Universität für Bodenkultur Wien
Department für Bautechnik und
Naturgefahren

# Sustainable Buildings

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University of Natural Resources and Applied Life
Sciences, Vienna, Austria
Institute for Structural Engineering, Sustainable
Constructions

# What is Sustainability?

Sustainability

Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

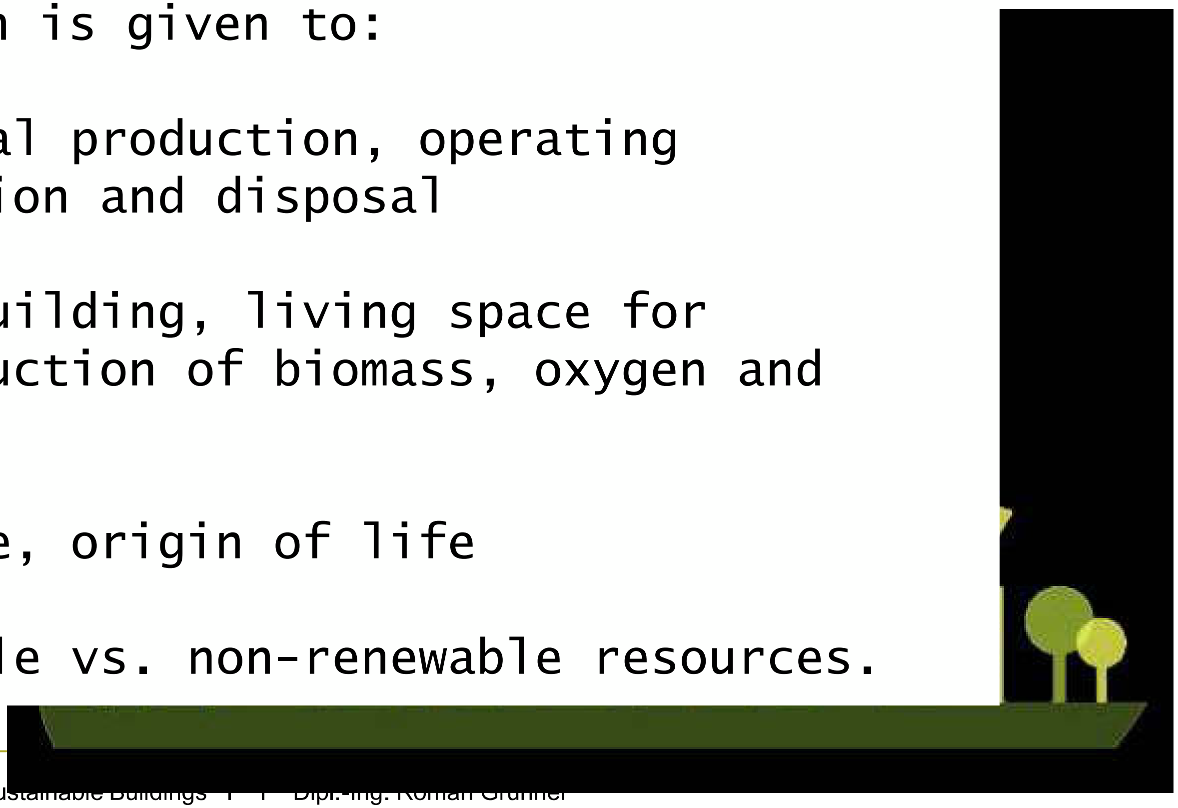
*World Commission on Environment and Development*

# Sustainable Design

Reduces the negative impact on the environment and human health, thus improving the performance during a building’s life cycle.

Careful consideration is given to:

- **Energy:** for Material production, operating buildings, demolition and disposal
- **Soil:** ground for building, living space for organisms and production of biomass, oxygen and drinking-water
- **Water:** living space, origin of life
- **Resources:** renewable vs. non-renewable resources.



## “The most sustainable energy is
## saved energy”

- Energy itself not of particular interest
  *-but is a means towards desired ends*

- Clients desire the services which energy can deliver - *comfort, illumination, power, transportation...*

- The architectural challenge: ensure energy services are delivered in a sustainable manner
  *-with maximum efficiency, and minimal environmental impact*

- Holistic perspective: integrated, contextual, whole life cycle, socially aware, economic solution

**Professor J Owen Lewis**
*UCD Energy Research Group*
*EURIMA Congress, Budapest June 2007*

# Sustainability

**Historical Development:**

The term originates in **German** language from the **forest industry.** First mentioned in 12th century.

1144: Forest arrangement of the alsatian cloister Mauermünster – „*not to cut more wood than it can grow back again*".

1480: Requirement - „*to preserve the forest, because the progeny will once also need it*".

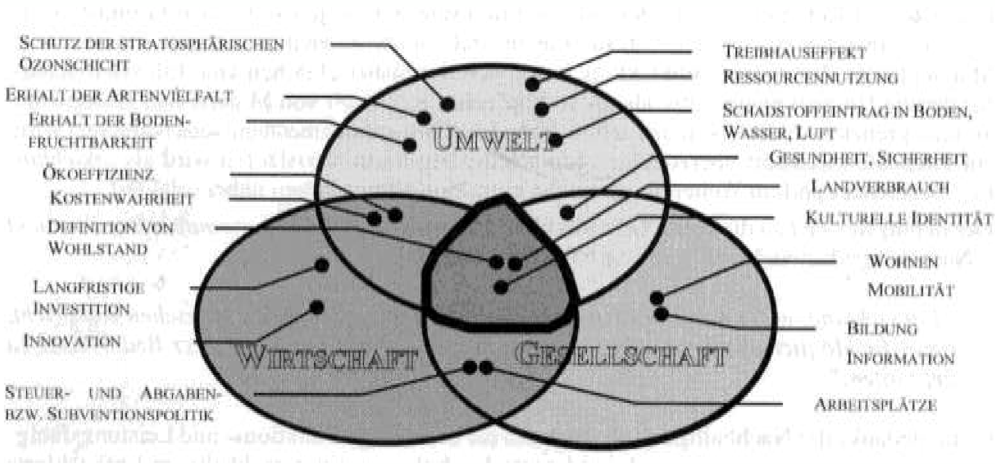
1713: Saxony Captain Hans Carl von Carlowitz demanded in „Sylvicultura Oeconomica", „*that a continuing sustainable use should become indispensable*".

1992: **Earth Summit in Rio de Janeiro** defined the sustainable development as a *development, that can be continued over the whole earth without affecting the natural balance and the society in their functionality*.

1997 and 1998 the EN ISO 14.040 and 14.041 were published, handling the Ecobalancing, replacing the simple SETAC Scheme.

1999 **Contract of Amsterdam:** Sustainability is and intangible part of the European Union.

2001 **Göteborg:** European council adds the environmental dimension to the social and economic dimension.




[Quelle: GRAUBNER, C.-A., HÜSKE, K. 2003]

# Principles of Sustainability in Architecture

- **Economy of Resources** - Reduce, recycle, and reuse natural resources

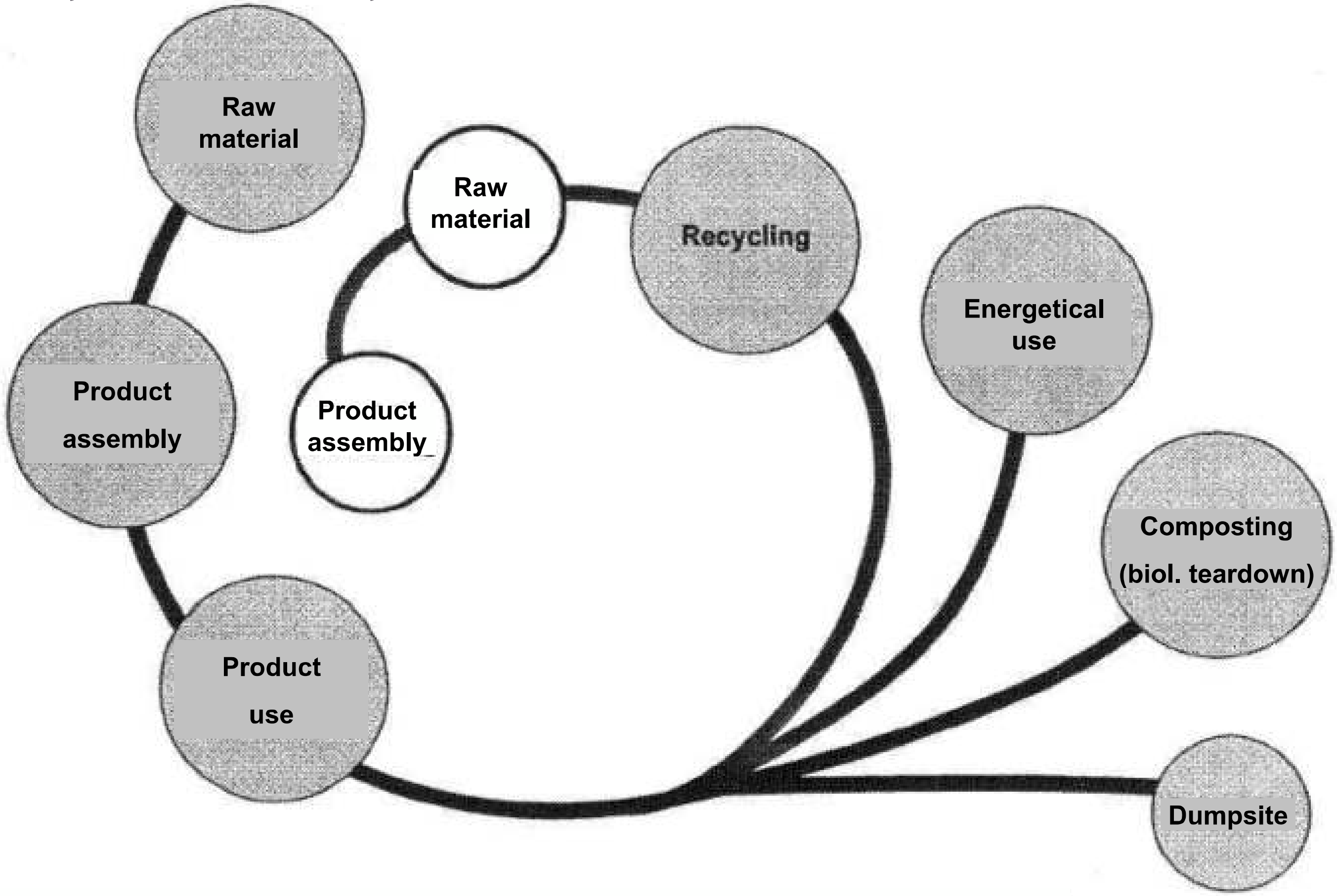
- **Life Cycle Design** - Structured methodology for the building process

- **Humane Design** - Harmony between humans and nature

# Evaluation methode: Lifecycle analysis (LCA, Ökobilanz)

***„Lifecycle analysis is important with relevance to the realisation of sustainable developement in the construction sector as the basis for decision-making in the design and planning stage"***

***Prof. Graubner, TU Darmstadt, Inst. F. Massivbau***




The life-cycle of a product – "from the cradle to the grave".

# Sustainable Building Life Cycle

- Pre-Building
- Building
- Post-Building



# Pre-Building Phase

Site selection, building design, and building material processes, up to but not including installation.

Examine the environmental consequences of the structure's design, orientation, impact on the landscape, and materials used.

# Building Phase

- Construction and operation processes reduce the environmental impact of resource consumption
- Long-term health effects of the building environment on its occupants are considered

# Post-Building Phase

Old materials become resources for other buildings or waste to be returned to nature. The sustainable design strategy focuses on reducing construction waste by recycling and reusing packaging and excess material.

# Preservation of Natural Conditions

An architect should minimize the impact of a building on its local ecosystem (e.g., existing topography, plants, and wildlife).

# Human Comforts

A building's design should enhance the work and home environments. This can improve productivity, reduce stress, and positively affect health and well being.

# Sustainable Remodeling

Existing buildings can remodel and install improved mechanical components and update operating systems to make a building green.

# Indoor Environmental Quality

Low Emitting Materials

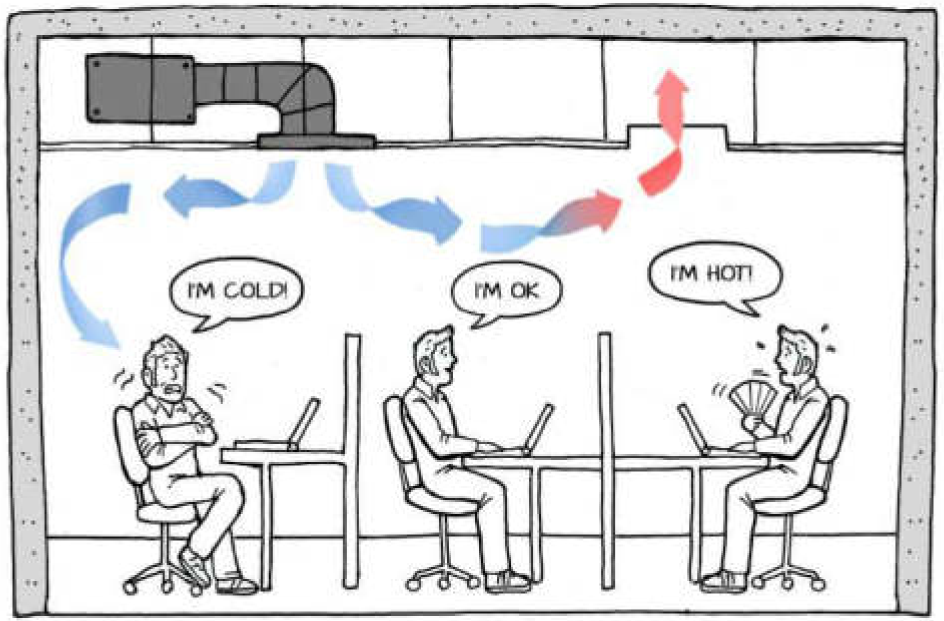
  - Adhesives and Sealants
  - Paints and Coatings
  - Composite Wood

Indoor Chemical and Pollutant Source Control

- Controllability of Systems
  - Perimeter Spaces
  - Non-Perimeter Spaces

# Indoor Environmental Quality

- Thermal Comfort
- Daylight and Views




# Rock and Earth Caves: the earliest forms of human housing

**Advantage**: Living temperature in the cave = middle-year temperature of the surrounding, Summer – cool, winter – warm, constant

**Examples**:

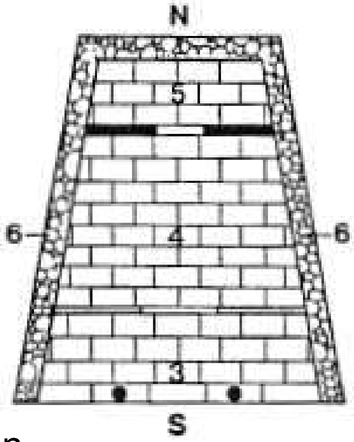
- in the valleys of Dordogne and Vézére (F),
- Göröme (Turkey),
- Matmata (Tunisia),
- Loyang (China),
- Montezuma Castle (Arizona),
- Mesa Verde (Colorado),
- Matera (Apulien).

Matmata, Tunisia

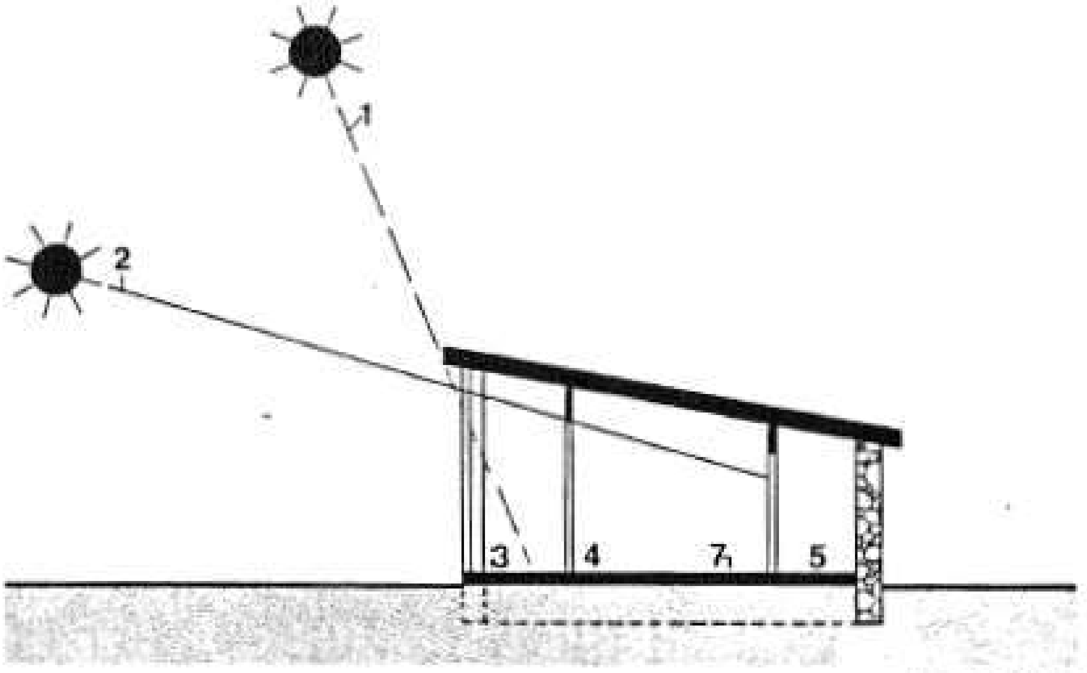
Matera

Matera, Apulien

# Sunhouse of Socrates (469 – 397 v. Chr.)

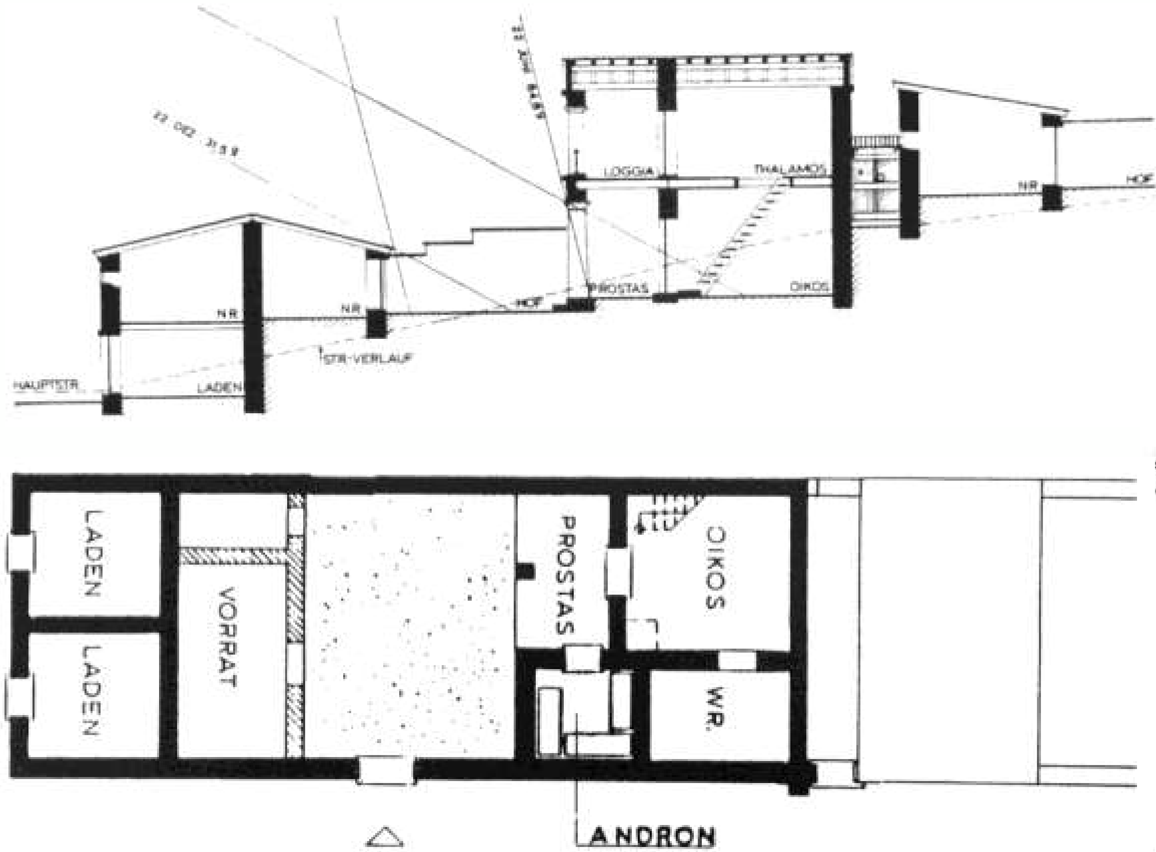


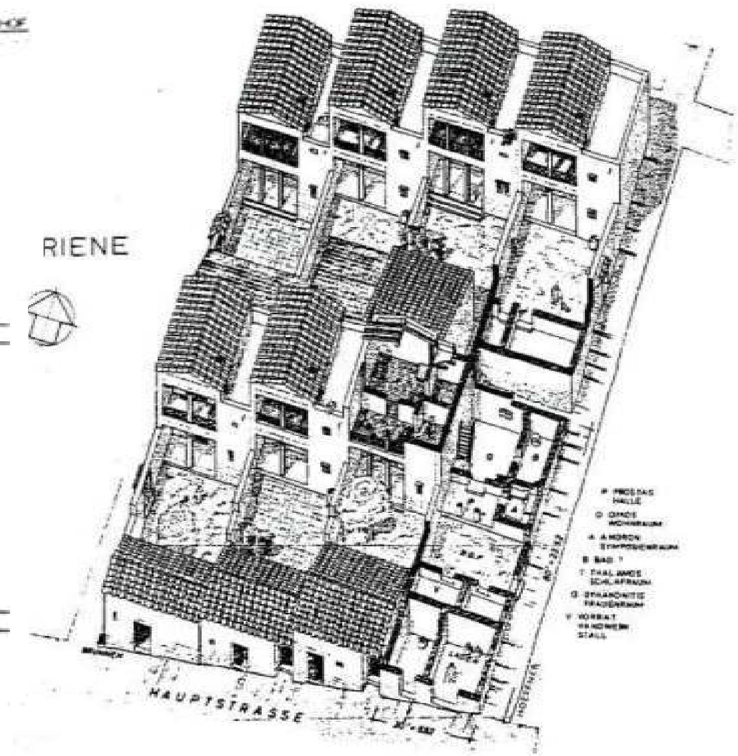

Floor plan



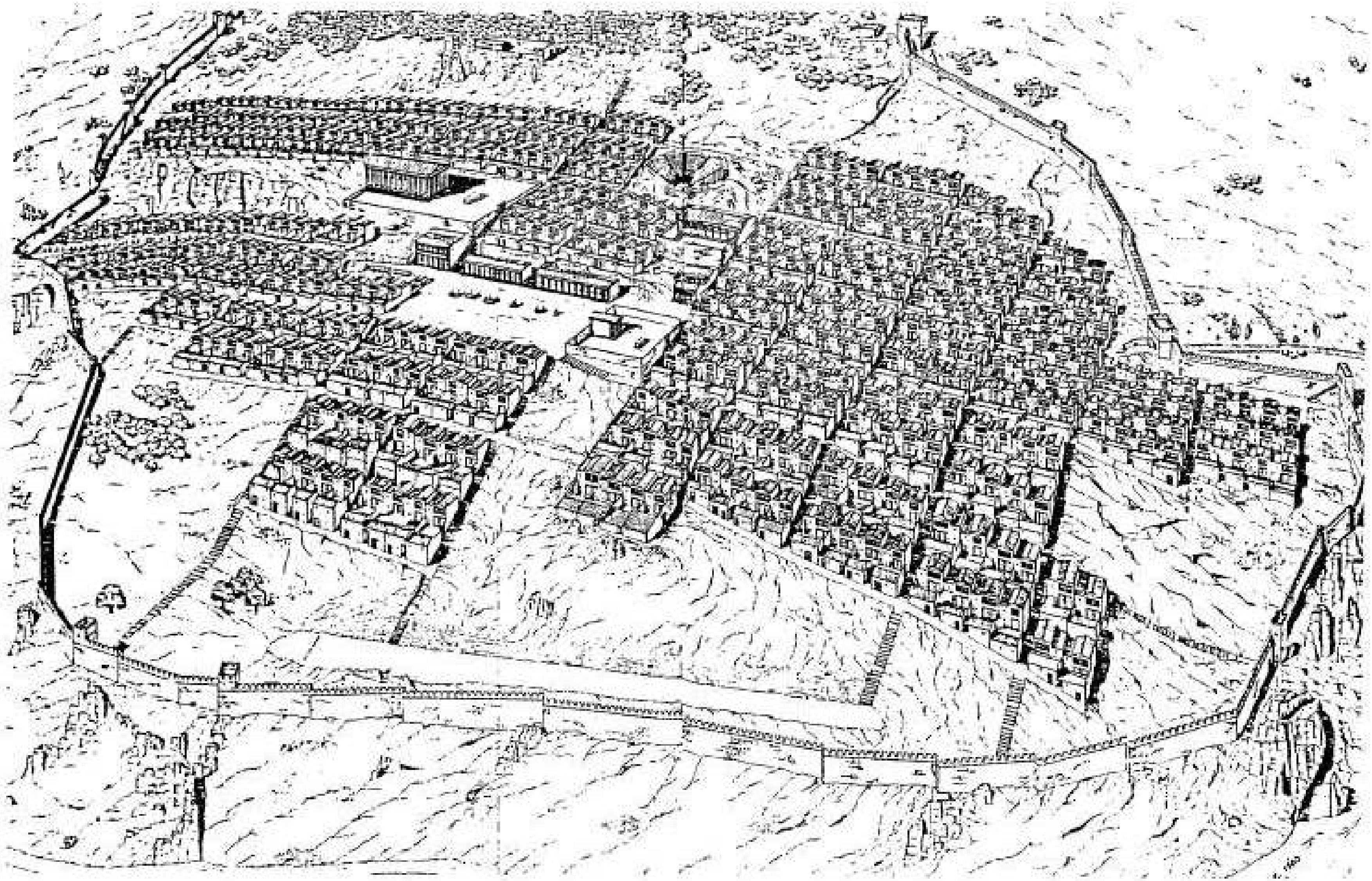

Cross section

Legend:
3 Terrace, Forecourt
4 Living space
5 Storage room, also buffer zone
6 Massive Wands for accumulation of heat
7 Stonefloor, also heat accumulation

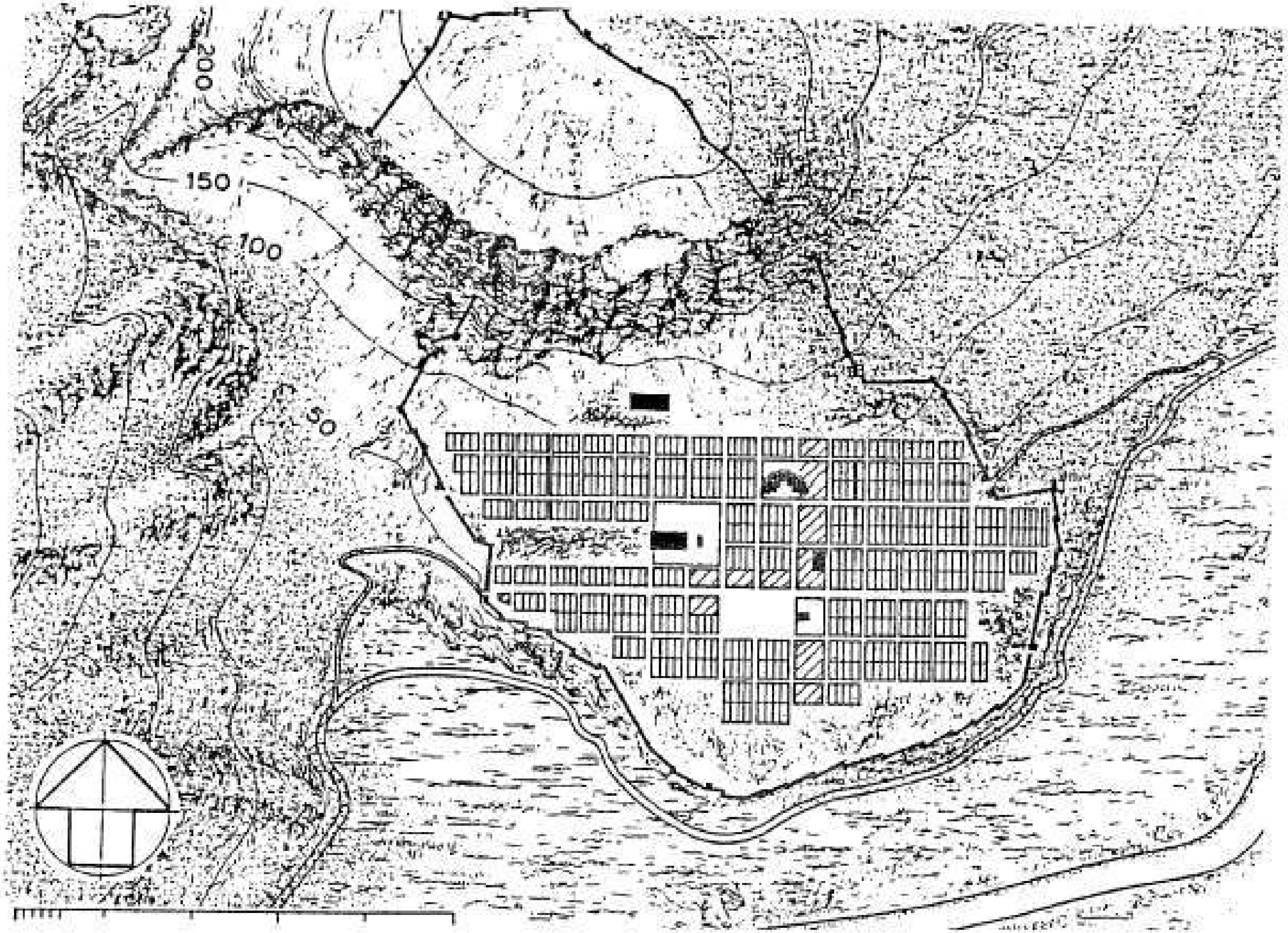


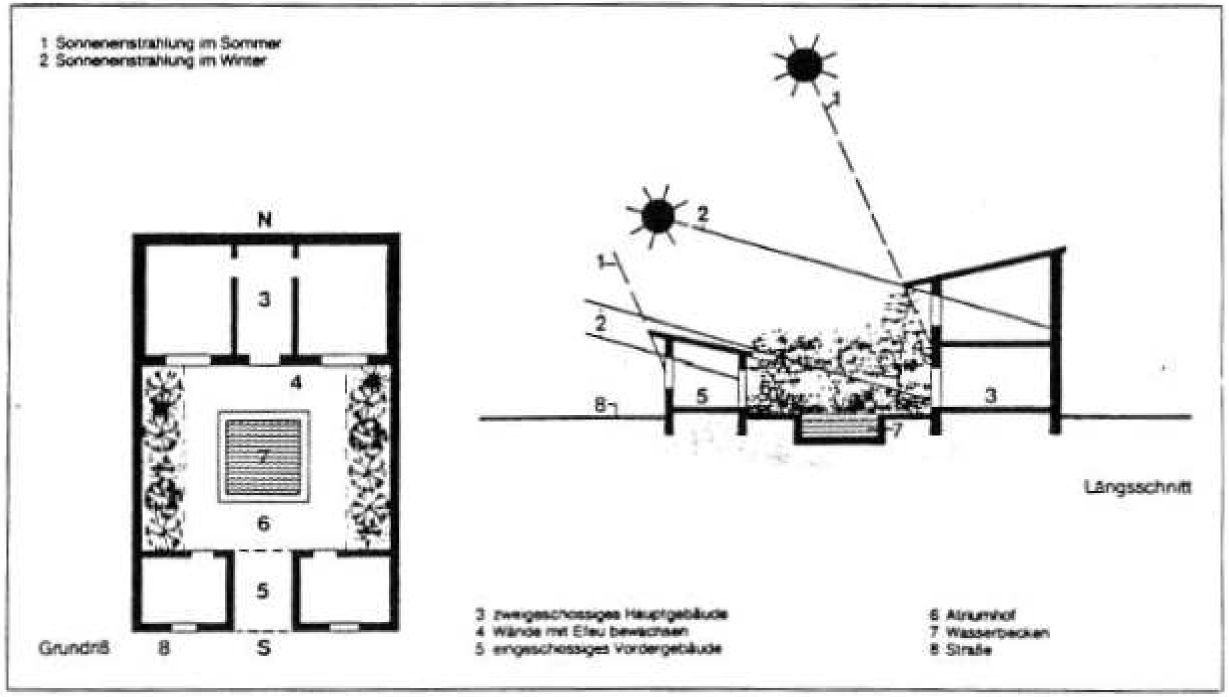

Atriumhouse in Priene



Reconstructed View of the Priene City (300 B.C)

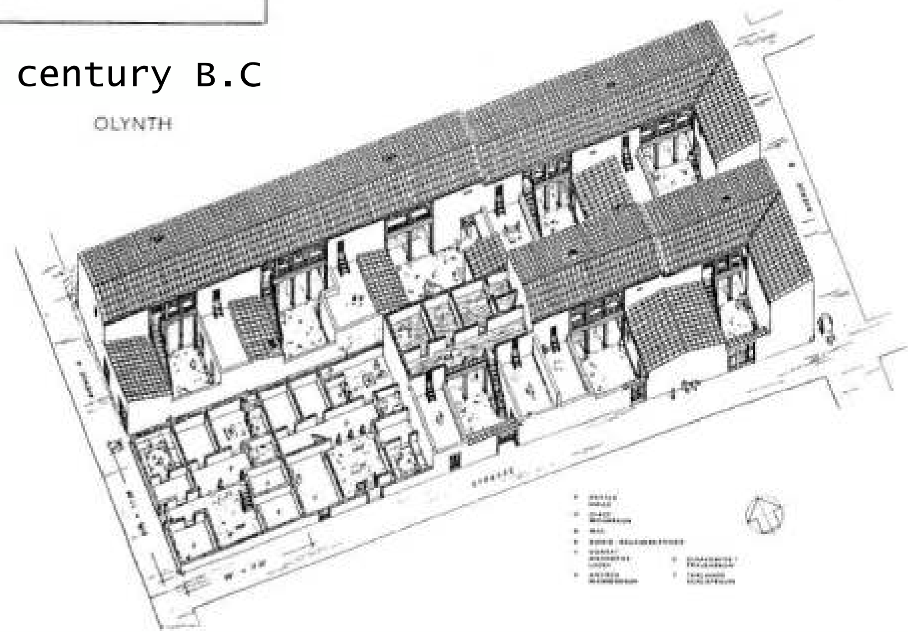


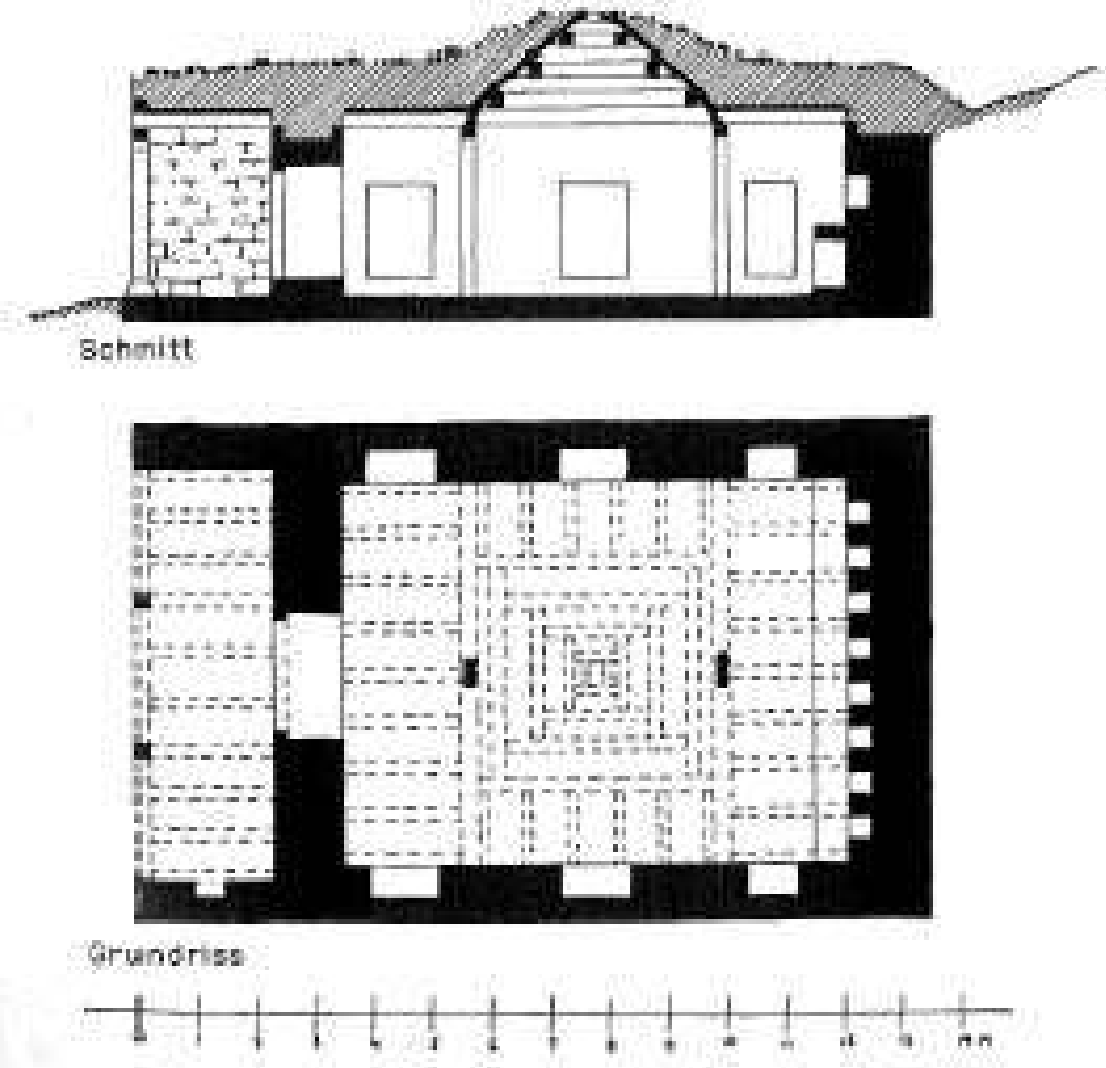

Streetplan of Priene



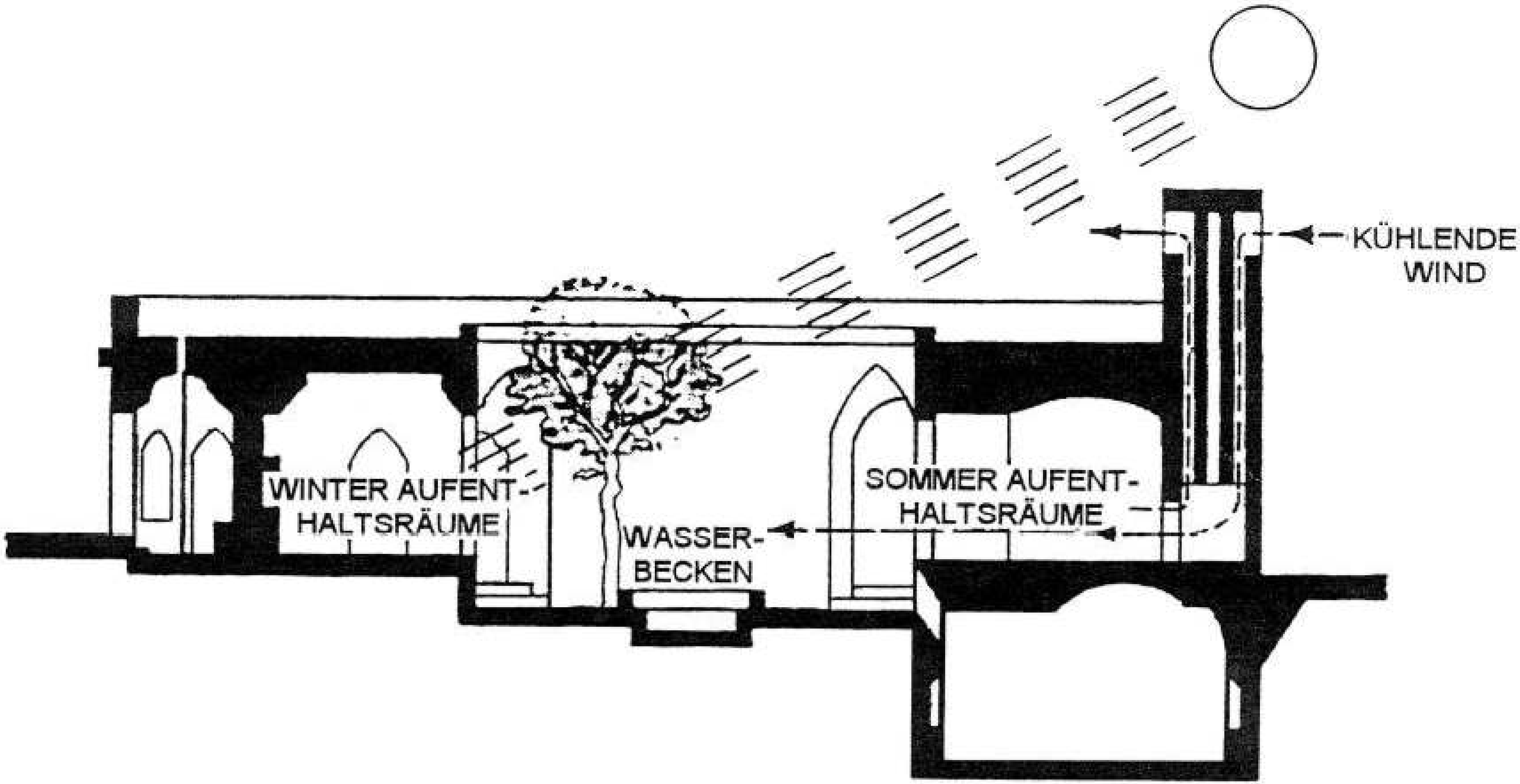

Atrium house of the ancient time (from 2nd century B.C

OLYNTH

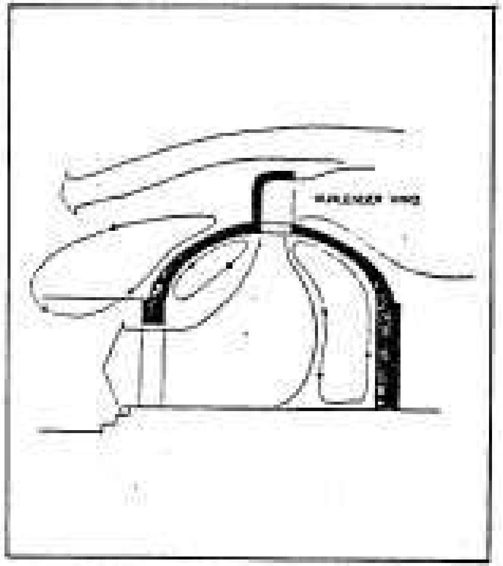


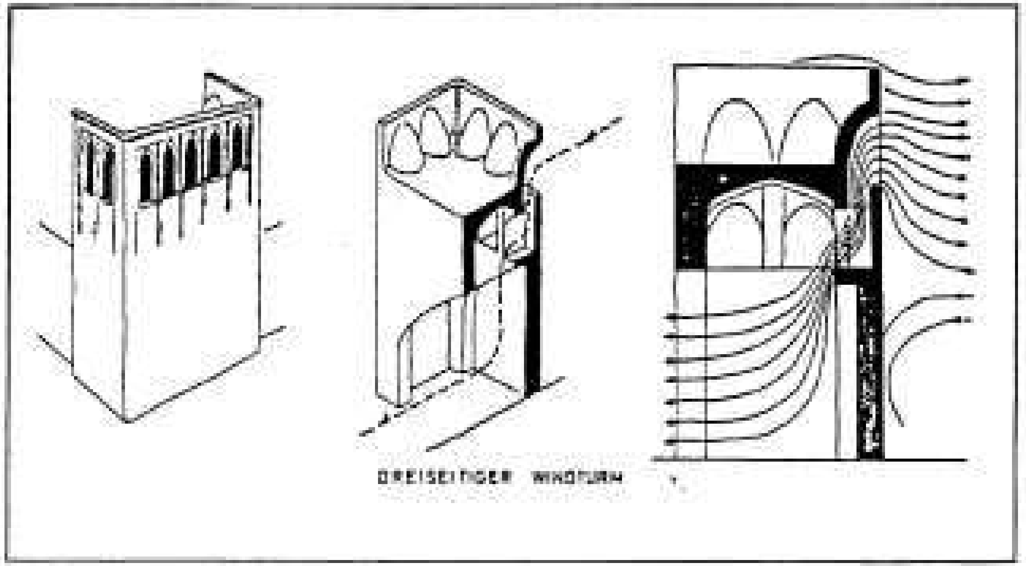



House in Digomi, Afghanistan

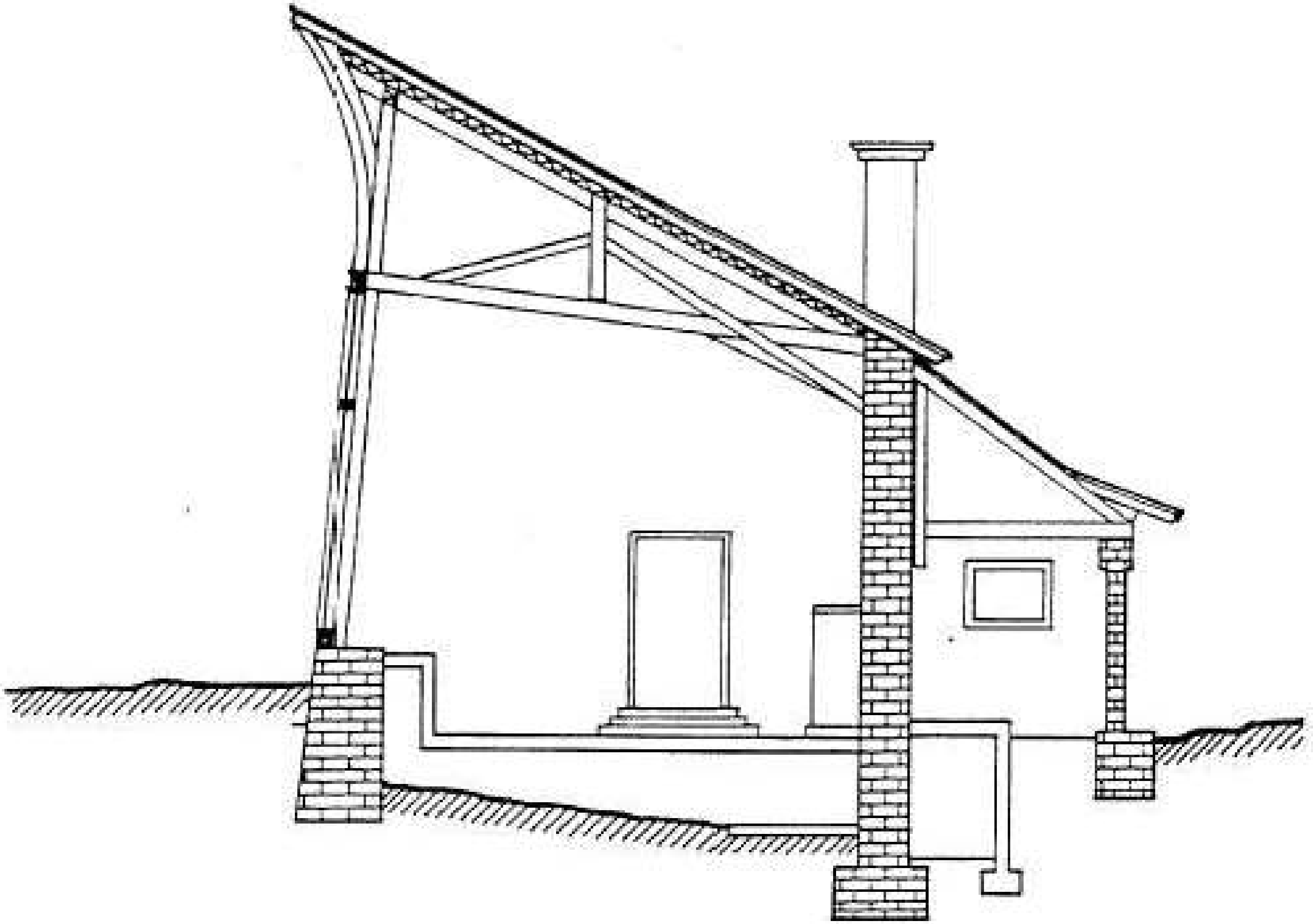



Persian House with sunloggia and wind tower






Natural air conditioning in building of persian times



Baroque greenhouse

Greenhouse Telc, Czech republic

Orangery Castle Schönbrunn, Vienna, 1755

Orangery Castle Schönbrunn, Vienna, 1755

# Steve Baer Haus

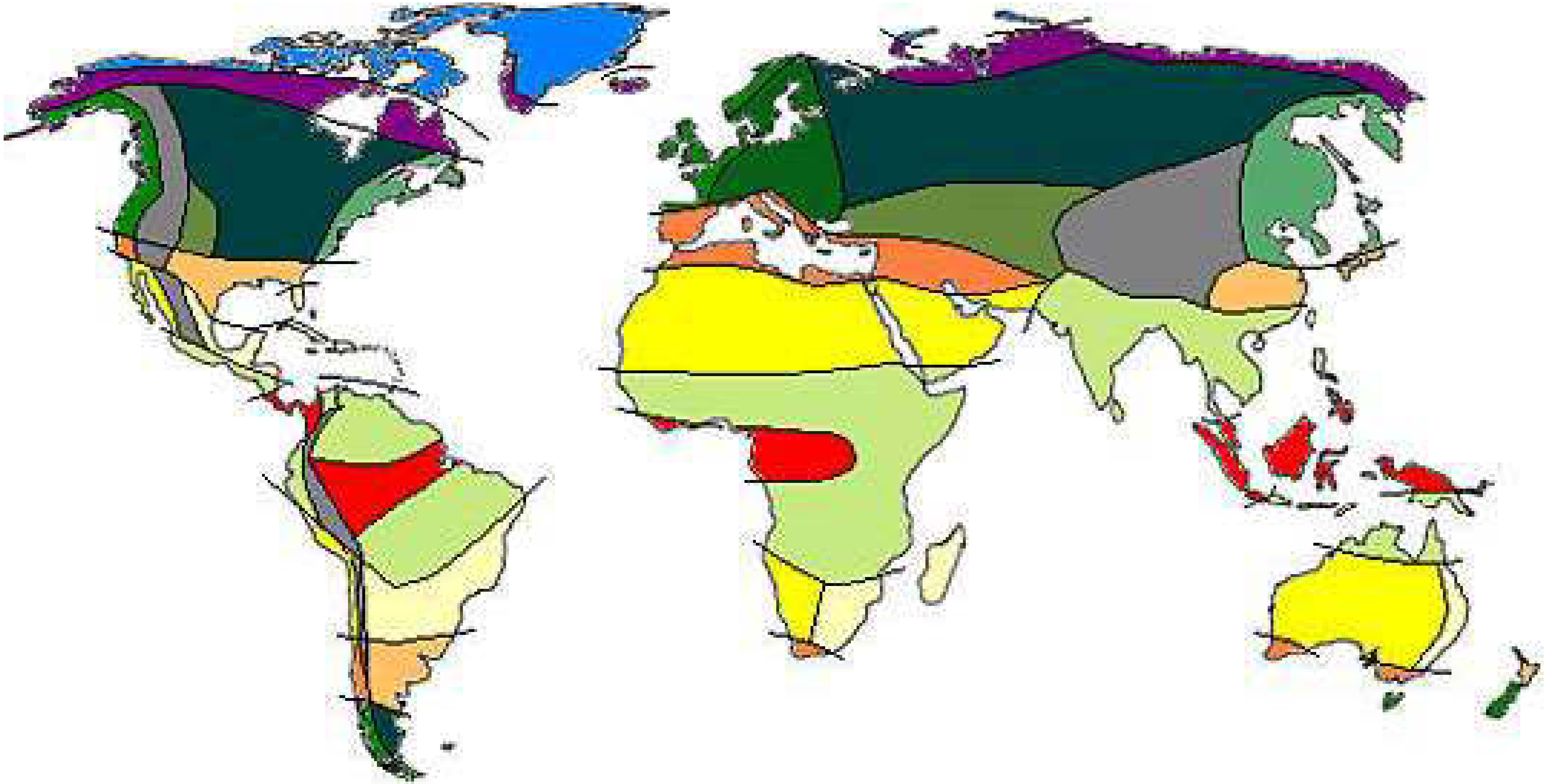
**Corrales – New Mexico, 1972, Drumwall (oildrums filled with water)**

Hippie-culture the 60´s as countermovement to consumerism, escape from Vietnam-war military duty, dropouters and consume deniers in the desert, pacifism and extensive energy self-sufficient housings

Geodetic domes, Houseboats, Shelters, idiosyncratic building forms

# ENVIRONMENTALY-FRIENDLY CONSTRUCTION

# CLIMATE ZONES



Climate regions based on Ernst Neef (1954); www.klima-der-erde.de/klimazonen.html


DESERT CLIMATE

CONTINENTAL CLIMATE

TROPICAL CLIMATE


Addis Abeba
London
Singapore
DESERT CLIMATE
CONTINENTAL CLIMATE
TROPICAL CLIMATE

**Example 1: Mediterranean climate**

Mild winters, warm + not to wet summer

- solid construction
- atrium houses
- flexible transition inside / outside
- water surfaces

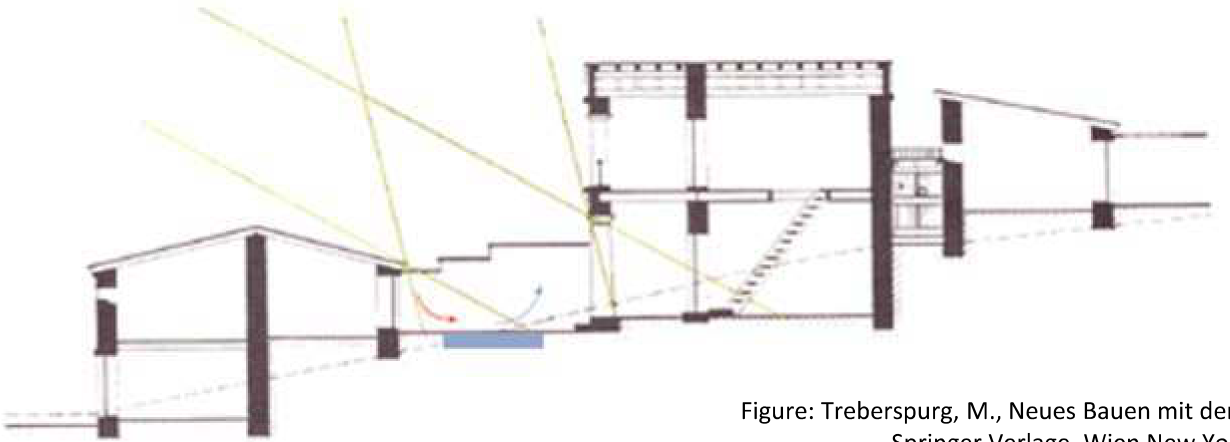


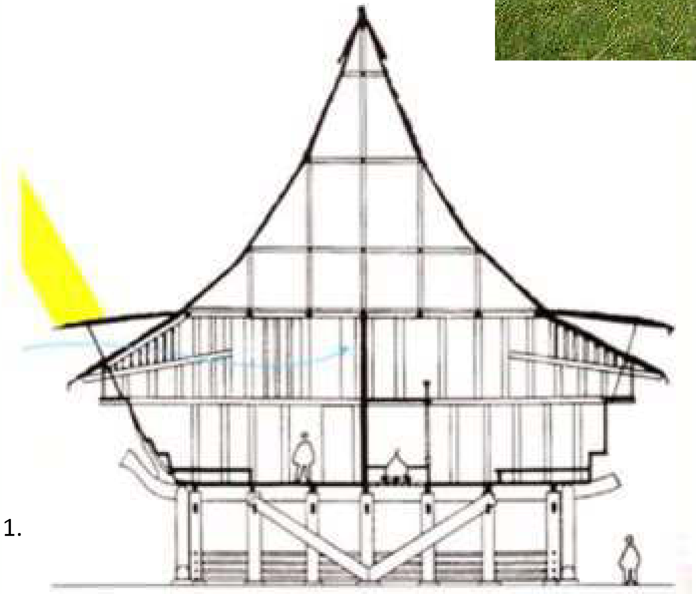
Figure: Treberspurg, M., Neues Bauen mit der Sonne, Springer Verlage, Wien New York, 1994

Source: Österreicher, D. (2015). GEBÄUDEPHYSIK, 1. Presentation, FH Campus Wien

**Example 2: the Tropics**

Very hot, very humid, heavy rainfall

- lightweight construction
- air circulation
- lifted off the ground
- large shading surfaces



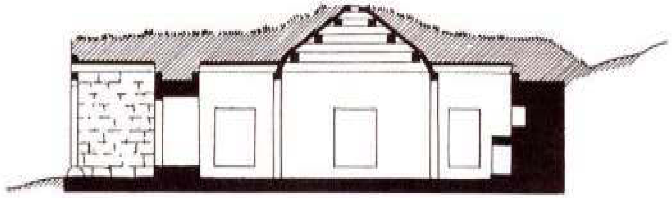
Source: Österreicher, D. (2015). GEBÄUDEPHYSIK, 1. Presentation, FH Campus Wien

Figure: Behling S und Behling S, Sol Power, Prestel, München-New York, 1996

## Example 3: Prairie

Very hot, very dry, strong winds

- o solid construction
- built in the earth
- natural ventilation systems (wind catcher)
- nested assembly



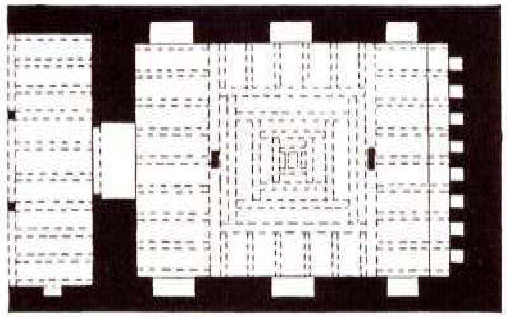


Figure: Treberspurg, M., Neues Bauen mit der Sonne, Springer Verlage, Wien New York, 1994

Source: Österreicher, D. (2015). GEBÄUDEPHYSIK, 1. Presentation, FH Campus Wien

## Target

identify relevant parameters for an energy-efficient design

- Temperature: minimum, maximum, frequency, year / day distribution
- Humidity (minimum, maximum, frequency, year / day distribution)
- Temperature in connection with humidity
- Wind (direction, frequency, speed)
- Solar radiation (direct, diffuse, intensity)

Source: Österreicher, D. (2015). GEBÄUDEPHYSIK, 1. Presentation, FH Campus Wien

# Urbanization

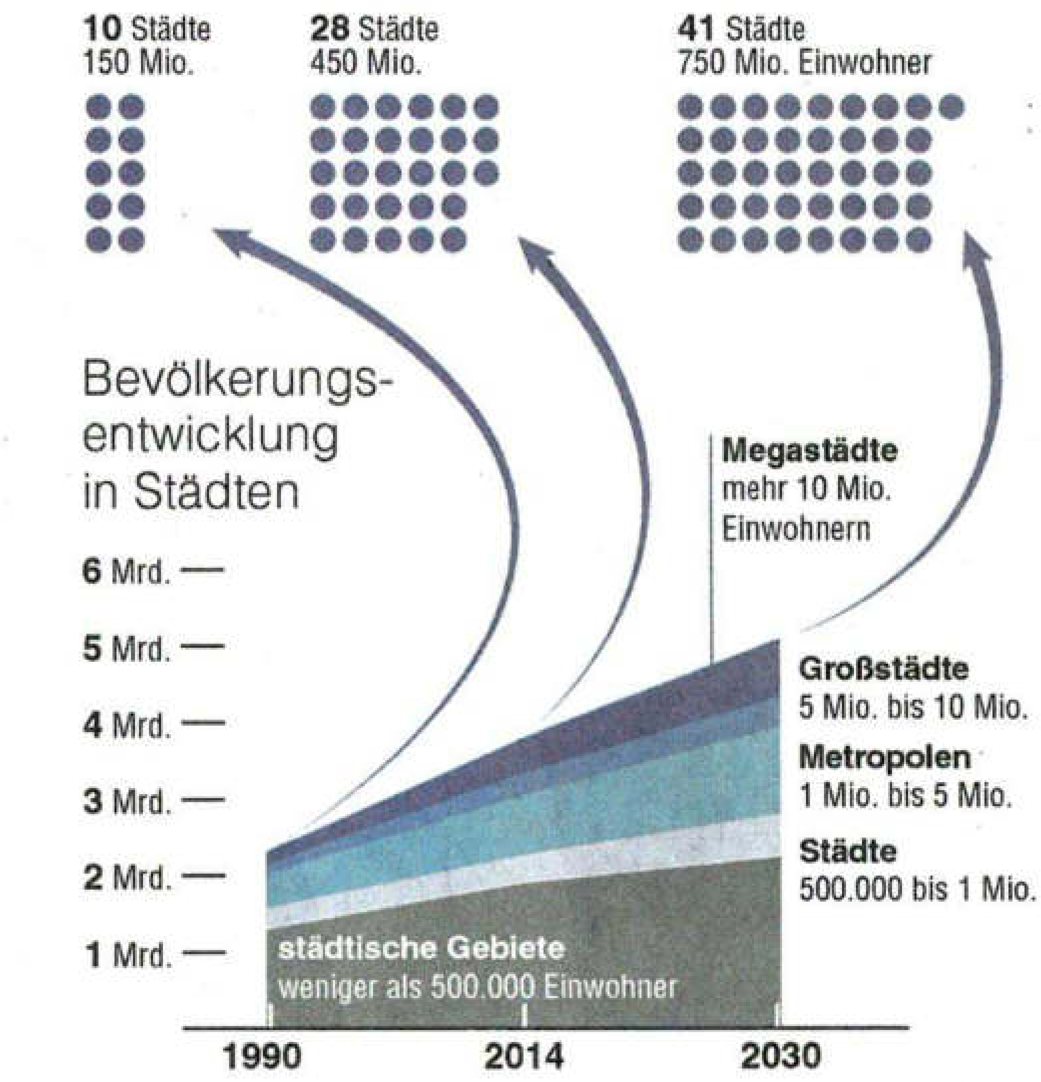
# Global development of urbanization

- In 1985, 41.2% of the global population lived in cities
- Today, there are more than 50%
- For the year 2050 a further increase to 75% is expected[1]
- High urbanization rates in Asia and Africa[2] -> The focus of world urbanization has long been shifted to the developing and emerging countries
- Today there are twice as many people living in urban conurbations as in industrializations, with 2.3 billion inhabitants
- In 2030, it will be four times as many as 3.9 billion people[3]
- Urbanization development in Europe and the USA completed: e.g. Germany: 73.8% in cities and metropolitan areas (1800 - 25%)

1) UN HABITAT (Hg.): State of the World's Cities 2010/2011. Nairobi, United Nations Human Settlements Programme 2007. S. 12.
2) United Nations (Hg.): World Urbanization Prospects: The 2007 Revision Population Database. New York 2008
3) Bundeszentrale für politische Bildung: Prognose der städtischen Bevölkerung. Internet: www.bpb.de/themen/WL9MSS,0,Staedtische_ Bevoelkerung.html, 12.05.2011.

# Number of cities with over 10 million inhabitants

**1990 2014 2030**




## Growth of population 2015-2035

- India +220 Mio
- Nigeria +70 Mio
- Pakistan + 60 Mio
- Ethiopia +40 Mio
- Bangladesch + 30 Mio
- Indonesien +30 Mio

- **China – 90 Mio**

# Climate change and biodiversity

- Cities are involved in decisions about global climate change and have a significant, sometimes negative impact on ecosystems
- Occupy only 2 percent of the surface of the earth,
- Cities need 75% of the energy and emit 80% greenhouse gases -> thus bear responsibility for global climate change
- Are partners and players in international climate policy and increasingly play a pioneering role
- At the same time, they are directly exposed to the dangers of climate change, with their population density, building fabric, and infrastructure (near-coastal typhoons, heat waves, mud slides ...)
- Urbanization is linked to population growth, resource depletion and climate change
- Problems: drinking water supply, nutrition and energy

Source: The Worldwatch Institute (Hg.): State of the World. Our Urban Future. New York (W.W. Norton & Company) 2007

# Goals and opportunities of urbanization

- Urbanization objectives: maximum quality of life, minimal environmental impact, good transport links with future-oriented mobility (train, bus, bike, e-bike, car sharing, vertical mobility)
- Competition of Cities: Cities with the highest quality of life: Vienna, Zurich and Geneva
- The future of the earth is largely determined by the eco-capacity of the mega and milion cities, "smart cities"
- Circular economy findes "City“, "City Mining“
- Future cities with plus-energy buildings will generate some of the energy they need

# Urban Food - Vertical Farming

- By 2050 about 9.7 billion people will live on Earth

  (World population January 2017: 7.473.690.000 (2016 increase of 83 million))
- In order to ensure sufficient food production, while maintaining the eating habits of today, additional areas of size of Brazil[1] will be needed
- This area is available, but would be accompanied by an immense destruction of rainforests and natural areas
- The ecological footprint - the area necessary to cover the lifestyle and living standard of a person in under modern production conditions in Vienna in the longer term is about the land area of the Burgenland
- New developments in urban food production: City-Farming, Vertical-Farming, Aquaponics, etc.

[1] Daniel Podmirseg: Mythos Marchfeld und Vertical Farming

# Vertical Farming

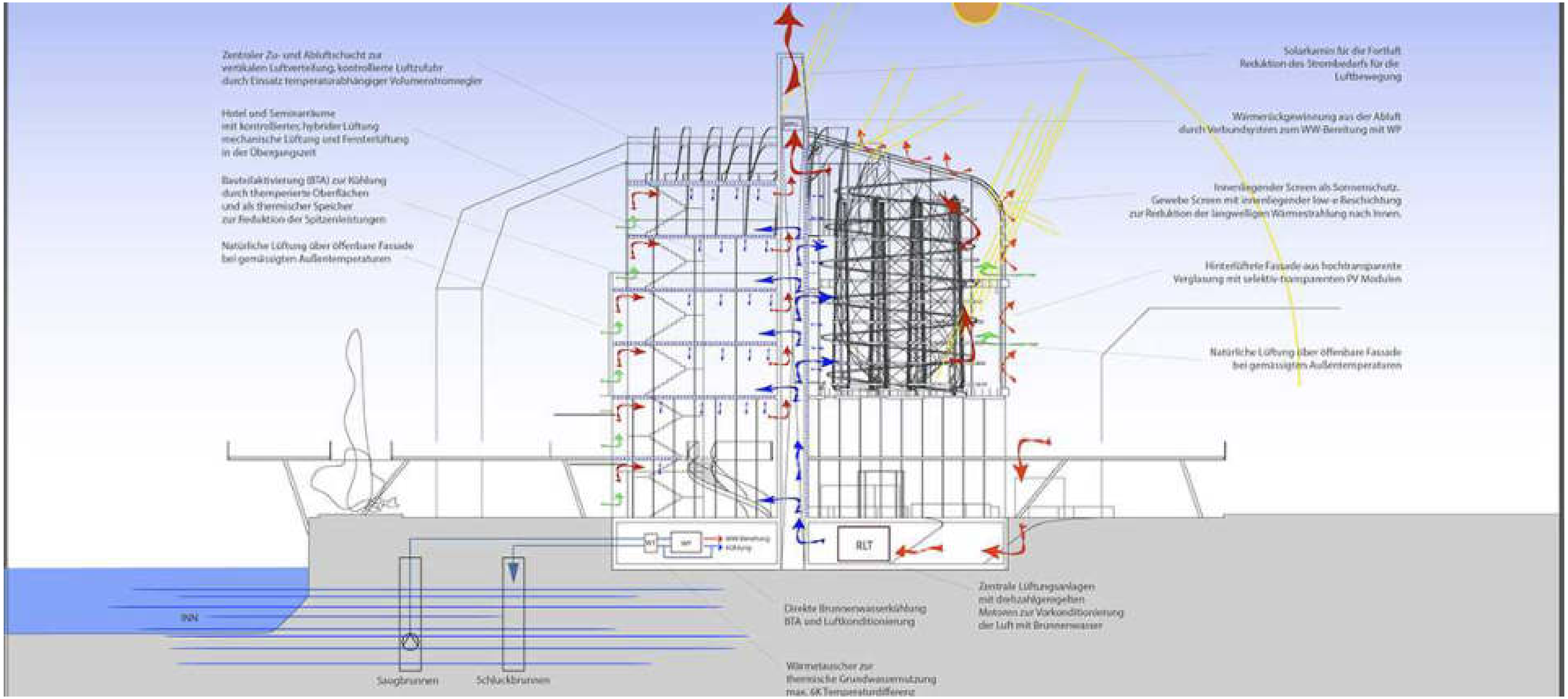
Food production in vertical farms:

- Is independent of climatic conditions (no flood or drought hazards).
- Takes place 365 days a year.
- Reduces the demand for oil due to transport reduction.
- Does not require pesticides or fertilizers.
- Reduces food imports.
- Reduces the need for fossil fuels.
- Works with recycled water. The closed water cycle reduces water consumption by up to 500 times compared to conventional agriculture.
- Is simultaneously accompanied by the generation of electrical current through the use of decomposed by-products (e.g., biogas).

# Vertical Farm Innsbruck

VFI - Vertical Farm Institute
http://www.verticalfarminstitute.org/

# Vertical Farm Innsbruck

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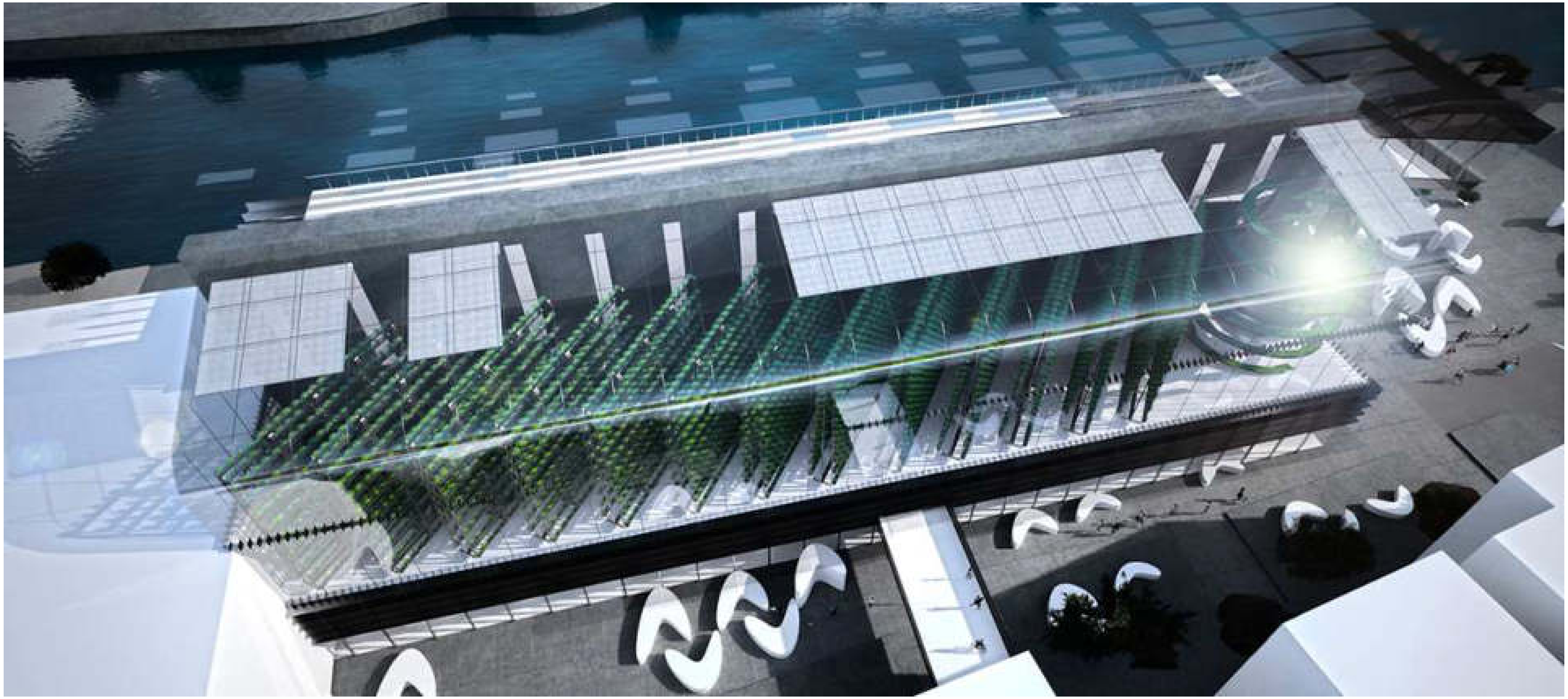
# Vertical Farm Innsbruck



VFI - Vertical Farm Institute
http://www.verticalfarminstitute.org/

# Renovation

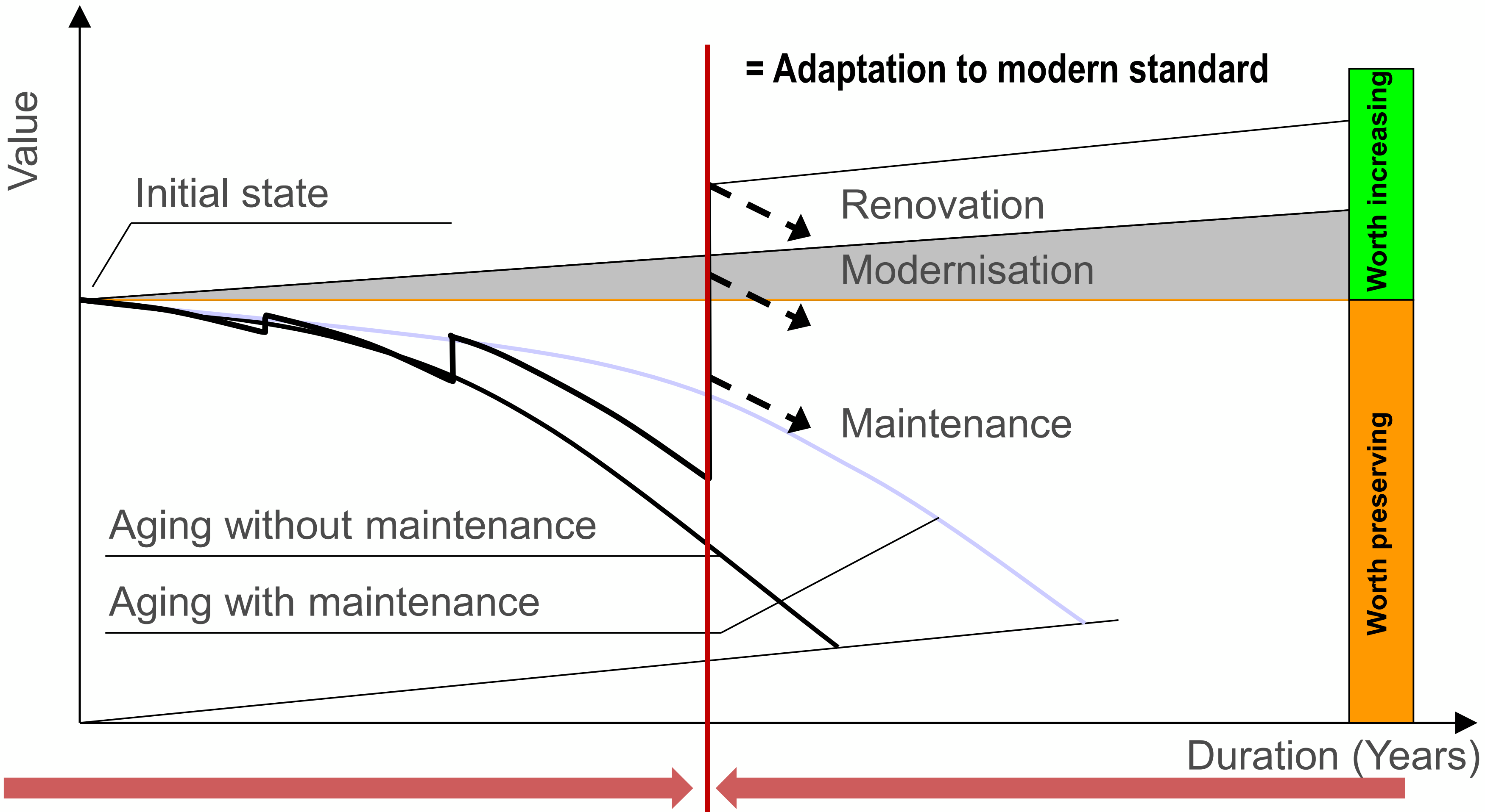
## Renovation, energy efficiency and building culture

Building renovation as an important building-cultural task that combines energy efficiency and value preservation.

***"A renewal that is not an improvement is a deterioration. "***

Adolf Loos

# Value preservation and renewal




Maintenance without planning

Building renovation with functional architectural improvement (reconstruction) - the highest challenge for planning

## Three Ways of Building Modernization

There are no general recipes for the right building renovation.

**Best practice examples for rehabilitation in three categories:**

- The Total building renovation
- The Hidden Building renovation
- Dialogue Old and New

# 1. The total building renovation

- Renovation of the old building to such an extent that only a new building is recognizable.
- Modern new building quality with advantageous use of old building elements (eg. storage room, cellar, etc.)
- More ecological and economical than demolition and new construction, but a much higher planning effort


**Dormitory ETHOUSE-Award 2015**

**Projekt:** Trientlgasse 44, Innsbruck | **Baujahr/Sanierungsjahr:** 1960/2013

**Architektur:** U1 Architektur, Innsbruck | **Bauherr:** Ärztekammer Tirol

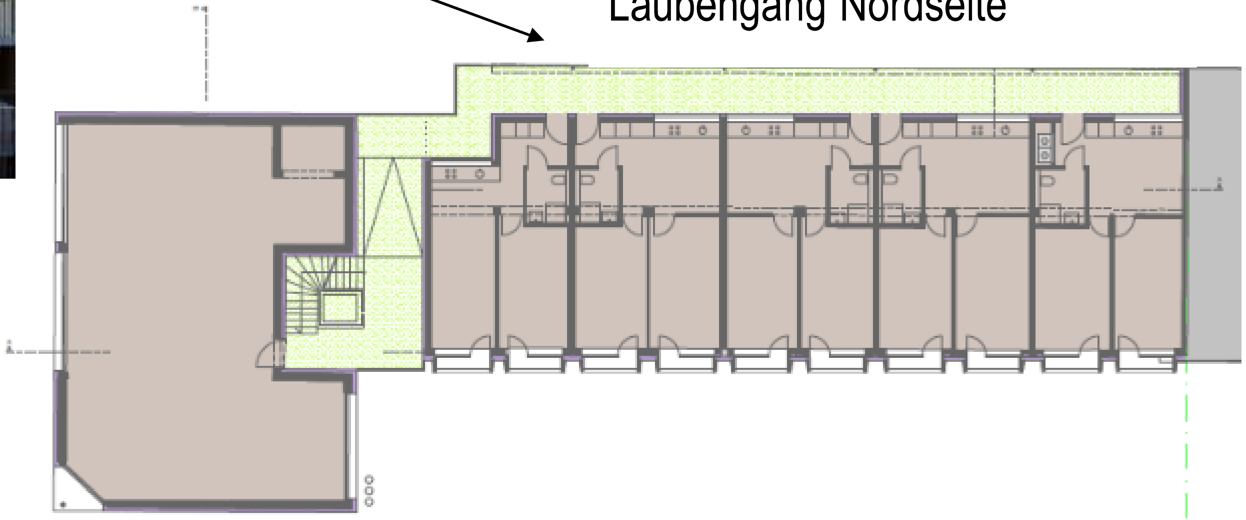
**HWB vor/nach:** 354 / 21 kWh/m²a | **Verbesserung:** 94%



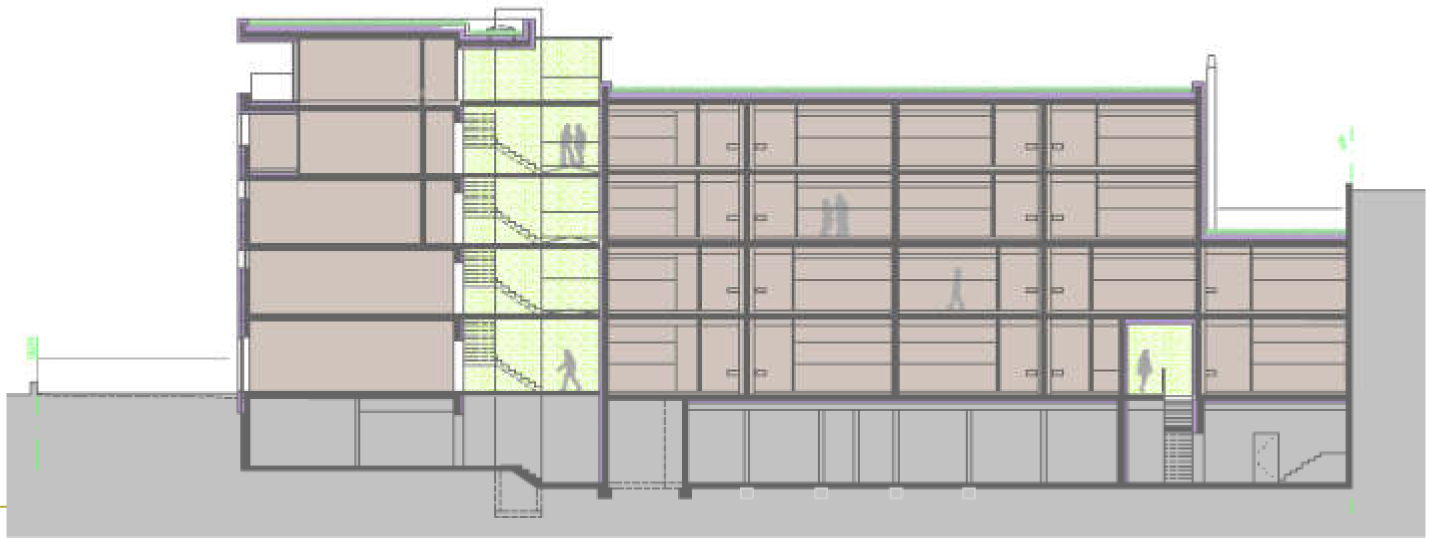
Before

After

Laubengang Nordseite



GR Regelgeschoß



Schnitt


**Betriebsgebäude ETHOUSE Award 2011**

**Projekt:** **Betriebsgebäudes MCM Klosterfrau GmbH | Baujahr/Sanierungsjahr: 1977/2010**

**Architektur:** **gaupenraub +/- Architekturbüro | Bauherr: MCM Klosterfrau Healthcare GbmH**

**HWB vor/nach: 233 / 39 kWh/m$^2$a | Verbesserung: 83 %**


**Bestand** **Sanierung**


**Bezirkshauptmannschaft ETHOUSE Award 2012**

**Projekt: BH Weiz | Baujahr/Sanierungsjahr: 1964/2011**

**Architektur: Kaltenegger + Partner Architekten | Bauherr: Land STMK**

**HWB vor/nach: 136 / 14 kWh/m$^2$a | Verbesserung: 90%**


BEZIRKSHAUPTMANNSCHAFT

**Bestand**


BEZIRKSHAUPTMANNSCHAFT

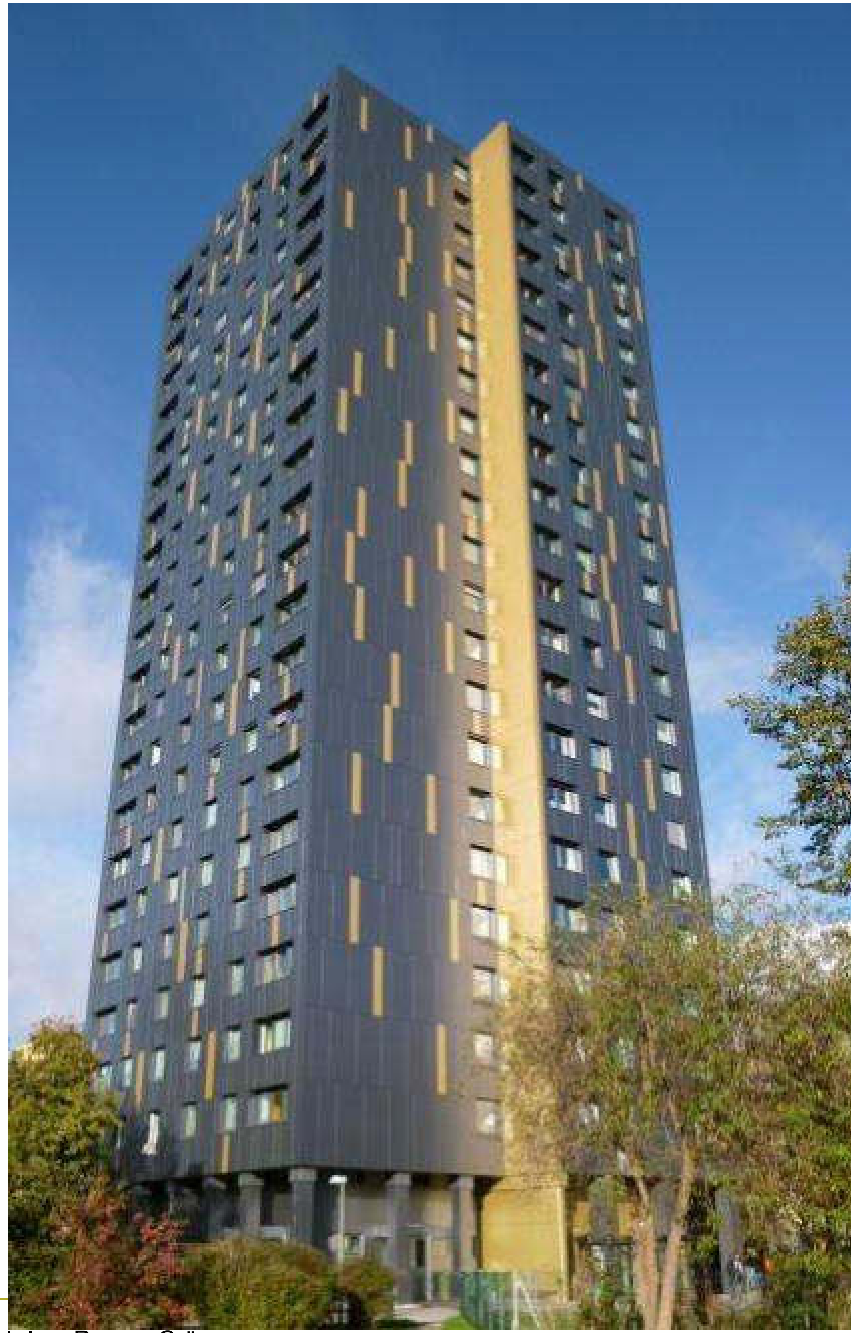

BEZIRKSHAUPTMANNSC

**Wohnhaus Innsbruck**

**Projekt: Hochhaus Kajetan-Sweth-Straße 54 | Baujahr/Sanierungsjahr: 1976/2011**

**Architektur: Gsottbauer Architekten | Bauherr: WEG Kajetan-Sweth-Straße 54**

**HWB vor/nach: 77 / 20 kWh/m²a | Verbesserung: 74%**





**Bestand 1976**

Fotos: Markus Bstieler


Foto: Markus Bstieler

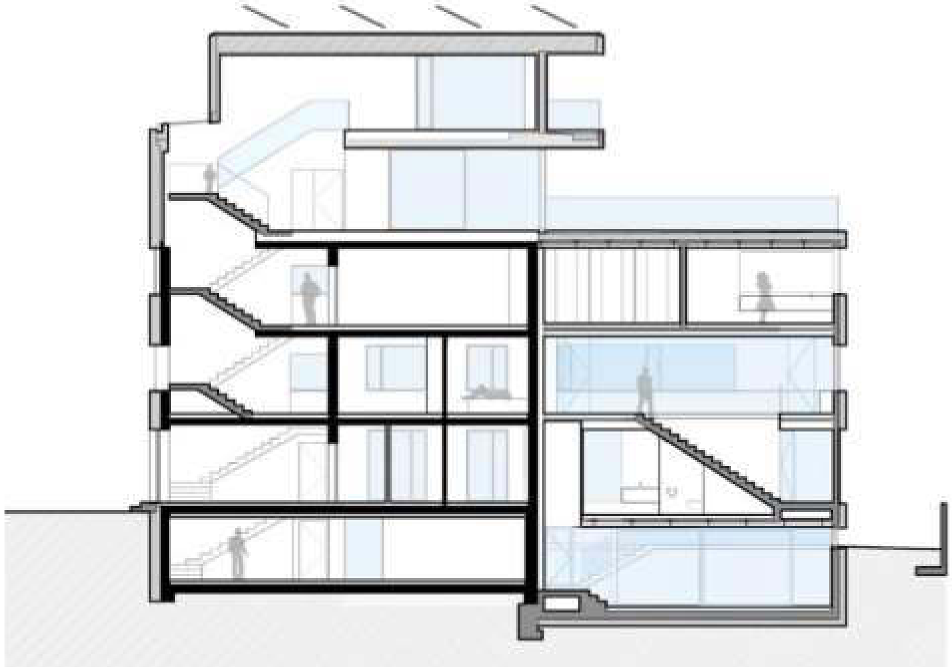
**Wohn- und Bürohaus eines Architekten – ETHOUSE Award 2013**

**Projekt: Energieautonomes Stadthaus Wels | Baujahr/Sanierung: 1965/2013**

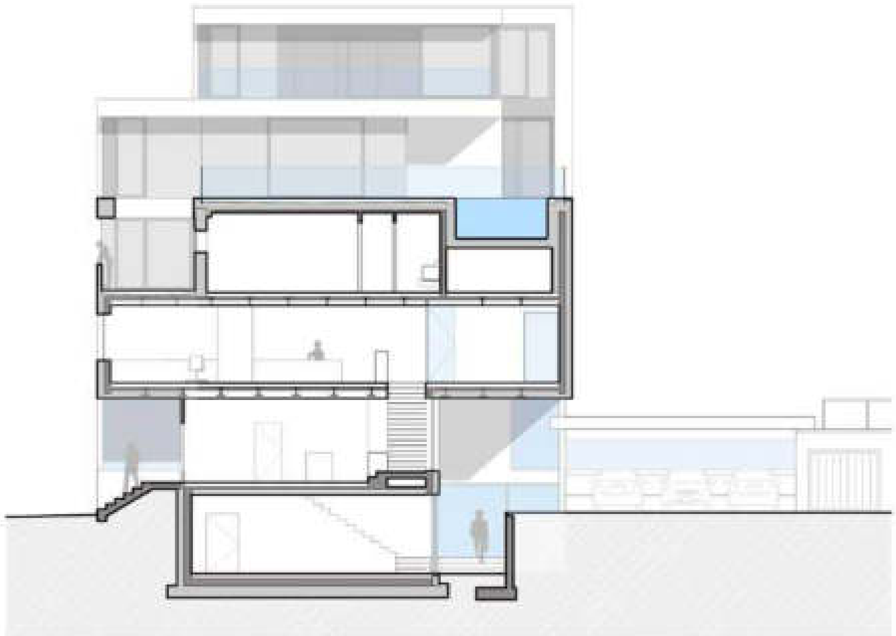
**Architektur: PAUAT Architekten ZT GmbH | Bauherr: Privat**

**HWB vor/nach: 150 / 8 kWh/m$^2$a | Verbesserung: 95%**

Gebäude vor. während und nach der Sanierung



Längsschnitt



Querschnitt [Quelle: PAUAT Architekten]



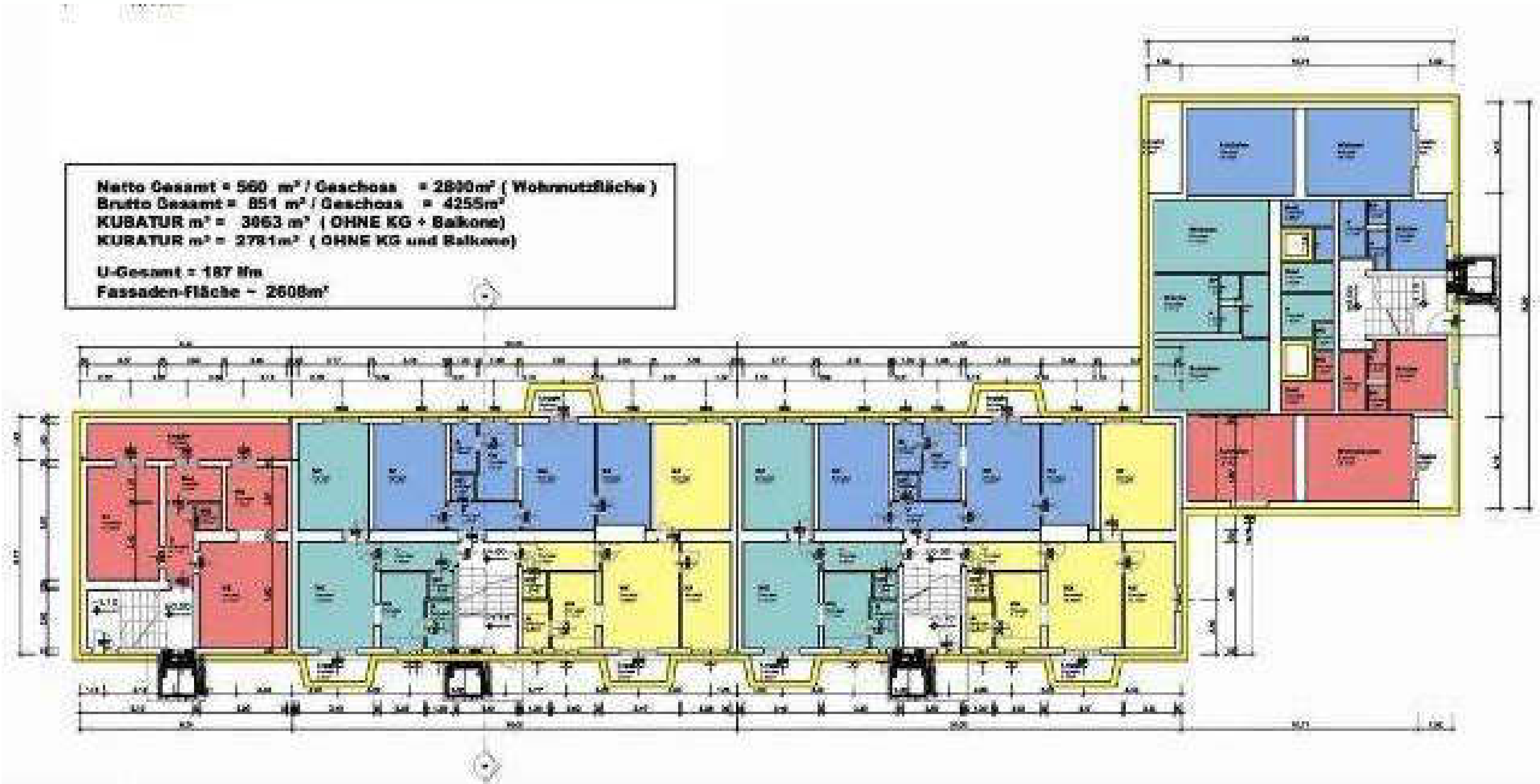


**Wohnhausanlage Linz**

**Projekt: Makartstraße, Linz | Baujahr/Sanierungsjahr: 1957/2006**

**Architektur: Architekturbüro ARCH+MORE | Bauherr: GIWOG**

**HWB vor/nach: 179 / 14 kWh/m²a | Verbesserung: 94%**




Quelle: HdZ-Bericht: in Arbeit; Projektleiter: Hr. Bmst. Ing. Willensdorfer Alfred, GIWOG Gemeinnützige Industrie-Wohnungs-AG

## Grundriss Regelgeschoss

**Schulzentrum ETHOUSE Award 2011**

**Projekt: Schulzentrum Neumarkt | Baujahr/Sanierungsjahr: 1978/2011**

**Architektur: Arch+More ZT GmbH | Bauherr: Marktgemeinde Neumarkt**

**HWB vor/nach: 196 / 15 kWh/m²a | Verbesserung: 92%**

Bestand

Sanierung


NATURPARK
MITTELSCHULE
NEUMARKT

# 2. The Hidden Building renovation

- Old buildings are preserved in their exterior design; modernization is hardly visible from the outside.
- Use in high-quality buildings in protected areas, conservation


**WHA der Stadt Wien, ETHOUSE Award 2015**

**Projekt: Breitenfurterstrasse 242 | Baujahr/Sanierungsjahr: 1928/2014**

**Einreicher: Treberspurg & Partner ZT GmbH | Bauherr: Wiener Wohnen**

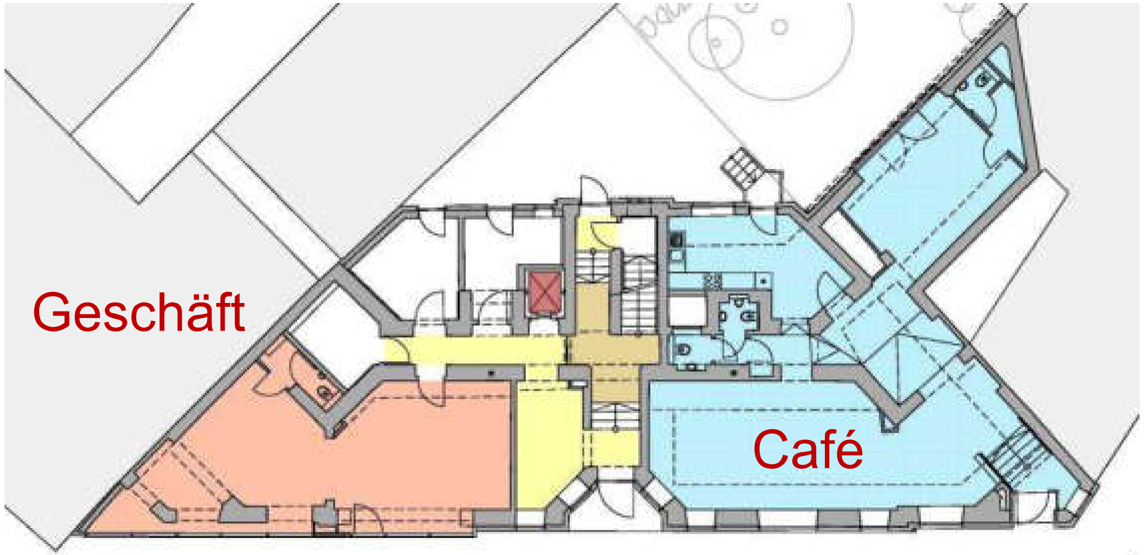
**HWB vor/nach: 204 / 22 kWh/m²a | Verbesserung: 92%**


Ende

Sanierungsarbeiten

Fertigstellung

# ERDGESCHOSSZONE




Barrierefreier Eingang

vorgesetztes Geschäftsportal

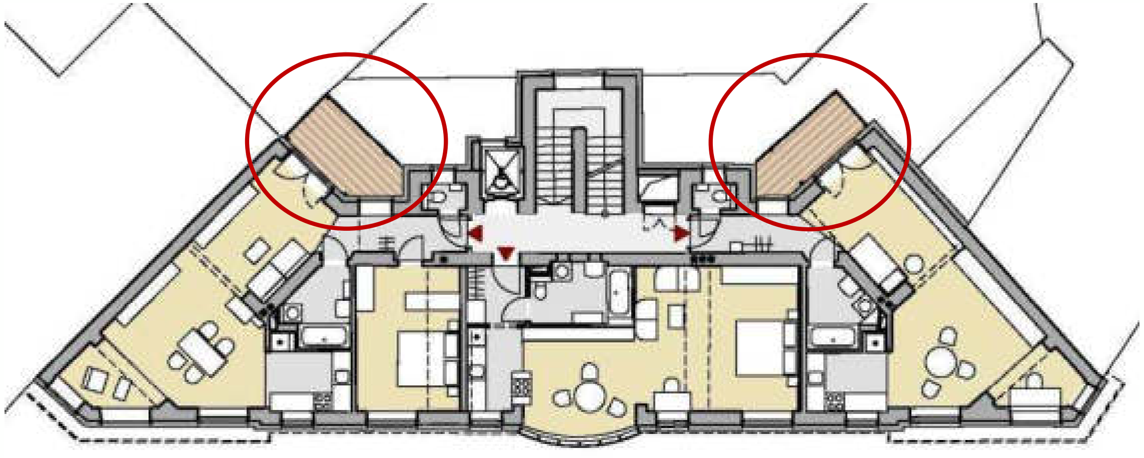
Cafe „Naschen und Lesen“

Neuorganisation des Grundrisses

Zubau Küche

einheitliche Auslagenfenster

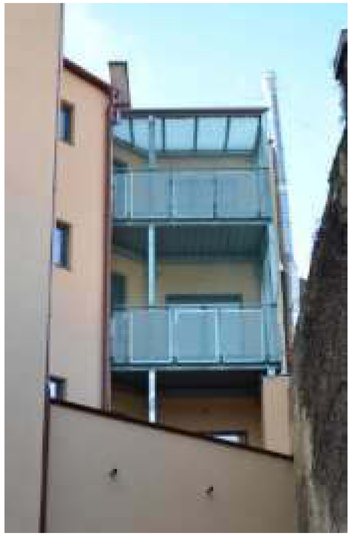

# HOFSEITIGER LOGGIENZUBAU



Stahlkonstruktion

thermisch getrennt

seitlich verglast



vorher

nachher

**EFH eines Architekten, Kärnten – ETHOUSE Award 2011**

**Projekt: Energie Plus Haus Weber | Baujahr/Sanierungsjahr: 1900/2011**

**Architektur: Architekten Ronacher ZT Gmbh | Bauherr: Arch. Ronacher**



**HWB vor/nach: 145 / 10 kWh/m²a | Verbesserung: 93%**

Altbestand vor Beginn der Baumaßnahmen

Baustellenfoto



Abbrucharbeiten des alten Dachstuhles

Neuer Dachstuhl samt neuer Dachdeckung




**Gründerzeitvilla in Wien 14**

**Projekt:** Herzmanskystraße 1 | **Baujahr/Sanierungsjahr:** 1878/2010

**Architektur:** Architekt Kronreif & Partner | **Bauherr:** Andreas und Bruno Spangl

**HWB vor/nach:** - / 39 kWh/m²a | **Verbesserung:** - %

Bestand

Sanierung

**WHA Felixdorf, ETHOUSE Award 2009**

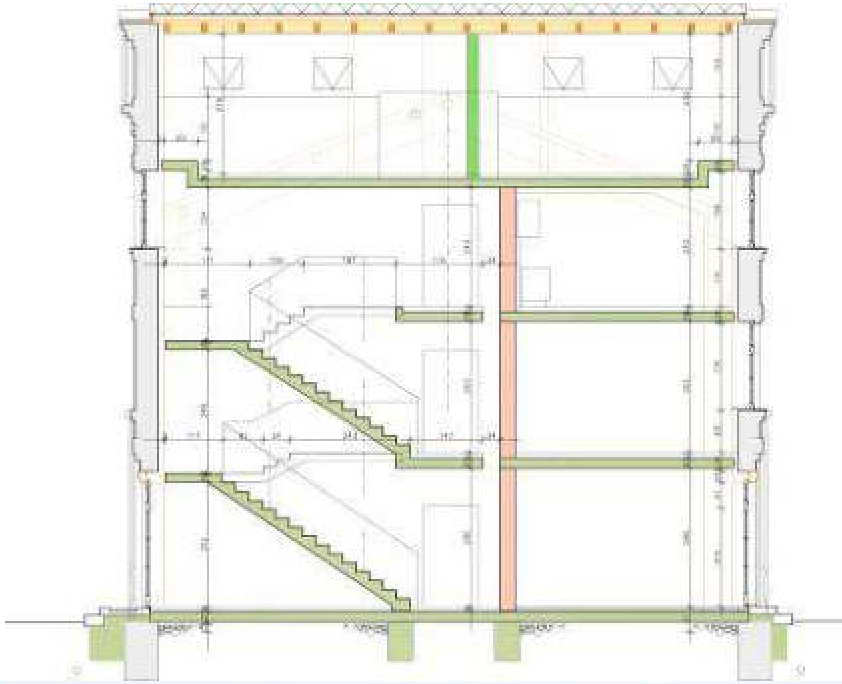
**Projekt: Tschechenring, Felixdorf | Baujahr/Sanierungsjahr: 1878/2010**

**Architektur:** DI Günter Spielmann, Stadtbau GmbH | **Bauherr: Wien Süd**

**HWB vor/nach: 198 / 32 kWh/m²a | Verbesserung: 62 %**

Bestand

Sanierung



s

**Passivhaus-EFH, Palfau, Steiermark**

**Projekt: Einfamilienhaus | Baujahr/Sanierungsjahr: 1940/2008**

**Architektur: Architekturbüro Georg W. Reinberg | Bauherr: Privat**

**HWB vor/nach: - / - kWh/m²a | Verbesserung: - %**

## 3. Dialogue Old and New - the third way of the building renovation

- A design dialogue between the original parts of the old building and the new parts of the buildings, which have been added in modern architectural design.
- Royal Route of the Old Building
- Greatest planning and design challenge
- Interesting results, which can result in a higher building value as a replacement building.


**Wohnhaus Wien 17**

**Projekt: Klopstockgasse 47 | Baujahr/Sanierungsjahr: 1890/2015**

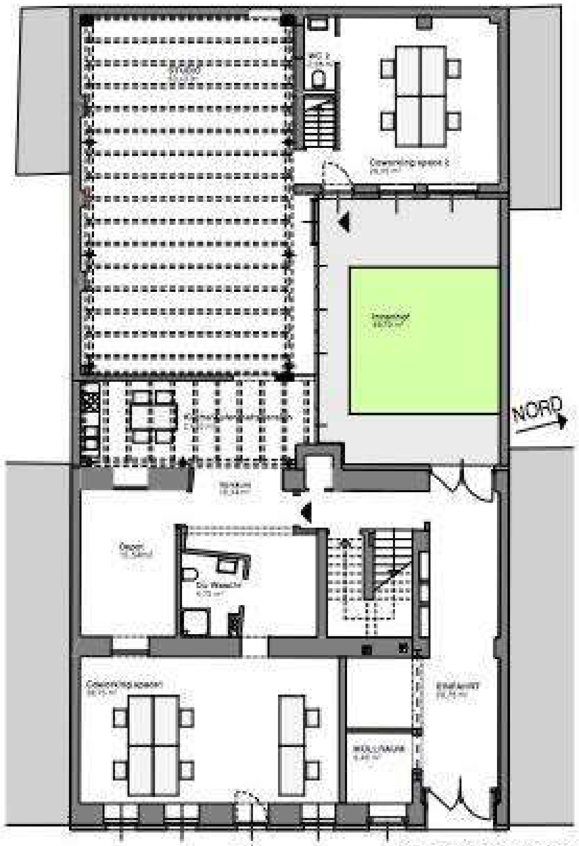
**Architektur: Architekt DI Martin Wurnig | Bauherr: Privat**



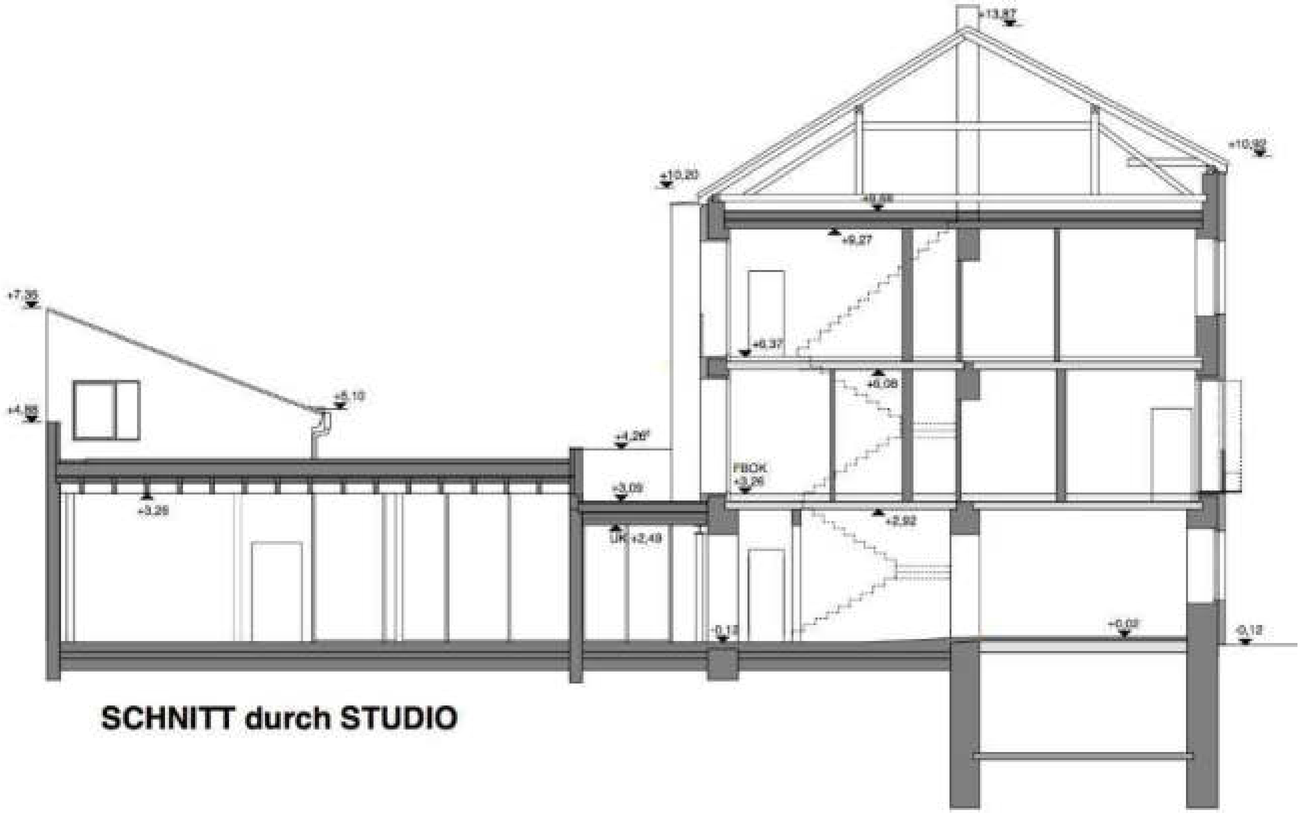
**HWB vor/nach: 144 / 10 kWh/m²a | Verbesserung: 93%**

Bestand

Sanierung




ERDGESCHOSS




SCHNITT durch STUDIO

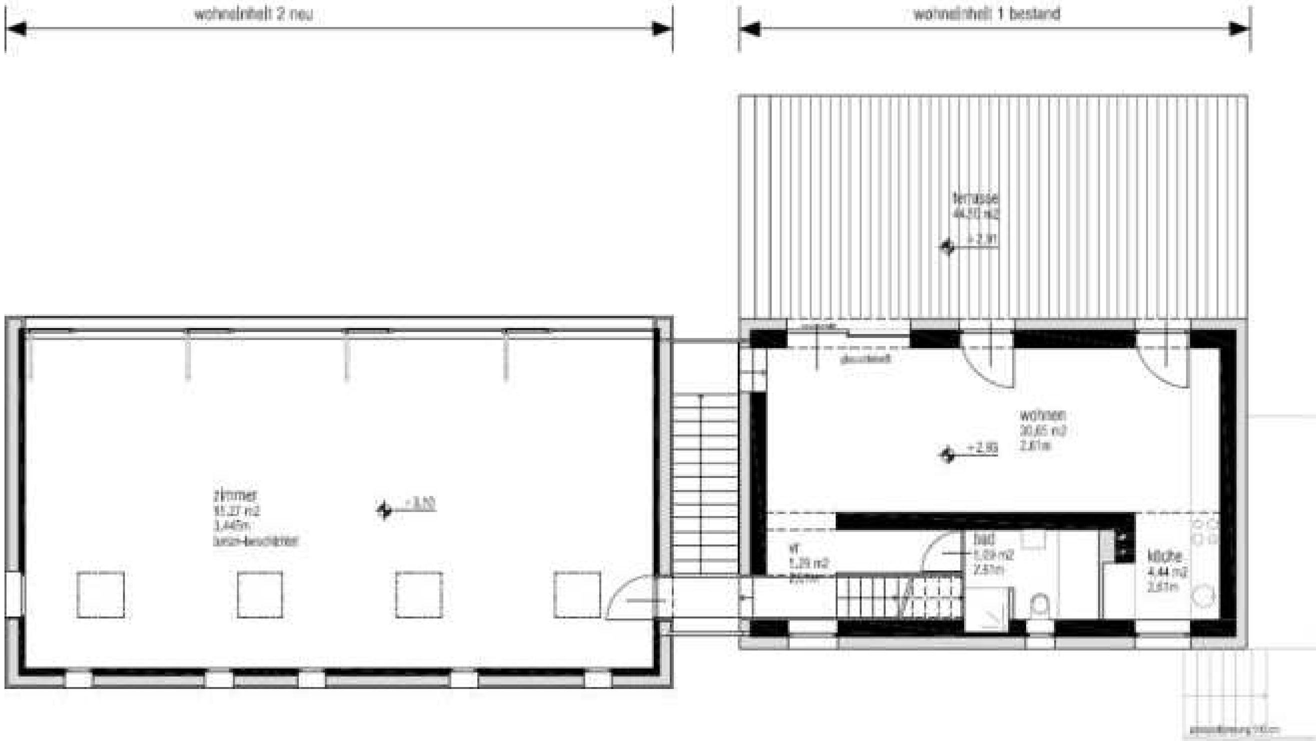
**Einfamilienhaus Eichgraben – ETHOUSE Award 2012**

**Projekt: EFH Eichgraben, Sankt Pölten | Baujahr/Sanierungsjahr: 1930/2011**

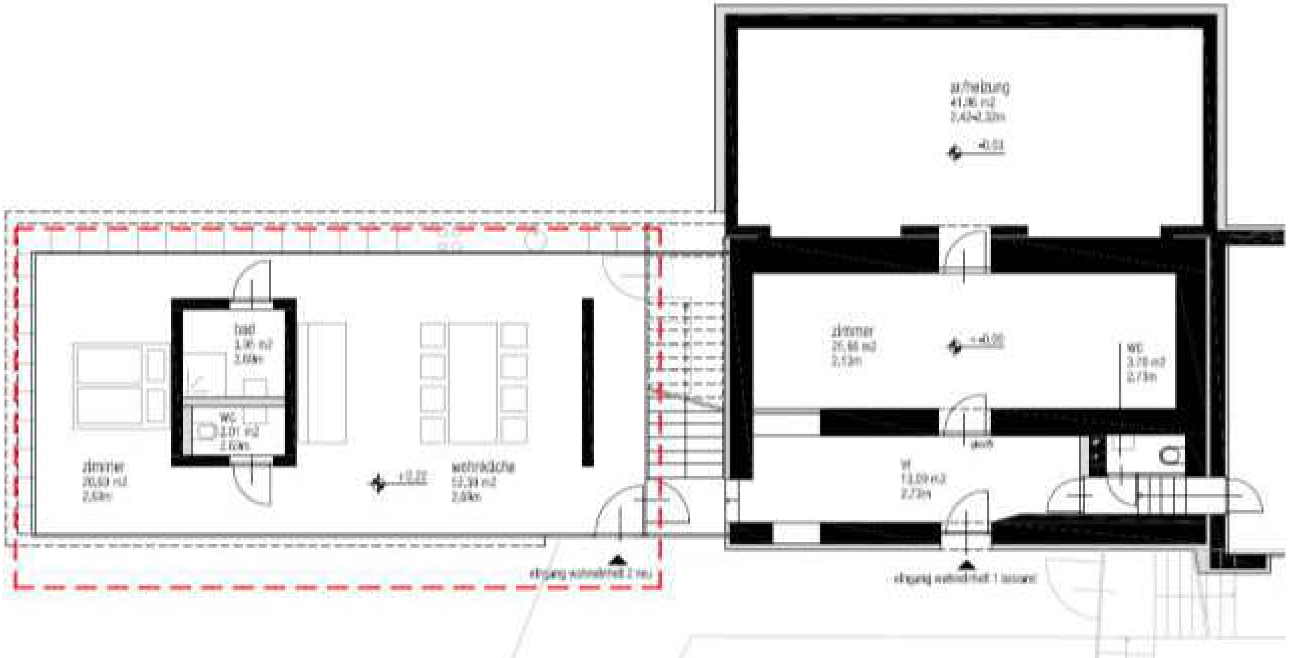
**Architektur: Franz ZT Gmbh | Bauherr: Privat**

**HWB vor/nach: 321 / 47 $kWh/m^2a$ | Verbesserung: 86%**

gs




Grundriss EG




Grundriss OG

**Wohnbau Wien 7 – ETHOUSE Award 2014**

**Projekt:** Kaiserstrasse 7, Wien | **Baujahr/Sanierungsjahr:** 1904/2014

**Architektur:** Kronreif_Trimmel & Partner Architektur

**Bauherr:** Kongregation der Mission vom heiligen Vinzenz von Paul

**HWB vor/nach**: 132 / 26 kWh/m$^2$a | **Verbesserung:** 80%

Bestand

Sanierung

Dachgeschoss

**Rathaus Ottensheim (OÖ) – Denkmalschutz Restaurierung und Zubau**

**Projekt:** Das offene Amtshaus Ottensheim | **Baujahr/Sanierungsjahr:** 1500/2010

**Architektur:** Sue Architekten ZT KG | **Bauherr:** Verein zur Förderung d. Infrastruktur der Marktgemeinde Ottensheim & CO KG (Ulrike Böker, Bürgermeisterin)

**HWB vor/nach:** - / Bestand 147, Zubau 46 kWh/m$^2$a

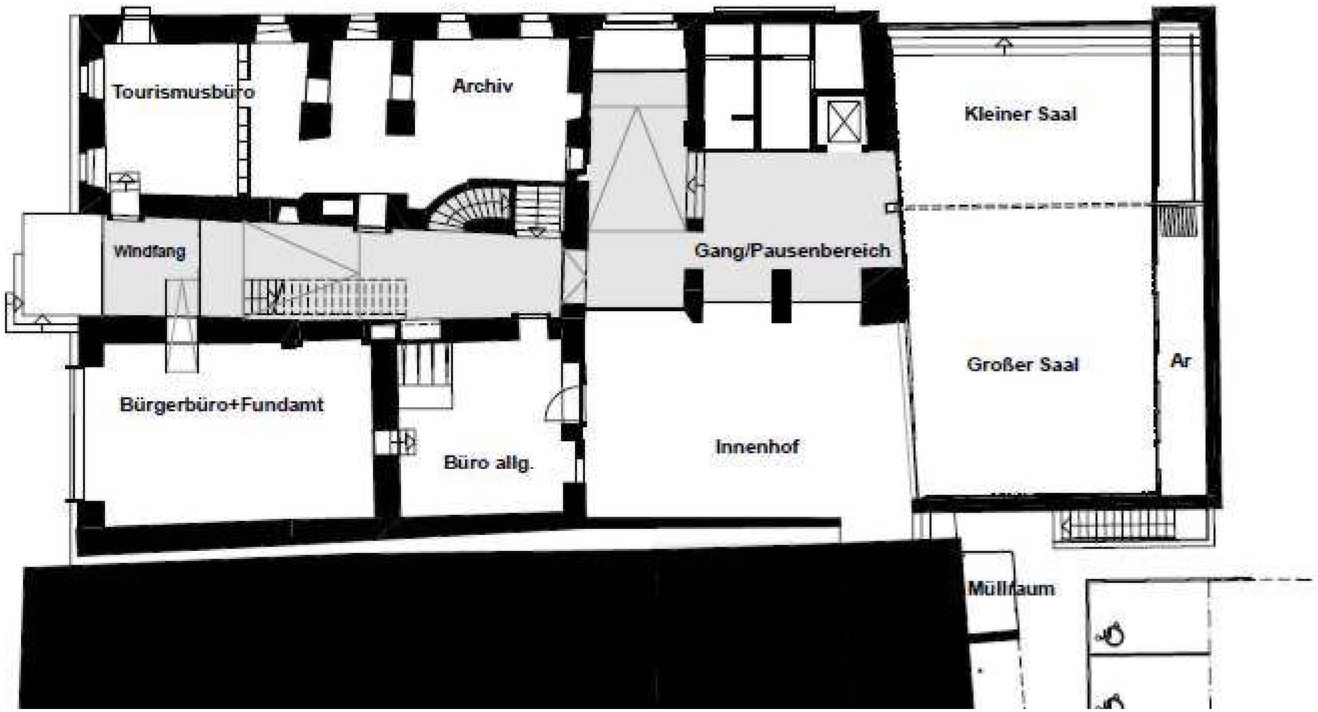
Bestand

Sanierung

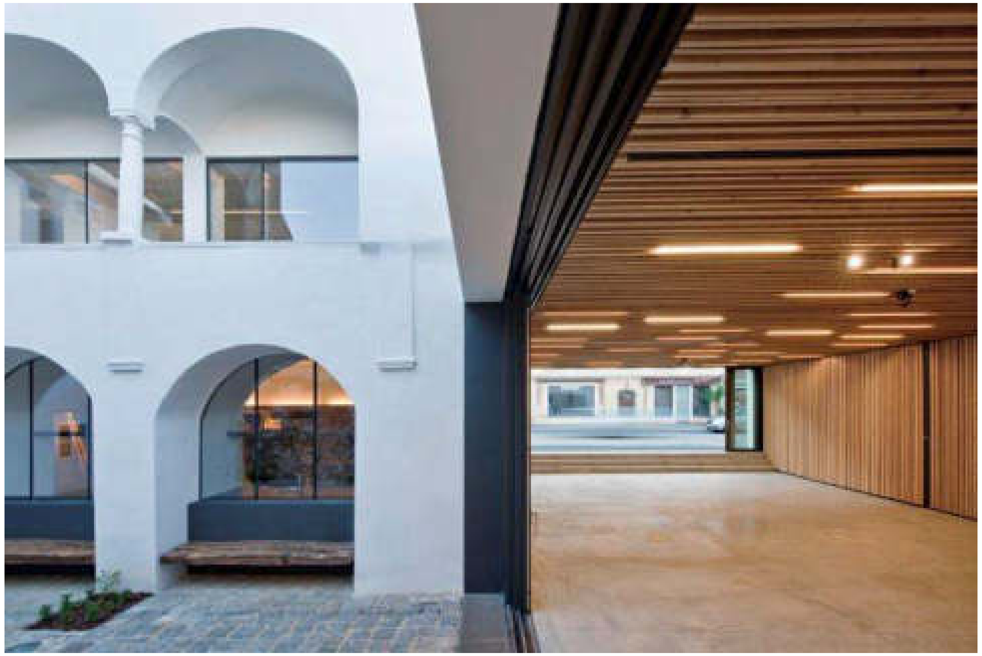
Bestand

Sanierung

Schnitt




Grundriss

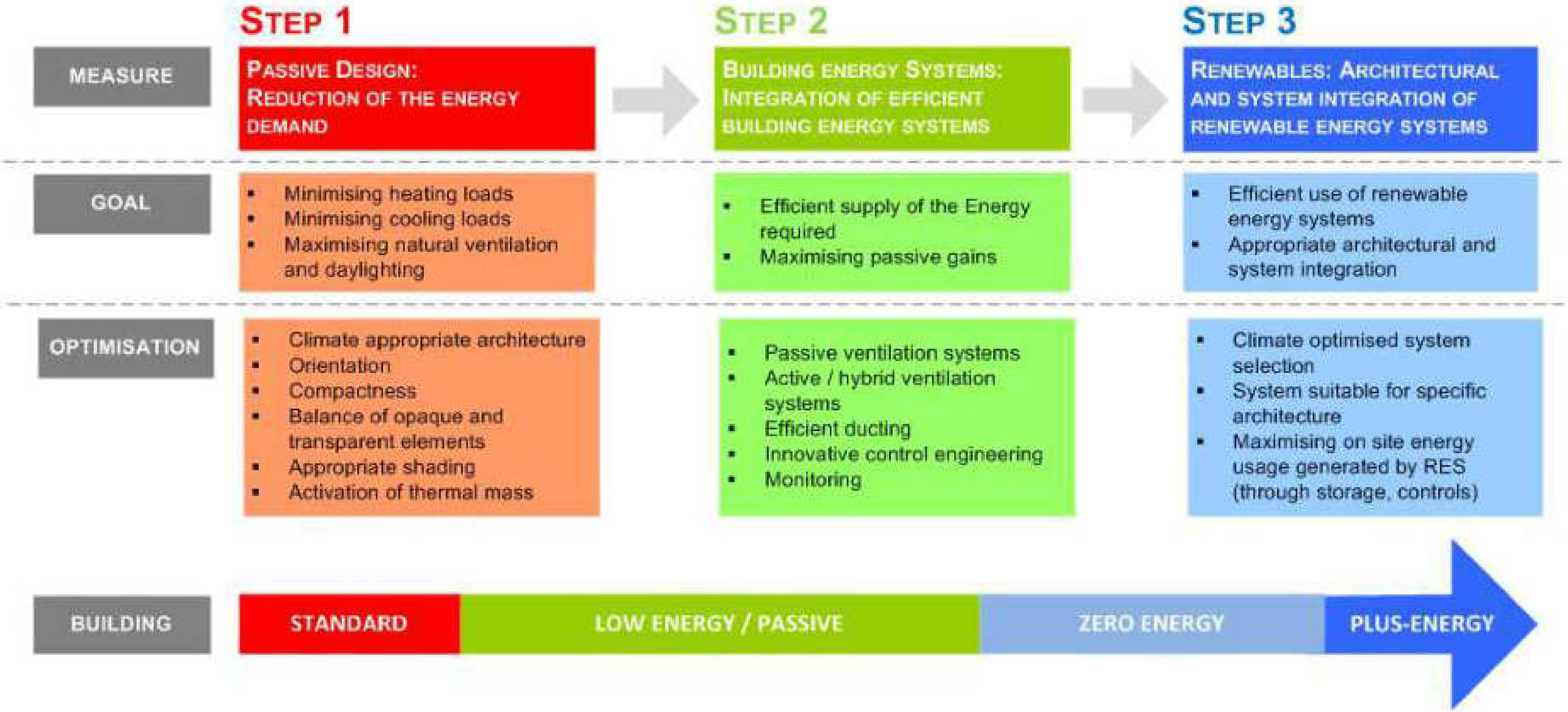
Hof (Bestand), neuer Veranstaltungsraum (Zubau)

## The overall refurbishment concept

- For cost reasons it is not always possible to refurbish a building in its entirety optimally -> step-by-step coordinated renovation plan
- The renovation plan should include:
  - Improvement of the building use
  - Possible redensification potentials
  - Thermal improvement taking into account renewable energy sources
  - A financing concept including possible subsidies

**The overall restructuring plan represents a great effort and should be performed by experienced qualified planners uniformly.**

# Smart structures and efficient buildings




Source: ÖSTERREICHER, D. (2015): INNOVATIVE ENERGIEKONZEPTE 1. Presentation, FH Campus Wien.

# Passive houses

- Basic Principles of the Passive House
- Projects from Austria from Treberspurg & Partner Architects ZT GmbH
- The Design of the Austria House

# Principles of the Passive House Concept

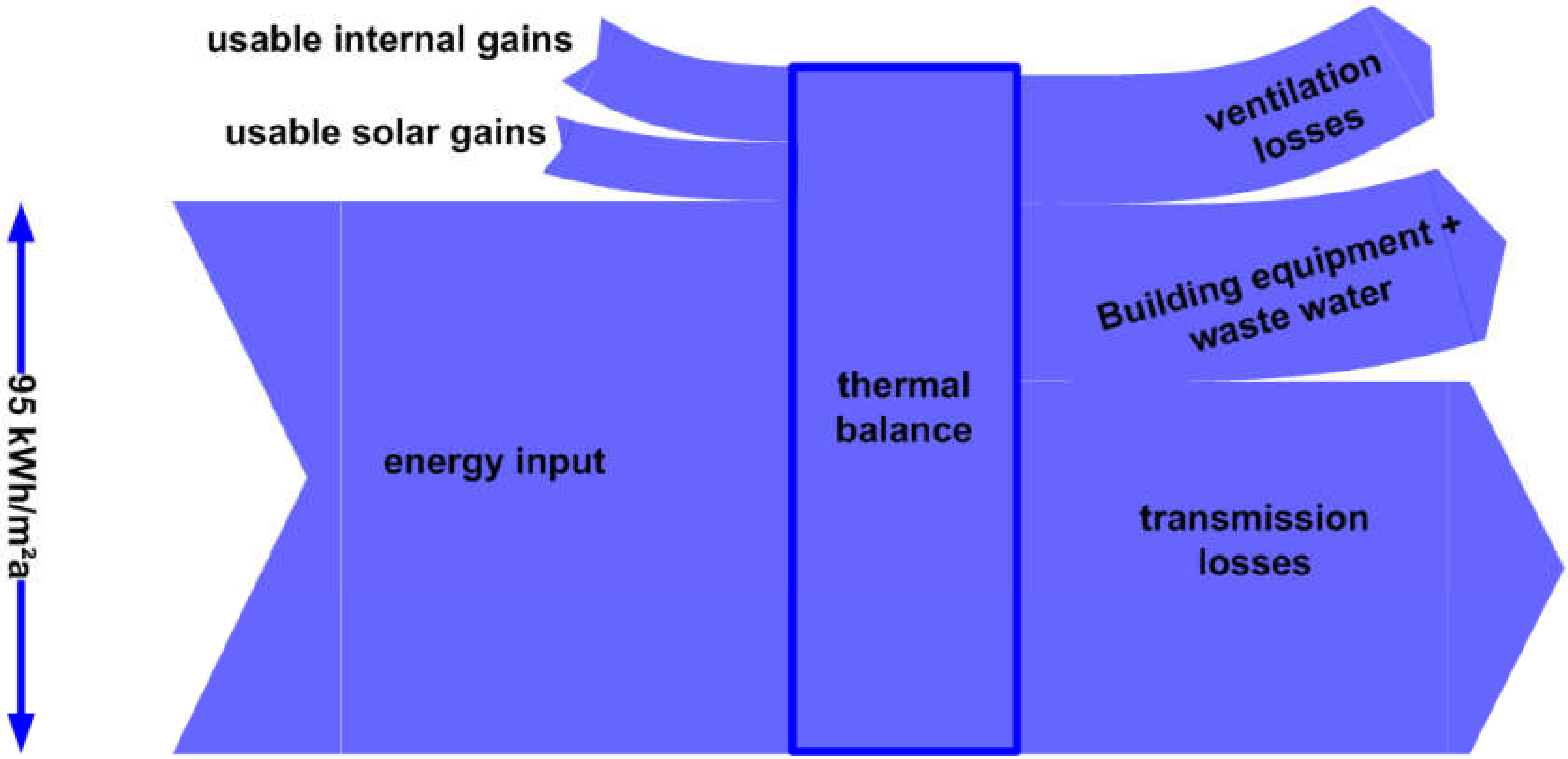
Definition (Passivhouse Institute Darmstadt - Dr. Feist):

**A Passive House is a building, for which thermal comfort can be achived solely by postheating or postcooling of the fresh air mass, which is required to fullfill sufficient indoor air quality conditions - without a need for recirculated air.**

- ► Optimizing the building shell
- ► Loss minimizing before Profit Maximizing

# Comparison of PH with conventional buildings

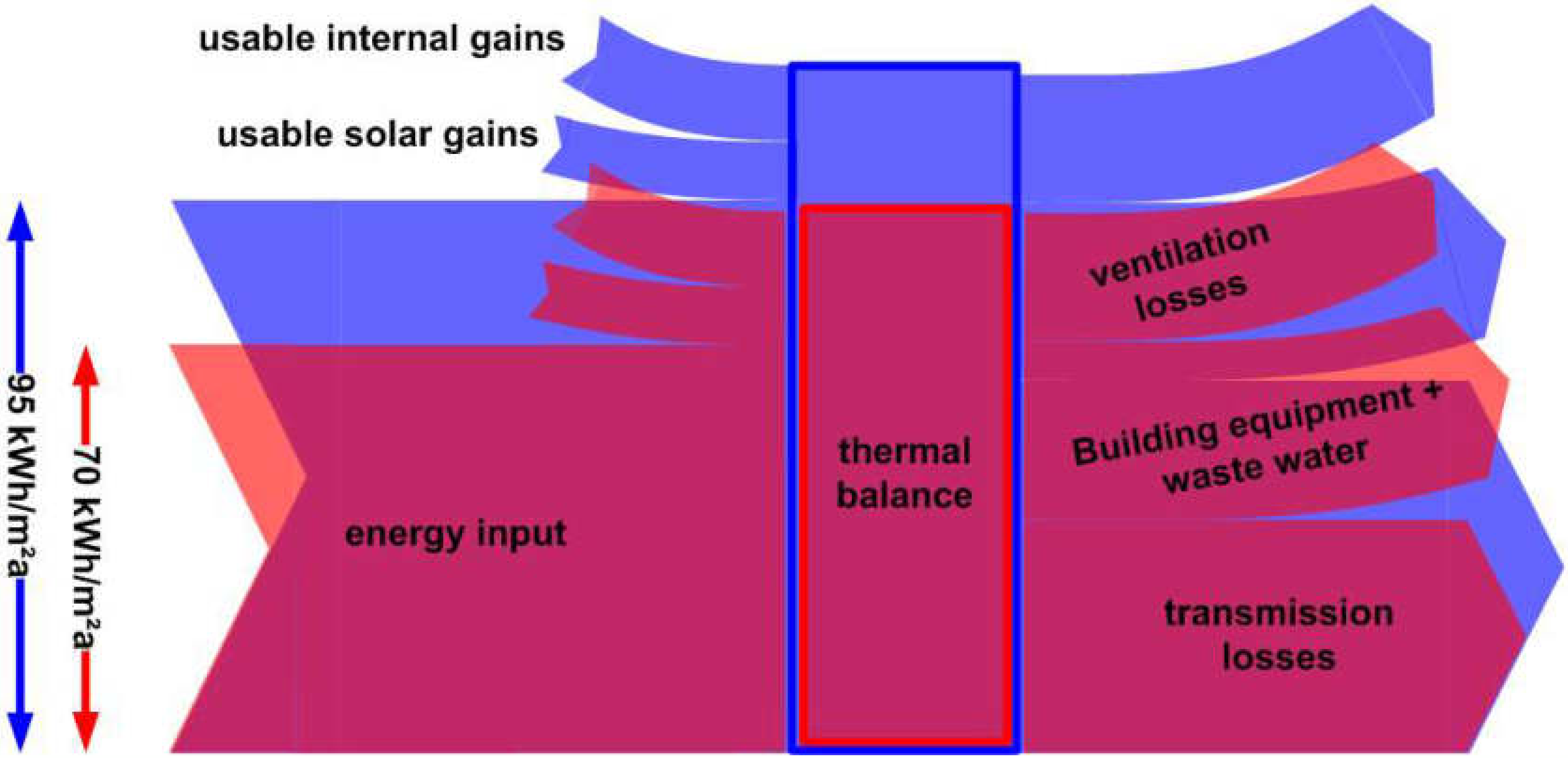
## Net final energy for space heating and hot water




20.10.2011, SB11-Helsinki, Roman Smutny, Christoph Neururer BOKU Vienna

# Comparison of PH with conventional buildings

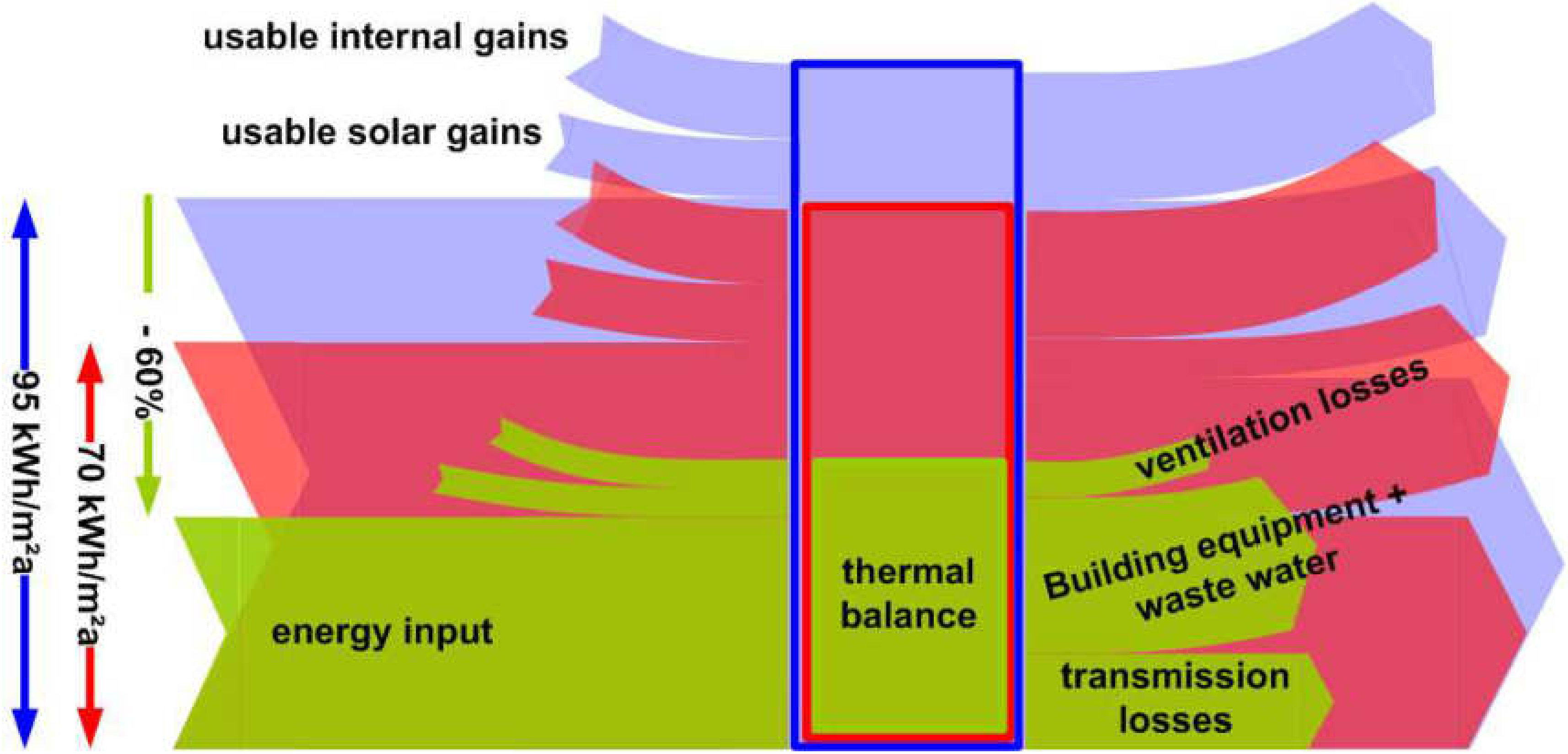
## Net final energy for space heating and hot water




20.10.2011, SB11-Helsinki, Roman Smutny, Christoph Neururer BOKU Vienna

# Comparison of PH with conventional buildings

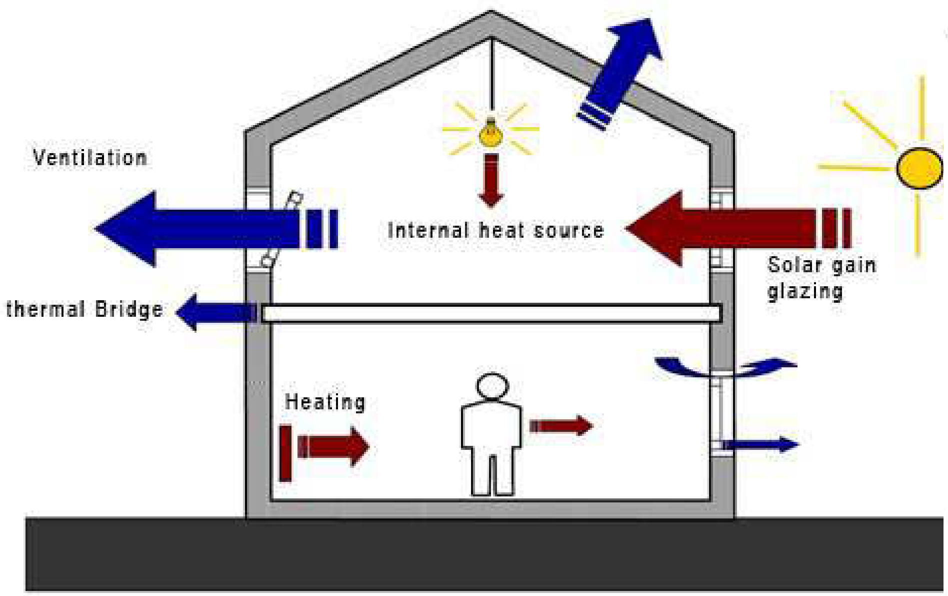
## Net final energy for space heating and hot water




20.10.2011, SB11-Helsinki, Roman Smutny, Christoph Neururer BOKU Vienna

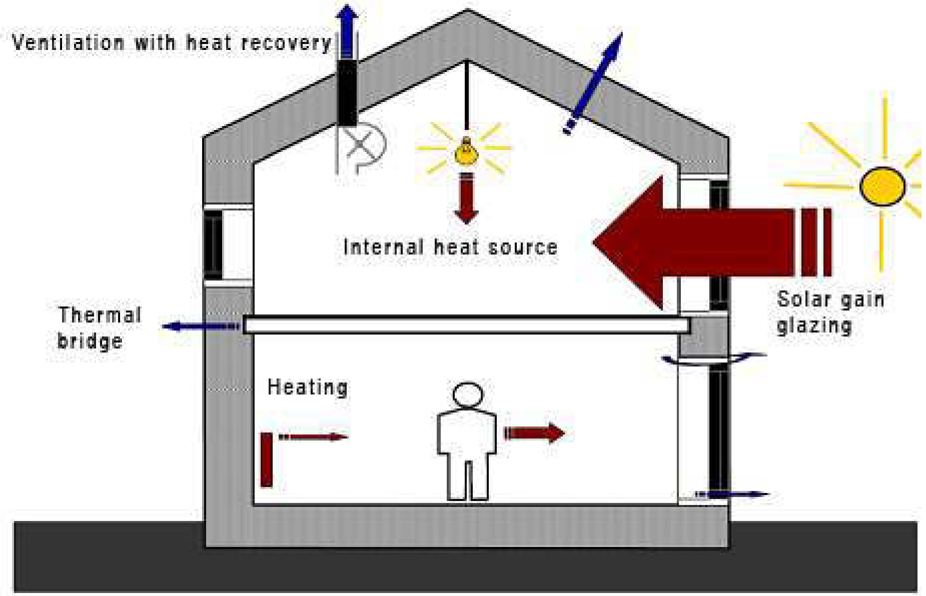
# Conventional House VS Passive House

Building Standard




Quellen: R. Ploss

Passive House:



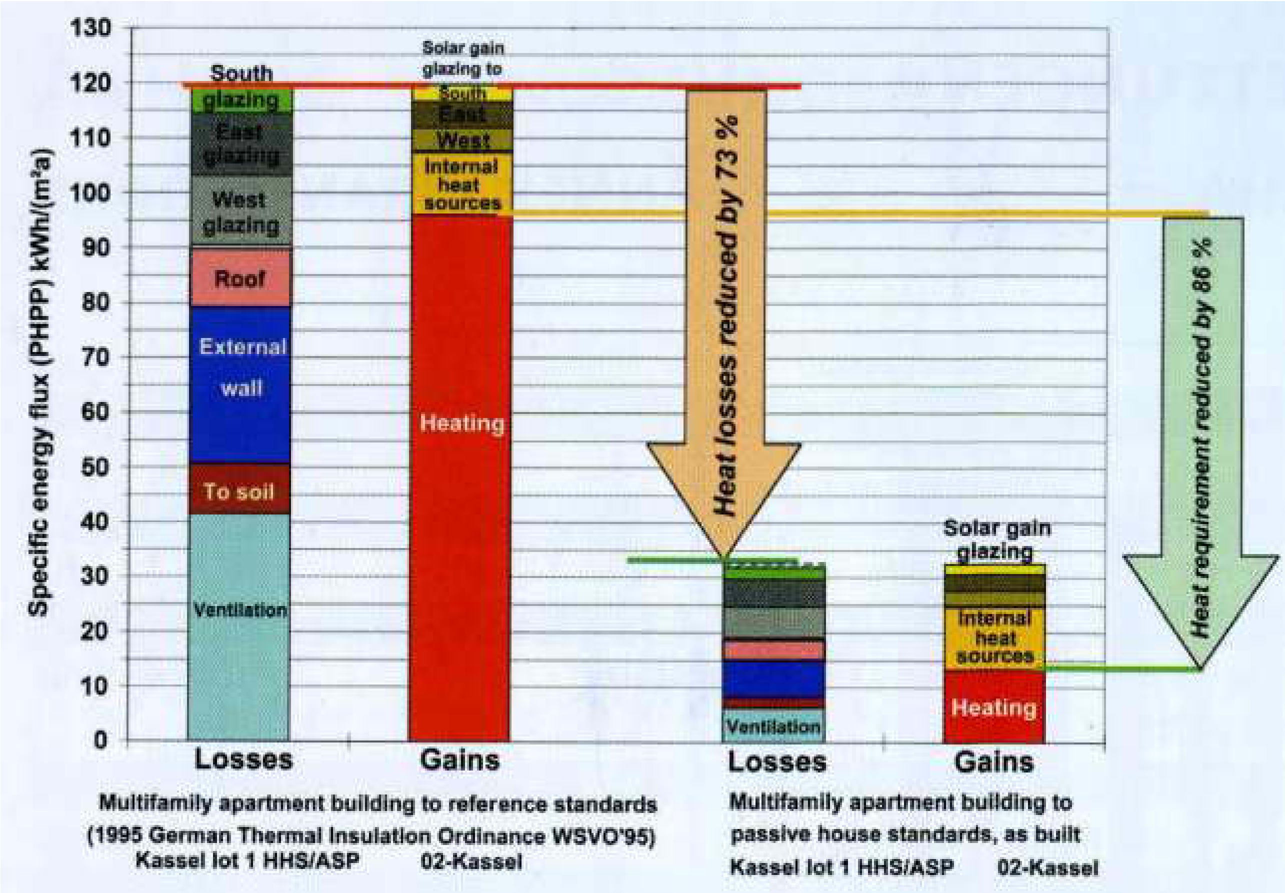

Quellen: R. Ploss

Losses – Gains

= Heating energy requirement

[source: HdZ - Passivhaus Schulungsunterlagen, 1.3 Ressourcenverbrauch im Gebäudebetrieb]

# Energy Saving!




Energy saved on heating is 86% compared to conventional standards of new buildings.

[source: CEPHEUS]

# Definition of kWh

- 1l heating oil ≈ 10 kWh
- 1l gas ≈ 7 kWh

# Definition of kWh

- **Conventional house** before year 1990
  -> 200 kWh / m2a
- 100 m2 -> 20 000 kWh -> 2000 liter oil

- **Passive house** -> max 15 kWh /m2a
- 100 m2 -> 1500 kWh -> 150 liter oil


before
after
HWB (in kWh/m²WNFl./a): 175 15
Oil/l/a: 38.210 3.536
Oil savings in l: 34.674

# Evolution

„1-Liter Car"

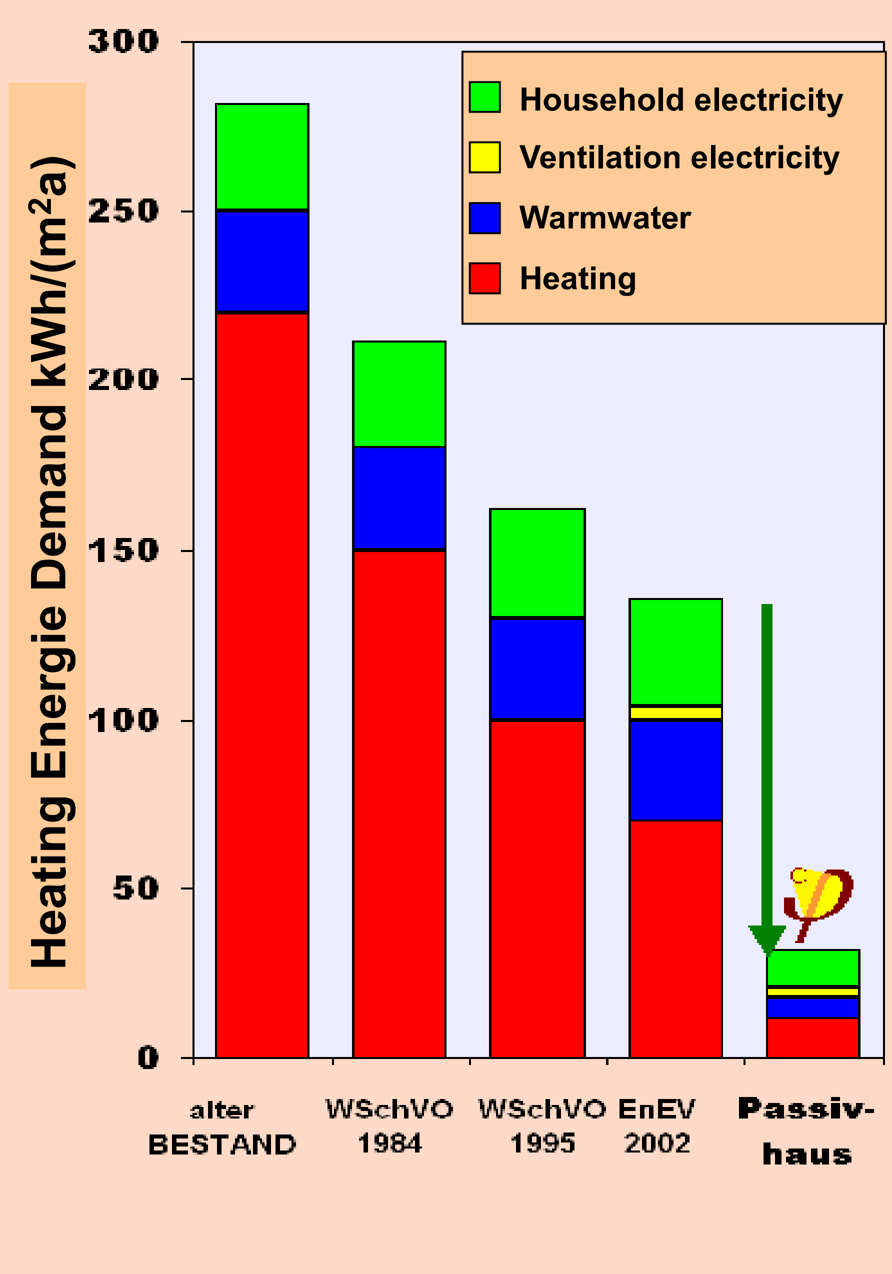
Over 80% Energy savings

„1-Liter House" = Passivhaus:

Since 1991

Over 90% Energy savings

**Factor 10 is possible**

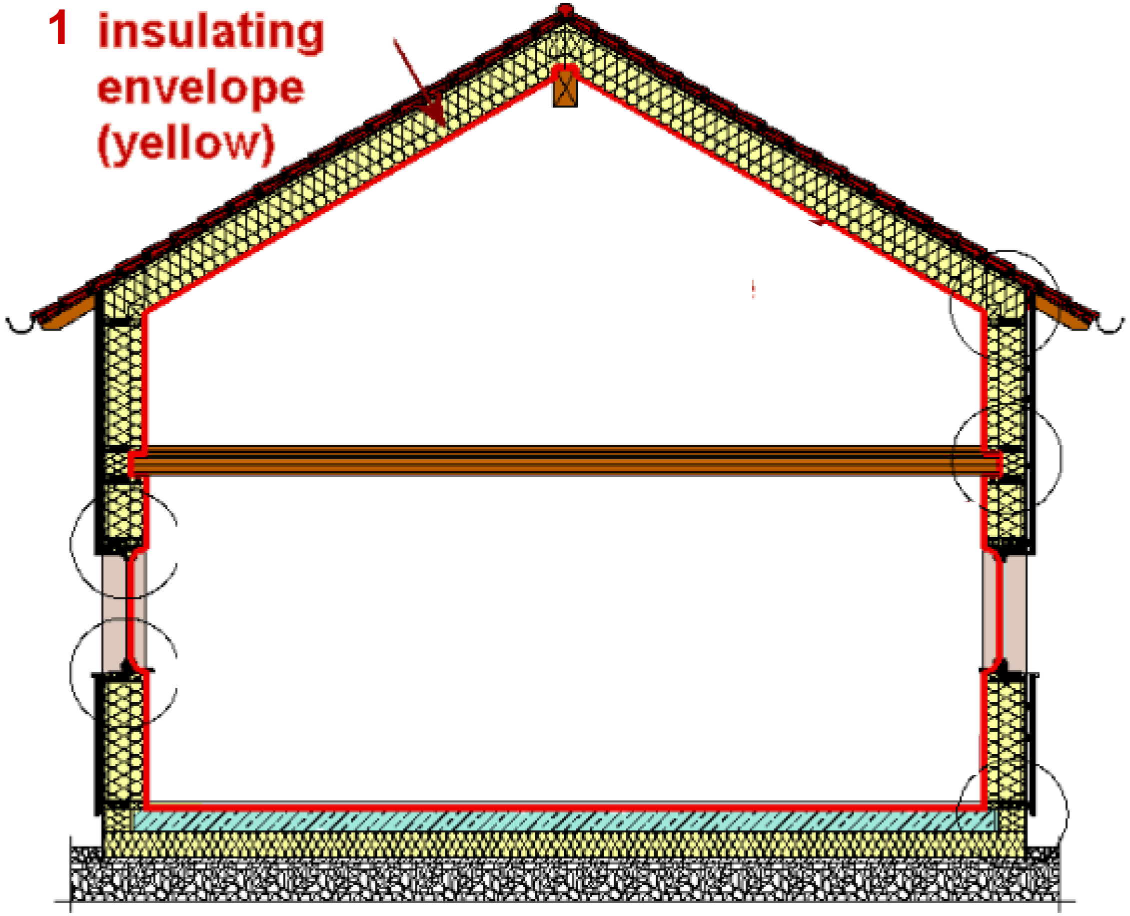


# Principles of the Passive House Concept

Passive Houses require superior design and components with respect to:

- Insulation
- Comfort windows
- Design without thermal bridges
- Air-thightness
- Ventilation with heat-recovery
- Innovative heating technology

# Building Envelope: High Thermal Insulation

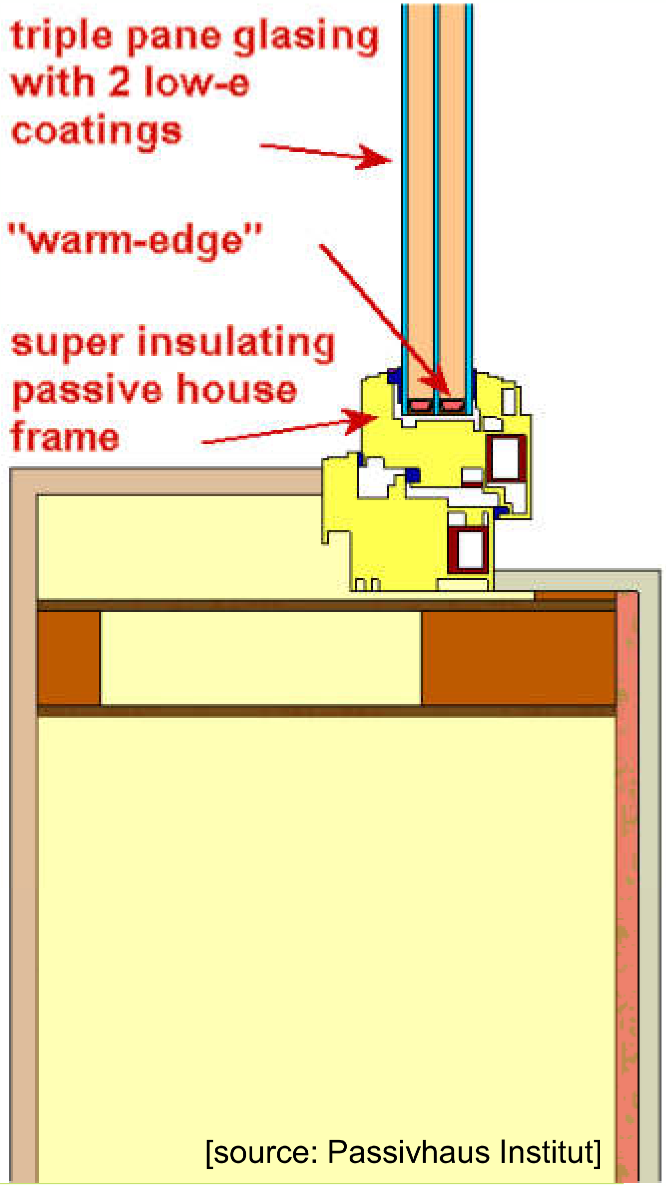



[source: Passivhaus Institut]

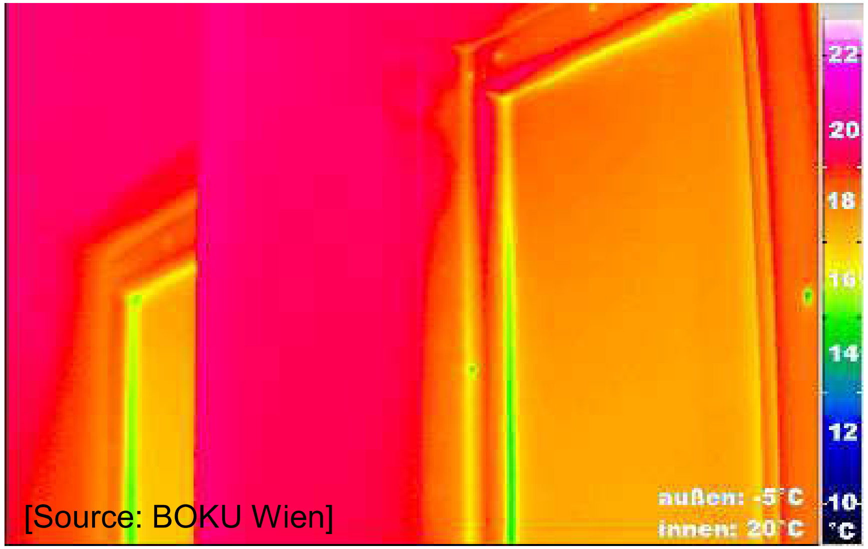
# Building Envelope: Comfort Windows

Example of triple pane glasing window

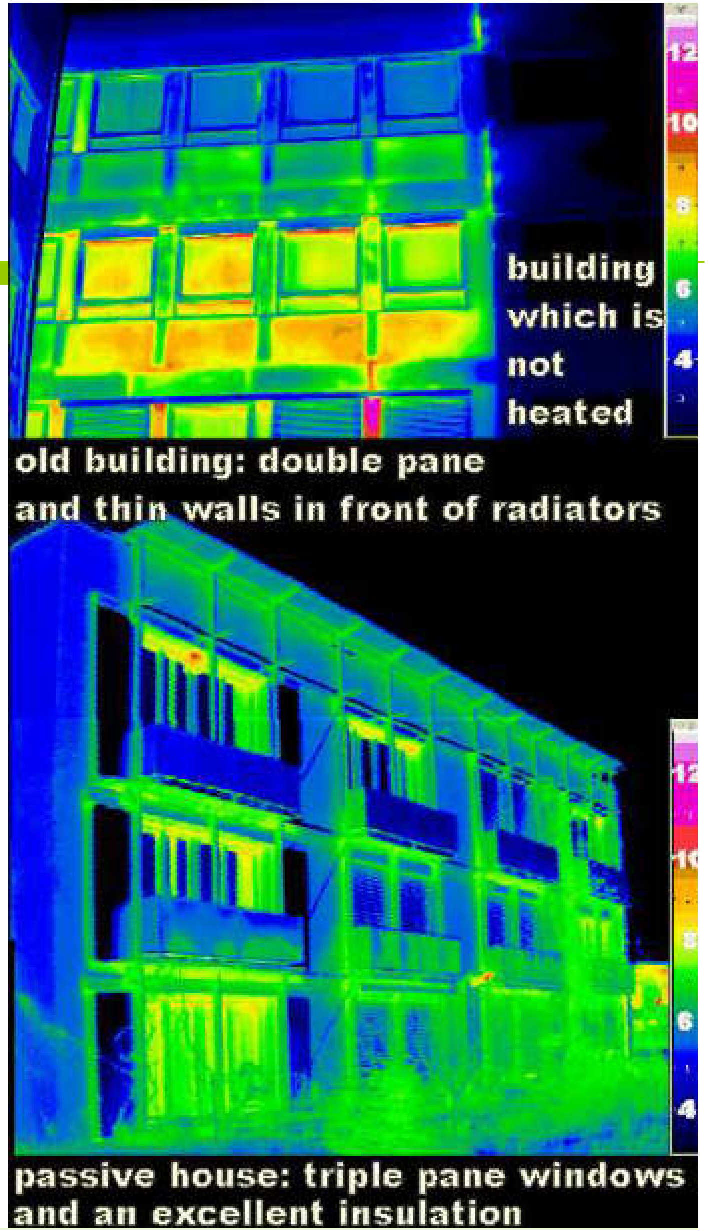
Window ≤ 0,8 W/(m²K) (R-7.1)



# Building Envelope: Comfort Windows

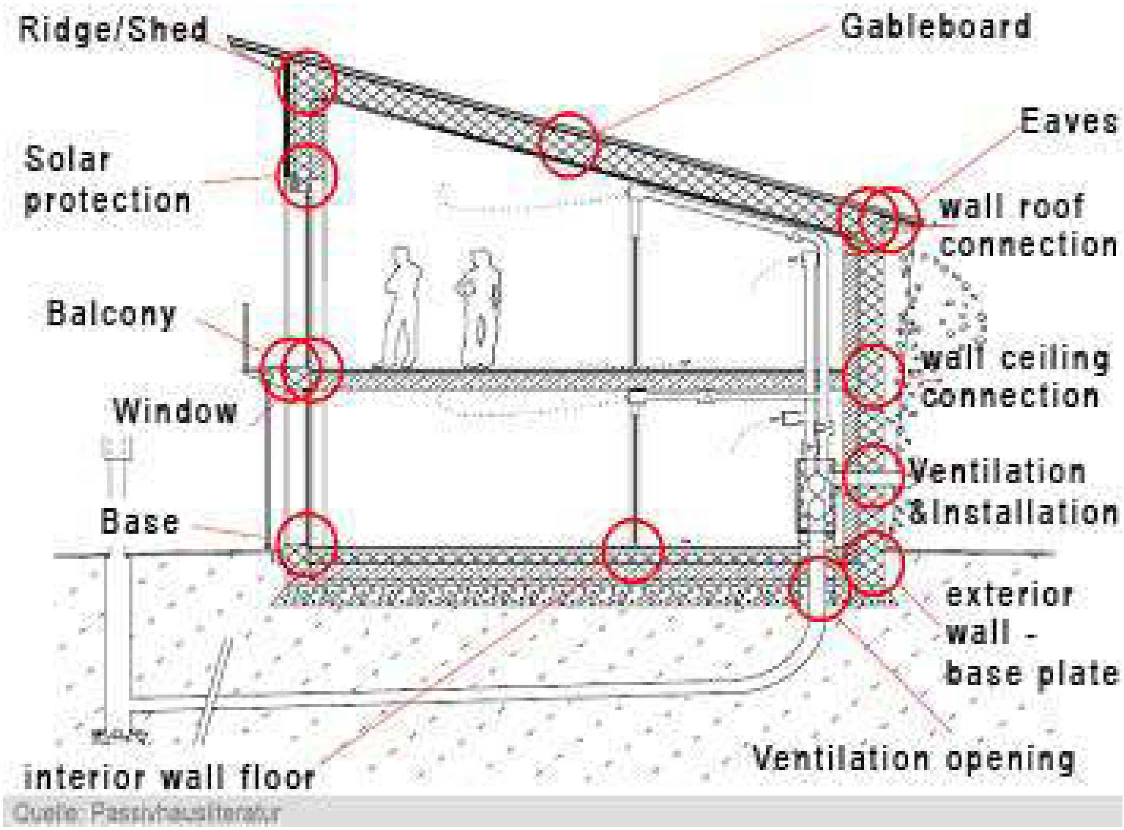



Passive House Window, Interior

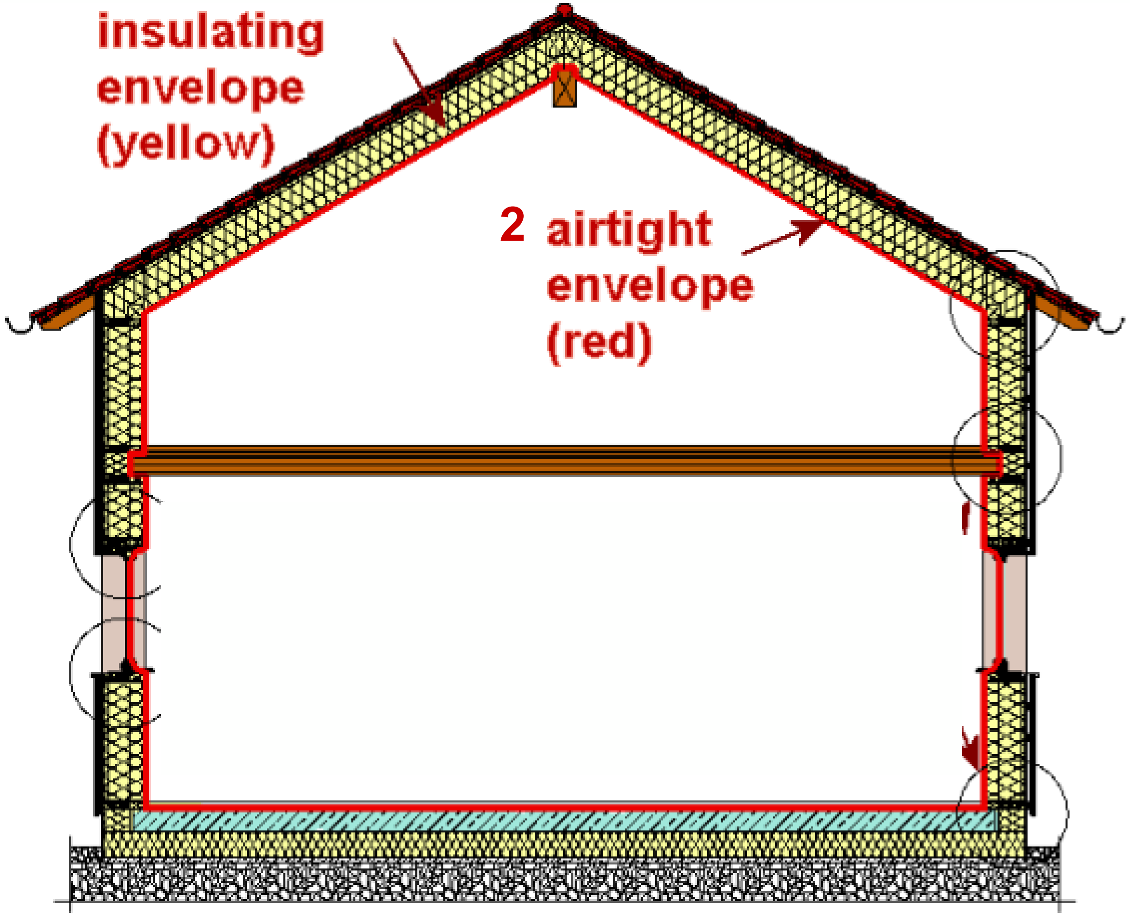



Infrared pictures of an old building and a passive house (at the bottom) for comparison (photos: PHI)

# Building Envelope:
# Avoiding Thermal Bridges



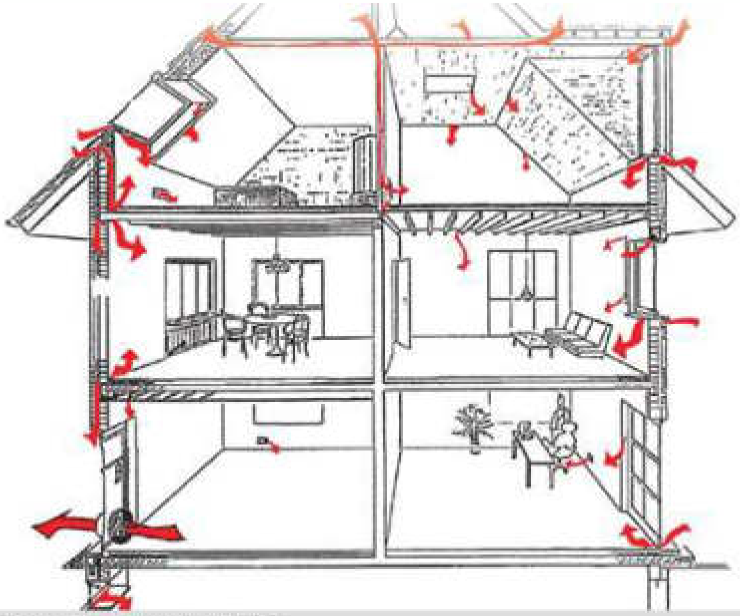
# Building Envelope: Airtight Construction




An envelope can be airtight only if its consists of ONE undisturbed airtight layer enwrapping the whole volume.

[source: Passivhaus Institut]

# Building Envelope: Airtight Construction

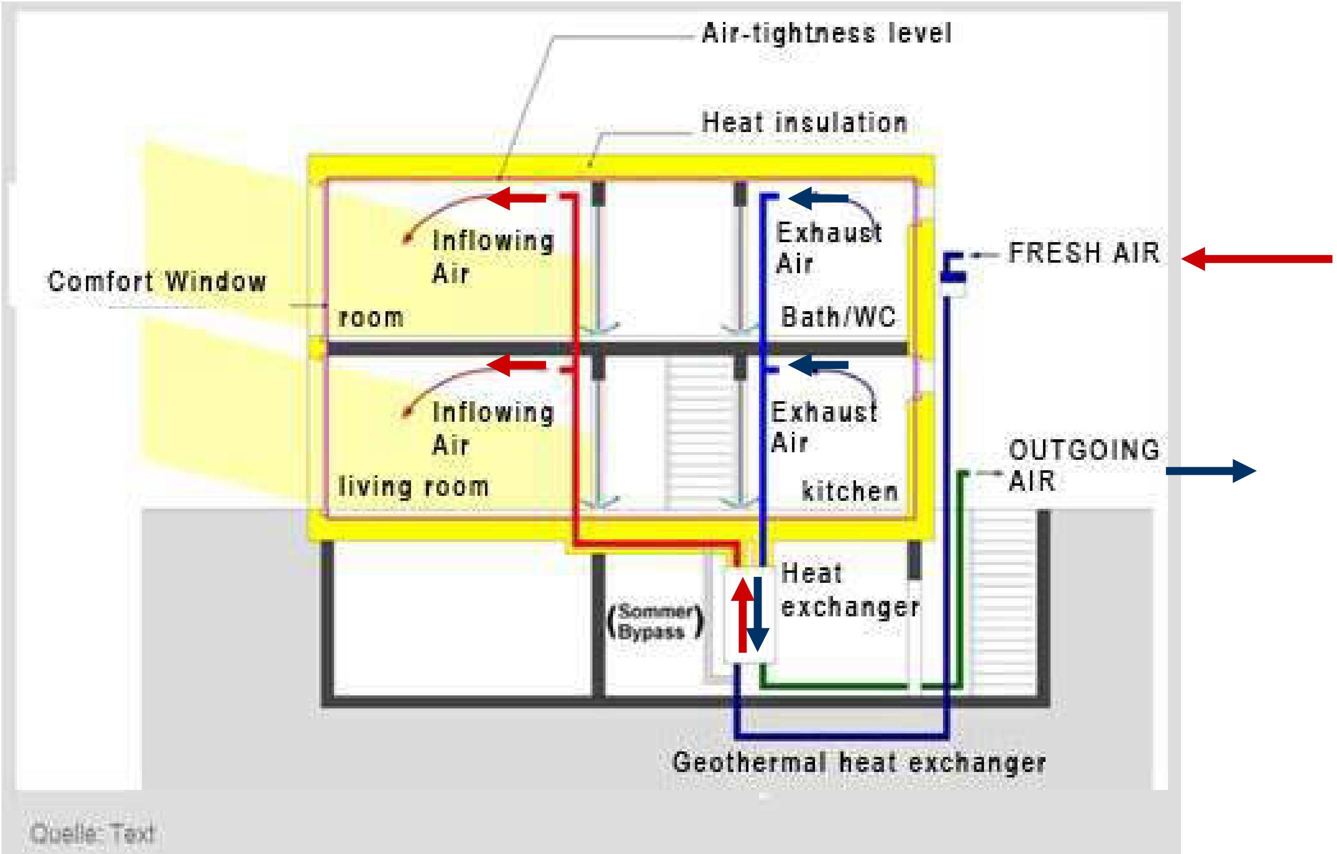


Quelle: Energie und Umweltzentrum (EUZ)


Quelle: Passivhaus Institut Darmstadt

- avoid damage caused by condensation of moist, room warm air penetrating the construction
- reduce losses through building envelope and ventilation

# Innovative Heating Technology: Ventilation with heat recovery



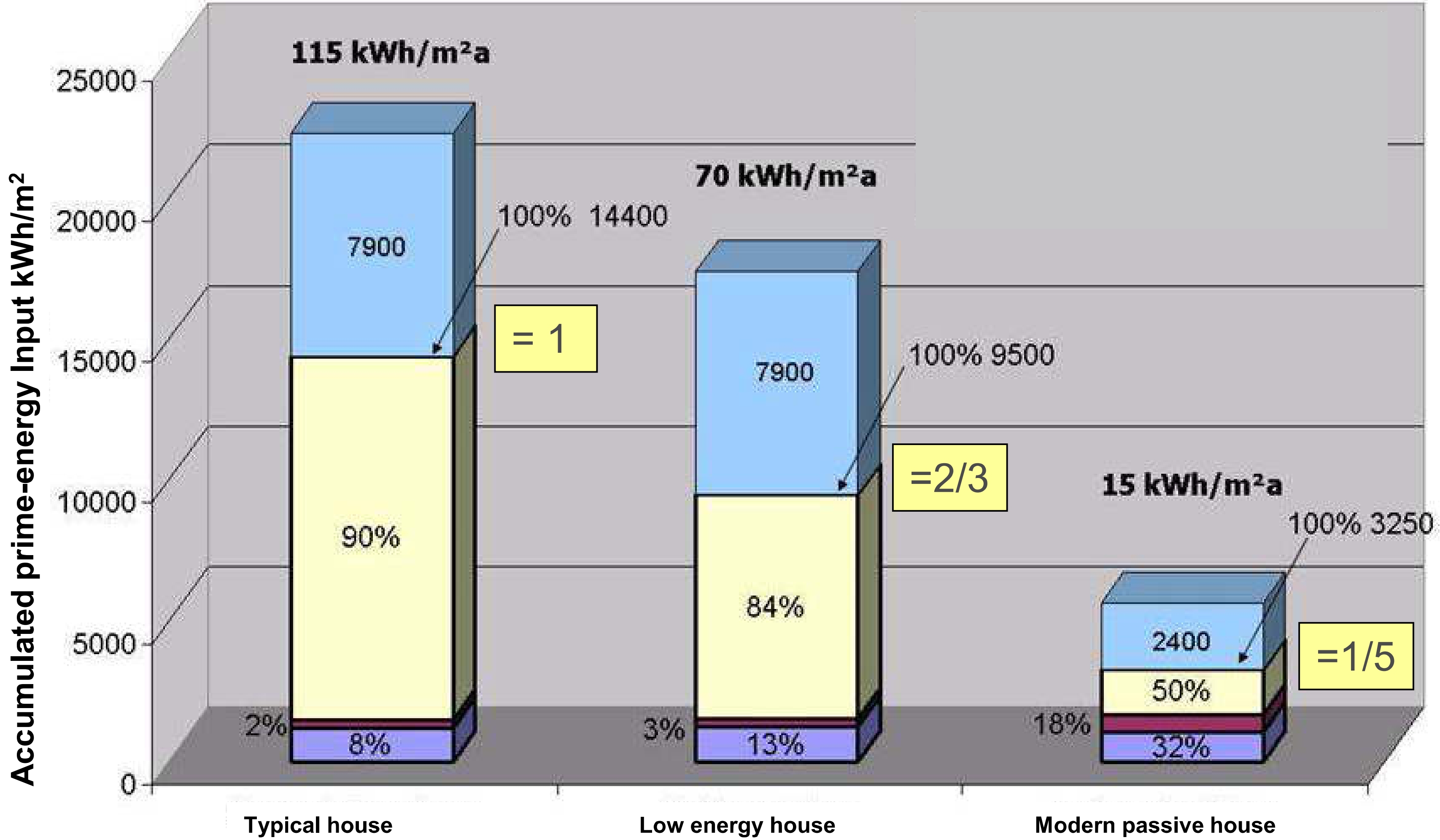

[source: CEPHEUS]

# Basic Numbers for Passive houses

<u>Values should be lower than:</u>

- 120 kWh/m2a – primary energy demand, net floor area
- 15 kWh/m2a – heating energy demand, net floor area
- 10 W/m2 – maximum heating load (in case of heating with ventilation system)
- 0,85 W/m2K – U value of whole window
- 0,75 – heat recovery performance
- 0,60 – airtightness: max. 60% of room volume air change per hour at 50 Pascal underpressure
- 0,45 Wh/m2 – ventilation system electricity consumption
- 0,10 – to ensure the internal comfort in summer, max.10% of the year, temperatures can be higher than 25 °C

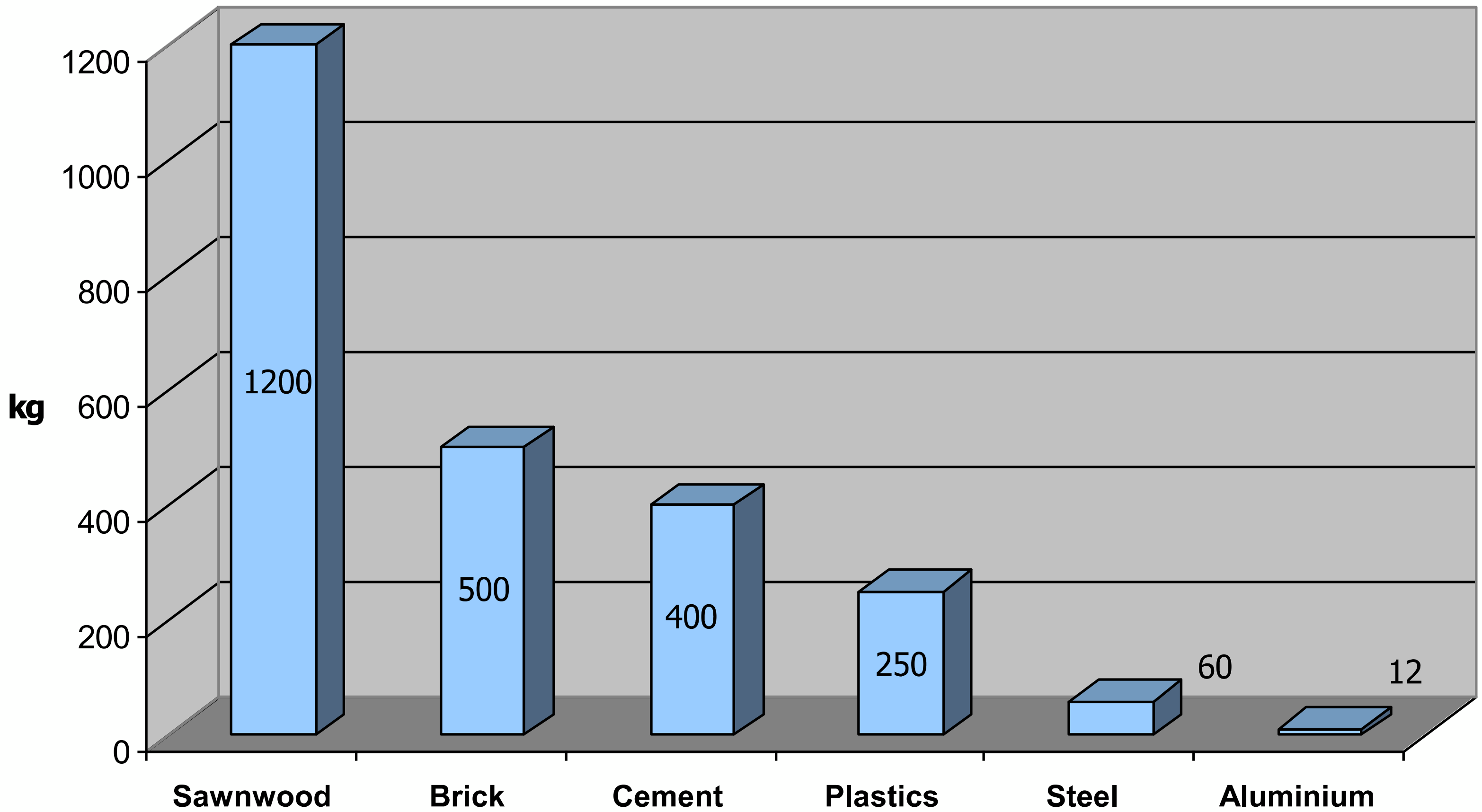
# Life Cycle Assessment




W. Feist, CIB W67 Symp 1996

- Household electricity consumption 80 years accumulated
- Heating energy consumption 80 years accumulated (Gas)
- Prime-energy content demolition and disposal
- Prime-energy content new building

## Producible building materials from 1000 kWh thermic Energy

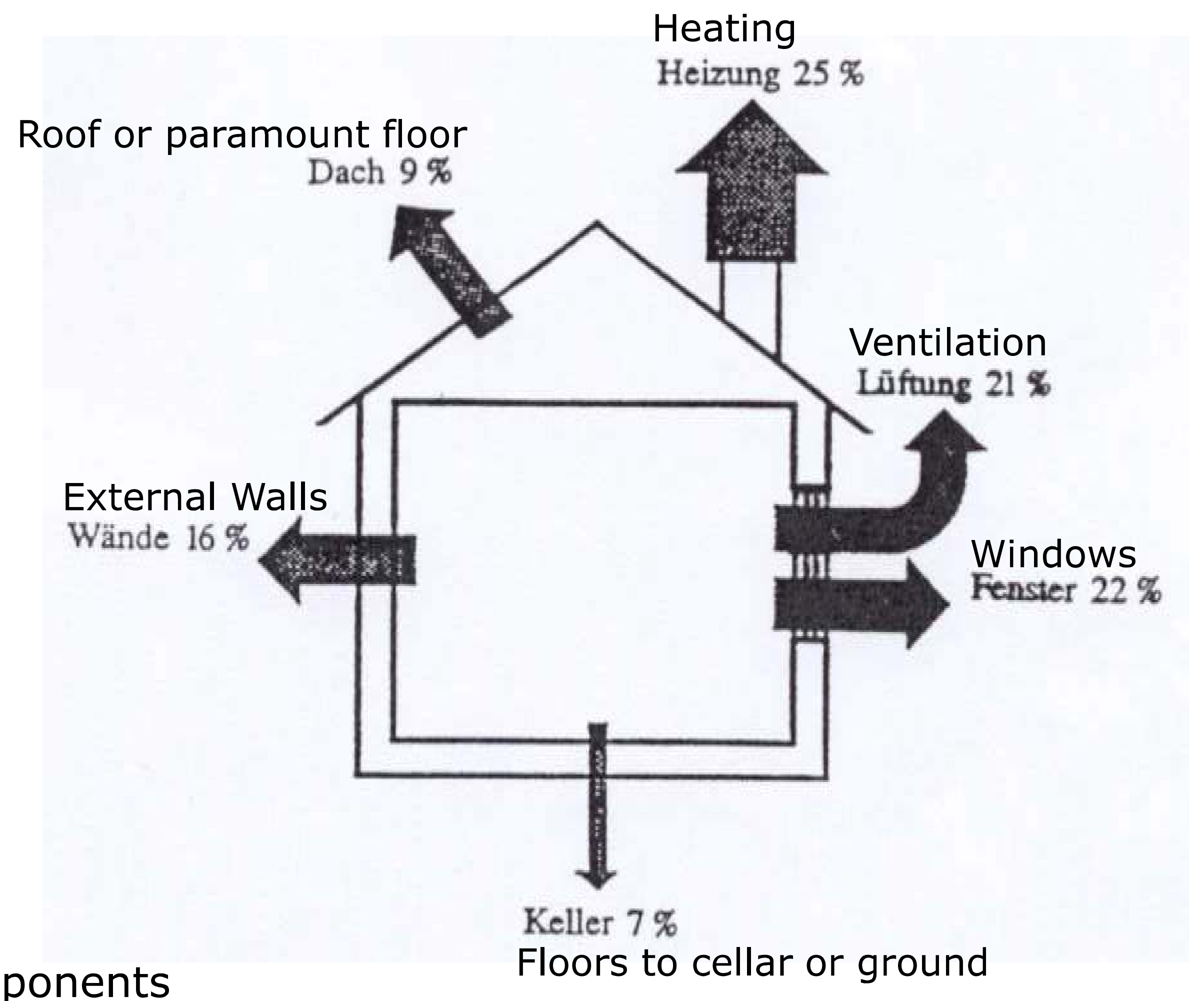



**1200 kg Sawnwood - 1000 kWh - 12 kg Aluminium**

Nach P. Sabady, Biologischer Sonnenhausbau 1989

# THERMAL REFURBISHMENT

Where is the heat lost?



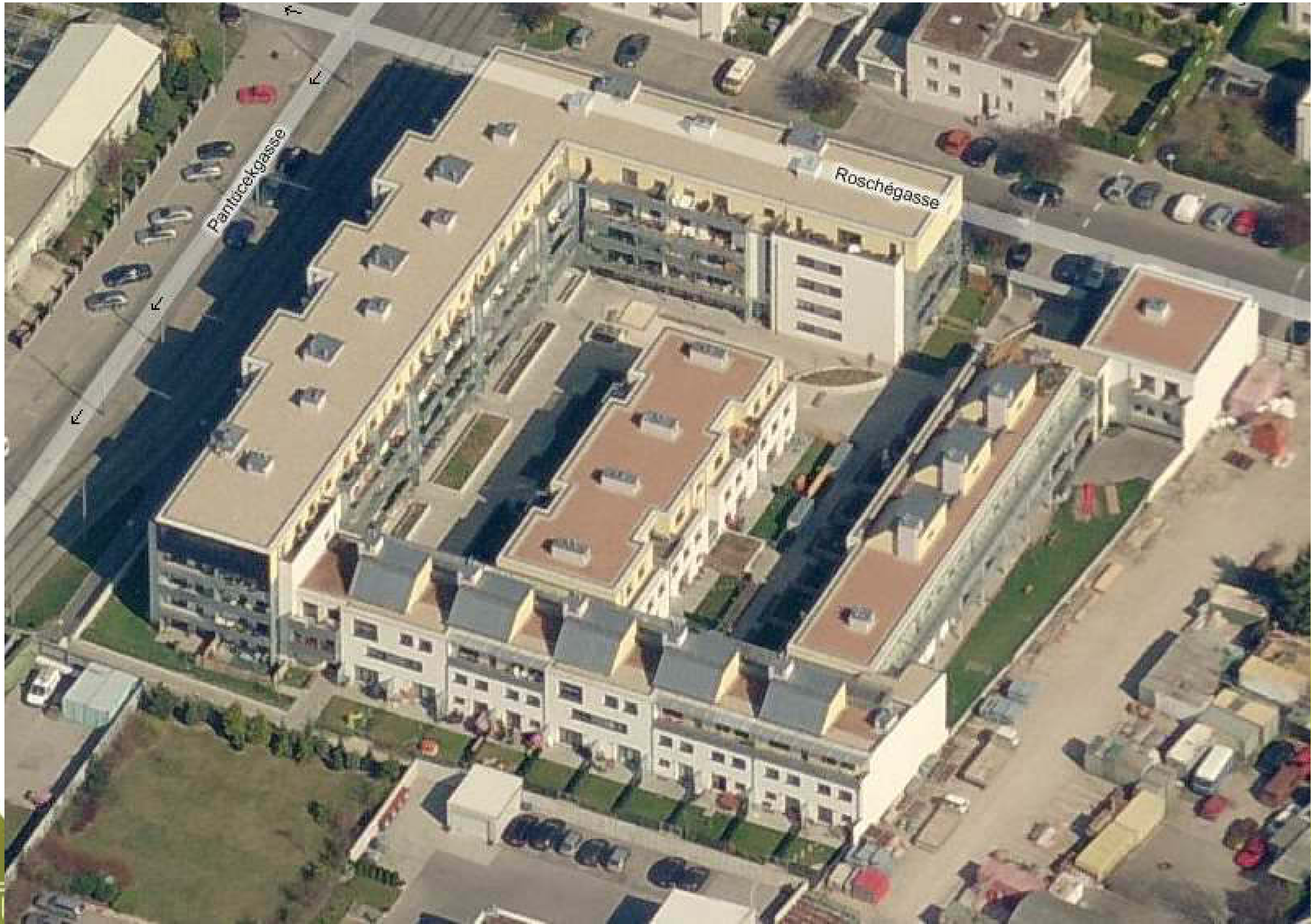

Heat losses of building components
in contact with outer air

[Source: WUPPERTAL INTSITUT FÜR KLIMA, UMWELT, energy (1996) energygerechtes Bauen und Modernisieren. Basel: Verlag für Architectur]

# Vienna City Development

**PH-RESIDENTIAL HOUSING ROSCHEGASSE**

Pantucekgasse Roschegasse 20, 1110 Vienna



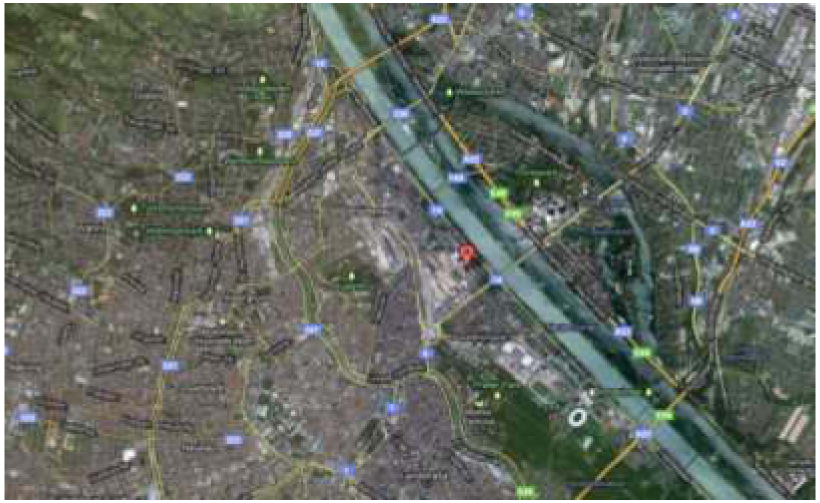
# PH-RESIDENTIAL HOUSING ROSCHEGASSE

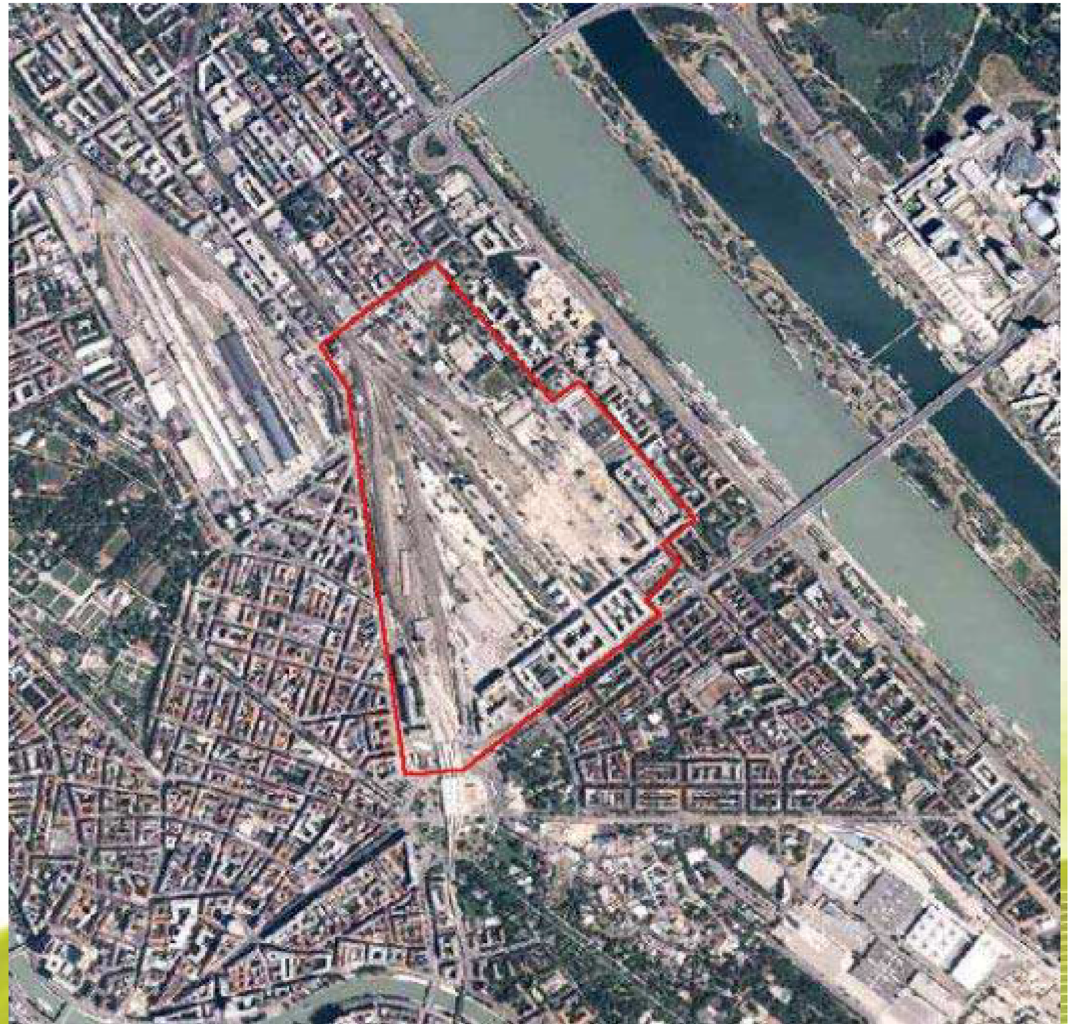
Pantucekgasse Roschegasse 20, 1110 Vienna

| | |
|---|---|
| Developer: | a:h, gemeinn. Siedlungsgenoss. Altmannsdorf - Hetzendorf |
| Design&Planning: | Treberspurg & Partner Architekten ZT GmbH |
| Size: | 9.900 m² living space, 114 apartments, common areas |
| Heating Energy: | 7,3 kWh/(m²a) (PHPP); biggest social residential Passive House! |
| Netto building costs: | 1.212 EURO/m² living space; 2006 |

# City development Nordbahnhof Vienna

Brownfield Nordbahnhof, 65 ha, 2025: 20.000 Inhabitans, 10.000 jobs





# City development Nordbahnhof Vienna

Statistically, each of the 1.9 million Viennese has 120 square meters of green space. Or: More than half of the city area are green spaces. This makes Vienna one of the greenest megacity cities in the world!

# City development Nordbahnhof Vienna

## **PH-RESIDENTIAL HOUSING ‚YOUNG CORNER'**

Leystraße 157+159, Nordbahnhofgelände, 1020 Vienna

**Developer:**

Kallco Bauträger GmbH.

**Architecture:**

Treberspurg & Partner Architects ZT GmbH

**Completion**:

April 2011

**Levels:**

8 above, 1 below ground

**Useable Area:**

6.965 m²

**Size:**

90 apartments, Kindergarden

**Passive House:**

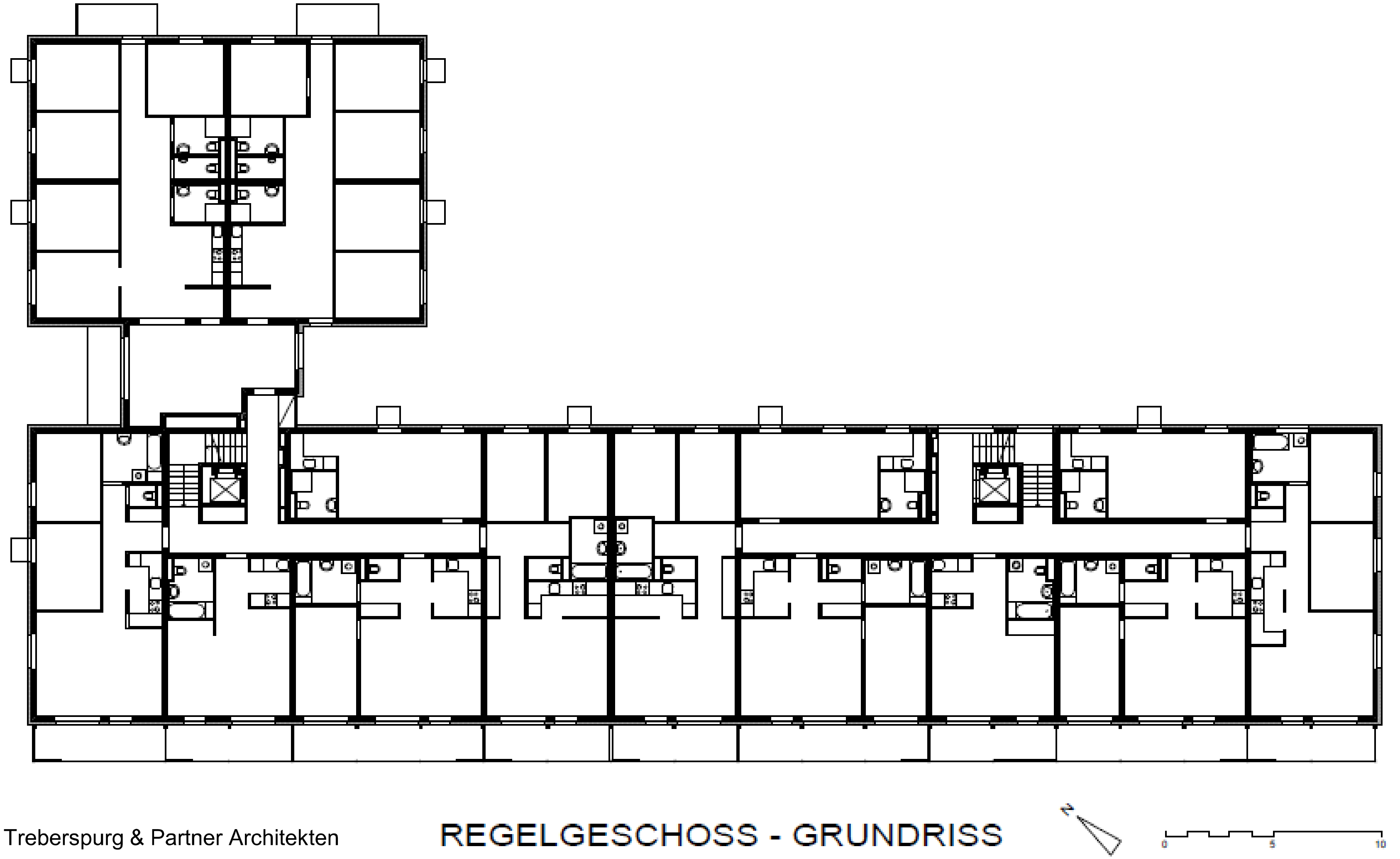
Space Heating Demand

**13 kWh/(m².a)** per treated floor area according to PHPP

**6 kWh/(m².a)** per gross floor area according to OIB Directive + ÖNORM

Photo: R. Grünner

# Floor plan



Treberspurg & Partner Architekten
REGELGESCHOSS - GRUNDRISS
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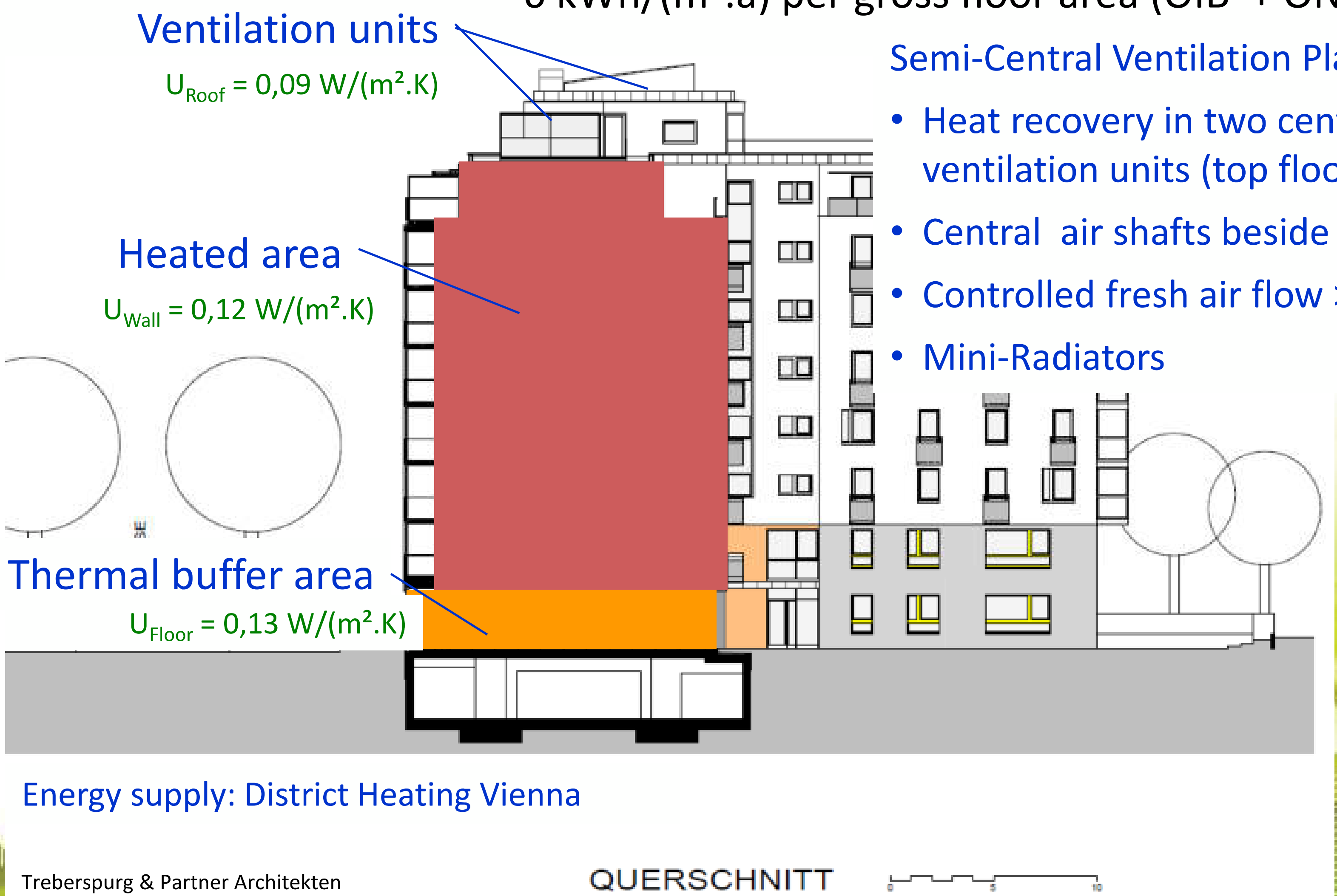
# Energy concept

Space Heating Demand: 13 kWh/(m².a) per treated floor area (PHPP)
6 kWh/(m².a) per gross floor area (OIB + ÖNORM )




Semi-Central Ventilation Plant:

- Heat recovery in two central ventilation units (top floor)
- Central air shafts beside staircase
- Controlled fresh air flow > 18 °C
- Mini-Radiators

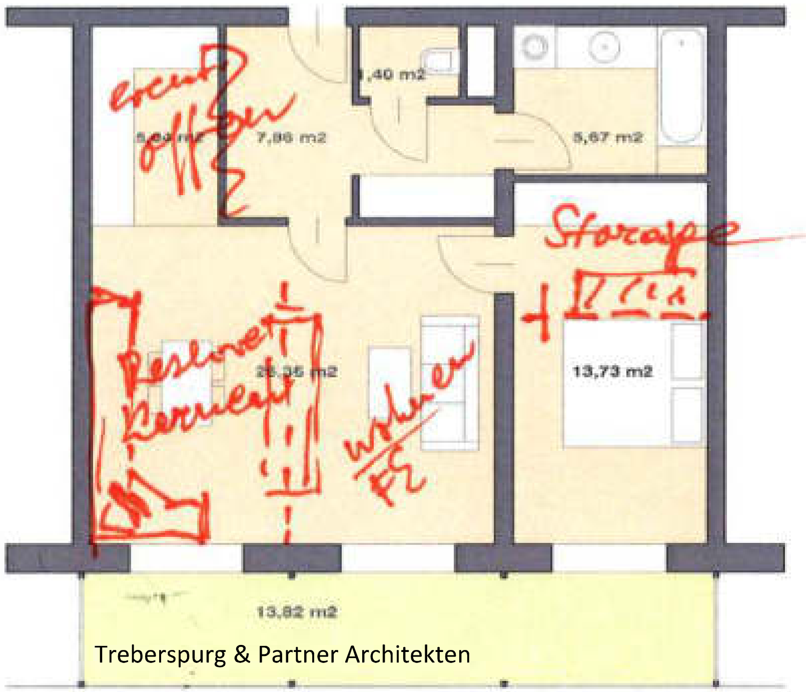
Energy supply: District Heating Vienna

Treberspurg & Partner Architekten

# Flexible Housing

City-Loft for 2 persons

60 m², 3450 € own capital, 300 € monthly rent

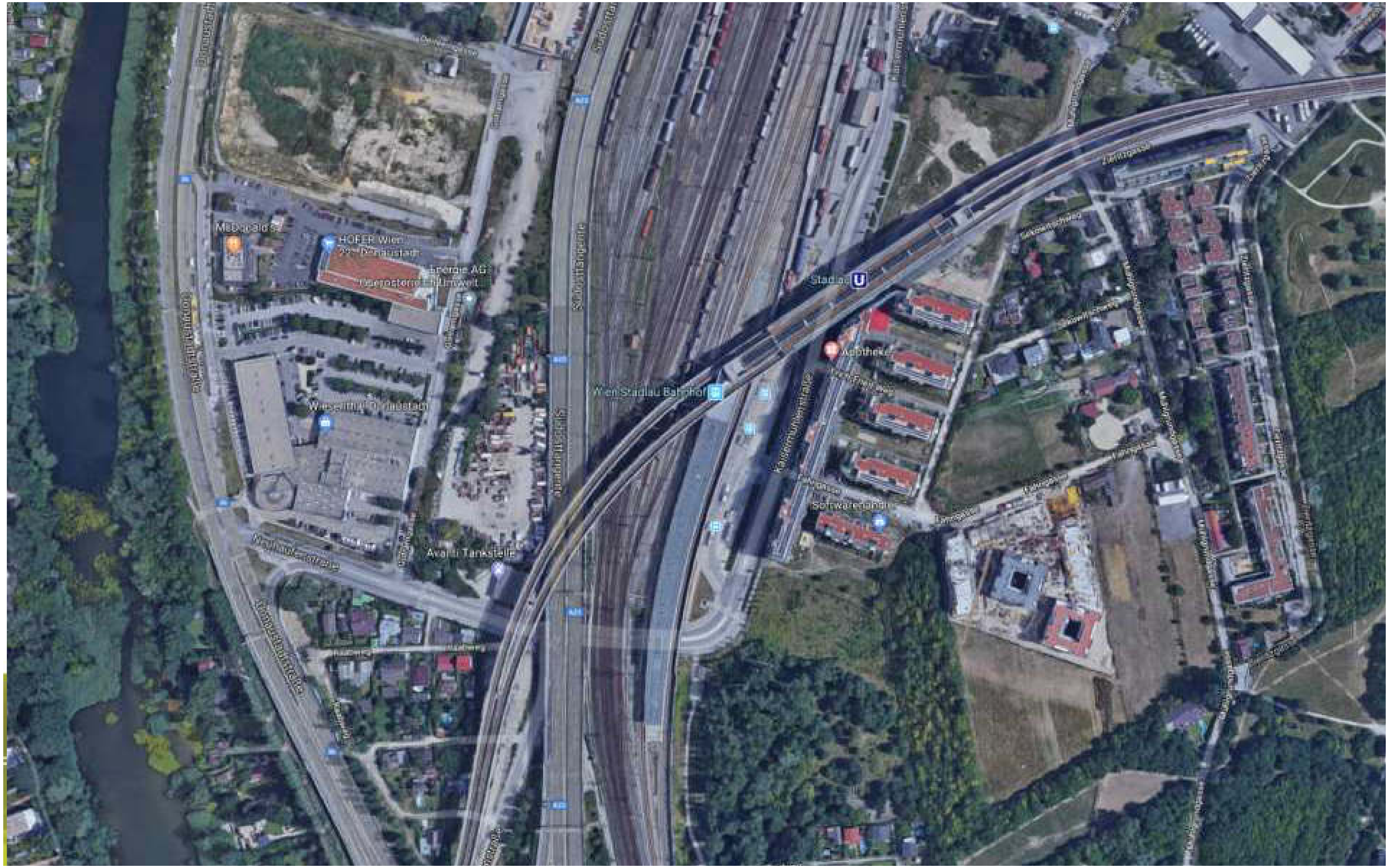



Treberspurg & Partner Architekten


Foto: R. Grünner


REYNAERS
REYNAERS
Foto: R. Grünner

# Stadlau


McDonald's
Wien Stadlau Bahnhof
Stadlau
Apotheke
Avanti Tankstelle

# Stadlau


Stadlau
Apotheke
Crazy Sun
Softwarehändler
Tabak Trafik Biber
Wien Stadlau Bahnhof
Kaisermühlenstraße

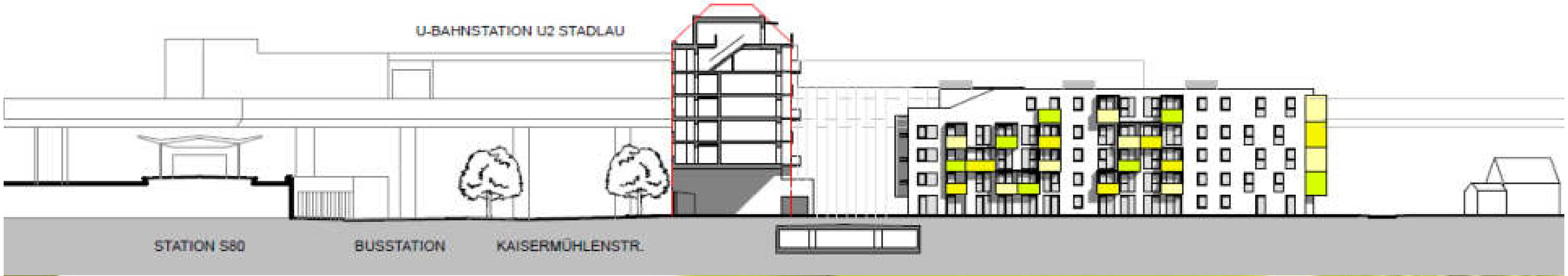
# 22 KAISERMÜHLENSTRASSE, 1220 Vienna

Passive-house residential building

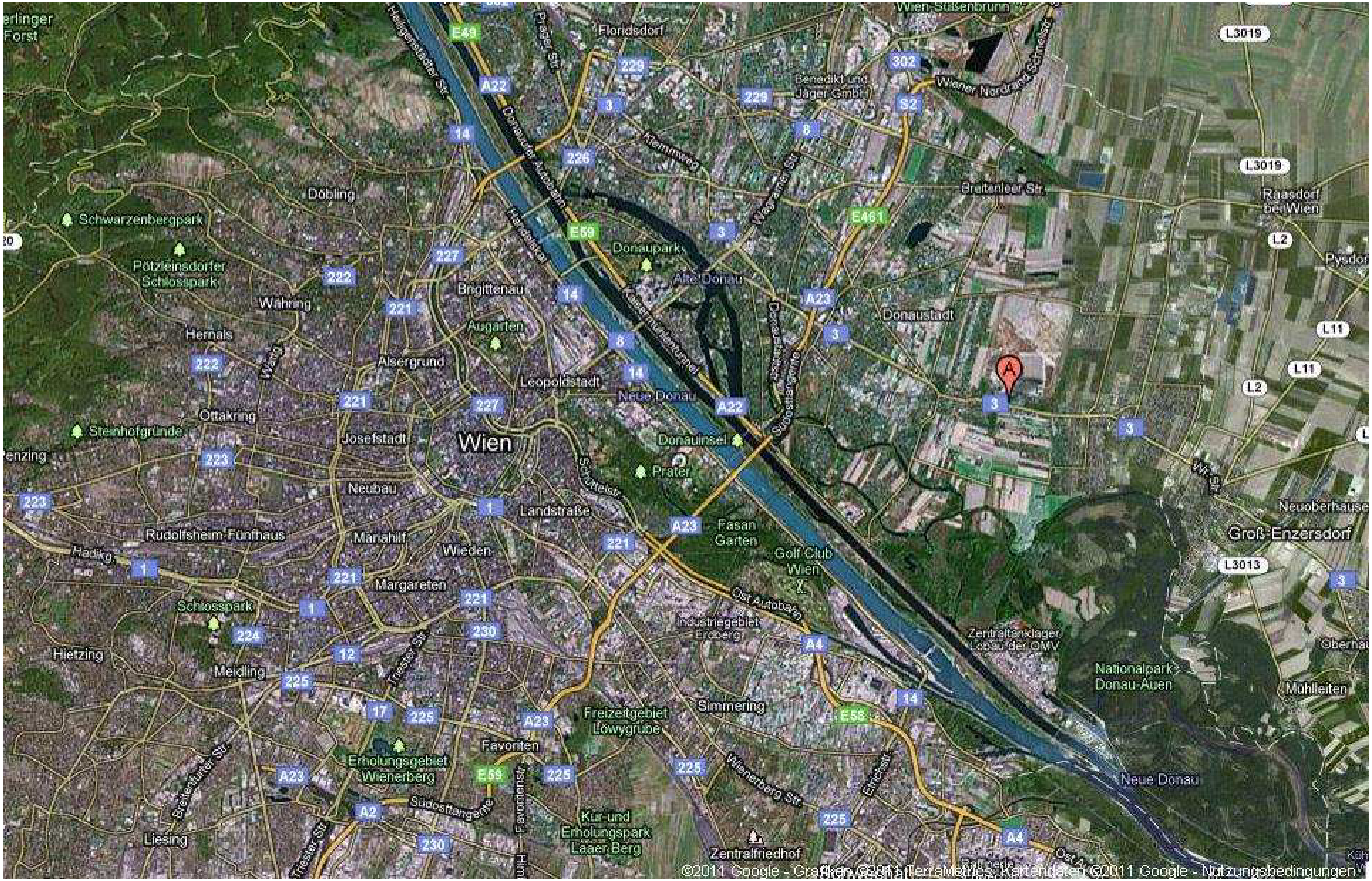
**OBJECT DATA**

| | |
|---|---|
| Investor: | BWS Gruppe |
| General Planning: | Treberspurg & Partner Architekten ZT GmbH |
| Building physics: | Technisches Büro Hofbauer |
| Completed: | 2014 |
| Area: | 24.500 m² |
| Capacity: | 264 Appartments, 4 offices, 4 business units |
| Netto Building Costs: | 34,8 Mio. EURO |
| Energy performance: | 13 kWh/m²a |

# Heavy Traffic



# Seestadt Aspern




Badeteich
Hirschstetten
302
S2
Süßenbrunner Straße
Quadenstraße
Friedhof
Hirschstetten
Schloßpark
Hirschstettner Straße
Stadlauer Straße
Aupark
Ostbahnbegleitstraße
Ostbahnbegleitstraße
Donaustadt
Aspernstraße
Erzherzog-Karl-Straße
Erzherzog-Karl-Straße
Aspernstraße
Hausfeldstraße
Telefonweg
Telefonweg
Himmelteich
Schafflerhofstraße
General
Motors Austria
Telefonweg
Gernotgasse
Groß-Enzersdorfer Straße
Eßlinger Hauptstraße
Eßlinger Hauptstraße
Sozialmedizinisches
Zentrum Ost der Stadt
Wien - Donauspital
Friedhof
Aspern
Biberhaufenweg
Kirschenallee
Unteres
Mühlwasser
Brockhausengasse
Grohmannstraße
Ultzmanngasse

# Meilensteine - Auszug

aspern Die Seestadt Wiens

**1912**
Errichtung des Wiener Flughafens, der größte und modernste in ganz Europa.

**1. und 2. Weltkrieg**
Luftwaffenstützpunkt

**Ab 1945**
Flugplatz für zivile fliegerische Zwecke genutzt

**Ab 1977**
Schließung des Flugplatzes durch fortschreitenden Ausbau von Schwechat.
Danach dienten die Pisten noch dem Flugsport, der Pilotenausbildung sowie Autorennen.

**1982**
Ansiedlung des General Motors Werk

**1992**
Erstes Stadtentwicklungsprojekt durch starkes Bevölkerungswachstum und Ostöffnung (Architekt Rüdiger Lainer)

**2002**
Entwicklung neuer Stadtteil am Flugfeld Aspern aufgrund steigenden Bedarfs an neuen Wohn- und Betriebsstandorten. Das ehemalige Flugfeld ist derzeit die größte Stadtentwicklung Wiens und eines der größten Städtebauprojekte Europas. Die Grundstückseigentümer einigten sich mit der Stadt Wien auf eine gemeinsame Projektentwicklung mit anspruchsvollen Zielvorgaben.

# Meilensteine - Auszug

**2004**
Gründung der Asperner Flugfeld Süd Entwicklungs- und Verwertungs AG (heute: Wien 3420 Aspern Development AG)

**2005**
EU-weiter 2-stufiger städtebaulicher Wettbewerb für die Masterplanung

**2007**
Genehmigung des Masterplans des schwedischen Architekten Johannes Tovatt

**2008**
Internationaler Wettbewerb zur Erstellung von Gestaltungsstrategien für den öffentlichen Raum. Gewinner: Gehl Architects aus Dänemark

**2009**
Spatenstich für die U2

**2010**

Wettbewerb Technologiezentrum Aspern, 1. Preis: ATP Architekten

**voraussichtlich 2011**
Bauträgerwettbewerbe für Wohnbau, Wettbewerb Schulcampus

**2013 bis 2028 (in Planung)**
Fertigstellung der Seestadt Aspern, für 20.000 Bewohner/Innen

## Zahlen und Fakten

- 2,4 Mio. m² Grundfläche
- 20.000 BewohnerInnen (bis 2028)
- 8.500 Wohneinheiten
- 20.000 Arbeitsplätze:
  - 15.000 Büros und Dienstleistungsunternehmen
  - 5.000 Produktions- und Gewerbebetriebe, sowie Wissenschaft und Forschung

- Naherholungs- und Freizeitgebiet:
  - 5 ha großer See
  - 9 ha großer zentraler Park

- Verkehrsinfrastruktur:
  - U-Bahnlinie U2
  - Schnellbahnanschluss
  - Buslinien
  - Rad- und Fußwegenetz
  - Autobahnanschluss A23

## Luftbild Seestadt Aspern

[Quelle: Stadtentwicklung Wien, Wien 3420 Aspern Development AG]

# Luftbild Seestadt Aspern

**Luftbild Seestadt Aspern**

# FAMILY HOUSE PENKA

3911 Rappottenstein 34, NÖ

**OBJECT DATA**

| | |
|---|---|
| Type: | New building of Passive House |
| Constructor: | Fam. Penka |
| Planung: | Treberspurg & Partner ZT GmbH |
| Completed: | 2000/2001 |
| Size: | 203 m² |
| Heating energy demand : | 14 kWh/(m²a) |
| Netto Building Costs: | ca. 24.000 EURO |

Ventilation system mit earth collector, heat recovery and fresh air preheating unit

# THE DESIGN OF THE AUSTRIA HOUSE IN WHISTLER, CANADA

# What´s the overvalue of the Olympic Austria House?

Symbol for Canada and the world, how the energy issue could be solved and how sustainable development could be realized

- Most energy efficient building in the Olympic history
- Ecological building materials
- Salubrious indoor climate: fresh air quality, natural light and other contributions to raise workplace productivity
- High quality of planning (coordinator Erich Reiner) and workmanship: Sohm Holzbau, Optiwin, drexel&weiss and others


WHISTLER
CANADA
SUSTAINABLE
EXPORT
AUSTRIA

# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

(credit:Ira Nicolai)

# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

From Austria …

… to Canada

# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

Day 3

Day 5

# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

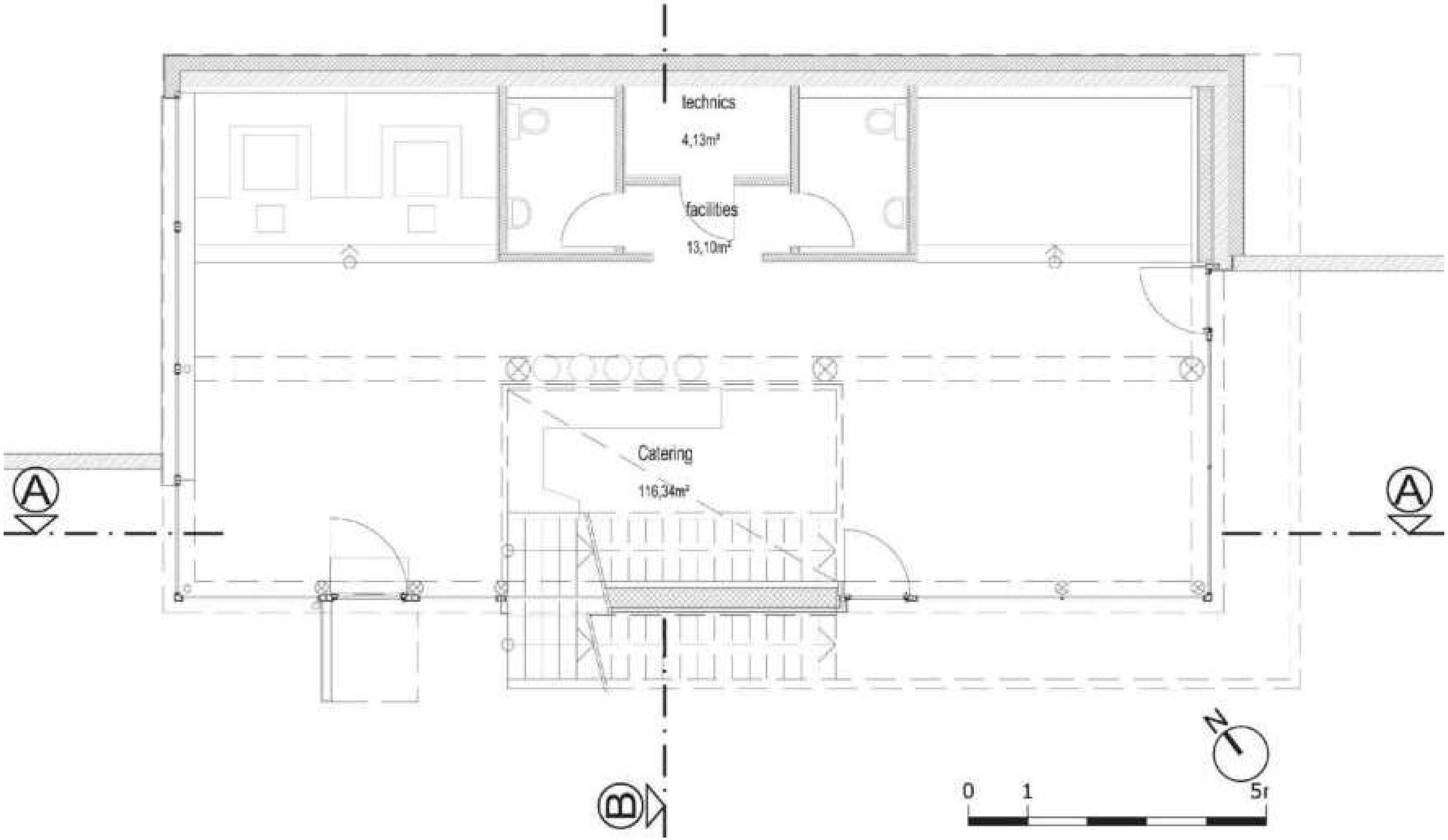
Installing windows

Topping out ceremony

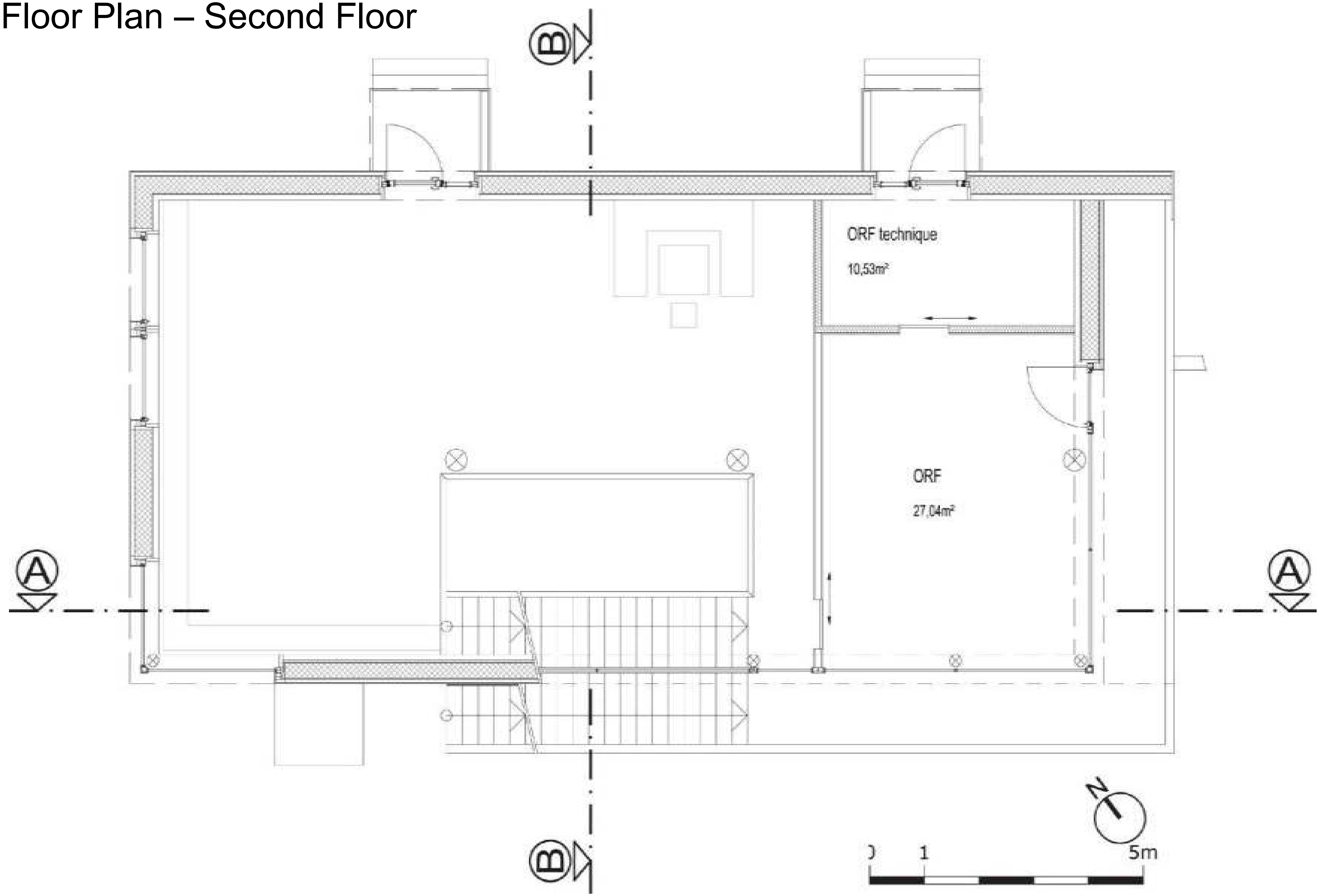
# THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

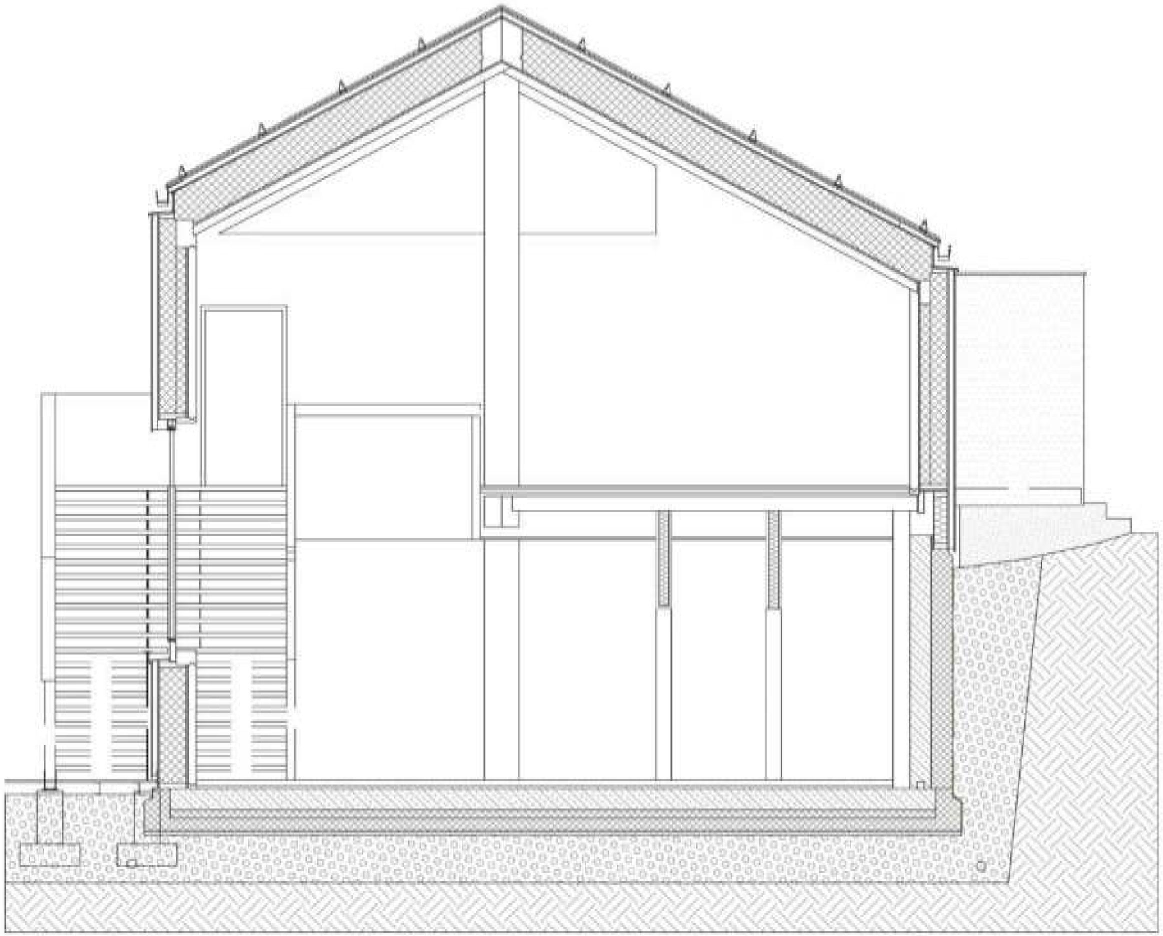
(credit: Ira Nicolai)

# Floor Plan – First Floor



# Floor Plan – Second Floor





**Cross section B M 1:100**

# AWARDS, PRIZES, QUALITY CERTIFICATES

The quality of the Austria House was awarded several times

ENERGY PERFORMANCE: Passive House Planning Package (PHPP). Passive House Institute Darmstadt

KLIMA:AKTIV Awarded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Manegement for Passive House Quality

DGNB – Pre-Certificate. International seal of quality for sustainable buildings. First building awarded by ÖGNI (World Green Building Council Austria)

# MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

## Hochschwab Mountain, Styria 2154 m

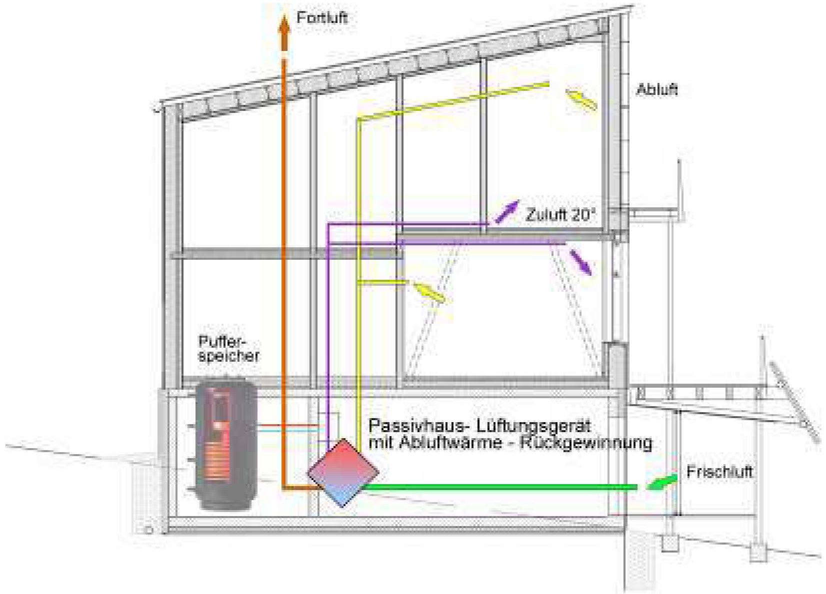
Developer: Austrian Tourist Club, Vienna
Architect: GP-ARGE pos architekten and Treberspurg & Partner Architekten ZT GmbH, Vienna

[Treberspurg & Partner Architekten ZT GmbH, Vienna]

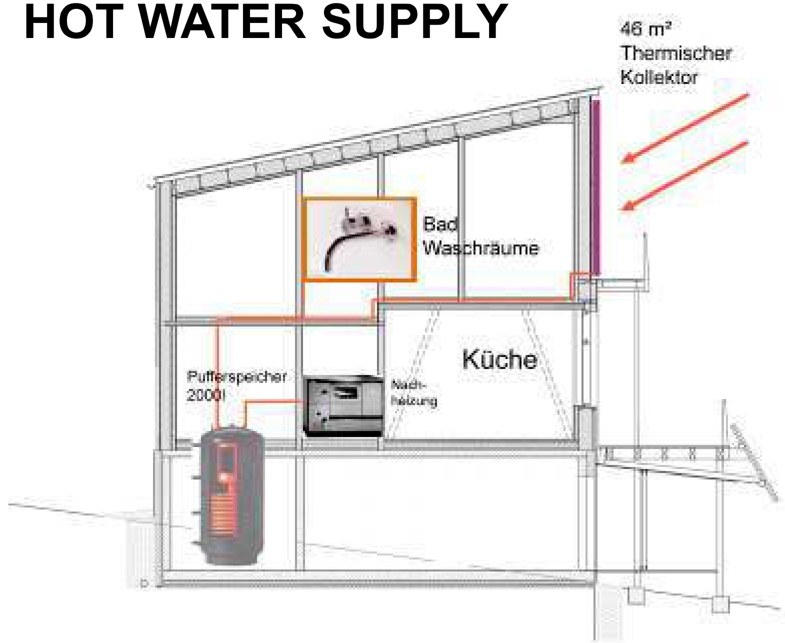
# MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

## Hochschwab Mountain, Styria 2154 m

### HEATING AND VENTILATION




### HOT WATER SUPPLY

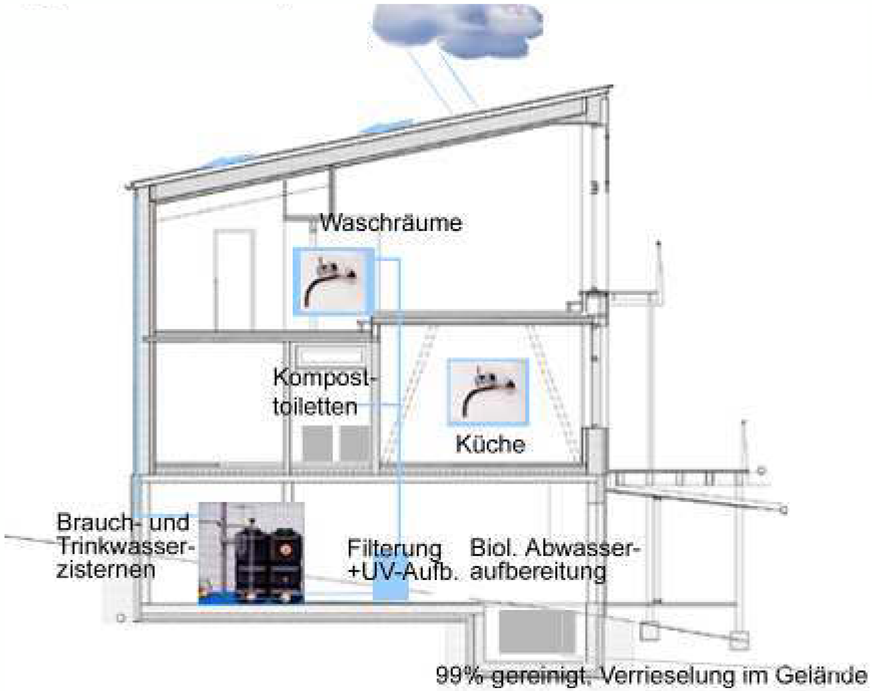



[Treberspurg & Partner Architekten ZT GmbH, Vienna]

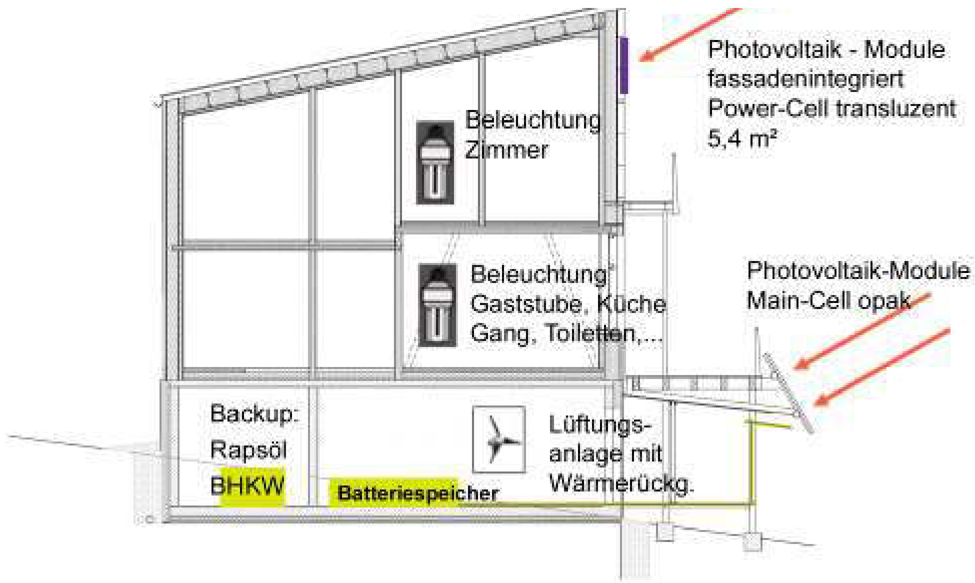
# MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

## Hochschwab Mountain, Styria 2154 m

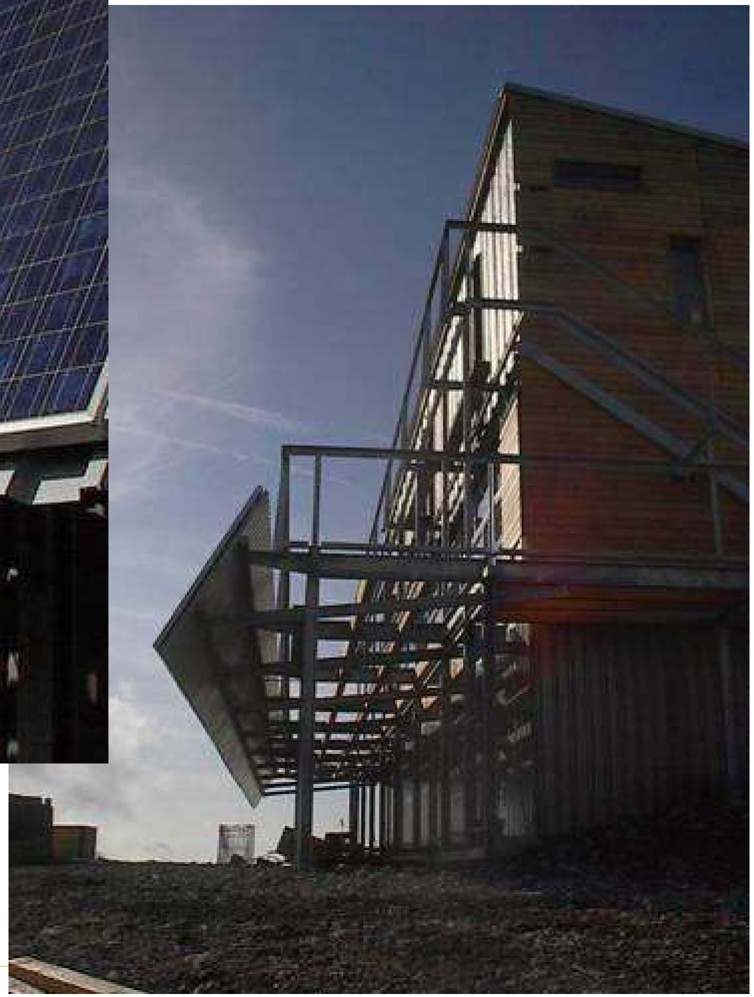
WATER SUPPLY ( RAIN WATER) AND BIOLOGICAL WASTE WATER SYSTEM




ELECTRIC POWER SUPPLY WITH PHOTOVOLTAIC SYSTEM




[Treberspurg & Partner Architekten ZT GmbH, Vienna]



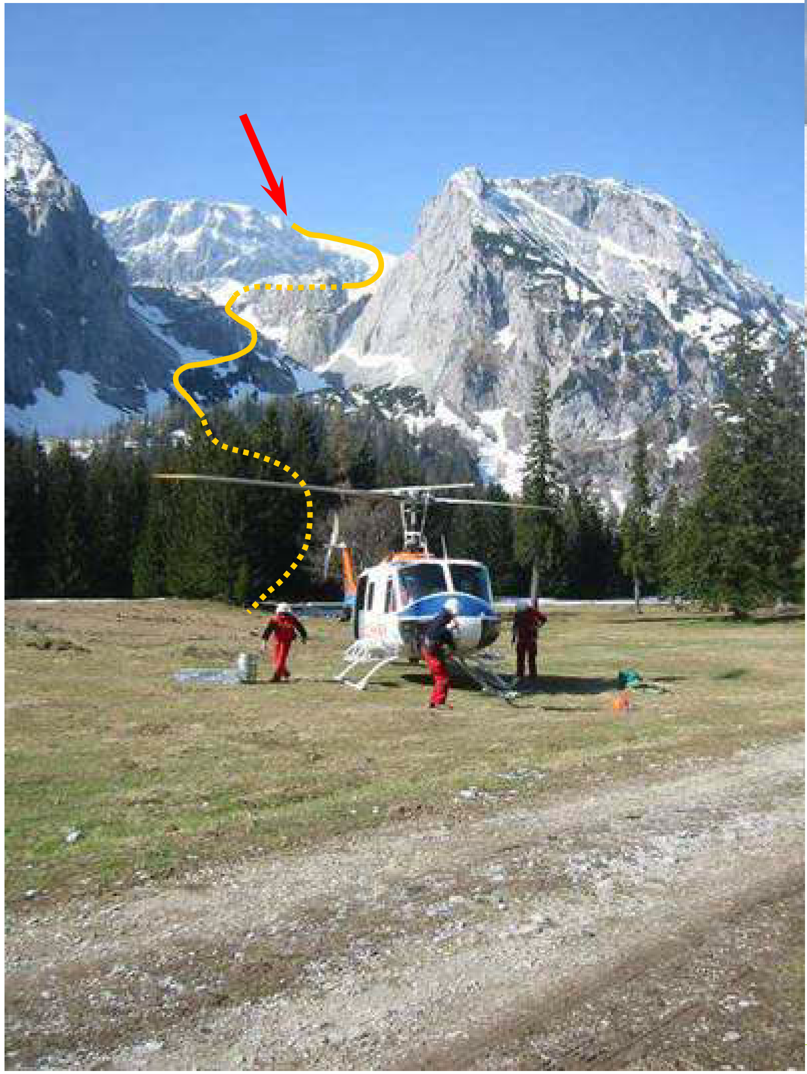
# 75 m² of photovoltaic cells

# MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

## Hochschwab Mountain, Styria 2154 m

[Treberspurg & Partner Architekten ZT GmbH, Vienna]

## May 2004: Transportation of building site equipment



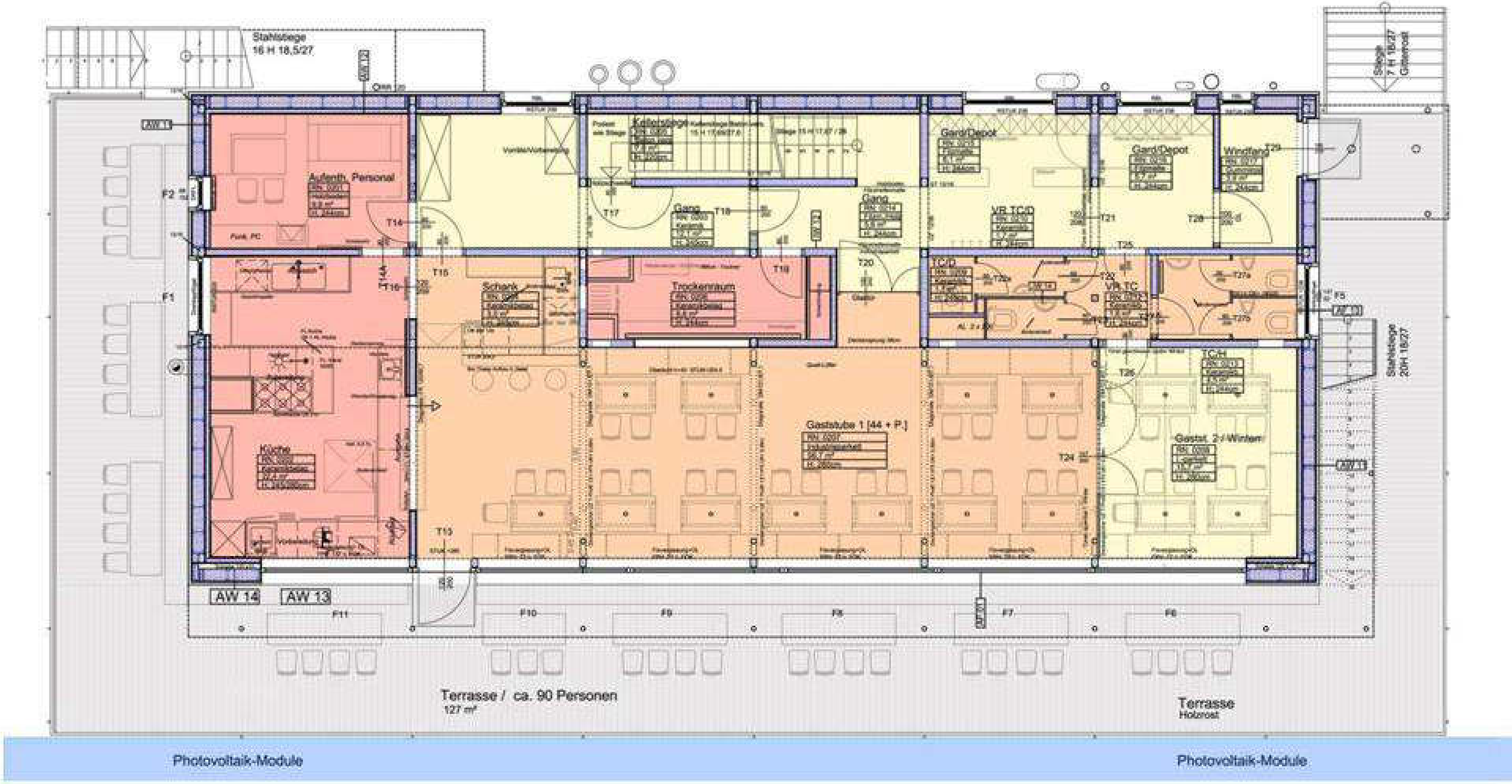
# MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

## Hochschwab Mountain, Styria 2154 m

January 2006

[Treberspurg & Partner Architekten ZT GmbH, Vienna]

[Treberspurg & Partner Architekten ZT GmbH, Vienna]




# BUILDING DESIGN – ORGANISATION OF FLOOR PLAN


The old Schiestlhaus - 120 years old and in a very bad condition.

## *…AGAIN AND AGAIN…. BAD WEATHER!!*



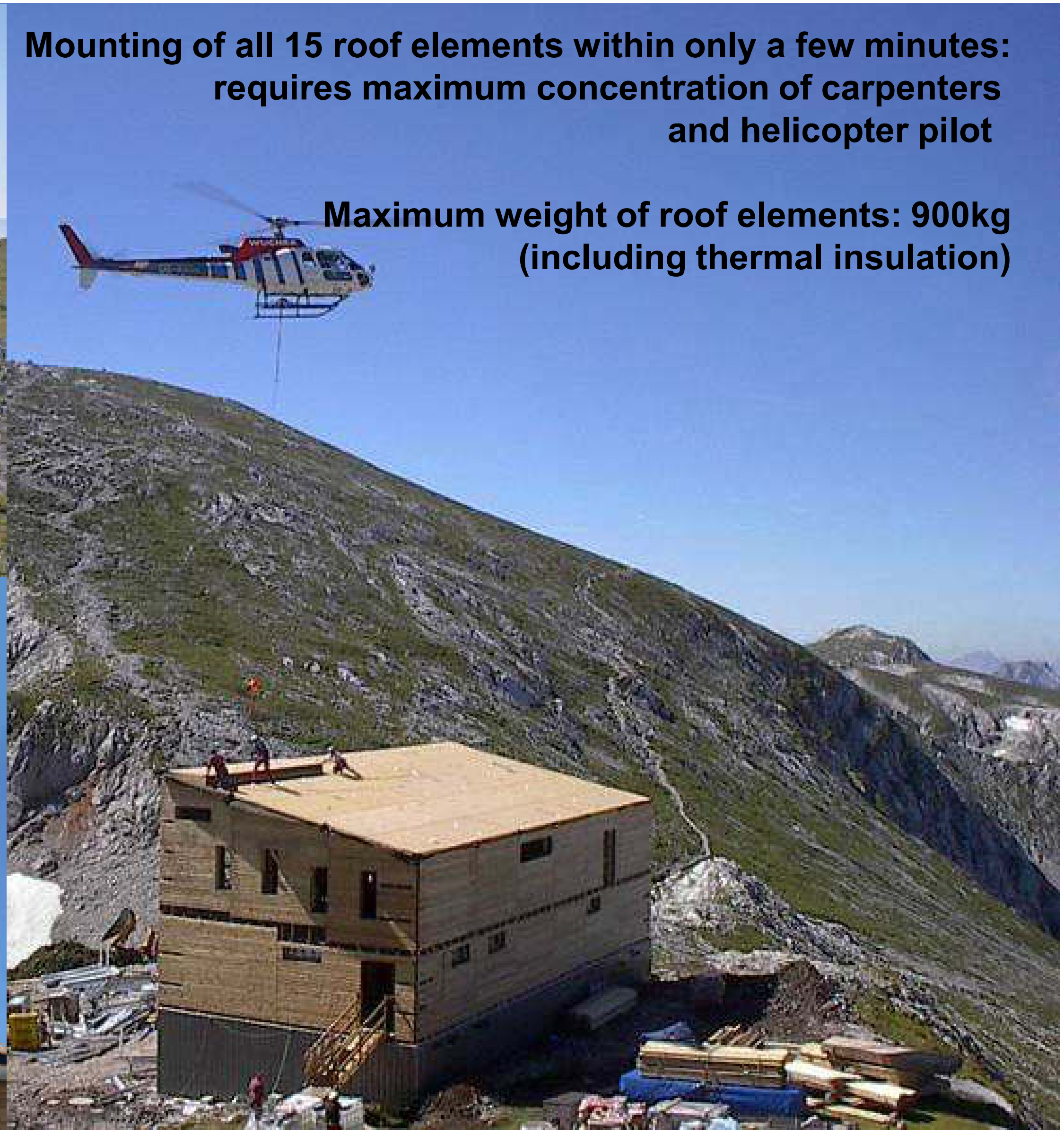

**Details of the wall-elements:**

**Joints of elements with pre-mounted air sealing and vapor barrier foils**

# Roof assembling
# September 2004

**Mounting of all 15 roof elements within only a few minutes: requires maximum concentration of carpenters and helicopter pilot**

**Maximum weight of roof elements: 900kg (including thermal insulation)**




YTONG
YTONG
YTONG
YTONG


winter 2004 / 2005


main guest room with large windows for solar gains

view from the north east


snow and ice covering as additional thermal insulation

Exhaust ventilator of the kitchen and radiation measurement units on the roof

# STATE OF THE ART

„1-liter car"

80% energy saving

„1-liter house" = Passivhouse

since 1991

90% less heating energy

# Green Roofs

# Examples of green roofs

„Neubau einer Wohnhausanlage", Wintergasse 53, 3002 Purkersdorf

Planning: DI Georg Reinberg, DI Martin Treberspurg, AusführungsPlanning und Bauaufsicht gemeinsam with Arch. Jörg Riesenhuber

Completed: 1984

- Refurbishment of an old villa inc. new roof (apartment) + 2 new buildings (apartments)
- 10 app. + common rooms
- Grass roofs

[Source: REINBERG]

# Examples of green roofs

„Neubau einer Wohnhausanlage“, Wintergasse 53, 3002 Purkersdorf

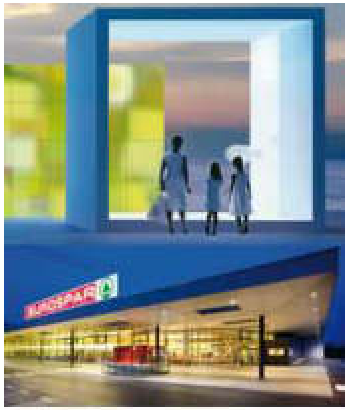
[Source: REINBERG]

# Spar Supermarket

Engerthstraße 230A, 1020 Vienna
Used space: 684 m2
Green space: 1.105 m2
- 230 m2 for sport


SPAR

SPAR

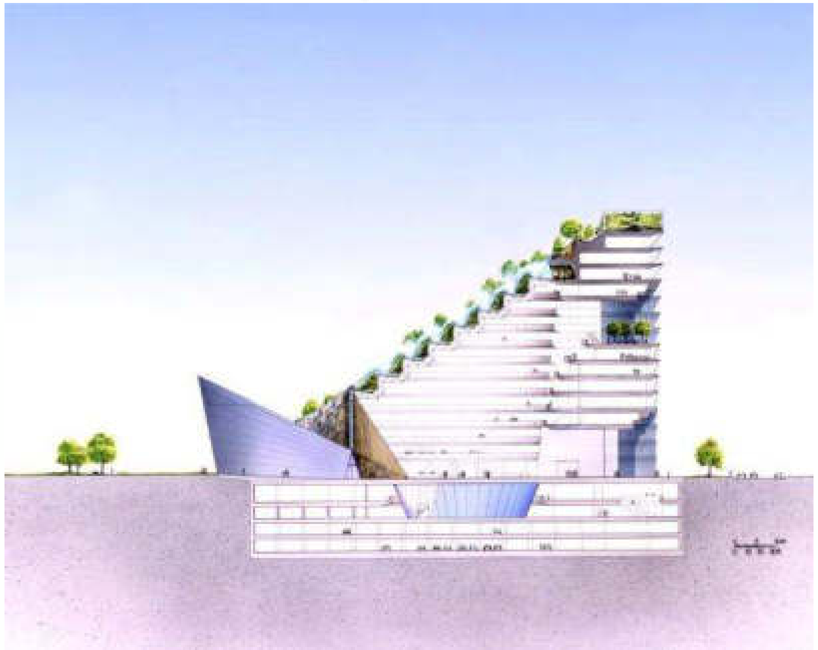


ZUMTOBEL

TANK E
WIEN ENERGIE

E
TANKSTELLE

# ACROS Fukuoka, offices under green terraces – Japan



# ACROS Fukuoka, offices under green terraces – Japan

**Art and Exhibition Hall roof garden** – Bonn, Germany.

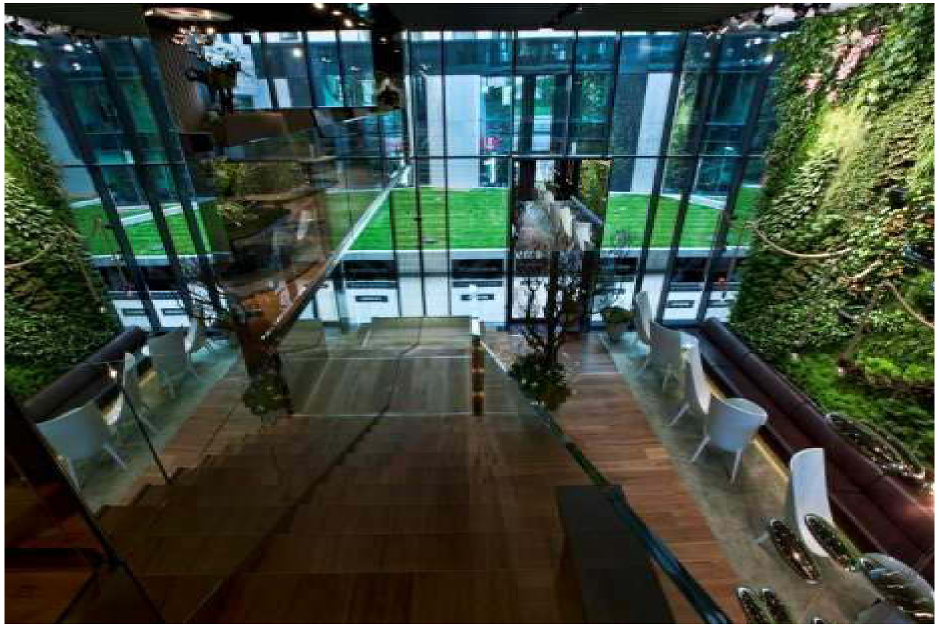

**Chicago City Hall** – the coolest place to be, thanks to this $2.5 million rooftop garden (*not* open to the public – the 11-storey drop might have something to do with this).

# Green Walls

# Patrick Blanc´s unique vertical garden

**Musée du quai Branly / Quai Branly Museum** , Paris

## **CaixaForum**, Museum in Madrid



**J&T Bank Cafee**, Bratislava

**Plants don’t need earth: only water, minerals, light and carbon dioxide”. Based on this simple axiom, Patrick Blanc built his first vertical garden in 1988, specifically in La Villette in Paris.**

# Thank you for your attention