MSc Program
Renewable Energy in Central and Eastern Europe



# What California can learn from the Austrian implementation of the European Energy Performance Directive – and what the Austrian can learn from Californian regulations concerning this matter.

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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2011, 6th of October, Eichgraben

# Affidavit

I, **MAG. HEIDE HITZENBERGER-SCHAUER, MBA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "WHAT CALIFORNIA CAN LEARN FROM THE AUSTRIAN IMPLEMENTATION OF THE EUROPEAN ENERGY PERFORMANCE DIRECTIVE – AND WHAT THE AUSTRIAN CAN LEARN FROM CALIFORNIAN REGULATIONS CONCERNING THIS MATTER.", 106 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 06.10.2011

Signature

# Abstract

Starting with the Austrian OIB-directive-6 the calculated heating demand of the energy-pass is compared to the Californian approach of energy-efficient homes. The focus is put on the building envelope. The legislative background in both countries is discussed.

Basis of pointing out the main differences of the Austrian energy-pass and the Californian HERS rating are 4 examples in Austria (Traunkirchen, Baden, Altenfelden and Schwarzenberg) and one example in California (San Francisco).

Both systems (of California and Austria) are not exchangeable to each other without adapting certain parameters (e.g. reference model that gives the number of the Austrian rating. It is necessary to adapt it otherwise insufficient improvements of the insulation are done.) California divides the country in several climatic zones to take this into account California has 2 different approaches (simple U-values) and HERS rating. Nevertheless we all have to improve our home’s efficiency. HERS raters give a good chance to check the whole house – from the building envelope to the individual electrical appliances of the household. In Austria “Energieberater” do a similar job, but the energy-pass can also be done by different professionals and does not include household devices.

Heating costs of improved buildings can go down from about 7% of the annual household income to 2% without changing the heating system. Better results can be received, if renewable energy like solar thermal of biomass is used instead.

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# 3 Introduction

“The best energy is energy which is not used!” Spain advertises (European Comission, 2011) on the European Commission Homepage. Energy-efficient homes are a big approach not wasting energy for heating or hot-water. Several countries thought about energy-rating-systems for residential houses.

There is the European Union with their legislative-basis of the “European Energy Performance Directive EPBD” that has to become law in their countries. Austria implements this European assignment with the Austrian “Energieausweis-Vorlage-Gesetz EAVG” and the OIB-directive-6.

Also the United States deal with that topic. California considers herself as the national leader in promoting energy efficiency (HERS-Booklet, 2011).

This master thesis will point out the main differences of both specifications with examples.

# 4 Abbreviations

- A/V parameter for compactness of a building
- BGF Bruttogrundfläche (gross floor area)
- CBSC California Building Standards Commission
- CFA conditioned floor area
- CCR California Code of Regulations
- CZ climate zone
- EAVG Energieausweis-Vorlagegesetz
- EEB Endenergiebedarf (final energy demand)
- EPBD European Energy Performance Directive
- GEQ calculation program for the Austrian energy-pass
- HDD heating degree days (abbreviation used in California)
- HERS Home Energy Rating System
- HGT Heizgradtage (abbreviation used in Austria) – heating degree days

- HDD heating degree days (abbreviation used in the USA)
- HTEB Heiztechnikenergiebedarf (specific energy demand of the equipment of a heating system)
- HWB Heizwärmebedarf (heating demand)
- $l_c$ characteristic length
- NEEAP national energy efficiency action plan
- OAL California Office of Administrative Law
- OIB Österreichisches Institut für Bautechnik
- OÖBauTG Oberösterreichisches Bautechnikgesetz
- RESNET Residential Energy Services network
- SHGC solar heat gain coefficient
- TDV time dependent value
- WWWB Warmwasserwärmebedarf (hot water heating demand)

# 5 Description of method of approach applied

This master thesis of the MSc Program "Renewable Energy in Central & Eastern Europe" shows an elaboration that compares the implementation of the European Performance Directive in Austria (Energieausweis-Vorlage-Gesetz EAVG, OIB-directive-6) and the analogous regulations in California (Californian Home-Energy-Rating Program. To find the differences I calculated the Austrian "Energieausweis" (energy-pass) with the calculation-program "GEQ" (GEQ, 2011) for 4 examples from Austria (Upper Austria, Lower Austria) and 1 example from California:

- 1st step: analysis
- 2nd step: Improvements of the insulation (if necessary) are shown with a second calculation of the energy-pass.
- 3rd step: check, if the results fit to both national regulations
- 4th step: improvements and their results are discussed comparing the necessary money for heating energy with the mean household budget in the individual cases.

Theoretical basis of the analysis is the literature-comparison of the legislative concerning energy-efficiency for residential homes of both countries.

Finally the main differences with the help of the examples are pointed out.

# 6 The European basis for energy-efficiency-regulations

Austria is part of the European Union since 1995. In 1993 there was the first directive "SAVE" (DIR 1993/76/EEC, 1993) to use energy certifications for buildings within the European Union. The focus of this directive was the reduction of carbon dioxide emissions. Therefore the member states were obliged to implement energy certification programs for buildings. Long-term programs should be installed to promote effective thermal insulation for new buildings.

Because one third of the European energy consumption is caused by buildings-related services (EU-LEGIS 2002/91/EC, 2002) the European Union foresees initiatives to support savings in this field. The commitments under the Kyoto Protocol and the aim of security of supply – to get out of the dilemma to need energy from outside the European Union – were the aims why this directive was released. The member states of the European Union have to put four major topics of this directive (EU-LEGIS 2002/91/EC, 2002) in their national law:

- Methodology for calculating the integrated energy performance of buildings
- Minimum standards on the energy performance of new buildings and existing buildings (to be renovated)
- Systems of the energy performance of new and existing buildings
- Regular inspections of installations

In April 2006 a new directive "energy end-use efficiency and energy services" (DIR 2006/32/EC, 2006) of the European Union was released repealing directive 93/76/EEC with the aim to increase the cost-effective improvement of energy end-use efficiency. The member states have to reach an energy saving target of 9 % (EU-LEGIS 2006/32/EC, 2006) within a national energy efficiency action plan (NEEAP). Furthermore the European countries have to develop energy auditing systems for final customers, what can be done to improve energy efficiency. The installation of the customer's own meters is necessary to reach amendments.

Directive 2010/31/EC "energy performance of buildings" (EPBD) from May 2010 is now the next step in the European legislation [ (DIR 2010/31/EU, 2010), (EU-LEGIS 2010/31/EC, 2010)]. The deadline for the member states to put the directive to national law is 9th of July 2012. With this paper the European Union wants to promote the energy performance of buildings and building units. The methodology for calculating the energy performance of buildings has to include defined elements (e.g. thermal characteristics, lighting, air-condition, hot water supply, heating insulation…). For new buildings a feasibility study is needed before construction starts, to analyze the possibilities for renewable energy supply systems. Minimum standards have to be fulfilled and checked every 5 years. For existing buildings also minimum targets have to be reached to increase better total energy efficiency. Nearly zero-energy buildings should be promoted, too. All new buildings should meet this criterion from 31th of December 2020. The member states have to work out national plans with intermediate mile stones to reach those goals. The usage of Energy performance certificates is concretized. The new directive repeals directive 2002/91/EC.

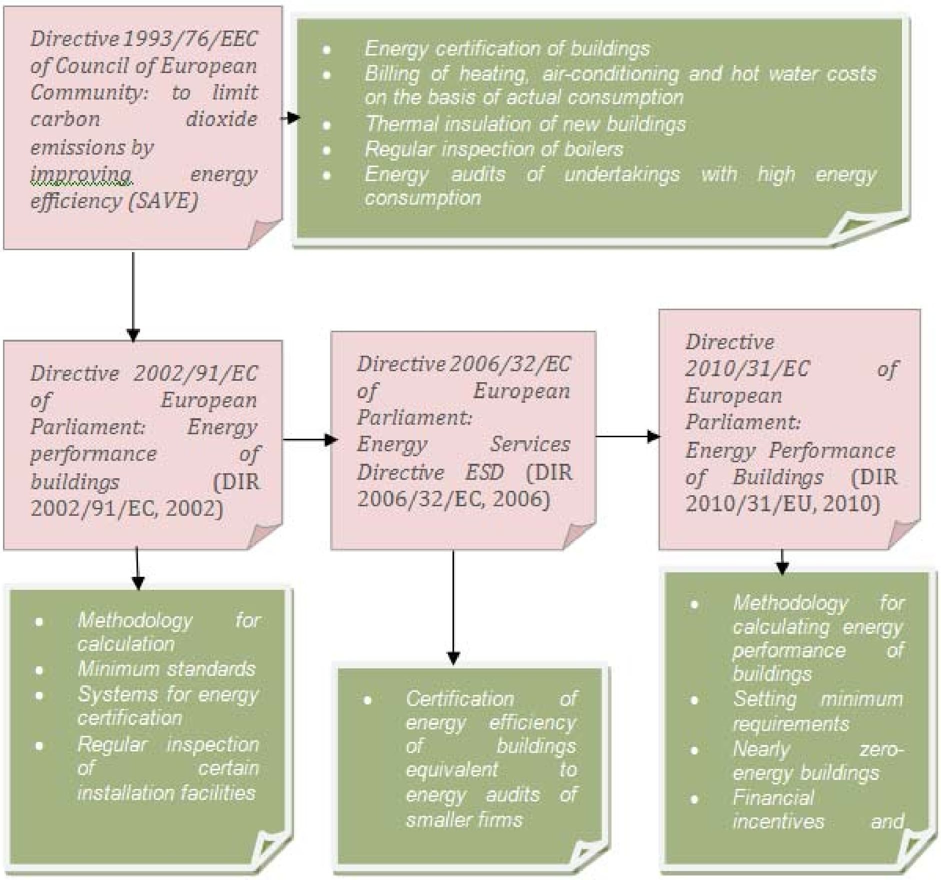


**Figure 1: Directives of European - relevant for energy efficiency of residential houses [own illustration based on (EU-LEGIS 2002/91/EC, 2002)]**

## 6.1 Austrian regulations for energy efficiency

The Austrian EAVG (Energieausweis Vorlagegesetz, (RIS EAVG, 2006)) is the implementation of the EBPD (Energy Performance of Buildings Directive) 2002/91/EG (DIR 2002/91/EC, 2002) on European Level. The Austrian energy pass is obliged in case of selling, renting or leasing of houses. The energy pass is needed for information and valid for 10 years. The law came into force in January 2008, when all federal states have implemented their individual energy pass-regulations.

The EAVG was also implemented with several federal state laws, like Bauordnung or Bautechnikverordnung that differ a bit from federal state to federal state.

To harmonize the law concerning building-energy-efficiency within Austria the OIB-directive-6 from the “Österreiches Institut für Bautechnik” was made valid with special regulations in each individual Federal State law. So Upper Austria included the directive with the OÖBauTG and Lower Austria with the NÖ BTV.

Upper Austria – as first province of Austria - takes directive “SAVE” (DIR 1993/76/EEC, 1993) into account in their OÖ. Bautechnikgesetz in 1998 (OÖ. BauTG, 1994) with §39 chapter “Energieausweis” (energy pass). Also the EPBD-directive (DIR 2002/91/EC, 2002) causes an update of this federal law.

Lower Austria goes a similar way. 2008 with the necessity of harmonizing the technical demand, there were effects in their NÖ Bauordnung in 2008 (NÖ BO 1996, 2011), NÖ Bautechnikverordnung 1997 (NÖ BTV 1997, 2010) and NÖ Gebäudeenergieeffizienzverordnung 2008 (NÖ GEEV 2008, 2009). NÖ GEEV 2008 deals with energy-saving and defines the essential usage of the energy-pass.

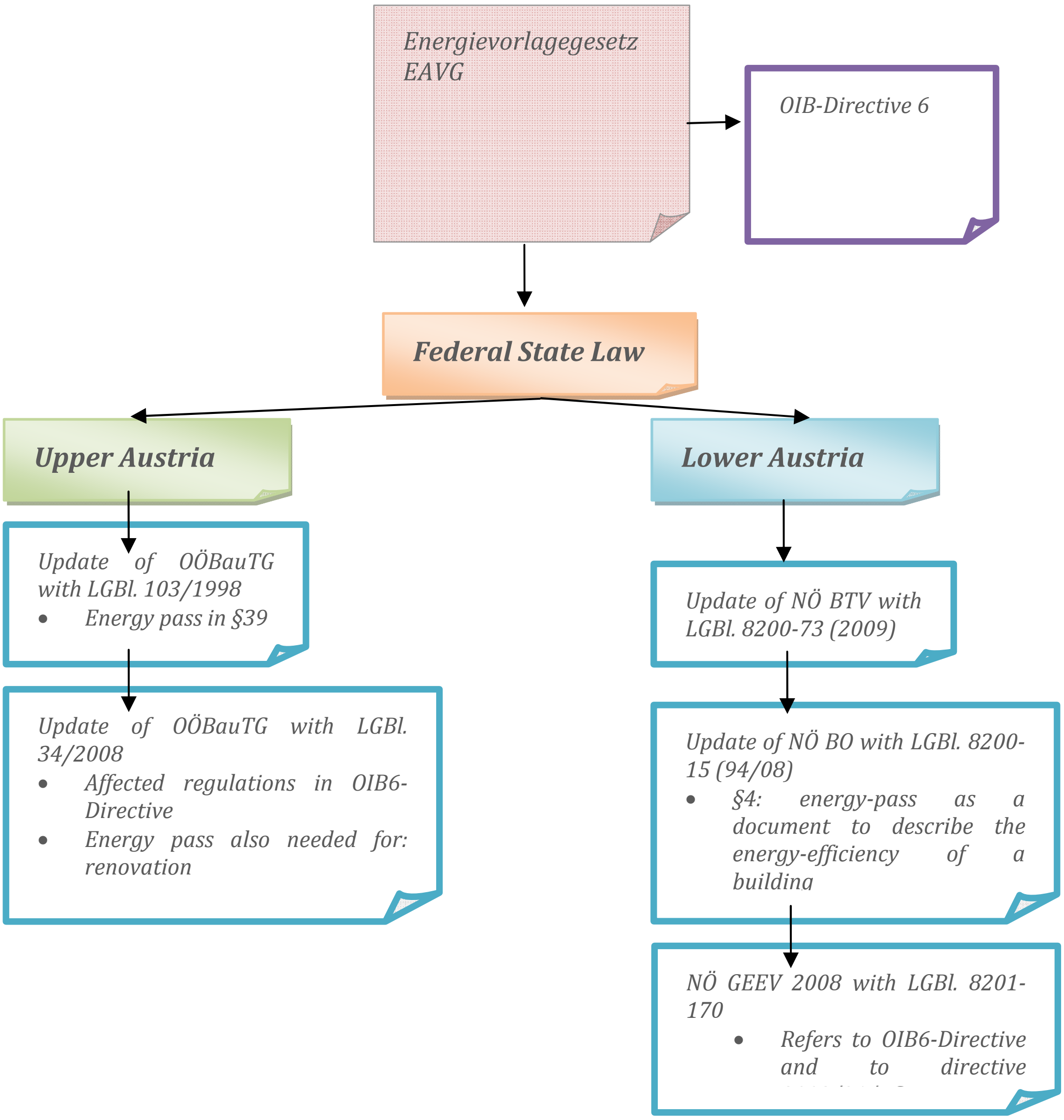


Figure 2: Law in Austria for building-energy-efficiency concerns (own illustration)

### 6.1.1 Details of OIB-directive-6

The OIB-directive-6 (OIB-Richtlinie 6, 2007) is also called “Energieeinsparung und Wärmeschutz” (saving of energy and thermal protection). This Austrian directive describes several specifications for residential and non-residential buildings. By the beginning of 2012 a new version of OIB-directive-6 will come into force. A draft (OIB-Draft, 2011) is already available.

The focus in this master thesis is concentrated on residential buildings. So the requirements of the actual OIB-directive-6 can be summarized by:

1. Definitions

   E.g. used parameters of the OIB-directive-6 are summarized within this chapter.

2. Heating and cooling demand

   a. Heating demand HWB (Heizwärmebedarf) for new buildings with maximum of 66,5 kWh/m²a:

   $$HWB_{BGF,WG,max,Ref}[kWh/m^2a] = 19 * \left(1 + \frac{2{,}5}{l_c}\right)$$

   (Note: The new OIB-directive-6 valid from 1st of January 2012 will have lower limits: $HWB_{BGF,WG,max,Ref}[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ with a maximum of 54,4 kWh/m²a)

      i. HWB is referred to the conditioned gross floor area BGF (“Bruttogrundfläche”) and the reference climate (the same all over Austria with heating degree days HDT = 3400 °Kd)

      ii. $l_c$ … characteristic length as a parameter for the relevant geometry

      $$I_c = \frac{V_B}{A_B}$$

         1. $V_B$ … conditioned gross volume
         2. $A_B$ … surface of the thermal building envelope
         3. The larger the characteristic length, the more compact is the construction. That means, that less energy is needed to heat the building, when the surface of the building is as small as possible.

      iii. 8 kWh/m²a has to be reduced when there is a ventilation system with heat recovery installed.

   b. For buildings after larger reconstructions the heating demand has to be smaller than 87,5 kWh/m²a for projects from 2011 (also valid for the upcoming OIB-directive-6 in 2012) with the following formula:

   $$HWB_{BGF,WG,max,Ref}[kWh/m^2a] = 25 * \left(1 + \frac{2{,}5}{l_c}\right)$$

3. Thermal quality of buildings

   a. LEK-value (“Linie europäischer Kriterien” (Fachbegriffe-LEK (2011))) is used for the description of the thermal protection of buildings:

   $$LEK = 300 * \left(\frac{U_m}{(2 + l_c)}\right)$$

i. $U_m$ … medium U-value of the building envelope
ii. $l_c$ … characteristic length as a parameter for the relevant geometry
iii. examples:
1. Low energy house: 20
2. Passive house: 10
iv. OIB-directive-6 foresees the following LEK-values:
1. New residential buildings: maximal LEK = 27
a. If ventilation system with heat recovery is installed, the maximal LEK is 31.
2. For buildings after larger reconstruction: maximal LEK = 36

b. To take into account the local climate situation of a building the maximal LEK-value is defined with “heating degree days” HGT (“Heizgradtage”) of the building location:

$$LEK_{Standort} = LEK_{max} * 3400/HGT_{Standort}$$

i. HGT [Kd] … heating degree days (Fachbegriffe-HGT, 2011) are the sum of the daily difference between the average temperature inside the house and the average outside temperature – calculated across all heating days within the yearly heating period.

4. Final energy demand EEB (“Endenergiebedarf”) has to be smaller than:

$$EEB_{BGF,WG} \leq HWB_{BGF,WG,max,local} + WWWB_{BGF} + 1{,}05 * HTEB_{BGF,WG,Ref}$$

i. $HWB_{BGF,WG,max,local}$ … HWB under local conditions:

$$HWB_{BGF,WG,max,local} = HWB_{BGF,WG,max,Ref} * HGT_{local}/3400$$

ii. $WWWB_{BGF}$ … Hot water heating demand (“Warmwasserwärmebedarf”) based on the gross floor area.
iii. $HTEB_{BGF,WG,Ref}$ … Specific energy demand of reference equipment of a heating system based on the gross floor area.

5. Heat transmitting construction components:
a. In addition to the definition of HWB and EEB the following U-values listed in OIB-directive-6 (OIB-Richtlinie 6, 2007) have to be taken into

account (similar limits will be valid for the upcoming version of the OIB-directive-6):

Table 1: Construction Components with U-value (OIB-direction-6) - (OIB-Richtlinie 6, 2007)

| Construction Component | U-value [W/m²K] |
|---|---|
| external wall (towards outdoor air) | 0,35 |
| small external wall (< 2% of the surface of the building towards outdoor air) - e.g. dormer | 0,7 |
| separating wall between different living-areas | 0,9 |
| walls towards not-conditioned (but frost-free) building parts | 0,6 |
| walls towards not-conditioned attic | 0,35 |
| walls towards other buildings at the site boundary | 0,5 |
| walls to ground | 0,4 |
| Windows towards not-conditioned building-areas | 2,5 |
| Windows towards outdoor air | 1,4 |
| other glass-areas towards outdoor air | 1,7 |
| skylights towards outdoor air | 1,7 |
| other transparent horizontal building-areas or situated in the pitch of the roof | 2 |
| ceiling towards outdoor air / attic - not isolated or ventilated / pitch of the roof towards outdoor air | 0,2 |
| inner ceiling towards not-conditioned building parts | 0,4 |

6. Energy systems
    a. There are specific standards to fulfill for isolating pipes and lines (heating and hot water).
    b. Heat loss is to be reduced by the use of heat storage tanks.
7. Other requirements:
    a. Minimize thermal bridges.
    b. Airtight and windproof construction
    c. In summer overheating of buildings is to avoid.
8. Energy pass
    a. The Austrian energy pass ("Energieausweis") consists of
        i. Scale of efficiency on the first page with $HWB_{BGF,Ref}$ – calculated for reference climate conditions. The following categories can be shown:

1. Category A++: $HWB_{BGF,REF} \leq 10$ kWh/m²a
2. Category A+: $HWB_{BGF,REF} \leq 15$ kWh/m²a
3. Category A: $HWB_{BGF,REF} \leq 25$ kWh/m²a
4. Category B: $HWB_{BGF,REF} \leq 50$ kWh/m²a
5. Category C: $HWB_{BGF,REF} \leq 100$ kWh/m²a
6. Category D: $HWB_{BGF,REF} \leq 150$ kWh/m²a
7. Category E: $HWB_{BGF,REF} \leq 200$ kWh/m²a
8. Category F: $HWB_{BGF,REF} \leq 250$ kWh/m²a
9. Category G: $HWB_{BGF,REF} > 250$ kWh/m²a

The rating can be summarized to:

1. Passive house: A++
2. Lowest energy house (Niedrigstenergiehaus): A, A+
3. Low energy house: B

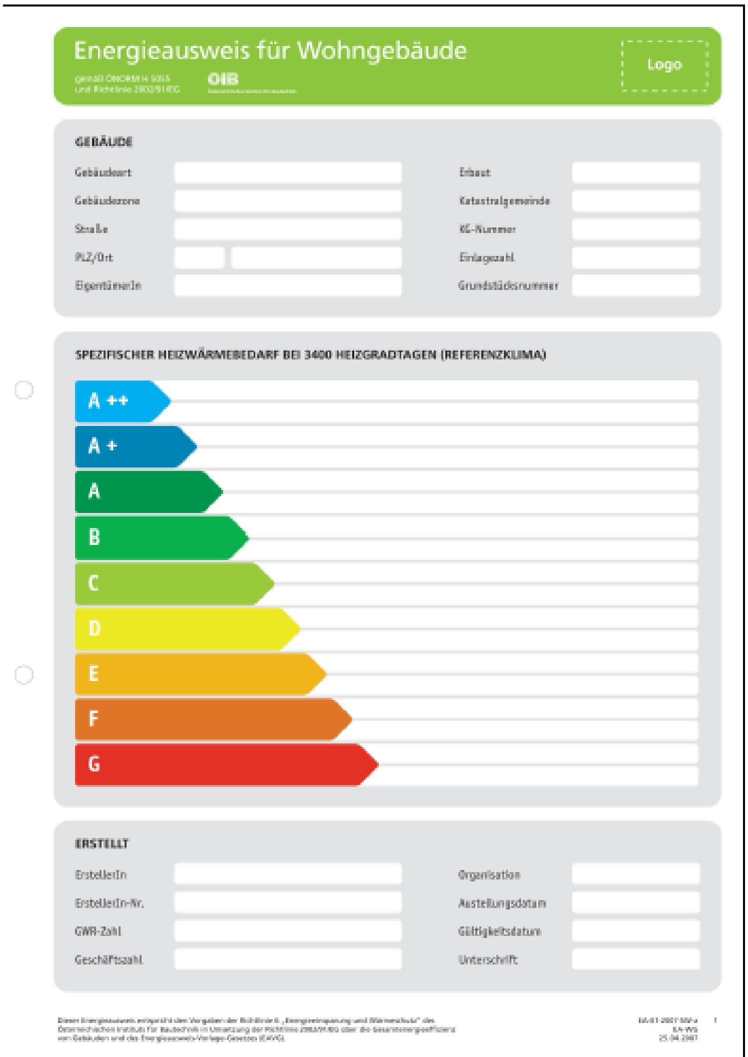
Energieausweis für Wohngebäude
Logo
GEBÄUDE
Gebäudeart
Erbaut
Gebäudezone
Katastralgemeinde
Straße
KG-Nummer
PLZ/Ort
Einlagezahl
EigentümerIn
Grundstücksnummer
SPEZIFISCHER HEIZWÄRMEBEDARF BEI 3400 HEIZGRADTAGEN (REFERENZKLIMA)
A ++
A +
A
B
C
D
E
F
G
ERSTELLT
ErstellerIn
Organisation
ErstellerIn-Nr.
Ausstellungsdatum
GWR-Zahl
Gültigkeitsdatum
Geschäftszahl
Unterschrift

Figure 3: first page of Austrian energy-pass (OIB-Richtlinie 6, 2007)

ii. Page 2 of the energy-pass shows the detail results

iii. The appendix of the energy pass shows the used standards and calculation basis.

b. Minimum information given by the Austrian energy-pass:
   i. HWB of the building and the comparison to a reference climate
   ii. HTEB of the building
   iii. EEB of the building
   iv. Measures to improve the EEB of the building with a technical and economic view.

# 7 California Legislation – relevant for energy-efficient buildings

## 7.1 Legislation basis – valid all over USA

In 1995 the Residential Energy Services network (RESNET) (RESNET, 1995) was founded by the National Association of State Energy Officials and Energy Rated Homes of America with the aim to develop a national market for home rating systems. Those standards are the basis for several programs of the federal government for verification of building energy performance, e.g.:

- "ENERGY STAR"-program (RESNET - HERS, 1995) of the Environmental Protection Agency
  - The HERS[1] Index of a house points out, if the home meets the ENERGY STAR performance guidelines. It is called a home energy rating tool, which makes different homes comparable.
    - RESNET defined a label – called "HERS Index" which compares an individual home with a HERS reference home

[1] HERS … home energy rating system

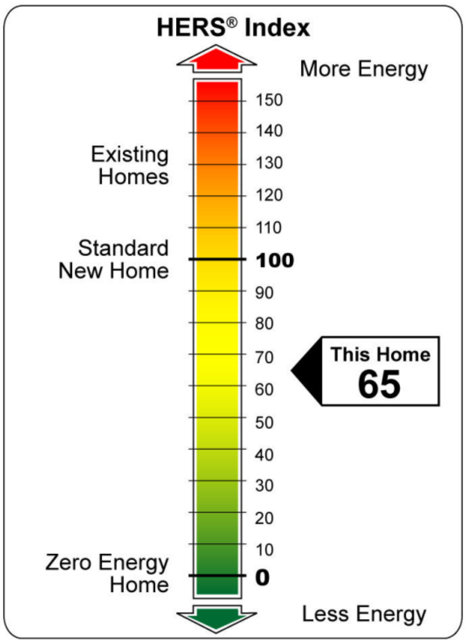


Figure 4: HERS Index - (RESNET - HERS, 1995)

- The index of 100 shows the scale basis. The closer the index moves to the zero-Energy-Home with a value of zero, the more energy-efficient is the house. 1 point reduction means 1% off the energy consumption of the Reference-House.
  - Therefore construction plans are analyzed, also onsite inspections are done (e.g. blower door test).
  - The usage of those standards are voluntarily but is also necessary when mortgages are needed.
- Program of the U.S. Department of Energy's Building America Program
- Federal tax incentives

## 7.2 Legislation basis – focus on California

The California Office of Administrative Law (OAL) publishes the regulations of the state California with the California Code of Regulations (CCR). There are 28 titles within these regulations. Those regulations are adapted by state agencies when there are necessities for changes e.g. because of new state laws or clarifications.

The 24th title (Guide - Title 24, 2010) of the CCR is called "Title 24" is relevant for building-issues (e.g. construction, installations) and called "California Building Standards Code". The California Building Standards Commission (CBSC) – consisting of 10 members (e.g. architect, mechanical engineer) – appointed by the Governor of California – has the responsibility for modification of this part of the

CCR. Cities and counties with their different climatic conditions throughout California are allowed to be much stricter in their building-regulations as Title 24.

Title 24 is divided in several different parts:

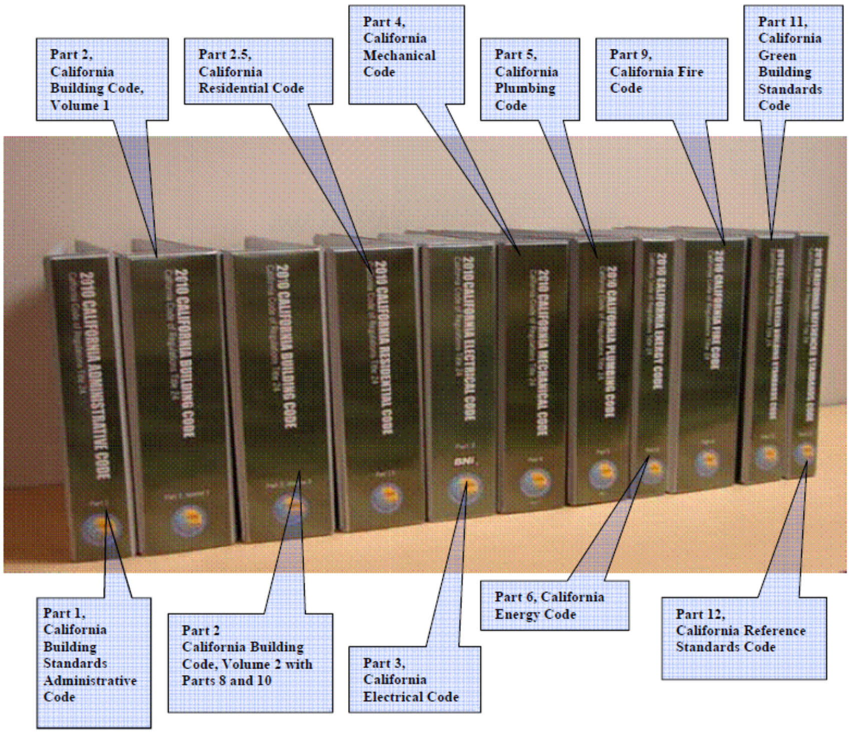


**Figure 5: Parts of Title 24 (Guide - Title 24, 2010) – part 7 is currently vacant.**

Part 6 of Title 24 focuses on energy-topics and is named “The Energy Efficiency Standards for Residential and Nonresidential Buildings”. In 1978 the Energy Efficiency Standards for Residential and Nonresidential Buildings (CAL-2008Standards, 2008) were written down to give the legislative basis reducing the energy consumption in California. To take into account changes of the last years the California Energy Commission regularly do some adoptions to the Building Energy Efficiency Standards of the California Code of Regulations (CCR). 2008 was the last update for the so called 2008-Standards. On the 1st of January 2010 the current standards (2008) went into effect, which means, that each building with building permits after this date, have to follow those 2008-Standards. The California Energy Commission stated several reasons adopting the 2008 changes to the Building Energy Standards (CAL-2008 Energy Commission, 2010):

1. “To provide California with an adequate, reasonably-priced, and environmentally-sound supply of energy.

2. To respond to Assembly Bill 32, the Global Warming Solutions Act of 2006, which mandates that California must reduce its greenhouse gas emissions to 1990 levels by 2020
3. To pursue California energy policy that energy efficiency is the resource of first choice for meeting California's energy needs.
4. To act on the findings of California's Integrated Energy Policy Report (IEPR) that Standards are the most cost effective means to achieve energy efficiency, expects the Building Energy Efficiency Standards to continue to be upgraded over time to reduce electricity and peak demand, and recognizes the role of the Standards in reducing energy related to meeting California's water needs and in reducing greenhouse gas emissions.
5. To meet the West Coast Governors' Global Warming Initiative commitment to include aggressive energy efficiency measures into updates of state building codes.
6. To meet the Executive Order in the Green Building Initiative to improve the energy efficiency of nonresidential buildings through aggressive standards."

## 7.3 2008 Building Energy Efficiency Standards – focused on residential buildings

The California Energy Commission describes in her paper "regulations / standards: 2008 building energy – efficiency standards for residential and nonresidential buildings" (CAL-2008 Energy Commission, 2010) and in the paper "2008 building energy efficiency standards – commission manual" (CAL-2008 Manual, 2008) to describe their standards for low-rise residential buildings. The aims of those standards are:

- reducing the energy costs
- Increasing the availability of electricity (to reduce the electric demand!)
- More comfort of energy efficient homes
- Economic benefit, reducing global warming
- Reducing the impact of buildings to our environment.

New homes have to follow those latest building-energy-efficiency standards. Mandatory measures have to be fulfilled. There are two methods for complying with low-rise residential energy budget described in the Commission Manual (CAL-2008 Manual, 2008):

a) Prescriptive approach: is the simplest way

- Choose from several packages (C, D, E) with individual parameters for different components of the building
    i. Package C: allows electric resistance space and water heating systems
    ii. Package D: (is also the basis of the performance approach)
    iii. Package E: defines usage of high-energy-efficient components
- Little flexibility – but easy
- The individual prescriptive packages regulate the necessary insulation of each building component. To meet these requirements, there are two possibilities:
    1. Install the necessary installation (from the limit-listing of the Commission Manual) in wood-framed construction. The regulations for package C call for more insulation.
    2. Use lower U-values than the according U-values in the Reference Joint Appendix JA4 (JA4, 2008), that are referred to wood-framed constructions. Then it is possible to use different assembly as mentioned in the paper JA4.

b) Performance approach: more complicated
- Design flexibility possible
- An approved computer program is needed to determine the annual Time Dependent Valuation (TDV) energy. The software calculates what type of energy that is when used (electricity, gas, etc.)
- Computer models get the energy budget for space conditioning and uses package D of the prescriptive package. During the calculation better values can be achieved, but each assembly has to meet minimum R-values / U-values, that are defined with "mandatory measures" in the Compliance Manual.

The house builders have to follow the "Guide to California Climate Zones" (CLIM, 2011) to get the right parameters for the climate data (e.g. temperature, wind speed etc.): 16 climate zones (CZ) were established (CZ, 2011), that represent an energy budget as a threshold of the maximum amount of energy a building can be built to consume per year:

- CZ 1: Arcata
- CZ 2: Santa Rosa
- CZ 3: Oakland
- CZ 4: Sunnyvale
- CZ 5: Santa Maria
- CZ 6: Los Angeles
- CZ 7: San Diego
- CZ 8: El Toro
- CZ 9: Pasadena
- CZ10: Riverside
- CZ11: Red Bluff
- CZ12: Sacramento
- CZ13: Fresno
- CZ14: China Lake
- CZ15: El Centro
- CZ16: Mount Shasta

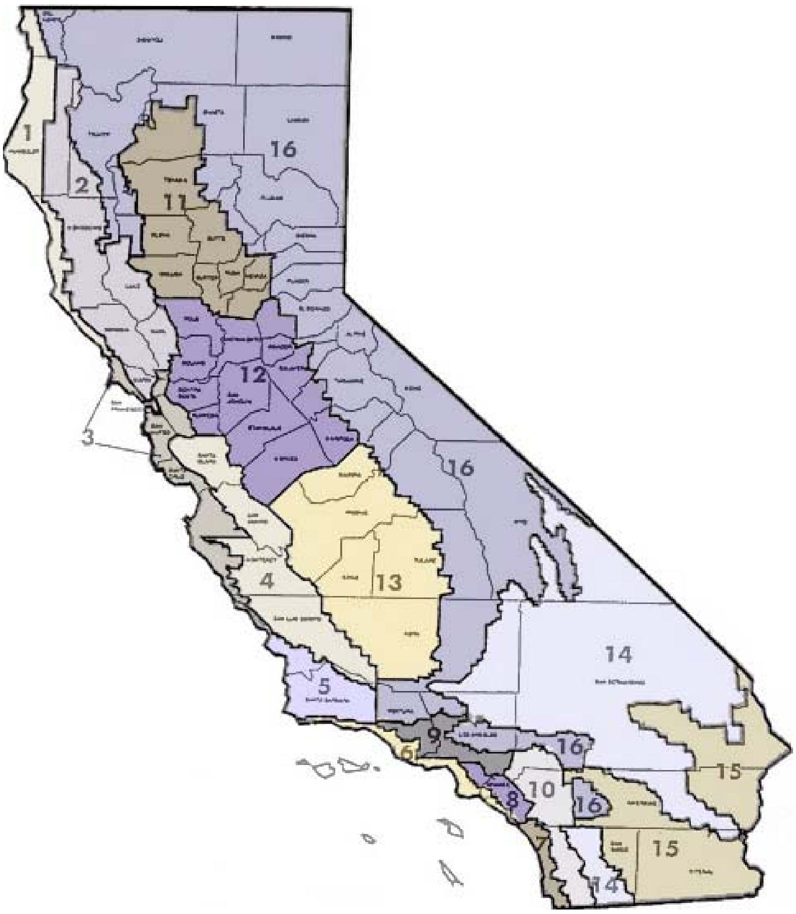


**Figure 6: Climate zones in California (CLIM, 2011)**

Similar as in Austria low-rise buildings need a permit from the local enforcement agency before building. The agency checks the plans and specifications and also verifies the compliance with the Building Energy Efficiency Standards. After finishing the building the enforcement agency approves the final house with the certificate of occupancy. In some cases (e.g. heat pumps, air condition systems, building envelope sealing, low leakage ducts etc.) third party inspectors (HERS rater) are invited to do special tests or verifications.

The building envelope has to fulfill several features: e.g.

- Fenestration:
  - Package C sets U-factor = 0,38 for all California climate zones
  - Package D sets U-factor = 0,40 for all zones
  - Package E: for climate zone 5 and 6 there are special solar heat gain coefficient-requirements needed (SHGC = 0,40)
    - SHGC (Window, 2011) is used in the USA and describes the increase of the temperature inside a house/room by solar radiation. The lower SHGC the less is the solar gain. SHGC is the fraction of incident radiation going through the window.
    - In Europe the G-value (solar factor) is used as a percentage.

## 7.4 Home Energy Rating in California

The California Energy Commission (CAL-HERS, 2011), (HERS-regulations, 2009) is responsible for implementing a HERS-program in California. Therefore few software products – used for rating – are certified, when they are in compliance with the HERS Regulations. Only specially trained HERS-raters are allowed to do the ratings.

California has developed a “Whole-House Home Energy Rating” (HERS-Booklet, 2011) to analyze the efficiency of the entire home (new and already existing homes). The rating is also called California Home Energy Audit, which is based on an inspection of the home by the HERS-rater. The California Energy Commission (HERS-manual, 2008) defines the requirements for HERS-software and the raters.

The owner of the rated buildings gets a report and recommendations (e.g. test and seal air leaks in building envelope, increase attic insulation) for cost-effective improvements:

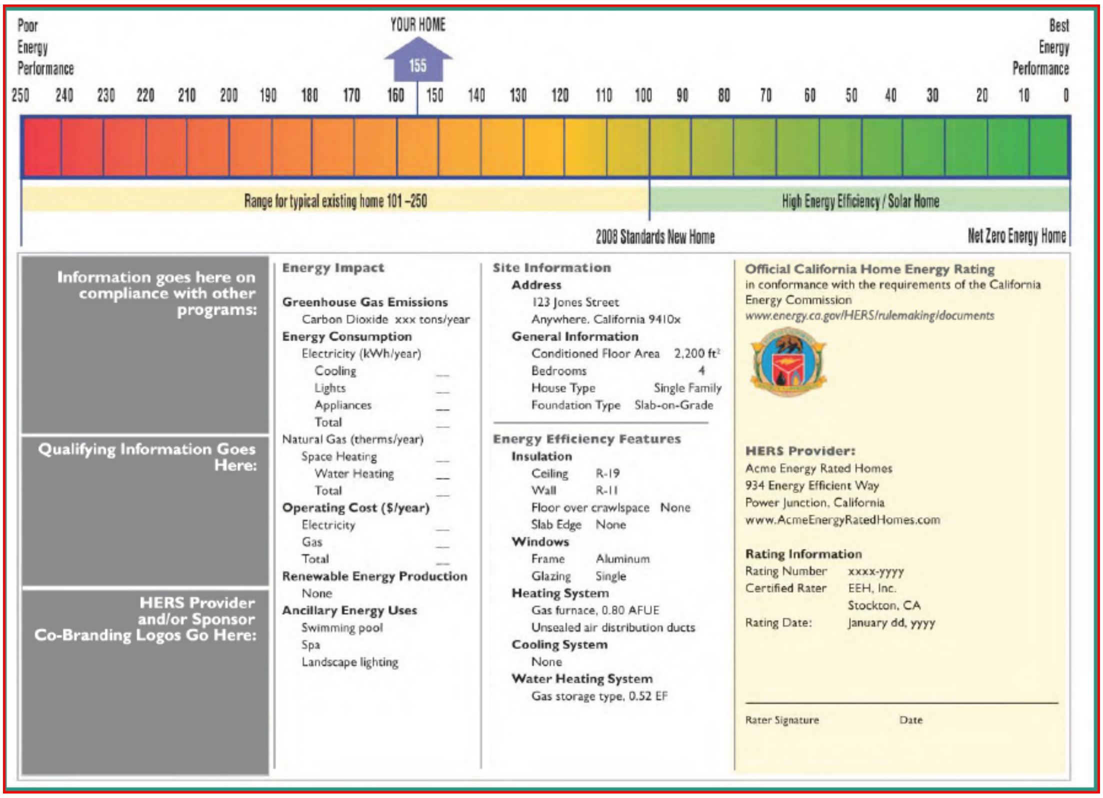


**Figure 7: official California Home Energy Rating Certificate with the seal of the California Energy Commission (HERS-Booklet, 2011)**

Here again – similar to the US-energy-star-version: The lower the HERS index (out of a 250 point scale) of the house the more energy efficient is the building. An index of 100 is the rating of the reference building of California's 2008 Building Energy Efficiency Standards. The California HERS index is defined (HERS-manual, 2008) by:

$$HERS\ Index = \frac{TDV_{Rated} - TDV_{PV}}{TDV_{Reference}} x100$$

With:

- $TDV_{Rated}$ — TDV (Time Dependent Value) energy of the rated home [kBtu / year]
- $TDV_{PV}$ — TDV energy produced by on-site PV-systems of other renewable energy systems [kBtu / year]; when not including on-site-generation, then the value is set to zero.
- $TDV_{Reference}$ — TDV energy of the reference home [kBtu / year]

Modeling rules are defined by the California Energy Commission.

Energy bills can be analyzed in that way, that the data is put into relation of the outdoor temperature data to differ between monthly and yearly energy-demand.

There are federal tax credits available, HERS rating is needed. Also loan programs (e.g. Energy Efficient Mortgage – EEM), that are specialized to energy efficiency improvements, need the HERS rating of an certified rater.

# 8 Calculation of energy efficiency

4 building-examples in Austria and one example from California were chosen to focus on the differences of both legislative energy-efficiency- basis in Austria and California. The Austrian houses are marked in the following map.

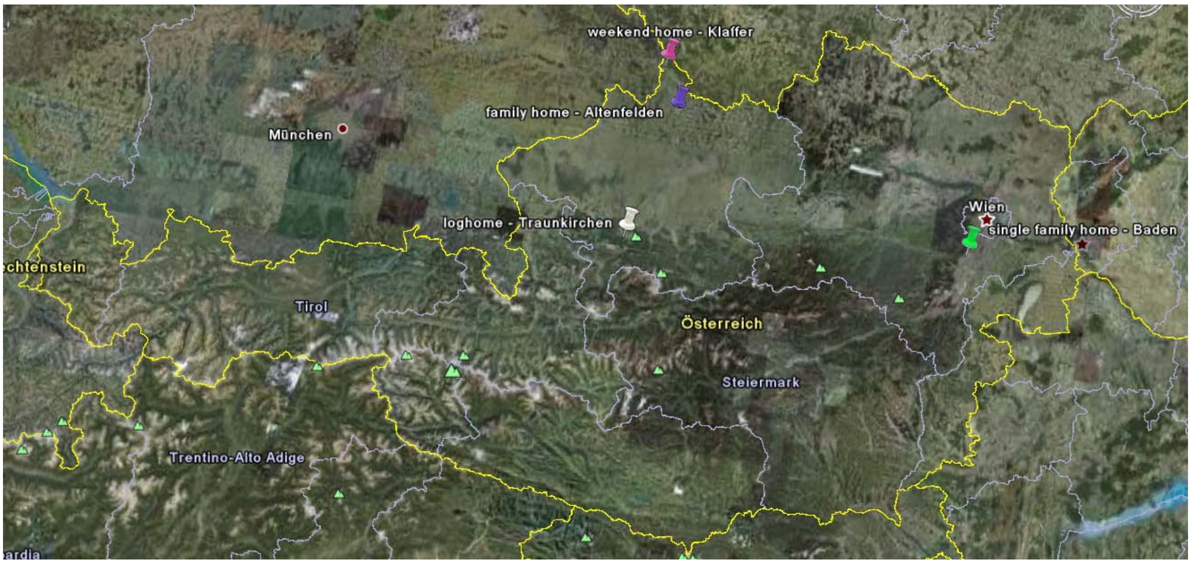


Figure 8: Austrian examples for the Austrian energy-pass-calculation (Google Earth, 2011)

**Table 2: parameter of the used examples (own table)**

| Location | Traunkirchen | Baden | Altenfelden | Schwarzenberg / Hochficht | San Francisco / California |
|---|---|---|---|---|---|
| *general information:* | | | | | |
| federal country | Upper Austria | Lower Austria | Upper Austria | Upper Austria | California |
| built | 1992 | 2010 | 1979 | 1910 | 1961 |
| sea level [m] | 580 | 237 | 580 | 630 | 154 |
| HGT [Kd] | 4.038 | 3.389 | 4.158 | 4.220 | 1.921 |
| standard outdoor temperature [°C] | - 14,3 | - 12,5 | - 15,9 | - 15,3 | not necessary |
| temperature inside house [°C] | 20 | 20 | 20 | 20 | 20 |
| hot-water with ... | heat pump | air heating pump | gas | wood-stove | gas |
| heating with... | heat pump | air heating pump | gas | wood-stove | gas |

# 8.1 Calculation of energy efficiency with the Austrian methodology – the "energy pass" (Energieausweis)

The detail energy-pass-calculation is included in the appendix. Basis of the calculation is the actual OIB-directive-6 (side-step to the upcoming version in 2012 is included).

## 8.1.1 Example 1 – single family house in Traunkirchen / Upper Austria

The first calculation example is an insulated log-home built in 1992 situated on the northern slope of a hill next to the Traunsee in Upper Austria. The sea-level is about 580 m (DORIS, 2011).

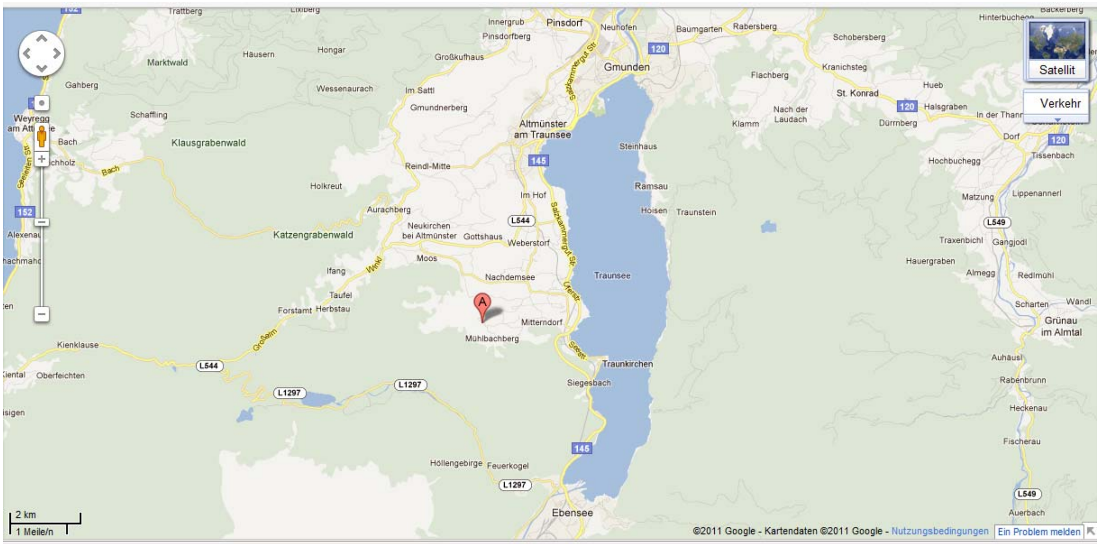


**Figure 9: position of the single-family house in Traunkirchen (Google Map, 2011)**

The house is used the whole year and heated by a heat-pump. Hot water is also generated by this heat-pump.

Figure 10: garden-view to the building (Traunkirchen), (own photograph)

The relevant U-values for the Austrian energy-pass show now the following situation (using building plans and information of the house owner):

Table 3: U-values of the building in Traunkirchen and their corresponding limit of the OIB-directive-6 (own calculation based on energy pass calculation with (GEQ, 2011)

| Construction Compound (Traunkirchen) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards unconditioned attic | 0,163 | 0,20 |
| external wall (towards outdoor air) | 0,251 | 0,35 |
| wintergarden (non-glass-part) | 0,855 | 0,70 |
| pitch of the roof | 0,169 | 0,20 |
| windows and door | 1,098 | 1,70 |
| ground-floor (wintergarden) | 0,235 | 0,40 |
| ceiling towards unconditioned cellar | 0,196 | 0,40 |
| external wall (towards non-heated areas) | 0,246 | 0,35 |
| external wall (towards non-heated wintergarden | 0,246 | 0,35 |

The individual construction-compounds still fit to the actual values of the OIB-directive-6. Only for the non-glass-winter garden-part with very few square-meters has a slight difference to the today-requirement.

The house is rated with “C”:

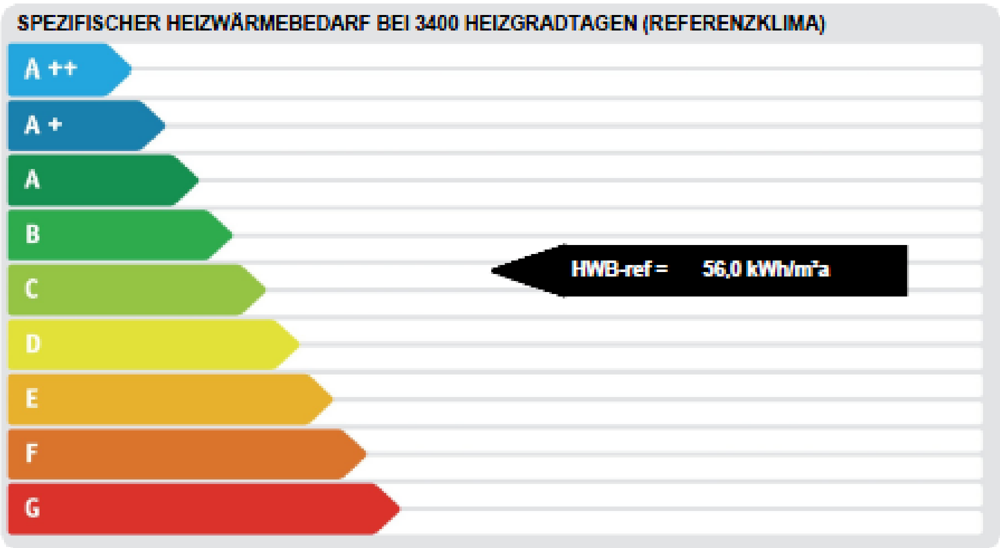


Figure 11: rating of building in Traunkirchen with Austrian energy-pass (own calculation based on (GEQ, 2011))

When we compare the calculated HWB, the almost 20 year old building still fulfills approximately the thermal requirements of the actual OIB-directive-6 for new houses:

Table 4: HWB-details for the calculated HWB for the reference-climate as well as the location itself (own calculation based on (GEQ, 2011))

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 207,20 |
| conditioned gross volume [m³] | 634,84 |
| surface of the thermal building envelope [m²] | 484,06 |
| characteristic length [m] | 1,31 |
| compactness (A/V) [1/m] | 0,76 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 55,97 |
| heating demand (reference) per year [kWh] | 11597 |
| calculated HWB_(BGF, local) [kWh/m² a] | 61,89 |
| heating demand (local) per year [kWh] | 12.823 |

The above stated heating demand of about 13000 kWh for the whole year was confirmed by the homeowner.

To check if the calculated HWB – in the fictitious case it is a new building - fits to the actual and to the upcoming version of the OIB-directive-6 the following calculations for the maximum allowed HWB were done with the above data:

**Table 5: calculated HWB versus maximum HWB for new buildings (OIB-directive-6) – own calculation based on (GEQ, 2011))**

| if the building will be built today, the following margins have to be fulfilled to be conform to OIB-directive-6: | |
|---|---|
| **when built < 2012: formula valid for actual OIB-directive-6 (2007)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 19 * \left(1 + \frac{2{,}5}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a] (2007): max. 66,5 kWh/m² a** | 55,22 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (2007) - local** | 65,58 |
| | |
| **when built > 2011: formula valid for actual OIB-directive-6 (draft - valid from 1st of January 2012)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a](draft - valid from 1st of January 2012): max. 54,4 kWh/m² a** | 52,60 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (draft - valid from 1st of January 2012) - local** | 62,47 |

The calculated HWB of the energy-pass (local and reference) has to be compared with those margins:

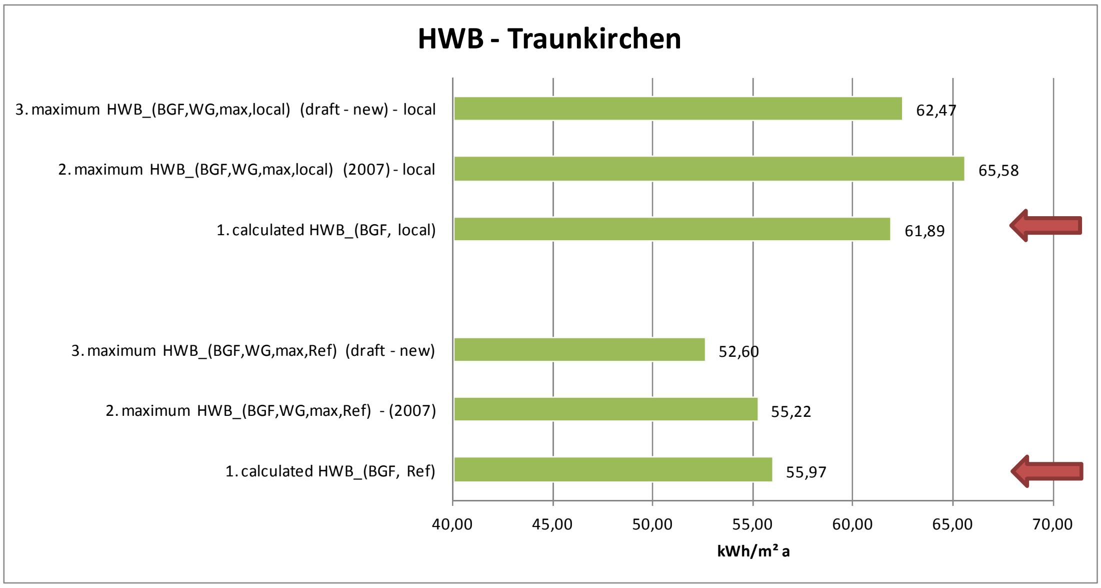


**Figure 12: HWB - Traunkirchen for new buildings (own illustration based on my calculation with (GEQ, 2011))**

If the house owner wants to build the same house once more now – in the year 2011, the whole energetic system fulfills the local 2007-specification of OIB-directive-6 (65,58 kWh/m²a). The HWB for the reference-climate already reaches the margin of 55,22 kWh/m²a.

But if built 2012 (next year) when the OIB-6-specification (HWB = 62,47 kWh/m²a for the local value) is much stricter (OIB-Draft, 2011). To fulfill the limits of the reference climate (52,6 kWh/m²a), the owner has to think over to enlarge the insulation layer in the ceiling to the attic and the pitch of the roof a little bit (15 cm). Also the external walls need more insulation of about 15 cm. 15 additional centimeter of insulation will also be added to the insufficient construction part in the winter garden.

The calculation of the Austrian energy-pass shows the following situation and is now rated with "B":

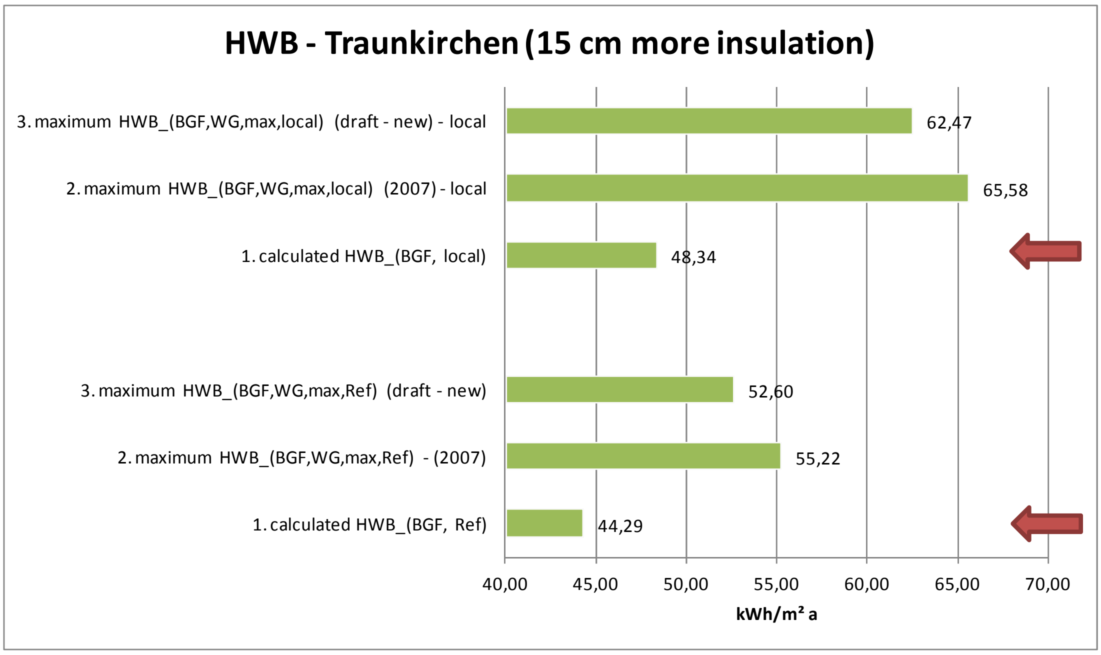


**Figure 13: HWB of the house in Traunkirchen with 15 cm more insulation (case of a new building) – own illustration based on my calculation with (GEQ, 2011))**

Different from above limit-values for new houses is the situation for larger reconstructions:

**Table 6: margins of HWB for improvements (own calculation based on (GEQ, 2011))**

| improvements (case of larger reconstructions) of the existing building ==> therefore the following margins have to be fulfilled after the reconstruction for the OIB-directive-6: | |
|---|---|
| **formula valid for actual OIB-directive-6 (2007 and new draft)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 25 * \left(1 + \frac{2{,}5}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a]: max. 87,5 kWh/m² a** | 72,66 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] - local** | 86,29 |

The limits for reconstruction an existing building are much bigger than for new buildings.

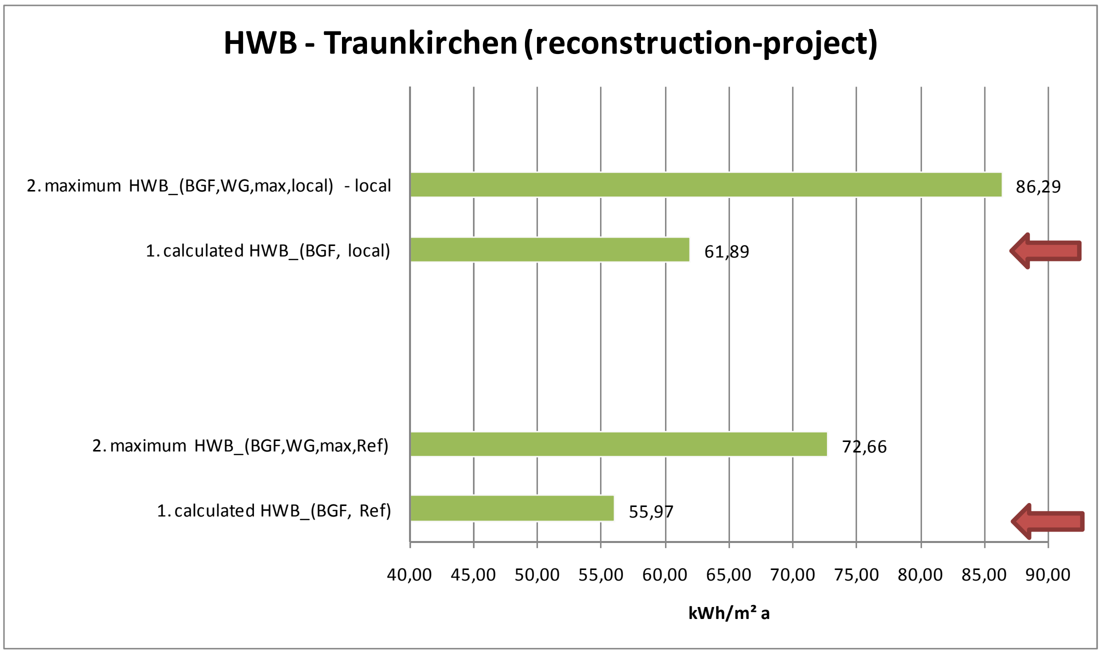


Figure 14: HWB of the house in Traunkirchen (case of reconstruction) – own illustration based on my calculation with (GEQ, 2011))

Now it is obvious, that using both OIB-directive-6 (2007 and upcoming 2012) no improvements are seen necessary.

### 8.1.2 Example 2 – single family house in Baden / Lower Austria

This new family-house was built in 2010 and is situated next to the vineyards in Baden at the edge of the town.

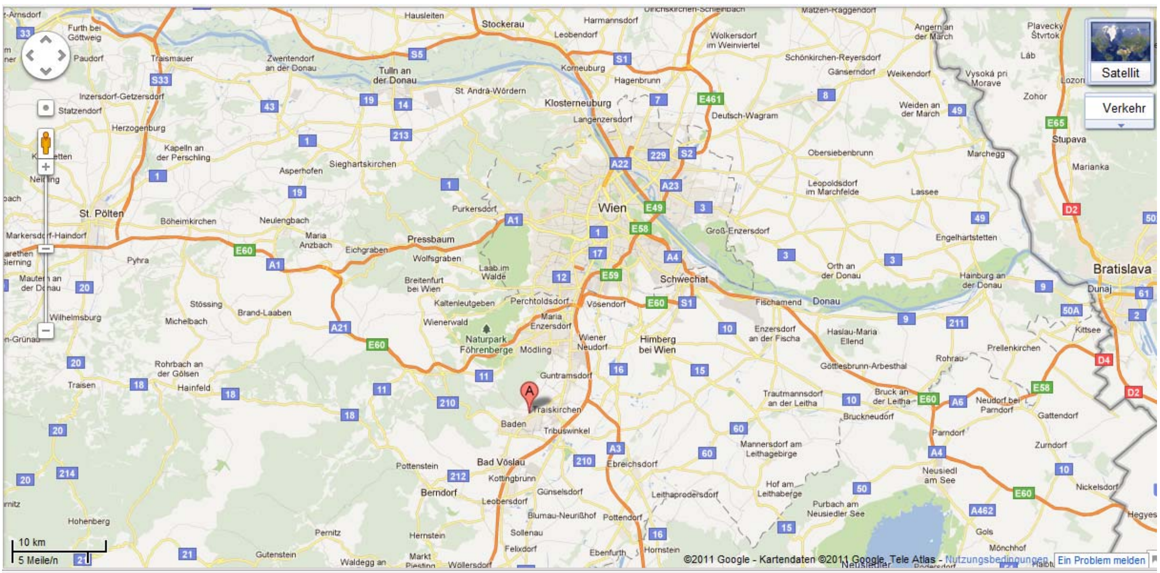


Figure 15: position of the single-family house in Baden (Google Map, 2011)

It is a design of timber-frame-construction executed as a prefabricated building. An air-heating-pump is responsible for hot water and heating. It is used the whole year.

Figure 16: garden-view to the building (Baden) – own photograph

The Austrian energy-pass was calculated with the following U-values of the individual construction compounds (using the building plans, technical descriptions and information of the house owner):

Table 7: U-values of the building in Baden – own table based on calculation with (GEQ, 2011)

| Construction Compound (Baden) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards outdoor air | 0,13 | 0,20 |
| external wall (towards outdoor air) | 0,14 | 0,35 |
| ceiling (sleeping room) towards outdoor air | 0,16 | 0,70 |
| ceiling towards unconditioned cellar | 0,23 | 0,40 |
| external wall (towards non-heated areas) | 0,14 | 0,35 |
| windows and door | 0,898 | 1,70 |

Of course the U-values (new house) fit perfectly to the limit-values. The building is rated with “B”:

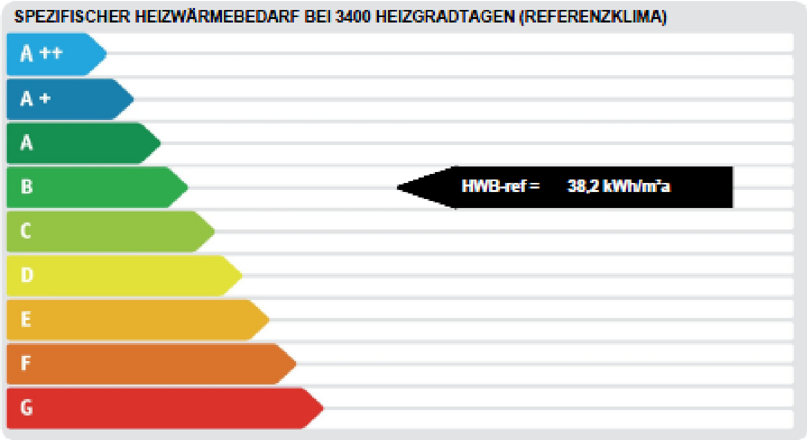


Figure 17: rating of house in Baden – own calculation based on (GEQ, 2011)

The HWB is expected to fit to the limits, too:

Table 8: HWB-details for house in Baden – own calculation based on (GEQ, 2011)

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 208,46 |
| conditioned gross volume [m³] | 657,78 |
| surface of the thermal building envelope [m²] | 489,88 |
| characteristic length [m] | 1,34 |
| compactness (A/V) [1/m] | 0,74 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 38,16 |
| heating demand (reference) per year [kWh] | 7954 |
| calculated HWB_(BGF, local) [kWh/m² a] | 37,56 |
| heating demand (local) per year [kWh] | 7830 |

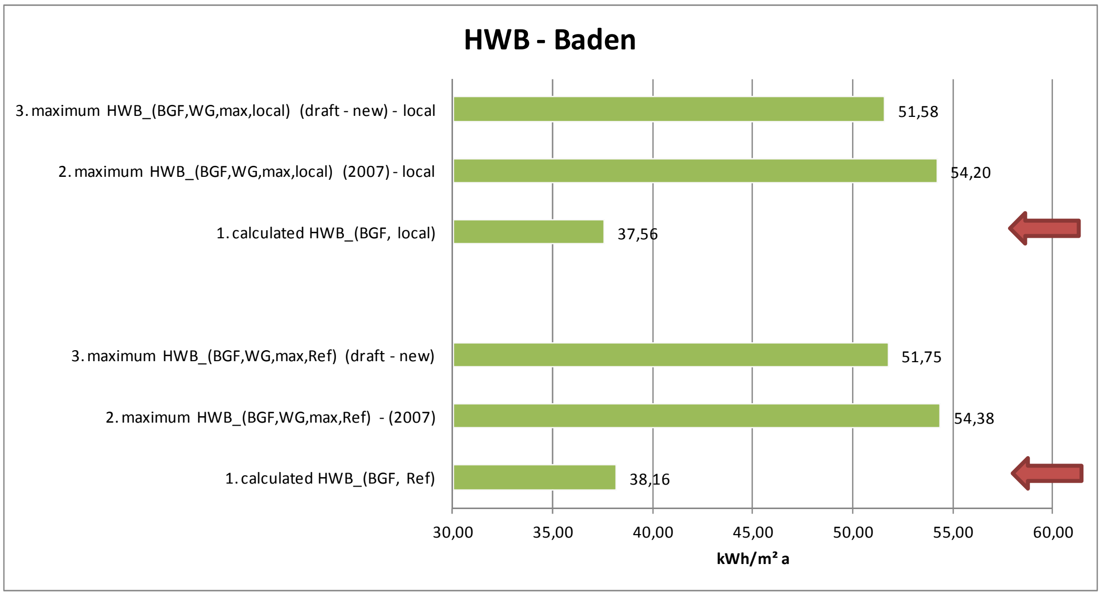


Figure 18: HWB-Baden for new buildings – own illustration based on my calculation with (GEQ, 2011)

If the house owner wants to build the same house once more now, the actual OIB-directive-6 as well as the upcoming one (valid from 2012) sees no need for improvements.

### 8.1.3 Example 3 – single family house in Altenfelden / Upper Austria

This house is located at the edge of Altenfelden / Upper Austria and was built in 1979. Altenfelden can be found in the heart of the northern part of Upper Austria – Mühlviertel.

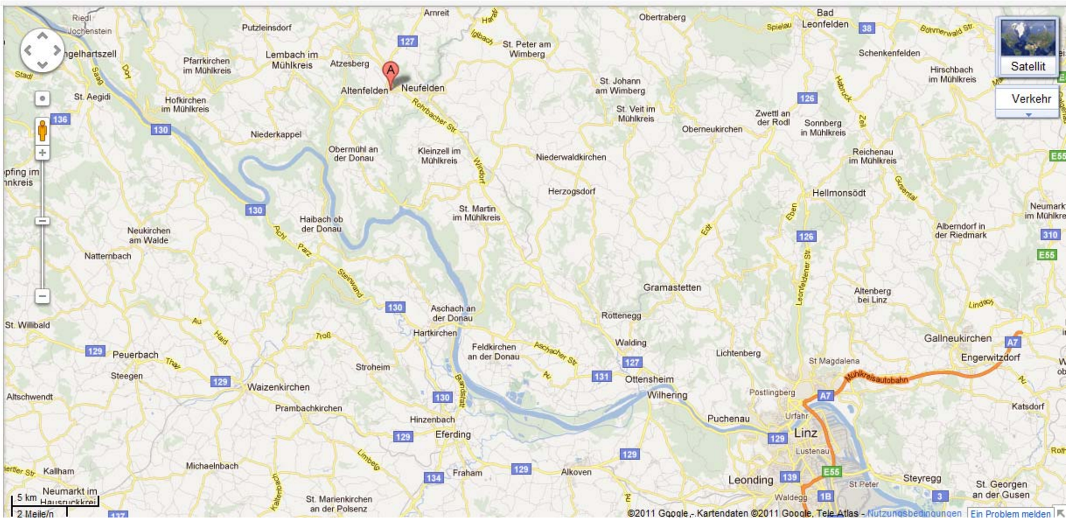


Figure 19: map around Altenfelden (Google Map, 2011)

It is now mainly used as weekend-home. The calculation is done for whole-year use to compare the results with other examples. Hot-water-supply and heating are done by gas.

Figure 20: street-view to the building in Altenfelden – own photograph

The Austrian energy-pass was done with the following current U-values (using building plans and information of the house owner):

Table 9: U-values of the building (status now) – own calculation based on (GEQ, 2011)

| Construction Compound (Altenfelden) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards unconditioned attic | 0,348 | 0,20 |
| wall towards staircase | 1,361 | 0,60 |
| external wall (towards outdoor air) - with eternit layer | 0,865 | 0,35 |
| external wall (towards outdoor air) | 1,142 | 0,35 |
| ground-floor (unconditioned cellar) | 0,654 | 0,40 |
| windows and door | 1,863 | 1,70 |

All above mentioned construction compounds are larger than the limits of the OIB-directive-6.

The house is rated with “E”:

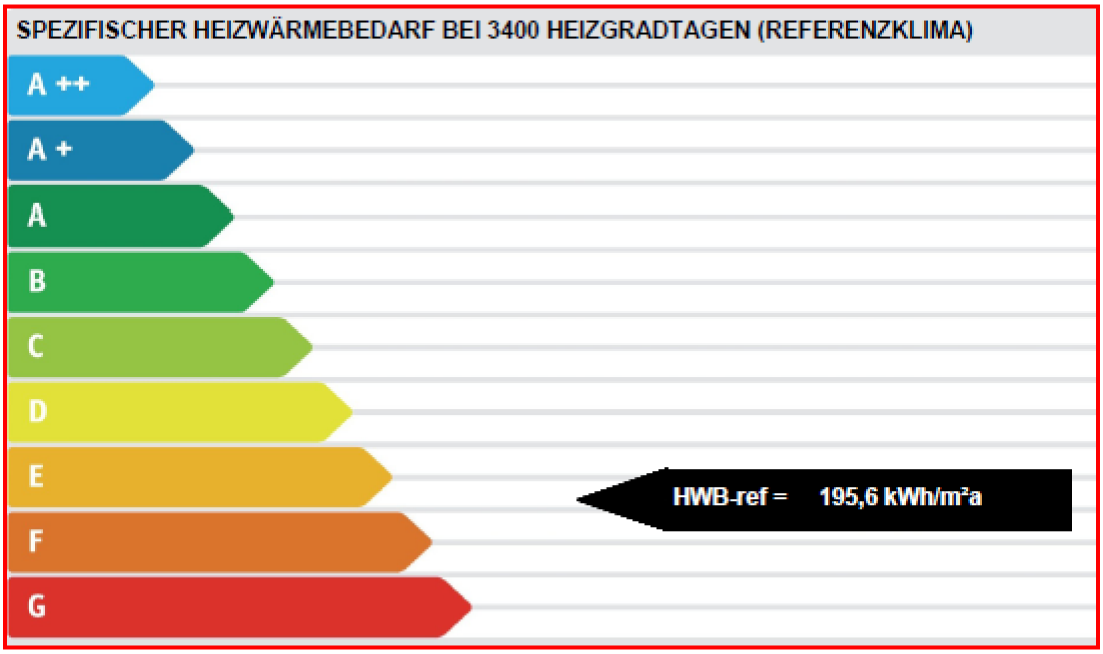


Figure 21: rating of building in Altenfelden with Austrian energy-pass – own calculation based on (GEQ, 2011)

The house owner has to think over more insulation for this more than 30 year old building. When the HWB-limits for new buildings are taken into account – the situation is as followed:

Table 10: HWB-details for the calculated HWB in Altenfelden – own calculation based on (GEQ, 2011)

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 149,21 |
| conditioned gross volume [m³] | 483,44 |
| surface of the thermal building envelope [m²] | 476,62 |
| characteristic length [m] | 1,01 |
| compactness (A/V) [1/m] | 0,99 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 195,56 |
| heating demand (reference) per year [kWh] | 29.180 |
| calculated HWB_(BGF, local) [kWh/m² a] | 245,64 |
| heating demand (local) per year [kWh] | 36.653 |

The check, if the calculated HWB still fits to the actual OBI-directive-6, shows big discrepancies, when the margins for new houses are analyzed:

**Table 11: margins (OIB-directive-6) for new building in Altenfelden – own calculation based on (GEQ, 2011)**

| | |
|---|---|
| if the building will be built today, the following margins have to be fulfilled to be conform to OIB-directive-6: | |
| **when built < 2012: formula valid for actual OIB-directive-6 (2007)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 19 * \left(1 + \frac{2,5}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a] (2007): max. 66,5 kWh/m² a** | 65,83 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (2007) - local** | 80,51 |
| | |
| **when built > 2011: formula valid for actual OIB-directive-6 (draft - valid from 1st of January 2012)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a](draft - valid from 1st of January 2012): max. 54,4 kWh/m² a** | 54,40 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (draft - valid from 1st of January 2012) - local** | 66,53 |

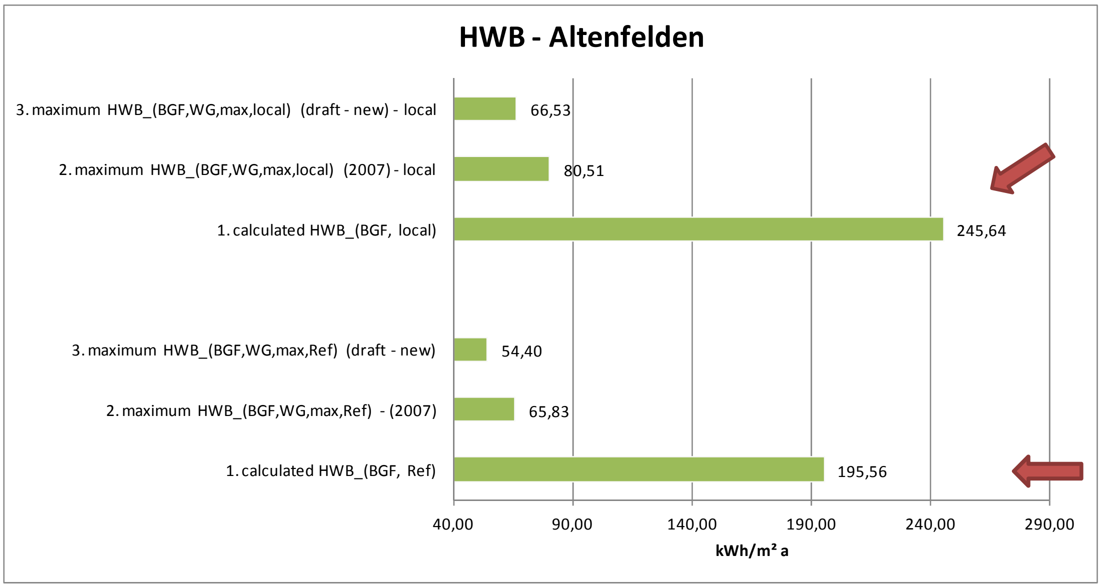


**Figure 22: HWB-Altenfelden for new buildings – own illustration based on my calculation with (GEQ, 2011)**

It is obvious, improvements of the insulation and of the windows are necessary, to fulfill the requirements of OIB-directive-6:

- Wall: 14 cm of additional insulation
- Floor: 12 cm of additional insulation
- Ceiling: 15 cm of additional insulation
- Change of windows

**Table 12: U-values after the planned improvements (Altenfelden) – own calculation based on (GEQ, 2011)**

| Construction Compound (Altenfelden - improvements) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards unconditioned attic | 0,127 | 0,20 |
| wall towards staircase | 0,201 | 0,60 |
| external wall (towards outdoor air) - with eternit layer | 0,197 | 0,35 |
| external wall (towards outdoor air) | 0,195 | 0,35 |
| ground-floor (unconditioned cellar) | 0,194 | 0,40 |
| windows and door | 1,061 | 1,70 |

New details for HWB, when building is improved by more insulation:

**Table 13: HWB-details (Altenfelden) - with improvements – own calculation based on (GEQ, 2011)**

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 149,21 |
| conditioned gross volume [m³] | 523,73 |
| surface of the thermal building envelope [m²] | 491,48 |
| characteristic length [m] | 1,07 |
| compactness (A/V) [1/m] | 0,94 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 51,06 |
| heating demand (reference) per year [kWh] | 7.619 |
| calculated HWB_(BGF, local) [kWh/m² a] | 63,92 |
| heating demand (local) per year [kWh] | 9.538 |

With above improvements the OIB-directive-6 limits (both: the actual version and the upcoming one) for new houses are fully fulfilled:

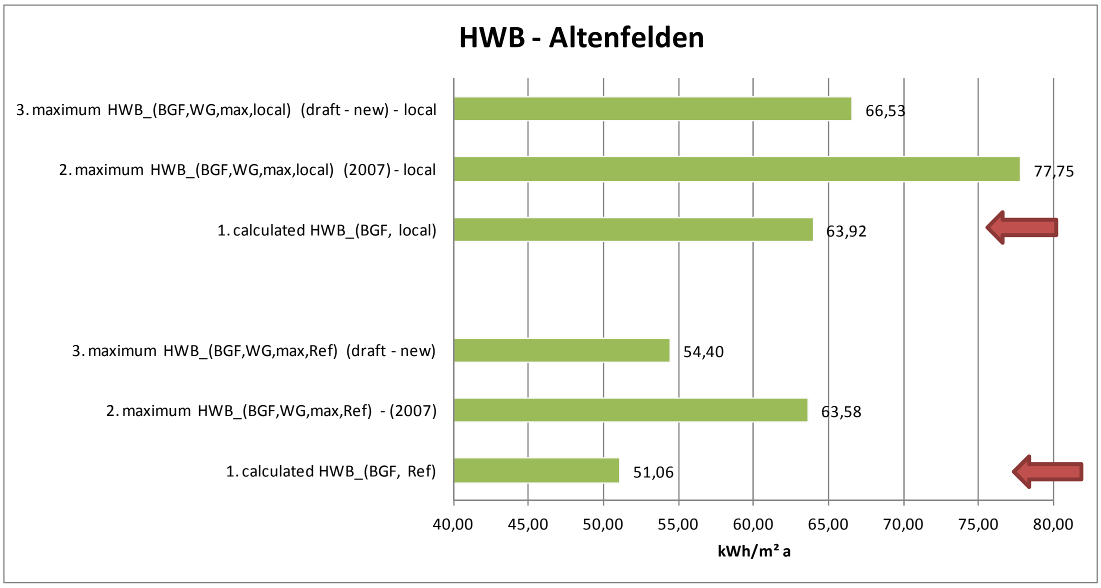


**Figure 23: OIB-directive-6 limits for new buildings (Altenfelden) – own illustration based on my calculation with (GEQ, 2011)**

Reconstruction-projects use lower limits – so they are again also fulfilled:

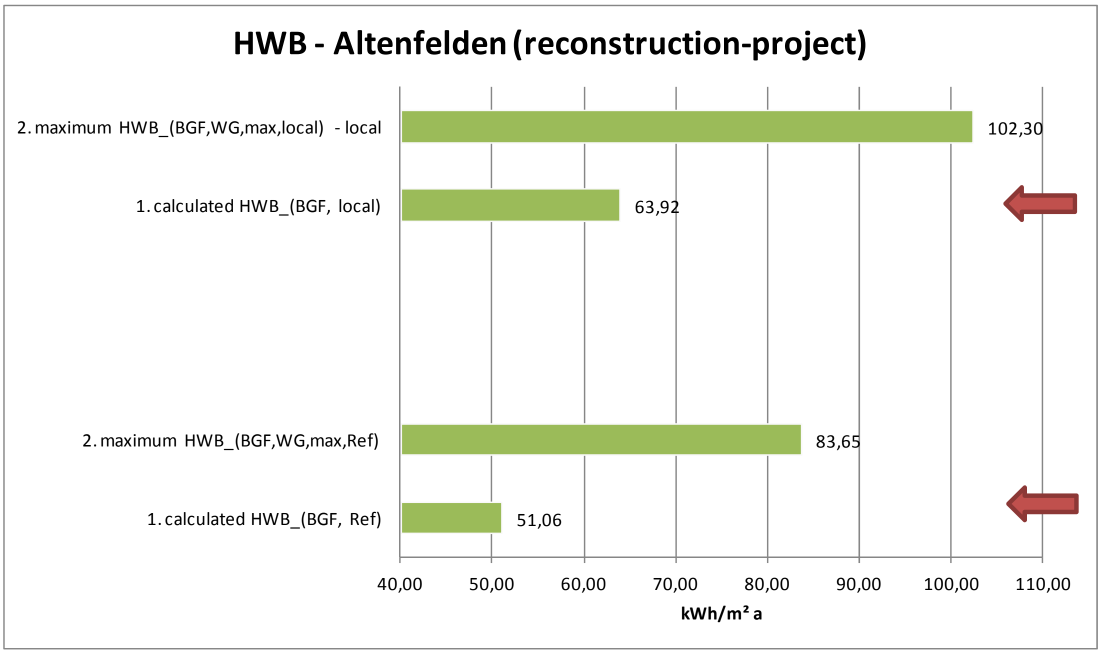


**Figure 24: OIB-directive-6 limits for reconstruction projects in Altenfelden – own illustration based on my calculation with (GEQ, 2011)**

With the reconstruction project HWB will be improved from 245,64 kWh/m² to 63,92 kWh / m² and therefore the heating demand will come from 36.653 kWh to 9.538 kWh. With simply upgrading the assembly of the building envelope it is possible to save energy for heating and money.

To know which part of the average income is needed for heating in this house I used the net household income data from Statistik Austria (Statistik Austria, 2011), (Statistik Austria _ 2009, 2011) and the gas-price of today – 2011 – from e-control using the tariff-calculator (Tarifkalkulator, 2011) and the years before (Statistik Austria_gasprice, 2011). The analysis back goes until 2003, when gas-market in Austria was fully liberalized (October 2002):

**Table 14: mean Upper-Austrian household net-income per household related to the costs for heating in Altenfelden – own calculation based on (Statistik Austria _ 2009, 2011), (Tarifkalkulator, 2011) and (Statistik Austria_gasprice, 2011)**

| house in: | Altenfelden | heating demand (status now) [kWh] | 36.653 | | heating demand (status upgraded [kWh] | 9.538 |
|---|---|---|---|---|---|---|
| Upgrading | Austrian net income per year | average price per kWh gas | price for heating [gas] - status now | price for heating [gas] - status upgraded | heating demand (status now) % of net income | heating demand (upgraded) % of net income |
| 2003 | € 22.228,00 | € 0,0545 | 1997,5885 | 519,821 | 8,99% | 2,34% |
| 2004 | € 23.421,00 | € 0,0545 | 1997,5885 | 519,821 | 8,53% | 2,22% |
| 2005 | € 24.741,00 | € 0,0522 | 1913,2866 | 497,8836 | 7,73% | 2,01% |
| 2006 | € 26.090,00 | € 0,0522 | 1913,2866 | 497,8836 | 7,33% | 1,91% |
| 2007 | € 27.313,00 | € 0,0631 | 2312,8043 | 601,8478 | 8,47% | 2,20% |
| 2008 | € 28.410,00 | € 0,0631 | 2312,8043 | 601,8478 | 8,14% | 2,12% |
| 2009 | € 29.849,00 | € 0,0652 | 2389,7756 | 621,8776 | 8,01% | 2,08% |
| 2010 (assuming + 2,3%) | € 30.535,53 | € 0,0652 | 2389,7756 | 621,8776 | 7,83% | 2,04% |
| 2011 (assuming + 2,3%) | € 31.237,84 | € 0,0700 | 2565,71 | 667,66 | 8,21% | 2,14% |
| price for 2011 from www.e-control.at "Tarifkalkulator" | | | | | | |
| prices 2002 to 2010 from Statistik Austria - assuming 1 m³ gas contains 10 kWh | | | | | | |

If the house owner does not improve the whole insulation layer of his house he has to pay more than 8% of his net income for heating. With upgrading the house envelope a reduction to 2% of his net income is possible.

Calculating predetermined standard rates for improving the house is difficult to mention. A builder and the energy consultant have to check the house on-site to discuss the possibilities together with the house owner. Depending on the necessary technical improvements of the building envelope (mold, thermal bridge, construction damages, is existing insulation ok etc.) the best solution must be found. It has to be taken into account that the biggest costs come from the building site facilities and scaffolds and of course the working time itself. So it is not really essential, if one or two layer of insulation has to be put on the walls. The paper “Wirtschaftlichkeit von Wärmedämm-Maßnahmen im Gebäudebestand 2005” (Passivhaus Institut, 2005) shows that there is a range of the optimal U-value, where the economic earnings (saving-costs for heating bigger than annual annuities) are maximized. This range depends on the kind of necessary improvements and their costs, the energy costs etc.

It can be assumed, that a large reconstruction project with more insulation (whole building envelope) and more efficient windows – without changing the heating system – has to be calculated with about 50.000,-- Euros. A rough calculation of amortization says:

$$Amortization = \frac{cost\ of\ the\ improvement}{(costs\ of\ heating\ demand_{OLD} - costs\ of\ heating\ demand_{improved})}$$

$= \frac{50000}{2565{,}71 - 667{,}66}$ =26,34 years.

Taking into account a discount rate of 5% and an increase of the price for heating with annual 2%, it can be calculated with the NPV (net present value):

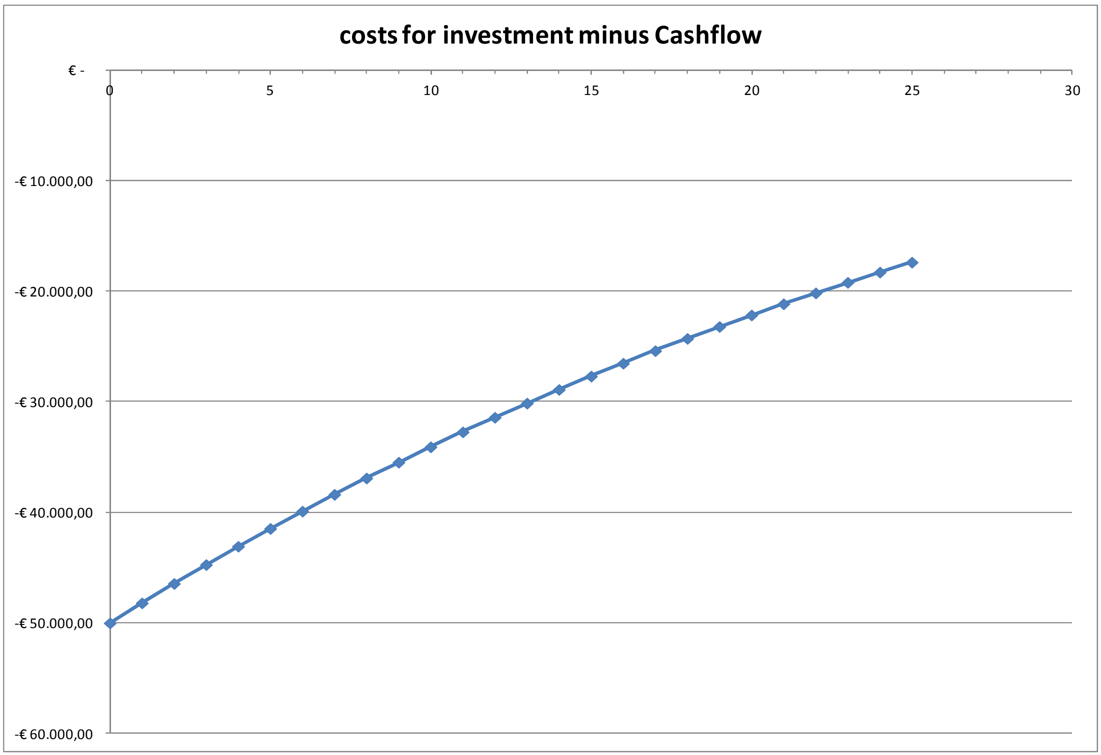


**Figure 25: NPV for investing in upgrading the building envelope (inclusive windows) – based on own calculation**

It can be seen, that the NPV is still negative after 25 years, when there are no additional incentives from the country.

But in most cases the house owner has to think about a new heating system. There are additional costs, but there is a chance to install a more efficient system using renewable energy. Of course the impulses for someone investing money in his house are multiple. An amortization time of more than 25 years can only be argued when windows are already for example leaky and an investment is essential for comfort-reasons. Of course the decision to spend money in this way also depends on the age of the resident. On the other hand an upgraded house will be worth a higher price, when it is sold. The "OÖ Energiesparverband" (Energiesparend - Infomappe, 2011) suggested the following steps, when a big reconstruction project is not possible:

- One comparatively cheap starting point for improving the house energy condition is to insulate the upper ceiling of the house. Costs of about 2000 Euro can decrease the heating-bill with about 20%

- Changing the windows to U-values of 0,5 – 0,7 W/m² K (about 20.000,-- Euro)
- Improve insulation of the ceiling of the cellar Costs of about 2500 Euro can decrease the heating-bill with about 10%.
- If improvement of the façade is necessary it should be combined with additional insulation.
- Check the hot-water and heating-facilities (add solar thermal)

In Upper Austria (OÖ - Wohnbauförderung, 2011) there is the possibility for people/families with lower than certain income limits to get cheap money from the country, to encourage more people to invest in energy-efficiency. It is necessary, that HWB after improvement is not higher than 65 kWh/m²a. The Upper Austrian housing program gives grants to annuity repayments to bank loans of maximum 37.000 Euro. It has to be mentioned that in Austria credits for reconstruction projects can lower the income tax.

### 8.1.4 Example 4 – weekend home in Schwarzenberg/Hochficht / Upper Austria

Between the German and Czech-border the 4th Austrian calculation-example can be found.

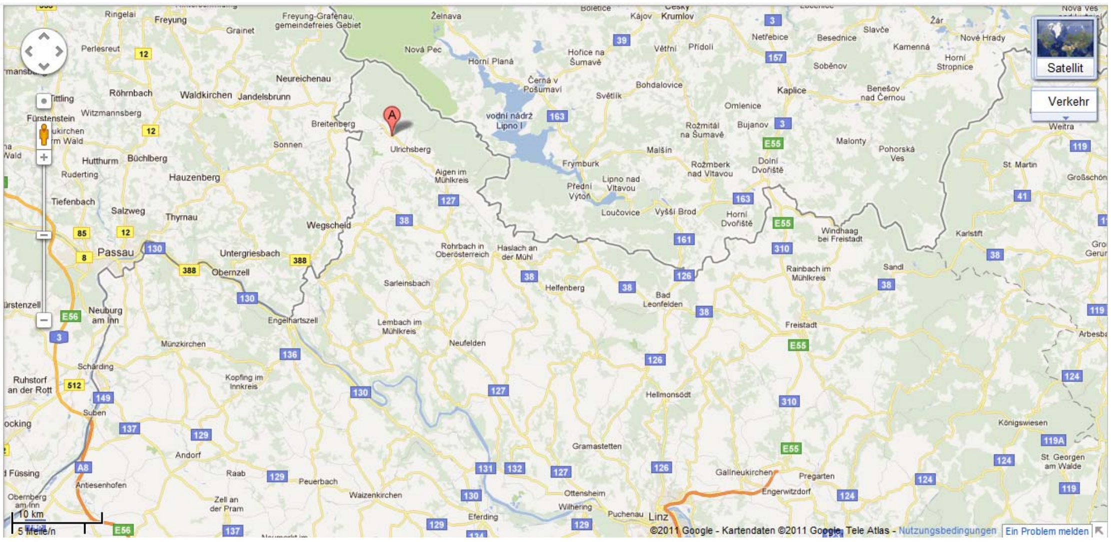


**Figure 26: position of the weekend-home in Schwarzenberg (Google Map, 2011)**

This house in the skiing-area in Hochficht (Upper Austria) is quite an old building and almost 100 years old. The beautiful door in front shows the year "1910". Several adaptations were done about 20 years ago. The calculation was done with the assumption, that the house will now be used the whole year. A wood-stove is used for hot water and heating.

Figure 27: entrance-view at the house in Schwarzenberg – own photograph

The following U-values are the input-data (based on building plans and information of the house owner) for the Austrian energy-pass-calculation to fix the current status.

Table 15: U-values for building in Schwarzenberg – based on (GEQ, 2011)

| Construction Compound (Schwarzenberg) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards unconditioned attic (kitchen) | 0,7 | 0,20 |
| ceiling towards unconditioned attic (sleeping room) | 3,63 | 0,20 |
| ceiling towards unconditioned attic (living room) | 0,15 | 0,20 |
| external wall (towards outdoor air) - granite | 0,74 | 0,35 |
| external wall (towards outdoor air) - brick | 0,77 | 0,35 |
| ground-floor | 0,46 | 0,40 |
| external wall (towards non-heated areas) - shelter (brick) | 0,76 | 0,35 |
| external wall (towards non-heated areas) - shelter (granite) | 0,7 | 0,35 |
| windows and door | 2,205 | 1,70 |

Almost each construction compound has increased values. Only the ceiling in the living-room seems to be well insulated.

This house in Schwarzenberg is rated with “F”:

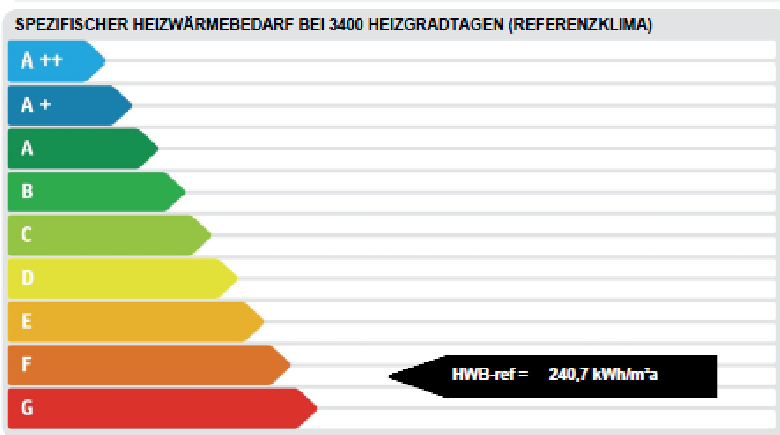


Figure 28: rating for building in Schwarzenberg – own calculation based on (GEQ, 2011)

Basis of the rating are the following HWB-values:

Table 16: HWB-details for house in Schwarzenberg – own calculation based on (GEQ, 2011)

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 152,67 |
| conditioned gross volume [m³] | 446,47 |
| surface of the thermal building envelope [m²] | 455,86 |
| characteristic length [m] | 0,98 |
| compactness (A/V) [1/m] | 1,02 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 240,71 |
| heating demand (reference) per year [kWh] | 36.750 |
| calculated HWB_(BGF, local) [kWh/m² a] | 310,52 |
| heating demand (local) per year [kWh] | 47.408 |

To check the deviation to the OIB-directive-6 margins, the following calculations for the maximum allowed HWB were done with above data.

**Table 17: calculated HWB versus maximum HWB for new building in Schwarzenberg – own calculation based on (GEQ, 2011)**

| | |
|---|---|
| if the building will be built today, the following margins have to be fulfilled to be conform to OIB-directive-6: | |
| **when built < 2012: formula valid for actual OIB-directive-6 (2007)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 19 * \left(1 + \frac{2{,}5}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a] (2007): max. 66,5 kWh/m² a** | 66,50 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (2007) - local** | 82,54 |
| | |
| **when built > 2011: formula valid for actual OIB-directive-6 (draft - valid from 1st of January 2012)** | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a](draft - valid from 1st of January 2012): max. 54,4 kWh/m² a** | 54,40 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (draft - valid from 1st of January 2012) - local** | 67,52 |

So, for the assumption, the same building is built once more now in 2011 or after, the graph for the comparison shows the following picture:

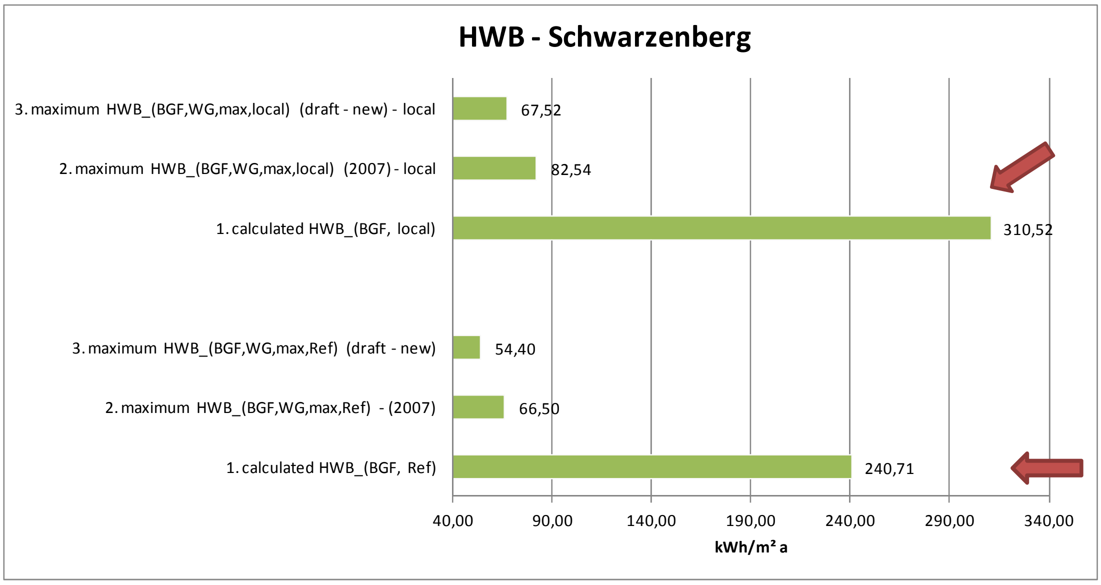


**Figure 29: HWB-Schwarzenberg for new buildings – own illustration based on my calculation with (GEQ, 2011)**

Due to the small insulation the calculated HWB is more than 3,5 times higher than the allowed margins of the OIB-directive-6.

If the house-owner wants to build the house today ones more, he has to add a thick insulation layer around the whole surface:

- 12 cm insulation on the outer part of the walls

- 24 cm additional insulation on the ceiling towards the unconditioned attic
- 16 cm insulation on the floor (change existing insulation)
- Better windows / door: at least U = 1,1 W/m²K

**Table 18: U-values for the insulation-improvements in Schwarzenberg – own calculation based on (GEQ, 2011)**

| Construction Compound (Schwarzenberg - improvements) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards unconditioned attic (kitchen) | 0,144 | 0,20 |
| ceiling towards unconditioned attic (sleeping room) | 0,173 | 0,20 |
| ceiling towards unconditioned attic (living room) | 0,169 | 0,20 |
| external wall (towards outdoor air) - granite | 0,197 | 0,35 |
| external wall (towards outdoor air) - brick | 0,199 | 0,35 |
| ground-floor | 0,214 | 0,40 |
| external wall (towards non-heated areas) - shelter (brick) | 0,197 | 0,35 |
| external wall (towards non-heated areas) - shelter (granite) | 0,198 | 0,35 |
| windows and door | 1,109 | 1,70 |

The whole building has to be discussed with a builder to find the best technical-planning solution for the house owner together with the energy consultant to reach the HWB-margins best.

From HWB-concerns point of view the above input-data changes the whole system:

**Table 19: HWB-details for improvements in Schwarzenberg – own calculation based on (GEQ, 2011)**

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 152,67 |
| conditioned gross volume [m³] | 488,02 |
| surface of the thermal building envelope [m²] | 470,53 |
| characteristic length [m] | 1,04 |
| compactness (A/V) [1/m] | 0,96 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 52,07 |
| heating demand (reference) per year [kWh] | 7.950 |
| calculated HWB_(BGF, local) [kWh/m² a] | 67,31 |
| heating demand (local) per year [kWh] | 10.276 |

So for a fictitious new building the following results can be seen, when improving the U-values (building is now rated with “C”):

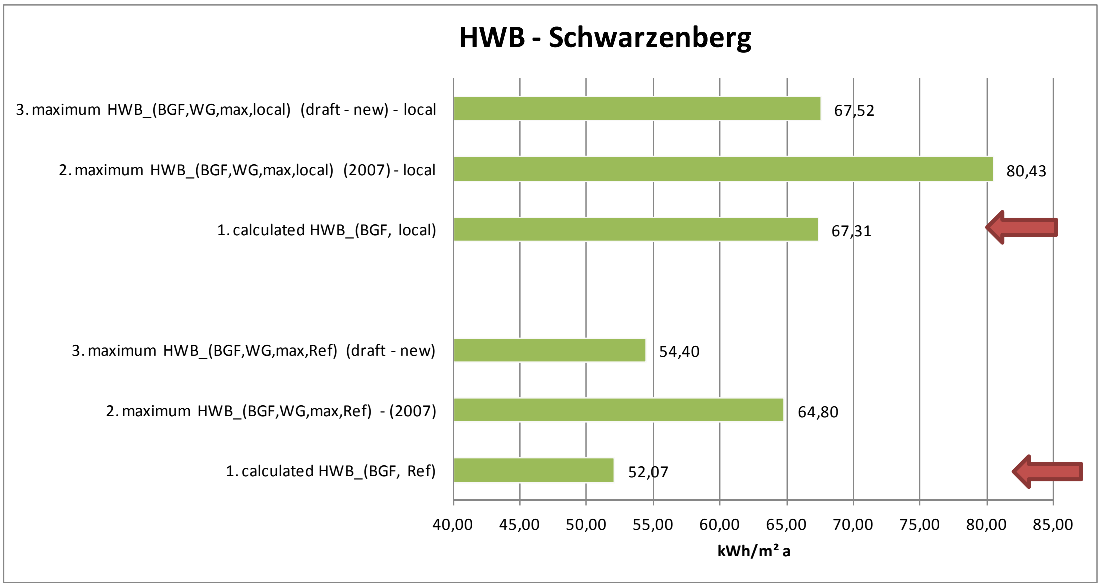


**Figure 30: HWB-Schwarzenberg (new building) - own calculation based on (GEQ (2011))**

In this building-example for larger reconstructions I have to use lower limit-values and get the following situation:

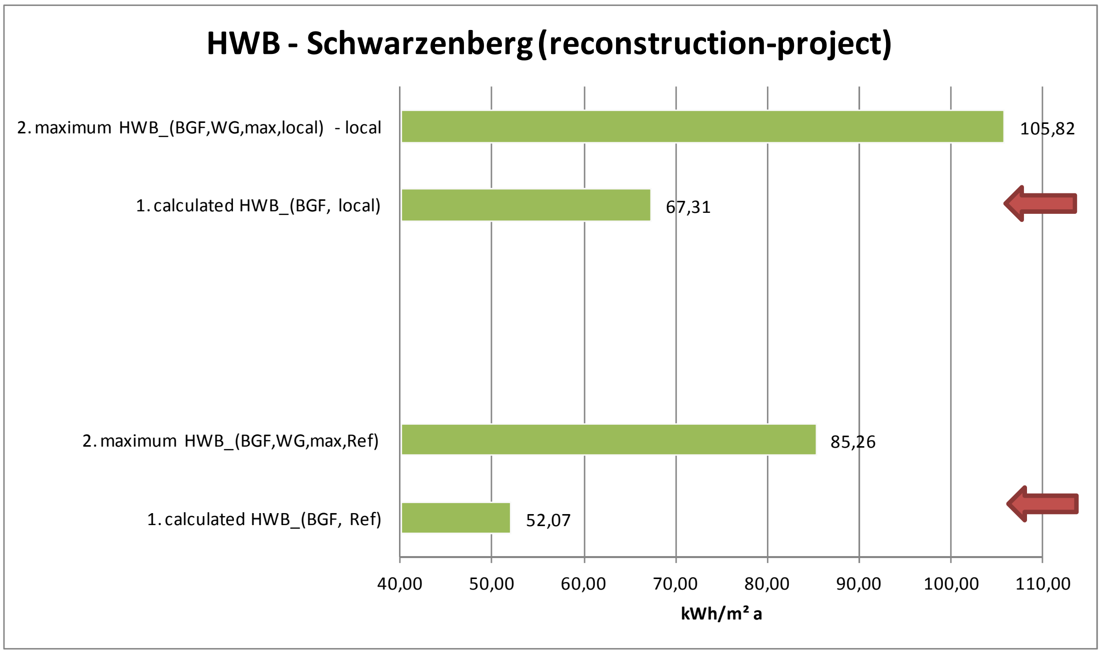


**Figure 31: HWB - Schwarzenberg (reconstruction-project) - own calculation based on (GEQ (2011))**

The new improvements fit perfectly to both margins (for new buildings and for larger reconstructions). The house-owners are well prepared for future rise in energy-prices.

To get a feeling about the payback time of this investment of reconstruction the calculation has to be done with the following assumption, that there is no change in providing hot water and heating, because the house-owner has a little wood for his own consumption. So it can be assumed, that there are no costs for his energy-demand. The improvements have to be argued with more comfort and being a part of a sustainable community.

### 8.1.5 Example 5 – single family house in San Francisco / California

This single-family house is situated in San Francisco nearby the Golden Gate Park.

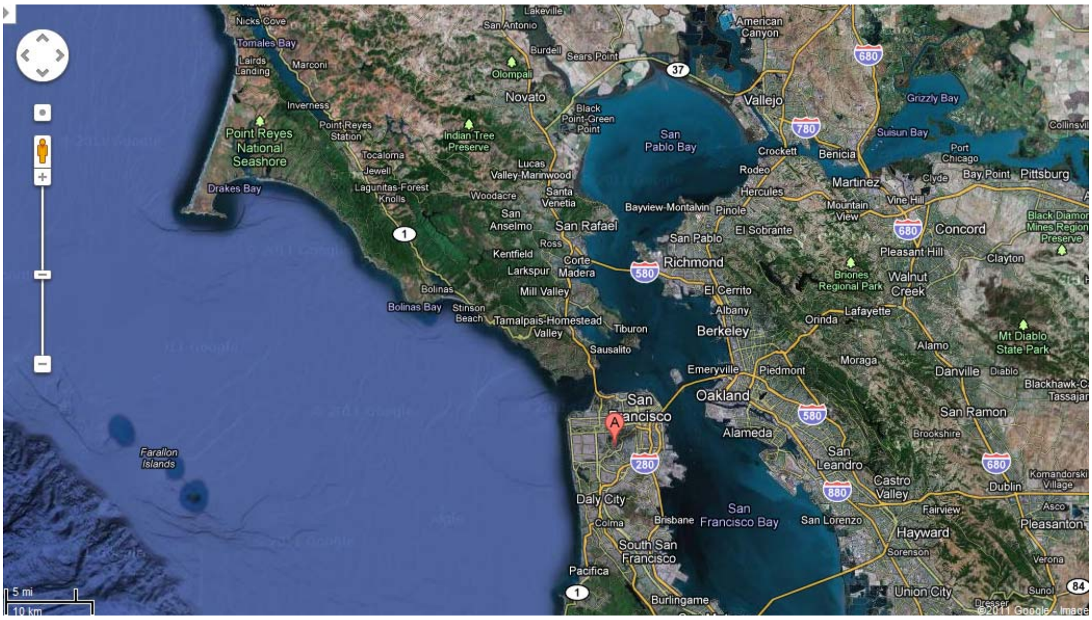


Figure 32: location of the investigated house in San Francisco (Google Earth, 2011)

The house was built in 1961 in typical timber-frame-construction. The windows were changed in 2000 into double-glazed windows.

Figure 33: street front-view of the San Francisco-house (Google Map, 2011)

The house is heated with gas and has also an air condition system. Because there are no detailed building plans available, several assumptions according to the discussion with the house-owner have to be done to do the further calculations.

The HWB should be calculated with the Austrian energy-pass – in the same way as the above examples; that means, that the used reference-climate is also the Austrian mean climate with HGT = 3400 Kd. So the calculations of the software-programe GEQ (GEQ, 2011) has to be adapted with the correct HGT for San Francisco with 1921 Kd (worldclimate, 2011) in that area to find an assumption for the local valid HWB (without considering the detailed heating conditions in San Francisco).

The following U-values are used for the calculations:

Table 20: U-values compared to the limits of the Austrian OIB-directive-6 – own calculation based on (GEQ, 2011)

| Construction Compound (San Francisco) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards outdoor air | 0,502 | 0,20 |
| external wall (towards outdoor air) | 0,35 | 0,35 |
| inner ceiling towards unconditioned garage | 0,35 | 0,40 |
| windows and door | 1,434 | 1,70 |

The ceiling to the roof doesn't fit to the Austrian OIB-directive-6. The external walls hit the limit exactly.

The energy-pass calculation with the Austrian reference shows the following picture:

Table 21: HWB-details (San Francisco) – own calculation based on (GEQ, 2011)

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 112,00 |
| conditioned gross volume [m³] | 334,32 |
| surface of the thermal building envelope [m²] | 355,34 |
| characteristic length [m] | 0,94 |
| compactness (A/V) [1/m] | 1,06 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 119,01 |
| heating demand (reference) per year [kWh] | 13.329 |
| calculated HWB_(BGF, local) [kWh/m² a] | 67,24 |
| heating demand (local) per year [kWh] | 7.531 |

The Californian house is rated with “D”.

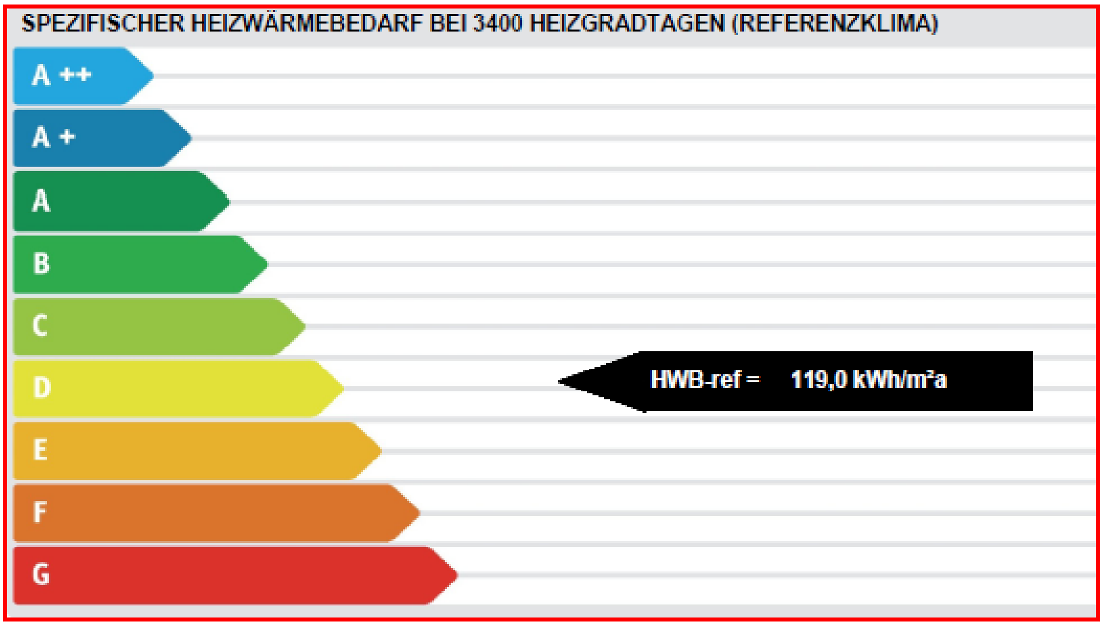


Figure 34: rating of house in San Francisco – own calculation based on (GEQ, 2011)

If the house-owner wants to build the same house today the HWB-limits are therefore – with the Austrian energy-pass-calculation:

**Table 22: margins (OIB-directive-6) for new buildings in San Francisco – own calculation based on (GEQ, 2011)**

| if the building will be built today, the following margins have to be fulfilled to be conform to OIB-directive-6: | |
|---|---|
| **when built < 2012: formula valid for actual OIB-directive-6 (2007)** | $HWB_{BGF,WG,max,Ref}[kWh/m^2a] = 19 * \left(1 + \frac{2,5}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a] (2007): max. 66,5 kWh/m² a** | 66,50 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (2007) - local** | 37,57 |
| | |
| **when built > 2011: formula valid for actual OIB-directive-6 (draft - valid from 1st of January 2012)** | $HWB_{BGF,WG,max,Ref}[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ |
| **maximum HWB_(BGF,WG,max,Ref) [kWh/m² a](draft - valid from 1st of January 2012): max. 54,4 kWh/m² a** | 54,40 |
| **maximum HWB_(BGF,WG,max,local) [kWh/m² a] (draft - valid from 1st of January 2012) - local** | 30,74 |

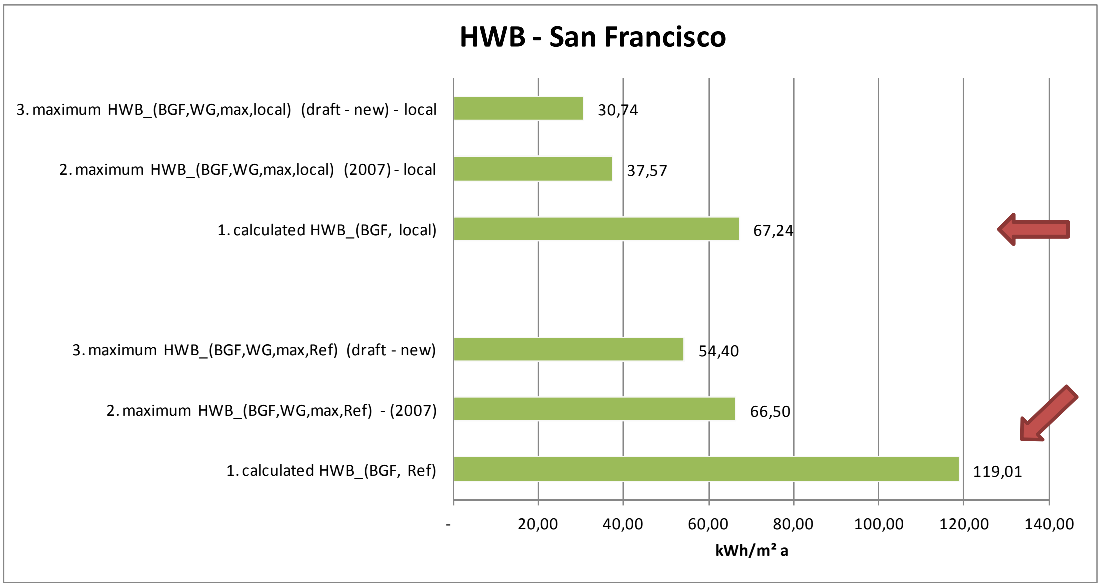


**Figure 35: HWB - San Francisco for new buildings – own illustration based on my calculation with (GEQ, 2011)**

The reference-values are quite high compared to the local value. The winters (heating period) are much milder than in warmer parts of Austria. This more than 40 years old house doesn't meet the Austrian HWB-limits; more insulation is needed, when the house-owner wants to reach these values for a new building: So the new U-values are:

**Table 23: U-values of improvements in San Francisco – own calculation based on (GEQ, 2011)**

| Construction Compound (San Francisco - improvements) | U-values [W/m²K] | limits of Austrian OIB-directive-6 |
|---|---|---|
| ceiling towards outdoor air | 0,167 | 0,20 |
| external wall (towards outdoor air) | 0,167 | 0,35 |
| inner ceiling towards unconditioned garage | 0,112 | 0,40 |
| windows and door | 1,284 | 1,70 |

Again the Austrian energy-pass-calculation has to consider HGT of San Francisco. This correction is done outside the calculation program (without considering the detailed heating conditions in San Francisco).

**Table 24: HWB-details of house in San Francisco with improvements – own calculation based on (GEQ, 2011)**

| HWB-details [kWh/m²a]: | |
|---|---|
| BGF [m²] | 112,00 |
| conditioned gross volume [m³] | 376,88 |
| surface of the thermal building envelope [m²] | 372,06 |
| characteristic length [m] | 1,01 |
| compactness (A/V) [1/m] | 0,99 |
| calculated HWB_(BGF, Ref) [kWh/m² a] | 59,40 |
| heating demand (reference) per year [kWh] | 6.653 |
| calculated HWB_(BGF, local) [kWh/m² a] | 33,56 |
| heating demand (local) per year [kWh] | 3.759 |

The improvements for new buildings that the building has to follow these margins:

**Table 25: calculated HWB versus maximum HWB for new buildings (OIB-directive-6) – own calculation based on (GEQ, 2011)**

| if the building will be built today, the following margins have to be fulfilled to be conform to OIB-directive-6: | |
|---|---|
| when built < 2012: formula valid for actual OIB-directive-6 (2007) | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 19 * \left(1 + \frac{2,5}{l_c}\right)$ |
| maximum HWB_(BGF,WG,max,Ref) [kWh/m² a] (2007): max. 66,5 kWh/m² a | 65,89 |
| maximum HWB_(BGF,WG,max,local) [kWh/m² a] (2007) - local | 37,23 |
| | |
| when built > 2011: formula valid for actual OIB-directive-6 (draft - valid from 1st of January 2012) | $HWB_{BGF,WG,max,Ref}\,[kWh/m^2a] = 16 * \left(1 + \frac{3}{l_c}\right)$ |
| maximum HWB_(BGF,WG,max,Ref) [kWh/m² a](draft - valid from 1st of January 2012): max. 54,4 kWh/m² a | 54,40 |
| maximum HWB_(BGF,WG,max,local) [kWh/m² a] (draft - valid from 1st of January 2012) - local | 30,74 |

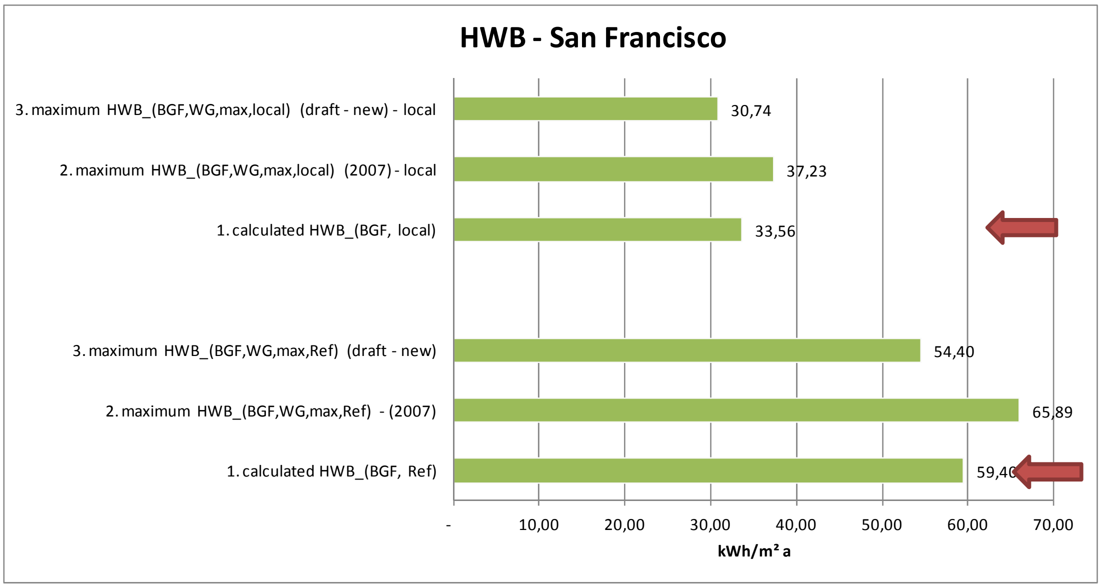


**Figure 36: HWB of the house in San Francisco with more insulation (case of a new building) – own illustration based on my calculation with (GEQ, 2011)**

The limits of the actual OIB-directive-6 fit perfectly, for the upcoming version the quality of the windows should be thought over to improve the total energy-efficiency-behavior of the building.

The margins for larger reconstruction-projects are again here less strict and the above suggestion of improvement is below both HWB-limits.

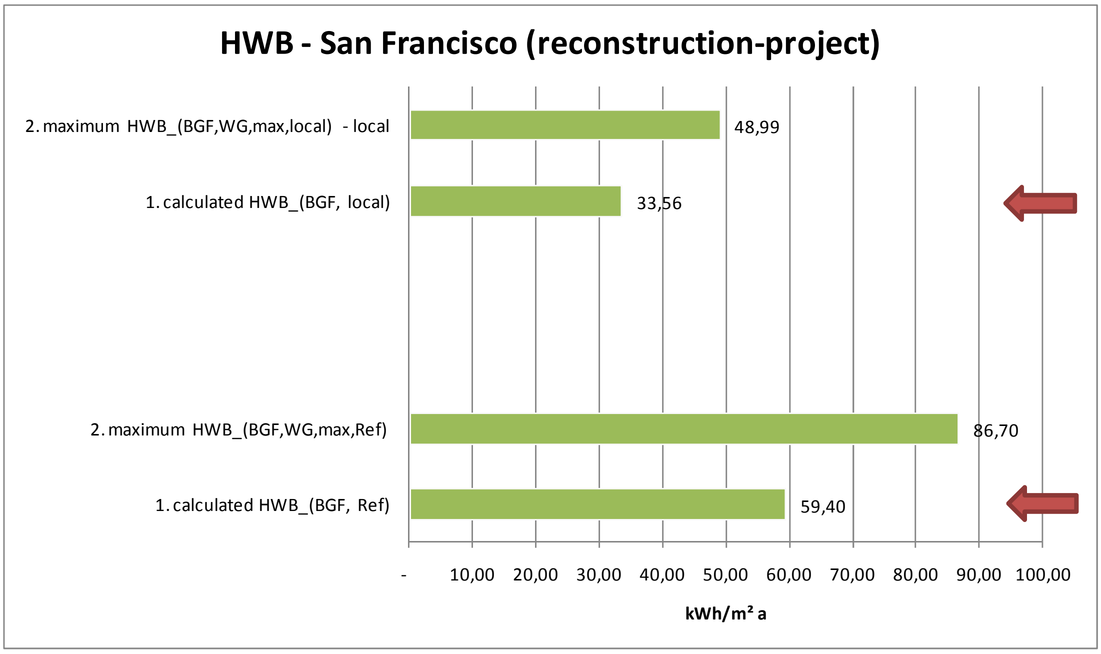


**Figure 37: HWB - San Francisco for larger construction projects – own illustration based on my calculation with (GEQ, 2011)**

The improvements mentioned above are perfect for OIB-directive-6 (2007 and upcoming 2012).

## 8.2 Calculation of energy efficiency with the Californian methodology – HERS

Depending on different climate-zones within California the regulations of the California Energy Commission (CAL-2008 Energy Commission, 2010) describe the envelope of high-rise-buildings differently. According to example 5 the following analysis is focused on the area of San Francisco. The city is located in zone “3”. The reference city is Oakland/San Francisco.

The calculations are done for package D for the zone “3”.

Buildings in San Francisco have to take into account the following requirements ( (CLIM02, 2011); (CAL-2008 Manual, 2008), (JA4, 2008) to fit to Title 24:

**Table 26: parameter relevant for San Francisco / climate zone 3 – own table**

| parameter | | comments |
|---|---|---|
| **HDD (heating degree days) (in Austria: HGT (“Heizgradtage”))** | 1921°C d/a with the basis of 18,3°C | HDD as the cumulative number of degrees in a year, when the mean temperature is below 65°F (= 18,3°C) HGT in Austria uses for room temperature of 20°C a limit, when heating is necessary at 12°C. |
| **U-value (fenestration)** | $U_{USA}$ = 0,40 Btu / ft² °F h ➔ $U_{Austria}$ = 2,271 W / m² K | SHGC is not relevant in zone 3 |
| **U-value (skylight)** | $U_{USA}$ = 0,40 Btu / ft² °F h ➔ $U_{Austria}$ = 2,271 W / m² K | |
| **Maximum of window area** | 20% of the conditioned floor | |
| **U-value of ceiling (roof)** | Package C: R-38<br>Package D: R-30 | |
| **U-value of walls** | Package C: R-25<br>Package D: R-13 | |

| | | |
|---|---|---|
| **U-value of walls (heavy mass)** | Package C: -<br>Package D: R-2.44 | notice: Walls of heavy mass have special limits, that are neglected here; for further discussion I used the limits of the wood-frame walls |
| **U-value of raised floors** | Package C: R-30<br>Package D: R-19 | Notice: for concrete raised floors (typical for buildings above the garage) no insulation is required in San Francisco. |
| **Space heating** | No electric resistance allowed ! | |

It has to be strictly rescinded, that above listed R-values of the building envelope are not the limits of the whole component, in fact they are limits of the insulation needed (CAL-2008 Manual, 2008).

The paper "Auswirkungen des Klimawandels auf Heiz- und Kühlenergiebedarf in Österreich" of the project StartClim2006.F (StartClim2006.F, 2007) correlates both definitions of HDD in the United States and the HGT in Austria:

- HDD is defined by the "balance point temperature" of 65°F (18,3°C)
  - o $HDD\ (T_1, T_2) = \sum_{t=T_1}^{T_2} (18{,}3 - \theta_t)$
    - ▪ If mean day temperature $\theta_t$ ≤ 18,3 °C in the period between $T_1$ and $T_2$
- HGT is defined by the limit temperature of 12°C, because for Austria the margin of 18,3°C would be much too high (e.g. solar radiation) to start heating. ÖNORM 8135 (ÖNORM EN 12831 (2003)) defines HGT with these margins. Germany on the contrary uses the margin of 15°C.
  - o $HGT\ (T_1, T_2) = \sum_{t=T_1}^{T_2} (20 - \theta_t)$
    - ▪ If mean day temperature (outside) $\theta_t$ ≤ 12 °C in the period between $T_1$ and $T_2$
- The paper compares both definitions with a graph (also included CDD/KGT [cooling degree days]:

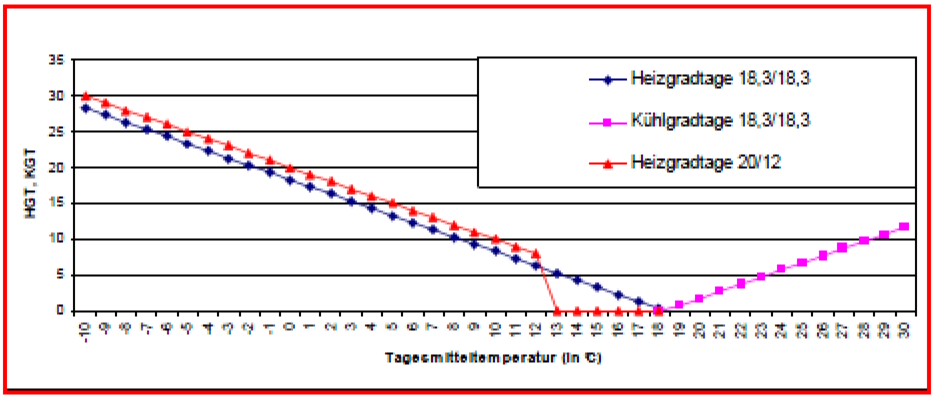


Figure 38: HGT (20/12), HGT (18,3; 18,3) and CDD (18,3; 18,3) - (StartClim2006.F, 2007)

- The calculation with HGT (20,12) is a little bit higher than the US-version. It is clear, that from 13°C onwards there is no heating, whereas HGT (18,3; 18,3) consider heating till 18,3°C. Then there is curve for cooling.

The conditioned floor area (CFA) is typically expressed as square feet. It can be compared with the Austrian BGF. CFA is needed for the purpose of compliance, because the annual energy demand is divided by CFA to get the energy budget. The maximum fenestration area is expressed as a percentage of this value.

In Austria the R-value (thermal resistance) is given in SI units: [m²K / W]. The U-value () is identical with 1/R with the dimension [W/m²K]. In the USA they do not use the SI-units (WIKI_01, 2011):

Table 27: R- and U-value units in Austria and the USA – own table

| | Austria | USA |
|---|---|---|
| R-value | m²K/W | ft² °F h / Btu |
| U-value | W/m²K | Btu / ft² °F h |

Whereas:

- 1 ft² °F h / Btu = 0,176110 m² K / W
- 1 m² K / W = 5,678263 ft² °F h / Btu

In the USA the units normally are not written with their units – they are much higher (about 6x) than the SI-units.
For example “R-40” means:
$R_{USA}$ = 40 ft² °F h / Btu → $R_{Austria}$= 7,04 m² K / W
$U_{USA}$ = 1/$R_{USA}$ = 0,025 Btu / ft² °F h → $U_{Austria}$ = 0,142 W/m²K

The usage of R-values are more common in the states whereas Europe uses its reciprocal numbers – the U-values.

This part of San Francisco is located in the North-Central-Climate Zone. Energy Star certifications should be taken into account with the following labels for windows and doors:

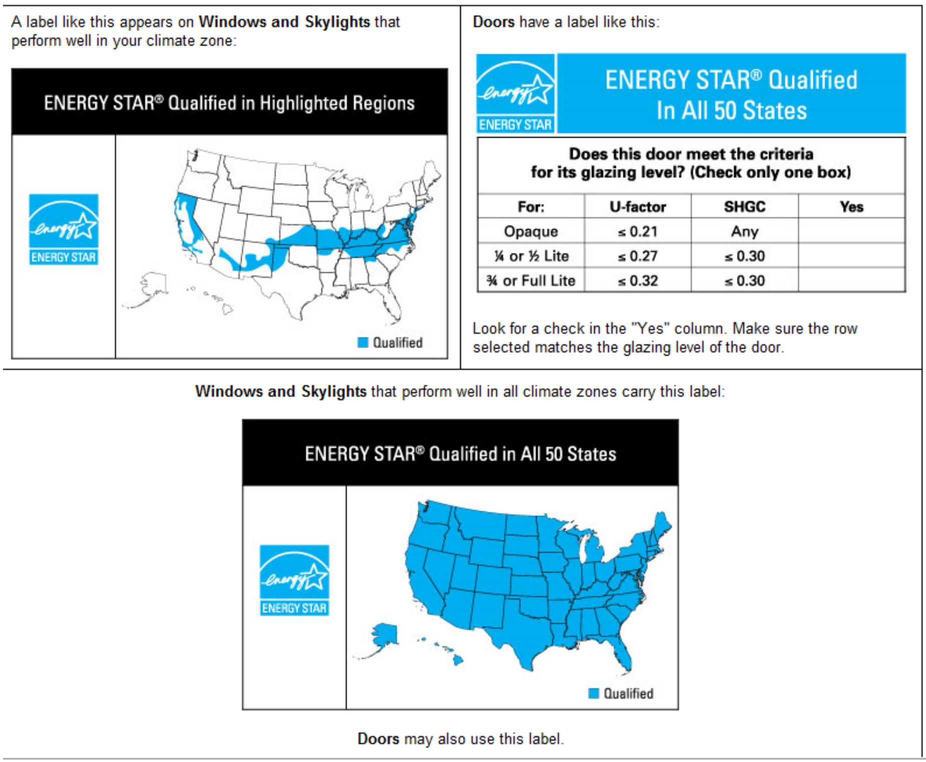


**Figure 39: energy-star labels - relevant for San Francisco (Energy Star_Windows, 2011)**

Energy Star (Energy Star_Windows, 2011) foresees these limits at the area of San Francisco:

⇨ Windows with U-factor of 0.32 or less AND an SHGC of 0.40 or less

⇨ Doors (without glass) with U-factor of 0.21 or less (no SHGC requirement)

With her paper “2008 Residential Compliance Manual” (CAL-2008 Manual, 2008) the California Energy Commission forces the restriction of switching from gas to electric resistance water heaters. The new heaters have to be certified by the Energy Commission. The Heating Seasonal Performance Factor HSPF [Btu / W h] is used to describe the efficiency of heat pumps or electric resistance.

### 8.2.1 Discussion of the usage of the Californian prescriptive approach for the 5 examples

According to the Commission Manual (CAL-2008 Manual, 2008) I used the Californian “prescriptive approach”. As this package is also the basis of the performance approach, when HERS raters are needed to do the “whole-house home energy rating” with a computer model, I chose package D for my further remarks. But also package C with its stronger margins is taken into account.

Paper “Joint Appendix JA4 – 2008” (JA4, 2008) is used to find out the limits of the whole assembly of the parts of the building. To understand the used R-value-limits in California also an additional comparison to the numbers of zone 16 in the “Golden State” was necessary, that is located in the higher region (> 5000 ft = 1524 m) in the north-western part of the country.

The differences between the Austrian and Californian approach are focused on the analysis of their limiting values for R- and U-value.

Bases are the R-values for the necessary insulation from (CAL-2008 Manual, 2008) and the corresponding U-values from (JA4, 2008) for the whole assembly.

**Table 28: R-value-margins in California for package C and D in San Francisco and Bishop own table based on (CAL-2008 Manual, 2008)**

| assembly | limits in California - area San Francisco (zone 3, package C) | | limits in California - area Bishop (zone 16, package C) | | limits in California - area San Francisco (zone 3, package D) | |
|---|---|---|---|---|---|---|
| | R-value [ft² °F h / Btu] of insulation | U-value [Btu / ft² °F h] of whole assembly | R-value [ft² °F h / Btu] of insulation | U-value [Btu / ft² °F h] of whole assembly | R-value [ft² °F h / Btu] of insulation | U-value [Btu / ft² °F h] of whole assembly |
| fenestration | - | 0,38 | - | 0,38 | | 0,4 |
| ceiling (roof) | R-38 | 0,026 | R-49 | 0,02 | R-30 | 0,032 |
| walls (wood) | R-25 | 0,057 | R-29 | 0,047 | R-13 | 0,102 |
| walls (heavy mass) - | R-25 | 0,057 | R-29 | 0,047 | R-13 | 0,102 |
| floor towards unconditioned cellar/ground | R-30 | 0,028 | R-30 | 0,028 | R-19 | 0,037 |
| concrete raised floor (garage in the USA) | no insulation needed | 0,269 | no insulation needed | 0,269 | R-0 | 0,269 |

notice: walls of heavy mass have special limits, that are neglected here - for further discussion limits of wood-frame walls are used
notice: raised floors are used in the USA - those values are used for further discussion

To compare the Californian results with the Austrian limits the data have to be converted in SI-units.

**Table 29: limits of U-values valid in Austria and California – own table**

| U-value of component | limits in Austria [W/m²K] | limits in California [W/m²K] - area San Francisco (zone 3, package C) | limits in California [W/m²K] - area Bishop (zone 16, package C) | limits in California [W/m²K] - area San Francisco (zone 3, package D) | limits in California [W/m²K] - area Bishop (zone 16, package D) |
|---|---|---|---|---|---|
| fenestration | 1,4 | 2,158 | 2,158 | 2,271 | 2,271 |
| U-value of ceiling (roof) | 0,2 | 0,148 | 0,114 | 0,182 | 0,148 |
| U-value of walls | 0,35 | 0,324 | 0,267 | 0,579 | 0,392 |
| floor towards unconditioned cellar/ground | 0,4 | 0,159 | 0,159 | 0,21 | 0,21 |
| concrete raised floor (garage in the USA) | 0,4 | 1,527 | 1,527 | 1,527 | 0,522 |

Only the main parts of each example-building will be taken into account:

**Table 30: U-values [W / m² K] of the main parts of the examples – own calculation**

| U-value of component | Traun-kirchen | Baden | Alten-felden | Schwarzen-berg | San Francisco |
|---|---|---|---|---|---|
| fenestration | 1,098 | 0,898 | 1,863 | 2,205 | 1,434 |
| U-value of ceiling (roof) | 0,163 | 0,13 | 0,348 | 3,63 | 0,502 |
| U-value of walls | 0,251 | 0,14 | 1,142 | 0,74 | 0,35 |
| floor towards unconditioned cellar/ground | 0,196 | 0,23 | 0,654 | 0,46 | - |
| concrete raised floor (garage in the USA) | - | - | - | - | 0,35 |

The differences are shown in the following graph:

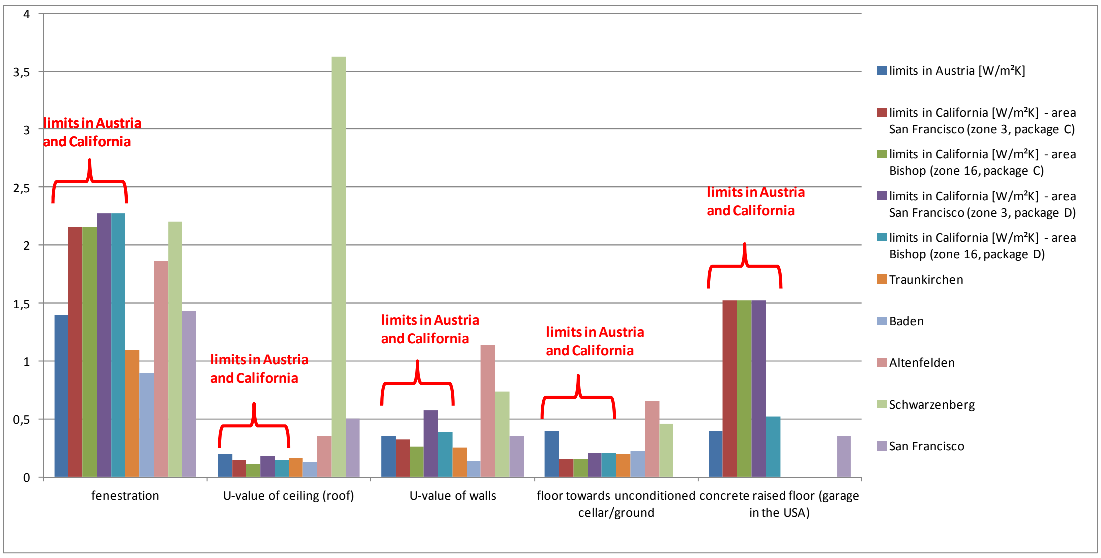


**Figure 40: different U-values for the limits in Austria and California + examples – own illustration**

It can be seen with above rough analysis that also the low energy-houses in Austria do not fully fit to all of the Californian margins. Low energy-houses are called those Austrian buildings with HWB lower than 50 kWh / m² K (similar to the Austrian ratings of A+, A, B, C). The strong limits of package C in California are especially in the mountain-region zone 16 very challenging for the Austrian low-energy houses in Traunkirchen and Baden. They would need additional insulation especially in the floor towards unconditioned cellar or ground and in the roof/ceiling.

## 8.3 Summary of the energy-efficiency calculation – comparison of both countries (description of the results)

To achieve better HWB with the Austrian energy pass calculation in 3 from 5 examples it was necessary to do several improvements (more insulation, windows with lower U-value). The rating of the new calculated Austrian energy-pass moves to a better grading – shown in below figure.

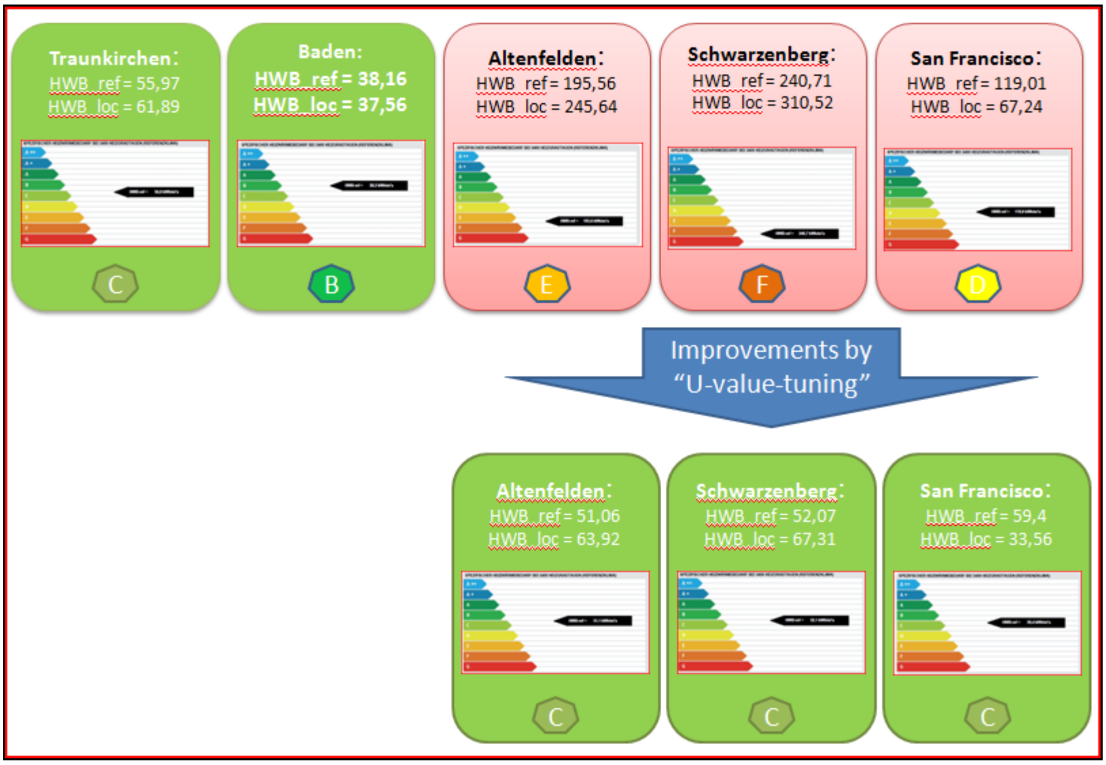


**Figure 41: overview of the improvements in HWB - calculated with the Austrian energy-pass – own illustration based on (GEQ, 2011)**

Similar is the situation in California. Here they work with different limits of U-values – depending on the location (climate zone) - (look at chapter 6.2.2):

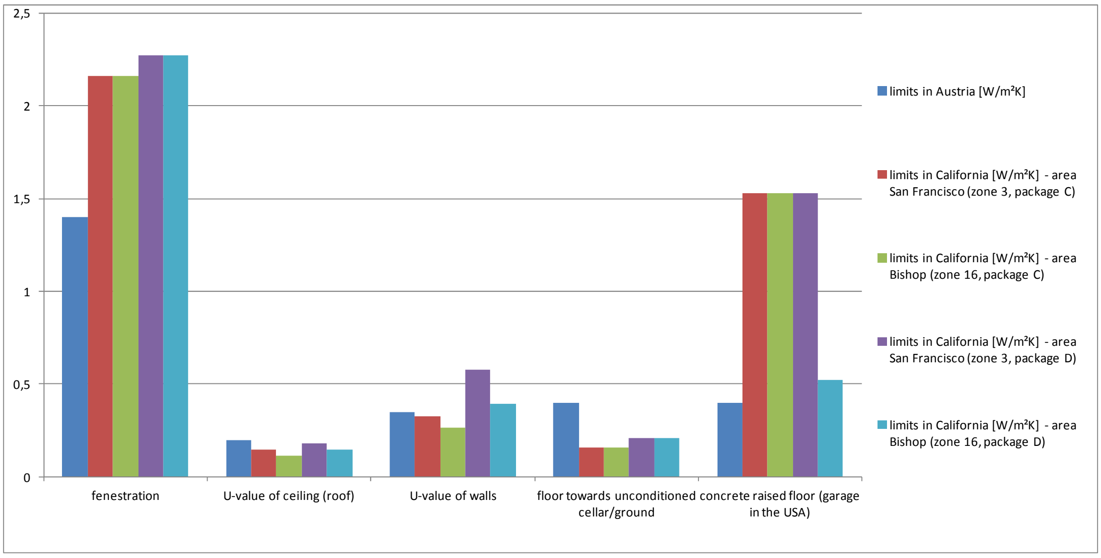


**Figure 42: limits in Austria and California for different U-values (own illustration)**

The following table shows an overview about the main differences between both country approaches:

**Table 31: differences of energy-efficiency calculation (own table)**

| Description | Austria | California |
|---|---|---|
| Method for documenting compliance with the energy efficiency standards of the country | Energy-pass calculation | • Simplest way: Prescriptive approach (look 5.3.)<br>• Performance approach: allows more flexibility (5.3.) |
| Definition of heating degree days | HGT ("Heizgradtage") is defined by the limit temperature of 12°C | HDD is defined by the balance point temperature of 65°F (18,3°C) |
| U-value limits (look at figure 42) | One set of limits | • Different values for 16 climate zones of California<br>• Different limits using different packages (chapter 5.3.)<br>• More severe limits for ceiling and floor/towards ground |
| Limits of heating | Yes, defined in OIB-directive 6 | No |

| | | |
|---|---|---|
| demand available? | | |
| Rating is done with | Energy-pass calculation – calculating HWB (referring to a reference calculation) | HERS-index (development out of US-energy-star-rating) with a 250 point scale – relating to a reference building at 100) |
| Is rating obligatory? | Yes, for new buildings and when building is sold. | • No, it is recommended<br>• Minimum: Prescriptive approach (fulfilling several limits of building components and other installation parts) |
| Who is allowed to do the rating? | Certain engineering offices | Certified Raters, trained by the Energy Commission |
| Is the using of special software obliged? | No, simple spreadsheet analysis is possible – results have to fulfill OIB-directive-6 | When using the performance approach, the used computer model has to be approved by the Energy Commission |
| Which topics are described in the energy-efficiency standards concerning the rating-pass? | • Heating demand HWB<br>• Thermal quality of buildings (LEK)<br>• Final energy demand (EEB)<br>• Heat transmitting construction components (U-values)<br>• Energy systems with their losses concerning pipes and storage<br>• Others: thermal bridges, airtight and windproof construction, summer overheating<br>• structure of the Austrian energy pass | • HERS-Index as a result of standard measurement of the energy efficiency of the home and its possibilities for improvements – relative to the reference house.<br>• HERS simulation tool to model the house and simulating the energy use for one year.<br>• End-use demands (inclusive cooking, fridge, other electronics) as standard assumptions (LBL, 2000) for examined house size. |
| Minimum information given by the local energy-pass? | • HWB of the building (relating to reference climate) | • Score of rating<br>• Recommendations with lifecycle savings of |

| | | |
|---|---|---|
| | • HTEB<br>• EEB<br>• Possible improvements of EEB | suggested improvements |

The difference of the definition between HGT and HDD has strong dependencies on the local climate with its solar radiation and the internal gains. So it does not make sense to mix those local parameters in the calculation.

In comparison with Austria, it can be summarized, that the focus in California's guidelines for U-values is set on higher U-values of the ceiling/roof and of the floor towards the ground or unconditioned cellar. But the system of California also allows a special computer program to do a whole-house energy rating (HERS) to get the possibility to model the house, to get the best values by simulating the whole system (that is not focus of this work).

So the effort to fit to the Californian limits is to improve the insulation of the whole building shell according to the given parameters in the California Energy Commission paper. There is a strong dependence on the location of the building. According to the climate-zone it is necessary to choose the right necessary thicknesses of the insulation of the building envelope. The Californian listings in the appendix of the paper of the California Energy Commission (CAL-2008 Manual, 2008) are a very good basis to go into a good simulation model-program to find the best solution for the individual case.

In Austria an energy-pass is always needed for new buildings and reconstruction projects. Used installations like dishwasher or washing machine are not a topic in this European country whereas California's HERS rating does a model calculation for the whole building. But it was seen quite difficult in California using a database of HERS input-data predicting the actual energy consumption. Now a lot of effort was and is put in improving the accuracy of HERS. (LBL, 2000)

There are strict trainings for the raters in California. Only certified raters are allowed to do these HERS ratings. In Austria it is sufficient if you fulfill a certain qualification like an engineering office of a special field. It is absolutely essential that all consultants are familiar with the latest innovation in their area and are well trained.

Both countries do a lot for advertising the necessity of improving the energy-efficiency of the people's homes. Austria has special subsidies to help people with cheaper credits, when they build energy-efficient buildings. Tax-reduction is possible in Austria and in California.

In both countries additional activities can be found in the environment of the mentioned energy-efficiency standards.

1. In Austria klima:aktiv (www.klimaaktiv.at) has worked out additional - but voluntarily - commitments for builders that are much stricter than the ones of OIB-directive-6. New buildings are forced to become passive house standard. Ecological requirements (e.g. using special ecologically optimized products for building, no PVC allowed, using water saving taps etc.) are listed to reach the klima:aktiv criteria (klima_aktiv_Gebäudeplattform, 2011).
2. In California there are several developments in several counties. Santa Monica (Santa Monica Municipal Code, 2010) for example developed guidelines for green buildings that also refer to the California Energy Code. The compliance requirements for Santa Monica Residents are even more severe (10%) than the requirements of California title 24 Energy Code standards. Additionally ecological criteria (e.g. water conservation, using green building materials) are listed.

Erecting a new building with the best possible U-values is all over the world the best way to reduce the heating costs as low as possible. Later adaptations in reconstruction projects mean high additional costs. On the other hand it might be better to invest in house improvements to reduce the energy-bill during ones pension than bringing the money to the bank.

# 9 Future prospects

From 1st of January 2012 a new OIB-directive-6 is valid for Austria. The restrictions for HWB will be more severe – but the done modifications are not really big. To my personal opinion the limits are still much too high. Even more effort has to be put in tuning the energy-efficiency of our houses. From technical and economical point of view much lower limits are possible.

In addition to further improvements in home-efficiencies the Austrian energy-pass also has to provide the primary energy demand (PEB) (relevant for the local conditions) and the amount of CO2-emission caused by the individual home. The limits for individual U-value will be the same as in the actual version of OIB-directive-6. With this update of OIB-directive-6 the European directive 2010/31/EU will come into force in Austria. Nearly zero-energy houses for all new buildings are the goal for 2020.

Also California just started working on new standards “2013 Building Energy Efficiency Standards”– coming into rule 2014 (California Energy Commission - Background, 2011). This update will emphasize the essential role of improving the building energy efficiency to achieve California’s goal of reducing greenhouse gas emissions. The new standards will be an essential step to achieve new building standards “net zero energy” levels for residences by 2020. With this new release [will be published as “2013 California Energy Code”] the life cycle costs (California Energy Commission - LifeCycle, 2011) will be based on TDV energy to get a better understanding of the saved energy during peak period or the distribution system is near capacity.

For both countries it is clear, that more effort is necessary to maximize the energy efficiency in all homes. Improving the building envelope is one essential step reducing greenhouse gases.

California wants to reduce its emission in order to reach 1990-level again in 2020 (similar to a reduction of 25% of the emission of 2006!). In Europe the strategy (e-control, 2010) is called “20-20-20”, that means that the European countries want to reduce their greenhouse gases by 20% (from the year 2005). 20% usage of renewable energy and 20% more energy efficiency are the other pillars. Each country has its own targets. The Austrian energy-strategy focuses on 3 points (more details can be found on: www.energiestrategie.at):

1. Increasing of energy-efficiency
2. More renewable energy of the Austrian energy mix
3. Securing of the Austrian energy supply

Especially for Europe there is the demand of becoming independent from instable importing countries for heating with gas or oil. Reducing the heating demand together with switching to renewable energy facilities is the way we have to work to.

# 10 Conclusions

When comparing the Austrian with the California legislation framework for residential homes, it is obvious, that both rating-systems follow the same idea:

- Requesting the necessary data
- Calculation of a rating/index of the efficiency of the house
- Pointing out the improvements of the existing house

The Austrian energy-pass only looks at the efficiency of the residential house itself, as well as the heating-system including hot-water-generation (HWB, WWEB etc.)

California's HERS also includes the used electrical installations (used lamps, fridge, pool etc.). The house owner gets an estimation of the energy-use of the individual home.

In both countries it is handled the same: if essential information is not provided by the owner, assumptions according to the age of the house and based on the experience of the rater can be made. The final results are compared to a reference.

In Austria the rating is necessary for new buildings and when buildings are sold. In California it is recommended.

The Austrian OIB-Directive-6 as well as the California Building Energy Standards itemizes individual U-values for single construction parts.

It is still necessary for both countries, that standards were implemented to reduce $CO_2$ and put even more effort in improving the building energy efficiency.

It has to be transparent for the citizens that improving the insulation of the house-envelope has more effects than reducing the monthly part used for heating:

- Feeling more cozy in winter and in summer (not so hot inside the house)

- Ratings are needed for selling or renting houses
    - If having a good value in the HERS rating or energy-pass the house has higher quality than others.
- The house-owner can be a part of reducing CO2-emissions.

We all are responsible for our nature and environment. It should be clear that we all need to do everything to get a better environment. 2005 Governor Schwarzenegger said (Schwarzenegger, 2005): "I SAY THE DEBATE IS OVER. WE KNOW THE SCIENCE. WE SEE THE THREAT. AND WE KNOW THE TIME FOR ACTION IS NOW." Let's do it!

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# 13 Annexes

## 13.1 Details (current status) of Austrian Energy-pass for the examples-houses – own calculations based on (GEQ, 2011)

### 13.1.1 Example 1 - Energy-pass for single family house in Traunkirchen

| | | | |
|---|---|---|---|
| Norm-Außentemperatur: | -14,3 °C | Standort: Traunkirchen | |
| Berechnungs-Raumtemperatur: | 20 °C | Brutto-Rauminhalt der | |
| Temperatur-Differenz: | 34,3 K | beheizten Gebäudeteile: | 634,84 m³ |
| | | Gebäudehüllfläche: | 484,06 m² |

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AD01 | Decke zu unkonditioniertem geschloss. Dachraum | 41,06 | 0,163 | 0,90 | | 6,04 |
| AW01 | Aussenwand - Holzblock | 109,59 | 0,251 | 1,00 | | 27,53 |
| AW02 | Wintergarten | 9,87 | 0,855 | 1,00 | | 8,44 |
| DS01 | Dachschräge hinterlüftet | 79,75 | 0,169 | 1,00 | | 13,47 |
| FE/TÜ | Fenster u. Türen | 73,59 | 1,098 | 1,00 | | 80,77 |
| EB02 | Wintergarten-Fussboden | 23,68 | 0,235 | 0,70 | 1,34 | 5,20 |
| KD01 | Kellerdecke | 101,87 | 0,196 | 0,50 | 1,34 | 13,36 |
| IW01 | Aussenwand - Holzblock (Holzlagerraum, Garage) | 29,10 | 0,246 | 0,70 | | 5,01 |
| IW02 | Aussenwand - Holzblock (WIGa-kalt Norden) | 15,55 | 0,246 | 0,80 | | 3,06 |
| | Summe OBEN-Bauteile | 138,57 | | | | |
| | Summe UNTEN-Bauteile | 125,55 | | | | |
| | Summe Außenwandflächen | 119,46 | | | | |
| | Summe Innenwandflächen | 44,65 | | | | |
| | Fensteranteil in Außenwänden 28,9 % | 48,64 | | | | |
| | Fenster in Innenwänden | 7,18 | | | | |
| | Fenster in Deckenflächen | 17,76 | | | | |
| **Summe** | | | | [W/K] | | **163** |

| | | | |
|---|---|---|---|
| Wärmebrücken (pauschal) | | [W/K] | 13 |
| Transmissions - Leitwert $L_T$ | | [W/K] | 176 |
| Lüftungs - Leitwert $L_V$ | | [W/K] | 58,61 |
| Gebäude - Heizlast $P_{tot}$ | Luftwechsel = 0,40 1/h | [kW] | 8,06 |
| Flächenbez. Heizlast $P_1$ bei einer BGF von | 207 m² | [W/m² BGF] | 38,89 |
| Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht) | Luftwechsel = 0,50 1/h | [kW] | 8,85 |

**Bauteile**

**Übungsversion_single-family home in Traunkirchen / Upper**

**AD01 Decke zu unkonditioniertem geschloss. Dachraum**

| | von Außen nach Innen | Dicke | λ | d / λ |
|---|---|---|---|---|
| Knauf Gipskarton Feuerschutzplatte | B | 0,0180 | 0,250 | 0,072 |
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | B | 0,0400 | 0,222 | 0,180 |
| Steinwolle MW-W (33) | B | 0,2000 | 0,038 | 5,263 |
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| 1.108.02 Gipsbauplatten | B | 0,0180 | 0,290 | 0,062 |
| | Rse+Rsi = 0,2 Dicke gesamt | 0,3240 | U-Wert | 0,16 |

**AW01 Aussenwand - Holzblock**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | 0,1000 | 0,038 | 2,632 |
| 1.402.02 Holz | B | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,17 Dicke gesamt | 0,2650 | U-Wert | 0,25 |

**DS01 Dachschräge hinterlüftet**

| | von Außen nach Innen | Dicke | λ | d / λ |
|---|---|---|---|---|
| Luft steh., W-Fluss horizontal 25 < d <= 30 mm | B | 0,0300 | 0,176 | 0,170 |
| 1.402.02 Holz | B | 0,0200 | 0,140 | 0,143 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | B | 0,0400 | 0,222 | 0,180 |
| Steinwolle MW-W (33) | B | 0,1800 | 0,038 | 4,737 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| Luft steh., W-Fluss horizontal 15 < d <= 20 mm | B | 0,0200 | 0,118 | 0,169 |
| 1.402.02 Holz | B | 0,0200 | 0,140 | 0,143 |
| | Rse+Rsi = 0,2 Dicke gesamt | 0,3350 | U-Wert | 0,17 |

**EB02 Wintergarten-Fussboden**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0100 | 1,000 | 0,010 |
| 1.202.06 Estrichbeton | F B | 0,0700 | 1,480 | 0,047 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| Styrodur 3035 C (140 mm) | B | 0,1500 | 0,038 | 3,947 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| 1.508.02 Schüttung (Sand, Kies, Splitt) | B | 0,0500 | 0,700 | 0,071 |
| | Rse+Rsi = 0,17 Dicke gesamt | 0,2820 | U-Wert | 0,23 |

**KD01 Kellerdecke**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.402.02 Holz | B | 0,0140 | 0,140 | 0,100 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | 0,0500 | 0,038 | 1,316 |
| 1.202.02 Stahlbeton | B | 0,1700 | 2,300 | 0,074 |
| Styrodur 2800 C (80 mm) | B | 0,0800 | 0,035 | 2,286 |
| ISOVER TDPT Trittschall-Dämmpl. 30/30 | B | 0,0300 | 0,033 | 0,909 |
| 1.202.06 Estrichbeton | F B | 0,0600 | 1,480 | 0,041 |
| 1.704.08 Fliesen | B | 0,0200 | 1,000 | 0,020 |
| | Rse+Rsi = 0,34 Dicke gesamt | 0,4250 | U-Wert | 0,20 |

**ZD01 warme Zwischendecke zw. EG und OG**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.402.02 Holz | B | 0,0400 | 0,140 | 0,286 |
| Steinwolle MW-W (33) | B | 0,1700 | 0,038 | 4,474 |
| 1.402.02 Holz | B | 0,0250 | 0,140 | 0,179 |
| Korkschrot (100), expandiert | B | 0,0050 | 0,050 | 0,100 |
| AB Berg & Berg Fertigparkett in Esche | B | 0,0250 | 0,120 | 0,208 |
| | Rse+Rsi = 0,26 Dicke gesamt | 0,2650 | U-Wert | 0,18 |

Bauteile

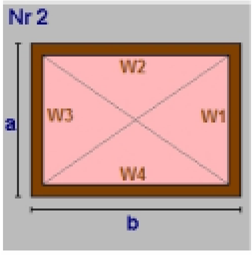
Übungsversion_single-family home in Traunkirchen / Upper

| | | | | |
|---|---|---|---|---|
| **IW01 Aussenwand - Holzblock (Holzlagerraum, Garage)** | von innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | 0,1000 | 0,038 | 2,632 |
| 1.402.02 Holz | B | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,26 | Dicke gesamt 0,2650 | U-Wert | 0,25 |
| **IW02 Aussenwand - Holzblock (WiGa-kalt Norden)** | von innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | B | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | 0,1000 | 0,038 | 2,632 |
| 1.402.02 Holz | B | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,26 | Dicke gesamt 0,2650 | U-Wert | 0,25 |
| **AW02 Wintergarten** | von innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | B | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,17 | Dicke gesamt 0,1400 | U-Wert | 0,85 |
| **EK01 Keller - in Basis nicht beheizt** | von innen nach Außen | Dicke | λ | d / λ |
| 1.704.08 Fliesen | B | 0,0200 | 1,000 | 0,020 |
| 1.202.06 Estrichbeton | B | 0,0600 | 1,480 | 0,041 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| EXPORIT EPS F 16 | B | 0,1600 | 0,040 | 4,000 |
| PVC-Dichtungsbahn | B | 0,0010 | 0,140 | 0,007 |
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| | Rse+Rsi = 0,17 | Dicke gesamt 0,2920 | U-Wert | 0,23 |
| **EW01 Kellerwand** | von innen nach Außen | Dicke | λ | d / λ |
| 1.108.04 Gipsbauplatten | B | 0,0150 | 0,410 | 0,037 |
| Styrodur 2800 C (50 mm) | B | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | 0,3000 | 2,300 | 0,130 |
| 1.604.06 Kunststoff- & Gummibelag | B | 0,0050 | 0,210 | 0,024 |
| Styrodur 2800 C (50 mm) | B | 0,0500 | 0,033 | 1,515 |
| | Rse+Rsi = 0,13 | Dicke gesamt 0,4200 | U-Wert | 0,30 |
| **EW02 Kellerwand - Bereich Gästezimmer** | von innen nach Außen | Dicke | λ | d / λ |
| 1.108.04 Gipsbauplatten | B | 0,0150 | 0,410 | 0,037 |
| Styrodur 2800 C (50 mm) | B | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | 0,3000 | 2,300 | 0,130 |
| 1.604.06 Kunststoff- & Gummibelag | B | 0,0050 | 0,210 | 0,024 |
| Styrodur 2800 C (50 mm) | B | 0,0500 | 0,033 | 1,515 |
| | Rse+Rsi = 0,13 | Dicke gesamt 0,4200 | U-Wert | 0,30 |

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

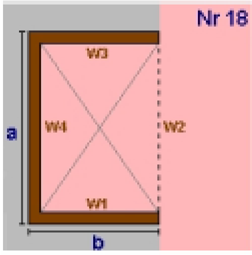
**Geometrieausdruck**
**Übungsversion_single-family home in Traunkirchen / Upper**

**EG basis**



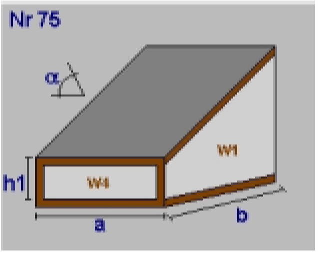

```
a =  9,72      b  =  9,72
lichte Raumhöhe  =  2,50 + obere Decke: 0,27 => 2,77m
BGF          94,48m² BRI     261,23m³

Wand W1     26,88m² AW01 Aussenwand - Holzblock
Wand W2     26,88m² AW01
Wand W3     26,88m² IW01 Aussenwand - Holzblock (Holzlagerraum
Wand W4     12,97m² AW01 Aussenwand - Holzblock
         Teilung  5,03 x 2,77 (Länge x Höhe)
            13,91m² IW02 Aussenwand - Holzblock (WiGa-kalt Nor

Decke       94,48m² ZD01 warme Zwischendecke zw. EG und OG
Boden       94,48m² KD01 Kellerdecke
```

**EG rectangle-Schlafzimmer**




```
a =  4,93      b  =  1,50
lichte Raumhöhe  =  2,50 + obere Decke: 0,27 => 2,77m
BGF           7,40m² BRI      20,45m³

Wand W1      4,15m² IW02 Aussenwand - Holzblock (WiGa-kalt Nor
Wand W2    -13,63m² AW01 Aussenwand - Holzblock
Wand W3      4,15m² AW01
Wand W4     13,63m² AW01
Decke        7,40m² ZD01 warme Zwischendecke zw. EG und OG
Boden        7,40m² KD01 Kellerdecke
```

**EG Wintergarten-Anbau West**




```
Dachneigung a(°) 18,00
a =  6,20      b  =  3,82
h1=  2,20
lichte Raumhöhe  =  3,09 + obere Decke: 0,35 => 3,44m
BGF         23,68m² BRI      66,80m³

Dachfl.     24,90m²
Wand W1     10,77m² AW02 Wintergarten
Wand W2    -21,34m² AW01 Aussenwand - Holzblock
Wand W3     10,77m² AW02 Wintergarten
Wand W4     13,64m² AW02
Dach        24,90m² DS01 Dachschräge hinterlüftet
Boden       23,68m² EB02 Wintergarten-Fussboden
```

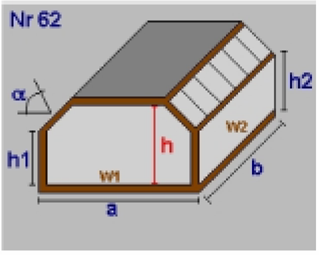
**EG Summe**

| | |
|---|---|
| EG Bruttogrundfläche [m²]: | 125,56 |
| EG Bruttorauminhalt [m³]: | 348,48 |

Geometrieausdruck

Übungsversion_single-family home in Traunkirchen / Upper

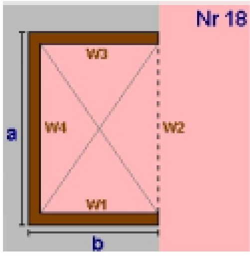
## DG Obergeschoss




Dachneigung a(°) 35,00
a = 9,72 b = 9,72
h1= 0,90 h2 = 0,90
lichte Raumhöhe(h)= 2,50 + obere Decke: 0,32 => 2,82m
BGF 94,48m² BRI 215,42m³

Dachfl. 65,21m²
Decke 41,06m²
Wand W1 22,16m² AW01 Aussenwand - Holzblock
Wand W2 8,75m² AW01
Wand W3 22,16m² AW01
Wand W4 8,75m² AW01
Dach 65,21m² DS01 Dachschräge hinterlüftet
Decke 41,06m² AD01 Decke zu unkonditionierten geschloss.
Boden -94,48m² ZD01 warme Zwischendecke zw. EG und OG

## DG rectangel - OG




a = 4,93 b = 1,50
lichte Raumhöhe = 2,50 + obere Decke: 0,34 => 2,84m
BGF 7,40m² BRI 20,96m³

Wand W1 4,25m² AW01 Aussenwand - Holzblock
Wand W2 -13,98m² AW01
Wand W3 4,25m² AW01
Wand W4 13,98m² AW01
Decke 7,40m² DS01 Dachschräge hinterlüftet
Boden -7,40m² ZD01 warme Zwischendecke zw. EG und OG

## DG Summe

DG Bruttogrundfläche [m²]: 101,87
DG Bruttorauminhalt [m³]: 236,39

## DG BGF - Reduzierung

BGF Reduzierung = BGF-Höhe kleiner 1.5 m

Reduzierung = -20,24 m²
**Summe Reduzierung Bruttogrundfläche [m²]: -20,24**

## Deckenvolumen EB02

Fläche 23,68 m² x Dicke 0,28 m = 6,68 m³

## Deckenvolumen KD01

Fläche 101,87 m² x Dicke 0,43 m = 43,29 m³

**Bruttorauminhalt [m³]: 49,97**

### Fenster und Türen
### Übungsversion_single-family home in Traunkirchen / Upper

| Typ | | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | | | | | | | | | | | | | | | |
| B | EG | AW01 | 2 | 1,07 x 1,19 - Schlafzimmer | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 3,78 x 2,20 - Wintergartenwand | 3,00 | 2,70 | 8,10 | | | | 5,67 | 1,10 | 8,91 | 0,62 | 0,85 |
| B | EG | IW02 | 1 | 2,40 x 2,20 - Wintergarten - Nord | 2,40 | 2,20 | 5,28 | | | | 3,70 | 1,30 | 5,49 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Empore | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 2,10 - Empore | 1,07 | 2,10 | 2,25 | | | | 1,57 | 1,30 | 2,92 | 0,62 | 0,85 |
| | | | **6** | | | | **19,45** | | | | | | **22,29** | | |
| **O** | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| B | EG | IW01 | 1 | 1,07 x 1,19 - Bad | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,16 | 0,62 | 0,85 |
| B | EG | IW01 | 1 | 1,07 x 0,59 - Stiegenhaus | 1,07 | 0,59 | 0,63 | | | | 0,44 | 1,30 | 0,57 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| | | | **4** | | | | **4,44** | | | | | | **5,05** | | |
| **S** | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 0,90 x 2,10 - Haustür | 0,90 | 2,10 | 1,89 | | | | | 2,33 | 4,40 | | |
| B | EG | AW01 | 2 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| B | EG | AW01 | 1 | 1,07 x 1,19 - essen | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 3,78 x 2,20 - Wintergartenwand | 3,00 | 2,70 | 8,10 | | | | 5,67 | 1,10 | 8,91 | 0,62 | 0,85 |
| B | DG | AW01 | 2 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| | | | **7** | | | | **16,36** | | | | | | **21,59** | | |
| **W** | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 5,92 x 2,20 - Wintergarten | 5,92 | 2,20 | 13,02 | | | | 9,12 | 1,10 | 14,33 | 0,62 | 0,85 |
| B | EG | DS01 | 1 | 5,92 x 3,00 - Wintergarten-Dach | 5,92 | 3,00 | 17,76 | | | | 12,43 | 0,80 | 14,21 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,66 | 0,62 | 0,85 |
| | | | **4** | | | | **33,32** | | | | | | **31,86** | | |
| **Summe** | | | **21** | | | | **73,57** | | | | | | **80,79** | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes

### 13.1.2 Example 2 – Energy-pass for single family house in Baden

| | | | | | | |
|---|---|---|---|---|---|---|
| Norm-Außentemperatur: | -12,5 °C | Standort: Baden | | | | |
| Berechnungs-Raumtemperatur: | 20 °C | Brutto-Rauminhalt der | | | | |
| Temperatur-Differenz: | 32,5 K | beheizten Gebäudeteile: | | 657,78 m³ | | |
| | | Gebäudehüllfläche: | | 489,88 m² | | |

| Bauteile | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|
| AW01 Außenwand - KG | 19,37 | 0,244 | 1,00 | | 4,73 |
| AW02 Aussenwand-verputzt | 188,77 | 0,144 | 1,00 | | 27,11 |
| DD01 Außendecke, Wärmestrom nach unten (SchlafZI) | 4,51 | 0,162 | 1,00 | 1,35 | 0,99 |
| FD01 Außendecke, Wärmestrom nach oben | 106,49 | 0,132 | 1,00 | | 14,09 |
| FE/TÜ Fenster u. Türen | 65,41 | 0,898 | 1,00 | | 58,76 |
| KD01 Decke zu unkonditioniertem gedämmten Keller | 101,97 | 0,227 | 0,50 | 1,35 | 15,67 |
| IW01 Aussenwand-verputzt (zu Garage) | 3,36 | 0,142 | 0,70 | | 0,33 |
| Summe OBEN-Bauteile | 106,49 | | | | |
| Summe UNTEN-Bauteile | 106,48 | | | | |
| Summe Außenwandflächen | 208,14 | | | | |
| Summe Innenwandflächen | 3,36 | | | | |
| Fensteranteil in Außenwänden 23,9 % | 65,41 | | | | |
| **Summe** | | | | [W/K] | 122 |
| **Wärmebrücken (pauschal)** | | | | [W/K] | 12 |
| **Transmissions - Leitwert $L_T$** | | | | [W/K] | 134 |
| **Lüftungs - Leitwert $L_V$** | | | | [W/K] | 58,97 |
| **Gebäude - Heizlast $P_{tot}$** | Luftwechsel = 0,40 1/h | | | [kW] | 6,27 |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | 208 m² | | | [W/m² BGF] | 30,07 |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | Luftwechsel = 0,50 1/h | | | [kW] | 7,12 |

## Bauteile

### Übungsversion_single-family home in Baden - (status now)

**AW01 Außenwand - KG**

| von Innen nach Außen | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| Knauf Gipskarton Feuerschutzplatte | B | | 0,0200 | 0,250 | 0,080 |
| 1.202.02 Stahlbeton dazw. | B | 8,0 % | | 2,300 | 0,063 |
| Stahlbeton | B | 8,7 % | 0,0500 | 2,300 | 0,011 |
| 1.202.02 Stahlbeton dazw. | B | 40,0 % | | 2,300 | 0,063 |
| Steinwolle MW-WF 60 | B | 43,3 % | 0,2500 | 0,043 | 3,023 |
| steinopor 700 EPS-W30 (220mm) | B | | 0,1000 | 0,035 | 2,857 |

RTo 4,8448 RTu 3,3508 RT 4,0978 **Dicke gesamt 0,4200 U-Wert 0,24**

1.202.02 Stahl: Achsabstand 0,625 Breite 0,300 Rse+Rsi 0,17

**AW02 Aussenwand-verputzt**

| von Innen nach Außen | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| StoLotusan K/MP | B | | 0,0050 | 0,700 | 0,007 |
| Sto Korkplatte | B | | 0,0400 | 0,045 | 0,889 |
| StoColl RC | B | | 0,0020 | 0,700 | 0,003 |
| DHF 13 mm | B | | 0,0130 | 0,100 | 0,130 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,1000 | 0,120 | 0,067 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 2,300 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,1000 | 0,120 | 0,067 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 2,300 |
| OSB 15 mm | B | | 0,0150 | 0,130 | 0,115 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,0500 | 0,120 | 0,033 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 1,150 |
| Fermacell 12,5 mm | B | | 0,0130 | 0,360 | 0,036 |

RTo 7,1880 RTu 6,7383 RT 6,9632 **Dicke gesamt 0,3380 U-Wert 0,14**

Abhängung - Lattung: Achsabstand 0,625 Breite 0,050 Rse+Rsi 0,17
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050

**EW01 Außenwand - KG - erdanliegend**

| von Innen nach Außen | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| Knauf Gipskarton Feuerschutzplatte | B | | 0,0200 | 0,250 | 0,080 |
| 1.202.02 Stahlbeton dazw. | B | 8,0 % | | 2,300 | 0,063 |
| Stahlbeton | B | 8,7 % | 0,0500 | 2,300 | 0,011 |
| 1.202.02 Stahlbeton dazw. | B | 40,0 % | | 2,300 | 0,063 |
| Steinwolle MW-WF 60 | B | 43,3 % | 0,2500 | 0,043 | 3,023 |
| steinopor 700 EPS-W30 (220mm) | B | | 0,1000 | 0,035 | 2,857 |

RTo 4,7957 RTu 3,3108 RT 4,0532 **Dicke gesamt 0,4200 U-Wert 0,25**

1.202.02 Stahl: Achsabstand 0,625 Breite 0,300 Rse+Rsi 0,13

**EK01 erdanliegender Fußboden in unkonditioniertem Keller (>1,5m unter Erdreich)**

| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0100 | 1,000 | 0,010 |
| Zementestrich | B | 0,0500 | 1,700 | 0,029 |
| Polyethylenbahn, -folie (PE) | B | 0,0001 | 0,500 | 0,000 |
| Polystyrol EPS Trittschalldämmplatte | B | 0,0400 | 0,044 | 0,909 |
| Polystyrol EPS 20 | B | 0,0600 | 0,038 | 1,579 |
| Bitumen | B | 0,0050 | 0,230 | 0,022 |
| Stahlbeton | B | 0,2000 | 2,500 | 0,080 |
| AUSTROTHERM XPS TOP 30 | B | 0,1000 | 0,038 | 2,632 |

Rse+Rsi = 0,17 **Dicke gesamt 0,4651 U-Wert 0,18**

## Bauteile

### Übungsversion_single-family home in Baden - (status now)

**ZD01 warme Zwischendecke**

| Schicht | von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| AB Berg & Berg Fertigparkett in Esche | B | | 0,0150 | 0,120 | 0,125 |
| Korkschrot natur | B | | 0,0050 | 0,060 | 0,083 |
| Fließestrich | F B | | 0,0950 | 1,400 | 0,068 |
| Estrichfolie | B | | 0,0001 | 0,500 | 0,000 |
| EPS T | B | | 0,0400 | 0,044 | 0,909 |
| Bachl EPS W-20 | B | | 0,0500 | 0,038 | 1,316 |
| Holz - Brettschichtholz | B | | 0,1470 | 0,120 | 1,225 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,3521 | U-Wert | 0,25 |

**KD01 Decke zu unkonditioniertem gedämmten Keller**

| Schicht | von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| AB Berg & Berg Fertigparkett in Esche | B | | 0,0150 | 0,120 | 0,125 |
| Korkschrot natur | B | | 0,0050 | 0,060 | 0,083 |
| Fließestrich | F B | | 0,0550 | 1,400 | 0,039 |
| Estrichfolie | B | | 0,0001 | 0,500 | 0,000 |
| Bachl EPS W-20 | B | | 0,0400 | 0,038 | 1,053 |
| Bachl EPS W-20 | B | | 0,0500 | 0,038 | 1,316 |
| Betonhohldiele - Decke (roh < = 280 kg/m³) | B | | 0,2000 | 1,000 | 0,200 |
| EPS F | B | | 0,0500 | 0,040 | 1,250 |
| | Rse+Rsi = 0,34 | Dicke gesamt | 0,4151 | U-Wert | 0,23 |

**DD01 Außendecke, Wärmestrom nach unten (SchlafZi)**

| Schicht | von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| AB Berg & Berg Fertigparkett in Esche | B | | 0,0150 | 0,120 | 0,125 |
| Korkschrot natur | B | | 0,0050 | 0,060 | 0,083 |
| Fließestrich | F B | | 0,0950 | 1,400 | 0,068 |
| Estrichfolie | B | | 0,0001 | 0,500 | 0,000 |
| EPS T | B | | 0,0400 | 0,044 | 0,909 |
| Bachl EPS W-20 | B | | 0,0500 | 0,038 | 1,316 |
| Holz - Brettschichtholz | B | | 0,1470 | 0,120 | 1,225 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,0500 | 0,120 | 0,033 |
| Zellulosedmämmplatte | B | 92,0 % | | 0,040 | 1,150 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,0500 | 0,120 | 0,033 |
| Zellulosedmämmplatte | B | 92,0 % | | 0,040 | 1,150 |
| 3S-Platte | B | | 0,0190 | 0,000 | 0,000 |
| RTo 6,2846 RTu 6,0914 | RT 6,1880 | Dicke gesamt | 0,4711 | U-Wert | 0,16 |

Abhängung - Lattung: Achsabstand 0,625 Breite 0,050 — Rse+Rsi 0,21
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050

**FD01 Außendecke, Wärmestrom nach oben**

| Schicht | von Außen nach Innen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| Sarnafil TG 66 | B | | 0,0020 | 0,200 | 0,010 |
| Polystyrol EPS 20 | B | | 0,2500 | 0,038 | 6,579 |
| Sarnavap 1000 E | B | | 0,0002 | 0,350 | 0,001 |
| Hakofelt 300 | B | | 0,0020 | 0,200 | 0,010 |
| Holz - Brettschichtholz | B | | 0,0980 | 0,120 | 0,817 |
| | Rse+Rsi = 0,14 | Dicke gesamt | 0,3522 | U-Wert | 0,13 |

## Bauteile

### Übungsversion_single-family home in Baden - (status now)

**IW01 Aussenwand-verputzt (zu Garage)**

| Schicht | von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| StoLotusan K/MP | B | | 0,0050 | 0,700 | 0,007 |
| Sto Korkplatte | B | | 0,0400 | 0,045 | 0,889 |
| StoColl RC | B | | 0,0020 | 0,700 | 0,003 |
| DHF 13 mm | B | | 0,0130 | 0,100 | 0,130 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,1000 | 0,120 | 0,067 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 2,300 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,1000 | 0,120 | 0,067 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 2,300 |
| OSB 15 mm | B | | 0,0150 | 0,130 | 0,115 |
| Abhängung - Lattung dazw. | B | 8,0 % | 0,0500 | 0,120 | 0,033 |
| Zellulosedämmplatte | B | 92,0 % | | 0,040 | 1,150 |
| Fermacell 12,5 mm | B | | 0,0130 | 0,360 | 0,036 |
| RTo 7,2792 RTu 6,8283 | RT 7,0538 | Dicke gesamt | 0,3380 | U-Wert | 0,14 |

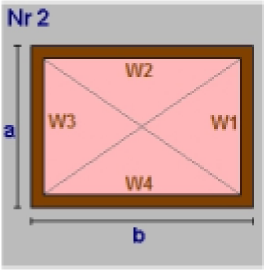
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050 — Rse+Rsi 0,26
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050
Abhängung - Lattung: Achsabstand 0,625 Breite 0,050

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

**Geometrieausdruck**

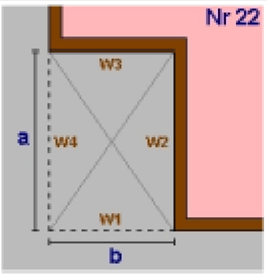
**Übungsversion_single-family home in Baden - (status now)**

## EG ground floor - basis



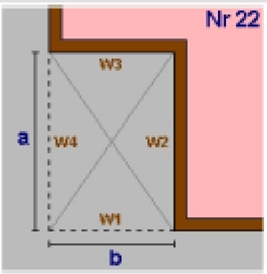

```
a =  9,71      b  = 11,82
lichte Raumhöhe  =  2,59 + obere Decke: 0,35 => 2,94m
BGF       114,77m² BRI     337,67m³

Wand W1    28,57m² AW02 Aussenwand-verputzt
Wand W2    34,78m² AW02
Wand W3    11,59m² AW02
          Teilung  5,77 x 2,94 (Länge x Höhe)
           16,98m² AW01 Außenwand - KG
Wand W4    34,78m² AW02

Decke     114,77m² ZD01 warme Zwischendecke
Boden     114,77m² KD01 Decke zu unkonditionierten gedämmten
```

## EG minus rectangle (garage)




```
a =  3,70      b  =  1,00
lichte Raumhöhe  =  2,59 + obere Decke: 0,35 => 2,94m
BGF        -3,70m² BRI     -10,89m³

Wand W1    -2,94m² AW02 Aussenwand-verputzt
Wand W2    10,89m² IW01 Aussenwand-verputzt (zu Garage)
Wand W3     2,94m² IW01
Wand W4   -10,89m² IW01
Decke      -3,70m² ZD01 warme Zwischendecke
Boden      -3,70m² KD01 Decke zu unkonditionierten gedämmten
```

## EG minus rectangle (toilet)

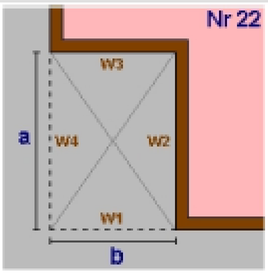



```
a =  3,70      b  =  0,65
lichte Raumhöhe  =  2,59 + obere Decke: 0,35 => 2,94m
BGF        -2,41m² BRI      -7,08m³

Wand W1    -1,91m² AW02 Aussenwand-verputzt
Wand W2    10,89m² AW02
Wand W3     1,91m² AW02
Wand W4   -10,89m² AW02
Decke      -2,41m² ZD01 warme Zwischendecke
Boden      -2,41m² KD01 Decke zu unkonditionierten gedämmten
```

**Geometrieausdruck**

**Übungsversion_single-family home in Baden - (status now)**

### EG minus rectangle (terrace)



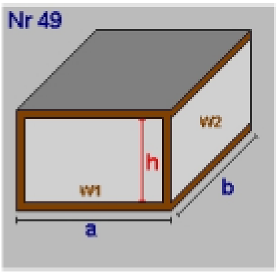

a = 0,94 b = 7,12
lichte Raumhöhe = 2,59 + obere Decke: 0,35 => 2,94m
BGF -6,69$m^2$ BRI -19,69$m^3$

Wand W1 -20,95$m^2$ AW02 Aussenwand-verputzt
Wand W2 2,77$m^2$ AW02
Wand W3 20,95$m^2$ AW02
Wand W4 -2,77$m^2$ AW02
Decke -6,69$m^2$ ZD01 warme Zwischendecke
Boden -6,69$m^2$ KD01 Decke zu unkonditionierten gedämmten

### EG Summe

**EG Bruttogrundfläche [m²]: 101,97**
**EG Bruttorauminhalt [m³]: 300,02**

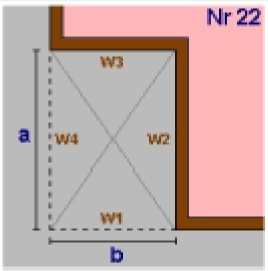
### DG 1st floor




a = 10,67 b = 11,82
lichte Raumhöhe(h)= 2,59 + obere Decke: 0,35 => 2,94m
BGF 126,12$m^2$ BRI 371,07$m^3$

Decke 126,12$m^2$
Wand W1 31,39$m^2$ AW02 Aussenwand-verputzt
Wand W2 34,78$m^2$ AW02
Wand W3 31,39$m^2$ AW02
Wand W4 34,78$m^2$ AW02
Decke 126,12$m^2$ FD01 Außendecke, Wärmestrom nach oben
Boden -121,61$m^2$ ZD01 warme Zwischendecke
Teilung 4,51$m^2$ DD01

### DG minus rectangle (garage)

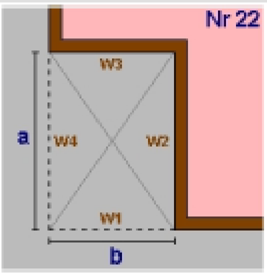



a = 3,70 b = 1,00
lichte Raumhöhe = 2,59 + obere Decke: 0,35 => 2,94m
BGF -3,70$m^2$ BRI -10,89$m^3$

Wand W1 -2,94$m^2$ AW02 Aussenwand-verputzt
Wand W2 10,89$m^2$ AW02
Wand W3 2,94$m^2$ AW02
Wand W4 -10,89$m^2$ AW02
Decke -3,70$m^2$ FD01 Außendecke, Wärmestrom nach oben
Boden 3,70$m^2$ ZD01 warme Zwischendecke

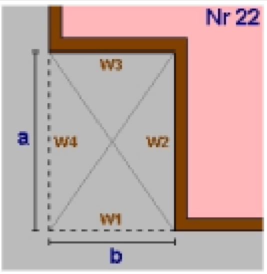
**Geometrieausdruck**
**Übungsversion_single-family home in Baden - (status now)**

**DG minus rectangle (bathroom)**




```
a =  3,70      b  =  0,65
lichte Raumhöhe  =  2,59 + obere Decke: 0,35 => 2,94m
BGF       -2,41m² BRI      -7,08m³

Wand W1    -1,91m² AW02 Aussenwand-verputzt
Wand W2    10,89m² AW02
Wand W3     1,91m² AW02
Wand W4   -10,89m² AW02
Decke      -2,41m² FD01 Außendecke, Wärmestrom nach oben
Boden       2,41m² ZD01 warme Zwischendecke
```

**DG minus rectangle (balcony)**




```
a =  1,90      b  =  7,12
lichte Raumhöhe  =  2,59 + obere Decke: 0,35 => 2,94m
BGF      -13,53m² BRI     -39,80m³

Wand W1   -20,95m² AW02 Aussenwand-verputzt
Wand W2     5,59m² AW02
Wand W3    20,95m² AW02
Wand W4    -5,59m² AW02
Decke     -13,53m² FD01 Außendecke, Wärmestrom nach oben
Boden      13,53m² ZD01 warme Zwischendecke
```

**DG Summe**

| | |
|---|---|
| **DG Bruttogrundfläche [m²]:** | **106,49** |
| **DG Bruttorauminhalt [m³]:** | **313,30** |

**Deckenvolumen KD01**

Fläche 101,97 m² x Dicke 0,42 m = 42,33 m³

**Deckenvolumen DD01**

Fläche 4,51 m² x Dicke 0,47 m = 2,12 m³

**Bruttorauminhalt [m³]: 44,45**

**Fenster und Türen**

**Übungsversion_single-family home in Baden - (status now)**

| Typ | | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 0,70 | 1,00 | 0,040 | 1,23 | 0,90 | | 0,51 | |
| **NO** | | | | | | | | | | | | | | | |
| B T1 | EG | AW02 | 2 | 1,75 x 0,87 | 1,75 | 0,87 | 3,05 | 0,70 | 1,00 | 0,040 | 1,90 | 0,93 | 2,82 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 0,50 x 2,28 | 0,50 | 2,28 | 1,14 | 0,70 | 1,00 | 0,040 | 0,53 | 1,02 | 1,17 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 0,97 x 0,87 | 0,97 | 0,87 | 0,84 | 0,70 | 1,00 | 0,040 | 0,46 | 0,97 | 0,81 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 1,10 x 2,28 - lt. Plan Eingangstür | 1,10 | 2,28 | 2,51 | | | | | 1,44 | 3,61 | | |
| B T1 | DG | AW02 | 3 | 1,75 x 0,87 | 1,75 | 0,87 | 4,57 | 0,70 | 1,00 | 0,040 | 2,85 | 0,93 | 4,23 | 0,51 | 0,85 |
| | | | **8** | | | | **12,11** | | | | | | **12,64** | | |
| **NW** | | | | | | | | | | | | | | | |
| B T1 | EG | AW02 | 1 | 1,34 x 2,64 | 1,34 | 2,64 | 3,54 | 0,70 | 1,00 | 0,040 | 2,64 | 0,86 | 3,02 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 1 | 1,08 x 2,28 | 1,08 | 2,28 | 2,45 | 0,70 | 1,00 | 0,040 | 1,70 | 0,89 | 2,17 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 1 | 0,88 x 0,87 | 0,88 | 0,87 | 0,76 | 0,70 | 1,00 | 0,040 | 0,40 | 0,98 | 0,74 | 0,51 | 0,85 |
| | | | **3** | | | | **6,75** | | | | | | **5,93** | | |
| **SO** | | | | | | | | | | | | | | | |
| B T1 | EG | AW02 | 1 | 0,94 x 2,64 | 0,94 | 2,64 | 2,48 | 0,70 | 1,00 | 0,040 | 1,68 | 0,90 | 2,22 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 1 | 1,89 x 1,37 | 1,89 | 1,37 | 2,59 | 0,70 | 1,00 | 0,040 | 1,86 | 0,87 | 2,25 | 0,51 | 0,85 |
| | | | **2** | | | | **5,07** | | | | | | **4,47** | | |
| **SW** | | | | | | | | | | | | | | | |
| B T1 | EG | AW02 | 2 | 1,47 x 2,64 | 1,47 | 2,64 | 7,75 | 0,70 | 1,00 | 0,040 | 5,89 | 0,85 | 6,57 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 3 | 1,08 x 2,64 | 1,08 | 2,64 | 8,51 | 0,70 | 1,00 | 0,040 | 6,01 | 0,88 | 7,48 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 0,74 x 2,64 | 0,74 | 2,64 | 1,95 | 0,70 | 1,00 | 0,040 | 1,20 | 0,93 | 1,83 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 2,44 x 2,64 | 2,44 | 2,64 | 6,45 | 0,70 | 1,00 | 0,040 | 5,28 | 0,81 | 5,23 | 0,51 | 0,85 |
| B T1 | EG | AW02 | 1 | 1,32 x 2,64 | 1,32 | 2,64 | 3,49 | 0,70 | 1,00 | 0,040 | 2,59 | 0,86 | 2,99 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 2 | 0,98 x 1,37 | 0,98 | 1,37 | 2,67 | 0,70 | 1,00 | 0,040 | 1,66 | 0,93 | 2,47 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 2 | 1,75 x 2,28 | 1,75 | 2,28 | 7,98 | 0,70 | 1,00 | 0,040 | 6,16 | 0,84 | 6,70 | 0,51 | 0,85 |
| B T1 | DG | AW02 | 1 | 1,95 x 1,37 | 1,95 | 1,37 | 2,67 | 0,70 | 1,00 | 0,040 | 1,93 | 0,87 | 2,32 | 0,51 | 0,85 |
| | | | **13** | | | | **41,47** | | | | | | **35,59** | | |
| **Summe** | | | **26** | | | | **65,40** | | | | | | **58,63** | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes

### 13.1.3 Example 3 – Energy-pass for single family house in Altenfelden

Norm-Außentemperatur: -15,9 °C
Berechnungs-Raumtemperatur: 20 °C
Temperatur-Differenz: 35,9 K

Standort: Altenfelden
Brutto-Rauminhalt der beheizten Gebäudeteile: 483,44 m³
Gebäudehüllfläche: 476,62 m³

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AD01 | Decke zu unkonditioniertem geschloss. Dachraum | 149,21 | 0,348 | 0,90 | | 46,74 |
| AW02 | Außenwand-EG | 110,97 | 1,142 | 1,00 | | 126,71 |
| AW03 | Außenwand-EG - mit Eternitverkleidung | 16,48 | 0,865 | 1,00 | | 14,26 |
| FE/TÜ | Fenster u. Türen | 22,21 | 1,863 | 1,00 | | 41,38 |
| KD01 | Decke zu unkonditioniertem ungedämmten Keller | 149,21 | 0,654 | 0,70 | | 68,29 |
| IW01 | Wand zu sonstigem Pufferraum (Stiegenhaus) | 28,54 | 1,361 | 0,70 | | 27,18 |
| | Summe OBEN-Bauteile | 149,21 | | | | |
| | Summe UNTEN-Bauteile | 149,21 | | | | |
| | Summe Außenwandflächen | 127,45 | | | | |
| | Summe Innenwandflächen | 28,54 | | | | |
| | Fensteranteil in Außenwänden 13,9 % | 20,56 | | | | |
| | Fenster in Innenwänden | 1,66 | | | | |
| **Summe** | | | | [W/K] | | 325 |

| | | | |
|---|---|---|---|
| **Wärmebrücken (pauschal)** | | [W/K] | 23 |
| **Transmissions - Leitwert $L_T$** | | [W/K] | 347 |
| **Lüftungs - Leitwert $L_V$** | | [W/K] | 42,21 |
| **Gebäude - Heizlast $P_{tot}$** | Luftwechsel = 0,40 1/h | [kW] | 13,98 |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | 149 m² | [W/m² BGF] | 93,70 |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | Luftwechsel = 0,50 1/h | [kW] | 14,83 |

## Bauteile
### Übungsversion_Single-Family home in Altenfelden / Upper

**AW02 Außenwand-EG**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0200 | 0,700 | 0,029 |
| 2.202.02 Lecabetonwandelement | B | 0,3000 | 0,830 | 0,361 |
| Dämmputz EPS | B | 0,0300 | 0,095 | 0,316 |
| | Rse+Rsi = 0,17 **Dicke gesamt** | **0,3500** | **U-Wert** | **1,14** |

**KD01 Decke zu unkonditioniertem ungedämmten Keller**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0100 | 1,000 | 0,010 |
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| Leca-Schüttung | B | 0,1000 | 0,120 | 0,833 |
| Ziegelhohlkörper mit Aufbeton (Decke) | B | 0,2200 | 0,738 | 0,298 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| | Rse+Rsi = 0,34 **Dicke gesamt** | **0,3900** | **U-Wert** | **0,65** |

**AD01 Decke zu unkonditioniertem geschloss. Dachraum**

| | von Außen nach Innen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| steinopor 700 EPS-F (100mm) | B | 0,1000 | 0,040 | 2,500 |
| Betonhohlkörper mit Aufbeton (Decke) | B | 0,1000 | 0,800 | 0,125 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| | Rse+Rsi = 0,2 **Dicke gesamt** | **0,2600** | **U-Wert** | **0,35** |

**IW01 Wand zu sonstigem Pufferraum (Stiegenhaus)**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| 2.108.0D Lecabetonstein | B | 0,2500 | 0,560 | 0,446 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| | Rse+Rsi = 0,26 **Dicke gesamt** | **0,2700** | **U-Wert** | **1,36** |

**AW03 Außenwand-EG - mit Eternitverkleidung**

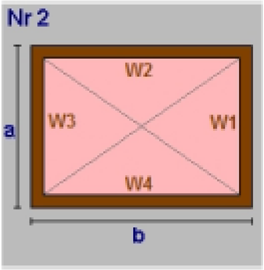
| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0200 | 0,700 | 0,029 |
| 2.202.02 Lecabetonwandelement | B | 0,3000 | 0,830 | 0,361 |
| Dämmputz EPS | B | 0,0300 | 0,095 | 0,316 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | B | 0,0400 | 0,222 | 0,180 |
| AURIA Wandschindel | B | 0,0050 | 0,500 | 0,010 |
| | Rse+Rsi = 0,26 **Dicke gesamt** | **0,3950** | **U-Wert** | **0,87** |

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

Geometrieausdruck

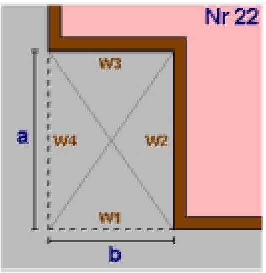
Übungsversion_Single-Family home in Altenfelden / Upper

### EG Basis



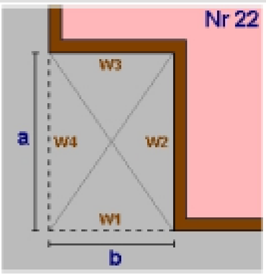

```
a = 11,50      b  = 16,00
lichte Raumhöhe  =  2,59 + obere Decke: 0,26 => 2,85m
BGF       184,00m² BRI     524,40m²

Wand W1    32,78m² AW02 Außenwand-EG
Wand W2    45,60m² AW02
Wand W3    32,78m² AW02
Wand W4    45,60m² AW03 Außenwand-EG - mit Eternitverkleidung
Decke     184,00m² AD01 Decke zu unkonditioniertem geschloss.
Boden     184,00m² KD01 Decke zu unkonditioniertem ungedämmte
```

### EG Windfang/Stiegenhaus-Korrektur




```
a =  7,87      b  =  2,70
lichte Raumhöhe  =  2,59 + obere Decke: 0,26 => 2,85m
BGF       -21,25m² BRI     -60,56m²

Wand W1    -7,70m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2    18,87m² IW01 Wand zu sonstigem Pufferraum (Stiegen
          Teilung  1,25 x 2,85 (Länge x Höhe)
            3,56m² AW02 Außenwand-EG
Wand W3     7,70m² IW01
Wand W4   -22,43m² AW02 Außenwand-EG

Decke     -21,25m² AD01 Decke zu unkonditioniertem geschloss.
Boden     -21,25m² KD01 Decke zu unkonditioniertem ungedämmte
```

### EG Balkonkorrektur-Westen

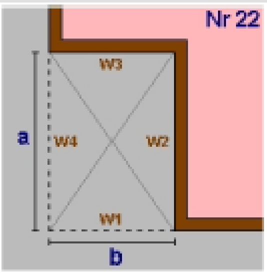



```
a =  1,00      b  =  6,00
lichte Raumhöhe  =  2,59 + obere Decke: 0,26 => 2,85m
BGF        -6,00m² BRI     -17,10m²

Wand W1   -17,10m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2     2,85m² AW02 Außenwand-EG
Wand W3    17,10m² AW02
Wand W4    -2,85m² AW02
Decke      -6,00m² AD01 Decke zu unkonditioniertem geschloss.
Boden      -6,00m² KD01 Decke zu unkonditioniertem ungedämmte
```

Geometrieausdruck

Übungsversion_Single-Family home in Altenfelden / Upper

### EG Balkonkorrektur-Süden




```
a =  5,80      b  =  1,30
lichte Raumhöhe  =  2,59 + obere Decke: 0,26 => 2,85m
BGF        -7,54m² BRI     -21,49m²

Wand W1    -3,71m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2    16,53m² AW02 Außenwand-EG
Wand W3     3,71m² AW02
Wand W4   -16,53m² AW02
Decke      -7,54m² AD01 Decke zu unkonditioniertem geschloss.
Boden      -7,54m² KD01 Decke zu unkonditioniertem ungedämmte
```

### EG Summe

| | |
|---|---|
| **EG Bruttogrundfläche [m²]:** | **149,21** |
| **EG Bruttorauminhalt [m³]:** | **425,25** |

### Deckenvolumen KD01

```
Fläche    149,21 m²  x Dicke 0,39 m =     58,19 m³
```

| | |
|---|---|
| **Bruttorauminhalt [m³]:** | **58,19** |

## Fenster und Türen

## Übungsversion_Single-Family home in Altenfelden / Upper

| Typ | | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 1,90 | 1,65 | 0,040 | 1,23 | 1,92 | | 0,63 | |
| **N** | | | | | | | | | | | | | | | |
| B | EG | IW01 | 1 | 0,85 x 1,95 - Haustür zu Stiegenhaus | 0,85 | 1,95 | 1,66 | | | | | 2,00 | 2,32 | | |
| | | | **1** | | | | **1,66** | | | | | | **2,32** | | |
| **O** | | | | | | | | | | | | | | | |
| B | EG | AW02 | 1 | 1,24 x 1,30 - Kinderzimmer | 1,24 | 1,30 | 1,61 | | | | 1,13 | 1,90 | 3,06 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,24 x 0,64 - Bad | 1,24 | 0,64 | 0,79 | | | | 0,56 | 1,90 | 1,51 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,24 x 1,30 - Schlafzimmer | 1,24 | 1,30 | 1,61 | | | | 1,13 | 1,90 | 3,06 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,14 x 1,40 - Wohnzimmer | 1,14 | 1,40 | 1,60 | | | | 1,12 | 1,90 | 3,03 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,10 x 2,10 - Wohnzimmer-Ausgang | 1,10 | 2,10 | 2,31 | | | | 1,62 | 1,90 | 4,39 | 0,62 | 0,85 |
| | | | **5** | | | | **7,92** | | | | | | **15,05** | | |
| **S** | | | | | | | | | | | | | | | |
| B | EG | AW02 | 1 | 2,24 x 1,30 - Wohnzimmer | 2,24 | 1,30 | 2,91 | | | | 2,04 | 1,90 | 5,53 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,10 x 2,10 - Essplatz | 1,10 | 2,10 | 2,31 | | | | 1,62 | 1,90 | 4,39 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,14 x 1,30 - Essplatz | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,90 | 2,82 | 0,62 | 0,85 |
| | | | **3** | | | | **6,70** | | | | | | **12,74** | | |
| **W** | | | | | | | | | | | | | | | |
| B | EG | AW02 | 2 | 1,14 x 1,30 - Essplatz / Küche | 1,14 | 1,30 | 2,96 | | | | 2,07 | 1,90 | 5,63 | 0,62 | 0,85 |
| B | EG | AW03 | 1 | 1,14 x 1,30 - Arbeitsraum | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,90 | 2,82 | 0,62 | 0,85 |
| B | EG | AW03 | 1 | 1,14 x 1,30 - Kinderzimmer | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,90 | 2,82 | 0,62 | 0,85 |
| | | | **4** | | | | **5,92** | | | | | | **11,27** | | |
| **Summe** | | | **13** | | | | **22,20** | | | | | | **41,38** | | |

Ug... Uwert Glas   Uf... Uwert Rahmen   PSI... Linearer Korrekturkoeffizient   Ag... Glasfläche
g... Energiedurchlassgrad Verglasung   fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp   B... Fenster gehört zum Bestand des Gebäudes

### 13.1.4 Example 4 – Energy-pass for weekend home in Schwarzenberg/Hochficht

| | | | | | | |
|---|---|---|---|---|---|---|
| Norm-Außentemperatur: -15,3 °C | | Standort: Schwarzenberg im Mühlkrei | | | | |
| Berechnungs-Raumtemperatur: 20 °C | | Brutto-Rauminhalt der | | | | |
| Temperatur-Differenz: 35,3 K | | beheizten Gebäudeteile: 446,47 m³ | | | | |
| | | Gebäudehüllfläche: 455,86 m² | | | | |
| **Bauteile** | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
| AW01 | Außenwand-Granit BESTAND | 83,07 | 0,745 | 1,00 | | 61,86 |
| AW02 | Außenwand-Ziegel (Adaption 1985) - nach Aussen | 8,81 | 0,772 | 1,00 | | 6,80 |
| FE/TÜ | Fenster u. Türen | 15,50 | 2,205 | 1,00 | | 34,19 |
| EB01 | erdanliegender Fußboden (<=1,5m unter Erdreich) | 152,67 | 0,464 | 0,70 | | 49,56 |
| AG01 | Decke zu sonstigem Pufferraum nach oben (living room) | 50,91 | 0,147 | 0,70 | | 5,25 |
| AG02 | Decke zu sonstigem Pufferraum nach oben (kitchen) | 15,50 | 0,698 | 0,70 | | 7,58 |
| AG03 | Decke zu sonstigem Pufferraum nach oben (sleeping-room) | 86,26 | 3,633 | 0,70 | | 219,40 |
| IW01 | Außenwand-Granit zu unbeheiztem Schuppen | 9,85 | 0,698 | 0,70 | | 4,81 |
| IW02 | Außenwand-Ziegel zu unbeheiztem Schuppen (Adaption 1985) | 33,29 | 0,760 | 0,70 | | 17,71 |
| | Summe OBEN-Bauteile | 152,67 | | | | |
| | Summe UNTEN-Bauteile | 152,67 | | | | |
| | Summe Außenwandflächen | 91,88 | | | | |
| | Summe Innenwandflächen | 43,14 | | | | |
| | Fensteranteil in Außenwänden 13,1 % | 13,80 | | | | |
| | Fenster in Innenwänden | 1,70 | | | | |
| **Summe** | | | | **[W/K]** | | **407** |
| **Wärmebrücken (pauschal)** | | | | **[W/K]** | | **10** |
| **Transmissions - Leitwert $L_T$** | | | | **[W/K]** | | **417** |
| **Lüftungs - Leitwert $L_V$** | | | | **[W/K]** | | **43,19** |
| **Gebäude - Heizlast $P_{tot}$** | | Luftwechsel = 0,40 1/h | | **[kW]** | | **16,25** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | | **153 m²** | | **[W/m² BGF]** | | **106,44** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | | Luftwechsel = 0,50 1/h | | **[kW]** | | **16,87** |

## Bauteile

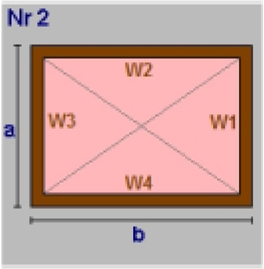
### Übungsversion_weekend-home in the mountains - (status

| | | | | | |
|---|---|---|---|---|---|
| **AW01** | **Außenwand-Granit BESTAND** | | | | |
| | von Innen nach Außen | | Dicke | λ | d / λ |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| StoGranit | B # | | 0,8000 | 0,700 | 1,143 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,8300 | U-Wert | 0,74 |
| **IW01** | **Außenwand-Granit zu unbeheiztem Schuppen** | | | | |
| | von Innen nach Außen | | Dicke | λ | d / λ |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| StoGranit | B # | | 0,8000 | 0,700 | 1,143 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,8300 | U-Wert | 0,70 |
| **IW02** | **Außenwand-Ziegel zu unbeheiztem Schuppen (Adaption 1985)** | | | | |
| | von Innen nach Außen | | Dicke | λ | d / λ |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| 2.406.02 Schlackenbetonstein 25 cm | B | | 0,3000 | 0,630 | 0,476 |
| Heraklith-BM (5,0cm) | B | | 0,0500 | 0,091 | 0,550 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,3800 | U-Wert | 0,76 |
| **AW02** | **Außenwand-Ziegel (Adaption 1985) - nach Aussen** | | | | |
| | von Innen nach Außen | | Dicke | λ | d / λ |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| 1.106.06 Betonhohlsteinmauerwerk | B | | 0,3000 | 0,550 | 0,545 |
| Heraklith-BM (5,0cm) | B | | 0,0500 | 0,091 | 0,550 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,3800 | U-Wert | 0,77 |
| **EB01** | **erdanliegender Fußboden (<=1,5m unter Erdreich)** | | | | |
| | von Innen nach Außen | | Dicke | λ | d / λ |
| Holzboden, Vollholz Nadel | B | | 0,0300 | 0,120 | 0,250 |
| Riegel dazw. | B # | 9,1 % | | 0,120 | 0,061 |
| steinopor 700 EPS-W15 (220mm) | B # | 90,9 % | 0,0800 | 0,041 | 1,774 |
| 1.202.02 Stahlbeton | B | | 0,1000 | 2,300 | 0,043 |
| | RTo 2,1886 RTu 2,1239 RT 2,1562 | Dicke gesamt | 0,2100 | U-Wert | 0,46 |
| Riegel: | Achsabstand 0,550 Breite 0,050 | | Rse+Rsi 0,17 | | |
| **AG01** | **Decke zu sonstigem Pufferraum nach oben (living room)** | | | | |
| | von Außen nach Innen | | Dicke | λ | d / λ |
| Stroh | B # | | 0,3000 | 0,047 | 6,383 |
| 3.304.02 Tram-Traversendecke 20 cm | B | | 0,2000 | 0,950 | 0,211 |
| | Rse+Rsi = 0,2 | Dicke gesamt | 0,5000 | U-Wert | 0,15 |
| **AG02** | **Decke zu sonstigem Pufferraum nach oben (kitchen)** | | | | |
| | von Außen nach Innen | | Dicke | λ | d / λ |
| 1.202.02 Stahlbeton | B | | 0,1500 | 2,300 | 0,065 |
| Riegel dazw. | B # | 5,5 % | | 0,120 | 0,023 |
| steinopor 700 EPS-W15 (220mm) | B # | 94,5 % | 0,0500 | 0,041 | 1,153 |
| 1.108.04 Gipsbauplatten | B | | 0,0200 | 0,410 | 0,049 |
| | RTo 1,4469 RTu 1,4176 RT 1,4322 | Dicke gesamt | 0,2200 | U-Wert | 0,70 |
| Riegel: | Achsabstand 0,550 Breite 0,030 | | Rse+Rsi 0,2 | | |
| **AG03** | **Decke zu sonstigem Pufferraum nach oben (sleeping-room)** | | | | |
| | von Außen nach Innen | | Dicke | λ | d / λ |
| 1.202.02 Stahlbeton | B | | 0,1500 | 2,300 | 0,065 |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| | Rse+Rsi = 0,2 | Dicke gesamt | 0,1600 | U-Wert | 3,63 |

## Geometrieausdruck

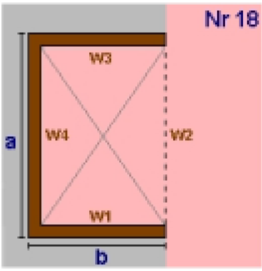
## Übungsversion_weekend-home in the mountains - (status

### EG basis - granite part




```
a = 12,10      b  = 10,60
lichte Raumhöhe  =  2,50 + obere Decke: 0,16 => 2,66m
BGF       128,26m³ BRI     341,17m³

Wand W1    32,19m³ IW01 Außenwand-Granit zu unbeheiztem Schup
Wand W2    28,20m³ AW01 Außenwand-Granit BESTAND
Wand W3    32,19m³ AW01
Wand W4    28,20m³ AW01
Decke      86,26m³ AG03 Decke zu sonstigem Pufferraum nach ob
Teilung    26,50m³ AG01
Teilung    15,50m³ AG02

Boden     128,26m³ EB01 erdanliegender Fußboden (<=1,5m unter
```

### EG rectangle with bathroom/toilet




```
a =  7,75      b  =  3,15
lichte Raumhöhe  =  2,50 + obere Decke: 0,50 => 3,00m
BGF        24,41m³ BRI      73,24m³

Wand W1     9,45m³ IW02 Außenwand-Ziegel zu unbeheiztem Schup
Wand W2   -23,25m³ IW01 Außenwand-Granit zu unbeheiztem Schup
Wand W3     9,45m³ AW02 Außenwand-Ziegel (Adaption 1985) - na
Wand W4    23,25m³ IW02 Außenwand-Ziegel zu unbeheiztem Schup
Decke      24,41m³ AG01 Decke zu sonstigem Pufferraum nach ob
Boden      24,41m³ EB01 erdanliegender Fußboden (<=1,5m unter
```

### EG Summe

**EG Bruttogrundfläche [m²]:** **152,67**
**EG Bruttorauminhalt [m³]:** **414,41**

### Deckenvolumen EB01

```
Fläche     152,67 m²  x Dicke 0,21 m =      32,06 m³
```

**Bruttorauminhalt [m³]:** **32,06**

## Fenster und Türen

## Übungsversion_weekend-home in the mountains - (status

| Typ | Bauteil | | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 2,70 | 1,55 | 0,040 | 1,23 | 2,42 | | 0,72 | |
| O | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,00 x 1,30 - Küche (Holz mit 2-fach | 1,00 | 1,30 | 1,30 | | | | 0,91 | 2,38 | 3,09 | 0,62 | 0,85 |
| B | EG | AW01 | 2 | 1,00 x 1,30 - WohnZi (Holz mit 2-fach | 1,00 | 1,30 | 2,60 | | | | 1,82 | 2,38 | 6,19 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,00 x 1,30 - Bad (Holz mit 2-fach Verbundglas) | 1,00 | 1,30 | 1,30 | | | | 0,91 | 2,38 | 3,09 | 0,62 | 0,85 |
| | | | **4** | | | | **5,20** | | | | | | **12,37** | | |
| S | | | | | | | | | | | | | | | |
| B | EG | AW01 | 3 | 1,00 x 1,30 - WohnZi (Holz mit 2-fach | 1,00 | 1,30 | 3,90 | | | | 2,73 | 2,38 | 9,28 | 0,62 | 0,85 |
| B | EG | AW01 | 1 | 1,00 x 1,30 - SchlafZ(Holz mit 2-fach | 1,00 | 1,30 | 1,30 | | | | 0,91 | 2,38 | 3,09 | 0,62 | 0,85 |
| B | EG | AW01 | 1 | 1,00 x 2,10 - Haustür | 1,00 | 2,10 | 2,10 | | | | | 1,67 | 3,51 | | |
| | | | **5** | | | | **7,30** | | | | | | **15,88** | | |
| W | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,00 x 1,30 - KindZi(Holz mit 2-fach Verbundglas) | 1,00 | 1,30 | 1,30 | | | | 0,91 | 2,38 | 3,09 | 0,62 | 0,85 |
| B | EG | IW02 | 1 | 0,85 x 2,00 - Tür zu unbeheiztem Schuppen | 0,85 | 2,00 | 1,70 | | | | | 2,38 | 2,83 | | |
| | | | **2** | | | | **3,00** | | | | | | **5,92** | | |
| **Summe** | | | **11** | | | | **15,50** | | | | | | **34,17** | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes

### 13.1.5 Example 5 – Energy-pass for building in San Francisco

| | | | |
|---|---|---|---|
| Norm-Außentemperatur: | Standort: | | |
| Berechnungs-Raumtemperatur: | Brutto-Rauminhalt der | | |
| Temperatur-Differenz: | beheizten Gebäudeteile: | 334,32 m³ | |
| | Gebäudehüllfläche: | 355,34 m³ | |

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AW01 | Außenwand | 117,54 | 0,350 | 1,00 | | 41,18 |
| FD01 | Außendecke, Wärmestrom nach oben | 112,00 | 0,350 | 1,00 | | 39,19 |
| FE/TÜ | Fenster u. Türen | 13,80 | 1,434 | 1,00 | | 19,79 |
| ID01 | Fußboden zu sonstigem Pufferraum (nach unten) | 112,00 | 0,502 | 0,70 | | 39,38 |
| | Summe OBEN-Bauteile | 112,00 | | | | |
| | Summe UNTEN-Bauteile | 112,00 | | | | |
| | Summe Außenwandflächen | 117,54 | | | | |
| | Fensteranteil in Außenwänden 10,5 % | 13,80 | | | | |
| **Summe** | | | | **[W/K]** | | **140** |
| **Wärmebrücken (pauschal)** | | | | **[W/K]** | | **10** |
| **Transmissions - Leitwert $L_T$** | | | | **[W/K]** | | **150** |
| **Lüftungs - Leitwert $L_V$** | | | | **[W/K]** | | **31,68** |
| **Gebäude - Heizlast $P_{tot}$** | | Luftwechsel = 0,40 1/h | | **[kW]** | | **5,89** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | | **112 m²** | | **[W/m² BGF]** | | **52,59** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | | Luftwechsel = 0,50 1/h | | **[kW]** | | **6,34** |

Bauteile

Übungsversion_California - San Francisco

**AW01 Außenwand**

| von Innen nach Außen | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |
| Riegel dazw. | B | 10,0 % | | 0,120 | 0,105 |
| Steinwolle MW-WF 60 | B | 90,0 % | 0,1260 | 0,043 | 2,637 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |

RTo 2,8822 RTu 2,8266 RT 2,8544 **Dicke gesamt 0,1500 U-Wert 0,35**

Riegel: Achsabstand 0,600 Breite 0,060 Rse+Rsi 0,17

**FD01 Außendecke, Wärmestrom nach oben**

| von Außen nach Innen | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| ETERNIT Dachplatten | B | | 0,0200 | 0,600 | 0,033 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |
| Riegel dazw. | B | 10,0 % | | 0,120 | 0,105 |
| Steinwolle MW-WF 60 | B | 90,0 % | 0,1260 | 0,043 | 2,637 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |

RTo 2,8859 RTu 2,8300 RT 2,8580 **Dicke gesamt 0,1700 U-Wert 0,35**

Riegel: Achsabstand 0,600 Breite 0,060 Rse+Rsi 0,14

**ID01 Fußboden zu sonstigem Pufferraum (nach unten)**

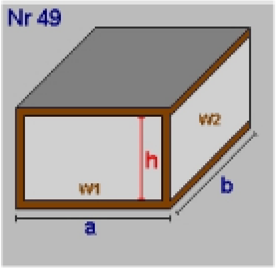
| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0150 | 1,000 | 0,015 |
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| ISOVER TDPS Trittschall-Dämmpl. 55/50 | B | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | 0,2000 | 2,300 | 0,087 |

Rse+Rsi = 0,34 **Dicke gesamt 0,3150 U-Wert 0,50**

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

## Geometrieausdruck
## Übungsversion_California - San Francisco

### DG Dachkörper




```
a =  8,00       b  = 14,00
lichte Raumhöhe(h)=  2,50 + obere Decke: 0,17 => 2,67m
BGF       112,00m² BRI     299,04m³

Decke     112,00m²
Wand W1    21,36m² AW01 Außenwand
Wand W2    37,38m² AW01
Wand W3    21,36m² AW01
Wand W4    37,38m² AW01
Decke     112,00m² FD01 Außendecke, Wärmestrom nach oben
Boden     112,00m² ID01 Fußboden zu sonstigem Pufferraum (nac
```

**DG Summe**

| | |
|---|---|
| **DG Bruttogrundfläche [m²]:** | **112,00** |
| **DG Bruttorauminhalt [m³]:** | **299,04** |

### Deckenvolumen ID01

Fläche 112,00 m² x Dicke 0,32 m = 35,28 m³

**Bruttorauminhalt [m³]: 35,28**

## Fenster und Türen
## Übungsversion_California - San Francisco

| Typ | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 1,25 | 1,40 | 0,070 | 1,23 | 1,47 | | 0,58 | |
| **N** | | | | | | | | | | | | | | |
| B T1 | DG AW01 | 1 | 1,20 x 1,00 | 1,20 | 1,00 | 1,20 | 1,25 | 1,40 | 0,070 | 0,73 | 1,51 | 1,81 | 0,58 | 0,85 |
| B T1 | DG AW01 | 1 | 0,80 x 1,00 | 0,80 | 1,00 | 0,80 | 1,25 | 1,40 | 0,070 | 0,43 | 1,55 | 1,24 | 0,58 | 0,85 |
| | | **2** | | | | **2,00** | | | | | | **3,05** | | |
| **O** | | | | | | | | | | | | | | |
| B T1 | DG AW01 | 2 | 1,20 x 1,00 | 1,20 | 1,00 | 2,40 | 1,25 | 1,40 | 0,070 | 1,46 | 1,51 | 3,62 | 0,58 | 0,85 |
| B T1 | DG AW01 | 1 | 1,00 x 2,20 - Gartentür | 1,00 | 2,20 | 2,20 | | | | | 1,67 | 3,67 | | |
| | | **3** | | | | **4,60** | | | | | | **7,29** | | |
| **S** | | | | | | | | | | | | | | |
| B T1 | DG AW01 | 1 | 1,20 x 1,00 | 1,20 | 1,00 | 1,20 | 1,25 | 1,40 | 0,070 | 0,73 | 1,51 | 1,81 | 0,58 | 0,85 |
| B T1 | DG AW01 | 1 | 0,80 x 1,00 | 0,80 | 1,00 | 0,80 | 1,25 | 1,40 | 0,070 | 0,43 | 1,55 | 1,24 | 0,58 | 0,85 |
| B T1 | DG AW01 | 1 | 1,00 x 2,20 - Haustür | 1,00 | 2,20 | 2,20 | | | | | 0,87 | 1,91 | | |
| | | **3** | | | | **4,20** | | | | | | **4,96** | | |
| **W** | | | | | | | | | | | | | | |
| B T1 | DG AW01 | 2 | 1,50 x 1,00 | 1,50 | 1,00 | 3,00 | 1,25 | 1,40 | 0,070 | 1,92 | 1,49 | 4,48 | 0,58 | 0,85 |
| | | **2** | | | | **3,00** | | | | | | **4,48** | | |
| **Summe** | | **10** | | | | **13,80** | | | | | | **19,78** | | |

Ug... Uwert Glas  Uf... Uwert Rahmen  PSI... Linearer Korrekturkoeffizient  Ag... Glasfläche
g... Energiedurchlassgrad Verglasung  fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp  B... Fenster gehört zum Bestand des Gebäudes

# 13.2 Details (status after suggested improvements of Austrian Energy-pass for the example-houses

## 13.2.1 Example 1 - Energy-pass for single family house in Traunkirchen

| | | | |
|---|---|---|---|
| Norm-Außentemperatur: | -14,3 °C | Standort: Traunkirchen | |
| Berechnungs-Raumtemperatur: | 20 °C | Brutto-Rauminhalt der | |
| Temperatur-Differenz: | 34,3 K | beheizten Gebäudeteile: | 641,80 m³ |
| | | Gebäudehüllfläche: | 486,63 m² |

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AD01 | Decke zu unkonditioniertem geschloss. Dachraum | 36,90 | 0,099 | 0,90 | | 3,30 |
| AW01 | Aussenwand - Holzblock | 111,24 | 0,126 | 1,00 | | 14,03 |
| AW02 | Wintergarten | 9,87 | 0,191 | 1,00 | | 1,89 |
| DS01 | Dachschräge hinterlüftet | 84,83 | 0,101 | 1,00 | | 8,60 |
| FE/TÜ | Fenster u. Türen | 73,59 | 1,098 | 1,00 | | 80,77 |
| EB02 | Wintergarten-Fussboden | 23,68 | 0,235 | 0,70 | 1,34 | 5,20 |
| KD01 | Kellerdecke | 101,87 | 0,196 | 0,50 | 1,34 | 13,36 |
| IW01 | Aussenwand - Holzblock (Holzlagerraum, Garage) | 29,10 | 0,125 | 0,70 | | 2,54 |
| IW02 | Aussenwand - Holzblock (WiGa-kalt Norden) | 15,55 | 0,125 | 0,80 | | 1,55 |
| | Summe OBEN-Bauteile | 139,49 | | | | |
| | Summe UNTEN-Bauteile | 125,55 | | | | |
| | Summe Außenwandflächen | 121,11 | | | | |
| | Summe Innenwandflächen | 44,65 | | | | |
| | Fensteranteil in Außenwänden 28,7 % | 48,64 | | | | |
| | Fenster in Innenwänden | 7,18 | | | | |
| | Fenster in Deckenflächen | 17,76 | | | | |
| **Summe** | | | | | **[W/K]** | **131** |

| | | | |
|---|---|---|---|
| **Wärmebrücken (pauschal)** | | **[W/K]** | **13** |
| **Transmissions - Leitwert $L_T$** | | **[W/K]** | **144** |
| **Lüftungs - Leitwert $L_V$** | | **[W/K]** | **57,17** |
| **Gebäude - Heizlast $P_{tot}$** | Luftwechsel = 0,40 1/h | **[kW]** | **6,89** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | **202 m²** | **[W/m² BGF]** | **34,11** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | Luftwechsel = 0,50 1/h | **[kW]** | **7,77** |

Die berechnete Heizlast kann von jener gemäß ÖNORM H 7500 bzw. EN ISO 12831 abweichen und ersetzt nicht den Nachweis der Gebäude-Normheizlast gemäß ÖNORM H 7500 bzw. EN ISO 12831. Die vereinfachte Heizlast EN 12831 berücksichtigt nicht die Aufheizleistung und gilt nur für Standardfälle.

**Bauteile**

**Übungsversion_single-family home in Traunkirchen / Upper**

| | | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| **AD01** | **Decke zu unkonditioniertem geschloss. Dachraum** | von Außen nach Innen | Dicke | λ | d / λ |
| Knauf Gipskarton Feuerschutzplatte | | B | 0,0180 | 0,250 | 0,072 |
| 1.402.02 Holz | | B | 0,0240 | 0,140 | 0,171 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | | B | 0,0400 | 0,222 | 0,180 |
| Steinwolle MW-W (33) | | B | 0,3500 | 0,038 | 9,211 |
| 1.402.02 Holz | | B | 0,0240 | 0,140 | 0,171 |
| 1.108.02 Gipsbauplatten | | B | 0,0180 | 0,290 | 0,062 |
| | | Rse+Rsi = 0,2 | **Dicke gesamt 0,4740** | **U-Wert** | **0,10** |
| **AW01** | **Aussenwand - Holzblock** | von Innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | | B | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | | B | 0,2500 | 0,038 | 6,579 |
| 1.402.02 Holz | | B | 0,1400 | 0,140 | 1,000 |
| | | Rse+Rsi = 0,17 | **Dicke gesamt 0,4150** | **U-Wert** | **0,13** |
| **DS01** | **Dachschräge hinterlüftet** | von Außen nach Innen | Dicke | λ | d / λ |
| Luft steh., W-Fluss horizontal 25 < d <= 30 mm | | B | 0,0300 | 0,176 | 0,170 |
| 1.402.02 Holz | | B | 0,0200 | 0,140 | 0,143 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | | B | 0,0400 | 0,222 | 0,180 |
| Steinwolle MW-W (33) | | B | 0,3300 | 0,038 | 8,684 |
| PVC-Dichtungsbahn | | B | 0,0010 | 0,140 | 0,007 |
| 1.402.02 Holz | | B | 0,0240 | 0,140 | 0,171 |
| Luft steh., W-Fluss horizontal 15 < d <= 20 mm | | B | 0,0200 | 0,118 | 0,169 |
| 1.402.02 Holz | | B | 0,0200 | 0,140 | 0,143 |
| | | Rse+Rsi = 0,2 | **Dicke gesamt 0,4850** | **U-Wert** | **0,10** |
| **EB02** | **Wintergarten-Fussboden** | von Innen nach Außen | Dicke | λ | d / λ |
| 1.704.08 Fliesen | | B | 0,0100 | 1,000 | 0,010 |
| 1.202.06 Estrichbeton | | F B | 0,0700 | 1,480 | 0,047 |
| PVC-Dichtungsbahn | | B | 0,0010 | 0,140 | 0,007 |
| Styrodur 3035 C (140 mm) | | B | 0,1500 | 0,038 | 3,947 |
| PVC-Dichtungsbahn | | B | 0,0010 | 0,140 | 0,007 |
| 1.508.02 Schüttung (Sand, Kies, Splitt) | | B | 0,0500 | 0,700 | 0,071 |
| | | Rse+Rsi = 0,17 | **Dicke gesamt 0,2820** | **U-Wert** | **0,23** |
| **KD01** | **Kellerdecke** | von Innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | | B | 0,0140 | 0,140 | 0,100 |
| PVC-Dichtungsbahn | | B | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | | B | 0,0500 | 0,038 | 1,316 |
| 1.202.02 Stahlbeton | | B | 0,1700 | 2,300 | 0,074 |
| Styrodur 2800 C (80 mm) | | B | 0,0800 | 0,035 | 2,286 |
| ISOVER TDPT Trittschall-Dämmpl. 30/30 | | B | 0,0300 | 0,033 | 0,909 |
| 1.202.06 Estrichbeton | | F B | 0,0600 | 1,480 | 0,041 |
| 1.704.08 Fliesen | | B | 0,0200 | 1,000 | 0,020 |
| | | Rse+Rsi = 0,34 | **Dicke gesamt 0,4250** | **U-Wert** | **0,20** |
| **ZD01** | **warme Zwischendecke zw. EG und OG** | von Innen nach Außen | Dicke | λ | d / λ |
| 1.402.02 Holz | | B | 0,0400 | 0,140 | 0,286 |
| Steinwolle MW-W (33) | | B | 0,1700 | 0,038 | 4,474 |
| 1.402.02 Holz | | B | 0,0250 | 0,140 | 0,179 |
| Korkschrot (100), expandiert | | B | 0,0050 | 0,050 | 0,100 |
| AB Berg & Berg Fertigparkett in Esche | | B | 0,0250 | 0,120 | 0,208 |
| | | Rse+Rsi = 0,26 | **Dicke gesamt 0,2650** | **U-Wert** | **0,18** |

**Bauteile**

**Übungsversion_single-family home in Traunkirchen / Upper**

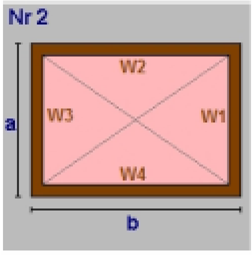
| | | | | | |
|---|---|---|---|---|---|
| **IW01** | **Aussenwand - Holzblock (Holzlagerraum, Garage)** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.402.02 Holz | B | | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | B | | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | | 0,2500 | 0,038 | 6,579 |
| 1.402.02 Holz | B | | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,4150 | U-Wert | 0,12 |
| **IW02** | **Aussenwand - Holzblock (WiGa-kalt Norden)** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.402.02 Holz | B | | 0,0240 | 0,140 | 0,171 |
| PVC-Dichtungsbahn | B | | 0,0010 | 0,140 | 0,007 |
| Steinwolle MW-W (33) | B | | 0,2500 | 0,038 | 6,579 |
| 1.402.02 Holz | B | | 0,1400 | 0,140 | 1,000 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,4150 | U-Wert | 0,12 |
| **AW02** | **Wintergarten** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.402.02 Holz | B | | 0,1400 | 0,140 | 1,000 |
| Steinwolle MW-W (33) | B | | 0,1500 | 0,038 | 3,947 |
| 1.402.02 Holz | B | | 0,0150 | 0,140 | 0,107 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,3050 | U-Wert | 0,19 |
| **EK01** | **Keller - in Basis nicht beheizt** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.704.08 Fliesen | B | | 0,0200 | 1,000 | 0,020 |
| 1.202.06 Estrichbeton | B | | 0,0600 | 1,480 | 0,041 |
| PVC-Dichtungsbahn | B | | 0,0010 | 0,140 | 0,007 |
| EXPORIT EPS F 16 | B | | 0,1600 | 0,040 | 4,000 |
| PVC-Dichtungsbahn | B | | 0,0010 | 0,140 | 0,007 |
| 1.202.06 Estrichbeton | B | | 0,0500 | 1,480 | 0,034 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,2920 | U-Wert | 0,23 |
| **EW01** | **Kellerwand** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.108.04 Gipsbauplatten | B | | 0,0150 | 0,410 | 0,037 |
| Styrodur 2800 C (50 mm) | B | | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | | 0,3000 | 2,300 | 0,130 |
| 1.604.06 Kunststoff- & Gummibelag | B | | 0,0050 | 0,210 | 0,024 |
| Styrodur 2800 C (50 mm) | B | | 0,0500 | 0,033 | 1,515 |
| | Rse+Rsi = 0,13 | Dicke gesamt | 0,4200 | U-Wert | 0,30 |
| **EW02** | **Kellerwand - Bereich Gästezimmer** | | | | |
| | von innen nach Außen | | Dicke | λ | d / λ |
| 1.108.04 Gipsbauplatten | B | | 0,0150 | 0,410 | 0,037 |
| Styrodur 2800 C (50 mm) | B | | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | | 0,3000 | 2,300 | 0,130 |
| 1.604.06 Kunststoff- & Gummibelag | B | | 0,0050 | 0,210 | 0,024 |
| Styrodur 2800 C (50 mm) | B | | 0,0500 | 0,033 | 1,515 |
| | Rse+Rsi = 0,13 | Dicke gesamt | 0,4200 | U-Wert | 0,30 |

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

Geometrieausdruck

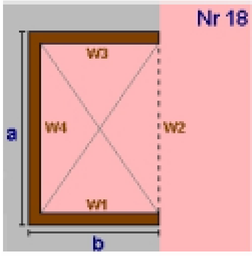
**Übungsversion_single-family home in Traunkirchen / Upper**

**EG basis**



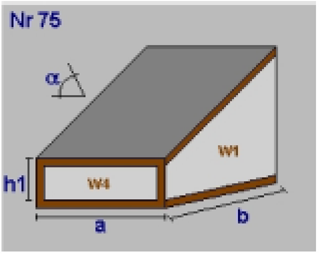

```
a =  9,72      b  =  9,72
lichte Raumhöhe  =  2,50 + obere Decke: 0,27 => 2,77m
BGF         94,48m² BRI     261,23m³

Wand W1     26,88m² AW01 Aussenwand - Holzblock
Wand W2     26,88m² AW01
Wand W3     26,88m² IW01 Aussenwand - Holzblock (Holzlagerraum
Wand W4     12,97m² AW01 Aussenwand - Holzblock
         Teilung  5,03 x 2,77 (Länge x Höhe)
            13,91m² IW02 Aussenwand - Holzblock (WiGa-kalt Nor

Decke       94,48m² ZD01 warme Zwischendecke zw. EG und OG
Boden       94,48m² KD01 Kellerdecke
```

**EG rectangle-Schlafzimmer**




```
a =  4,93      b  =  1,50
lichte Raumhöhe  =  2,50 + obere Decke: 0,27 => 2,77m
BGF          7,40m² BRI      20,45m³

Wand W1      4,15m² IW02 Aussenwand - Holzblock (WiGa-kalt Nor
Wand W2    -13,63m² AW01 Aussenwand - Holzblock
Wand W3      4,15m² AW01
Wand W4     13,63m² AW01
Decke        7,40m² ZD01 warme Zwischendecke zw. EG und OG
Boden        7,40m² KD01 Kellerdecke
```

**EG Wintergarten-Anbau West**



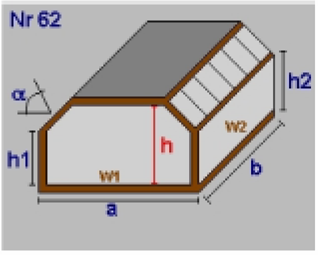

```
Dachneigung a(°) 18,00
a =  6,20      b  =  3,82
h1=  2,20
lichte Raumhöhe  =  2,93 + obere Decke: 0,51 => 3,44m
BGF         23,68m² BRI      66,80m³

Dachfl.     24,90m²
Wand W1     10,77m² AW02 Wintergarten
Wand W2    -21,34m² AW01 Aussenwand - Holzblock
Wand W3     10,77m² AW02 Wintergarten
Wand W4     13,64m² AW02
Dach        24,90m² DS01 Dachschräge hinterlüftet
Boden       23,68m² EB02 Wintergarten-Fussboden
```

**EG Summe**

| | |
|---|---|
| EG Bruttogrundfläche [m²]: | 125,56 |
| EG Bruttorauminhalt [m³]: | 348,48 |

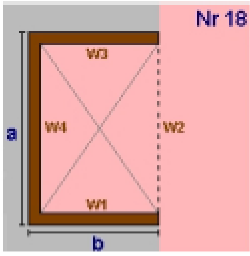
Geometrieausdruck
**Übungsversion_single-family home in Traunkirchen / Upper**

**DG Obergeschoss**




```
Dachneigung a(°) 35,00
a =  9,72      b  =  9,72
h1=  0,90      h2 =  0,90
lichte Raumhöhe(h)=  2,50 + obere Decke: 0,47 => 2,97m
BGF         94,48m² BRI     221,27m³

Dachfl.     70,29m²
Decke       36,90m²
Wand W1     22,76m² AW01 Aussenwand - Holzblock
Wand W2      8,75m² AW01
Wand W3     22,76m² AW01
Wand W4      8,75m² AW01
Dach        70,29m² DS01 Dachschräge hinterlüftet
Decke       36,90m² AD01 Decke zu unkonditionierten geschloss.
Boden      -94,48m² ZD01 warme Zwischendecke zw. EG und OG
```

**DG rectangel - OG**




```
a =  4,93      b  =  1,50
lichte Raumhöhe  =  2,50 + obere Decke: 0,49 => 2,99m
BGF          7,40m² BRI      22,07m³

Wand W1      4,48m² AW01 Aussenwand - Holzblock
Wand W2    -14,72m² AW01
Wand W3      4,48m² AW01
Wand W4     14,72m² AW01
Decke        7,40m² DS01 Dachschräge hinterlüftet
Boden       -7,40m² ZD01 warme Zwischendecke zw. EG und OG
```

**DG Summe**

| | |
|---|---|
| DG Bruttogrundfläche [m²]: | 101,87 |
| DG Bruttorauminhalt [m³]: | 243,34 |

**DG BGF - Reduzierung**

```
BGF Reduzierung = BGF-Höhe kleiner 1.5 m

Reduzierung =     -25,32 m²
```

**Summe Reduzierung Bruttogrundfläche [m²]:** -25,32

**Deckenvolumen EB02**

```
Fläche      23,68 m²  x Dicke 0,28 m =       6,68 m³
```

**Deckenvolumen KD01**

```
Fläche     101,87 m²  x Dicke 0,43 m =      43,29 m³
```

**Bruttorauminhalt [m³]:** 49,97

**Fenster und Türen**
**Übungsversion_single-family home in Traunkirchen / Upper**

| Typ | | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | | | | | | | | | | | | | | | |
| B | EG | AW01 | 2 | 1,07 x 1,19 - Schlafzimmer | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 3,78 x 2,20 - Wintergartenwand | 3,00 | 2,70 | 8,10 | | | | 5,67 | 1,10 | 8,91 | 0,62 | 0,85 |
| B | EG | IW02 | 1 | 2,40 x 2,20 - Wintergarten - Nord | 2,40 | 2,20 | 5,28 | | | | 3,70 | 1,30 | 5,49 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Empore | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 2,10 - Empore | 1,07 | 2,10 | 2,25 | | | | 1,57 | 1,30 | 2,92 | 0,62 | 0,85 |
| | | | 6 | | | | 19,45 | | | | | | 22,29 | | |
| O | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| B | EG | IW01 | 1 | 1,07 x 1,19 - Bad | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,16 | 0,62 | 0,85 |
| B | EG | IW01 | 1 | 1,07 x 0,59 - Stiegenhaus | 1,07 | 0,59 | 0,63 | | | | 0,44 | 1,30 | 0,57 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| | | | 4 | | | | 4,44 | | | | | | 5,05 | | |
| S | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 0,90 x 2,10 - Haustür | 0,90 | 2,10 | 1,89 | | | | | 2,33 | 4,40 | | |
| B | EG | AW01 | 2 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| B | EG | AW01 | 1 | 1,07 x 1,19 - essen | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 3,78 x 2,20 - Wintergartenwand | 3,00 | 2,70 | 8,10 | | | | 5,67 | 1,10 | 8,91 | 0,62 | 0,85 |
| B | DG | AW01 | 2 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 2,55 | | | | 1,78 | 1,30 | 3,31 | 0,62 | 0,85 |
| | | | 7 | | | | 16,36 | | | | | | 21,59 | | |
| W | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 5,92 x 2,20 - Wintergarten | 5,92 | 2,20 | 13,02 | | | | 9,12 | 1,10 | 14,33 | 0,62 | 0,85 |
| B | EG | DS01 | 1 | 5,92 x 3,00 - Wintergarten-Dach | 5,92 | 3,00 | 17,76 | | | | 12,43 | 0,80 | 14,21 | 0,62 | 0,85 |
| B | DG | AW01 | 1 | 1,07 x 1,19 - Erker | 1,07 | 1,19 | 1,27 | | | | 0,89 | 1,30 | 1,68 | 0,62 | 0,85 |
| | | | 4 | | | | 33,32 | | | | | | 31,88 | | |
| Summe | | | 21 | | | | 73,57 | | | | | | 80,79 | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes

## 13.2.2 Example 3 – Energy-pass for single family house in Altenfelden

| | | | |
|---|---|---|---|
| Norm-Außentemperatur: | -15,9 °C | Standort: | Altenfelden |
| Berechnungs-Raumtemperatur: | 20 °C | Brutto-Rauminhalt der | |
| Temperatur-Differenz: | 35,9 K | beheizten Gebäudeteile: | 523,73 m³ |
| | | Gebäudehüllfläche: | 491,48 m² |

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AD01 | Decke zu unkonditioniertem geschloss. Dachraum | 149,21 | 0,127 | 0,90 | | 17,06 |
| AW02 | Außenwand-EG | 121,69 | 0,195 | 1,00 | | 23,78 |
| AW03 | Außenwand-EG - mit Eternitverkleidung | 18,10 | 0,197 | 1,00 | | 3,56 |
| FE/TÜ | Fenster u. Türen | 22,21 | 1,061 | 1,00 | | 23,58 |
| KD01 | Decke zu unkonditioniertem ungedämmten Keller | 149,21 | 0,194 | 0,70 | | 20,22 |
| IW01 | Wand zu sonstigem Pufferraum (Stiegenhaus) | 31,06 | 0,201 | 0,70 | | 4,37 |
| | Summe OBEN-Bauteile | 149,21 | | | | |
| | Summe UNTEN-Bauteile | 149,21 | | | | |
| | Summe Außenwandflächen | 139,79 | | | | |
| | Summe Innenwandflächen | 31,06 | | | | |
| | Fensteranteil in Außenwänden 12,8 % | 20,56 | | | | |
| | Fenster in Innenwänden | 1,66 | | | | |
| **Summe** | | | | **[W/K]** | | **93** |
| **Wärmebrücken (pauschal)** | | | | **[W/K]** | | **10** |
| **Transmissions - Leitwert $L_T$** | | | | **[W/K]** | | **103** |
| **Lüftungs - Leitwert $L_V$** | | | | **[W/K]** | | **42,21** |
| **Gebäude - Heizlast $P_{tot}$** | | Luftwechsel = 0,40 1/h | | **[kW]** | | **5,21** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | | **149 m²** | | **[W/m² BGF]** | | **34,93** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | | Luftwechsel = 0,50 1/h | | **[kW]** | | **6,25** |

## Bauteile

### Übungsversion_Single-Family home in Altenfelden / Upper

**AW02 Außenwand-EG**

| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0200 | 0,700 | 0,029 |
| 2.202.02 Lecabetonwandelement | B | 0,3000 | 0,830 | 0,361 |
| ISOVER FDP Fassadendämmplatte 14 | B | 0,1400 | 0,033 | 4,242 |
| Dämmputz EPS | B | 0,0300 | 0,095 | 0,316 |
| Rse+Rsi = 0,17 | **Dicke gesamt** | **0,4900** | **U-Wert** | **0,20** |

**KD01 Decke zu unkonditioniertem ungedämmten Keller**

| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0100 | 1,000 | 0,010 |
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| Leca-Schüttung | B | 0,1000 | 0,120 | 0,833 |
| Ziegelhohlkörper mit Aufbeton (Decke) | B | 0,2200 | 0,738 | 0,298 |
| ISOVER KDP Kellerdecken-Dämmplatte 12 | B | 0,1200 | 0,033 | 3,636 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| Rse+Rsi = 0,34 | **Dicke gesamt** | **0,5100** | **U-Wert** | **0,19** |

**AD01 Decke zu unkonditioniertem geschloss. Dachraum**

| von Außen nach Innen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| AUSTROTHERM EPS W30 PLUS | B | 0,1500 | 0,030 | 5,000 |
| steinopor 700 EPS-F (100mm) | B | 0,1000 | 0,040 | 2,500 |
| Betonhohlkörper mit Aufbeton (Decke) | B | 0,1000 | 0,800 | 0,125 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| Rse+Rsi = 0,2 | **Dicke gesamt** | **0,4100** | **U-Wert** | **0,13** |

**IW01 Wand zu sonstigem Pufferraum (Stiegenhaus)**

| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| 2.108.0D Lecabetonstein | B | 0,2500 | 0,560 | 0,446 |
| ISOVER FDP Fassadendämmplatte 14 | B | 0,1400 | 0,033 | 4,242 |
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0100 | 0,700 | 0,014 |
| Rse+Rsi = 0,26 | **Dicke gesamt** | **0,4100** | **U-Wert** | **0,20** |

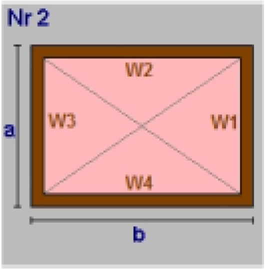
**AW03 Außenwand-EG - mit Eternitverkleidung**

| von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|
| Röfix 190 Kalk-Gips-Innenputz | B | 0,0200 | 0,700 | 0,029 |
| 2.202.02 Lecabetonwandelement | B | 0,3000 | 0,830 | 0,361 |
| ISOVER FDP Fassadendämmplatte 14 | B | 0,1400 | 0,033 | 4,242 |
| Luft steh., W-Fluss horizontal 35 < d <= 40 mm | B | 0,0400 | 0,222 | 0,180 |
| AURIA Wandschindel | B | 0,0050 | 0,500 | 0,010 |
| Rse+Rsi = 0,26 | **Dicke gesamt** | **0,5050** | **U-Wert** | **0,20** |

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

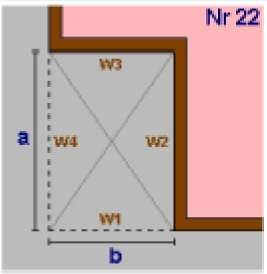
Geometrieausdruck
**Übungsversion_Single-Family home in Altenfelden / Upper**

## EG Basis



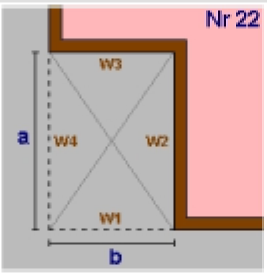

```
a = 11,50      b  = 16,00
lichte Raumhöhe  =  2,59 + obere Decke: 0,41 => 3,00m
BGF       184,00m² BRI     552,00m³

Wand W1    34,50m² AW02 Außenwand-EG
Wand W2    48,00m² AW02
Wand W3    34,50m² AW02
Wand W4    48,00m² AW03 Außenwand-EG - mit Eternitverkleidung
Decke     184,00m² AD01 Decke zu unkonditioniertem geschloss.
Boden     184,00m² KD01 Decke zu unkonditioniertem ungedämmte
```

## EG Windfang/Stiegenhaus-Korrektur




```
a =  7,87      b  =  2,70
lichte Raumhöhe  =  2,59 + obere Decke: 0,41 => 3,00m
BGF      -21,25m² BRI     -63,75m³

Wand W1    -8,10m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2    19,86m² IW01 Wand zu sonstigem Pufferraum (Stiegen
         Teilung  1,25 x 3,00 (Länge x Höhe)
            3,75m² AW02 Außenwand-EG
Wand W3     8,10m² IW01
Wand W4   -23,61m² AW02 Außenwand-EG

Decke     -21,25m² AD01 Decke zu unkonditioniertem geschloss.
Boden     -21,25m² KD01 Decke zu unkonditioniertem ungedämmte
```

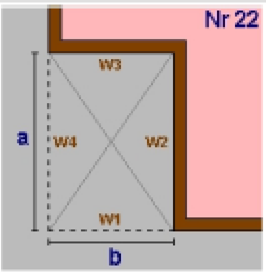
## EG Balkonkorrektur-Westen




```
a =  1,00      b  =  6,00
lichte Raumhöhe  =  2,59 + obere Decke: 0,41 => 3,00m
BGF        -6,00m² BRI     -18,00m³

Wand W1   -18,00m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2     3,00m² AW02 Außenwand-EG
Wand W3    18,00m² AW02
Wand W4    -3,00m² AW02
Decke      -6,00m² AD01 Decke zu unkonditioniertem geschloss.
Boden      -6,00m² KD01 Decke zu unkonditioniertem ungedämmte
```

Geometrieausdruck
**Übungsversion_Single-Family home in Altenfelden / Upper**

## EG Balkonkorrektur-Süden




```
a =  5,80      b  =  1,30
lichte Raumhöhe  =  2,59 + obere Decke: 0,41 => 3,00m
BGF        -7,54m² BRI     -22,62m³

Wand W1    -3,90m² AW03 Außenwand-EG - mit Eternitverkleidung
Wand W2    17,40m² AW02 Außenwand-EG
Wand W3     3,90m² AW02
Wand W4   -17,40m² AW02
Decke      -7,54m² AD01 Decke zu unkonditioniertem geschloss.
Boden      -7,54m² KD01 Decke zu unkonditioniertem ungedämmte
```

**EG Summe**

| | |
|---|---|
| **EG Bruttogrundfläche [m²]:** | **149,21** |
| **EG Bruttorauminhalt [m³]:** | **447,63** |

## Deckenvolumen KD01

```
Fläche     149,21 m²   x Dicke 0,51 m =       76,10 m³
```

| | |
|---|---|
| **Bruttorauminhalt [m³]:** | **76,10** |

## Fenster und Türen

## Übungsversion_Single-Family home in Altenfelden / Upper

| Typ | Bauteil | | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 1,10 | 0,87 | 0,028 | 1,23 | 1,09 | | 0,63 | |
| B | | | | Prüfnormmaß Typ 2 (T2) | 1,23 | 1,48 | 1,82 | 1,90 | 1,65 | 0,040 | 1,23 | 1,92 | | 0,63 | |
| N | | | | | | | | | | | | | | | |
| B | EG | IW01 | 1 | 0,85 x 1,95 - Haustür zu Stiegenhaus | 0,85 | 1,95 | 1,66 | | | | | 1,01 | 1,17 | | |
| | | | **1** | | | | **1,66** | | | | | | **1,17** | | |
| O | | | | | | | | | | | | | | | |
| B | EG | AW02 | 1 | 1,24 x 1,30 - Kinderzimmer | 1,24 | 1,30 | 1,61 | | | | 1,13 | 1,09 | 1,76 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,24 x 0,64 - Bad | 1,24 | 0,64 | 0,79 | | | | 0,56 | 1,09 | 0,87 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,24 x 1,30 - Schlafzimmer | 1,24 | 1,30 | 1,61 | | | | 1,13 | 1,09 | 1,76 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,14 x 1,40 - Wohnzimmer | 1,14 | 1,40 | 1,60 | | | | 1,12 | 1,09 | 1,74 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,10 x 2,10 - Wohnzimmer-Ausgang | 1,10 | 2,10 | 2,31 | | | | 1,62 | 1,09 | 2,52 | 0,62 | 0,85 |
| | | | **5** | | | | **7,92** | | | | | | **8,65** | | |
| S | | | | | | | | | | | | | | | |
| B | EG | AW02 | 1 | 2,24 x 1,30 - Wohnzimmer | 2,24 | 1,30 | 2,91 | | | | 2,04 | 1,09 | 3,17 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,10 x 2,10 - Essplatz | 1,10 | 2,10 | 2,31 | | | | 1,62 | 1,09 | 2,52 | 0,62 | 0,85 |
| B | EG | AW02 | 1 | 1,14 x 1,30 - Essplatz | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,09 | 1,62 | 0,62 | 0,85 |
| | | | **3** | | | | **6,70** | | | | | | **7,31** | | |
| W | | | | | | | | | | | | | | | |
| B | EG | AW02 | 2 | 1,14 x 1,30 - Essplatz / Küche | 1,14 | 1,30 | 2,96 | | | | 2,07 | 1,09 | 3,23 | 0,62 | 0,85 |
| B | EG | AW03 | 1 | 1,14 x 1,30 - Arbeitsraum | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,09 | 1,62 | 0,62 | 0,85 |
| B | EG | AW03 | 1 | 1,14 x 1,30 - Kinderzimmer | 1,14 | 1,30 | 1,48 | | | | 1,04 | 1,09 | 1,62 | 0,62 | 0,85 |
| | | | **4** | | | | **5,92** | | | | | | **6,47** | | |
| **Summe** | | | **13** | | | | **22,20** | | | | | | **23,60** | | |

Ug... Uwert Glas  Uf... Uwert Rahmen  PSI... Linearer Korrekturkoeffizient  Ag... Glasfläche
g... Energiedurchlassgrad Verglasung  fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp  B... Fenster gehört zum Bestand des Gebäudes

### 13.2.3 Example 4 – Energy-pass for weekend home in Schwarzenberg/Hochficht

Norm-Außentemperatur: -15,3 °C
Berechnungs-Raumtemperatur: 20 °C
Temperatur-Differenz: 35,3 K

Standort: Schwarzenberg im Mühlkrei
Brutto-Rauminhalt der beheizten Gebäudeteile: 488,02 m³
Gebäudehüllfläche: 470,53 m²

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AW01 | Außenwand-Granit BESTAND | 93,73 | 0,197 | 1,00 | | 18,44 |
| AW02 | Außenwand-Ziegel (Adaption 1985) - nach Aussen | 8,88 | 0,199 | 1,00 | | 1,76 |
| FE/TÜ | Fenster u. Türen | 15,50 | 1,109 | 1,00 | | 17,19 |
| EB01 | erdanliegender Fußboden (<=1,5m unter Erdreich) | 152,67 | 0,214 | 0,70 | | 22,86 |
| AG01 | Decke zu sonstigem Pufferraum nach oben (living room) | 50,91 | 0,169 | 0,70 | | 6,03 |
| AG02 | Decke zu sonstigem Pufferraum nach oben (kitchen) | 15,50 | 0,144 | 0,70 | | 1,56 |
| AG03 | Decke zu sonstigem Pufferraum nach oben (sleeping-room) | 86,26 | 0,173 | 0,70 | | 10,46 |
| IW01 | Außenwand-Granit zu unbeheiztem Schuppen | 13,57 | 0,193 | 0,70 | | 1,84 |
| IW02 | Außenwand-Ziegel zu unbeheiztem Schuppen (Adaption 1985) | 33,51 | 0,198 | 0,70 | | 4,64 |
| | Summe OBEN-Bauteile | 152,67 | | | | |
| | Summe UNTEN-Bauteile | 152,67 | | | | |
| | Summe Außenwandflächen | 102,61 | | | | |
| | Summe Innenwandflächen | 47,08 | | | | |
| | Fensteranteil in Außenwänden 11,9 % | 13,80 | | | | |
| | Fenster in Innenwänden | 1,70 | | | | |
| **Summe** | | | | **[W/K]** | | **85** |
| **Wärmebrücken (pauschal)** | | | | **[W/K]** | | **10** |
| **Transmissions - Leitwert $L_T$** | | | | **[W/K]** | | **94** |
| **Lüftungs - Leitwert $L_V$** | | | | **[W/K]** | | **43,19** |
| **Gebäude - Heizlast $P_{tot}$** | | Luftwechsel = 0,40 1/h | | **[kW]** | | **4,86** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | | **153 m²** | | **[W/m² BGF]** | | **31,82** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | | Luftwechsel = 0,50 1/h | | **[kW]** | | **5,68** |

## Bauteile

### Übungsversion_weekend-home in the mountains -

**AW01 Außenwand-Granit BESTAND**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Innen nach Außen | | | | |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| StoGranit | B # | | 0,8000 | 0,700 | 1,143 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| ISOVER FDP Fassadendämmplatte 12 | B | | 0,1200 | 0,033 | 3,636 |
| EPS-Dämmputz (300) | B | | 0,0100 | 0,095 | 0,105 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,9600 | U-Wert | 0,20 |

**IW01 Außenwand-Granit zu unbeheiztem Schuppen**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Innen nach Außen | | | | |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| StoGranit | B # | | 0,8000 | 0,700 | 1,143 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| ISOVER FDP Fassadendämmplatte 12 | B | | 0,1200 | 0,033 | 3,636 |
| EPS-Dämmputz (300) | B | | 0,0100 | 0,095 | 0,105 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,9600 | U-Wert | 0,19 |

**IW02 Außenwand-Ziegel zu unbeheiztem Schuppen (Adaption 1985)**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Innen nach Außen | | | | |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| 2.406.02 Schlackenbetonstein 25 cm | B | | 0,3000 | 0,630 | 0,476 |
| Heraklith-BM (5,0cm) | B | | 0,0500 | 0,091 | 0,550 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| ISOVER FDP Fassadendämmplatte 12 | B | | 0,1200 | 0,033 | 3,636 |
| EPS-Dämmputz (300) | B | | 0,0100 | 0,095 | 0,105 |
| | Rse+Rsi = 0,26 | Dicke gesamt | 0,5100 | U-Wert | 0,20 |

**AW02 Außenwand-Ziegel (Adaption 1985) - nach Aussen**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Innen nach Außen | | | | |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| 1.106.06 Betonhohlsteinmauerwerk | B | | 0,3000 | 0,550 | 0,545 |
| Heraklith-BM (5,0cm) | B | | 0,0500 | 0,091 | 0,550 |
| Zementputz | B | | 0,0200 | 1,000 | 0,020 |
| ISOVER FDP Fassadendämmplatte 12 | B | | 0,1200 | 0,033 | 3,636 |
| EPS-Dämmputz (300) | B | | 0,0100 | 0,095 | 0,105 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,5100 | U-Wert | 0,20 |

**EB01 erdanliegender Fußboden (<=1,5m unter Erdreich)**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Innen nach Außen | | | | |
| Holzboden, Vollholz Nadel | B | | 0,0300 | 0,120 | 0,250 |
| steinopor 700 EPS-W20 (160mm) | B | | 0,1600 | 0,038 | 4,211 |
| ISOVER VARIO KM | B | | 0,0001 | 0,200 | 0,001 |
| 1.202.02 Stahlbeton | B | | 0,1000 | 2,300 | 0,043 |
| | Rse+Rsi = 0,17 | Dicke gesamt | 0,2901 | U-Wert | 0,21 |

**AG01 Decke zu sonstigem Pufferraum nach oben (living room)**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Außen nach Innen | | | | |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| 3.304.02 Tram-Traversendecke 20 cm | B | | 0,2000 | 0,950 | 0,211 |
| | Rse+Rsi = 0,2 | Dicke gesamt | 0,4400 | U-Wert | 0,17 |

## Bauteile

### Übungsversion_weekend-home in the mountains -

**AG02 Decke zu sonstigem Pufferraum nach oben (kitchen)**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Außen nach Innen | | | | |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| 1.202.02 Stahlbeton | B | | 0,1500 | 2,300 | 0,065 |
| Riegel dazw. | B # | 5,5 % | | 0,120 | 0,023 |
| steinopor 700 EPS-W15 (220mm) | B # | 94,6 % | 0,0500 | 0,041 | 1,153 |
| 1.108.04 Gipsbauplatten | B | | 0,0200 | 0,410 | 0,049 |
| RTo 6,9845 | RTu 6,9176 | RT 6,9510 Dicke gesamt | 0,4600 | U-Wert | 0,14 |
| Riegel: Achsabstand 0,550 | Breite 0,030 | Rse+Rsi | 0,2 | | |

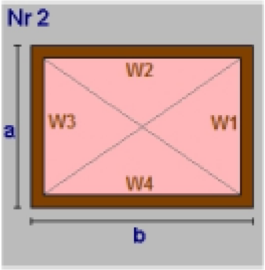
**AG03 Decke zu sonstigem Pufferraum nach oben (sleeping-room)**

| | | | Dicke | $\lambda$ | $d / \lambda$ |
|---|---|---|---|---|---|
| | von Außen nach Innen | | | | |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| ROCKWOOL Isolith Dachboden-Dämmelement OG-03 (12cm) | B | | 0,1200 | 0,044 | 2,750 |
| 1.202.02 Stahlbeton | B | | 0,1500 | 2,300 | 0,065 |
| Zementputz | B | | 0,0100 | 1,000 | 0,010 |
| | Rse+Rsi = 0,2 | Dicke gesamt | 0,4000 | U-Wert | 0,17 |

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert #... Schicht zählt nicht zur OI3-Berechnung F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

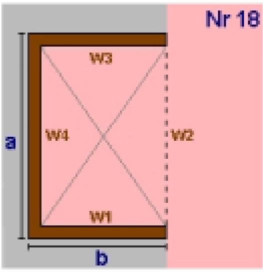
## Geometrieausdruck
### Übungsversion_weekend-home in the mountains -

**EG basis - granite part**




```
a = 12,10      b  = 10,60
lichte Raumhöhe  =  2,50 + obere Decke: 0,40 => 2,90m
BGF        128,26m² BRI     371,95m³

Wand W1    35,09m² TW01 Außenwand-Granit zu unbeheiztem Schup
Wand W2    30,74m² AW01 Außenwand-Granit BESTAND
Wand W3    35,09m² AW01
Wand W4    30,74m² AW01
Decke      86,26m² AG03 Decke zu sonstigem Pufferraum nach ob
Teilung    26,50m² AG01
Teilung    15,50m² AG02

Boden     128,26m² EB01 erdanliegender Fußboden (<=1,5m unter
```

**EG rectangle with bathroom/toilet**




```
a =  7,75      b  =  3,15
lichte Raumhöhe  =  2,50 + obere Decke: 0,44 => 2,94m
BGF         24,41m² BRI      71,77m³

Wand W1     9,26m² TW02 Außenwand-Ziegel zu unbeheiztem Schup
Wand W2   -22,79m² TW01 Außenwand-Granit zu unbeheiztem Schup
Wand W3     9,26m² AW02 Außenwand-Ziegel (Adaption 1985) - na
Wand W4    22,79m² TW02 Außenwand-Ziegel zu unbeheiztem Schup
Decke      24,41m² AG01 Decke zu sonstigem Pufferraum nach ob
Boden      24,41m² EB01 erdanliegender Fußboden (<=1,5m unter
```

**EG Summe**

| | |
|---|---|
| EG Bruttogrundfläche [m²]: | 152,67 |
| EG Bruttorauminhalt [m³]: | 443,73 |

**Deckenvolumen EB01**

```
Fläche     152,67 m²    x Dicke 0,29 m =      44,29 m³
```

**Bruttorauminhalt [m³]: 44,29**

## Fenster und Türen
### Übungsversion_weekend-home in the mountains -

| Typ | | Bauteil | Anz | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 0,70 | 1,25 | 0,040 | 1,23 | 0,98 | | 0,51 | |
| B | | | | Prüfnormmaß Typ 2 (T2) | 1,23 | 1,48 | 1,82 | 2,70 | 1,55 | 0,040 | 1,23 | 2,42 | | 0,72 | |
| O | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,00 x 1,30 - Küche (Holz mit 2-fach | 1,00 | 1,30 | 1,30 | | | | 0,91 | 1,02 | 1,33 | 0,51 | 0,85 |
| B | EG | AW01 | 2 | 1,00 x 1,30 - WohnZi (Holz mit 2-fach | 1,00 | 1,30 | 2,60 | | | | 1,82 | 1,02 | 2,65 | 0,51 | 0,85 |
| B | EG | AW02 | 1 | 1,00 x 1,30 - Bad (Holz mit 2-fach Verbundglas) | 1,00 | 1,30 | 1,30 | | | | 0,91 | 1,02 | 1,33 | 0,51 | 0,85 |
| | | | 4 | | | | 5,20 | | | | | | 5,31 | | |
| S | | | | | | | | | | | | | | | |
| B | EG | AW01 | 3 | 1,00 x 1,30 - WohnZi (Holz mit 2-fach | 1,00 | 1,30 | 3,90 | | | | 2,73 | 1,02 | 3,98 | 0,51 | 0,85 |
| B | EG | AW01 | 1 | 1,00 x 1,30 - SchlafZ(Holz mit 2-fach | 1,00 | 1,30 | 1,30 | | | | 0,91 | 1,02 | 1,33 | 0,51 | 0,85 |
| B | EG | AW01 | 1 | 1,00 x 2,10 - Haustür | 1,00 | 2,10 | 2,10 | | | | | 1,67 | 3,51 | | |
| | | | 5 | | | | 7,30 | | | | | | 8,82 | | |
| W | | | | | | | | | | | | | | | |
| B | EG | AW01 | 1 | 1,00 x 1,30 - KindZi(Holz mit 2-fach Verbundglas) | 1,00 | 1,30 | 1,30 | | | | 0,91 | 1,02 | 1,33 | 0,51 | 0,85 |
| B | EG | IW02 | 1 | 0,85 x 2,00 - Tür zu unbeheiztem Schuppen | 0,85 | 2,00 | 1,70 | | | | | 1,47 | 1,75 | | |
| | | | 2 | | | | 3,00 | | | | | | 3,08 | | |
| Summe | | | 11 | | | | 15,50 | | | | | | 17,21 | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes

## 13.2.4 Example 5 – Energy-pass for building in San Francisco

| | | | |
|---|---|---|---|
| Norm-Außentemperatur: | | Standort: | |
| Berechnungs-Raumtemperatur: | | Brutto-Rauminhalt der | |
| Temperatur-Differenz: | | beheizten Gebäudeteile: | 376,88 m³ |
| | | Gebäudehüllfläche: | 372,06 m³ |

| Bauteile | | Fläche A [m²] | Wärmed.-koeffiz. U [W/m² K] | Korr.-faktor f [1] | Korr.-faktor ffh [1] | A x U x f [W/K] |
|---|---|---|---|---|---|---|
| AW01 | Außenwand | 134,26 | 0,167 | 1,00 | | 22,45 |
| FD01 | Außendecke, Wärmestrom nach oben | 112,00 | 0,167 | 1,00 | | 18,72 |
| FE/TÜ | Fenster u. Türen | 13,80 | 1,284 | 1,00 | | 17,72 |
| ID01 | Fußboden zu sonstigem Pufferraum (nach unten) | 112,00 | 0,112 | 0,70 | | 8,82 |
| | Summe OBEN-Bauteile | 112,00 | | | | |
| | Summe UNTEN-Bauteile | 112,00 | | | | |
| | Summe Außenwandflächen | 134,26 | | | | |
| | Fensteranteil in Außenwänden 9,3 % | 13,80 | | | | |

| | | | |
|---|---|---|---|
| **Summe** | | **[W/K]** | **68** |
| **Wärmebrücken (pauschal)** | | **[W/K]** | **8** |
| **Transmissions - Leitwert $L_T$** | | **[W/K]** | **75** |
| **Lüftungs - Leitwert $L_V$** | | **[W/K]** | **31,68** |
| **Gebäude - Heizlast $P_{tot}$** | Luftwechsel = 0,40 1/h | **[kW]** | **3,48** |
| **Flächenbez. Heizlast $P_1$ bei einer BGF von** | **112 m²** | **[W/m² BGF]** | **31,07** |
| **Gebäude - Heizlast $P_{tot}$ (EN 12831 vereinfacht)** | Luftwechsel = 0,50 1/h | **[kW]** | **4,12** |

**Bauteile**

**Übungsversion_California - San Francisco - (improvements)**

**AW01 Außenwand**

| | von Innen nach Außen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |
| Lattung dazw. | B | 10,0 % | 0,1260 | 0,120 | 0,105 |
| Steinwolle MW-W | B | 90,0 % | | 0,043 | 2,637 |
| Lattung dazw. | B | 10,0 % | 0,1500 | 0,120 | 0,125 |
| Steinwolle MW-W | B | 90,0 % | | 0,043 | 3,140 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |

RTo 6,1745 RTu 5,7852 RT 5,9799 — **Dicke gesamt 0,3000 U-Wert 0,17**

Lattung: Achsabstand 0,600 Breite 0,060 — Rse+Rsi 0,17
Lattung: Achsabstand 0,600 Breite 0,060

**FD01 Außendecke, Wärmestrom nach oben**

| | von Außen nach Innen | | Dicke | λ | d / λ |
|---|---|---|---|---|---|
| ETERNIT Dachplatten | B | | 0,0200 | 0,600 | 0,033 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |
| Lattung dazw. | B | 10,0 % | 0,1260 | 0,120 | 0,105 |
| Steinwolle MW-W | B | 90,0 % | | 0,043 | 2,637 |
| Lattung dazw. | B | 10,0 % | 0,1500 | 0,120 | 0,125 |
| Steinwolle MW-W | B | 90,0 % | | 0,043 | 3,140 |
| 1.402.02 Holz | B | | 0,0120 | 0,140 | 0,086 |

RTo 6,1780 RTu 5,7885 RT 5,9833 — **Dicke gesamt 0,3200 U-Wert 0,17**

Lattung: Achsabstand 0,600 Breite 0,060 — Rse+Rsi 0,14
Lattung: Achsabstand 0,600 Breite 0,060

**ID01 Fußboden zu sonstigem Pufferraum (nach unten)**

| | von Innen nach Außen | Dicke | λ | d / λ |
|---|---|---|---|---|
| 1.704.08 Fliesen | B | 0,0150 | 1,000 | 0,015 |
| 1.202.06 Estrichbeton | B | 0,0500 | 1,480 | 0,034 |
| ISOVER TDPS Trittschall-Dämmpl. 55/50 | B | 0,0500 | 0,033 | 1,515 |
| 1.202.02 Stahlbeton | B | 0,2000 | 2,300 | 0,087 |
| ISOVER KDP Kellerdecken-Dämmplatte 22 | B | 0,2200 | 0,032 | 6,875 |
| Gipsputz (1000) | B | 0,0100 | 0,400 | 0,025 |

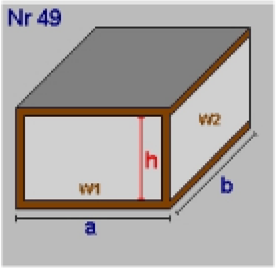
Rse+Rsi = 0,34 — **Dicke gesamt 0,5450 U-Wert 0,11**

Einheiten: Dicke [m], Achsabstand [m], Breite [m], U-Wert [W/m²K], Dichte [kg/m³], λ [W/mK]
*... Schicht zählt nicht zum U-Wert F... enthält Flächenheizung B... Bestandsschicht **...Defaultwert lt. OIB
RTu ... unterer Grenzwert RTo ... oberer Grenzwert laut ÖNORM EN ISO 6946

## Geometrieausdruck

### Übungsversion_California - San Francisco - (improvements)

### DG Dachkörper




```
a =  8,00     b  = 14,00
lichte Raumhöhe(h)=  2,50 + obere Decke: 0,32 => 2,82m
BGF      112,00m² BRI     315,84m³

Decke    112,00m²
Wand W1   22,56m² AW01 Außenwand
Wand W2   39,48m² AW01
Wand W3   22,56m² AW01
Wand W4   39,48m² AW01
Decke    112,00m² FD01 Außendecke, Wärmestrom nach oben
Boden    112,00m² ID01 Fußboden zu sonstigem Pufferraum (nac
```

**DG Summe**

**DG Bruttogrundfläche [m²]:** 112,00
**DG Bruttorauminhalt [m³]:** 315,84

### Deckenvolumen ID01

Fläche 112,00 m² x Dicke 0,55 m = 61,04 m³

**Bruttorauminhalt [m³]:** 61,04

## Fenster und Türen

### Übungsversion_California - San Francisco - (improvements)

| Typ | Bauteil | Anz. | Bezeichnung | Breite [m] | Höhe [m] | Fläche [m²] | Ug [W/m²K] | Uf [W/m²K] | PSI [W/mK] | Ag [m²] | Uw [W/m²K] | AxUxf [W/K] | g | fs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | | | Prüfnormmaß Typ 1 (T1) | 1,23 | 1,48 | 1,82 | 1,25 | 1,40 | 0,070 | 1,23 | 1,47 | | 0,58 | |
| **N** | | | | | | | | | | | | | | |
| B T1 | DG | AW01 | 1 1,20 x 1,00 | 1,20 | 1,00 | 1,20 | 1,25 | 1,40 | 0,070 | 0,73 | 1,51 | 1,81 | 0,58 | 0,85 |
| B T1 | DG | AW01 | 1 0,80 x 1,00 | 0,80 | 1,00 | 0,80 | 1,25 | 1,40 | 0,070 | 0,43 | 1,55 | 1,24 | 0,58 | 0,85 |
| | | | **2** | | | **2,00** | | | | | | **3,05** | | |
| **O** | | | | | | | | | | | | | | |
| B T1 | DG | AW01 | 2 1,20 x 1,00 | 1,20 | 1,00 | 2,40 | 1,25 | 1,40 | 0,070 | 1,46 | 1,51 | 3,62 | 0,58 | 0,85 |
| B T1 | DG | AW01 | 1 1,00 x 2,20 - Gartentür | 1,00 | 2,20 | 2,20 | | | | | 0,73 | 1,61 | | |
| | | | **3** | | | **4,60** | | | | | | **5,23** | | |
| **S** | | | | | | | | | | | | | | |
| B T1 | DG | AW01 | 1 1,20 x 1,00 | 1,20 | 1,00 | 1,20 | 1,25 | 1,40 | 0,070 | 0,73 | 1,51 | 1,81 | 0,58 | 0,85 |
| B T1 | DG | AW01 | 1 0,80 x 1,00 | 0,80 | 1,00 | 0,80 | 1,25 | 1,40 | 0,070 | 0,43 | 1,55 | 1,24 | 0,58 | 0,85 |
| B T1 | DG | AW01 | 1 1,00 x 2,20 - Haustür | 1,00 | 2,20 | 2,20 | | | | | 0,87 | 1,91 | | |
| | | | **3** | | | **4,20** | | | | | | **4,96** | | |
| **W** | | | | | | | | | | | | | | |
| B T1 | DG | AW01 | 2 1,50 x 1,00 | 1,50 | 1,00 | 3,00 | 1,25 | 1,40 | 0,070 | 1,92 | 1,49 | 4,48 | 0,58 | 0,85 |
| | | | **2** | | | **3,00** | | | | | | **4,48** | | |
| **Summe** | | | **10** | | | **13,80** | | | | | | **17,72** | | |

Ug... Uwert Glas Uf... Uwert Rahmen PSI... Linearer Korrekturkoeffizient Ag... Glasfläche
g... Energiedurchlassgrad Verglasung fs... Verschattungsfaktor
Typ... Prüfnormmaßtyp B... Fenster gehört zum Bestand des Gebäudes