EUROPEAN ECONOMIC CHAMBER OF TRADE, COMMERCE AND INDUSTRY (EEIG)
Central Office for European Quality Standards, Audits and Certifications
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EUROPEAN QUALITY STANDARD FOR ECOLOGICAL HOUSING (EU-ECO-QS)

Applicable for Private Houses, Offices and Company Buildings

A. Instructions for use

A.1. Quality Seal

The quality seal EuQSEH qualifies products and services which allow a more efficient input of energy and a broader use of sustainable energies and at the same time improve the quality of living, protect the competitiveness, and reduce the damage to the environment. The main aim of the quality seal is to strengthen the confidence in these products and services.

The products and services have to comply with general requirements to be in agreement with the specifications of the European Quality Standard for Ecological Housing. For the given reason,

(a) the total energy consumption has to be at least 25% less and the fossil energy consumption at least 50% less than the average of the latest technological development,
(b) the whole construction, installations, performance and implementation have to ensure at least the same comfort as actually customary,
(c) the whole construction, installations, performance and implementation have to be offered at competitive prices, i.e. the price must not exceed the price of comparable, conventional products by more than 10%,
(d) the waste management of the consumed goods has to be at least as problem-free as of conventional goods.

A.2. Property

Owner of the European Quality Standard for Ecological Housing is the European Economic Chamber of Trade, Commerce and Industry (EEIG). At the request of interested parties, the owner can allow the right of use of the European Quality Standard for Ecological Housing and the relevant quality seal for an unlimited time. The right of use may gain property developers, builder owners, master builders, architects, producers of building and construction materials, and the producers of absorbent and insulating materials.

A.3. Conformity

The quality seal can only be used if the offered products and services are in conformity with general legal requirements (e.g. national construction standards, local fire police instructions, EN 832/September 1998, EN ISO 6946/January 1997, EN ISO 7345/May 1996, EN ISO 10211-1/March 1996, EN ISO 13370/Oktober 1998, EN ISO 13789/July 1997, EN ISO 10077-1/December 2003, etc.) as a precondition and with the specific stipulations of the European Quality Standard for Ecological Housing. The user of the quality seal has to be registered at the European Economic Chamber of Trade, Commerce and Industry (EEIG).

A.4. Controls

The obedience to the European Quality Standard for Ecological Housing can be monitored and controlled by spot checks by the experts of the European Economic Chamber of Trade, Commerce and Industry (EEIG) or by independent institutions, e.g. consulting engineers, sworn appraisers, national institutes for heating and ventilation engineering, institutes for air-conditioning engineering, institutes for building material technology, institutes for construction technique, institutes for environ-mental technologies, and institutes for ecological house building.

Disobedience can be sanctioned by withdrawal of the right of use, debiting of examination expenses and administrative fees, payment of penalty for breach of contract, and claim of compensation, in case of damage by misuse.

A.5. Fees

The fees for using the brand and quality seal of the European Quality Standard for Ecological Housing depend on the extent of the project.

A.6. Liability

The European Economic Chamber of Trade, Commerce and Industry (EEIG) as owner of the European Quality Standard for Ecological Housing and the quality seal offers only information. From using this information cannot be deduced any compensation.

B. Area of application

The area of application includes housing (detached family homes, multiple dwelling houses for several families), blocks of flats (apartment houses), hotels, administration, offices, schools, sales rooms, restaurants, meeting places, hospitals, health resorts and wellness centres, industrial buildings, store rooms, sports halls, and indoor swimming pools.

C. General terms and definitions

Heated zone: rooms which are, with regard to their usual destination, heated directly or in-directly together with other rooms

Unheated zone: rooms which are not a part of a heated zone, especially attics, cold cellars, added car-parks, and winter gardens

Winter garden: Glass porch which is ventilated but not permanently opened to adjacent heated room

Outside temperature: Temperature of the open air

Indoor temperature: also “target temperature”; temperature of the heated zone which is the basis of calculation

Heat loss: quantity of thermal energy which passes from the heated zone to the outside surroundings by heat transport or ventilation (dissipation heat)

Heat gain: quantity of thermal energy which arises within the heated zone or enters into it independently of the heating system

Heat gain factor: Percentage of solar energy profit which gets into a building and other thermal energy which arises in the building and can be used for heating purposes

Effective heat storage capacity: Amount of the storage capacity of thermal energy which influences the need of heating energy

Heat demand: Calculated amount of thermal energy to maintain a fixed indoor temperature

Heating energy demand: Calculated demand of primary energy which is needed to cover the thermal energy with regard to transformation losses

Heating period: Period during which a building is heated

Heating threshold temperature: Outside temperature which is sufficient to hold a fixed indoor temperature in a building without heating

D. System of notation

Symbol	Denomination	Unit
a	numeric parameter for the extent of exploitation	-
A_B	area of the building which emits thermal energy	m^2
A_f	area of a frame and door	m^2
A_g	area of glass	m^2
A_i	area of part of the building	m^2
A_w	area of window	m^2
BGF_B	gross area of heated floor	m^2
$BGF_{B,DG}$	gross area of heated attic	m^2
C	effective heat storage capacity	Wh/K

c_a	specific thermal capacity of the air	Wh/(kg.K)
d	thickness of a construction part	m
f_g	percentage of glass of transparent construction parts	-
f_i	temperature correction factor of the construction part i	-
f_s	reduction factor for shading	-
g	total energy permeability of glass	-
g_w	effective energy permeability extent of glass	-
h_{DG}	gross height of the attic storey	m
HGT	heating grade days per month	Kd/M
	heating grade days per heating period	Kd/a
HT	number of heating days per months	d/M
	number of heating days per heating period	d/a
HWB_{BGF}	thermal energy demand related to area	kWh/(m^2.a)
I_j	radiation intensity with orientation j per month	kWh/(m^2.M)
	radiation intensity with orientation j per heating period	kWh/(m^2.a)
l_c	characteristic length of the building	m
k	thermal transmission factor	kWH/(m^2.h. °C)
L_e	transmission factor for construction parts which border on the fresh air	W/K
LEK	special LEK factor	-
l_g	length of the glass frame	m
L_g	transmission factor for construction parts which touch the ground	W/K
L_T	transmission factor of the building envelope	W/K
L_u	transmission factor for construction parts which border on unheated rooms	W/K
L_V	ventilation factor of the building envelope	W/K
L_χ	additive factor for point-based thermal bridges	W/K
L_ψ	additive factor for linear thermal bridges	W/K
n	air-exchange rate	1/h
n_x	additional air-exchange rate by wind and buoyancy	1/h
P_1	heating capacity related to area	W/m^2
$P_{T,V}$	transmission factor related to volume	W/(m^3.K)
P_{tot}	heating capacity of the total building	W
Q_h	quantity of heating energy demand per month	kWh/M
	quantity of heating energy demand per heating period	kWh/a
q_i	middle heat flow density of internal heat gains	W/m^2
Q_i	internal heat gains per month	kWh/M
	internal heat gains per year	kWh/a
Q_s	solar heat gains via transparent construction parts per month	kWh/M
	solar heat gains via transparent construction parts per year	kWh/a
Q_T	transmission heat loss per month	kWh/M
	transmission heat loss per year	kWh/a
Q_V	ventilation heat loss per month	kWh/M
	ventilation heat loss per year	kWh/a
$q_{V,f}$	air-flow volume by mechanical ventilation	m^3/h
R_{si}	heat transfer resistance of inside air to construction surface	m^2.K/W
R_{se}	heat transfer resistance of construction surface to outside air	m^2.K/W
SPF	seasonal performance factor (ratio heating output to electric power input	-
U_f	heat transfer coefficient of frames	W/(m^2.K)
U_g	heat transfer coefficient of glass	W/(m^2.K)
Ui	heat transfer coefficient of construction part i	W/(m^2.K)

U_m	middle heat transfer coefficient of heat emitting building envelope	$W/(m^2.K)$
U_w	heat transfer coefficient of windows	$W/(m^2.K)$
V_B	heated gross volume of the building	m^3
$V_{B,DG}$	heated gross volume of developped attic	m^3
V_N	ventilated net volume of the building	m^3
WE	thermal energy unit	kWh/m^2
γ	ratio of heat gains to heat losses	-
η	exploitation factor of heat gains	-
η_v	efficiency of the heat recovery system	-
$\eta_{v,eff}$	effective heat supply factor of the heat recovery system	-
λ	measurement of the heat conductivity	W/(m.K)
θ_i	middle inside temperature during one month or heating period	°C
θ_e	middle outside temperature during one month or heating period	°C
θ_{ne}	standard outside temperature	°C
ρ_a	density of the air	kg/m^3
τ	time constant of the building	h
ψ_g	correction coefficient for heat bridges between frame and glass	W/(m.K)

Index figures:

a	air	c	characteristic	e	external
f	fan, frame	g	ground, glass	h	heating, heated
i	internal, numerator	j	orientation	m	middle
s	solar	se	external surface	si	internal surface
u	unheated	v	ventilated	w	window, effect.
x	extra	B	gross, heated	N	net
S	shading	T	transmission	V	ventilation, vol.

E. Assessment criteria

For the assessment and evaluation of the practical results of using the European Quality Standard for Ecological Housing serves a system of 1,000 ecological points, according to the following catalogue:

1	**Planning and performance**	**maximum**	**140 points**
1.1	Quality of infrastructure (near to school, supermarket, pharmacy, sports hall, cultural centre, etc.)	15	
1.2	Storeroom for bicycles	10	
1.3	Hindrance-free building – outside (to avoid accidents)[1)]	20	
1.4	Hindrance-free building – inside (to avoid accidents)[1)]		20
1.5	Building surface, heat bridges sparse[2)]	25	

1.6	Building surface, heat bridges free[2]	35	
1.7	Building surface airtight (standard)[3]	20	
1.8	Building surface airtight (with special ventilation)[3]		40

2 Energy supply for heating purposes maximum 545 points

2.1	Calculation of the heating energy demand	150
2.2	Heating with coal, coke, or electric resistance heating	0
2.3	Heating with natural gas or oil	0
2.4	Heat pump monovalent (without thermal recovery)[4]	100
2.5	Heat pump compact aggregate[4]	250
2.6	District heating and long-distance supply[4]	300
2.7	Heating with biogene fuels[4]	200
2.8	Electric water heater[5]	25
2.9	Electric hot-water tank[5]	55
2.10	Solar hot-water supply[5]	95

3 Electric energy supply for other purposes maximum 90 points

3.1	Mechanical ventilation (with comfort and energy-efficient use)	25
3.2	Lighting (energy-saving use)	10
3.3	Rinsing and washing with warm water	10
3.4	Photovoltaic installations	45

4 Water supply maximum 30 points

4.1	Wash-basin with water-saving water tap	10
4.2	Shower with water-saving hothead	10
4.3	Bath tube with water-saving hothead	10

5 Building material and construction maximum 85 points

5.1	Insulating materials (free of HFCHC)	5
5.2	Windows, doors, shutters and blinds (free of PVC)	10
5.3	Pipes, films, layers, coating, covering, wallpapers (free of PVC)	20
5.4	Bitumen and other paintings, adhesives (free of solvents)	5
5.5	Building material, ecologically optimized	15
5.6	Ecological assessment of the whole building[8]	30

6 Air quality and amenities maximum 110 points

6.1	The building is suitable for summer (cool rooms etc.)	15
6.2	Fresh air ventilation (sound absorbing)[6)]	20
6.3	Comfort fresh air ventilation (soundproof, filter, free of CO_2)[6)]	30
6.4	Floor covering materials, filler, adhesives (free of VOC)[7)]	5
6.5	Floor covering materials, filler, adhesives (free of VOC and CMT)[7)]	15
6.6	Wooden parts of the building (free of emissions)	10
6.7	Paintings of walls and ceilings (free of emission)	10
6.8	Measuring of volatile hydrocarbons and formaldehyde	30

Total evaluation **maximum 1,000 points**

Explanatory remarks:

1) 2) 3) 4) 5) 6) 7)	= alternatively used
8)	= additionally
VOC	= organic volatile compounds
CMT	= carcinogenic mutagenic and teratogenic compounds
HFCHC	= halogenous fluoride chloride hydrocarbons

A certification according to the European Standard of Ecological Housing with the right of using the quality seal of the European Economic Chamber of Trade, Commerce and Industry (EEIG) can take place when at least 750 points of 1,000 possible points are reached.

F. Explanations

Buildings according to the European Quality Standard for Ecological Housing are buildings with a very low demand of thermal energy. They have an energetically efficient and silent mechanic ventilation, an energetically efficient hot-water system and water-saving fittings. The use of gas and oil is permissible if the heating technologies applied are efficient and other measures are used to reduce the emission of harmful substances (insulation, filters) and to recycle thermal energy etc.

Further criteria of ecological buildings are environmentally beneficial building materials and constructions, non-polluting installations, and a high living comfort because of a good fresh air quality inside (free of immissions from outside) and protection against humidity, bad smell, and mould.

Planning and performance

1.1 All places to cover the daily need (shopping, school, doctor etc.) should be within a radius of 500 m to be able to do it without car or only by bicycle (for distances up to 4 kms.. Without traffic, there is a higher living quality since less dust, noise and exhaust fumes are produced.

1.2 The minimum storeroom for bicycles is 0.05 m^2 per m^2 gross area of heated floor (BGF_h). The storeroom should be ground level and, if necessary, with a ramp. The thermal need can be calculated with 5 WE (thermal energy unit) per m^2.

1.3 To avoid accidents, especially of elderly persons, there should be no barriers and hindrances, e.g. sills, thresholds, embankments, near the entrance of the building and in the surroundings.

1.4 For the same reason, there should be no thresholds inside the building. Doors and passages should have a breadth of at least 0.80 m. Toilets, bathrooms (bath tubes, and showers should be on the same level as the floor. Inside these rooms should be a turning circle of at least 1.50 m.

1.5/1.6 The loss of thermal energy in parts of the construction with a low surface temperature should be avoided because that causes, besides higher cost for energy, condensates on the inner side and damage of the construction. The result can be high humidity and mould on these parts (walls etc.) which damages the health and reduces the living quality. Using the right materials and methods the need of thermal energy can be reduced by 12 $kWh/m^2_{BGF}.a$.

1.7/1.8 The aim is to have an airtight building since leaks cause humidity and structural damages which is particularly essential for occupied attics because of smoke and smells from neighbouring apartments. There is also a higher level of noises in building that is not airtight. In old houses with normal leaks the air exchange rate amounts to $n < 0.6\ h^{-1}$. The air exchange rate of mechanically ventilated buildings is $n < 1.5\ h^{-1}$.

2.1 The main aim of ecological houses according to the European Quality Standard for Ecological buildings is to reduce the total need of thermal energy to save costs and to reduce ecological damages, mainly by emissions. Optimized ecological buildings can reduce the need of thermal energy by 35-40% or roughly 45 $kWh/(m^2_{BGFh}.a)$.

The specific demand of thermal energy related to area (HWB_{BGF}) is the amount of energy per heated m^2 of the building to hold an inside temperature of 20°C at a certain place (depending on the climate) during one year. The ratio for the compactness of a building is $1/lc = A/V$. The thermal energy demand depends not only on the compactness, air tightness, building materials and insulations used but also on the sea level, strength of wind, directions, percentage of doors and windows and other parts of lightweight construction.

2.2/2.3 It should be paid attention to keep the needed amount of primary energy and the emission of CO_2 as small as possible. Since the transmission ration (kWh_{prim}/kWh_{end}) of electricity (approx. 3) is rather unfavourable in comparison e.g. to gas (1.1), the share of electric energy should be kept below 2 kWh/m^2.

2.4/2.5 Heat pumps with a seasonal performance factor (SPF) of 4.0 are able to reduce the CO_2 emission in comparison to gas heating by nearly 20%. This seasonal performance factor describes the ratio of heating output to the electric power input. The heating systems works with water temperature less than 35°C. Usually only 80% of the total heat can be covered by this system.

2.6 The most efficient way to use the primary energy of district heating is to combine heating and hot-water preparation.

2.7 Using these means helps to become independent from non-regenerative fuels and to reduce the CO_2 emission by relying on sustainable fuels as e.g. wood pellets and bio-mass.

2.8/2.9 Since the transmission factor of electric energy is rather inefficient, general heating of water by electricity as a primary energy should be avoided. Hot-water tanks should have an insulation of at least 10 cm with a conductivity of the insulating material of 0.04 W/(m.K). Example for an energy loss calculation:

Storage volume: 500 litres
Product specific thermal loss factor: 3.0
Middle storage temperature: 55°C
Middle room temperature: 20°C
Thermal energy loss of the tank: 3.0 * (55 – 20) = 105 W

Thermal energy loss of insulated hot-water tanks:

Storage volume (litres)	Thermal loss (Watt) insulation 10 cm	Thermal loss (Watt) insulation 15 cm
25	20	15
50	29	22
75	37	28
100	43	32
150	54	41
200	64	48
300	80	60
500	108	81
750	137	103
1000	162	122
1500	207	155
2000	247	185

2.10 Thermic solar systems can contribute to a considerable amount to the total demand of primary energy for the hot-water supply.

3.1 Using energy efficient direct currency (DC) ventilation with thermal recycling, the needed electricity can be reduced by 260 kWh/a per year. The electric power need should be less than 0.3 W/(m^3.h).

3.2 As the consumption of electric energy of households is rising it is essential to find means to reduce it, e.g. by sensible using of movement signals, automatically operating switches, energy-saving lamps, neon tubes with electronic bulkhead units.

3.3 Cold and hot water-service pipe (taps) for dishwashers and washing-machines.

3.4 Photovoltaic installations can be integrated on roofs, facades, carports etc. Their dimension should be 1 – 5 W_{peak} per m^2_{BGFh}.

4.1/4.2/4.3 It makes sense to save water, not only by financial and energetic reasons but also to take care of the environment and the valuable drinking water and hot water. Therefore, the consumption of water should be reduced to:

wash-basin	maximum 6 litres per minute
water-saving hotheads	maximum 9 litres per minute
bath tubes	maximum 12 litres per minute

5. General principles for all building materials and construction are:
   (a) avoiding materials which contain halogenous fluoride and chloride hydrocarbons and tropical woods
   (b) avoiding of materials which show weaknesses during their life cycle, e.g. PVC
   (c) avoiding of materials contain solvents and other substances which cause problems in the waste management
   (d) pushing products which have good qualities during their life cycle, as e.g. ecologically tested materials
   (e) ecologically optimized use of building materials and constructions.

6.1. The aim is to build houses which are not too hot in summer and which do not need to be refurnished with cooling aggregates at a later stage.

6.2/6.3 The fresh air ventilation should be steered by the content of humidity, CO_2 and dust particles. It should operate in a silent way. The internal leak stream should be less than 3% with 100 Pa. There should be a three degrees or a continuous regulation. The fresh air inflow in a standard house for one family is approx. 30 m^3/h. The inflowing air should have a temperature of at least 17°C to minimize draught phenomena. The air-exchange rate amounts to more than 0.3 h^{-1}.

6.4/6.5 The limits of total organic volatile compounds are less than:

100 µg/m^3 … for filling material
200 µg/m^3 … for adhesives
500 µg/m^3 … for floor covering materials

Final limits of emission of elastic floor coverings on the 28th day:

Aromas incl. Styrol	70 µg/m^2 h
Halogenous volatile organic compounds	40 µg/m^2 h
Total of volatile organic compounds	380 µg/m^2 h
Smell and irritating substance:	
Nonanal	70 µg/m^2 h
Hexanal	20 µg/m^2 h
Styrol	30 µg/m^2 h

Final limits of emission of textile floor coverings on the 28th day:

TVOC	< 300

6.6 Final limits of emission of wood, e.g. doors, panelling, laminates, finished parquet, on the 28th day:

Formaldehyde	0.05 ppm
Organic compounds (boiling point 50-25)	300 µg/m³
Organic compounds (boiling point > 250°C)	100 µg/m³
CMT substances	< 1 µg/m³

6.7 Approx. ¾ of all areas of a building are walls and ceilings. Limits of emission of paintings of walls and ceilings (volatile organic compounds):

Synthetic resin dispersion	max. 0.1 (mass)%
Natural resin dispersion	max. 1.0 (mass)%
Other organic substances in silicate dispersion	max. 5.0 (mass)%

All organic compounds with a boiling point of max. 250°C at normal pressure (101,3 kPa) should follow the stipulations of EC/2002/739 of the European Commission.

6.8 The air quality should be measured 28 days after finishing of the rooms. The total content of organic volatile compounds (TVOC) must be less than 500 µg/m³. The limit of formaldehyde concentration has to be less than 0.05 ppm.

G. Additional technical data

Influence of climate

For every 100 m difference of level there are supplements of:

+/- 3% …… to HGT

+/- 8% …… to HT

+/- 0.5 K …. to i_f

Inside temperature (i_f):

Residential buildings, offices, schools ……	i_f = 20 °C
Hospitals, nursing homes ……	θ_i = 22 °C
Industrial buildings ……	θ_i = 18 °C

Heating grade days:

$HGT = HT * (\theta_i - \theta_e)$ …. Kd/M (per month), resp. Kd/a (per year)

Ventilated net volume of the building:

$V_N = 0.75 * V_B =$ …. m^3

Gross area of heated floor:

$BGF_B =$ …. m^2

Gross area of heated attic:

$BGF_{B,DG} = V_{B, DG} / h_{DG} =$ …. m_2

Characteristic length of building:

$l_c = V_B / A_B =$ …. m

Area of glass and frames:

$A_g = f_g * A_W =$ …. m^2

$A_f = (1 - f_g) * A_w =$ …. m^2

$f_g = 0.7$

Length of window frames:

$l_g = 3 * A_W =$ …. m

Total heat energy demand:

$Q_h = (Q_T + Q_V) - \eta * (Q_i + Q_s) =$ …. kWh/M (per month), resp. kWh/a (per year)

Transmission loss of thermal energy:

$Q_T = 0.024 * L_T * HGT =$ …. kWh/M (per month), resp. kWh/a (per year)

Transmission factor of the building envelope:

$L_T = L_e + L_u + L_g + L_\psi + L_\chi =$ …. W/K

Transmission factors for building parts:

$L_e + L_u + L_g = \sum_i f_i * U_i * A_i =$ …. W/K

Additive factor for thermal bridges:

$L\psi + L\chi = 0.2 * [0.75 - (L_e + L_u + L_g)/A_B] * (L_e + L_u + L_g) > 0.$ ….. W/K

Heat transfer coefficient for building parts:

$U_i = 1/(R_{si} + \sum_m \frac{d_m}{\lambda_m} + R_{se}) =$ ….. $W/(m^2.K)$

Heat transfer coefficient of windows:

$U_w = (A_g * U_g + A_f * U_f + l_g * \psi_g)7 (Ag + Af) =$ …… $W/(m^2.K)$

Temporal heat protection:

It can be achieved by roller blinds and folding shutters.

Middle heat transfer coefficient of heat emitting building envelope:

$U_m = L_T / A_B =$ …. $W/(m^2.K)$

Ventilation heat losses:

$Q_V = 0.024 * L_V * HGT =$ …. kWh/M (per month), resp. kWh/a (per year)

Ventilation factor of the building envelope:

$L_V = \rho_a * c_a * n * V_N =$ …. W/K

In this equation the specific thermal capacity of the air is equivalent to
$\rho_a * c_a = 0.33\ Wh/(m^3.K)$

Air-exchange rate:

The air exchange depends on the purpose of the building. Normally, the air-exchange rate is

n = 0.4 …. in 1/h

By reasons of hygiene, there can be higher air-exchange rates.

The air-exchange rate in heat recovering systems is

$n = q_{V,f}/V_N * (1 - \eta_V) + n_x =$ …. in 1/h

as has to be higher than 0.4/h.

Heat supply factor:

The heat supply factor of a geothermal exchanger (EWT) is

$\eta_{v,ges} = 1 - (1 - \eta_{v,eff}) * (1 - \eta_{v,EWT})$

An additional air-exchange rate for false air (infiltrated air) has to be considered:

> 0.6 fold air exchange with air permeability test …..	n_x = 0.04
0.6 – 1.0 fold air exchange with air permeability test ….	n_x = 0.07
1.0 – 1.5 fold air exchange with air permeability test ..…	n_x = 0,12
> 1.5 fold air exchange with air permeability test ….	n_x = 0,20
without any air permeability test …..	n_x = 0,20

If the manufacturer's data of heat exchangers are ….% (η_v) the real heat supply ($\eta_{v,eff}$) is….% taking into account a general reduction of 12% for the installation of ventilation systems:

stream-crossing heat exchanger	η_v = 65%	$\eta_{v,eff}$ = 53%
counter-current and rotation heat exchanger	η_v = 85%	$\eta_{v,eff}$ = 73%
counter-current canal heat exchanger	η_v = 90%	$\eta_{v,eff}$ = 78%
heat pump with or without static heat exchanger	---	$\eta_{v,eff}$ = 78%

The real efficiency of geothermal heat exchanger is around:

$\eta_{v,EWT}$ = 20%

Air permeability test:

This test has to be done in at least 25% of all apartments of an apartment building, 50% of them have to be apartment in exposed situation (e.g. corner apartments), further all apartments with dry construction walls, and all apartments with skylight windows.

Solar heat gains via transparent construction parts:

$Q_S = \sum_i I_i * (\sum A_g * f_S * g_w)_i =$ ….. kWh/M (per months), resp. kWh/a (per year)

Orientation:

It is part of the climate and depends also on azimuth and inclination. Roof windows with an inclination of more than 15° to the horizontal are treated like vertical areas, windows with an inclination of less than 15° are treated like horizontal transparent areas.

Reduction factor for shading:

Shading is the reduction of solar radiation by topographic and structural obstacles (balconies, recessed balconies/loggias, protruding building edges), trees and bushes etc.

location without any shade …..	$f_S = 0.9$
shaded location …..	$f_S = 0.6$

Windows are regarded as shaded if more than 50% are shaded.

Total energy permeability factor:

It is denominated g. If the glass of the windows is dirty and the their inclination is not vertical the effective energy permeability extent of glass is defined as:

$g_w = 0.9 * g$ (i.e. it is reduced by 10%)

Winter gardens:

Heat gains by solar radiation are only calculated if there is a direct irradiation of the glass areas.

Transparent heat insulation:

Heat gains via transparent heat insulation can be included:

on the south, east, and west side …..	+ 20%
on the north side …..	+ 10%

to the heating energy demand.

Internal heat gains:

They are caused by electric gears, lighting, and the body temperature of persons. It is

$Q_i = 0.024 * q_i * BGF_B * HT$ = ….. kWh/M (per month), resp. kWh/a (per year)

The middle heat flow density (q_i) can be calculated as follows:

Residential buildings, offices, schools ……	$q_i = 3.0 W/m^2$
Hospitals, nursing homes ……	$q_i = 4.0 W/m^2$
Industrial buildings ……	$q_i = 5.0 W/m^2$

Exploitation factor of heat gains:

It can be calculated according to the equation:

$\eta = (1 - \gamma^{a}) / (1 - \gamma^{a+1})$ … if $\gamma \neq 1$

$\eta = a \, 7 \, (a + 1)$ … if $\gamma = 1$

or using the factor:

$\eta = 1.00$ for heavy constructions
$\eta = 0.98$ for light-heavy constructions
$\eta = 0.90$ for light constructions

Ratio of heat gains to heat losses:

$\gamma = (Q_S + {}_{Qi}) / (Q_T + Q_V)$

The numeric parameter is

$a = 1.0 + \tau/16$ for calculating on a month basis

$a = 0.8 + \tau/28$ for calculating on a year basis

Time constant of the building:

It describes the internal thermal inertia:

$\tau = C / (L_T + L_V) =$ …. h

Effective heat storage capacity:

$C = 15 * V_B =$ ….. Wh/K for light constructions
$C = 30 * V_B =$ ….. Wh/K for light-heavy constructions
$C = 60 * V_B =$ ….. Wh/K for heavy constructions

Transmission factor related to volume:

$P_{T,V} = L_T / V_B =$ ….. $W/(m^3.K)$

LEK-factor:

This factor characterizes the heat protection of a building envelope taking into consideration the geometry of the building. It is defined as:

$LEK = 300 * U_m / (2 + I_c)$

Heating capacity related to area:

$P_1 = P_{tot} / BGF_B = ... W/m^2$

The total heating capacity of the building is an equation of transmission heat losses and ventilation heat losses considering the standard outside temperature:

$P_{tot} = (L_T + L_V) * (\theta_i - \theta_{ne}) = ... W$

Thermal energy demand related to area:

The annual heating energy demand related to the heated gross area of floors follows the equation:

$HWB_{BDF} = Q_h / BGF_B = ... kWh/(m^2.a)$

H. List of relevant factors and coefficients

Chart 1: Heat transfer resistances and temperature correction factors

	Heat transfer resistance in $m^2.K/W$ R_{si}	R_{se}	$R_{si} + R_{se}$	temperature correction factor f_i
Construction parts bordering to the outside air:				
outside wall, not ventilated	0.13	0.04	0.17	1.0
outside wall, ventilated	0.13	0.13	0.26	1.0
outside ceiling, upwards, not ventilated	0.10	0.04	0.14	1.0
outside ceiling, upwards, ventilated	0.10	0.10	0.20	1.0
outside ceiling, downwards, not ventilated	0.17	0.04	0.21	1.0
outside ceiling, downwards, ventilated	0.17	0.17	0.34	1.0
roof batter, not ventilated	0.10	0.04	0.14	1.0
roof batter, ventilated	0.10	0.10	0.20	1.0
Construction parts bordering to unheated rooms:				
wall to unheated attic	0.13	0.13	0.26	0.9
ceiling to unheated attic	0.10	0.10	0.20	0.9
wall to underground car park	0.13	0.13	0.26	0.9
ceiling to underground car park	0.17	0.17	0.34	0.9
wall to unheated winter garden	0.13	0.13	0.26	

single glazing U > 2.5 W/(m².K)				0.7
insulation glass U < 2.5 W/(m².K)				0.6
heat-protection glass U < 1.6 W/(m².K)				0.5
wall to unheated basement	0.13	0.13	0.26	0.5
ceiling to unheated basement	0.17	0.17	0.34	0.5
wall to unheated stairwell which is exposed to outside air	0.13	0.13	0.26	0.5
wall to inner courtyard with glass roof	0.13	0.13	0.26	0.5
wall to other buffer room	0.13	0.13	0.26	0.5
ceiling to other buffer room, upwards	0.10	0.10	0.20	0.5
ceiling to other buffer room, downwards	0.17	0.17	0.34	0.5
Construction parts touching the soil:				
wall touching the soil	0.13	0.00	0.13	0.6
floor touching the soil	0.17	0.00	0.17	0.5

Chart 2: Temperature correction factor to tempered adjoining rooms and buildings

Construction parts bordering to slightly tempered buildings or parts of buildings
e.g. car parks, workshops, halls, storehouses, shelters

wall to neighbouring building part, slightly retained …. f_i = 0.8
wall to neighbouring building part, well retained …. f_i = 0.7
wall to neighbouring stables (only sensible heat of animals) if stable construction is not retained …. f_i = 0.5
wall to neighbouring stables (only sensible heat of animals) if stable construction is well retained …. f_i = 0.4

Chart 3: Heat transfer coefficients of glass and total energy permeability of glass

	U_g in W/(m².K)	g
Single glazing 6 mm	5.8	0.83
Double insulation glass 6-8-6	3.2	0.71
Double compound glass 6-30-6	2.7	0.72

Triple insulation glass 6-12-6-12-6	1.9	0.63
Double heat-protection glass coated 4-16-4 (air)	1.5	0.61
Double heat-protection glass IR coated 4-14-4 (Ar)	1.35	0.62
Double heat-protection glass low coated 4-16-3 (Ar)	1.25	0.58
Double heat-protection glass IR coated 4-14-4 (Kr)	1.2	0.62
Double heat-protection glass low coated 4-10-4 (Kr)	1.1	0.58
Double heat-protection glass low coated 4-8-4 (Kr)	1.0	0.58
Triple heat-protection glass 2xIR coated 4-8-4-8-4 (Kr)	0.75	0.48
Triple heat-protection glass 2xIR coated 4-16-4-16-4 (Ar)	0.65	0.48
Triple heat-protection glass 2xIR coated 4-16-4-16-4 (Kr)	0.55	0.48
Triple heat-protection glass 2xIR coated 4-8-4-8-4 (Xe)	0.55	0.42
Double sun-protection glass 6-15-6 (Ar)	1.3	0.25
Double sun-protection glass 6-12-4 (Ar)	1.4	0.27
Double sun-protection glass 6-15-4 (Ar)	1.4	0.33
Acrylic glass for light cupola windows, double-leaf	2.7	0.70
Acrylic glass for light cupola windows, triple wall	2.0	0.60

Chart 4: Heat transfer coefficients U_f of wooden frames

thickness d_f in mm	soft-textured wood (500 kgs/m^3) $\lambda = 0.13$ W/(m.K)	hardwood (700 kgs/m^3) $\lambda = 0.18$ W/(m.K)
30	2.3	2.70
50	1.8	2.35
70	1.6	2.05
90	1.5	1.85
110	1.3	1.65

Chart 5: Heat transfer coefficients U_f of wood-aluminium frames

thickness d_f in mm	U_f in W/(m^2.K)
30	2.35

50	1.8
70	1.6
90	1.5
110	1.3

Chart 6: Heat transfer coefficients U_f of plastic frames

Polyurethane		2.6
PVC hollow profile	2 cavities	2.2
	3 cavities	2.0
	3 cavities + aluminium skin	2.0
	4 cavities	1.5
	4 cavities + aluminium skin	1.5
	5 cavities	1.3
	5 cavities + aluminium skin	1.3

Chart 7: Heat transfer coefficients U_f of high heat-insulating frames

aluminium frames	0.9
wood-aluminium frames	0.9
wood frames + fossil or foamed insulating material	0.9
wood frames + natural insulating material	1.0
plastic frames	0.9

Chart 8: Heat transfer coefficients U_f of metal frames

with thermal separation	4.0
without thermal separation	6.0

Chart 9: Heat transfer coefficients U_f of light-cupola frames

frames with 3o cm PP apron	2.0
frames with 50 cm PP apron	1.8

Chart 10: Correction coefficient for heat bridges between frame and glass

	double and multiple glass, uncoated	double and triple insulating glass, with coating
	correction coefficient ψ_g	
wood and plastic frames	0.04	0.06
metal frames with thermal bridge stoppage	0.06	0.08
metal frames without thermal bridge stoppage	0.00	0.02

Chart 11: Measurement of the heat conductivity and thickness of insulating materials

	λ (W/mK)	d (kg/m^3)
construction panels:		
gypsum boards or gypsum fibre	0.21	900
wood fibre soft (d = 18, 22, 24 mm)	0.055	270
soft (d = 36 mm)	0.050	250
soft (d = 40, 60, 80, 100 mm)	0.40	160
medium hard	0.10	600
hard	0.15	1000
extruded particle boards, standard	0.13	700
cement-bound	0.26	1250
OSB	0.13	600
plywood panels	0.15	600
fibre-cement boards	0.60	2000
aerated structure boards	0.12	500
wood-wool boards	0.10	400
earth building panel	0.14	500
reed or straw panels, not plastered	0.056	190
high insulating panels, EPS, cement-bound	0.07	140

insulating materials:		
mineral wool	0.04	15-50
mineral fibre panels 50 – 80 kg/m^3	0.037	50-80
> 80 kg/m^3	0.039	80-170
sheep's wool	0.04	10-30
cotton	0.04	25-30
flax	0.04	20
coconut mats	0.045	60-90
cork, fine, expanded	0.042	120-200
multi-cellular glass, light	0.045	120
heavy	0.050	160
cellulose flocks and panels B2	0.039	30-70
cellulose flocks B1	0.045	30-70
EPS polystyrole, expanded	0.04	15-18
XPS-G polystyrole, extruded	0.035	35
XPS-R polystyrole, extruded	0.037	35
PU polyurethane	0.03	30-80
masonry bricks and concrete:		
bloating bricks, solid	0.18	800
cavity	0.22	650
hollow concrete blocks	0.6	1500
wood-chip concrete	0.45	1500
clinker bricks	1.8	1800
solid bricks	0.7	1600
cavity bricks	0.38	1200
partition wall bricks	0.38	1100
porous cavity bricks	0.25	800
high porous cavity bricks with insulating mortar	0.18	650
sound-absorbing bricks	0.55	1700
natural stone masonry	2.3	2600
aerated concrete blocks, 400 kgs	0.11	400
500 kgs	0.14	500
600 kgs	0.16	600
800 kgs	0.24	800
solid clay (earth)	1.0	2000
light loam, 800-1200 kgs	0.3	1200
600-800 kgs	0.16	800
armoured concrete	2.3	2400
cast and compacted concrete	1.6	1800
lightweight concrete	0.5	1100
ceilings: cavity bricks with concrete topping	0.8	1400
hollow concrete with concrete topping	0.8	1400
porous filler bricks	0.67	1000
hollow core slab, solid concrete	1.33	1800
hollow core slab, light concrete	1.0	1400

mortar and plastering coats:		
cement mortar	1.4	2200
cement-lime mortar	1.0	1800
insulating mortar EPS (polystyrole) or perlite	0.28	800
PIR polyisocyanurate	0.033	35-80
wood, dry-to-fit (8 -15%relative humidity):		
conifer wood, heat flow at right angles to fibre	0.13	500
conifer wood, heat flow lengthways to fibre	0.22	500
deciduous wood	0.16	800
floorings and floor coverings:		
cement screed	1.4	2000
anhydrite flowing screed, standard	1.1	2000
porous	0.4	1200
asphalted screed	0.8	2200
ceramic coverings	1.2	2000
adhesive hard-wood parquet floor	0.22	850
cork panels	0.06	300
linoleum floor	0.18	1000
cork-linoleum floor	0.08	700
pure materials:		
steel	60	7800
copper	380	8900
aluminium	200	2800
glass	0.8	2500
acrylic glass	0.19	1180
PE-sealing mats, bitumen flaming-roofing felt	0.26	1700
Ni Cr-steel, stainless	13	7700
fillings:		
perlite	0.05	100
expanded mica	0.07	100
expanded clay	0.11	350
grinded cork, expanded	0.042	90
natural	0.06	140
cellulose, loose	0.042	35
polystyrole, loose	0.044	10
mineral wool, loose	0.044	15
sawdust, wood chippings	0.1	200
slag, cinders	0.35	750
EPS, granulate, cement-bound	0.7	250
bitumen-bound	0.05	125
perlite, expanded, hydrophobic	0.042	100
sand, gravel, air-dry	0.7	1800
20% humidity	1.4	1650