Universität für Bodenkultur Wien
Department für Bautechnik und Naturgefahren

Green Architecture

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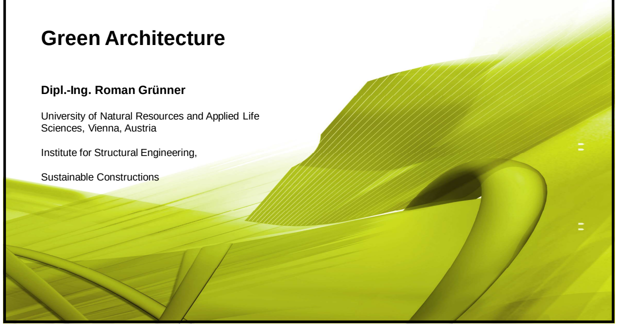
Institute for Structural Engineering,

Sustainable Constructions



Content

What is green architecture

The 10 Green Commandments

1. Green urbanism
2. Relationship to nature, climate
3. Local traditions, architecture as an ecosystem
4. Environment friendly materials
5. Energy savings in building operation
6. Alternative energy sources
7. Life-cycle management
8. Adapting to the needs
9. Greenery and architecture
10. Combination of the principles

Ing. arch. Henrich Pifko, PhD.
iEPD, FA Bratislava

1. Green urbanism

Leaving the cities – ideal of many people

Result: destruction of recreation and agricultural areas
heterogenous living mash
mostly depending on car traffic
collaps

Solution: adding greenery
rising quality of life
providing diversity of housing
social qualities

Bo01, Västra Hamnen, Malmö, Sweden

Charakter územia Bo01 a dominanta 'Turning Torso' Foto © Jana Milosovicova / EcoCityLab

Bo01, Västra Hamnen (Malmö, Sweden) Foto © Rafael Pizarro / EcoCityLab

Bo01, Västra Hamnen, Malmö, Sweden

Park v Bo01 Foto © Jana Milosovicova / EcoCityLab

Novo založená cyklistická infraštruktúra v Bo01 Foto © Rafael Pizarro / EcoCityLab

2.Relationship to nature, climate

Respons of the architecture to nature

Invasive dimensions
Soil sealing with asphalt and concrete
Solar architecture - adapting to local clima,
- wintergardens,
- shaded atrium

3.Local traditions, architecture as an ecosystem

Tradition is not directly related to environmental protection, but rather the protection of identity, genius loci and socio-cultural values.

The traditional approach is often a considerate approach to environment, generations of experience helping in choosing a suitable site and to optimize the design and choice of materials.

4. Environment friendly materials

- materials from renewable resources (wood in the forest grow back if it reasonably taken)
- or from abundantly available sources,
- energy efficient,
- recycled (such as cellulose insulation)
- and recyclable
- materials that do not harm the environment when manufactured, in construction, by operation or liquidation.

5. Energy savings in building operation

- Lowering energy consumption in buildings
- Energy for heating
- Energy for warm water
- Electricity

- Low energy houses
- Passive houses

6. Alternative energy sources

- Even energy efficient building need energy
- Can be covered from renewable sources
- Photovoltaics
- Heat pump
- Solar collectors

7. Life-cycle management

„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

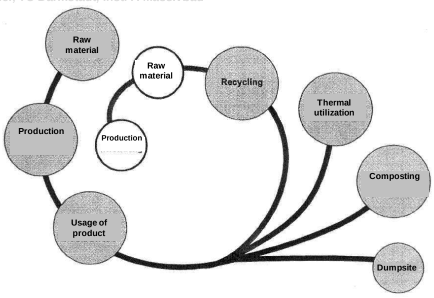


Fig 1 - The life-cycle of a product – "from the cradle to the grave".

8. Adapting to the needs

- People mostly cannot define the size of their needs
  - Result: unnecessarily big houses, gardens, cars
    - City streets designed for cars
    - Missing link to open spaces

9. Greenery and architecture

- Plants can become part of architecture, not only addition

10. Combination of the principles

- Partial solution are not effective
- synergistic effect of active measures can push the architectural value to a qualitatively higher level.

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“.

Green architecture = Sustainable architecture

Sustainability

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.

Resources in Building Industry

-Energy: for Material production, operating buildings, demolition and disposal

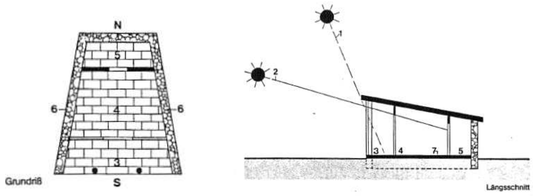
-Soil: ground for building, living space for organisms and production of biomass, oxygen and drinking-water

-Water: living space, origin of life

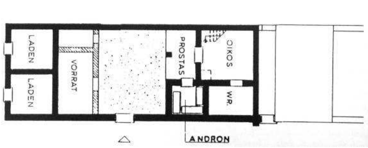
-Resources: renewable vs. non-renewable ressources.

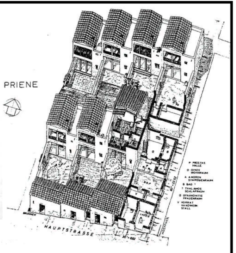
History

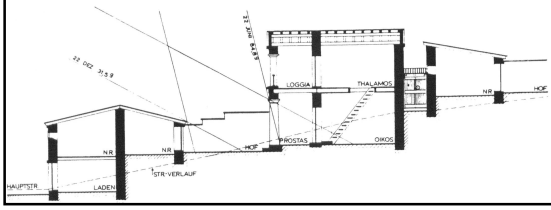
SOLAR ARCHITECTURE
House of Socrates (469 – 397 b. C.)



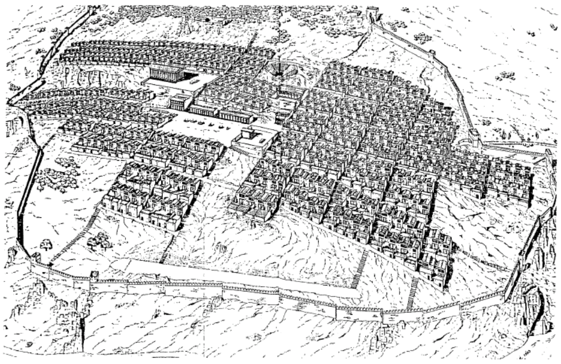
SOLAR ARCHITECTURE
Atriun house in Priene







SOLAR ARCHITECTURE
Reconstruction of the city of Priene (300 b.C.)



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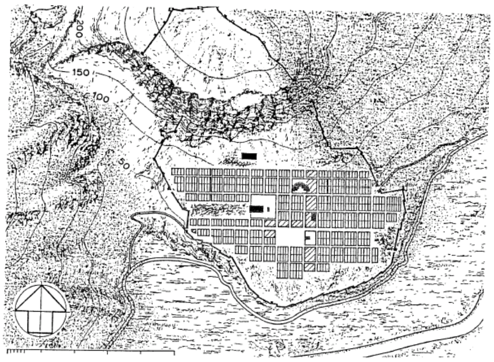
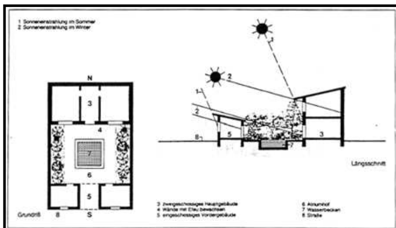
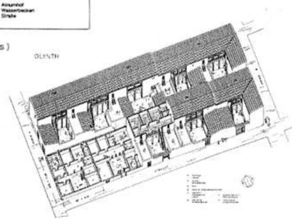


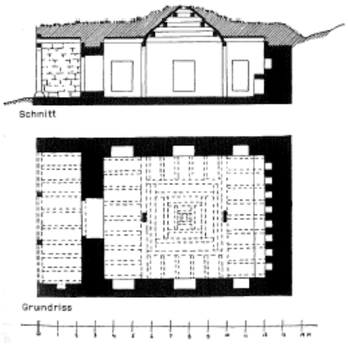
Stadtplan von Priene



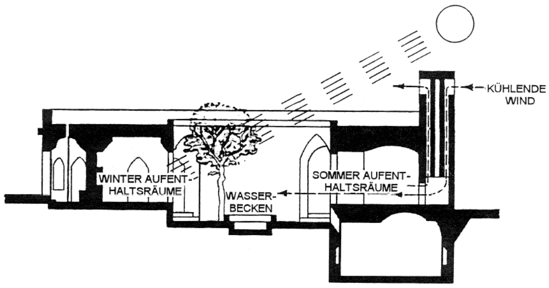
Atriumhaus der Antike (ab 2.Jh.v.Christus)

Atrium house in Ancient time

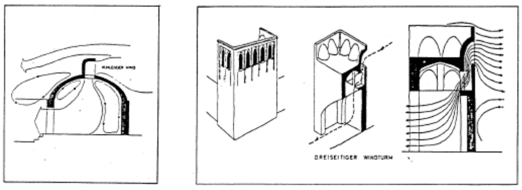




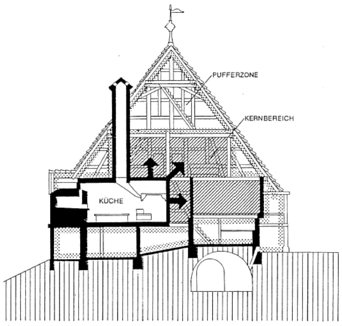
House in Digomi, Afghanistan



Persian House with sunloggia and wind tower



Natural air conditioning in building of persian times



Bavarian village house

SOLAR ARCHICTURE
Solarhouse – Low energy house – Passive house
Greenhouse + Winter garden

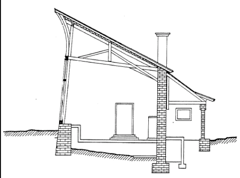
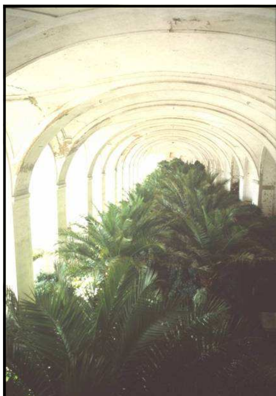
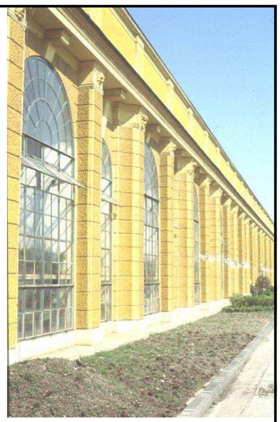


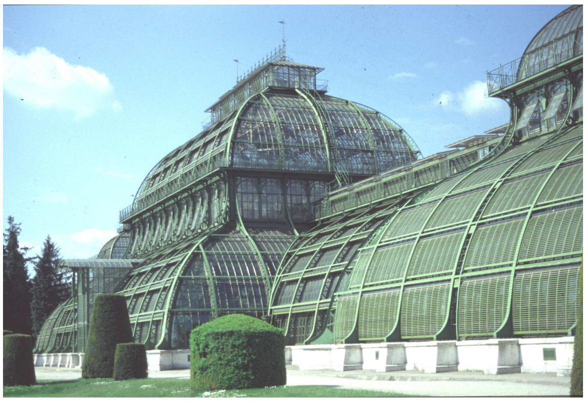
Abb. 2.14. :
Barockes Gewächshaus (Schnitt)

Telč, ca. 1800





Orangerie Schloss Schönbrunn, Wien, 1755

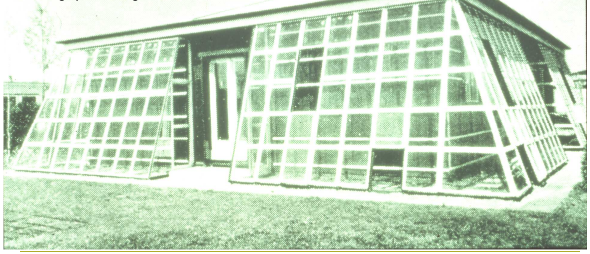


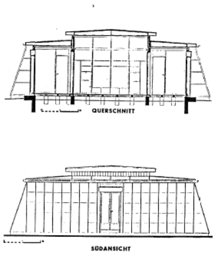
Competition „The Growing House“, Berlin 1931

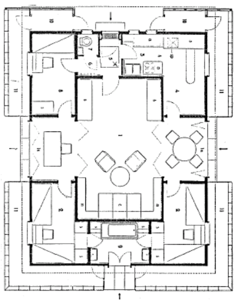
1000 Participants: from 24 award-winning projects 13 houses with wintergarden

Project Martin Wagner, Onionskin principle - House with three thermal areas:

1. „Protecting Glass Walls “ as „Suncatcher“ and „Topcoat“ = unheated buffer
2. Bedrooms = tempered
3. Living space = highest heat zone

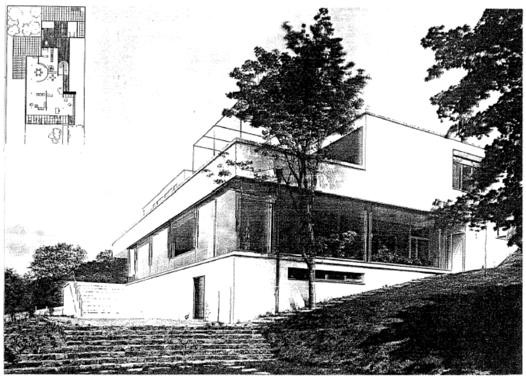




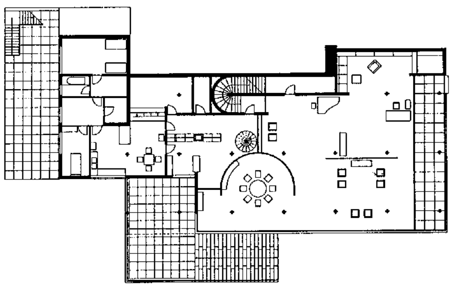


Martin Wagner – Competition project, “The growing House”

Villa Tugendhat, Brünn, 1928 – 1930, Ludwig Mies van der Rohe

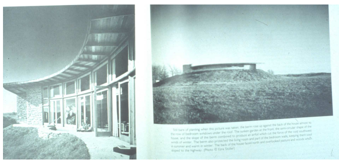


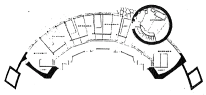
Villa Tugendhat in Brünn, 1928 – 1930, Ludwig Mies van der Rohe



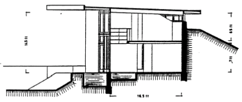
Villa Tugendhat in Brünn, 1928 – 1930, Ludwig Mies van der Rohe

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





GRUNDRISS



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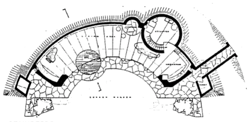
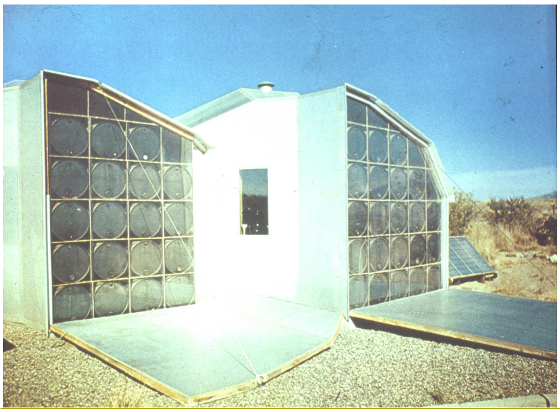


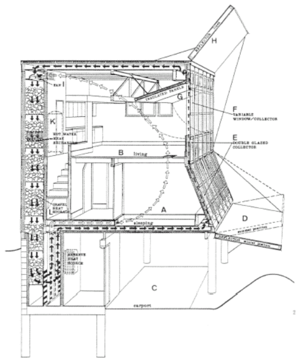
GRUNDRISS

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





Passive solar-technical components

Passive sun-energy utilisation,Sun-windows, Windows-glazings

Definition

Precondition: positive energy balance

Passive sun-technical components: more energy is lead through their capturing (glazed) solar-collection-surface into the interior as the energy lost through heat-transmition via the entire component.

3 types:

-**Sun-windows**, glazes façade elements
-**Sun-energy winning wallsystems**, Trombé walls, walls with transparent heat-insulation
-**Wintergardens**, glazed buffer rooms, glazed areas

Cooperation of 5 Elements

-**Collector** (south-orientated solar collecting surfaces, e.g. windows, solar wall, wintergarden, sun-patio,…)

-**Absorber** (surface, where the radiation is tranformed into the heat, e.g. interior wall, floor,…)

-**Heat accumulator** (z.B. walls, floor,…)

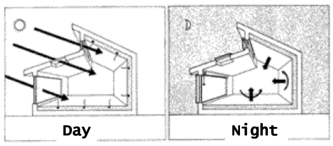
-**Heat distribution** (through conduction, radiation and convection)

-**Regulation** (ventilation opening, sun-protection, ventilators, mobile sun-protection…)

Passive use of the sun-energy

Direct gain of heat

Solar radiation falling direct through the glass surface is absorbed by the interior surface, transformed into heat and time-delayed delivered in the night and in the morning.

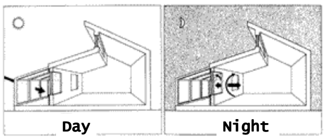


On cold sunny days, no heating is required = 100% solar coverage.

Passive use of the sun-energy

Indirect gain of heat

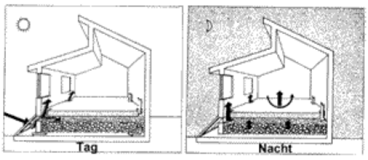
Through sun radiation, heated accumulation mass (e.g. 40-60° C on a black accumulation wall) releases at lower temperatures (e.g. 25-30° C at the inner wall) time-delayed the stored heat.



Passive use of the sun-energy

Isolated gain of heat

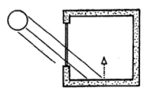
Sun energy is captured through indirect system, heat accumulator and room to heat are detached.



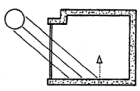
isolierter Wärmegewinn

Components for pasive use of the sun-energy

Glased facade elements / sun-windows



Sonnenfenster II



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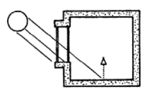
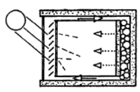


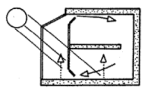
Blumenfenster



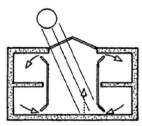
Fensterkollektor II

Components for pasive use of the sun-energy

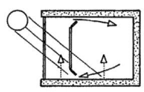
Glased buffer-rooms/ sun patios/ Verglaste Pufferräume/Sonnenveranda/glased areas, passages



Wintergarten, vorgesetzt



glasüberdeckter Bereich II

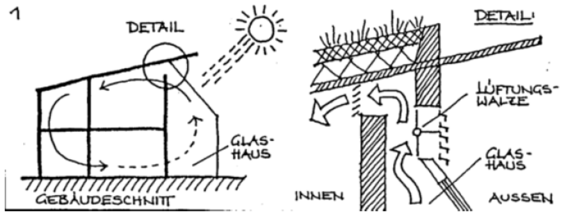


Wintergarten, eingebaut

Stadlau

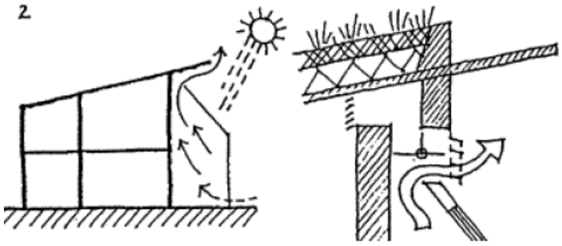
Wien 22 (Austria) - ARGE Reinberg, Treberspurg, Raith (1989-91)


Planning: Arge Reinberg - Treberspurg - Raith
Location: Vienna XXII
Constructor: Neues Leben - Gemeinnützige Bau-, Wohn- und Siedlungsgenossenschaft
Project data: 10 terraced houses and one community center,
Area: 1.251 m²
Finished: 1991
Energy index: 70 kWh/m²a
Building costs: 12 000 ÖS/m²



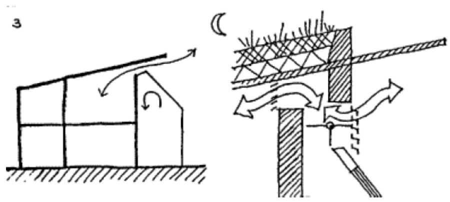
1. Function: Energy earning
When the temperature in glass house is approx. 2° C higher than in the living room, the ventilation barrel opens a connection between the glass house and the house interior.
(in winter up to a temperature of 26° C, in summer max up to 20° C).

Source: ARGE Reinberg, Treberspurg, Raith



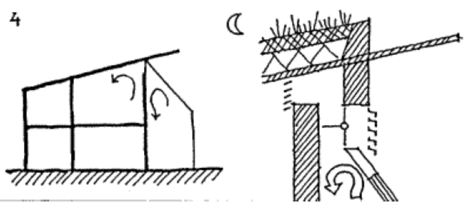
2. Function: Protection against extreme overheating and ventilation:
When the temperature in glass house becomes higher than the one in living space.

Source: ARGE Reinberg, Treberspurg, Raith



3. Function: Ventilation of the Bedroom
This function is not automated, has to be operated manually.

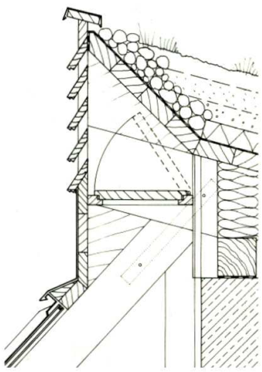
Source: ARGE Reinberg, Treberspurg, Raith



4. Function: The Glasshouse is separated from the house.
This function is not automated, has to be operated manually.

Source: ARGE Reinberg, Treberspurg, Raith

Summer ventilation



Source: Georg Reinberg

Attached Winter-garden
House in Annaberg (Austria)

Source: Georg Reinberg

House Sagberggasse (Austria)

Lüftungsklappen Source: ARGE Reinberg, Treberspurg

Internal sunscreen

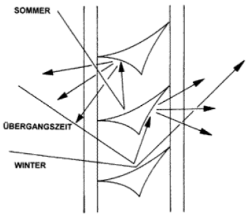
TERRACED HOUSE - NATURE NEARBY LIVING
Fred Raymondgasse 19, 1220 Vienna

OBJECT DATA

Type:	New Building of Terraced Houses
Constructor:	Stadt Vienna, MA 24
General Planning:	Arch. DI Dr. Martin Treberspurg
Bauphysics:	DI Wilhelm Hofbauer
Completed:	1996
Dimension:	4.300 m²
Amount :	41 accommodation units, 1 community centre
Heating energy demand:	40 kWh/(m²a)
Netto Building Costs:	ca. 5,23 Mio. EURO

Neue Produkte für Sonnenfenster

Isoliergläser mit fest angeordneten Spiegelprofilen im Luftzwischenraum



Okasolar-Grafik

Okasolar-Bild

Neue Produkte für Sonnenfenster

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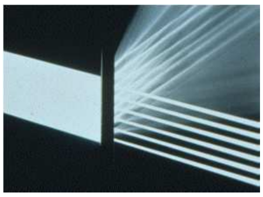
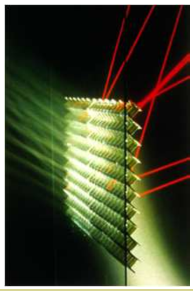




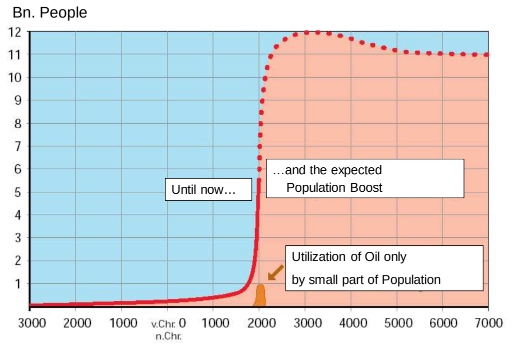
Beispiel für Sonnenfenster

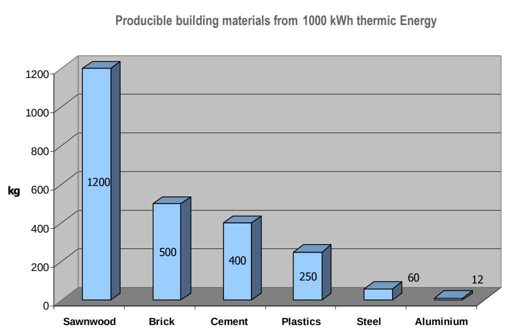
Projektname:
Wohnhausanlage "Naturnahes Wohnen"
Planung:
Treberspurg
Standort:
Wien 22
Bauherr:
Demonstrativprojekt Naturnahes Wohnen der Gemeinde Wien
Fertigstellung:
1996

Beispiele zur TWD

Energy consumption

- Peak Oil
- Energy consumption
- Life Cycle Assessment

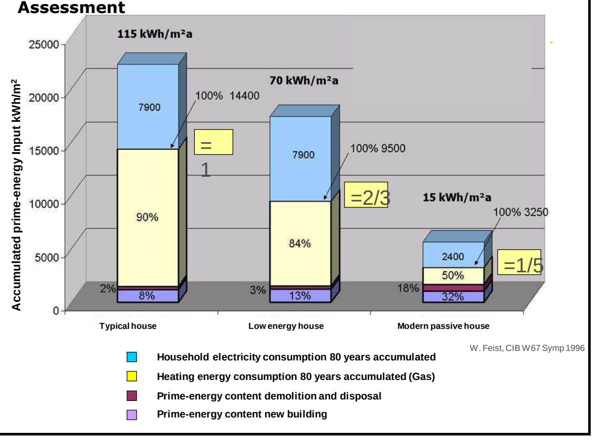




1200 kg Sawnwood - 1000 kWh - 12 kg Aluminium

Nach P. Sabady, Biologischer Sonnenhausbau 1989

Life Cycle Assessment



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

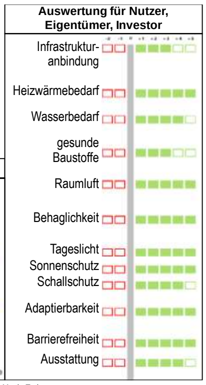
Total Quality Assessment (TQ) für Planung + Evaluation.
TQ-Zertifikation: Kosten ab 6.000,- €

- 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: 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

Energy standards

Use of energy standards:

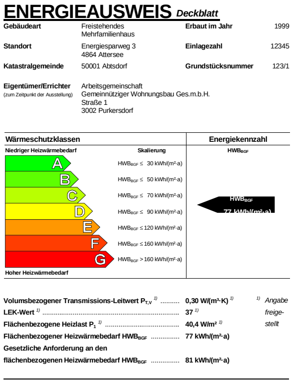
Comparability of figures (standardised classification) through national implementation

Increase in market transparency 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	Skalierung	Energiekennzahl
Niedriger Heizwärmebedarf		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)	
D	$HWB_{BGF} \leq$ 90 kWh/(m²·a)	HWB_{BGF} 77 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 freige-stellt*
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 05.03.1999)

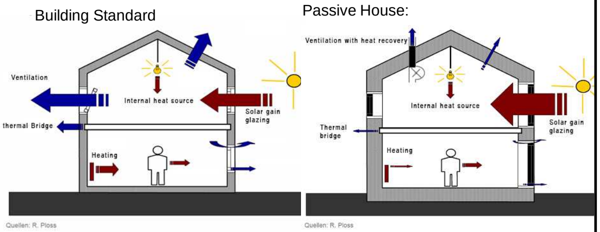
Principles of the Passive House Concept

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



Losses – Gains

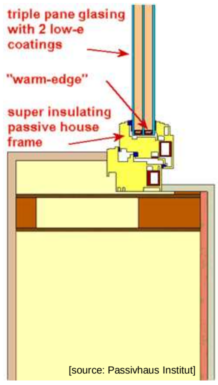
= Heating energy requirement

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

Building Envelope: Comfort Windows

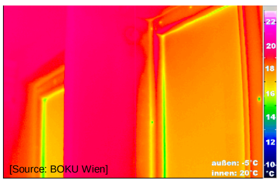
Example of triple pane glasing window

Window ≤ 0,8 W/(m²K) (R-7.1)

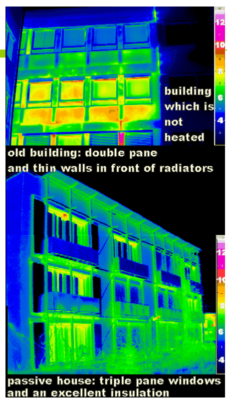


[source: Passivhaus Institut]

Building Envelope: Comfort Windows

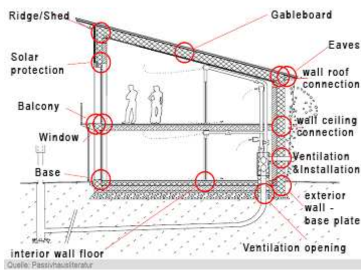


Passive House Window, Interior

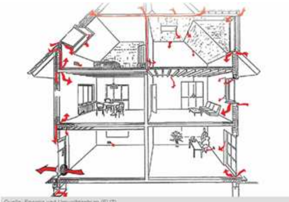


Infrared pictures of an old building and a passive house (at the bottom) for comparison (photos: PHI)

Building Envelope: Avoiding Thermal Bridges



Building Envelope: Airtight Construction



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

Evolution

„1-Liter House“ = Passivhaus:

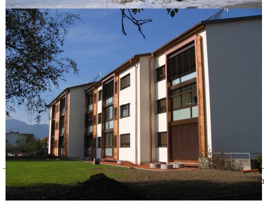
Since 1991

Over 90% Energy savings

„1-Liter Car“

Over 80% Energy savings

General refurbishment 2007

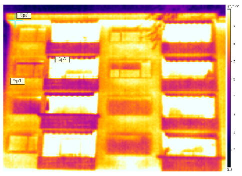


Factor 10 - Refurbishment

- 3 app. houses with 42 flats
- Example: Rankweil-Schleipfweg (18 Wo)
- refurb. scale – ÖKO 3:
  - Upgraded insulation facade 26 cm
  - Window / Shutter renovation
  - New roof with insulationg
  - Balcony glazings
  - Ventilation with heat recovery
  - Heating system renovation
  - Solar facility on the roof
  - Airtight building envelope
- Heat energy demand after:
  15 kWh/m²/a
- Costs netto: € 925.000,--

Before

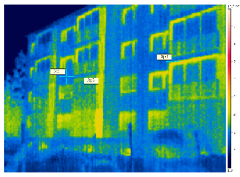
After



Übersaxenstrasse 3 Rankweil
Außentemperatur +3°
BG-398
Südseite

Sp1 8,2 °C
Sp2 12,1 °C
Sp3 10,3 °C

Dateiname 7-Übersaxenstr.13.jpg
Datum 05.04.2006 04:39:39



Vogewosi Rankweil Übersaxnerstraße
Außentemperatur +4° Bewölkt
Südfassade

Sp1 3,0 °C
Sp2 3,8 °C
Sp3 4,7 °C

Dateiname übersaxnerstraße-11.11.2007 (17).jpg
Datum 10.11.2007 22:19:43

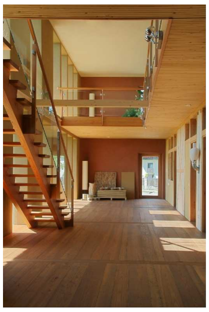
Clay passive-house office building, Tattendorf (NÖ)

HdZ-Demonstration building - Clay-passive-office building, Tattendorf (NÖ)

Project:	Neubau Bürogebäude in Passivhausstandard
Constructor:	Firma natur&lehm – Lehmbaustoffe GmbH, Tattendorf
Planning:	Arch. Prof. DI Reinberg; Dr. Karlheinz Hollinsky & Partner ZT-GmbH; Univ.Prof. Dr Krec und Ing. Waxmann
Size:	315.00 m2
Energy index:	12,00 kWh/(m²a) according to PHPP
Heating load:	6,00 W/m² according to PHPP
Airtightness n50:	0,4/h

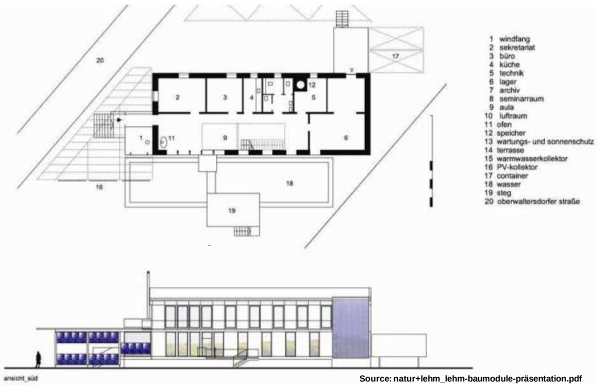
Source:
HdZ-Bericht 29/2005;
Meingast, 2005

Clay passive-house office building, Tattendorf (NÖ)



Source: HdZ-Bericht 29/2005; Meingast, 2005

Clay passive-house office building, Tattendorf (NÖ)



Source: natur+lehm_lehm-baumodule-präsentation.pdf