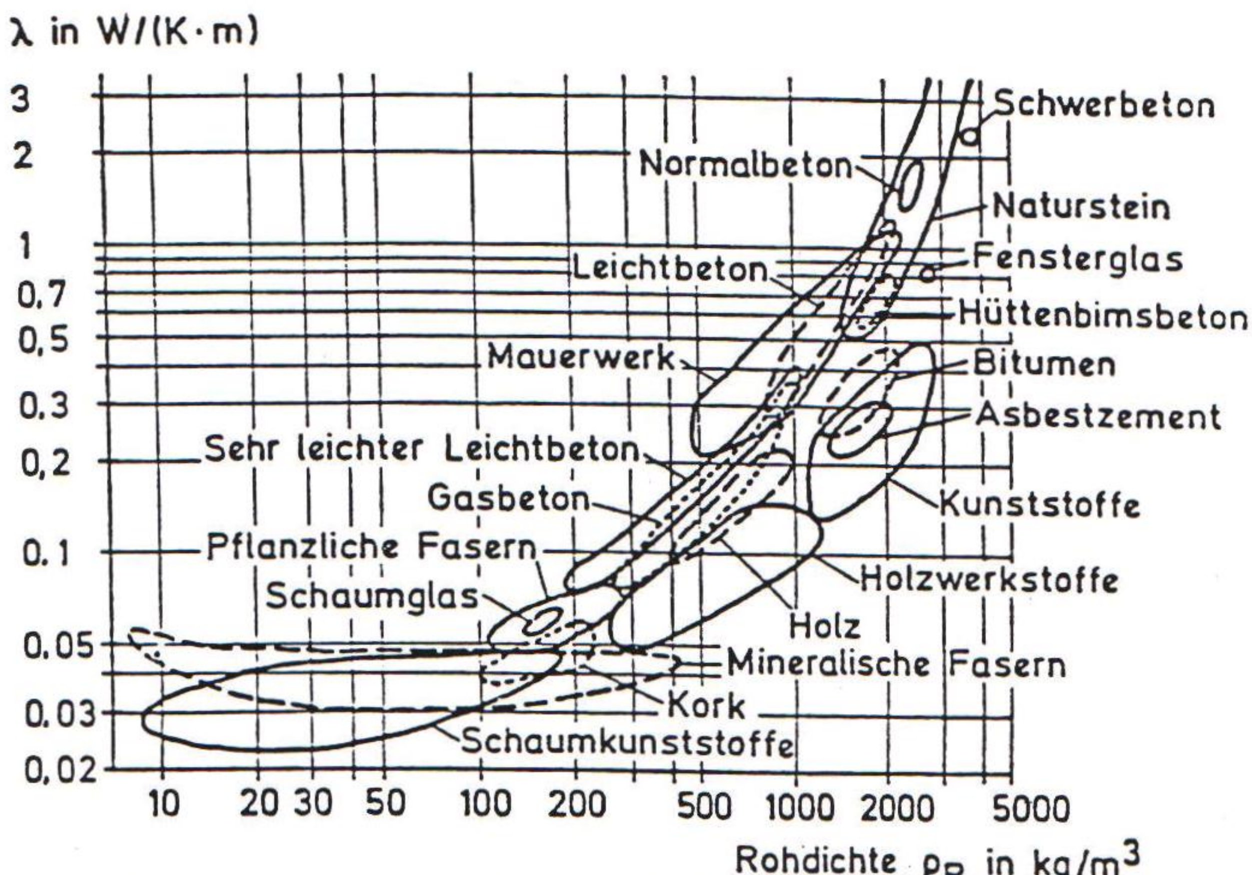
Stored and released heat : 0.076 kWh/(m² d).

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

Material: Thermal conductivity λ and density ρ

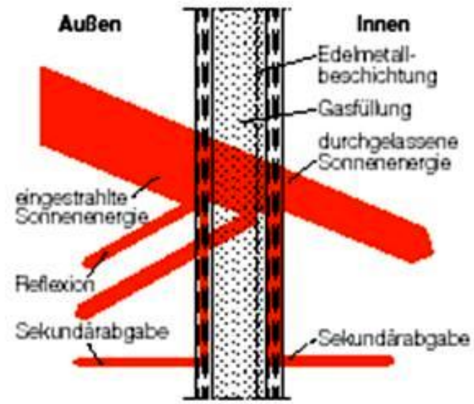


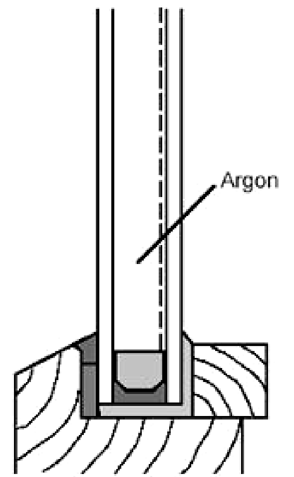
Beziehung zwischen Wärmeleitfähigkeit λ und Rohdichte ϱ_R

Energy transmitttance through windows

Solar Energy input by radiation convection and conduction

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





k_V = 1,3 W/(m² K)

k_F = 1,4 W/(m² K)

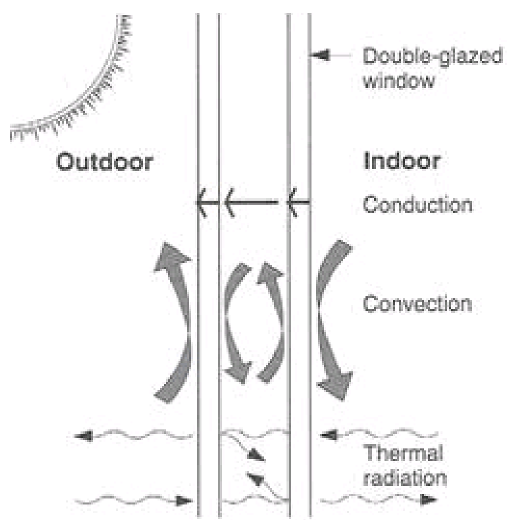
g_F = 0,62

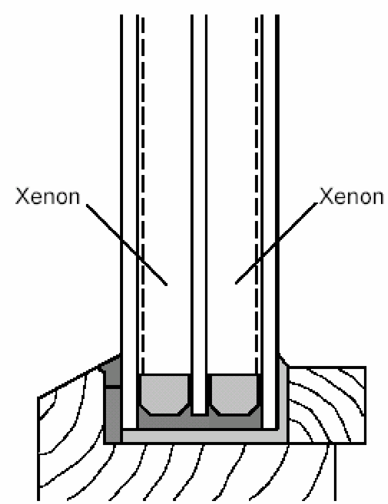
$k_{eq,F,Nord}$ = 0,81 W/(m² K)

$k_{eq,F,Ost/West}$ = 0,38 W/(m² K)

$k_{eq,F,Süd}$ = -0,09 W/(m² K)

Heat losses by conection, radiation and conduction





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)

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

	Diffuse *g*-value	*U*-value glazing in W/(m^2 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.

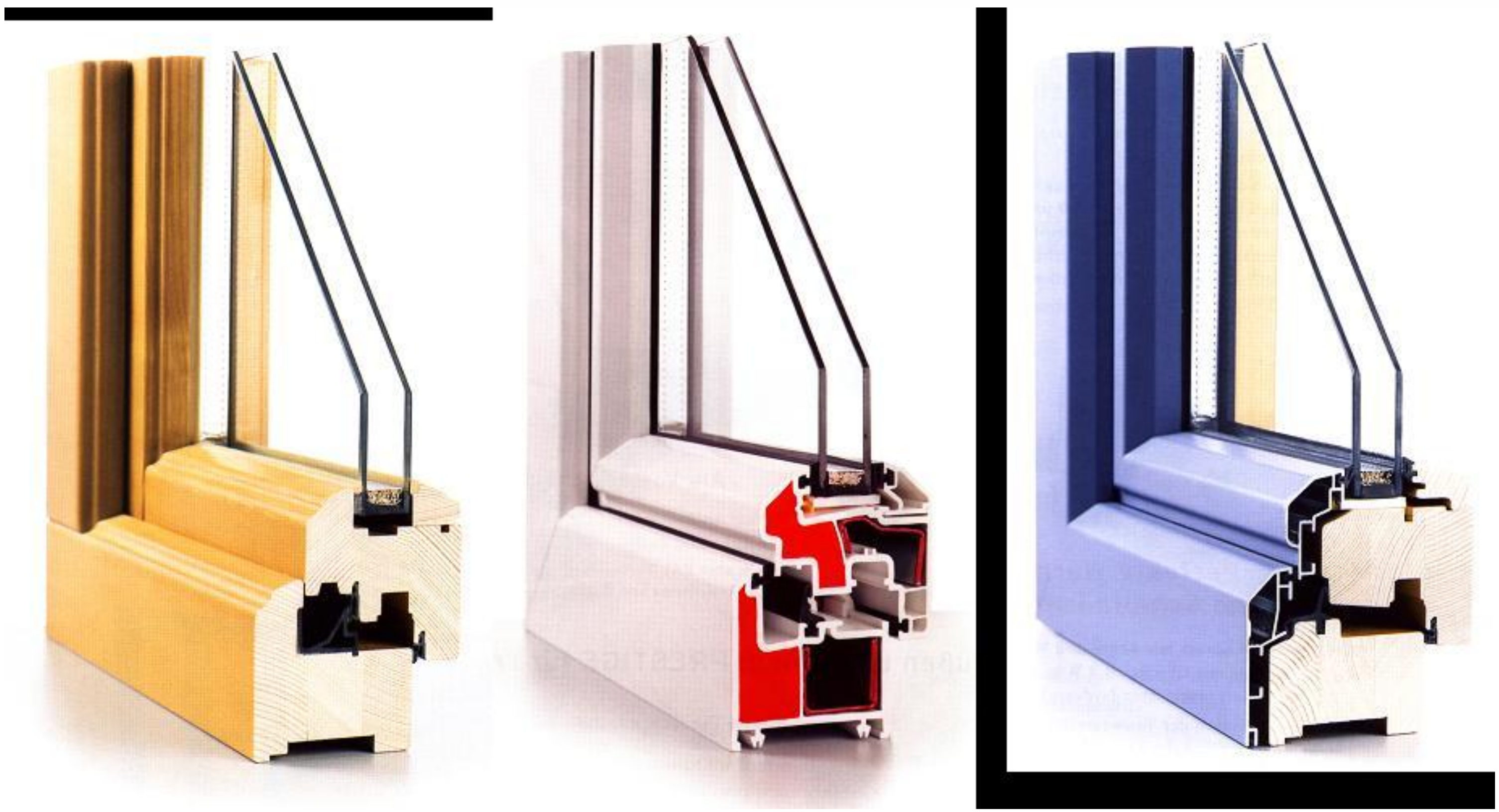
$$U_{eq} = U_W - S_F\, g$$

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

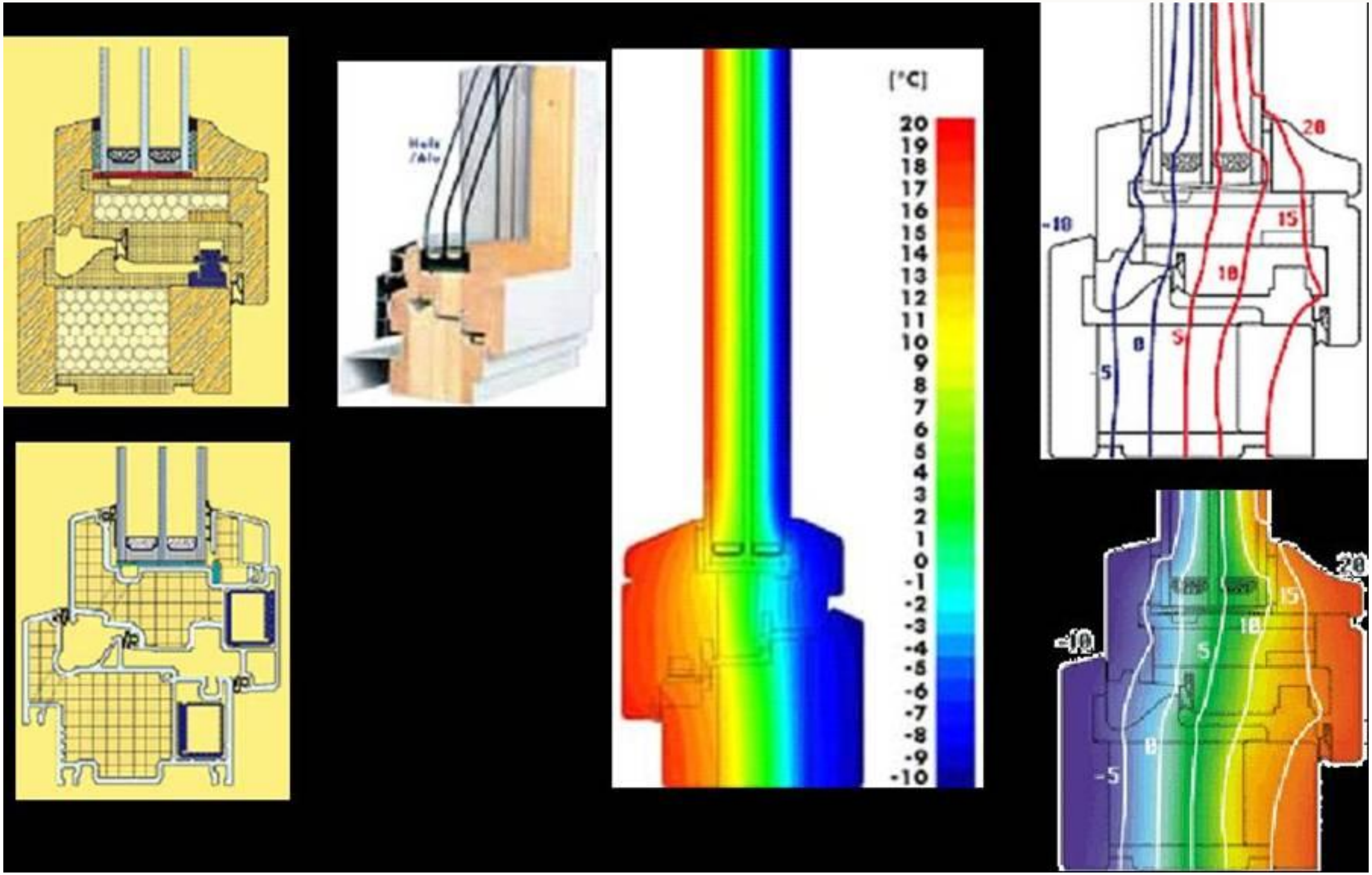
Diffuse g-value ($g_{diffuse}$), *U*-value of the window (U_w) and equivalent *U*-values (U_{eq}) corresponding to different glazing types (see /3-5/)

	$g_{diffuse}$	U_w	U_{eq} (south)	U_{eq} (east/west)	U_{eq} (north)
			in W/(m^2 K)		
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

2-panes windows



3-pane low U windows



Factors influencing the solar transmittance of windows

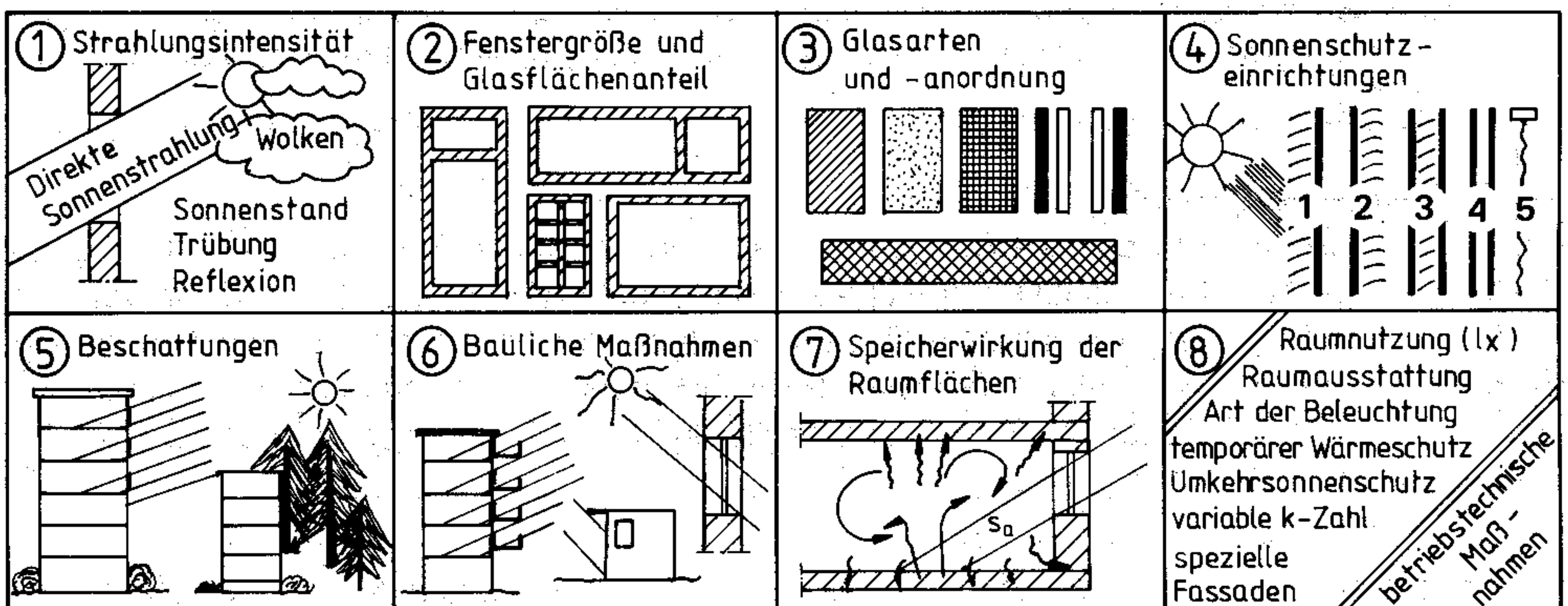
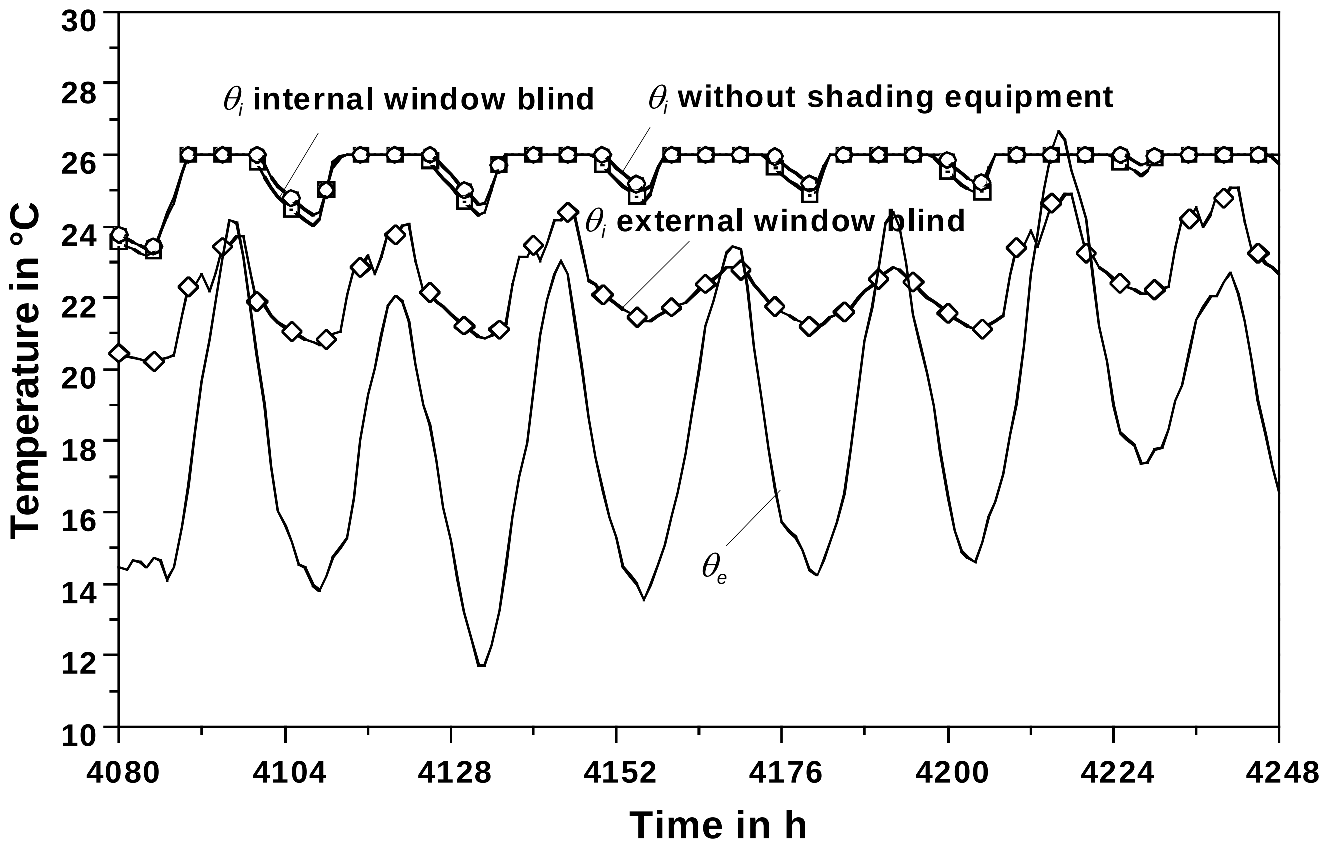
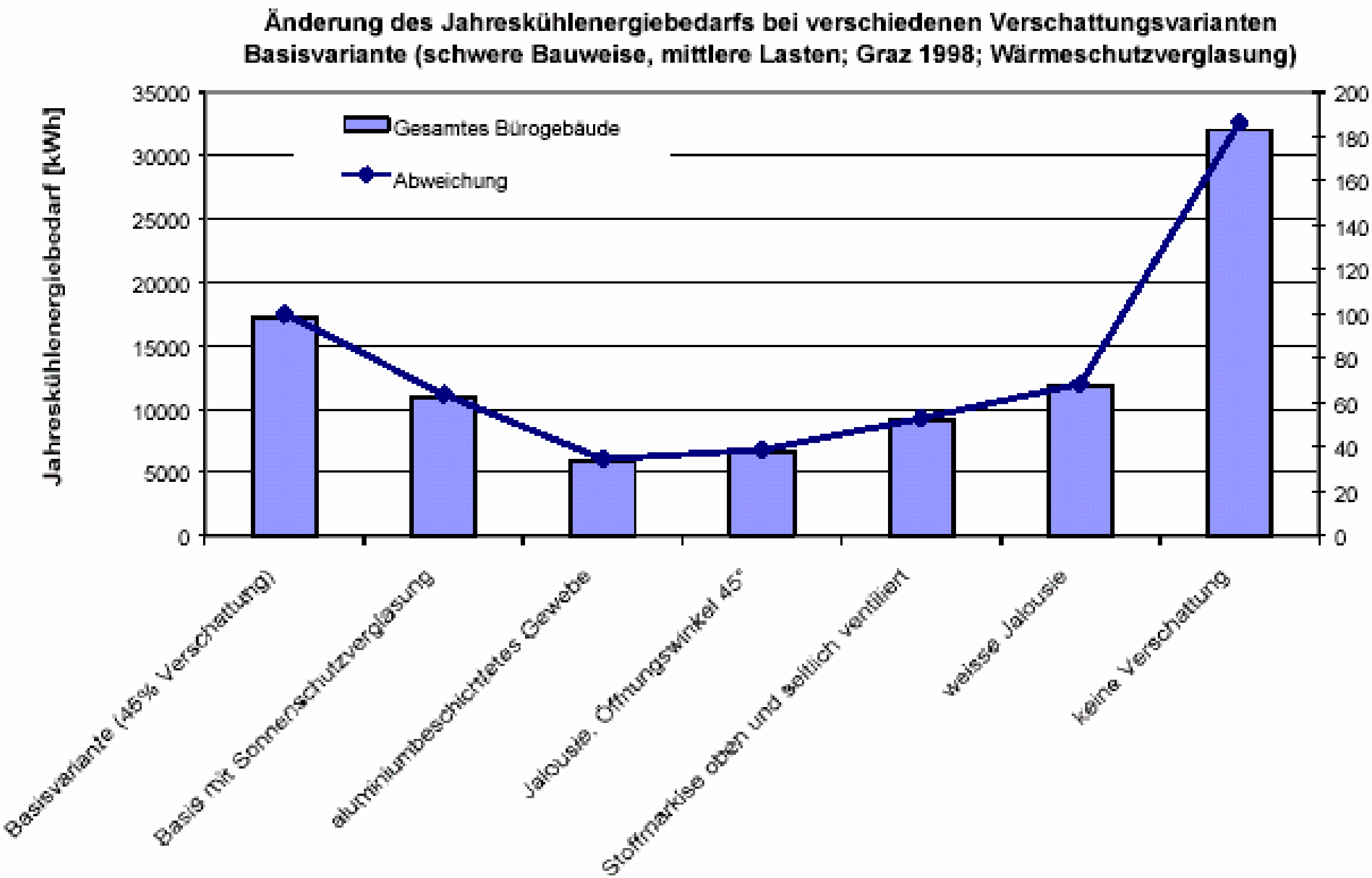


Abb. 7.24 Einflußgrößen auf Sonnenwärme durch Fenster

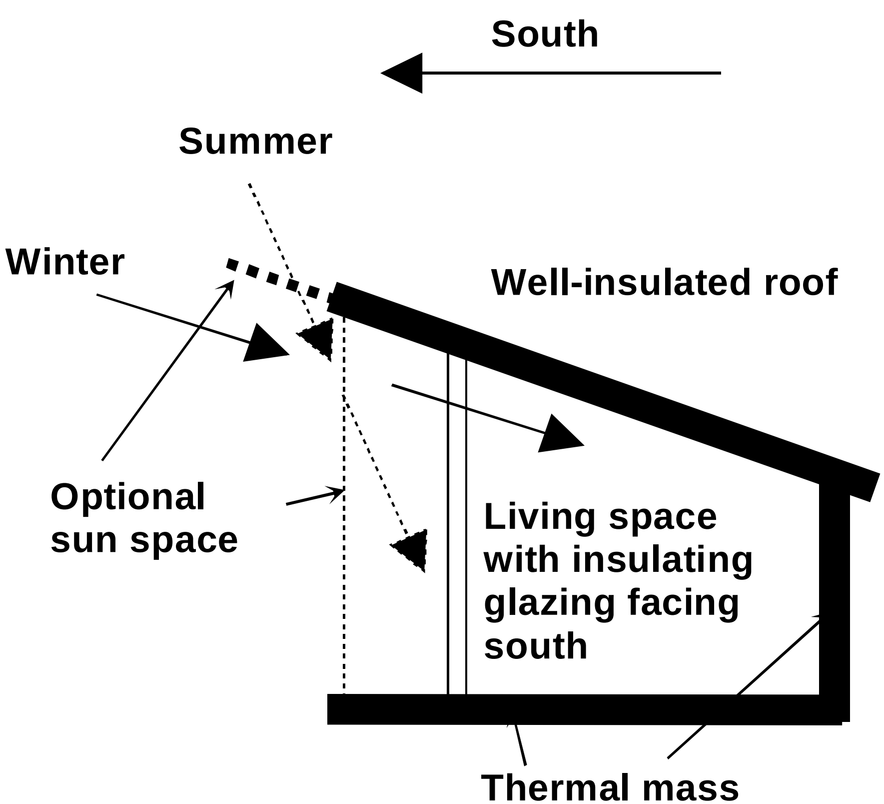
Shading by internal and external window blinds (θ_e ambient temperature, θ_i room temperature)

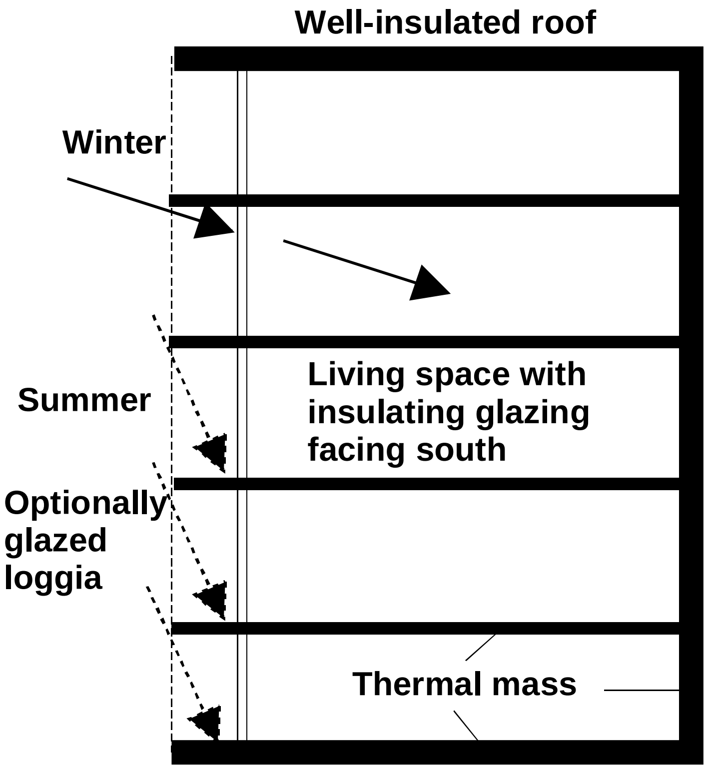


Cooling energy demand for different shading strategies in an office building

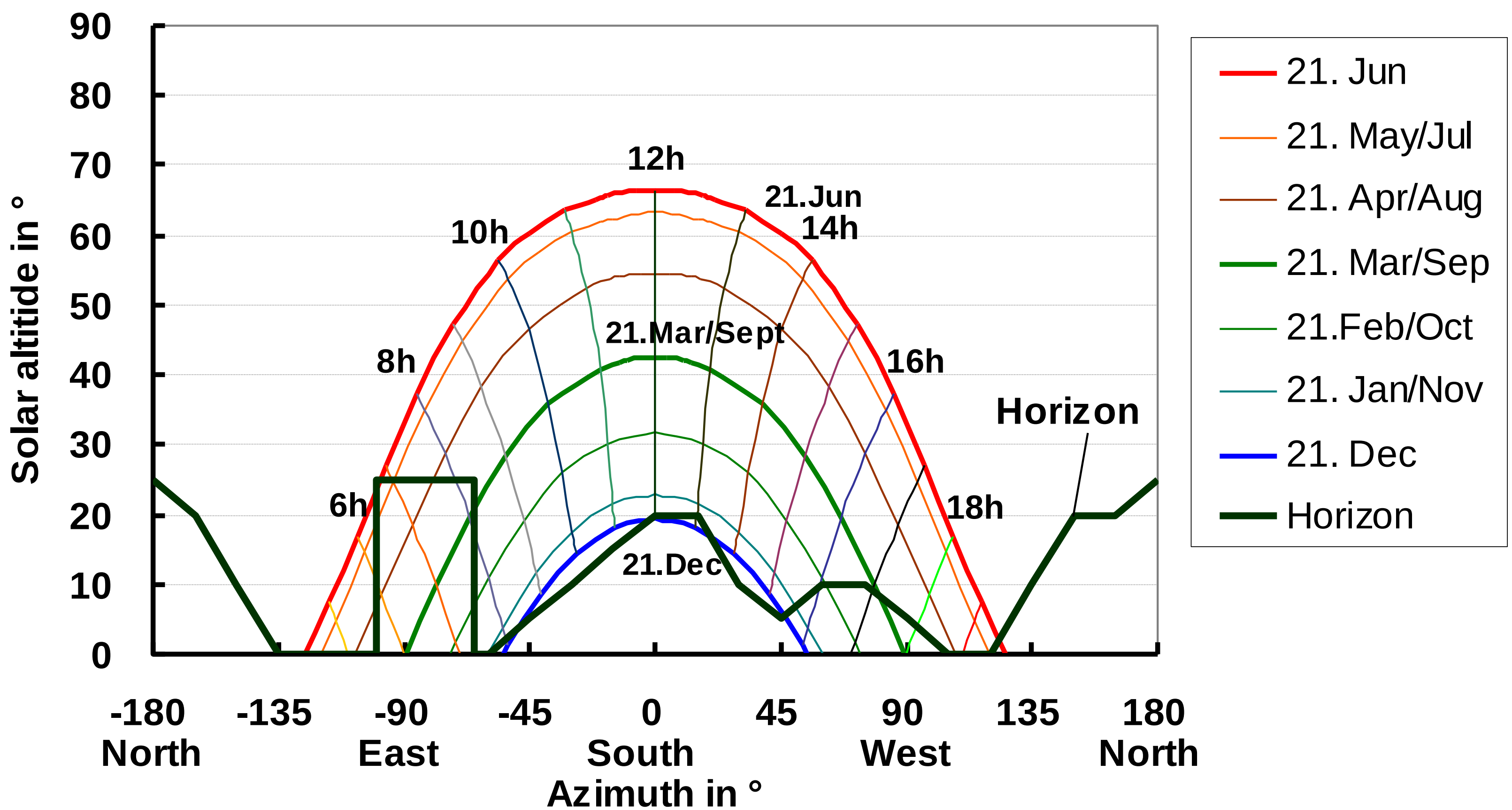


Shading of transparent building surfaces by roof overhangs (left: one family home, right: multiple families home)

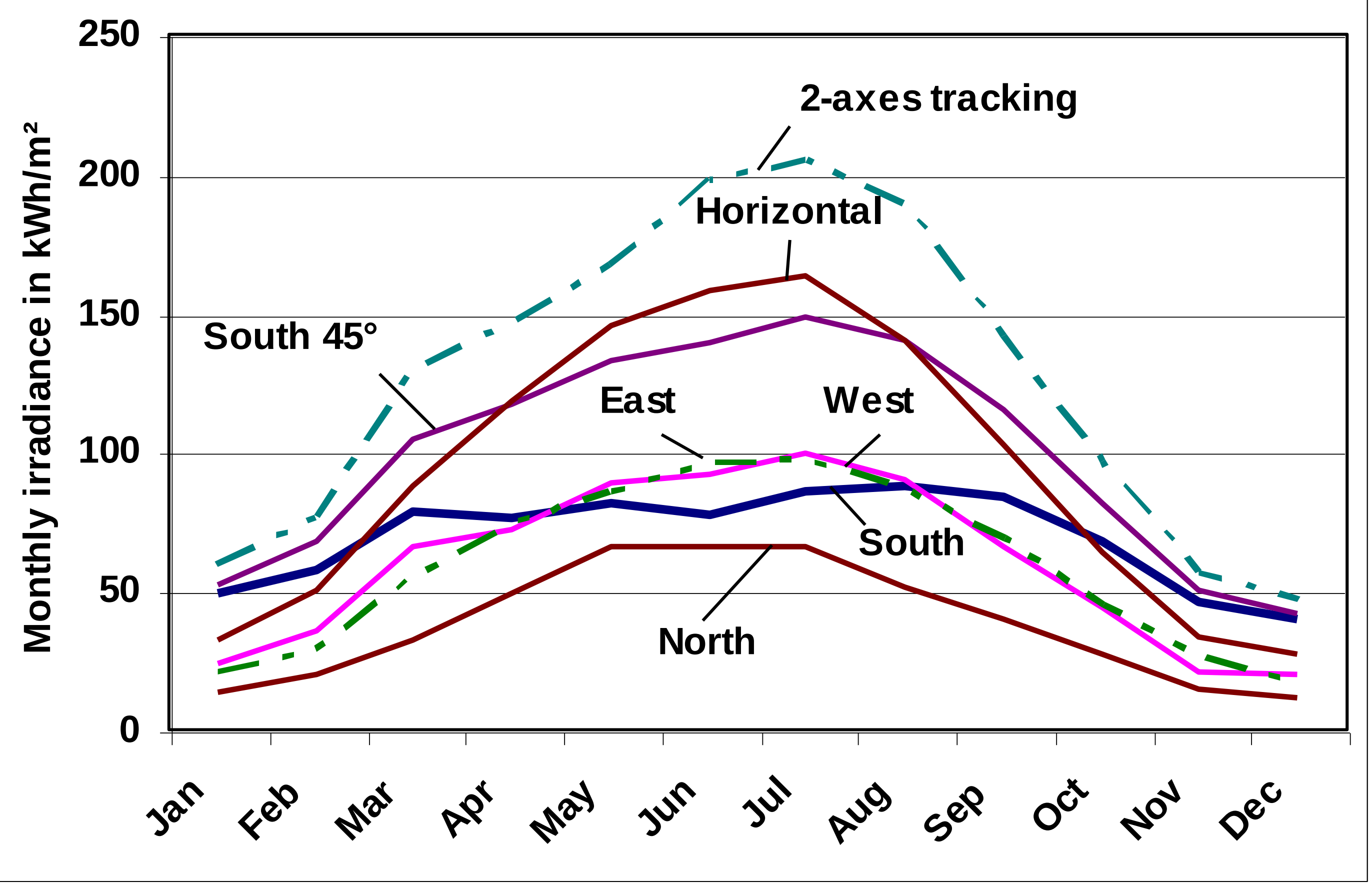




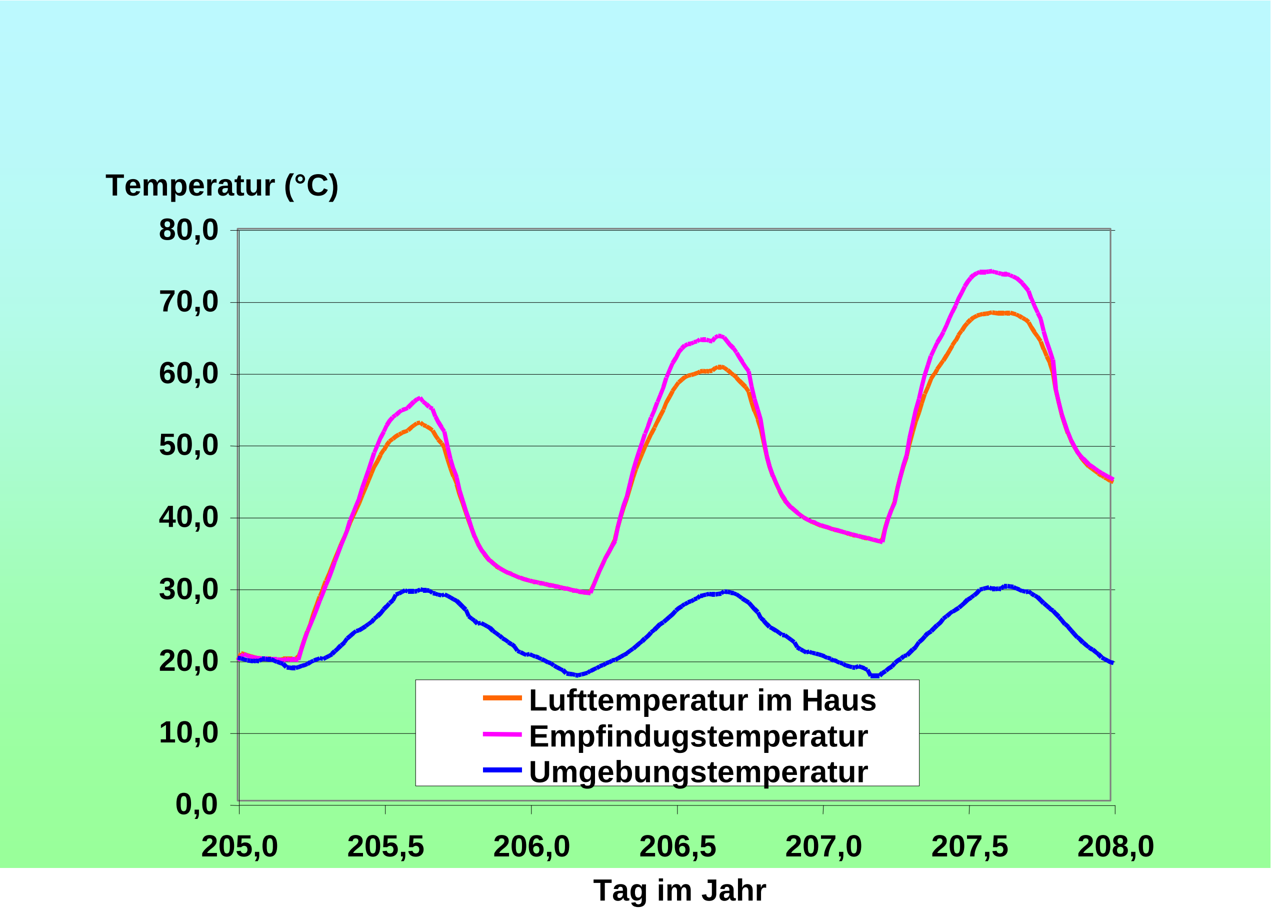
Solar position plot



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



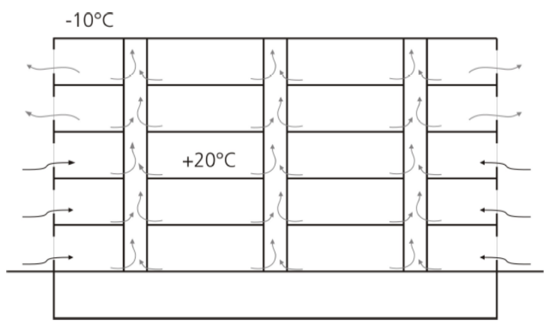
Summer Overheating in an office building (simulated)



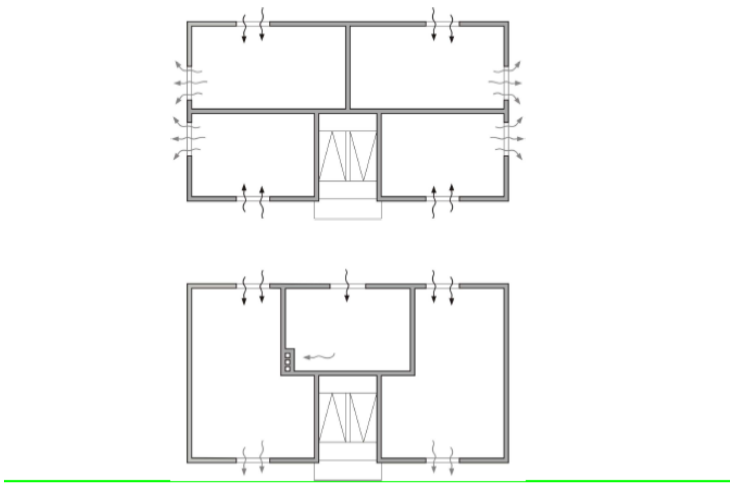
Natural ventilation

Natürliche Luftströmung durch Gebäude

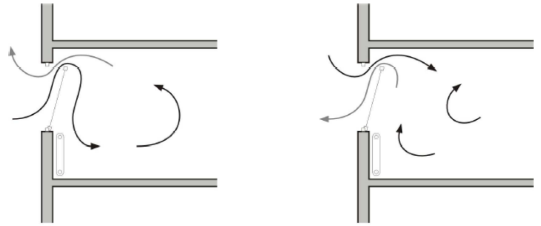
Schachtwirkung durch thermischen Auftrieb



Querlüftung bei natürlicher Lüftung



Natürliche Lüftung Sommer/Winter



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

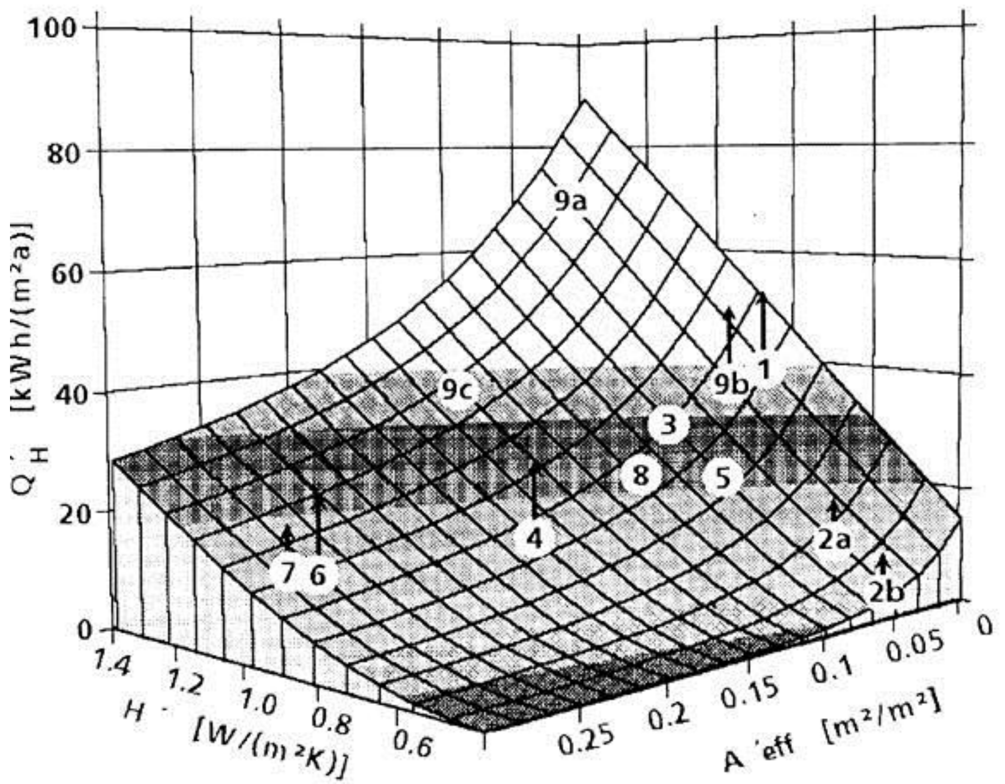
Low-energy lean multi family building

Solar houses

„Passive row houses“

„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)



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

Motivation for Directive (16.12.2002)

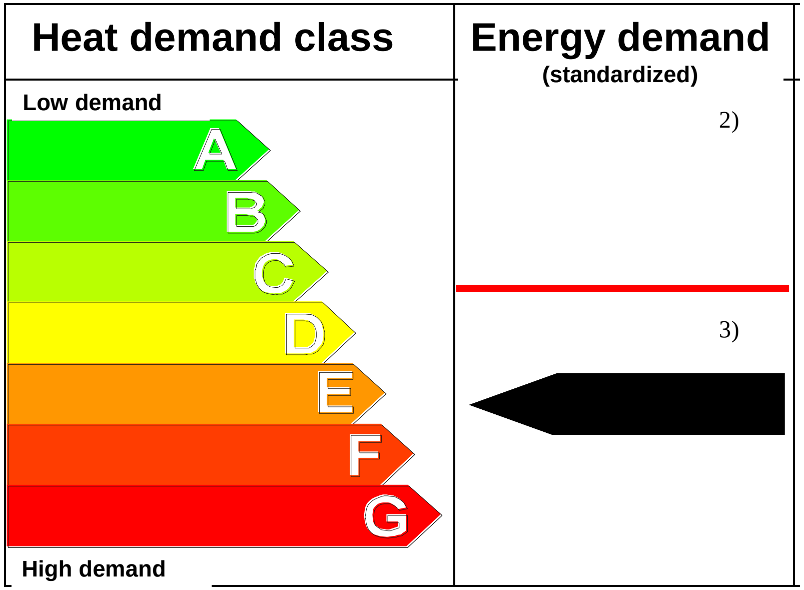
- Reduction of the energy demand and the CO2 emission of buildings (space heating and hot tap water amounts to 40% of the total end-use energy demand in Europe)
- Value of buildings not (only) because of the location but also because of the energy demand and the operating costs
- European harmonization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

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)

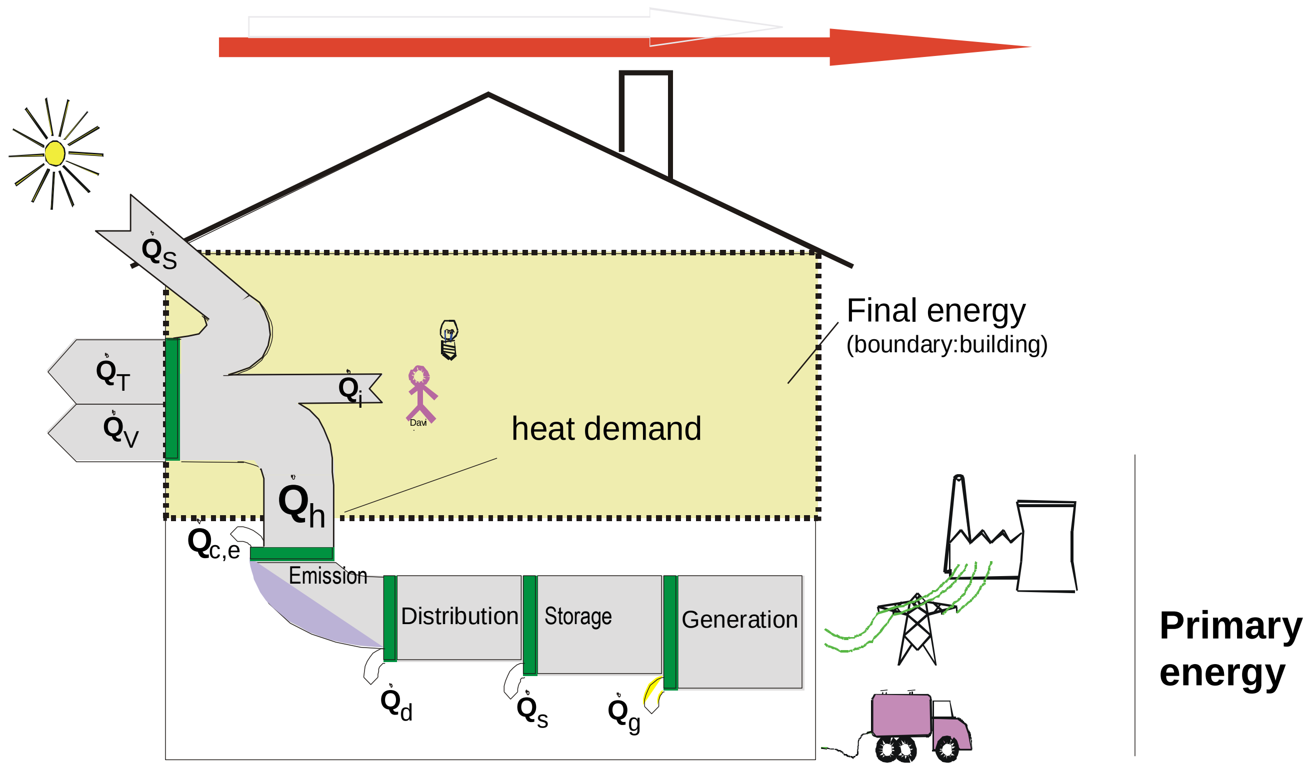
- Fixing of average, minimum and maximum energy demand of buildings by the national governments

- Development of energy certificates for buildings



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

Calculation direction (from the demand to the source)



Energy direction (from the source to the demand)

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

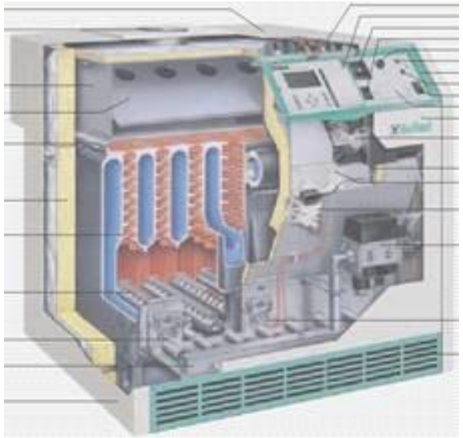
- CO_2 – key figure $kgCO_2/m^2.a$

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

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 in Austria since

!!! 2009 !!!

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

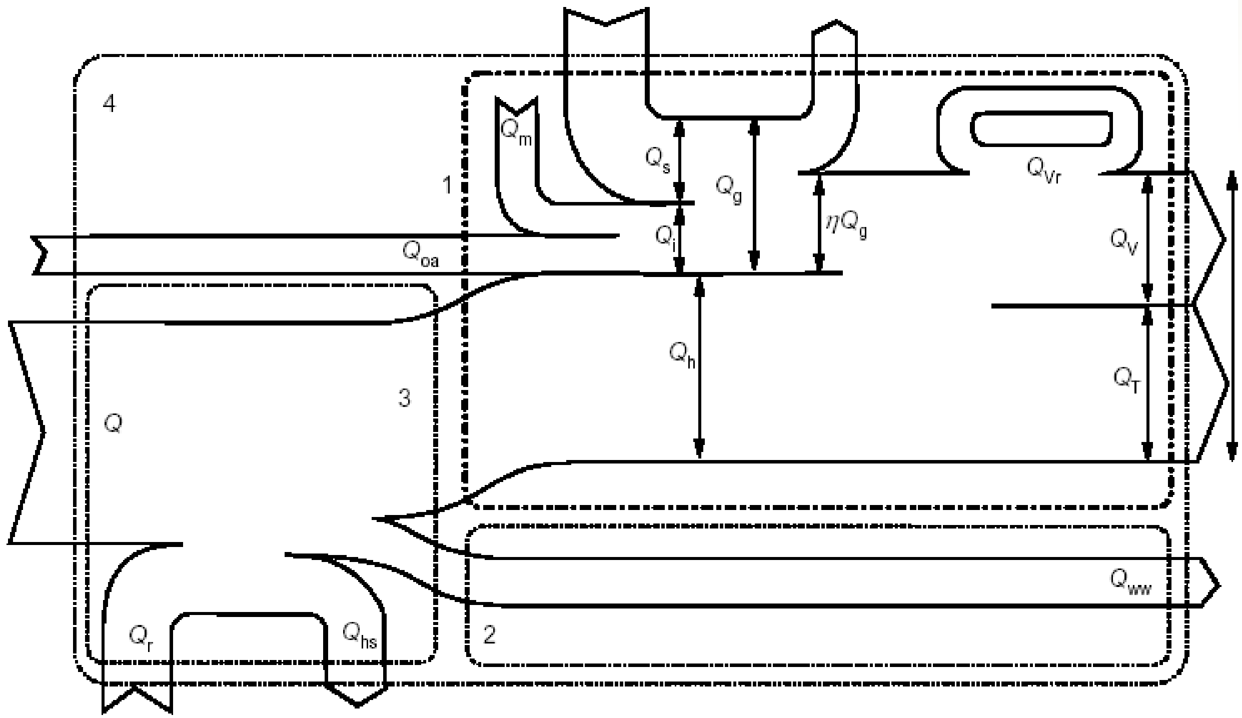
Status of the EPBD development (CEN)

- 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

New Directive on the Energy Performance of Buildings 2010/31/EU

- For all new buildings the possible use of renewable energies has to be evaluated
- All new buildings have to be build as nearly zero energy buildings by 2020 (public authorities starting with 2018)
- ‘nearly zero-energy building’ means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;

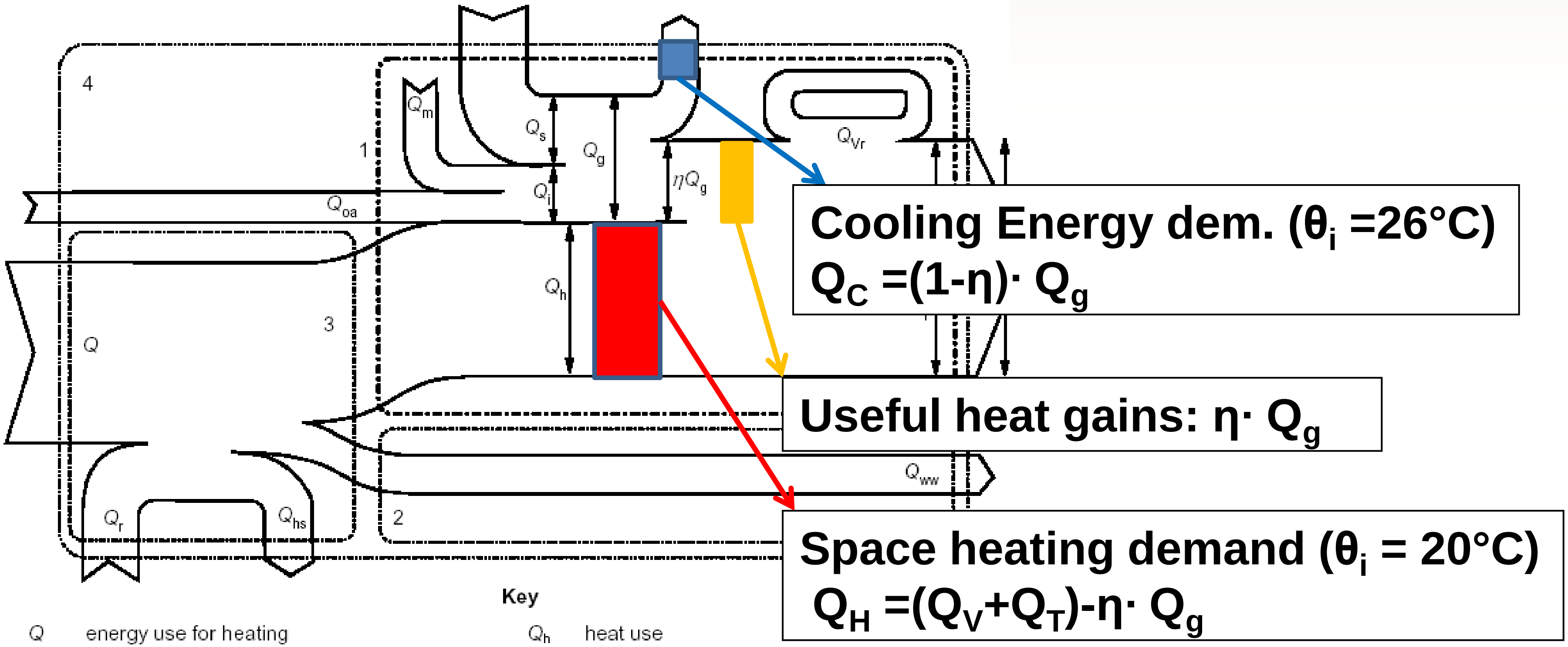
Energy Flow in Buildings by En ISO 13790



Key

Q	energy use for heating	Q_h	heat use
Q_{oa}	heat from other appliances	Q_V	ventilation heat loss
Q_r	recovered energy	Q_{Vr}	ventilation heat recovery
Q_{hs}	losses from the heating system	Q_T	transmission heat loss
Q_m	metabolic heat	Q_{ww}	heat for hot water preparation
Q_s	passive solar gains	Q_L	total heat loss
Q_i	internal gains		
Q_g	total gains	1	boundary of the heated zone
ηQ_g	useful gains	2	boundary of the hot water system
		3	boundary of the heating plant
		4	boundary of the building

Energy Flow in Buildings by En ISO 13790



Key

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$\eta\ Q_g$	useful gains	2	boundary of the hot water system
		3	boundary of the heating plant
		4	boundary of the building

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]

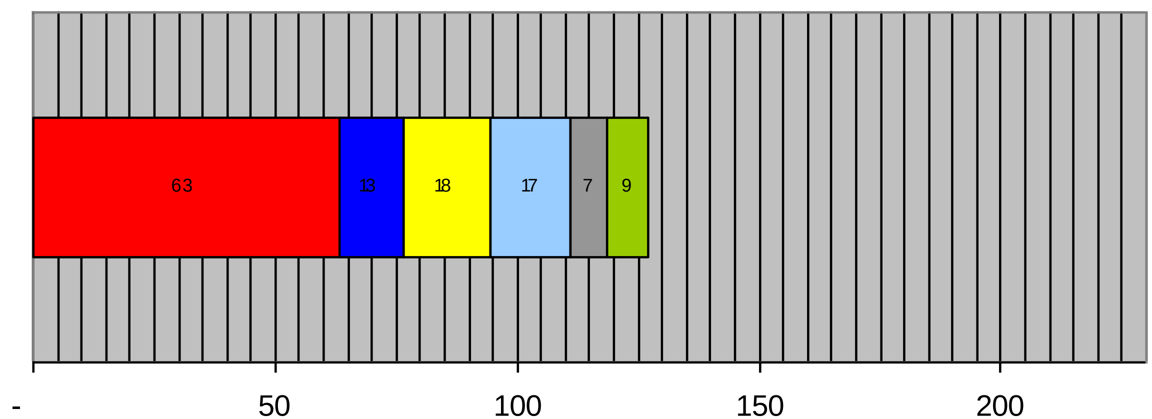
Results useful energy, example Berlaymont, Brüssel

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)]



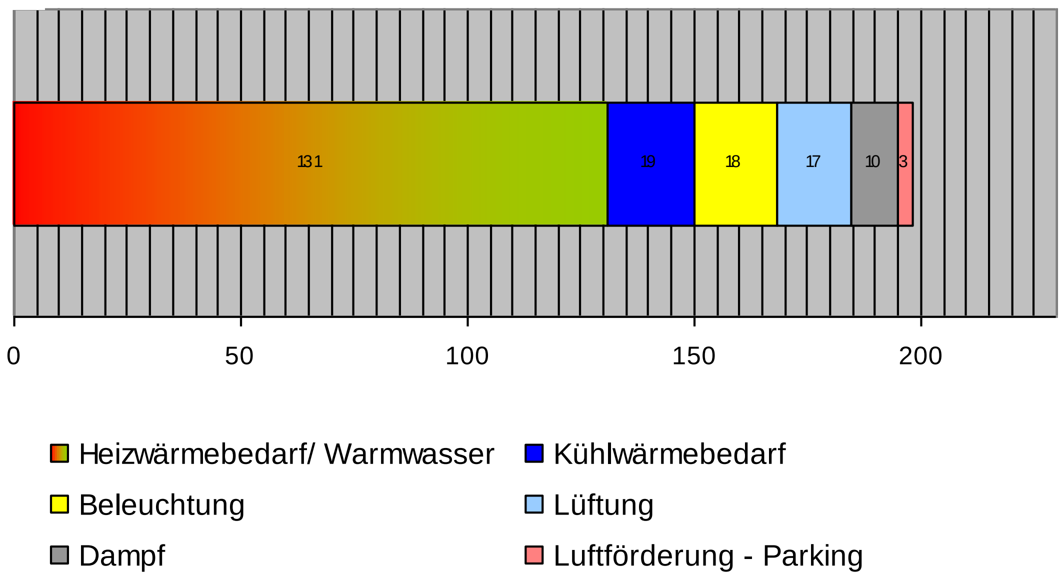
Endenergie:

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)]

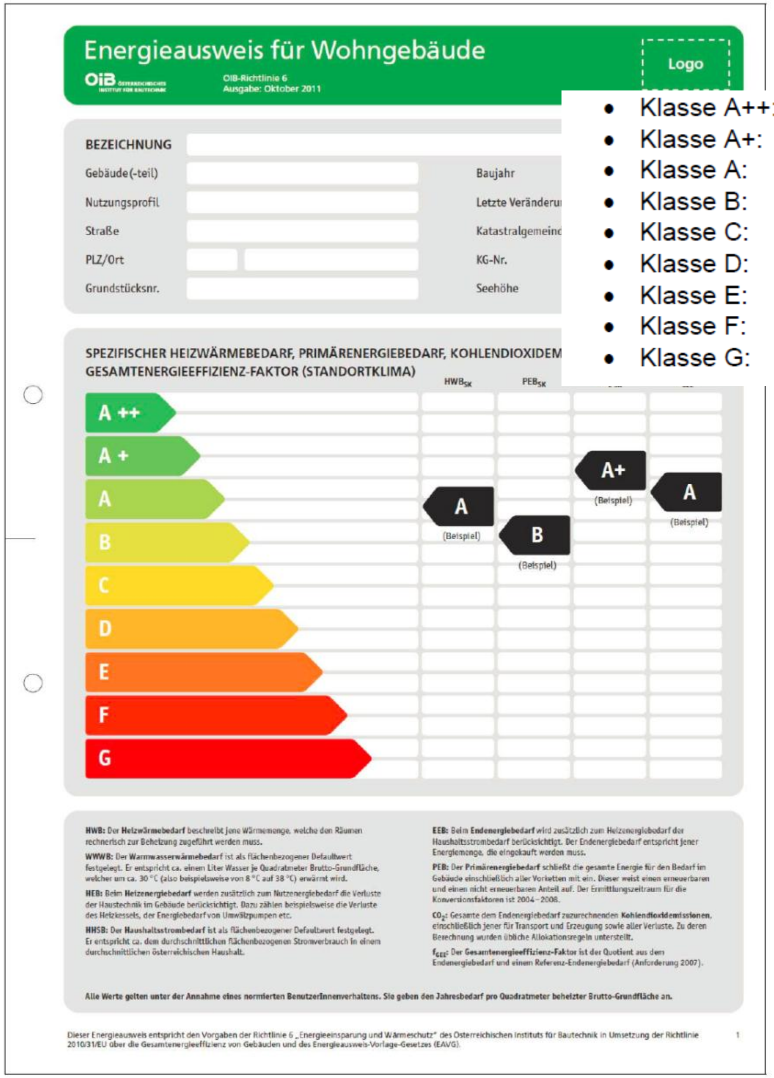
Results end use energy, example Berlaymont, Brüssel

spezifischer Endenergiebedarf [kWh/(m².a)]



Energy Certificate Residential Buildings, Austria 2012

- Klasse A++: $HWB_{BGF,SK} \leq$ 10 kWh/m²a
- Klasse A+: $HWB_{BGF,SK} \leq$ 15 kWh/m²a
- Klasse A: $HWB_{BGF,SK} \leq$ 25 kWh/m²a
- Klasse B: $HWB_{BGF,SK} \leq$ 50 kWh/m²a
- Klasse C: $HWB_{BGF,SK} \leq$ 100 kWh/m²a
- Klasse D: $HWB_{BGF,SK} \leq$ 150 kWh/m²a
- Klasse E: $HWB_{BGF,SK} \leq$ 200 kWh/m²a
- Klasse F: $HWB_{BGF,SK} \leq$ 250 kWh/m²a
- Klasse G: $HWB_{BGF,SK} >$ 250 kWh/m²a


Energieausweis für Wohngebäude
OIB
OIB-Richtlinie 6
Ausgabe: Oktober 2011
Logo

BEZEICHNUNG
Gebäude(-teil) | Baujahr
Nutzungsprofil | Letzte Veränderu[ng]
Straße | Katastralgemeind[e]
PLZ/Ort | KG-Nr.
Grundstücksnr. | Seehöhe

SPEZIFISCHER HEIZWÄRMEBEDARF, PRIMÄRENERGIEBEDARF, KOHLENDIOXIDEM[ISSIONEN UND]
GESAMTENERGIEEFFIZIENZ-FAKTOR (STANDORTKLIMA)
HWB_{SK} PEB_{SK}

A ++
A +
A
B
C
D
E
F
G

A (Beispiel) B (Beispiel) A+ (Beispiel) A (Beispiel)

HWB: Der **Heizwärmebedarf** beschreibt jene Wärmemenge, welche den Räumen rechnerisch zur Beheizung zugeführt werden muss.

WWWB: Der **Warmwasserwärmebedarf** ist als flächenbezogener Defaultwert festgelegt. Er entspricht ca. einem Liter Wasser je Quadratmeter Brutto-Grundfläche, welcher um ca. 30 °C (also beispielsweise von 8 °C auf 38 °C) erwärmt wird.

HEB: Beim **Heizenergiebedarf** werden zusätzlich zum Nutzenergiebedarf die Verluste der Haustechnik im Gebäude berücksichtigt. Dazu zählen beispielsweise die Verluste des Heizkessels, der Energiebedarf von Umwälzpumpen etc.

HHSB: Der **Haushaltsstrombedarf** ist als flächenbezogener Defaultwert festgelegt. Er entspricht ca. dem durchschnittlichen flächenbezogenen Stromverbrauch in einem durchschnittlichen österreichischen Haushalt.

EEB: Beim **Endenergiebedarf** wird zusätzlich zum Heizenergiebedarf der Haushaltsstrombedarf berücksichtigt. Der Endenergiebedarf entspricht jener Energiemenge, die eingekauft werden muss.

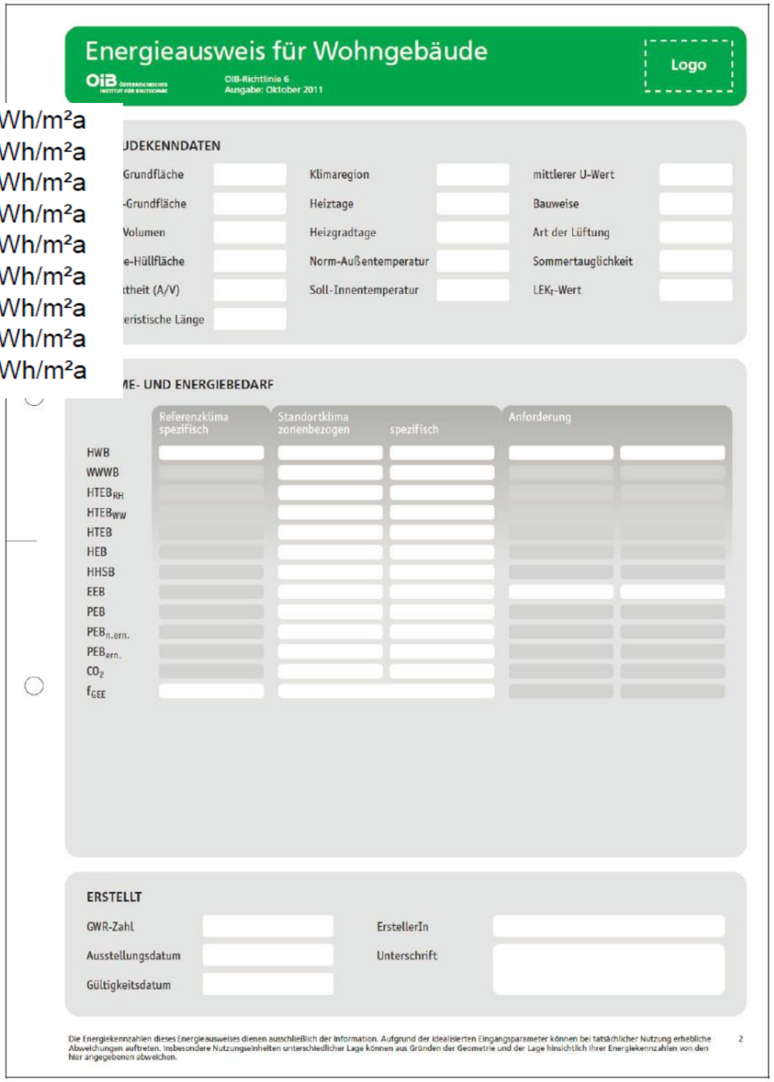
PEB: Der **Primärenergiebedarf** schließt die gesamte Energie für den Bedarf im Gebäude einschließlich aller Vorketten mit ein. Dieser weist einen erneuerbaren und einen nicht erneuerbaren Anteil auf. Der Ermittlungszeitraum für die Konversionsfaktoren ist 2004–2008.

CO_2: Gesamte dem Endenergiebedarf zuzurechnenden **Kohlendioxidemissionen**, einschließlich jener für Transport und Erzeugung sowie aller Verluste. Zu deren Berechnung wurden übliche Allokationsregeln unterstellt.

f_{GEE}: Der **Gesamtenergieeffizienz-Faktor** ist der Quotient aus dem Endenergiebedarf und einem Referenz-Endenergiebedarf (Anforderung 2007).

Alle Werte gelten unter der Annahme eines normierten BenutzerInnenverhaltens. Sie geben den Jahresbedarf pro Quadratmeter beheizter Brutto-Grundfläche an.

Dieser Energieausweis entspricht den Vorgaben der Richtlinie 6 „Energieeinsparung und Wärmeschutz" des Österreichischen Instituts für Bautechnik in Umsetzung der Richtlinie 2010/31/EU über die Gesamtenergieeffizienz von Gebäuden und des Energieausweis-Vorlage-Gesetzes (EAVG). 1


Energieausweis für Wohngebäude
OIB
OIB-Richtlinie 6
Ausgabe: Oktober 2011
Logo

[GEBÄ]UDEKENNDATEN
[Brutto-]Grundfläche | Klimaregion | mittlerer U-Wert
[Bezugs-]Grundfläche | Heiztage | Bauweise
[Brutto-]Volumen | Heizgradtage | Art der Lüftung
[Gebäud]e-Hüllfläche | Norm-Außentemperatur | Sommertauglichkeit
[Kompak]theit (A/V) | Soll-Innentemperatur | LEK_T-Wert
[charakt]eristische Länge

[WÄR]ME- UND ENERGIEBEDARF

	Referenzklima spezifisch	Standortklima zonenbezogen	spezifisch	Anforderung	
HWB					
WWWB					
$HTEB_{RH}$					
$HTEB_{WW}$					
HTEB					
HEB					
HHSB					
EEB					
PEB					
$PEB_{n.ern.}$					
$PEB_{ern.}$					
CO_2					
f_{GEE}					

ERSTELLT
GWR-Zahl | ErstellerIn
Ausstellungsdatum | Unterschrift
Gültigkeitsdatum

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. 2

Energy Certificate Non-Residential Buildings, Austria 2012

Energieausweis für Nicht-Wohngebäude

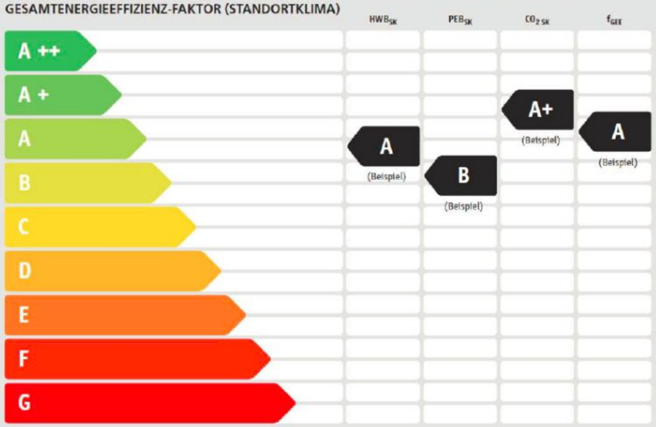
OIB Österreichisches Institut für Bautechnik
OIB-Richtlinie 6
Ausgabe: Oktober 2011

Logo

BEZEICHNUNG

Gebäude(-teil)
Baujahr
Nutzungsprofil
Letzte Veränderung
Straße
Katastralgemeinde
PLZ/Ort
KG-Nr.
Grundstücksnr.
Seehöhe

SPEZIFISCHER HEIZWÄRMEBEDARF, PRIMÄRENERGIEBEDARF, KOHLENDIOXIDEMISSIONEN UND GESAMTENERGIEEFFIZIENZ-FAKTOR (STANDORTKLIMA)



HWB: Der **Heizwärmebedarf** beschreibt jene Wärmemenge, welche den Räumen rechnerisch zur Beheizung zugeführt werden muss. Die Anforderung richtet sich an den wohngebäudeäquivalenten Heizwärmebedarf.

KB: Der **Kühlbedarf** beschreibt jene Wärmemenge, welche aus den Räumen rechnerisch abgeführt werden muss. Die Anforderung richtet sich an den außenluftinduzierten Kühlbedarf.

WWWB: Der **Warmwasserwärmebedarf** ist als flächenbezogener Defaultwert festgelegt. Er entspricht ca. einem Liter Wasser je Quadratmeter Brutto-Grundfläche, welcher um ca. 30 °C (also beispielsweise von 8 °C auf 38 °C) erwärmt wird.

HEB: Beim **Heizenergiebedarf** werden zusätzlich zum Nutzenergiebedarf die Verluste der Haustechnik im Gebäude berücksichtigt. Dazu zählen beispielsweise die Verluste des Heizkessels, der Energiebedarf von Umwälzpumpen etc.

BSB: Der **Betriebsstrombedarf** ist als flächenbezogener Defaultwert festgelegt. Er entspricht der Hälfte der mittleren inneren Lasten.

EEB: Beim **Endenergiebedarf** wird zusätzlich zum Heizenergiebedarf der Haushaltsstrombedarf berücksichtigt. Der Endenergiebedarf entspricht jener Energiemenge, die eingekauft werden muss.

PEB: Der **Primärenergiebedarf** schließt die gesamte Energie für den Bedarf im Gebäude einschließlich aller Vorketten mit ein. Dieser weist einen erneuerbaren und einen nicht erneuerbaren Anteil auf. Der Ermittlungszeitraum für die Konversionsfaktoren ist 2004 – 2008.

CO_2: Gesamte dem Endenergiebedarf zuzurechnenden **Kohlendioxidemissionen**, einschließlich jener für Transport und Erzeugung sowie aller Verluste. Zu deren Berechnung wurden übliche Allokationsregeln unterstellt.

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Alle Werte gelten unter der Annahme eines normierten BenutzerInnenverhaltens. Sie geben den Jahresbedarf pro Quadratmeter beheizter Brutto-Grundfläche an.

Dieser Energieausweis entspricht den Vorgaben der Richtlinie 6 „Energieeinsparung und Wärmeschutz" des Österreichischen Instituts für Bautechnik in Umsetzung der Richtlinie 2010/31/EU über die Gesamtenergieeffizienz von Gebäuden und des Energieausweis-Vorlage-Gesetzes (EAVG). 1

Energieausweis für Nicht-Wohngebäude

OIB Österreichisches Institut für Bautechnik
OIB-Richtlinie 6
Ausgabe: Oktober 2011

Logo

GEBÄUDEKENNDATEN

Brutto-Grundfläche		Klimaregion		mittlerer U-Wert	
Bezugs-Grundfläche		Heiztage		Bauweise	
Brutto-Volumen		Heizgradtage		Art der Lüftung	
Gebäude-Hüllfläche		Norm-Außentemperatur		Sommertauglichkeit	
Kompaktheit (A/V)		Soll-Innentemperatur		LEK_T-Wert	
charakteristische Länge					

WÄRME- UND ENERGIEBEDARF

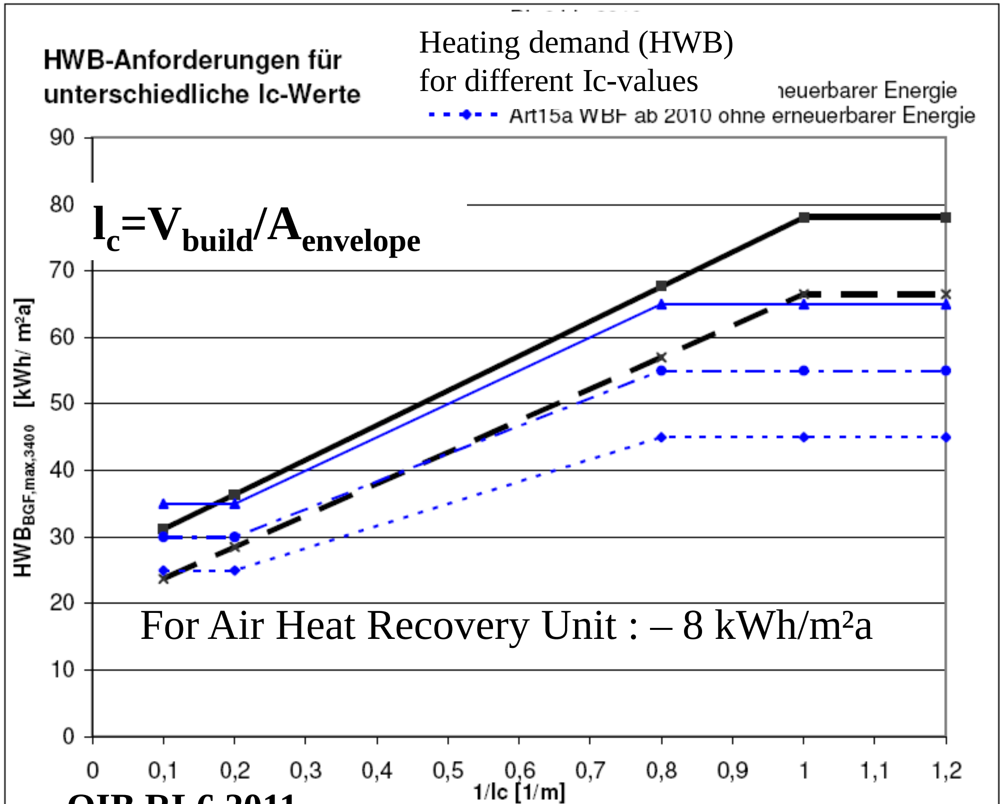
	Referenzklima spezifisch	Standortklima zonenbezogen	spezifisch	Anforderung	
HWB*					
HWB					
WWWB					
KB*					
KB					
BefEB					
$HTEB_{RH}$					
$HTEB_{WW}$					
HTEB					
KTEB					
HEB					
KEB					
BelEB					
BSB					
EEB					
PEB					
$PEB_{n.ern.}$					
$PEB_{ern.}$					
CO_2					
f_{GEE}					

ERSTELLT

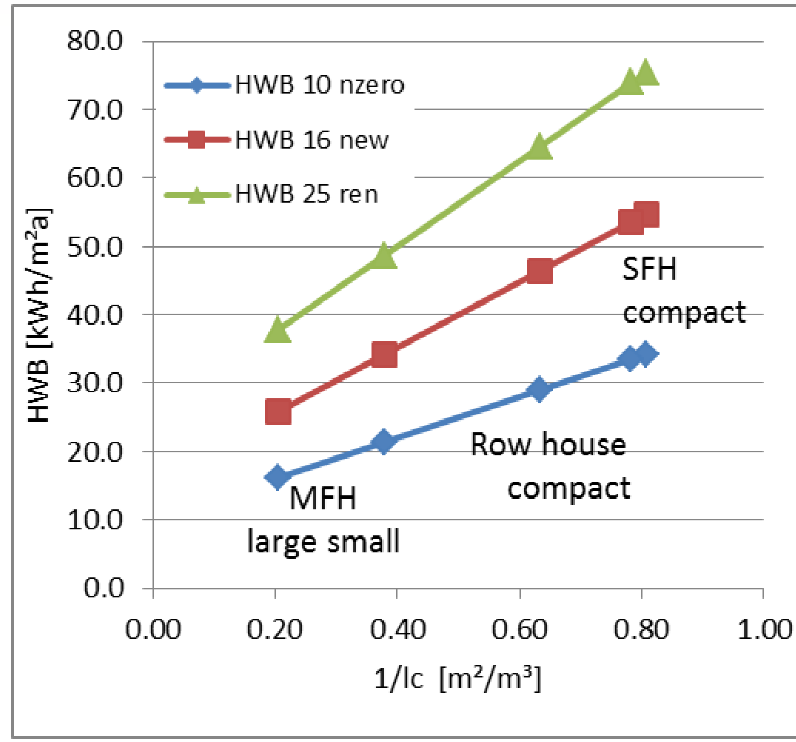
GWR-Zahl
ErstellerIn
Ausstellungsdatum
Unterschrift
Gültigkeitsdatum

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. 2

Example Austria: Limits: Useful Energy Demand Heating New residential Buildings (OIB - Richtlinie 6 (2011))



OIB RL6 2011



Coming into effect	$HWB_{BGF,WG,max,RK} = 16 \times (1+3{,}0/l_c)$ [kWh/m²a]	Maximum	54,4 [kWh/m²a][1)]

[1)] For buildings with a conditioned brutto-area of max. 100m² the max. value of 54,4kWh/m²a is invalid.

Situation Austria, proposed limits

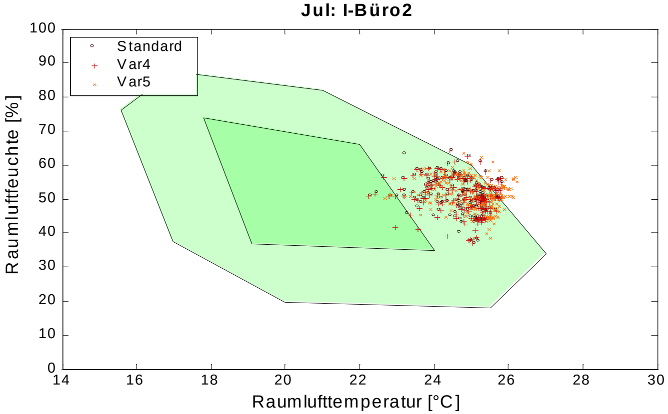
- **For residential buildings cooling demand is NOT allowed** (building must be build in a way that NO summer cooling load occurs, ÖNORM B 8110 Part 3)

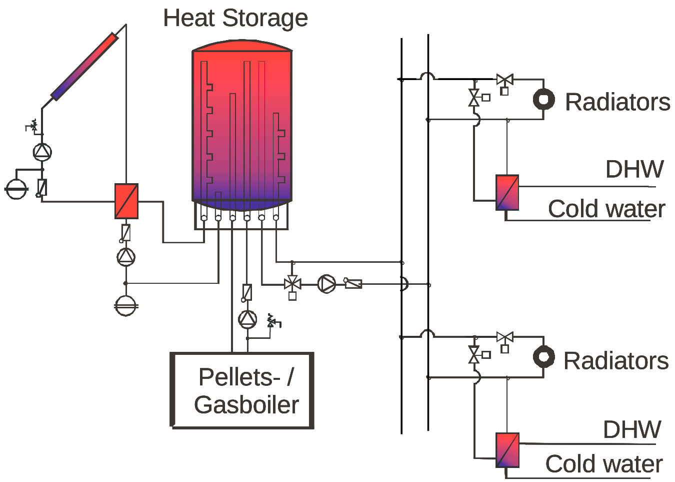
- Also for **non-residential buildings cooling demand is not allowed** when the internal gains and the ventilation are taken into account as for residential buildings (glass-palaces are not allowed with this in the future).

- No maximum allowed values for the end-use of non-residential buildings are given (lack of experience)

What can't be done with the calculation via EPBD

- Heating / cooling load
- Statistic about over-temperature
- Detailed effects of complex hydraulics and controls

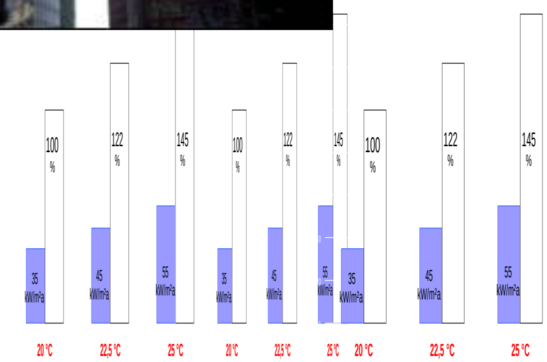




What can‘t be done with the calculation via EPBD

- 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.

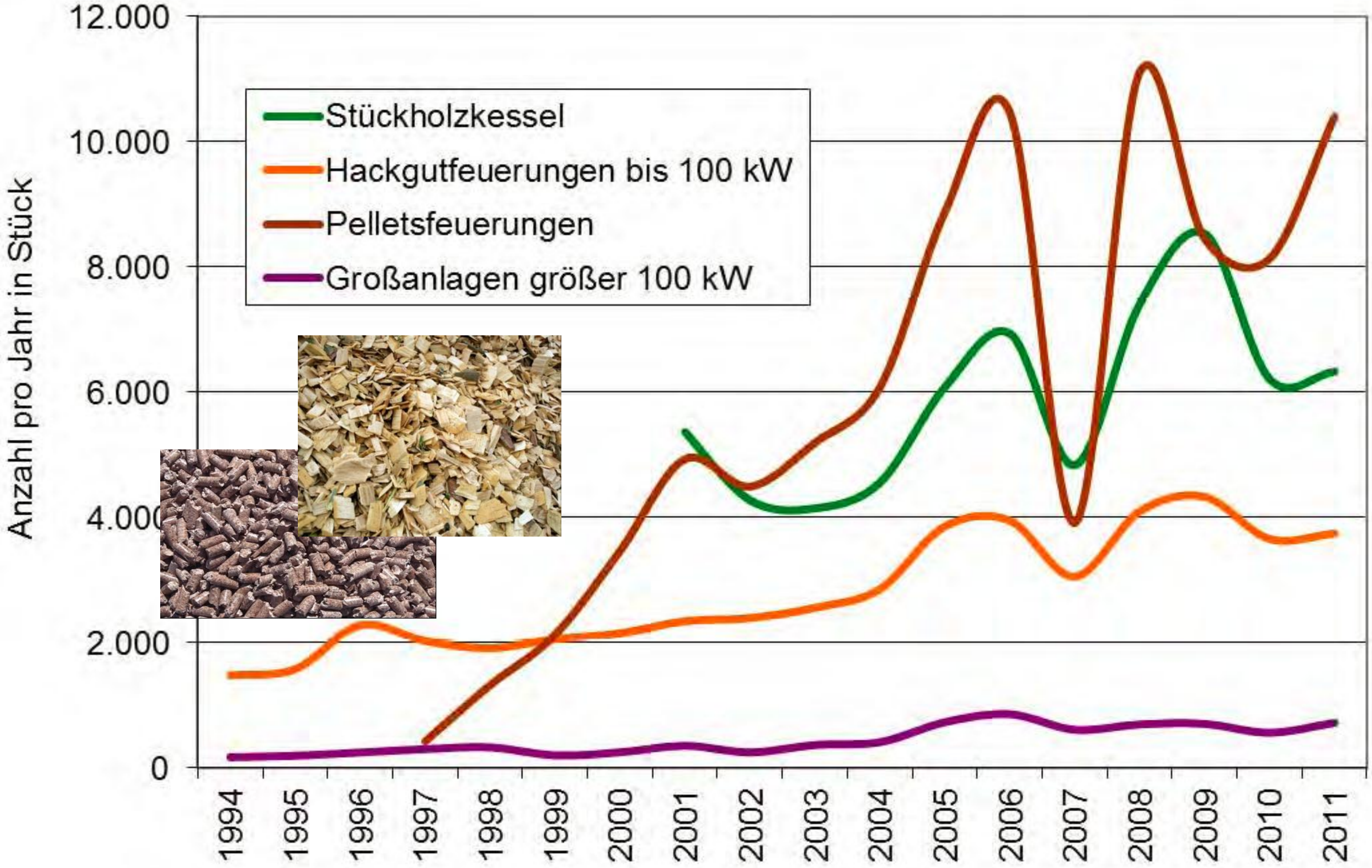
Further upcoming EU-regulations

- **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**

Biomass

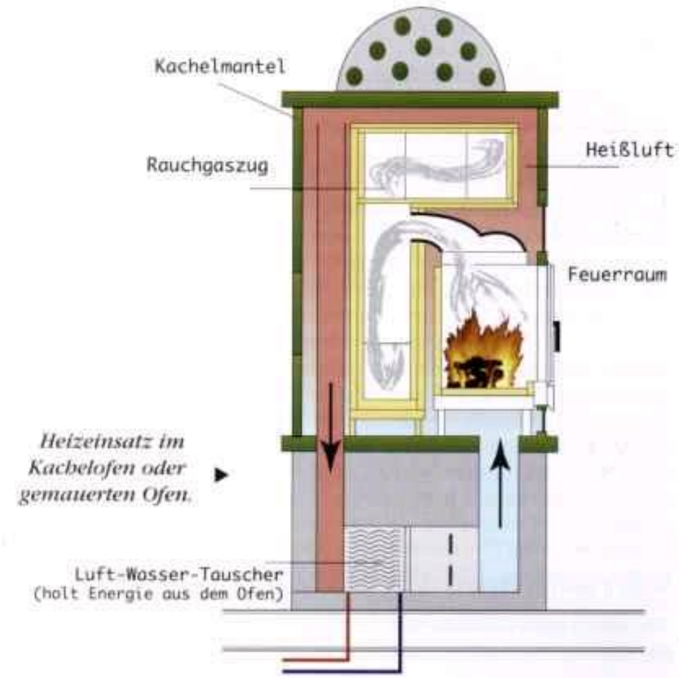



Yearly increase of biomass heating systems in Austria



Innovative Energietechnologien in Österreich, Marktentwicklung 2011, BMVIT

„Kachelofen“

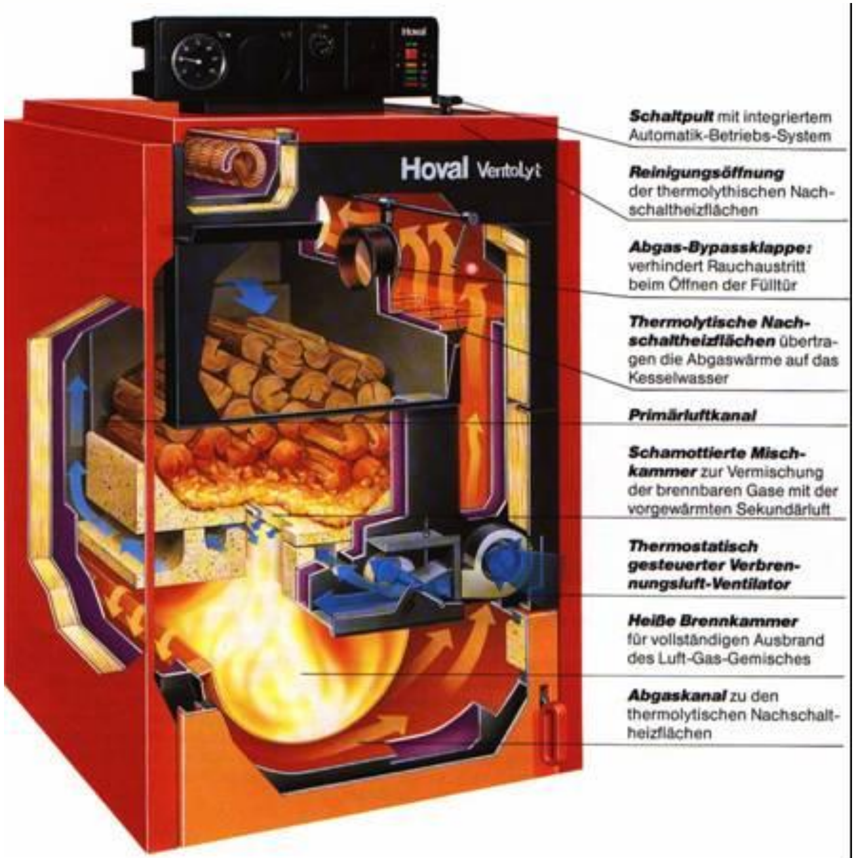


- Positioning that several rooms can be heated, with water HX inside a coupling to a water heating system can be done
- Efficiency about 60-70 %
- High startup emissions (cold burning chamber)

“Kaminofen”

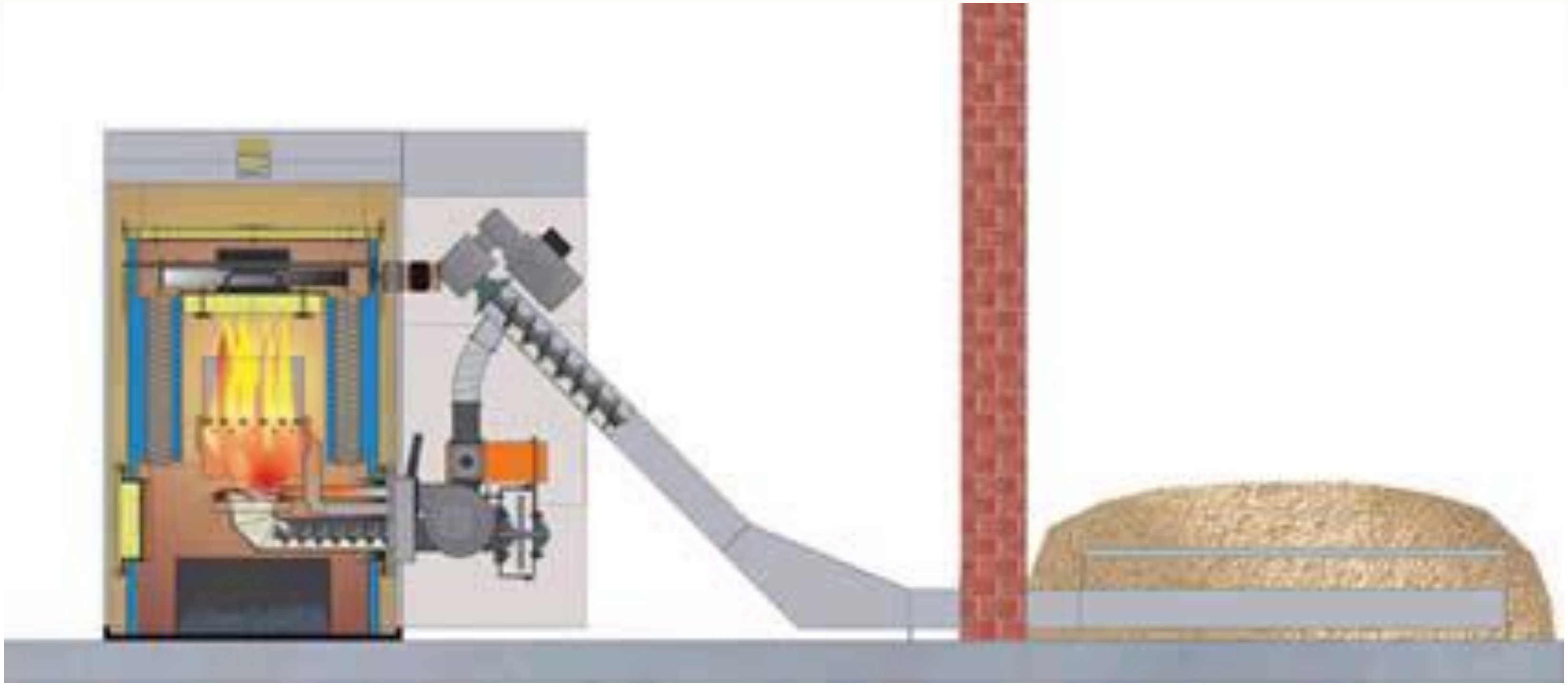
- Positioning that several rooms can be heated, with water HX inside a coupling to a water heating system can be done
- Efficiency about 60-70 %
- High startup emissions (cold burning chamber)

Log wood burner with downward flame



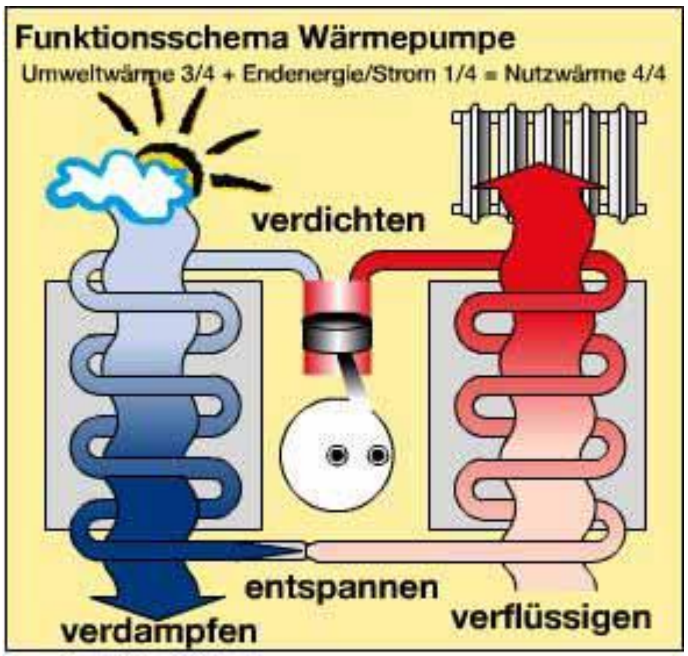
- Logs and ash is transported autmomatically downwards
- Logs are dries before burned
- Burning chamber is NOT cooled

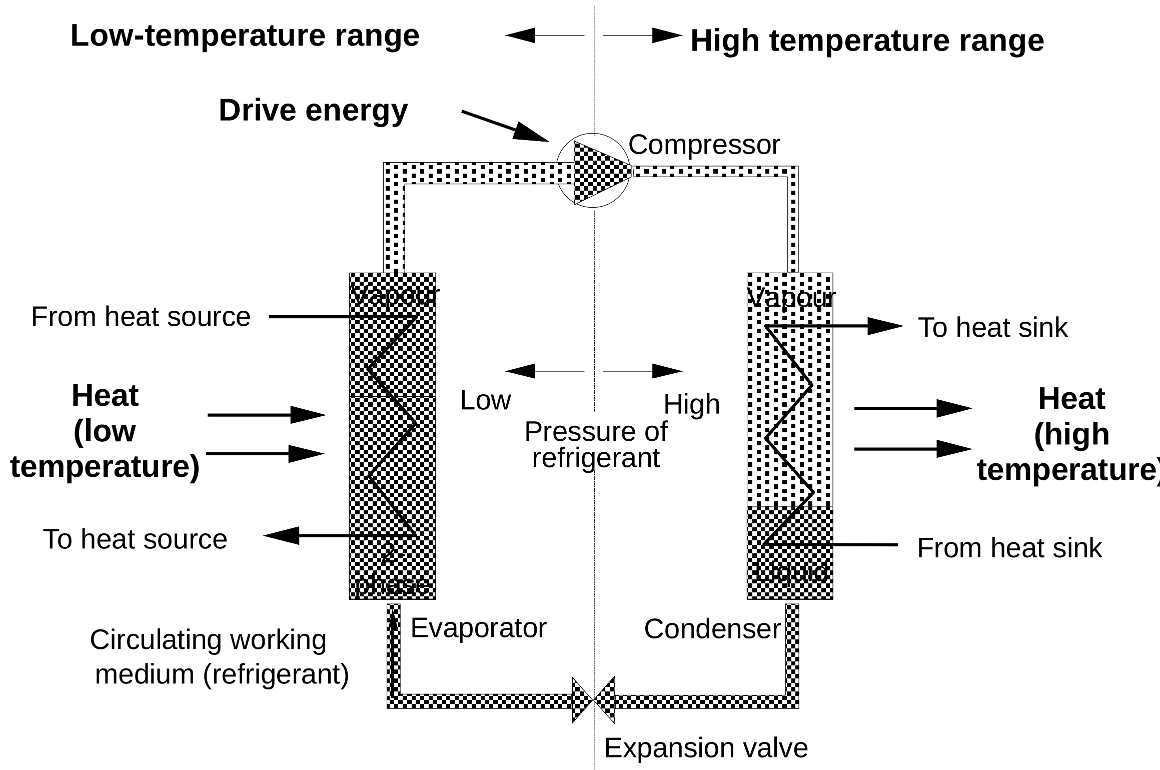
Automatic wood chips/pellets burner



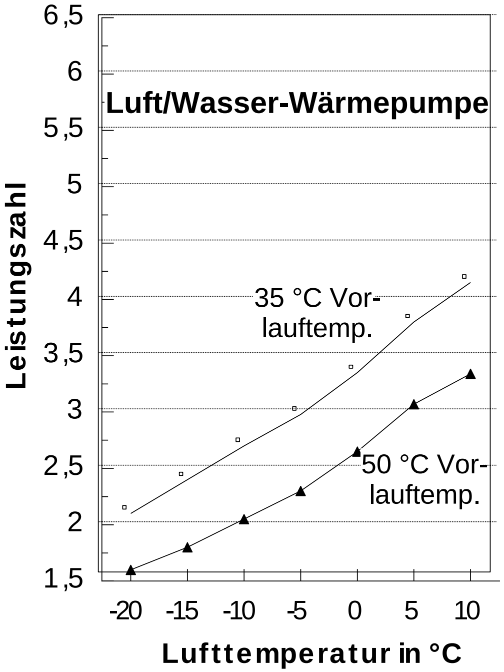
- Similar maintenance a soil or gas burners
- Similar emissions as oil burner
- Slightly higher investment than oil burner
- Biomass store has to be reached yb the blowing tube of the truck

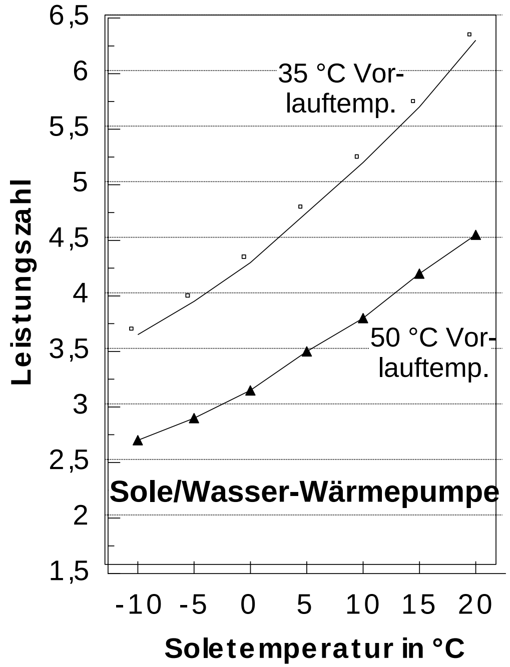
Heat pumps

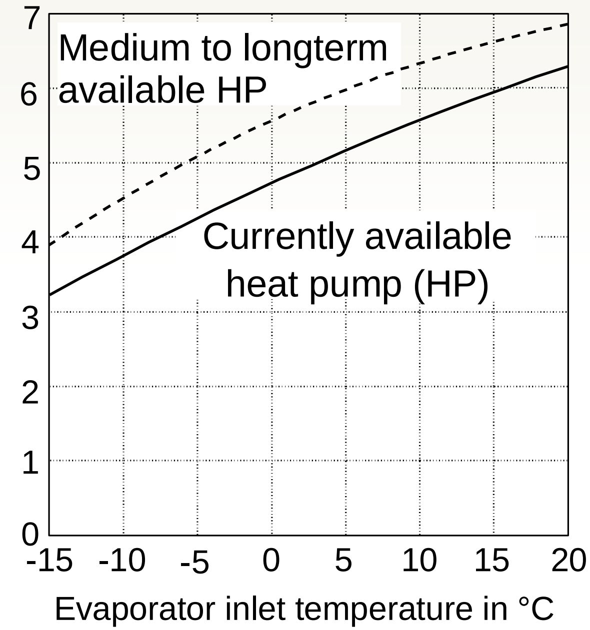

Funktionsschema Wärmepumpe
Umweltwärme 3/4 + Endenergie/Strom 1/4 = Nutzwärme 4/4
verdichten
entspannen
verdampfen
verflüssigen

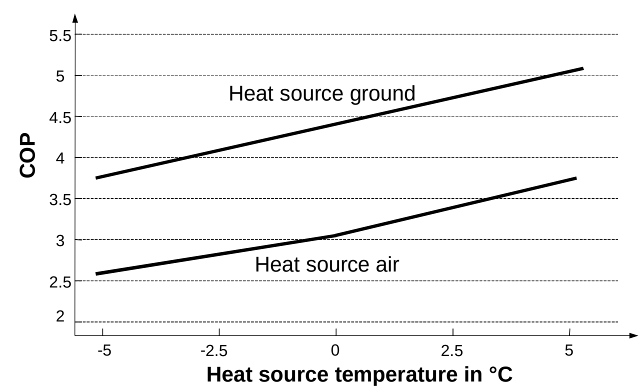

Low-temperature range
High temperature range
Drive energy
Compressor
From heat source
Vapour
Vapour
To heat sink
Low
High
Pressure of
refrigerant
Heat
(low
temperature)
Heat
(high
temperature)
To heat source
From heat sink
Liquid
phase
Evaporator
Condenser
Circulating working
medium (refrigerant)
Expansion valve

Heat pump COP and boundary conditions



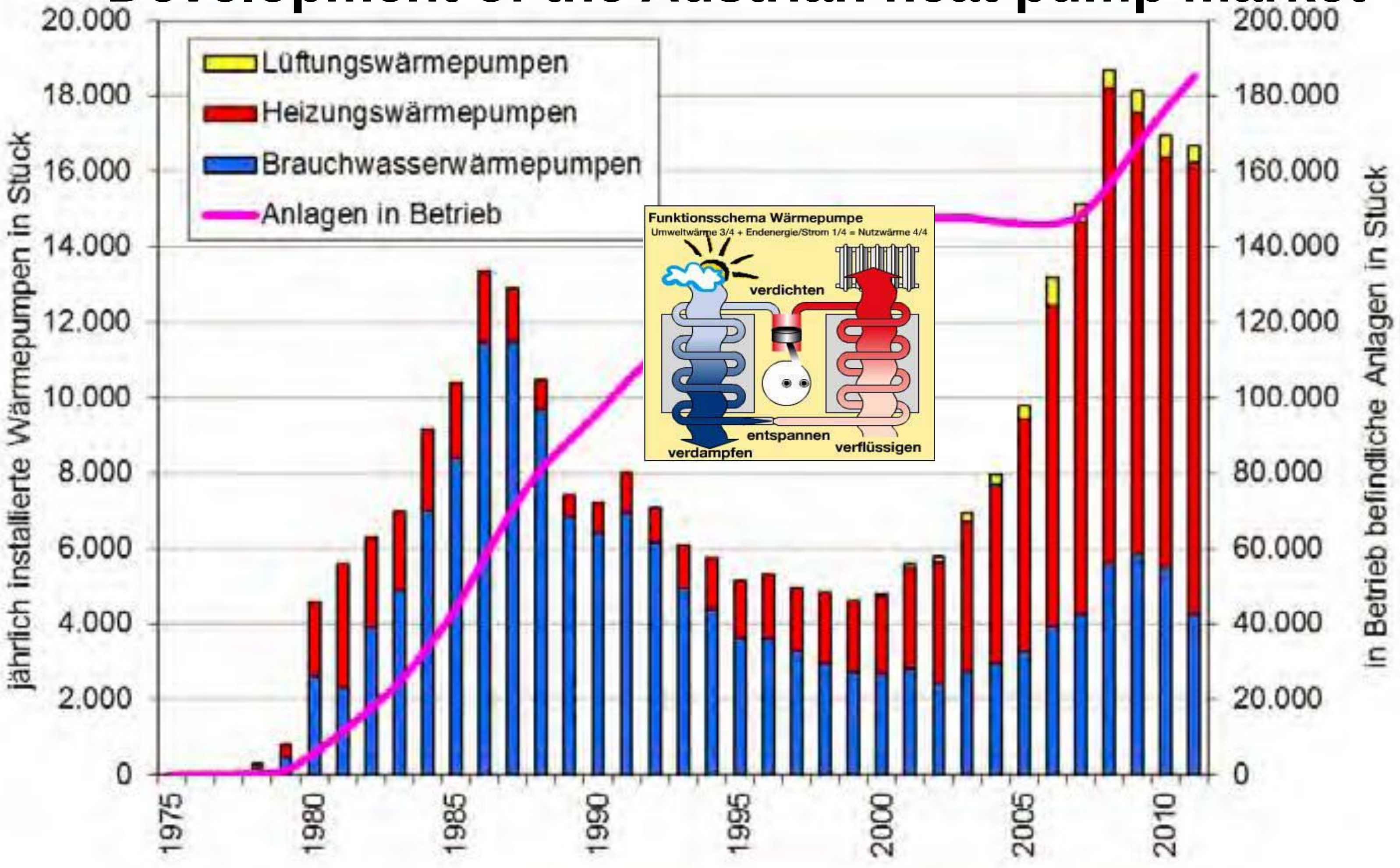






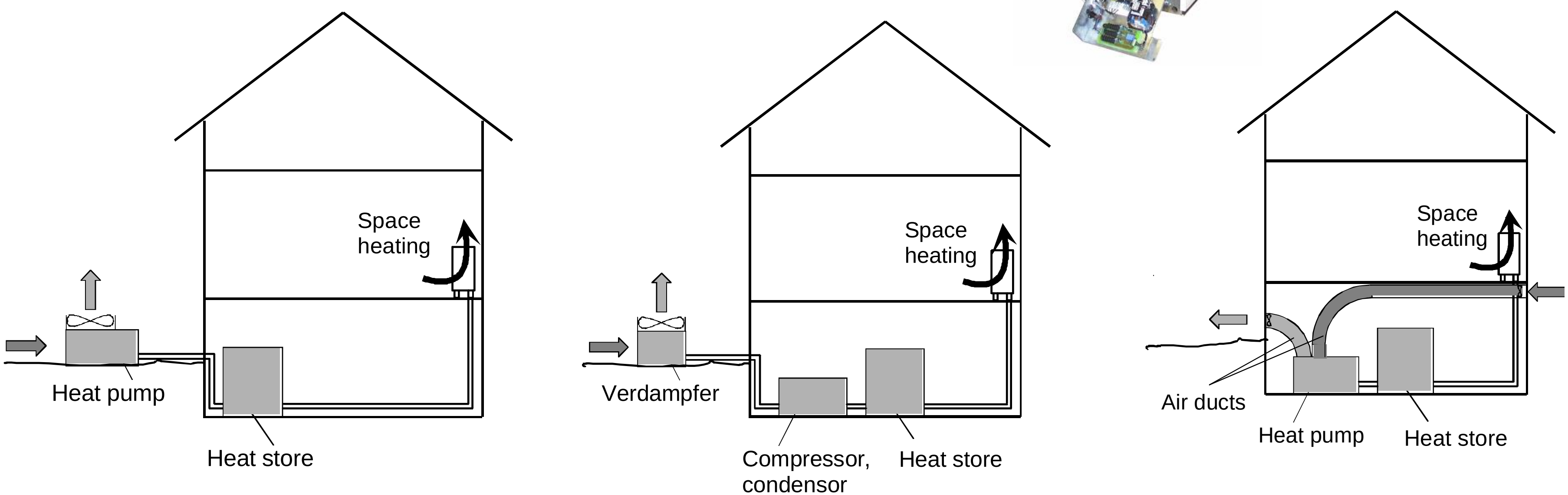
Quelle: Kaltschmitt, Streicher, Wiese, 2006

Development of the Austrian heat pump market



Innovative Energietechnologien in Österreich, Marktentwicklung 2011, BMVIT

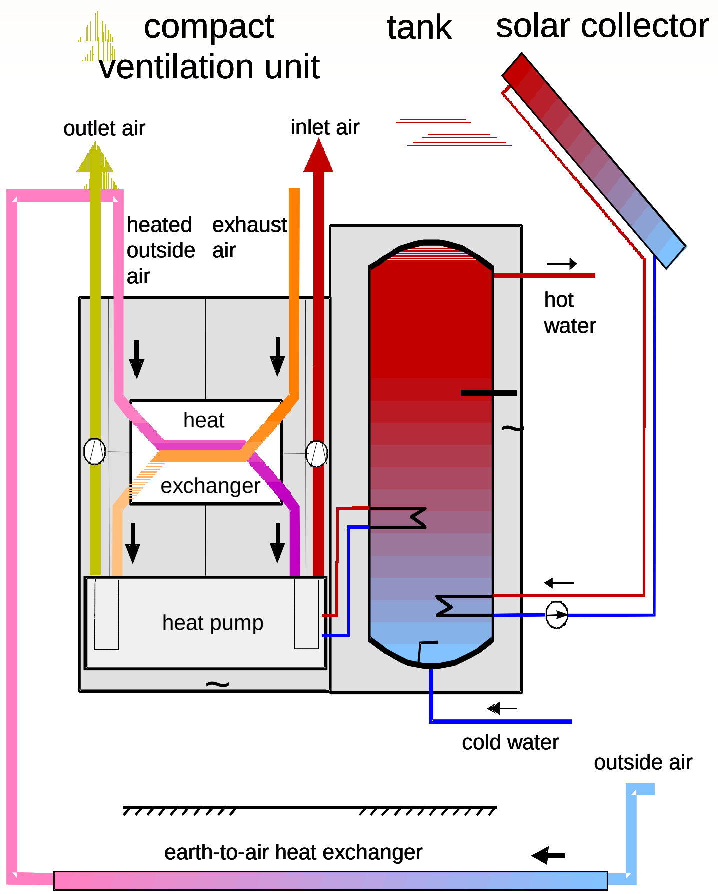
Ambient air as heat source



Quelle: Kaltschmitt, Streicher, Wiese, 2006

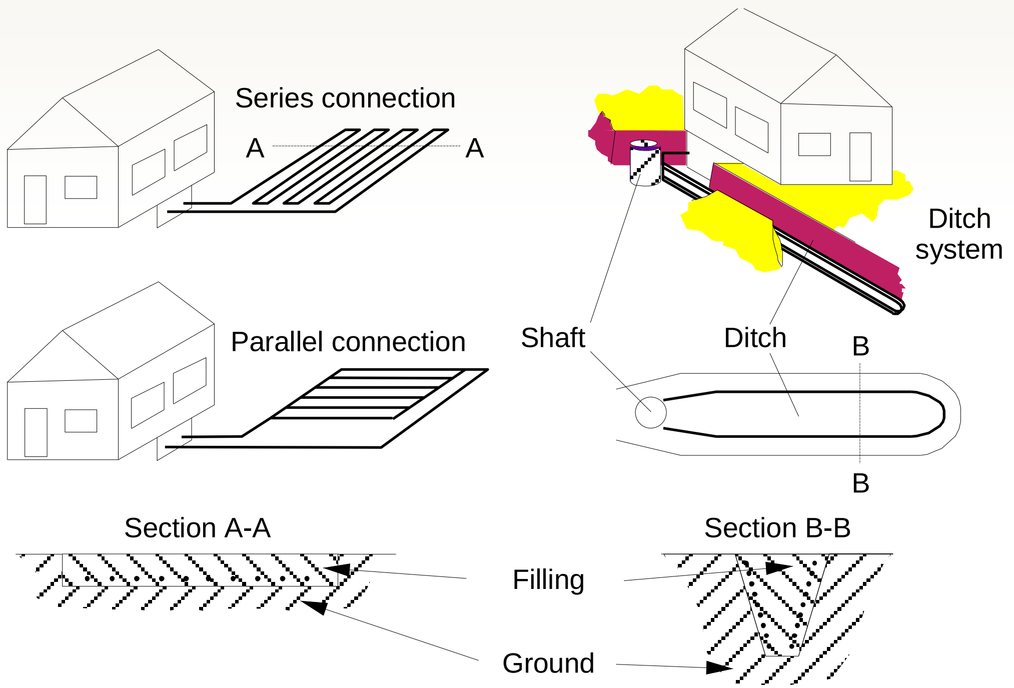
Compact heating and domestic hot water unit

- 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

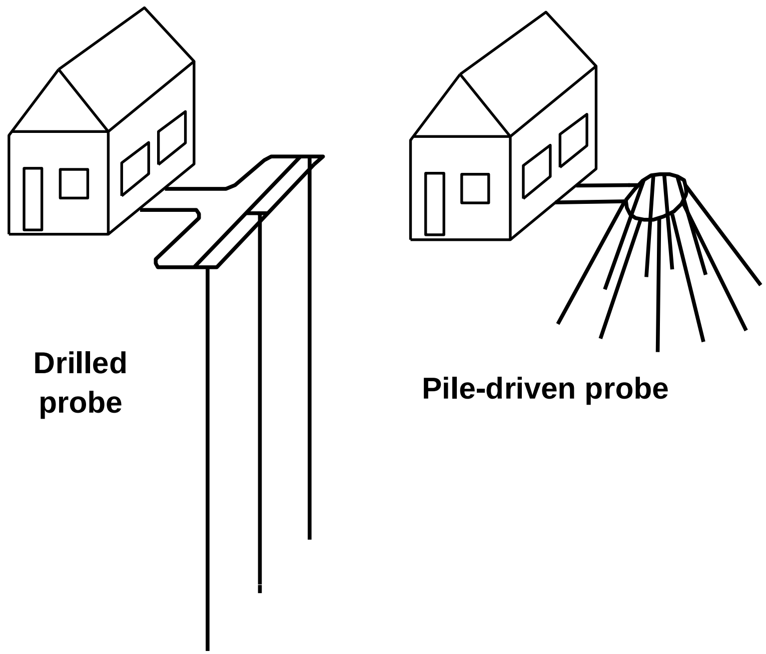
Ground as heat source

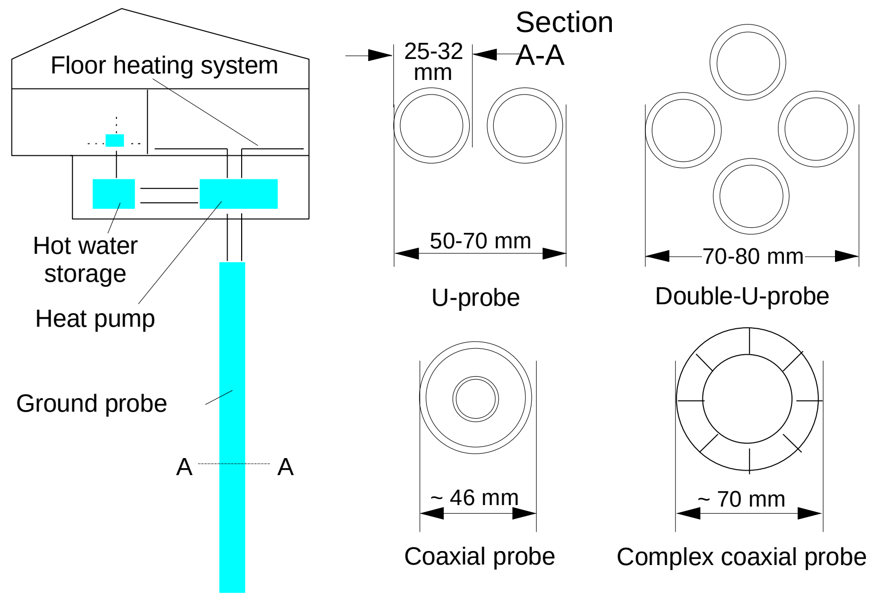


Type of soil	Withdrawn heat capacity
Dry, sandy soil	10 – 15 W/m^2
Humid, sandy soil	15 – 20 W/m^2
Dry loamy soil	20 – 25 W/m^2
Humid loamy soil	25 – 30 W/m^2
Water saturated sand/gravel	30 – 40 W/m^2

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

Ground as heat source





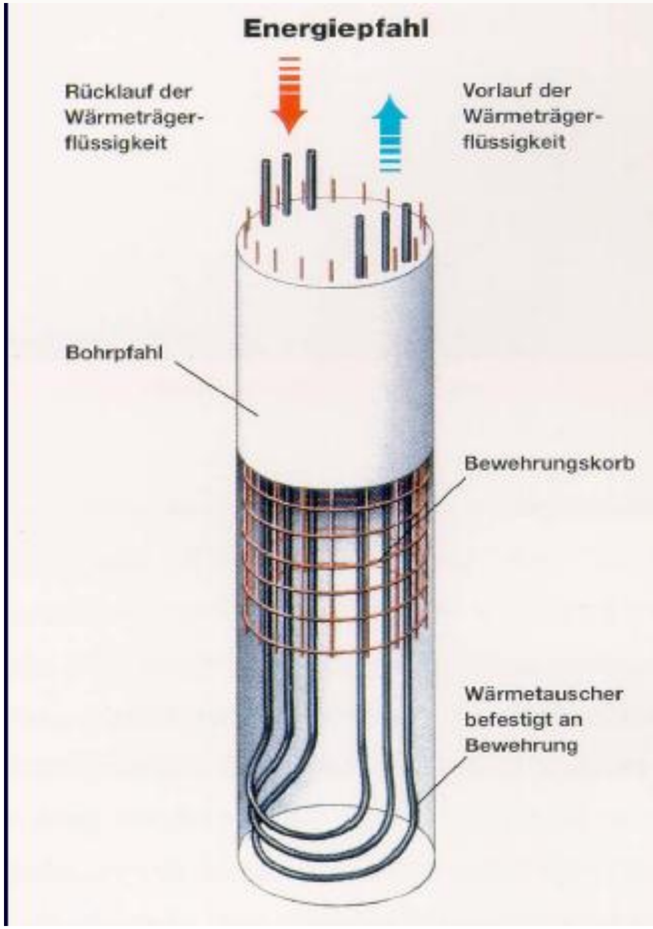
Quelle: Kaltschmitt, Streicher, Wiese, 2006

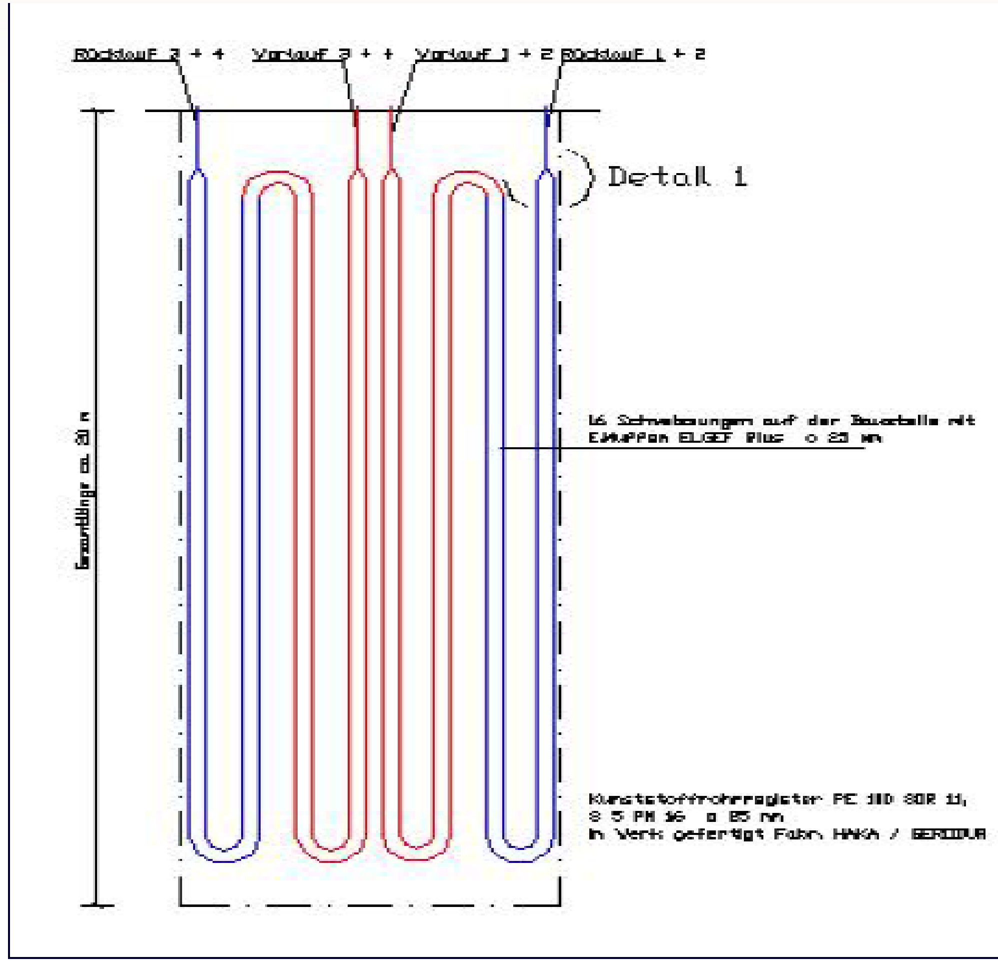
	1 800 h/a	2 400 h/a
General guidelines		
Bad subsoil (dry lose rocks)	25 W/m	20 W/m
Solid rock subsoil, water-saturated lose rock	60 W/m	50 W/m
Solid rock with high heat conductivity	84 W/m	70 W/m
Individual soils		
Gravel, sand, dry	< 25 W/m	< 20 W/m
Gravel, sand, carrying water	65 – 80 W/m	55 – 65 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

Energy poles

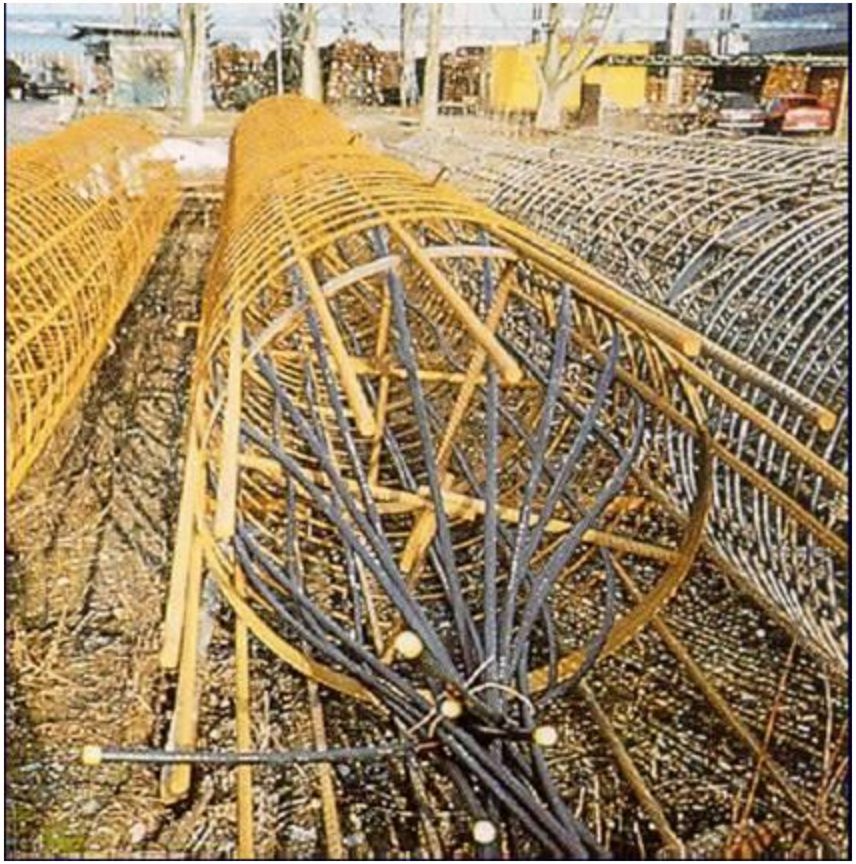




Quelle: Sauerwein, Bilfinger Berger,

Energy poles

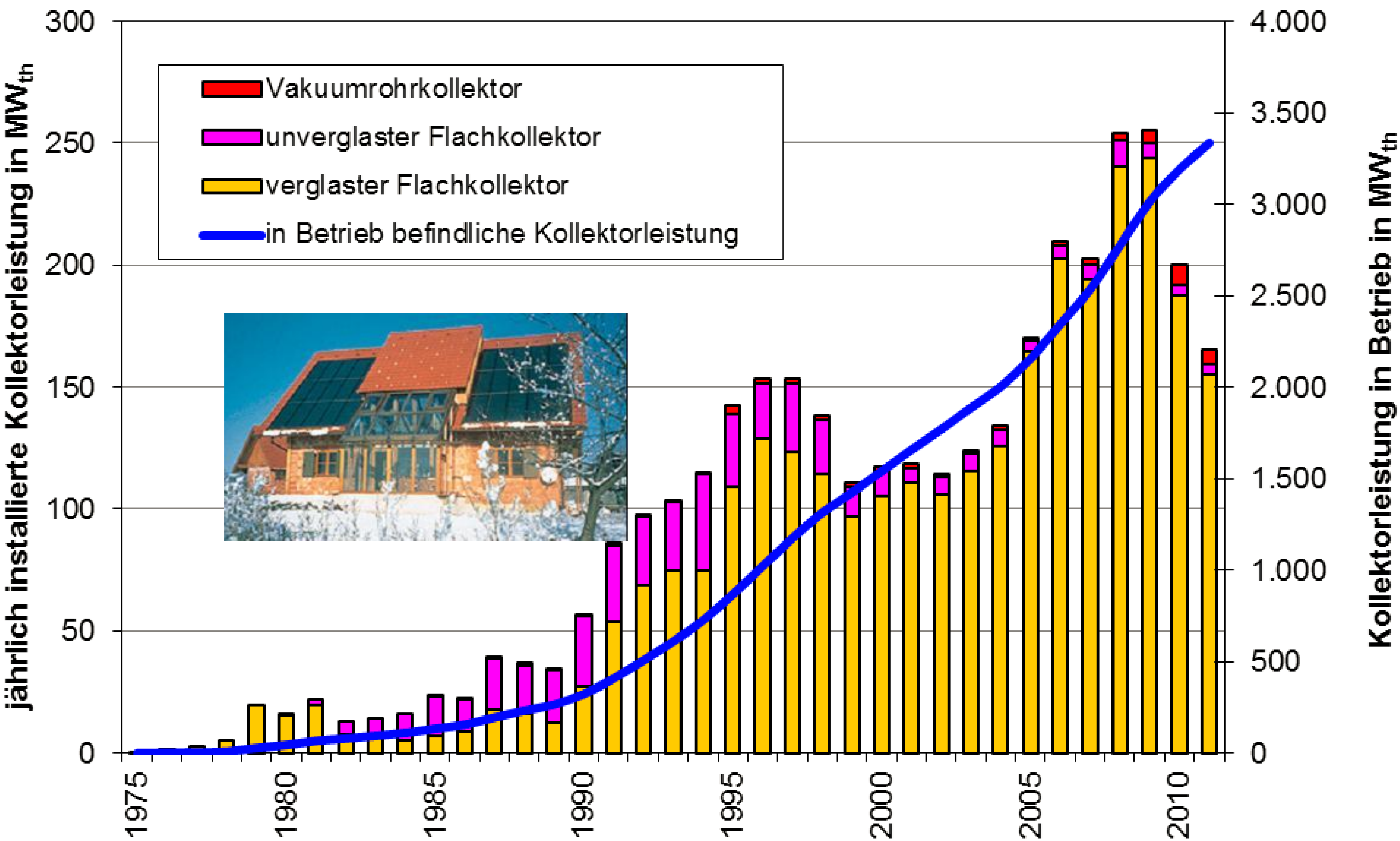
Vorgefertigter Bewehrungskorb



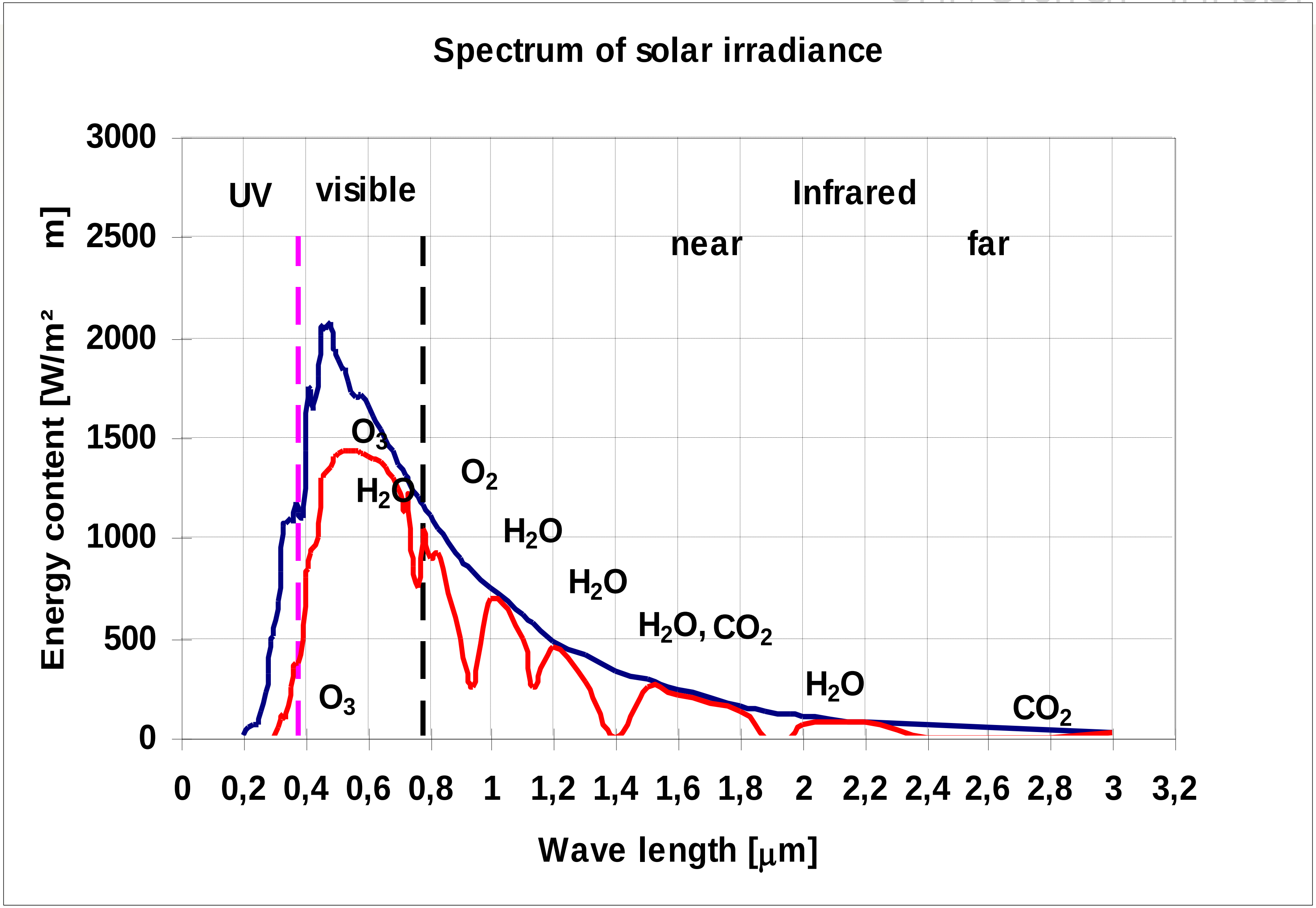
Verteilerstation Energiepfähle

Solar Thermal Systems

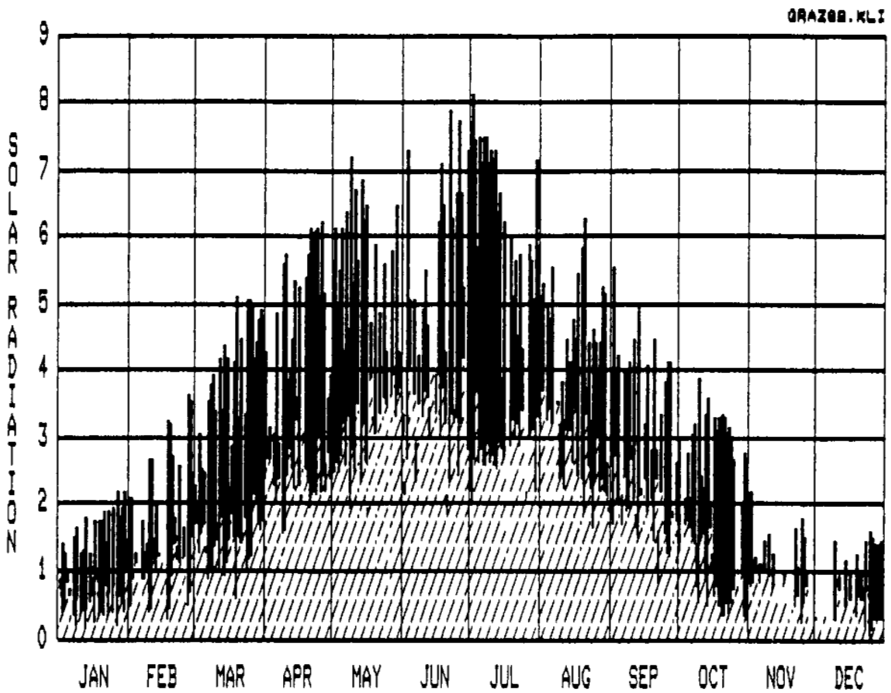
Austrian market development of solar thermal systems

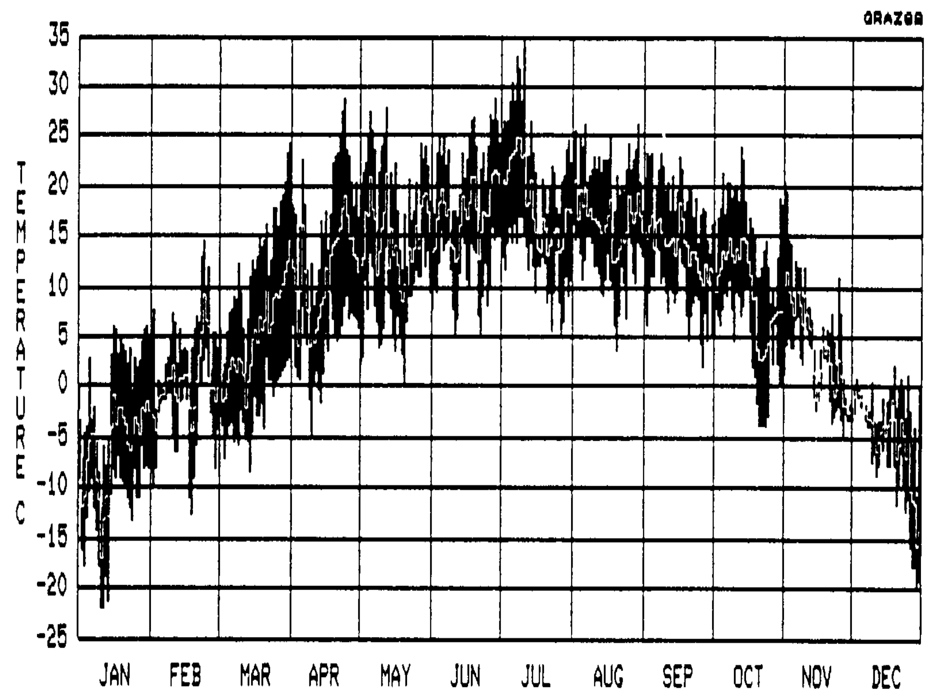


Innovative Energietechnologien in Österreich, Marktentwicklung 2011, BMVIT


Spectrum of solar irradiance
Energy content [W/m² µm]
3000
2500
2000
1500
1000
500
0
UV
visible
Infrared
near
far
O_3
H_2O
O_2
H_2O
H_2O
H_2O, CO_2
H_2O
CO_2
O_3
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
2,2
2,4
2,6
2,8
3
3,2
Wave length [µm]

Daily global irradiation (on a horizontal surface) and hourly ambient temperature of Graz climate

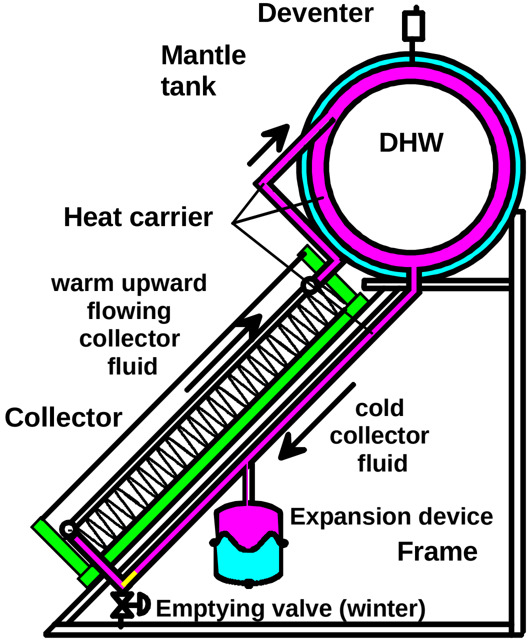


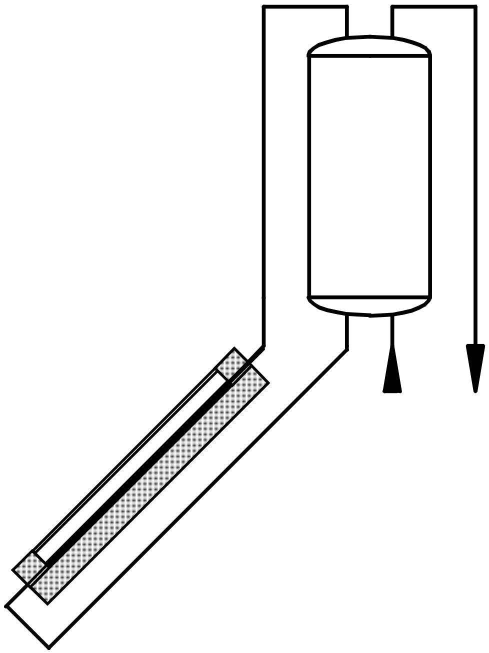


Where to use solar thermal

- Domestic hot water (DHW)
- Space heating + DHW
- District heating networks
- Swimming pools
- Cooling
- Process Heat
- Electricity production

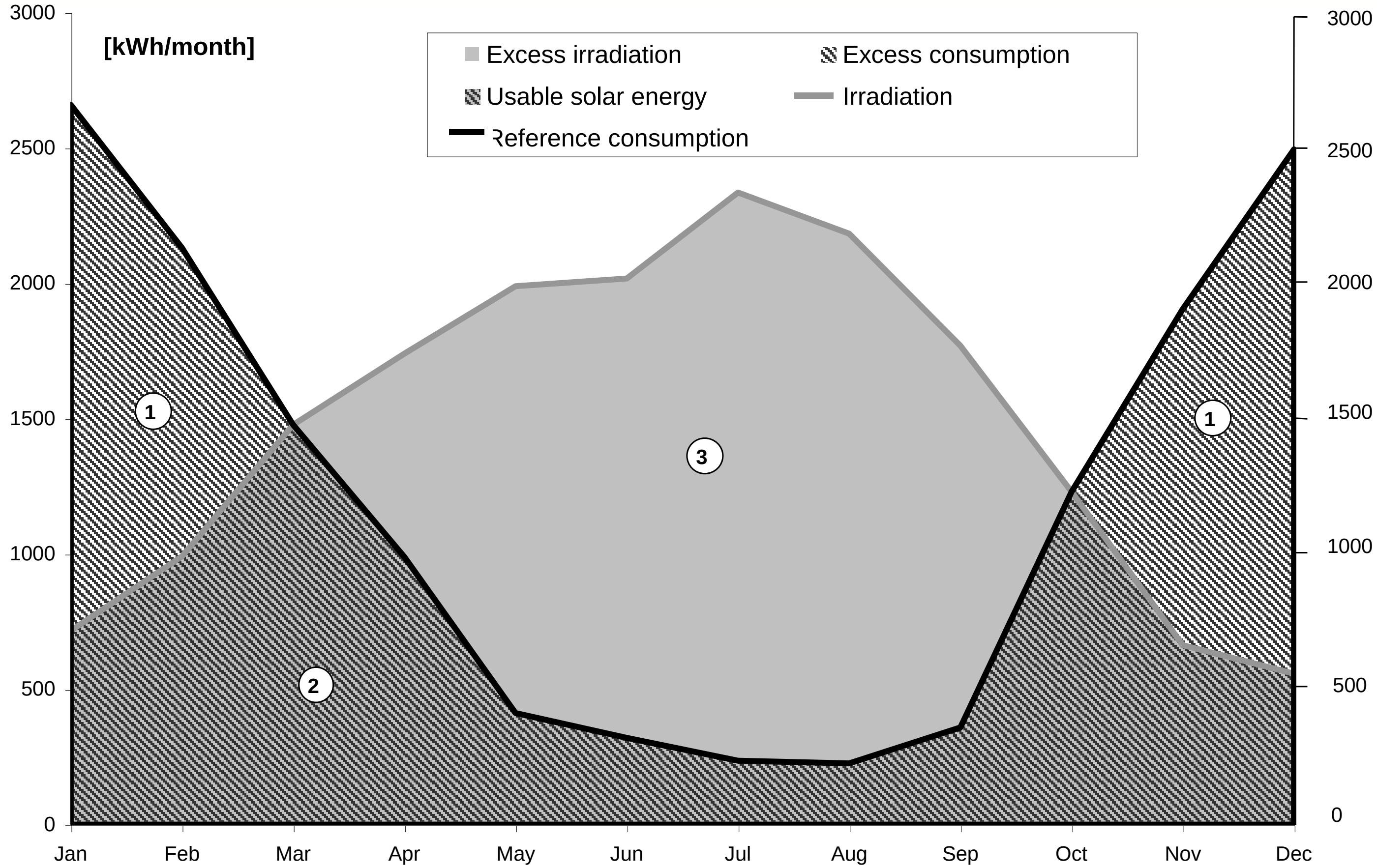
Principle of Solar Thermal Energy Use Natural Circulation Systems



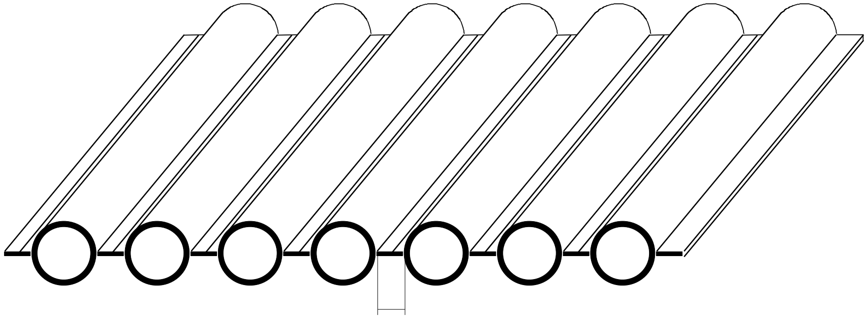


Solar Combisystems

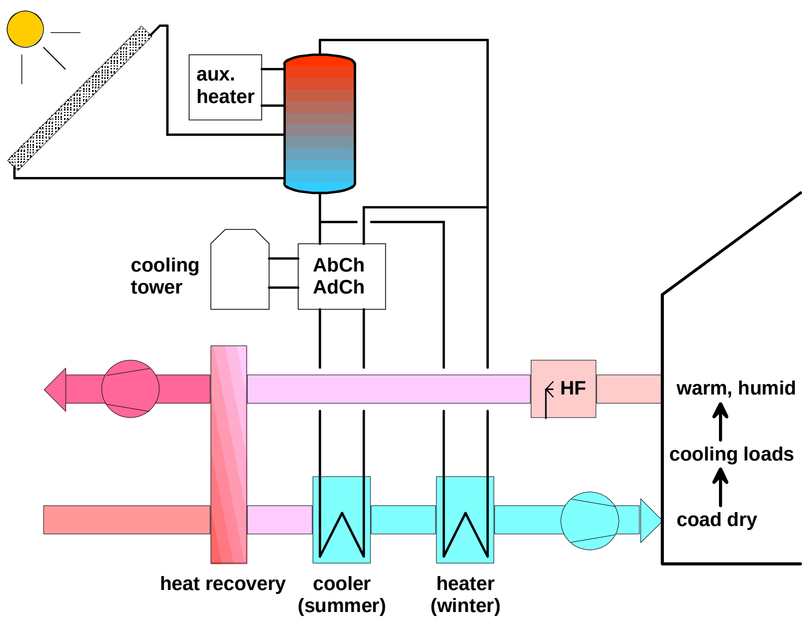
Solar Combisystems,space heating demand



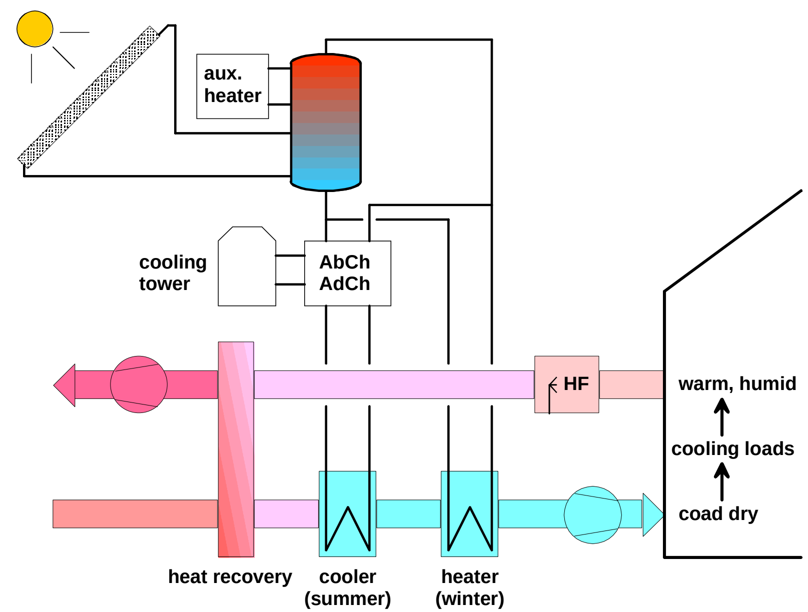
Solar heated swimming pools



Solar assisted cooling

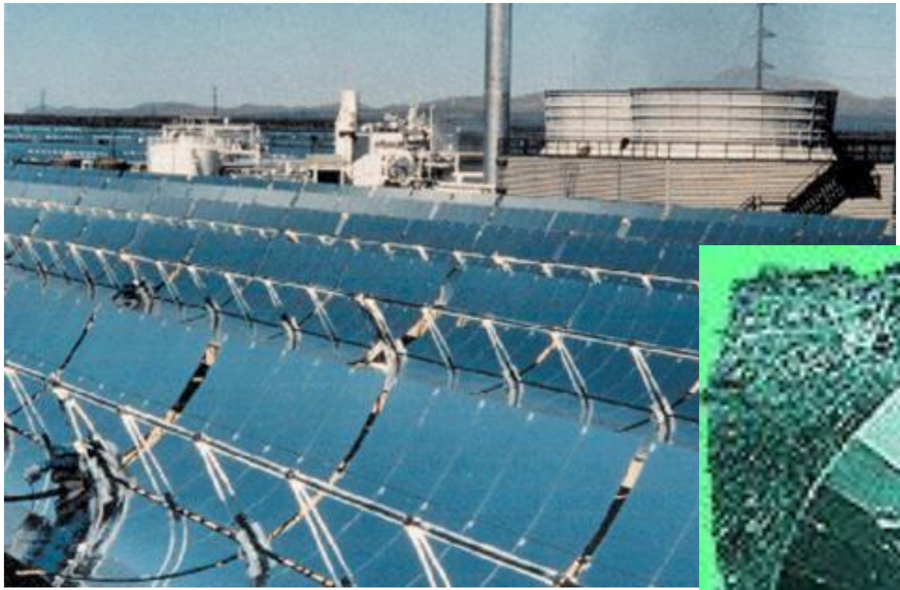


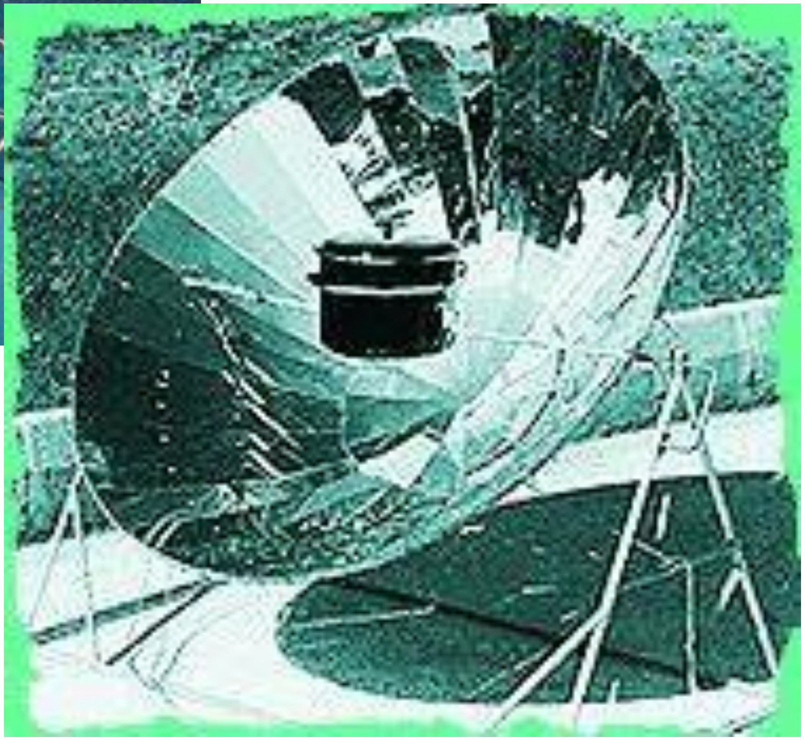
Deccicant system



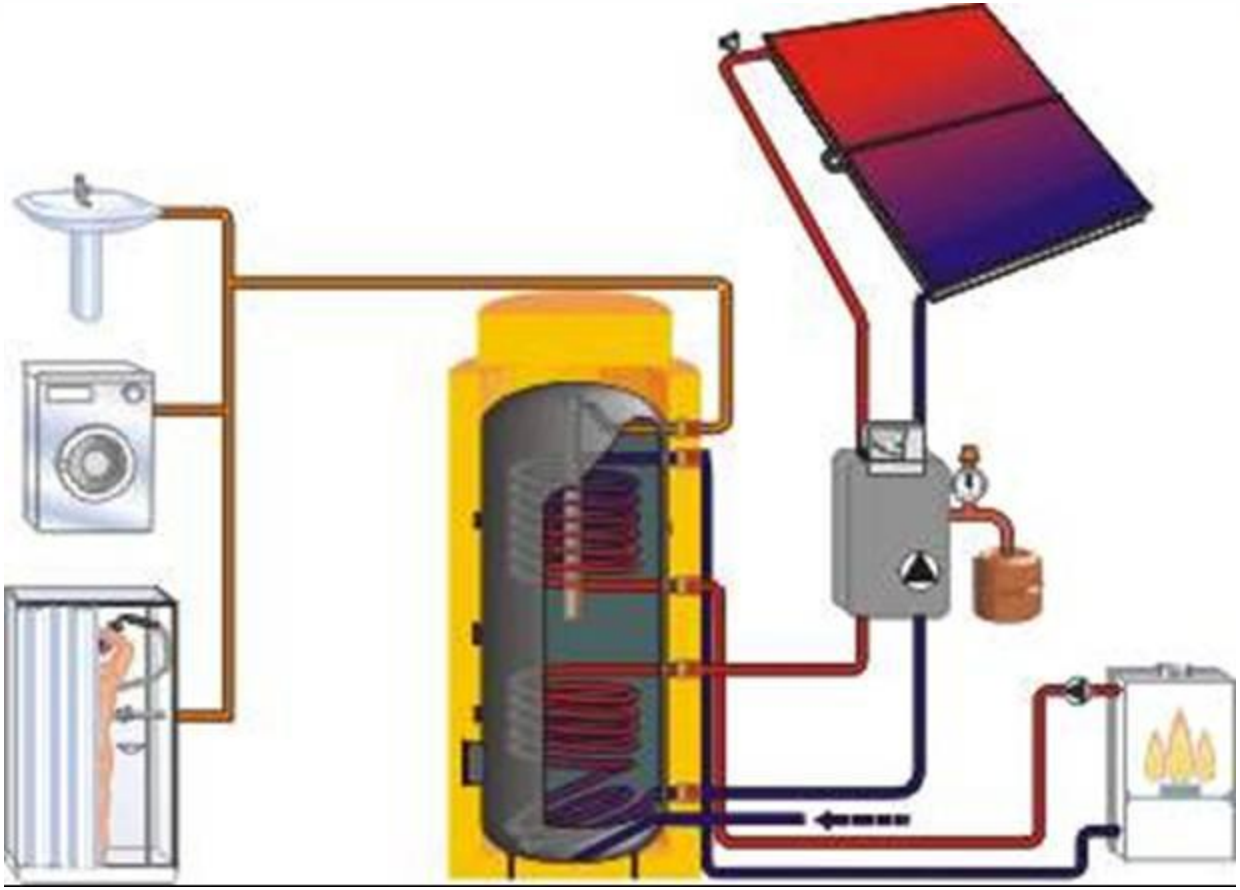
Ab/Adsorption system

Process heat

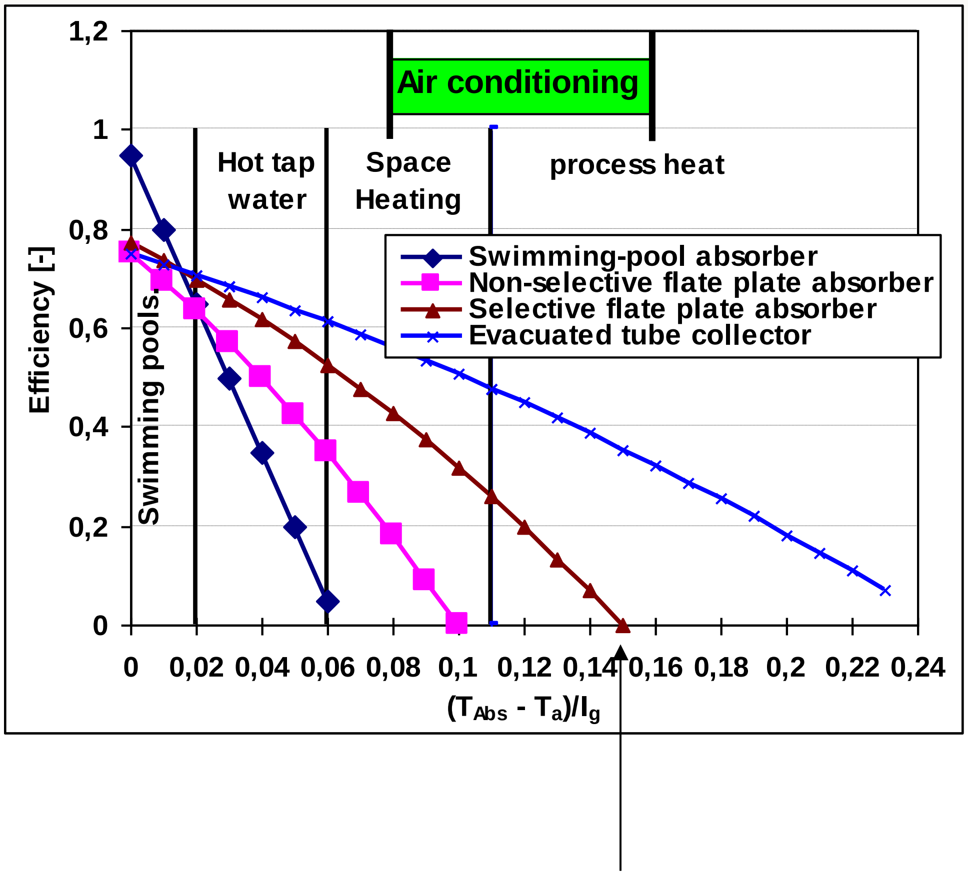


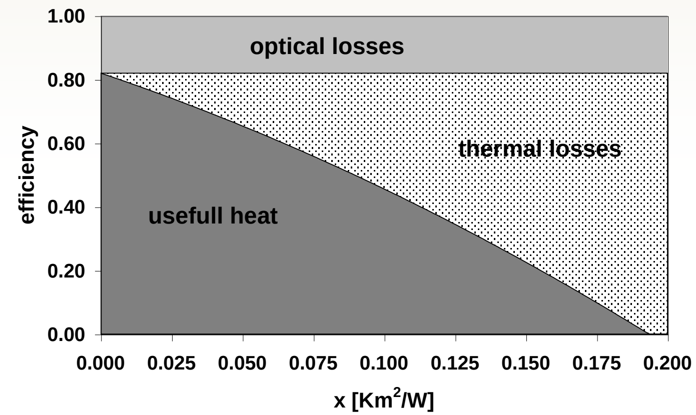


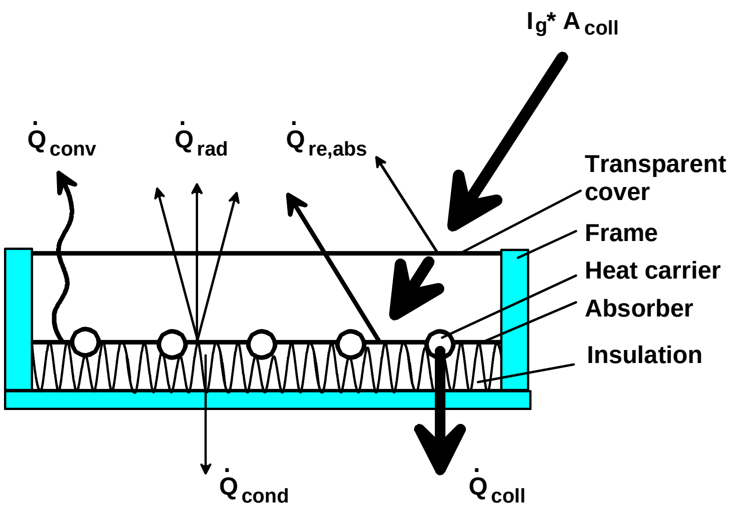
Principle of Solar Thermal Energy Use
Forced Circulation Systems



Collector characteristics

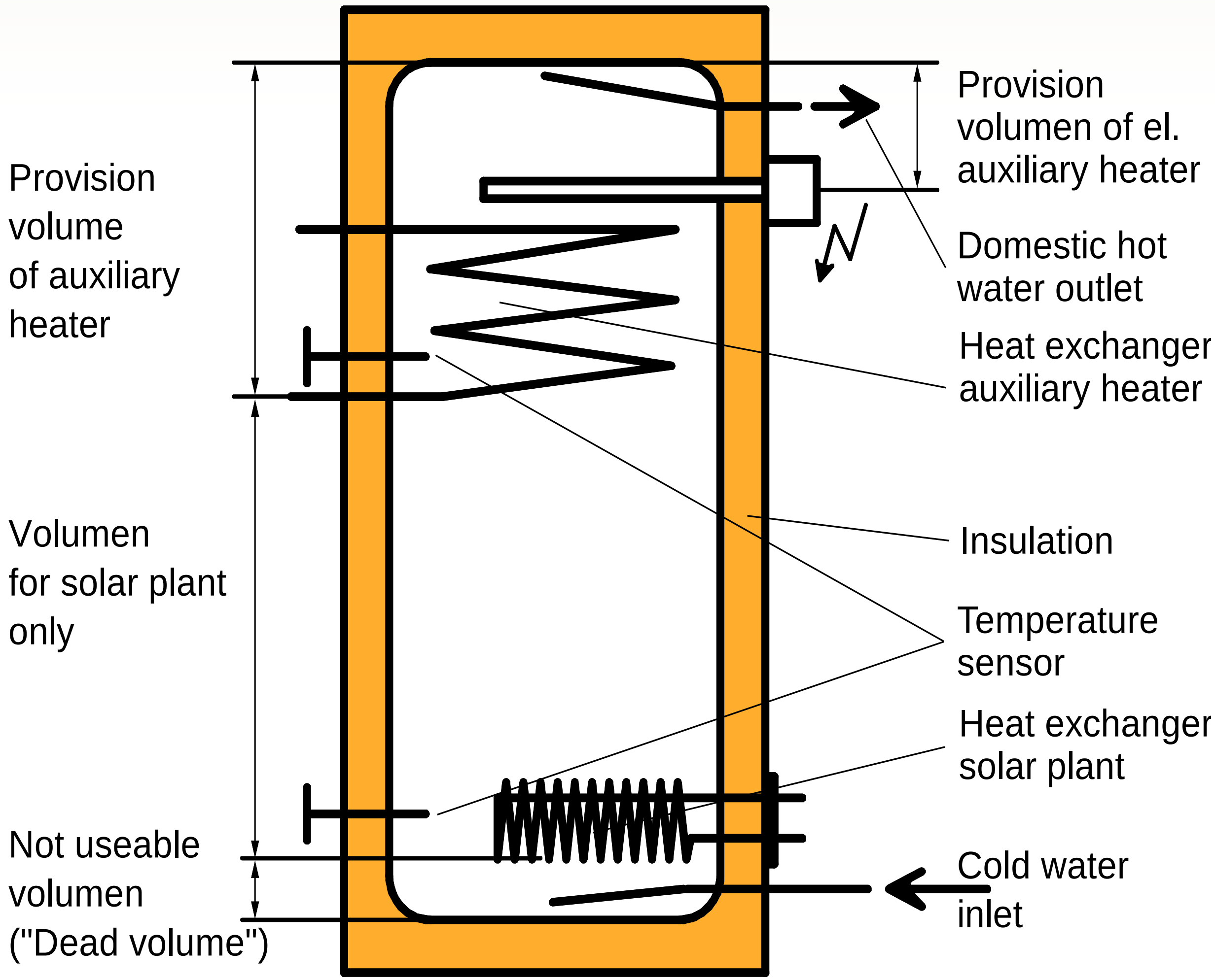




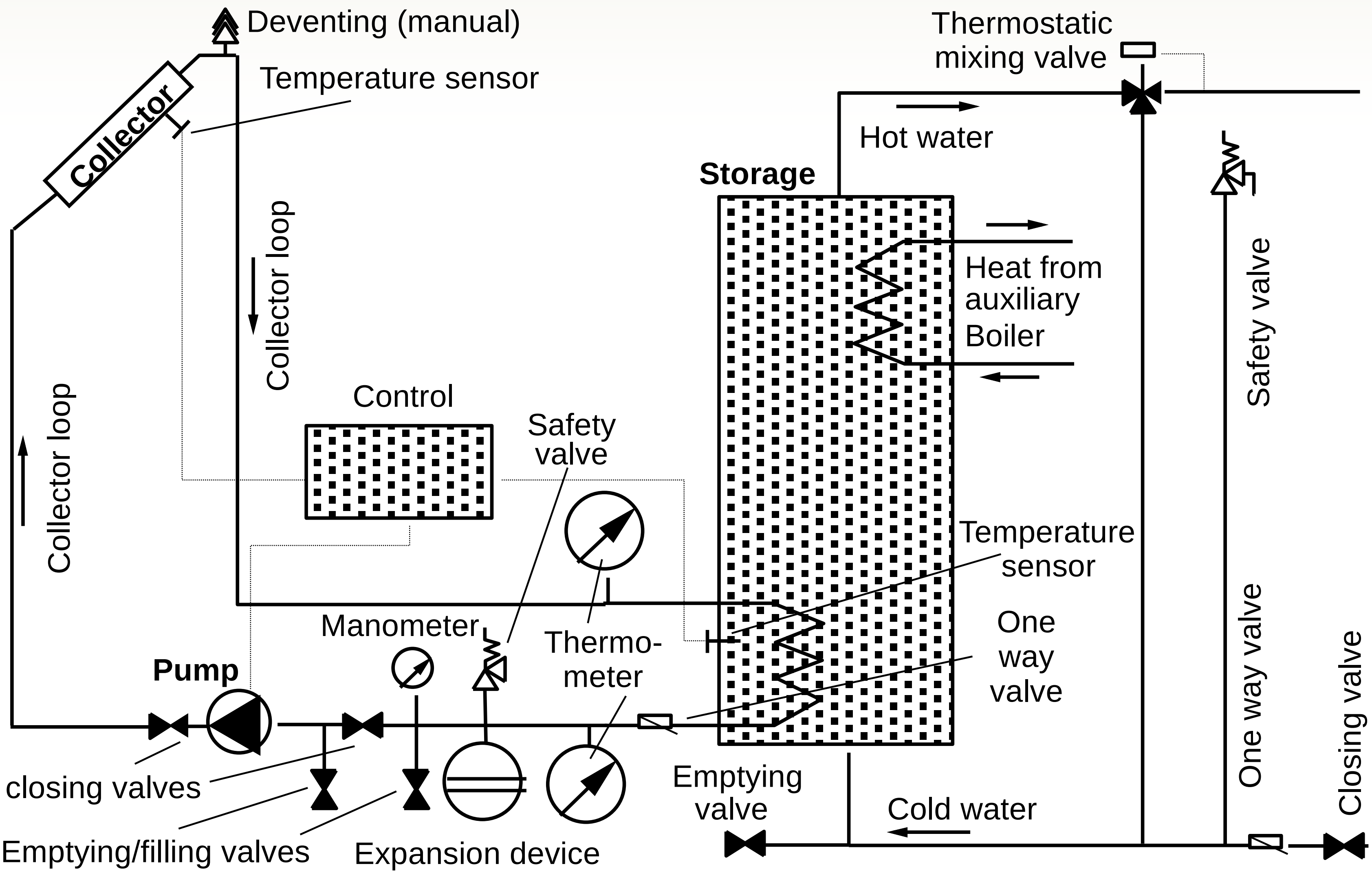


Note : Maximum collector standstill temperature at 1000 W/m² irradiance and 30 °C ambient temperature: Tabs = (0,15*1000)+30 = 180 °C

Solar Domestic Hot Water Stores

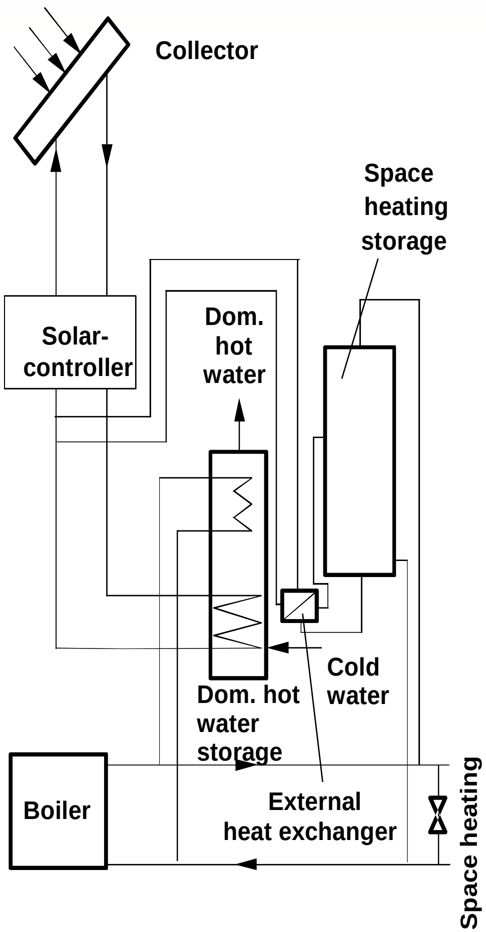


Domestic hot water forced hydraulics

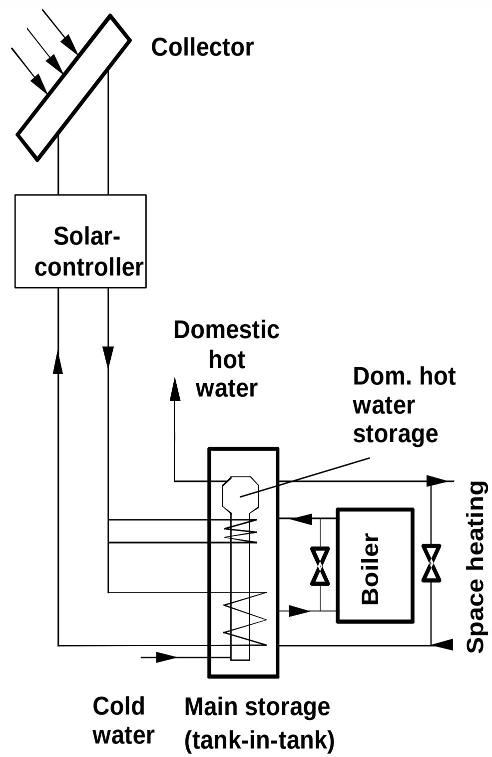


Solar combisystem schemes

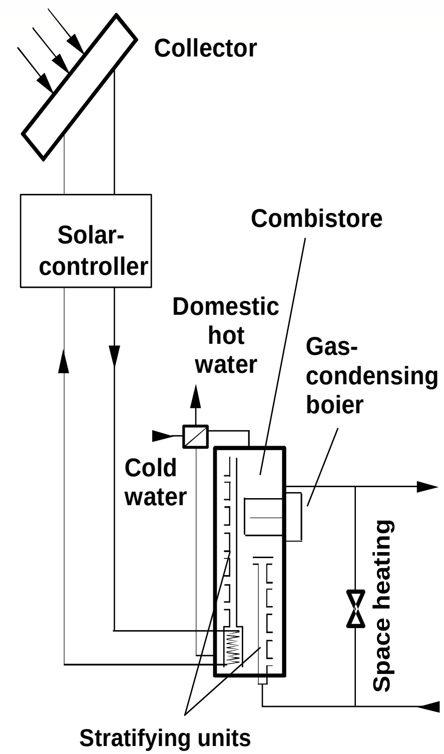
Two stores with oil or gas-fired boiler



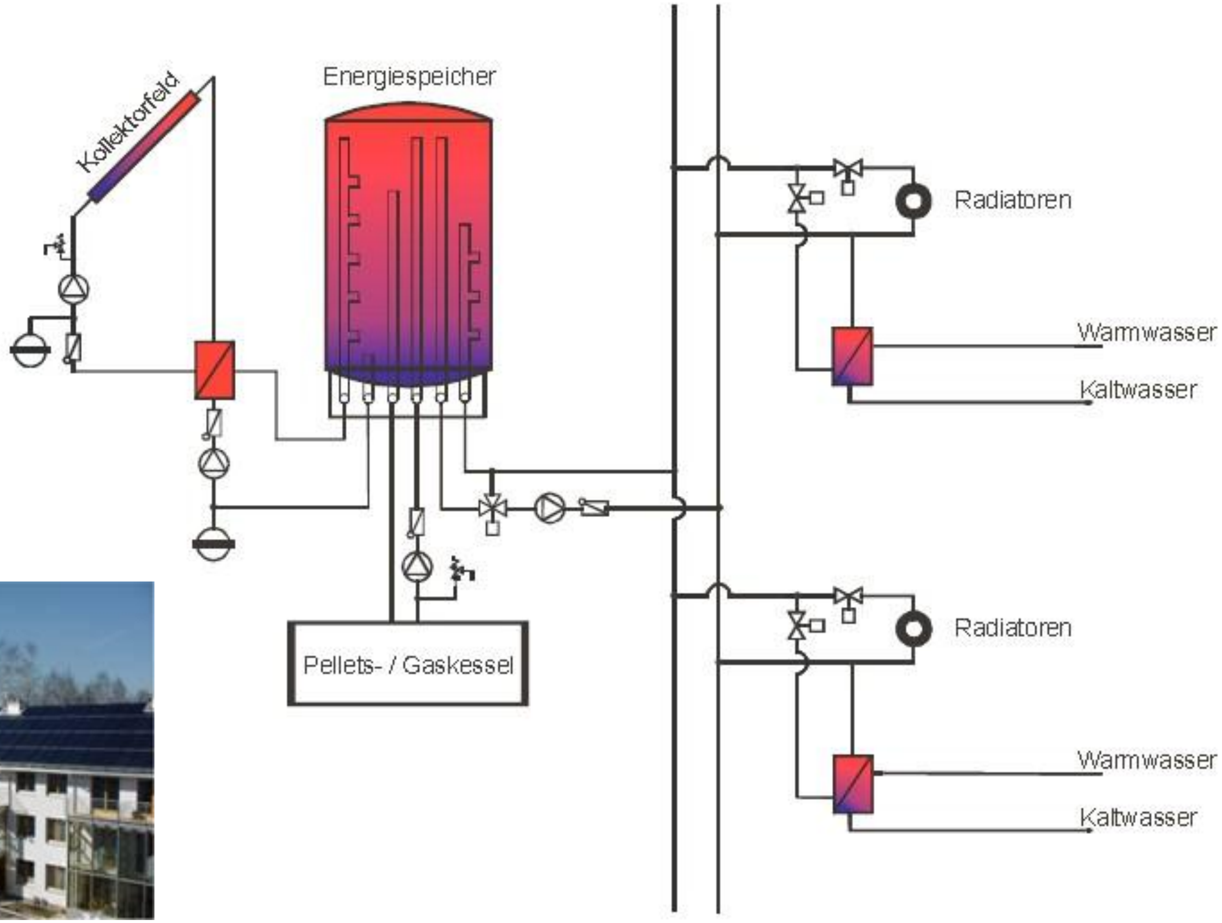
Tank in tank storage with solid fuel boiler



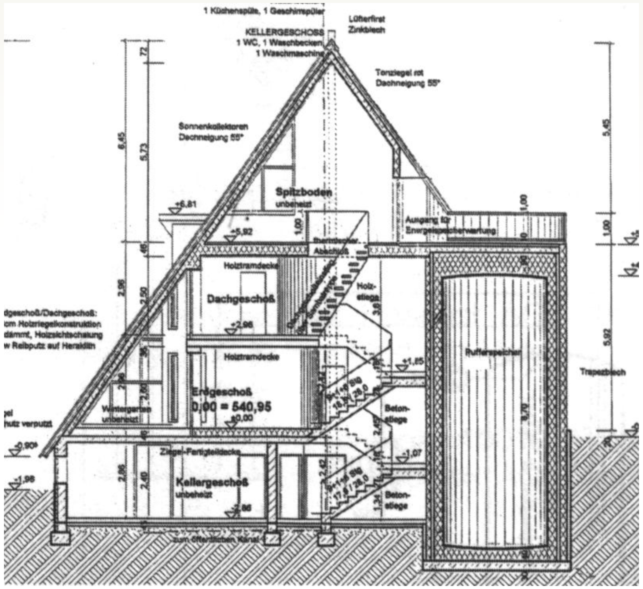
Single storage with inegrated gas-condensing boiler

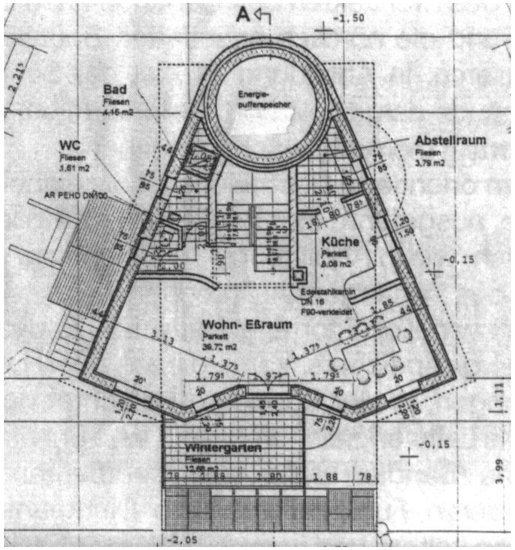


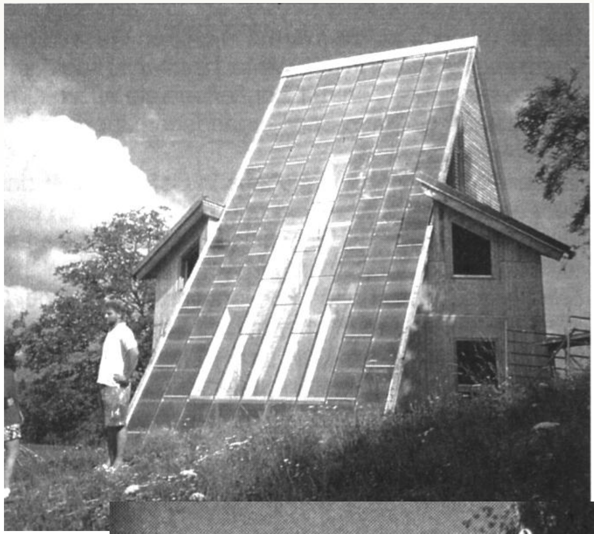
Systems for Multi Family House „Legionella free“, ÖNORM B 5019

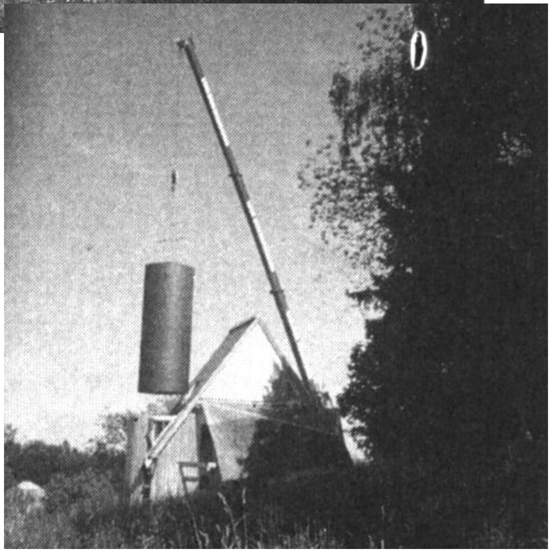


Example of purely solar heated house







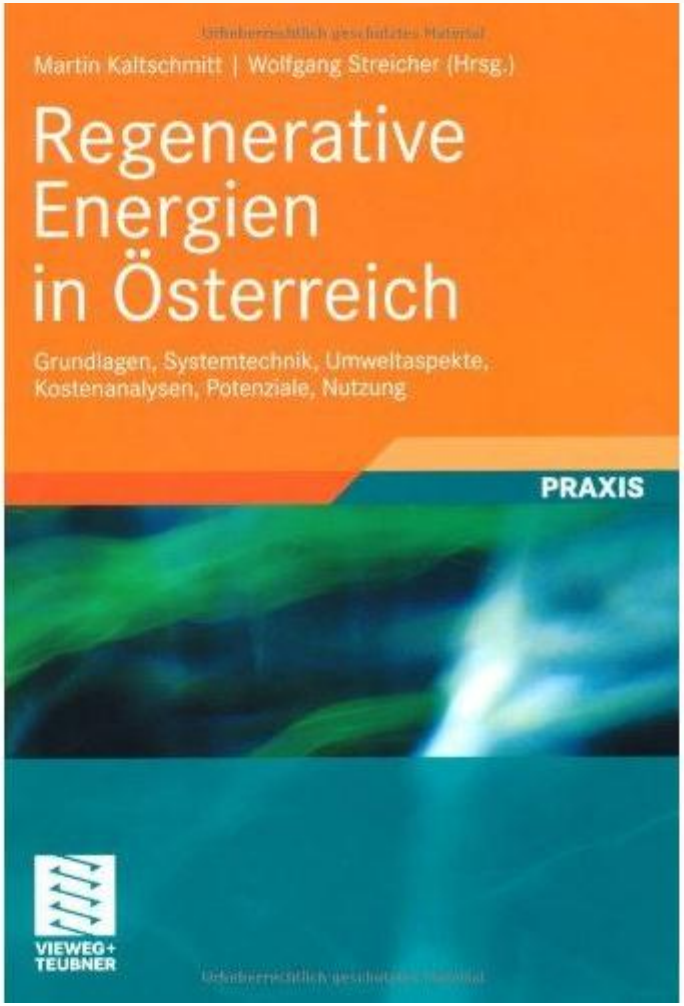


Renewable Energy in Austria – Perspektives and Potentials –

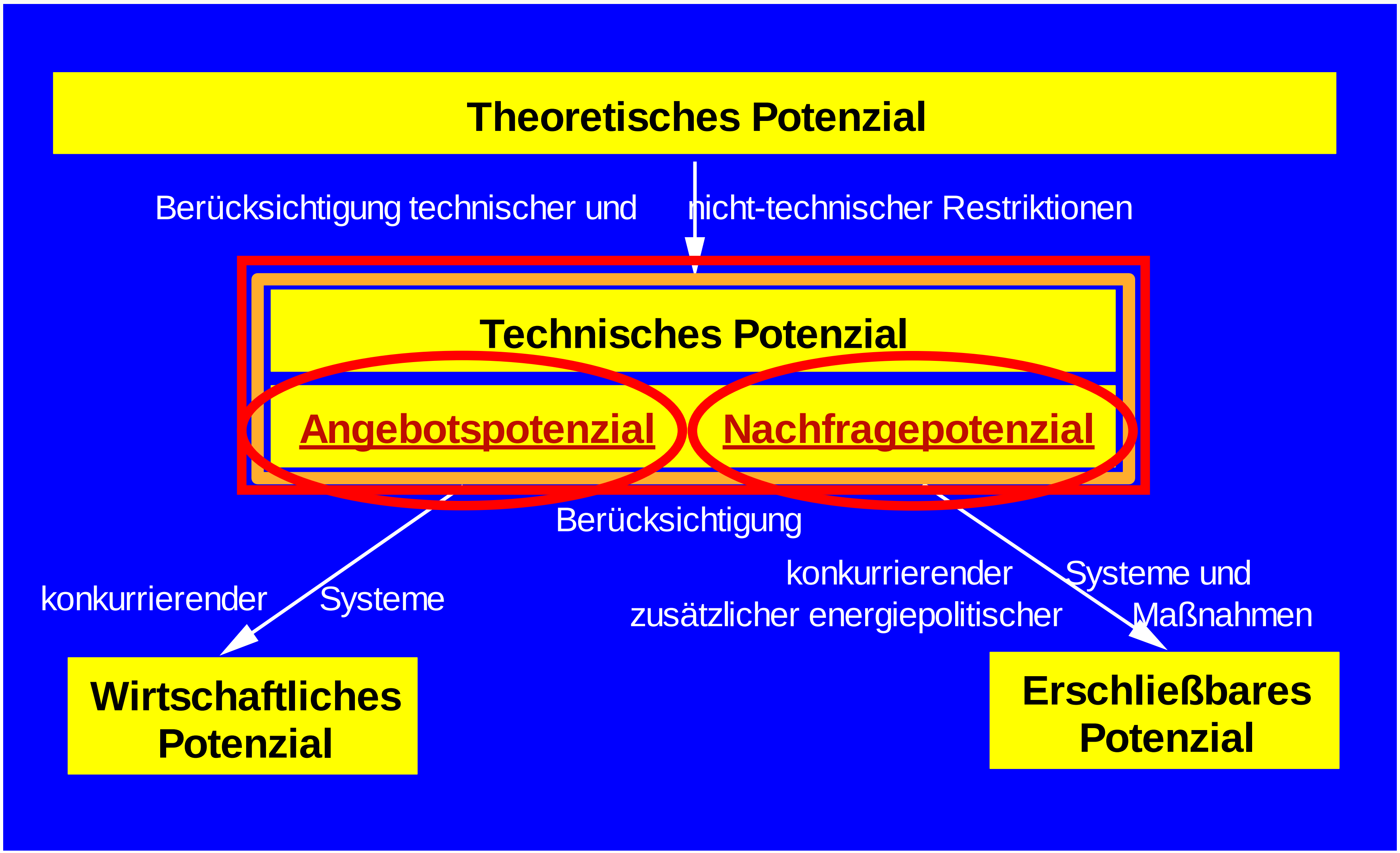
Martin Kaltschmitt, Wolfgang Streicher

Studie im Auftrag des Verbandes der Elektrizitätswerke Österreichs

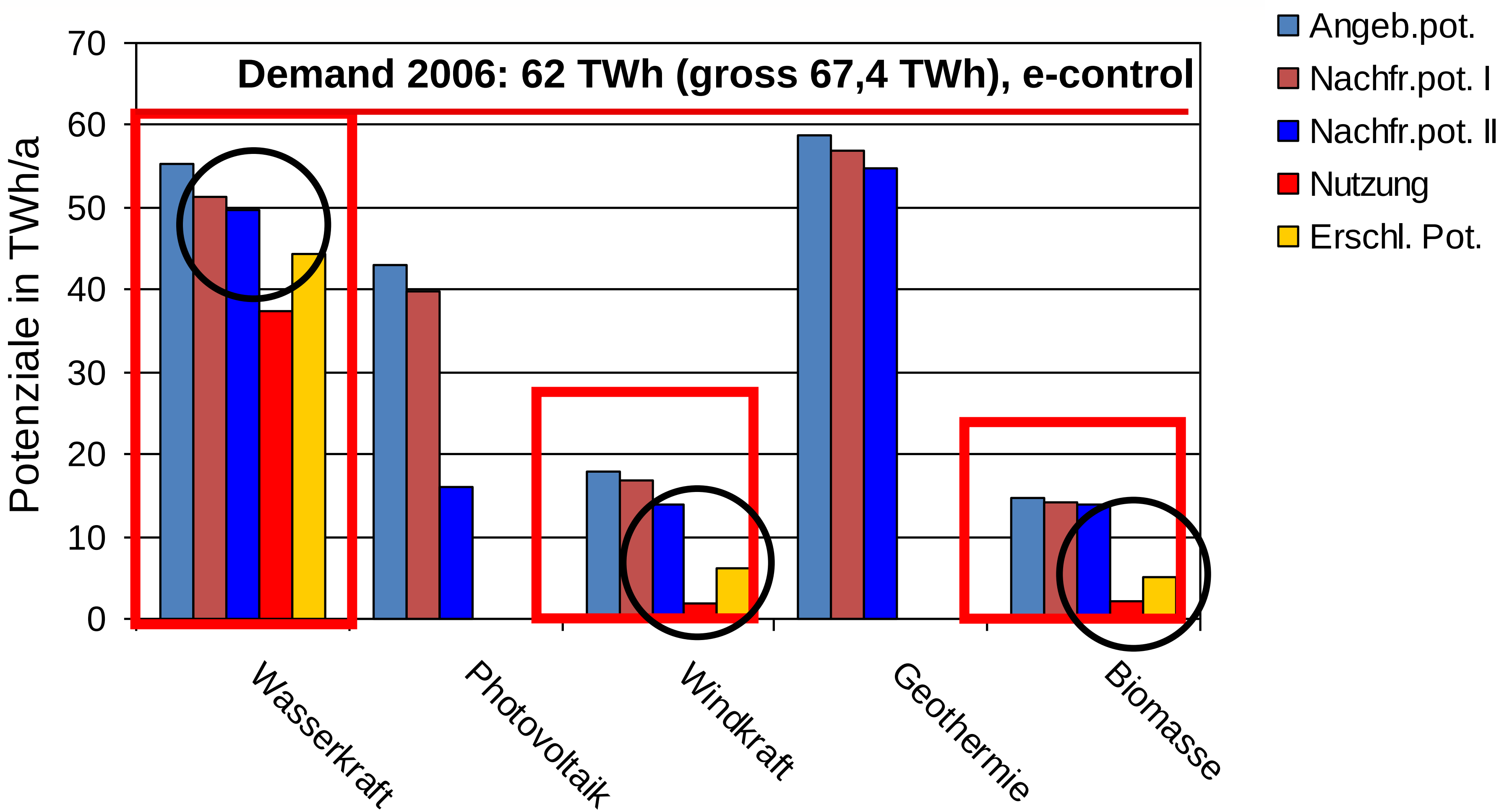
Verlag Vieweg&Teubner



Definition of Potentials

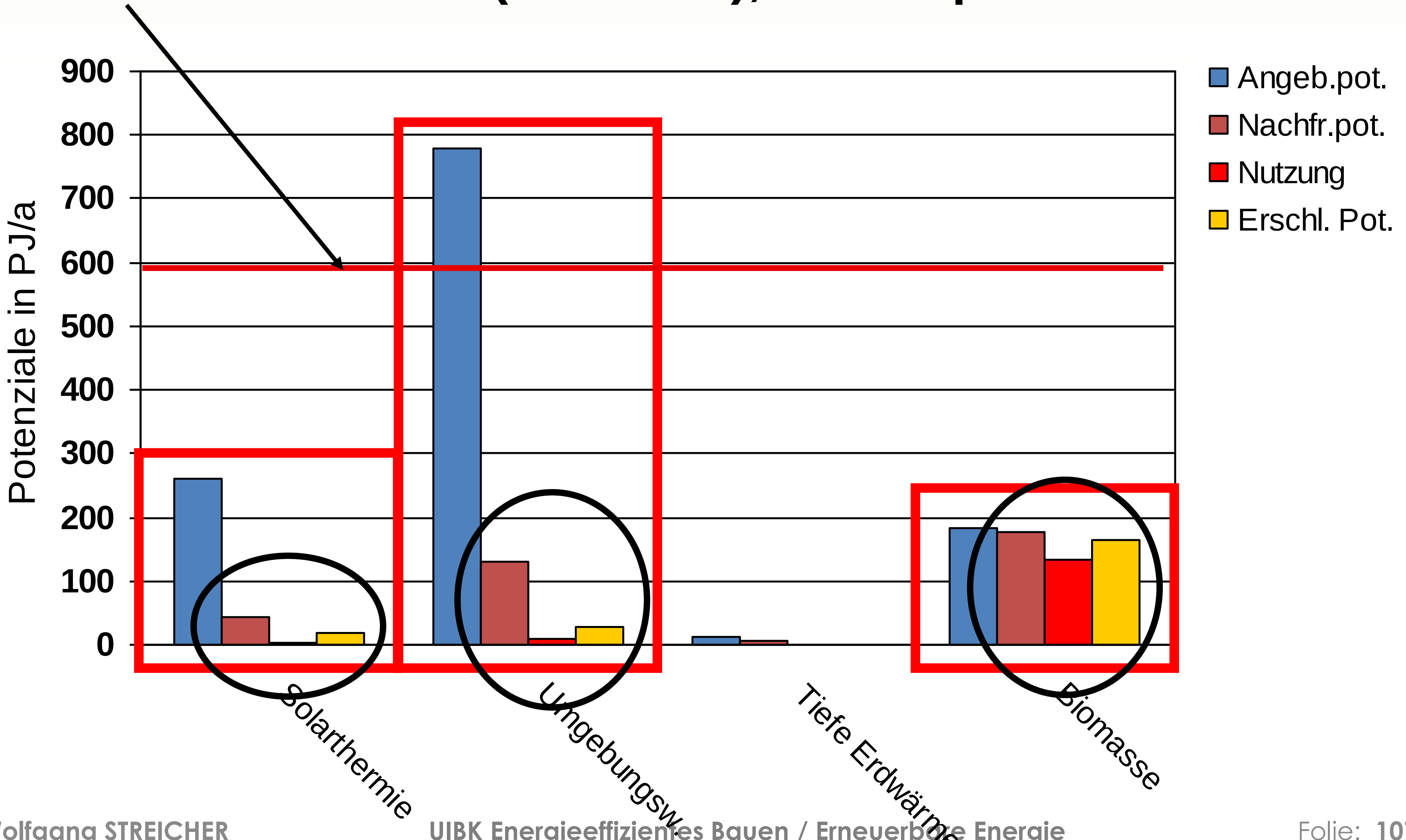


Electrical Energy – Medium term potentials in Austria



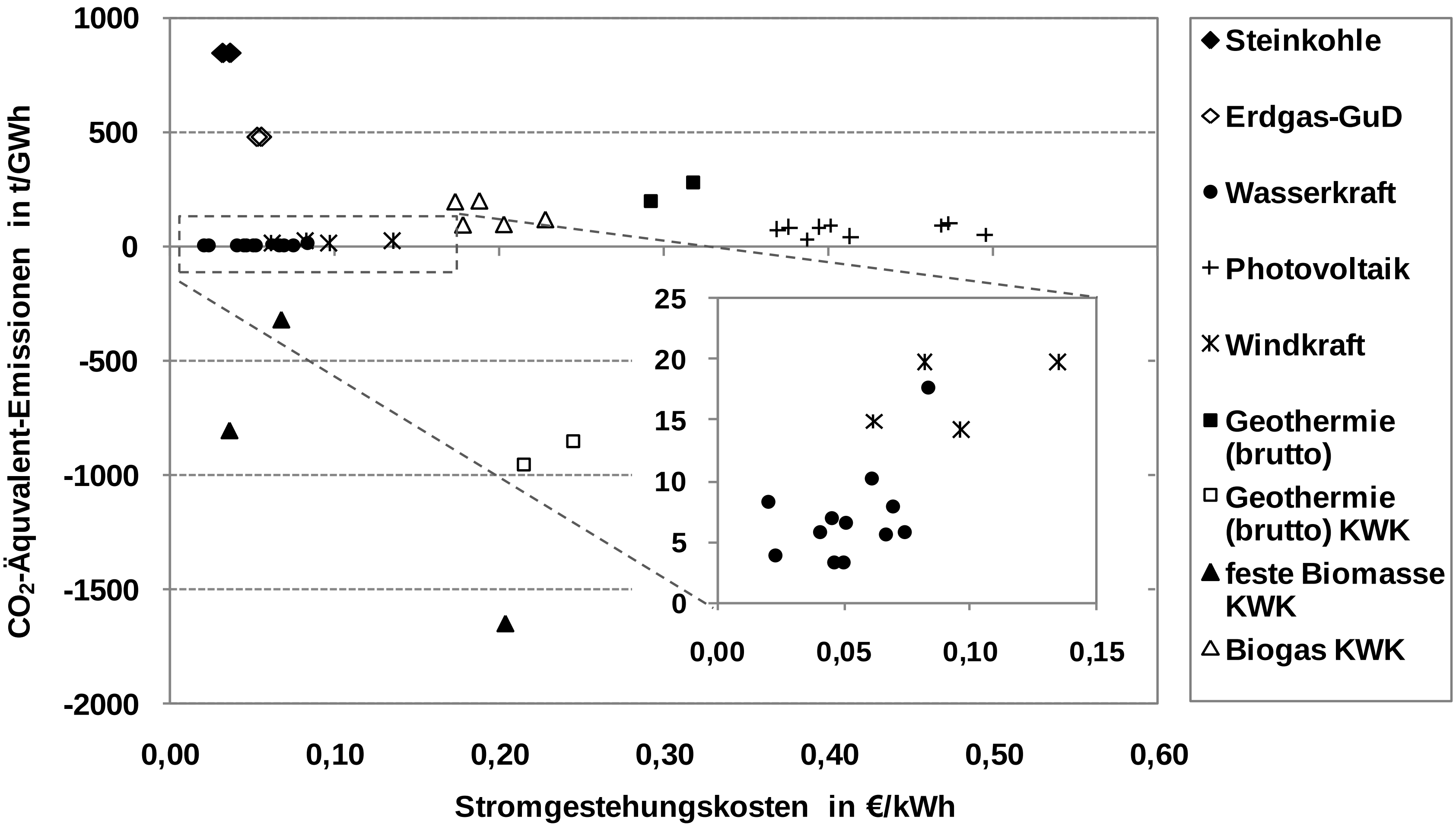
Thermal Energy – Medium term potentials in Austria

Demand 2006: 592 PJ (DHW+SH), 251 PJ process heat



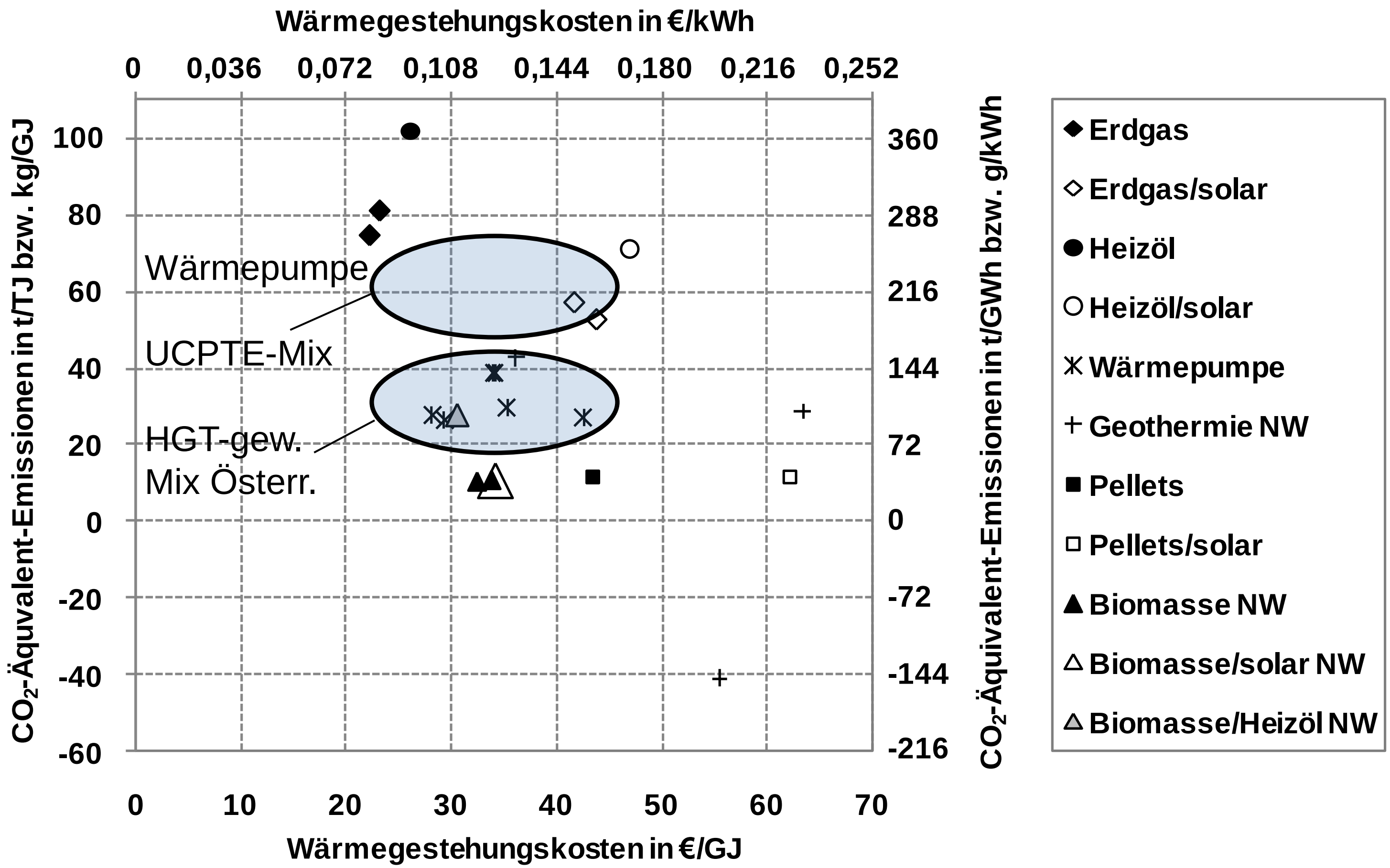
Electricity

specific CO2-equivalent-emissions – electricity generation costs



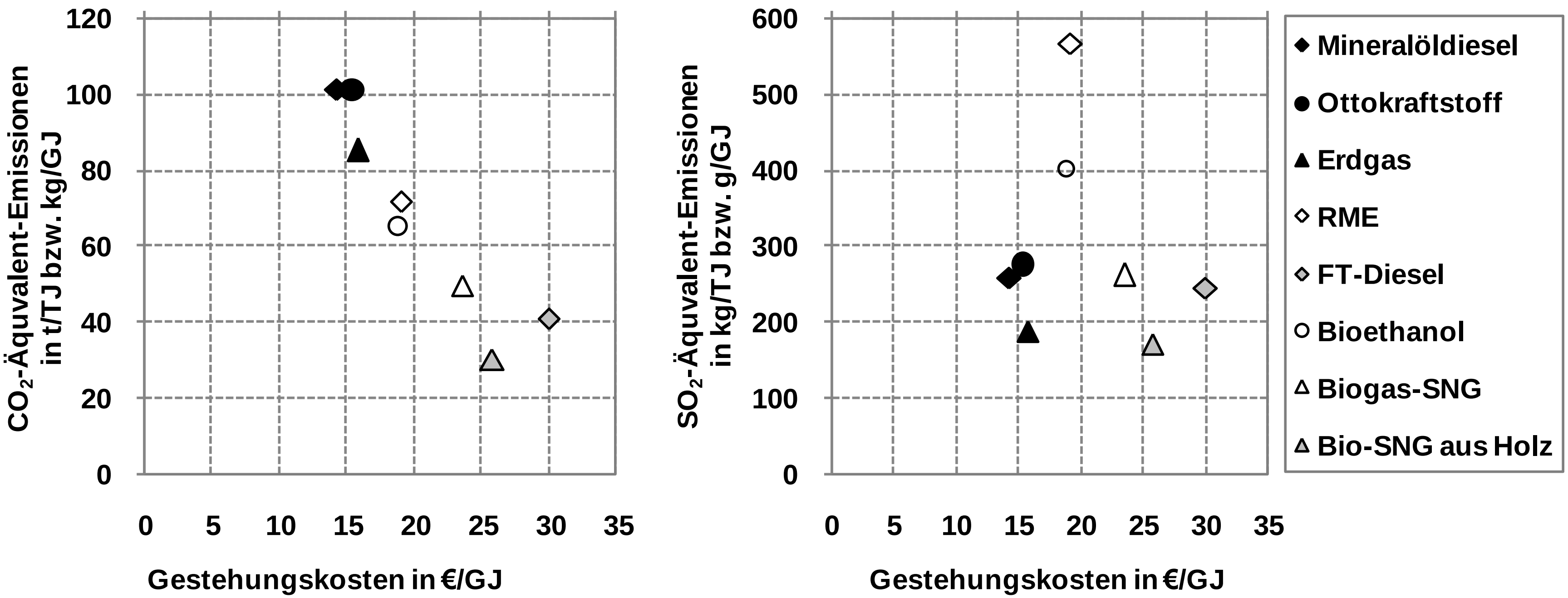
Heat generation

specific CO2-equivalent-emissions – heat generation costs
Example of EFH-1 with 8 KW heating load



Biofuels

specific CO2-equivalent-emissions – fuel generation costs



Energyautarky Austria 2050
Feasibility Study

lebensministerium.at

Lead, Overall Modell

Wolfgang Streicher, Universität Innsbruck, Institut für Konstruktion und Materialwissenschaften, Arbeitsbereich Energieeffizientes Bauen

Sector Industry/Production

Hans Schnitzer, Michaela Titz, TU Graz, Institut für Prozess- und Partikeltechnik

Sector Buildings

Florian Tatzber, Richard Heimrath, Ina Wetz, TU Graz, Institut für Wärmetechnik

Sector Transportation

Stefan Hausberger, TU Graz, Institut für Verbrennungskraftmaschinen und Thermodynamik
Andrea Damm, Karl Steininger, Universität Graz - Wegener Center for Climate and Global Change

Sector Energy Economy

Reinhard Haas, Gerald Kalt, TU Wien, Institut für Elektrische Anlagen und Energiewirtschaft, Energy Economics Group
Stephan Oblasser, Landesenergiebeauftragter Tirol

Review

Michael Cerveny, Andreas Veigl, ÖGUT, Wien

Consulting

Martin Kaltschmitt, Universität Hamburg-Harburg

Boundary Conditions

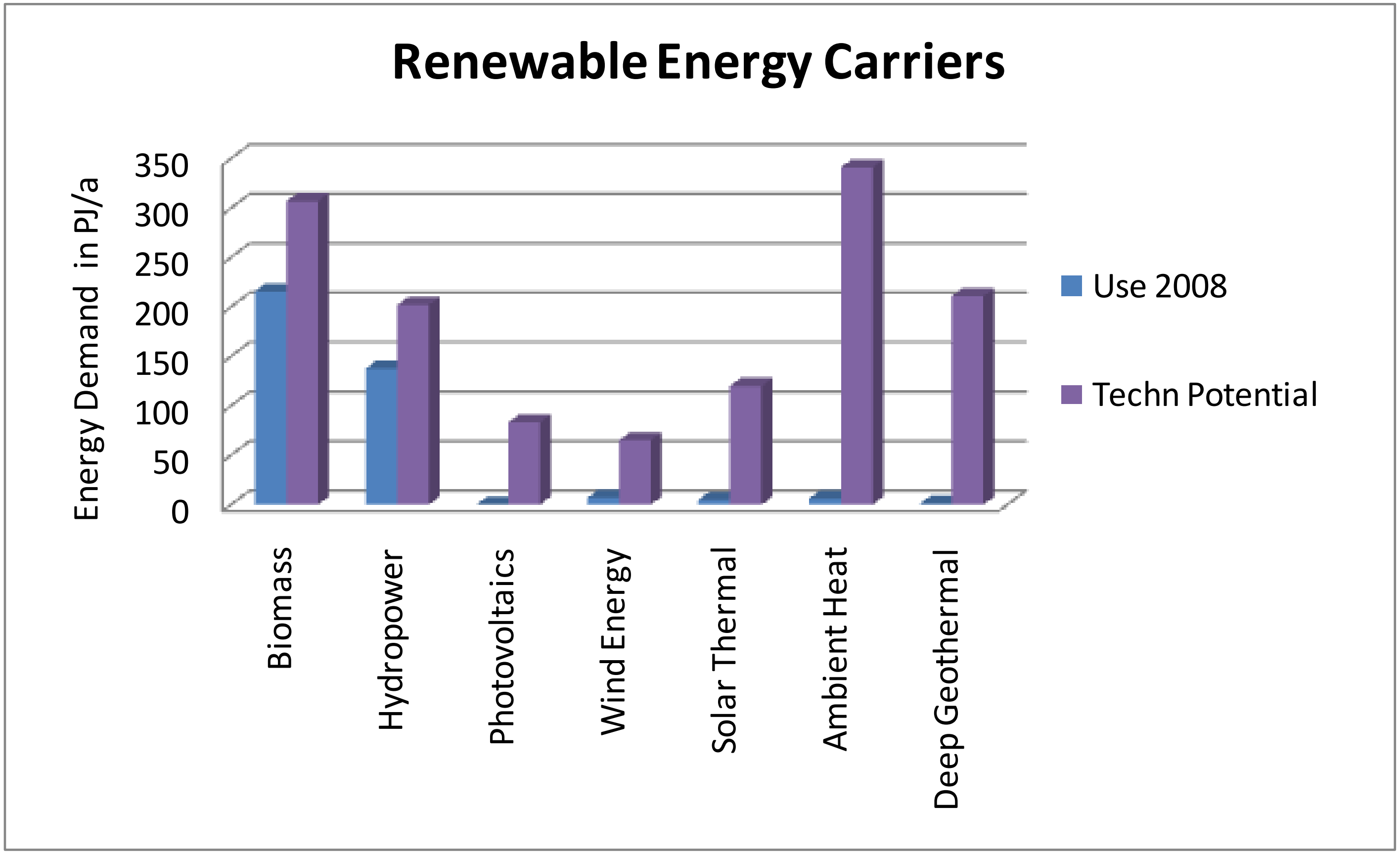
- Only Potentials of Renewable Energy Carriers from Austria (biomass, water, wind, sun, ambient heat, deep geothermal heat)
- Daily and weekly electricity exchange with neighbouring countries (European Context)
- Seasonal storage of electricity and Bio fuels in Austria
- Constant agricultural area for food and animal feed
- No fossil energy carriers, no nuclear energy
- „Backpack“ from imported food and goods is NOT taken into account (about 44 % of today fossil energy needs).
- Included sectors: Buildings, Mobility and Production (Industry)
- NO economic analysis

2 Scenarios

- *Constant-Scenario*: Constant Energy service until 2050 (conditioned m² building floor area, Pkm, tkm, constant gross value added of the industry)
- *Growth-Scenario*: Increase of the energy services by 0,8 %/a (ca. 40 % total growth from 2008 to 2050)

=> No reduction of population needs

Current Use and Technical Potential of Renewable Energies in Austria

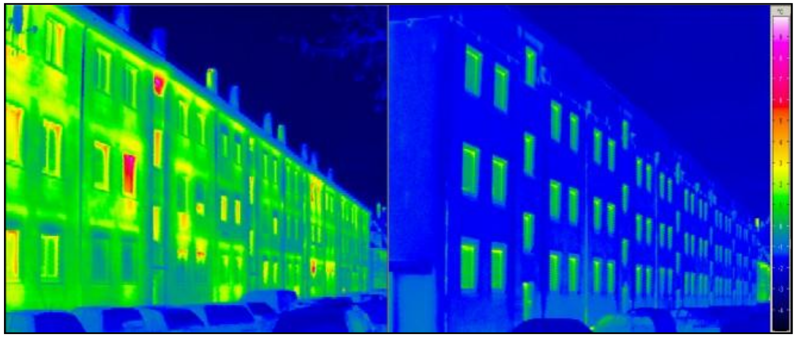


Solutions:

Reduction of Energy Demand
Buildings

- High Level Thermal Renovation of Old Buildings
- Building Codes, Spatial Planning

MFH rather than SFH



Solutions:
Reduction of Energy Demand in Mobility

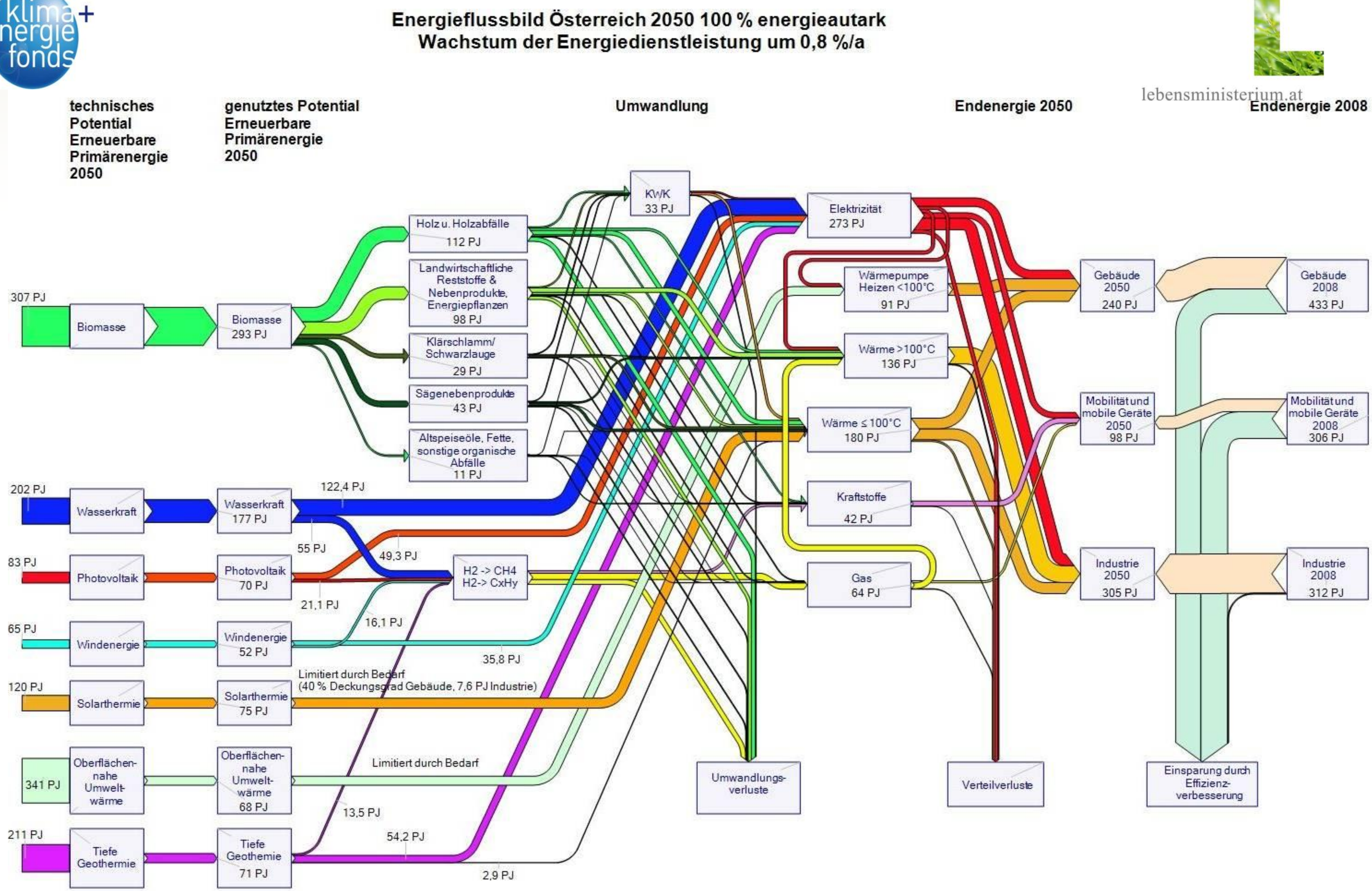
- Spatial planning (Mixed Land Use)
- Modal Split (Switch to Public Transportation and Non Motorized Traffic) (= Infrastructure)
- Low Fleet Fuel Demand, E-Mobility
- Interregional/International transport 100 % on rail



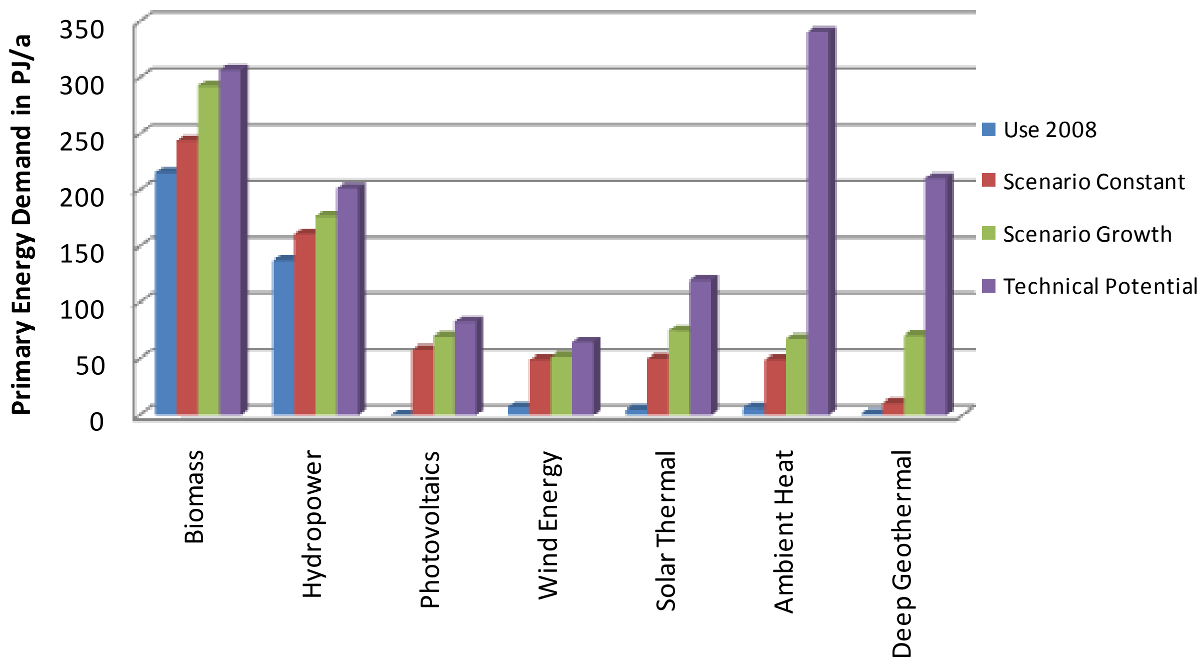

Solutions:

Reduction of the Energy Demand in Industry

- European Union Energie Efficiency Directive = 1 %/a Increase of Efficiency per Country
- Technological Progress

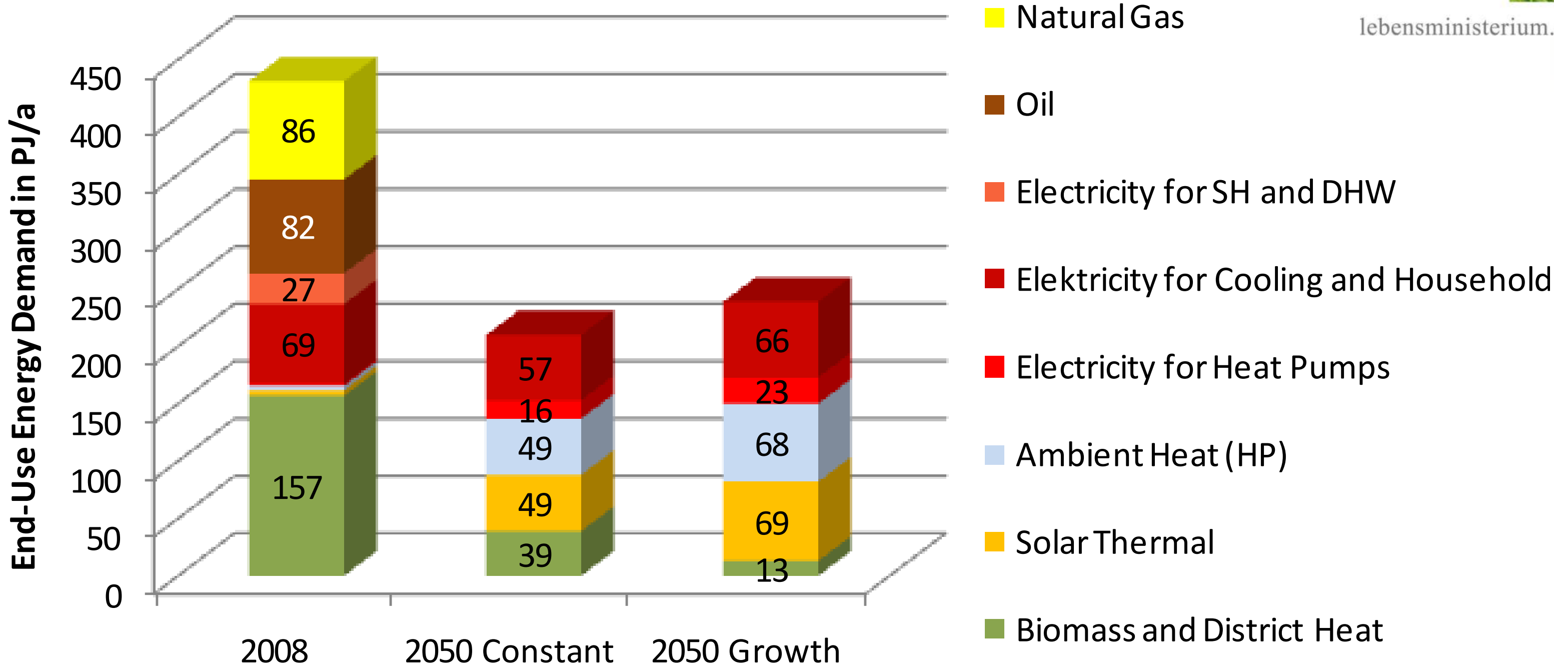

Energieflussbild Österreich 2050 100 % energieautark
Wachstum der Energiedienstleistung um 0,8 %/a
technisches Potential Erneuerbare Primärenergie 2050
genutztes Potential Erneuerbare Primärenergie 2050
Umwandlung
Endenergie 2050
Endenergie 2008
lebensministerium.at
307 PJ
Biomasse
Biomasse 293 PJ
Holz u. Holzabfälle 112 PJ
Landwirtschaftliche Reststoffe & Nebenprodukte, Energiepflanzen 98 PJ
Klärschlamm/ Schwarzlauge 29 PJ
Sägenebenprodukte 43 PJ
Altspeiseöle, Fette, sonstige organische Abfälle 11 PJ
202 PJ
Wasserkraft
Wasserkraft 177 PJ
122,4 PJ
55 PJ
49,3 PJ
83 PJ
Photovoltaik
Photovoltaik 70 PJ
21,1 PJ
16,1 PJ
H2 -> CH4
H2-> CxHy
65 PJ
Windenergie
Windenergie 52 PJ
35,8 PJ
120 PJ
Solarthermie
Solarthermie 75 PJ
Limitiert durch Bedarf
(40 % Deckungsgrad Gebäude, 7,6 PJ Industrie)
341 PJ
Oberflächen-nahe Umwelt-wärme
Oberflächen-nahe Umwelt-wärme 68 PJ
Limitiert durch Bedarf
13,5 PJ
211 PJ
Tiefe Geothermie
Tiefe Geothermie 71 PJ
54,2 PJ
2,9 PJ
KWK 33 PJ
Elektrizität 273 PJ
Wärmepumpe Heizen <100°C 91 PJ
Wärme >100°C 136 PJ
Wärme ≤ 100°C 180 PJ
Kraftstoffe 42 PJ
Gas 64 PJ
Umwandlungs-verluste
Verteilverluste
Gebäude 2050 240 PJ
Mobilität und mobile Geräte 2050 98 PJ
Industrie 2050 305 PJ
Gebäude 2008 433 PJ
Mobilität und mobile Geräte 2008 306 PJ
Industrie 2008 312 PJ
Einsparung durch Effizienz-verbesserung

Results: Primary Energy Renewable Energy Carriers



- **Potentials are nearly used up in the Growth Scenario**
- **Strong Increase for PV, Wind, Solar Thermal, Ambient Heat, Deep Geothermal**
- **Increase of the power of Pumping Power Stations by 85 % bzw. 130 %**

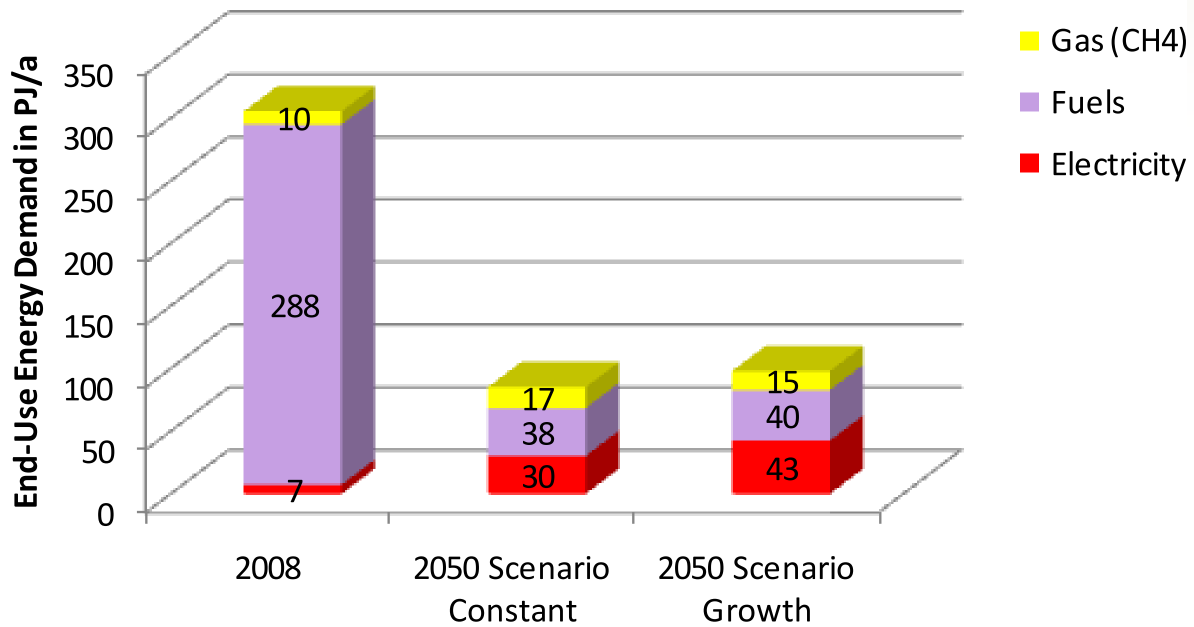
Results Buildings



- **Ca. 50 % Energy Demand Reduction =>**
  High Level Thermal Renovation of Old Buildings, New Buildings as Passive Houses

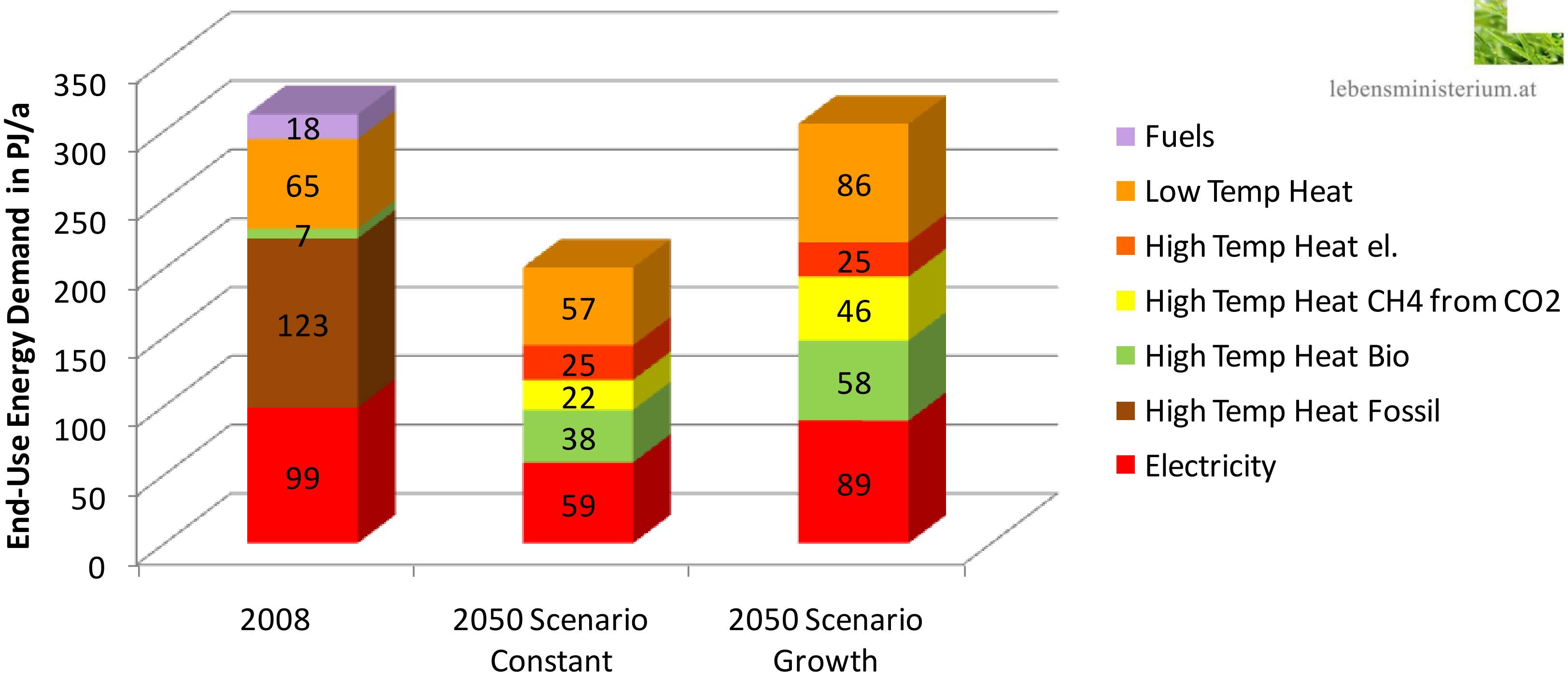
- **Switch to Solar Thermal, Heat Pumps, Reduction of Househol Electricity Demand (Biomass is used mainly in Mobility and Industry, especially in the Growth Scenario**

Results Mobility



- **Ca. 70 % Reduction of Energy Demand =>**
  Non Motorized Individual Traffic, Public Transportation, E-Vehicles (lightweight) 12 kWh/100km), Cars < 3 ltr/100 km, Long Distant Good Transport 100 % on Rail
- **Strong Increase of Public Transportation (Infrastructure)**
- **Fuels and CH_4 from Biomass as well as CO_2 from Athmosphere and H_2 from water (Fischer Tropsch)**

Results Industry



- **Ca. 35 % reduction (Constant-Scenario) e.g. constant demand (Growth Scenario) => this equals the EU Energy Efficiency Directive**
- **Low Temperature heat also from Solar Thermal, High Temperature Heat from CH_4 (from El. + CO_2) , Biomass, Electricity**

Results

- Energy Autarky is Theoretically Possible Without a Reduction of the Energy Services
- For a growth of the Energy Services (due to an increase of the population or an increase per person) over 0,8 %a a complete coverage of the energy demand will need additional effort in energy demand reduction
- The Needed Increase of the Energy Efficiency for the Scenarios of this Study already imply a Crucial Change of the Energy System and the form of the Energy Services
- The Degree of Freedom is Relatively Small, as the Potentials of Renewable Energy Carriers have to be Used Nearly Completely
- The Electricity Economy has to be seen always in a European Context
- To be able to Reach Energy Autarky in 2050 the Political Framework Conditions have to be set Already Today