Universität für Bodenkultur Wien
Department für Bautechnik und Naturgefahren

Eco-efficiency buildings and architecture

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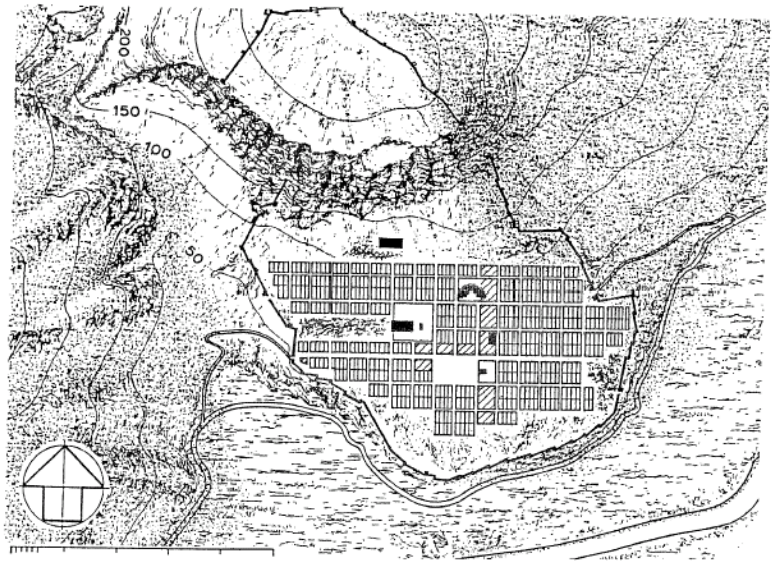
Institute for Structural Engineering, Sustainable Constructions

Prague
01.07.2010

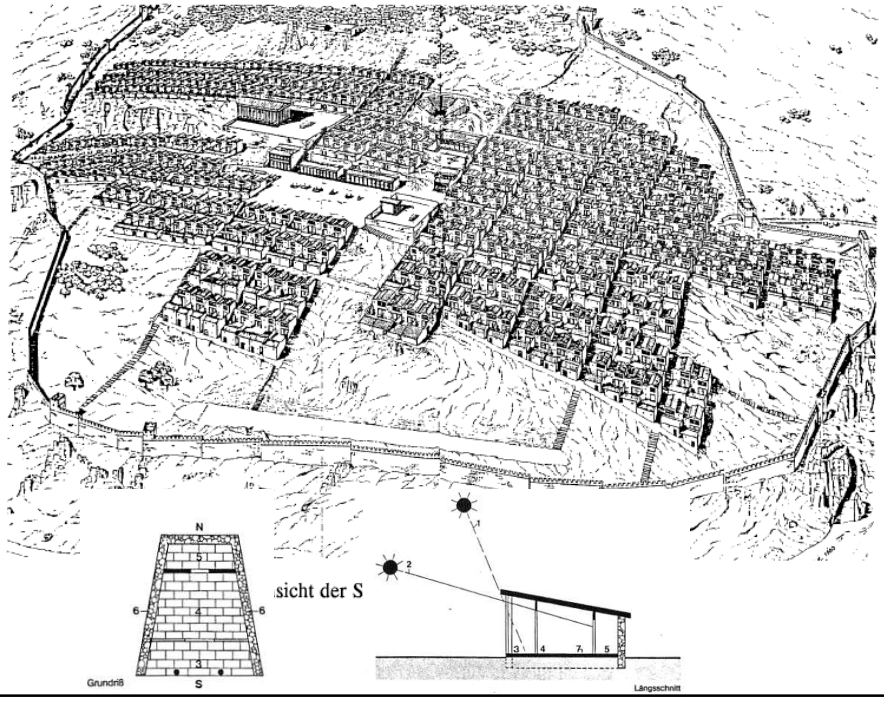
Introduction

- History
- Solarhouse, Greenhouse
- Consumption
- Passive house
- Examples

SOLAR ARCHITECTURE
Solarhouse – Low energy house – Passive house
ANCIENT WORLD: Sunhouse of Socrates (469 – 397 v. Chr.)



Stadtplan von Priene



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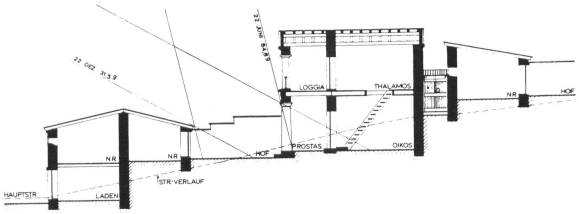
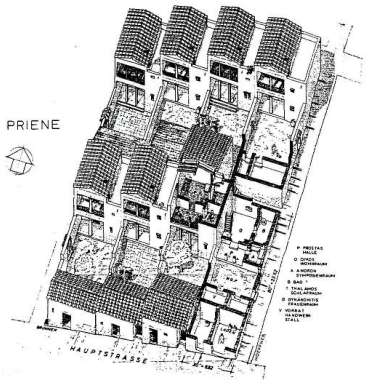
SOLAR ARCHITECTURE
Solarhouse – Low energy house – Passive house
ANCIENT WORLD: House in Priene





SOLAR ARCHITECTURE
Solarhouse – Low energy house – Passive house
GREENHOUSE + WINTERGARDEN

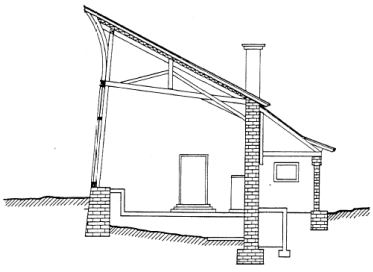
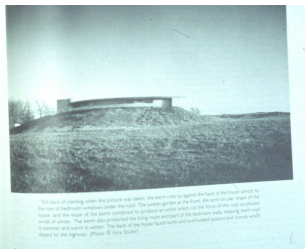
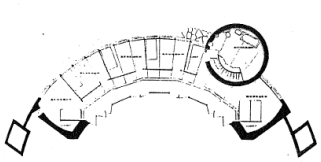


Abb. 2.14. :
Barockes Gewächshaus (Schnitt)

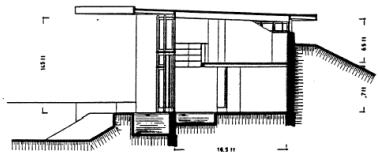
Greenhouse, Palace Garden of Telc, ca. 1800

SOLAR ARCHITECTURE
Solarhouse – Low energy house – Passive house
USA
Haus Jacobs II, „Solar Hemicycle“, in Middleton, Wisconsin, 1944, Frank Loyd Wright





GRUNDRISS



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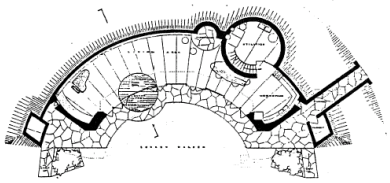
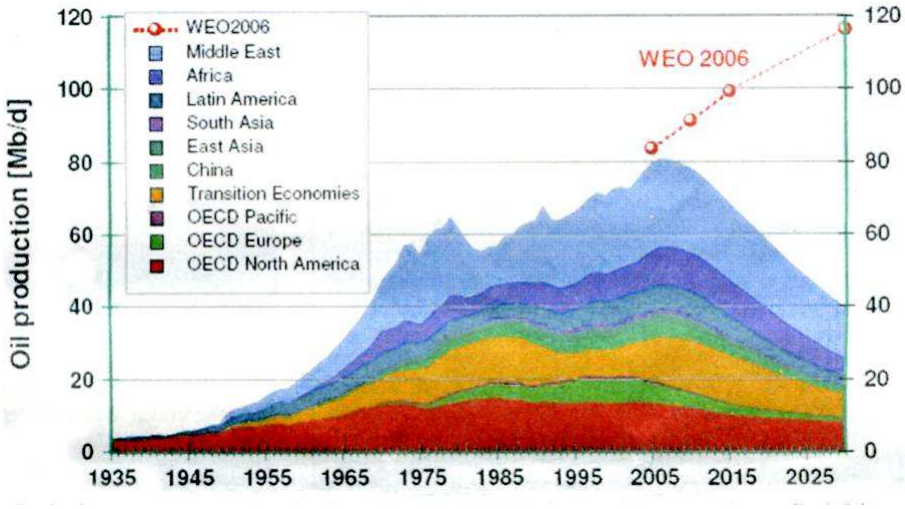


GRUNDRISS

Consumption

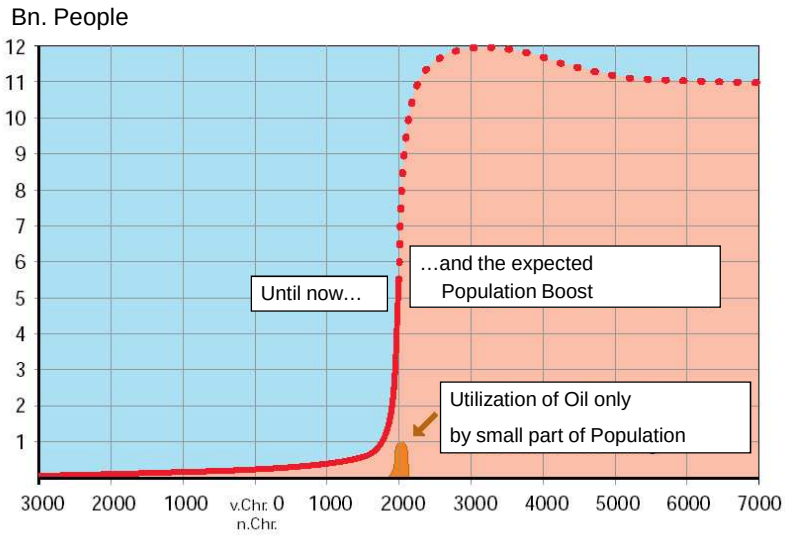
- Peak Oil
- Energy consumption
- Lifecycle

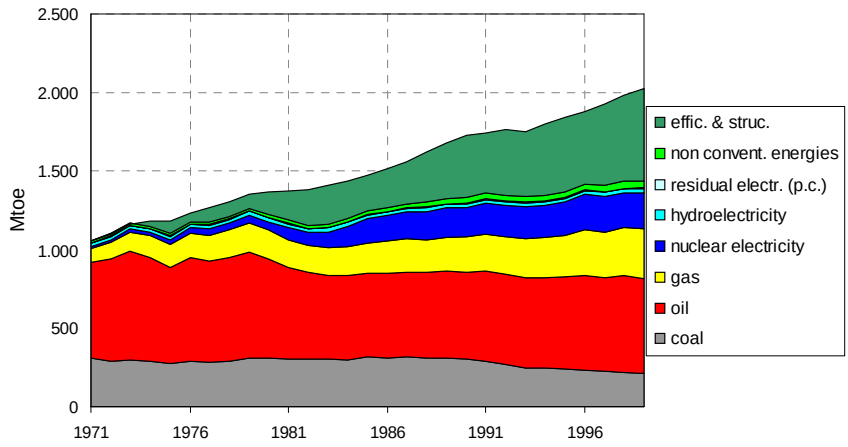
„Peak Oil“ was already in



Oilproduction [Mb/d] in 1935 – 2030. „Peak Oil“ continued after 2006.

[Quelle: Ludwig-Bölkow-Systemtechnik (2007) „Crude Oil – The Supply Outlook“. Energy Watch Group (Hrsg.)]





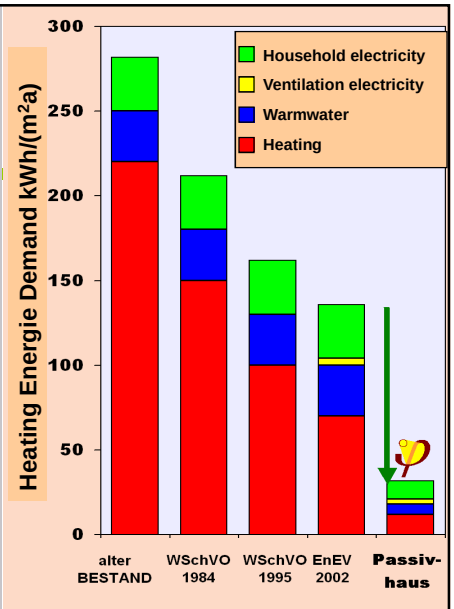
EUROPEAN UNION (15)*: Development of the primar energy consumption related to 1971. Source: ENERDATA / World Energy Database*

BIERMAYER, P., HEINDLER, M., HAAS, R., SEBESTA, B. (2004): Perspektive. In: Kernenergie, Klimaschutz und Nachhaltigkeit. Argumentarium zur Vorbereitung der UNFCCC COP 2004. Forum für Atomfragen, Vienna.

Factor 10

is

possible



Principles of the Passive House Concept

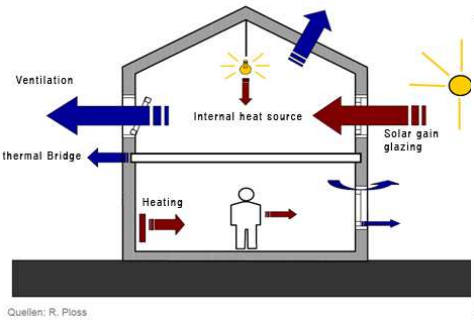
Definition (Passivhouse Institute Darmstadt - Dr. Feist):

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.

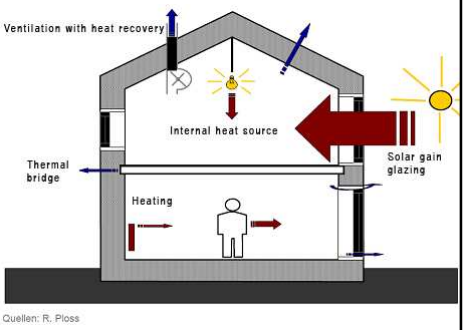
- ► Optimizing the building shell
- ► Loss minimizing before Profit Maximizing

Conventional House VS Passive House

Building Standard



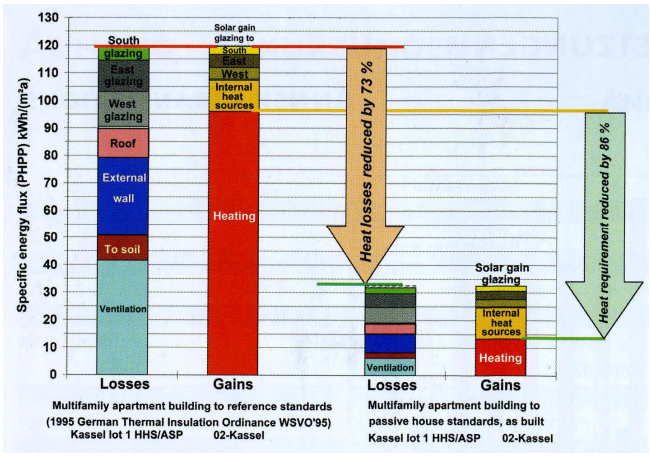
Passive House:



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.

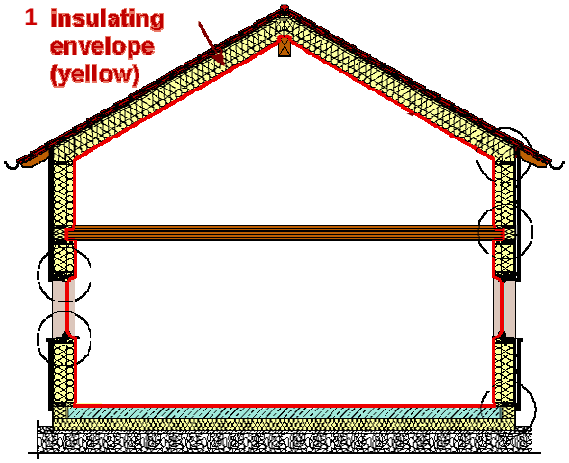
[source: CEPHEUS]

Principles of the Passive House Concept

Passive Houses require superior design and components with respect to:

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

Building Envelope: High Thermal Insulation

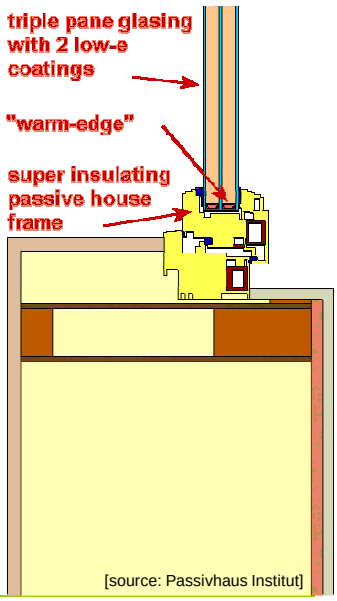


[source: Passivhaus Institut]

Building Envelope: Comfort Windows

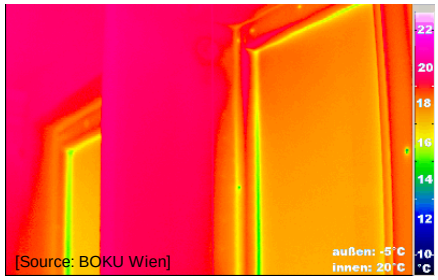
Example of triple pane glasing window

Window ≤ 0,8 W/(m²K) (R-7.1)



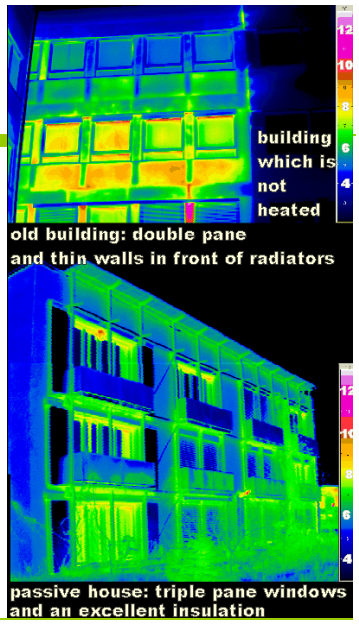
[source: Passivhaus Institut]

Building Envelope: Comfort Windows

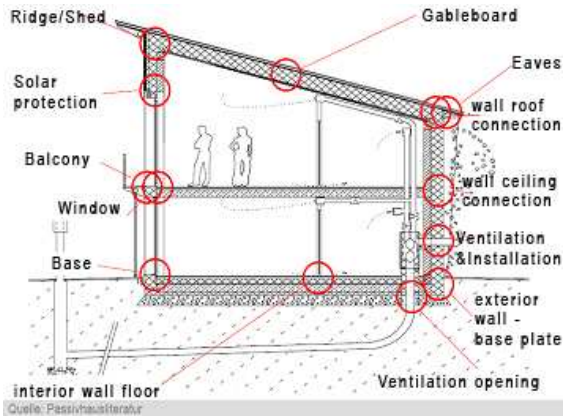


Passive House Window, Interior

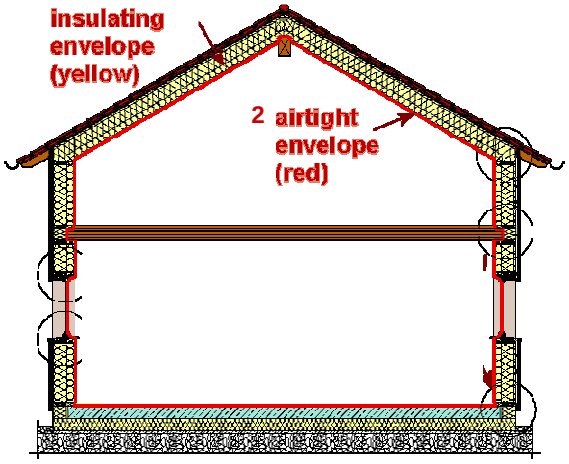
Infrared pictures of an old building and a passive house (at the bottom) for comparison (photos: PHI)



Building Envelope: Avoiding Thermal Bridges



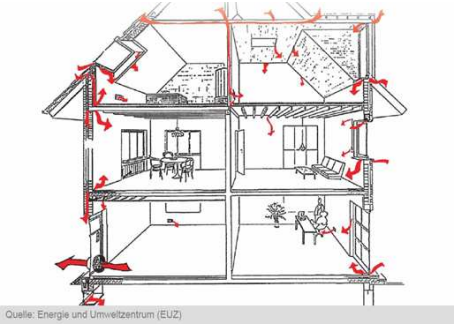
Building Envelope: Airtight Construction



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

[source: Passivhaus Institut]

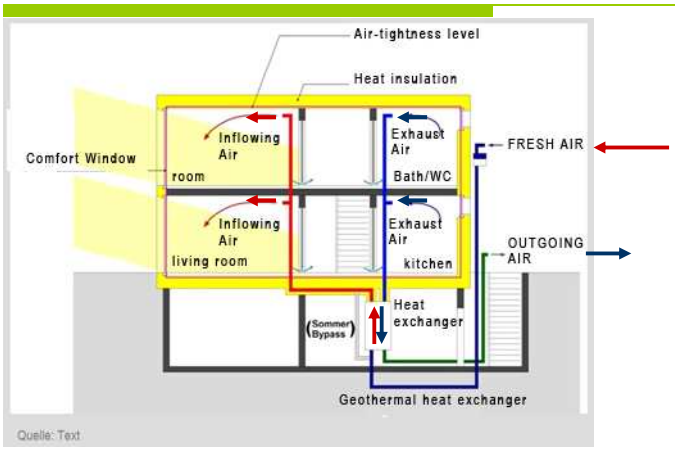
Building Envelope: Airtight Construction


Quelle: Energie und Umweltzentrum (EUZ)


„Blower-Door Test“
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

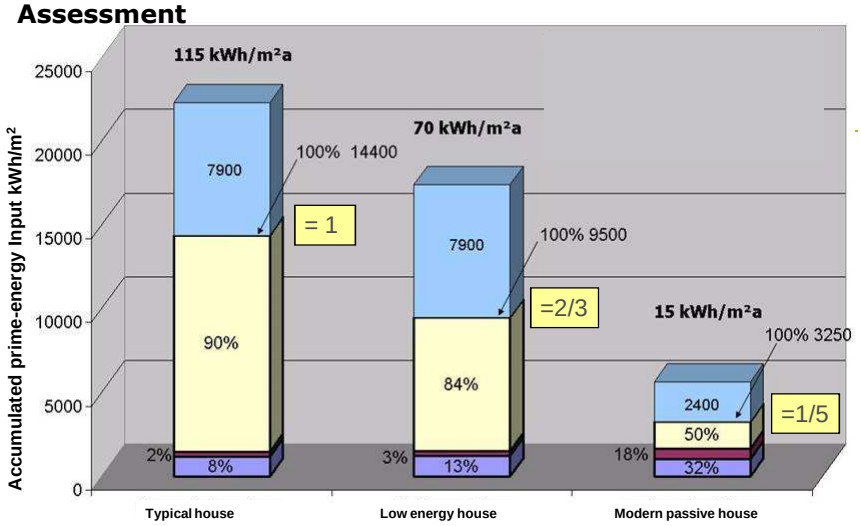


[source: CEPHEUS]

Passive House Challenges

- Know How for Planning and Construction Details necessary
  ->Architects of passive houses are familiar with the design of high quality and enduring joints.
- Higher costs for premium quality building components
  -> lack of conventional heating systems balances these costs
- User Behaviour plays an important role!

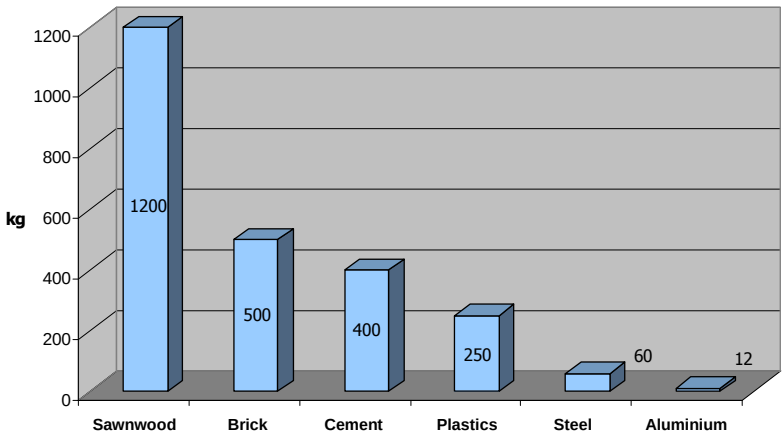
Life Cycle Assessment



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

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

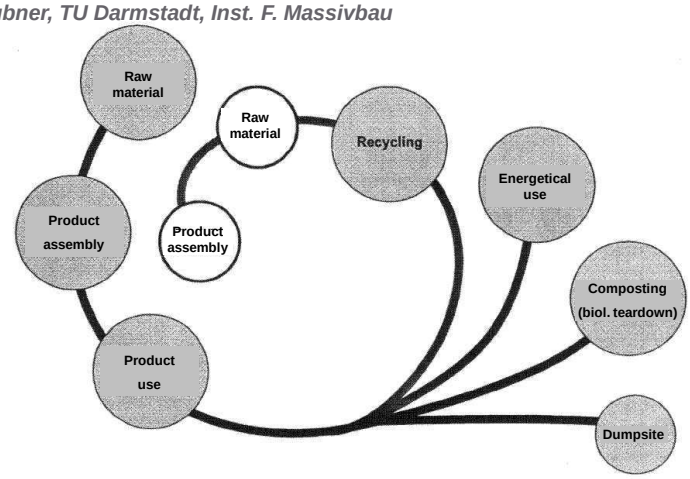


Fig 1 - The life-cycle of a product – "from the cradle to the grave".

Passive House Qualities

- Thermal comfort
- Air Quality
- Heating Adequacy
- Crisis Safety
- Architectural Neutrality
- Ecological Quality: low energy use, Renewable energy sources eg.: Solarthermal, Photovoltaic, Biomass, etc, ecological building material

-> SUSTAINABLE, COMFORTABLE & ENERGY EFFICIENT TECHNOLOGY

Certificates

- TQ-Bewertung
- TQ-Gebäudezertifikat
- IBO ÖKOPASS
- Zertifikate für nachhaltige Gebäude: Gebäudeausweis-Vorarlbg
- Energieausweis

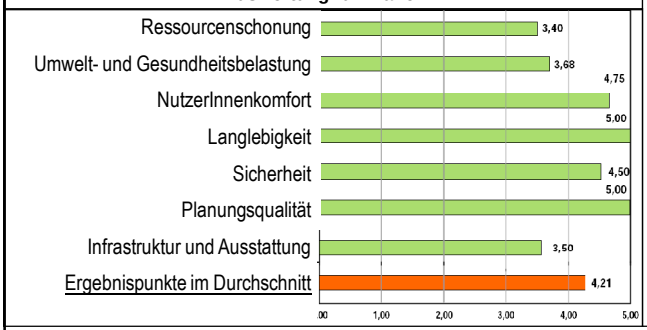
Zertifikate für nachhaltige Gebäude: TQ-Bewertung (2-fach)

Total Quality Assessment (TQ) für Planung + Evaluation.
TQ-Zertifikation: Kosten ab 6.000,- €

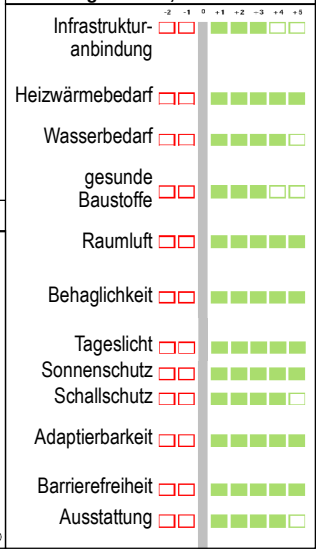
- 1. Vorprüfung
- 2. Datenerhebung
- 3. Anwendung der Kriterien und Indikatoren (TQ Tool 2_0.xls)
- 4. Total-Aggregation mittels Punktesystem
- 5. Zertifikat

LEGENDE
-2 **Schlechteste Wertung**
0 **Durchschnitt Bestand**
+5 **Beste Wertung**

Auswertung für Planer

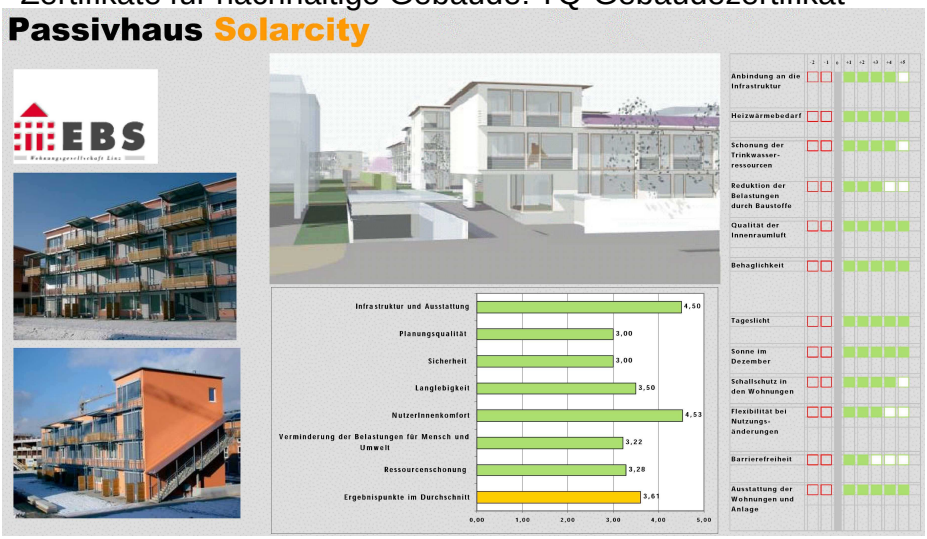


Auswertung für Nutzer, Eigentümer, Investor



Quelle: HdZ-Projekt 08/2004; Geissler et al., 2004

Zertifikate für nachhaltige Gebäude: TQ-Gebäudezertifikat



Lechner2005

Zertifikate für nachhaltige Gebäude: IBO ÖKOPASS

Qualitätskriterien:

Nutzungsqualität

- Behaglichkeit im Sommer und Winter
- Innenraumluftqualität
- Schallschutz
- Tageslicht und Besonnung
- Elektromagnetische Qualität

Ökologische Qualität

- Ökologische Qualität der Baustoffe und Konstruktionen
- Gesamtenergiekonzept
- Wassernutzung

Zertifikate für nachhaltige Gebäude: Gebäudeausweis-Vorarlbg.

Wohnbauförderung - Ökologischer Wohnbau 2004 - Neubau / Altbau

G E B Ä U D E A U S W E I S

Gebäudeart	Mehrfamilienwohnhaus	Wohnnutzfläche	1060	m^2 gesamt (WNF lt. Förderg)
Wohneinheiten	17	Bruttogeschossfläche	1276	m^2 gesamt (BGF)
Objektadresse	Errichterweg 9	Wohnungskosten	2180	€/m^2 WNF lt. Förderung
Plz., Ort	6850 Dornbirn	Grundstückkosten	150	€/m^2
Jahr der Erstellung	1972	Heizwärmebedarf spez.	42,5	kWh/(m^2 u. Jahr) BGF
Jahr der Sanierung	1990	Heizwärmebedarf	54230	kWh/Jahr
Parzelle-Nummer	Gp. 1234/12, 1234/13, 1234/14			

Planung	Behaglichkeit und Funktionalität	A	69%	9 von 13 Punkten
Standort	Flächen- und Grundbedarf	A	78%	7 von 9 Punkten
Energie	Heizwärmebedarf	B	84%	84 von 100 Punkten
Haustechnik	Energieversorgung	C	100%	25 von 25 Punkten
	Wärmeverteilung, Warmwasser	C	57%	29 von 51 Punkten
	Wasser und Elektrische Energie	C	40%	4 von 10 Punkten
Materialwahl	Ökologische Bewertung	D	69%	24 von 35 Punkten
	Ökoindex 3	D	80%	20 von 25 Punkten
	Lebensdauer und Wartung	D	50%	11 von 22 Punkten
Innenraum	Emissionsfrei	E	80%	8 von 10 Punkten
	Ökologische Gebäudequalität		75%	221 von 300 Punkten

50 Ökologische Maßnahmen mit 300 Punkten

Gmeiner2005

Energy standards

Use of energy standards:

Comparability of figures (standardised classification) through national implementation

Increase in market transperancy for renters, buyers and investors

Suggests recommended improvement measures to property owners

Assures quality to customers of newly built houses and renovation standards

Marketing-instrument for residential and real estate sector

ENERGIEAUSWEIS *Deckblatt*

Gebäudeart	Freistehendes Mehrfamilienhaus	**Erbaut im Jahr**	1999
Standort	Energiesparweg 3 4864 Attersee	**Einlagezahl**	12345
Katastralgemeinde	50001 Abtsdorf	**Grundstücksnummer**	123/1

Eigentümer/Errichter (zum Zeitpunkt der Ausstellung): Arbeitsgemeinschaft Gemeinnütziger Wohnungsbau Ges.m.b.H., Straße 1, 3002 Purkersdorf

Wärmeschutzklassen		Energiekennzahl
Niedriger Heizwärmebedarf	Skalierung	HWB_{BGF}
A	$HWB_{BGF} \leq$ 30 kWh/(m²·a)	
B	$HWB_{BGF} \leq$ 50 kWh/(m²·a)	
C	$HWB_{BGF} \leq$ 70 kWh/(m²·a)	HWB_{BGF} 77 kWh/(m²·a)
D	$HWB_{BGF} \leq$ 90 kWh/(m²·a)	
E	$HWB_{BGF} \leq$ 120 kWh/(m²·a)	
F	$HWB_{BGF} \leq$ 160 kWh/(m²·a)	
G	$HWB_{BGF} >$ 160 kWh/(m²·a)	
Hoher Heizwärmebedarf		

Volumsbezogener Transmissions-Leitwert $P_{T,V}$ [1]	**0,30 W/(m³·K)** [1]	[1] *Angabe freigestellt*
LEK-Wert [1]	**37** [1]	
Flächenbezogene Heizlast P_1 [1]	**40,4 W/m²** [1]	
Flächenbezogener Heizwärmebedarf HWB_{BGF}	**77 kWh/(m²·a)**	
Gesetzliche Anforderung an den flächenbezogenen Heizwärmebedarf HWB_{BGF}	**81 kWh/(m²·a)**	

Abbildung: Beispiel eines Energieausweises (OIB Muster für einen Energieausweis; Stand 06.08.1998)

Examples

- Austria house
- Schiestl-house
- Solarcity
- Roschegasse
- Family house Penka
- Osramgrunde
- Raymondgasse
- ....

THE DESIGN OF THE AUSTRIA HOUSE WHISTLER

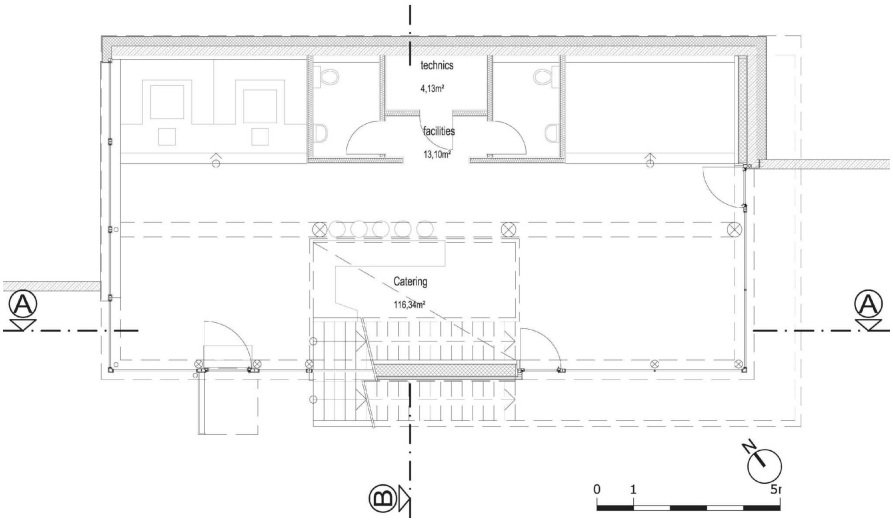
What´s the overvalue of the Olympic Austria House?

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

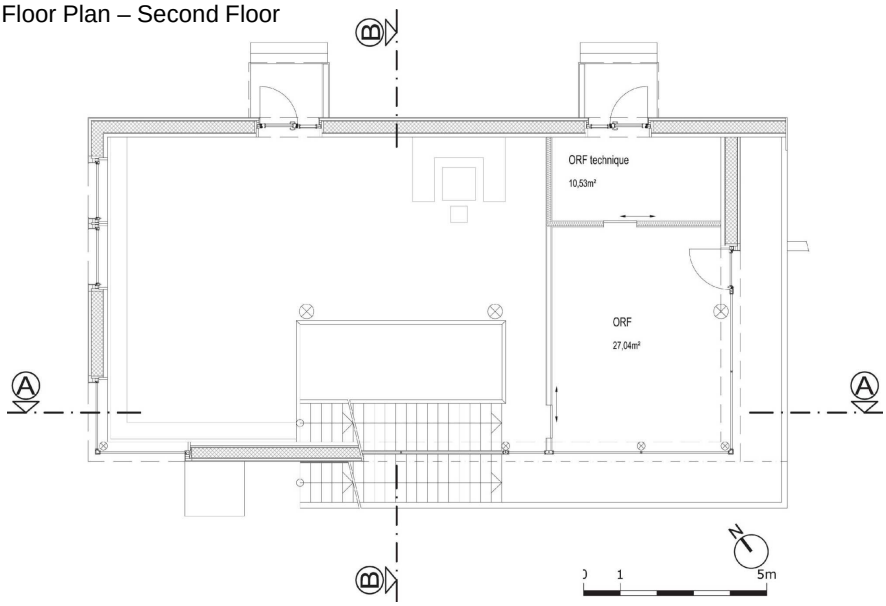
- Most energy efficient building in the Olympic history
- Ecological building materials
- Salubrious indoor climate: fresh air quality, natural light and other contributions to raise workplace productivity
- High quality of planning (coordinator Erich Reiner) and workmanship: Sohm Holzbau, Optiwin, drexel&weiss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

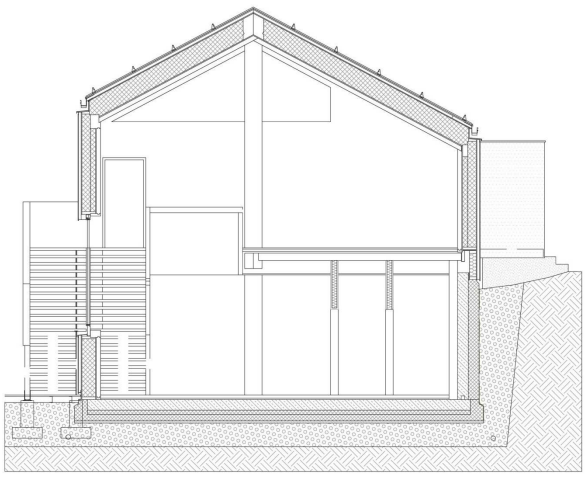
Eco-efficiency buildings and architecture I I University of Natural Resources and Applied Life Sciences

Floor Plan – First Floor



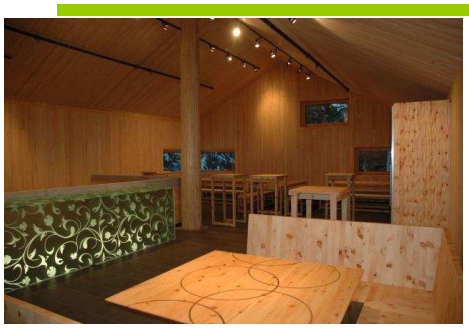
Floor Plan – Second Floor





Cross section B M 1:100

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)

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

klima:aktiv

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

DGNB ÖGNI

Team & Partners:

Architect
Treberspurg & Partner Architects ZT GmbH, 1140 Vienna

Austrian Passive House Group APG:
Ingenieurbüro Reiner, Bezau (Coordination)
drexel und weiss – innovative compact comfort ventilation system, Wolfurt
Optiwin Fenster+Türen, - PH-Windows, Ebbs
Sohm Holzbautechnik, Timber Construction, Alberschwende
Zweiraum Werbeagentur, Imst (Marketing)

(credit:Ira Nicolai)

Partner in Canada
Sea to Sky Consulting, Vancouver
Dürfeld Log Construction, Whistler (Construction)

Projectpartner
Resort Municipality of Whistler, Whistler Blackcomb Foundation,
Österreichisches Olympisches Comitee (ÖOC),
BOKU-Wien, Uni Innsbruck, ORF, klima:aktiv, WKO, SOS Kinderdorf,
www.oesterreichhaus.at

MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

Hochschwab Mountain, Styria 2154 m

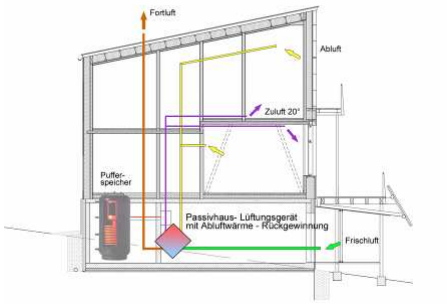
Developer: Austrian Tourist Club, Vienna
Architect: GP-ARGE pos architekten and Treberspurg & Partner Architekten ZT GmbH, Vienna

[Treberspurg & Partner Architekten ZT GmbH, Vienna]

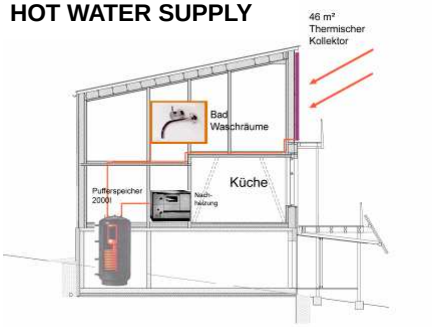
MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

Hochschwab Mountain, Styria 2154 m

HEATING AND VENTILATION



HOT WATER SUPPLY

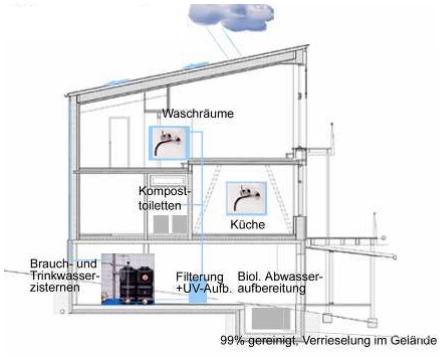


[Treberspurg & Partner Architekten ZT GmbH, Vienna]

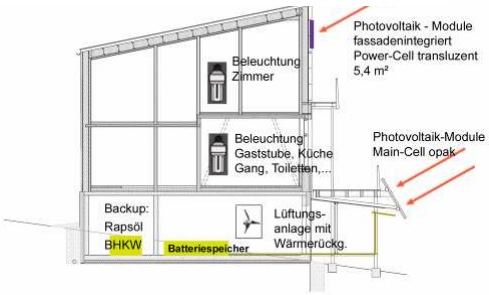
MOUNTAIN REFUGE USING PASSIVE HOUSE TECHNOLOGY „SCHIESTL-HOUSE“

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]

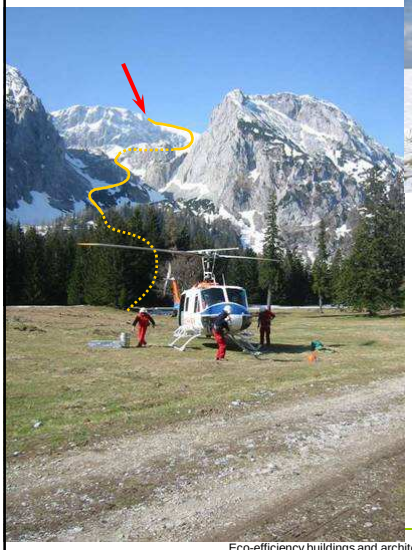
75 m² of photovoltaic cells

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]

Snímek 55

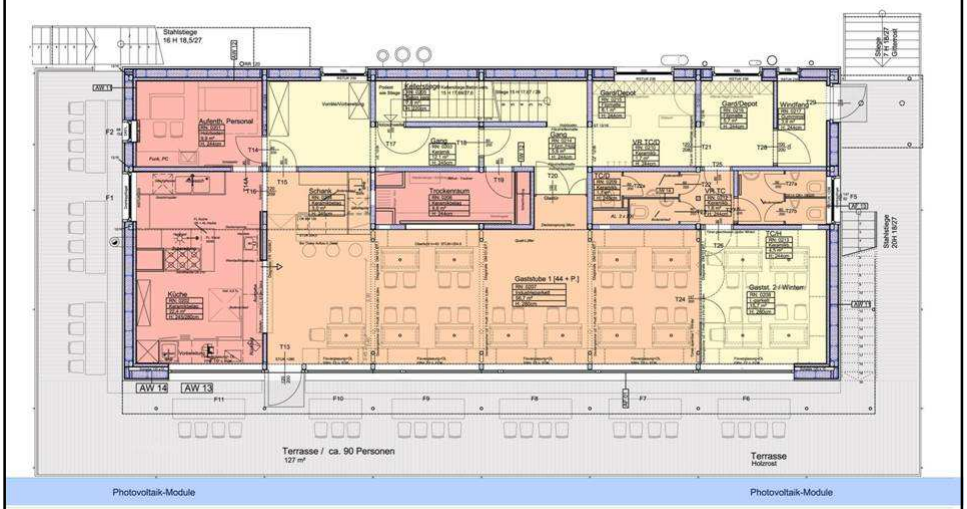
CW15 Baustelleneinrichtung:

Dirket Sichtverbindung zwischen Edelbodenalm und Bauplatz, Flugzeit 3min, Gehzeit knapp unter 2 Stunden

Baumaschienen mußten auf Transportkapazität der Helikopter zerlegt werden und zusammengebaut werden (tlw. eigene Monteure)

Christian Wolfert; 23.4.2005

[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!!

CW16

Details of the wall-elements:

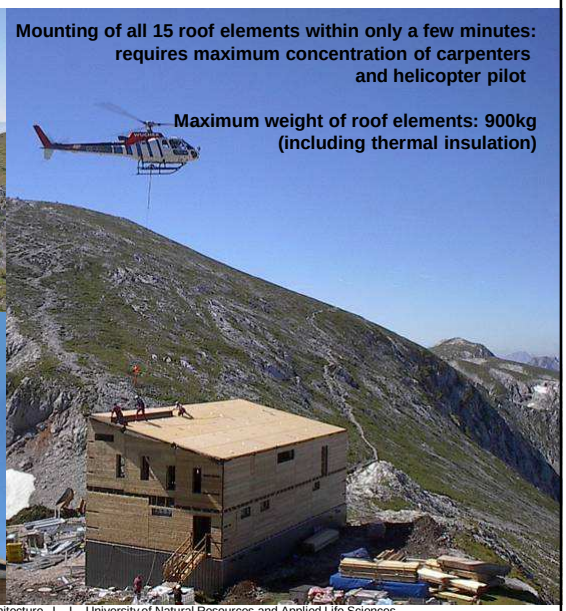
Joints of elements with pre-mounted air sealing and vapor barrier foils

CW17

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)



Snímek 61

CW16

Alle Steher der tragenden Querschotten wurden sind bereits im Werk mit Dampfbremse umwickelt worden, damit beim Aufbrungen der Dampfsperre an dem Außenwänden keine Schwachstellen entstehen.

Auch die Windsperre wurde mit großen Überständen im Werk montiert, einerseit zu Schutz vor Witterung auf der Baustelle und andererseits zur leichteren Verbindung (Verklbung) untereinander
Christian Wolfert; 26.4.2005

Snímek 62

CW17

Alle Dachelemente werde zuerst zur Baustelle geflogen und dann innerhalb kürzester Zeit montiert

Dachelemente bestehen aus DJI-Trägern , komplett fertig mit Wärmedämmung und oberer und unterer Beplankung.

Riesige Erleichterung von allen Beteiligten.
Christian Wolfert; 26.4.2005


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"

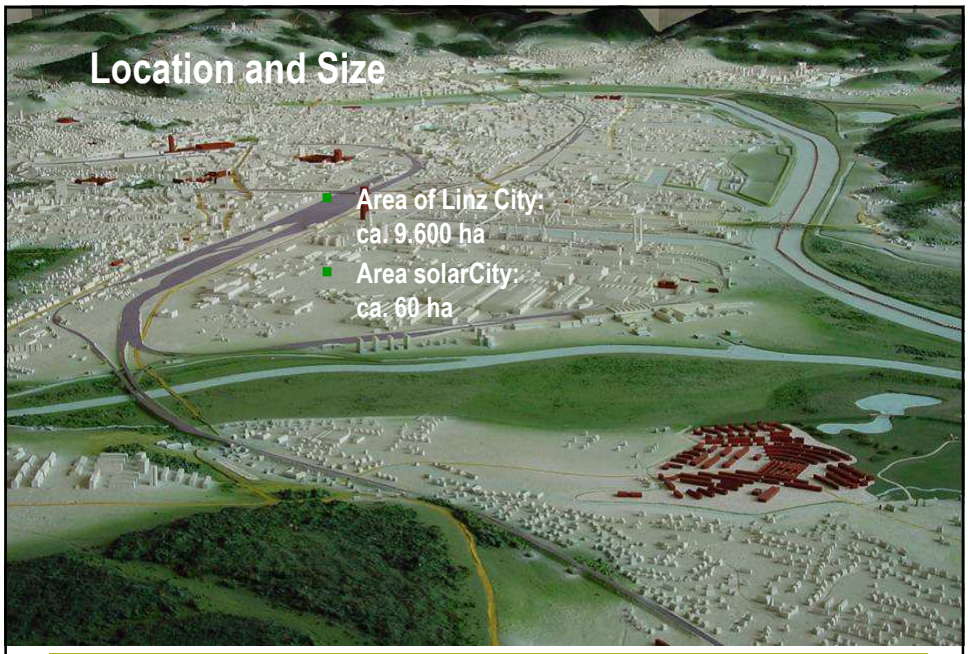
80% energy saving

„1-liter house" = Passivhouse

since 1991

90% less heating energy


solarCity
Linz City Expansion Project
1996-2005


Location and Size
Area of Linz City:
ca. 9.600 ha
Area solarCity:
ca. 60 ha