Passive House beyond Single Family construction
Austria's Multi-family and Commercial Passivhaus Revolution
Seattle, 2011-09-16
Information of European Commission from 2011-03-08

Road map for lean CO$_2$ economy until 2050
Reduction of CO$_2$-emissions at 80 – 95% until 2050

Building sector: Reduction of CO$_2$-emissions at 53% until 2030
Reduction of CO$_2$-emissions at 91% until 2030

Sustainable Passive Houses for old and new buildings
“Utilize all energy efficiency potentials of buildings”

All new buildings must be “Nearly Zero Energy Buildings” at least by 2020

That implies:
  – new build must comply Passive House Standard at least
  – minimal residual energy demand must be covered with renewable energy

At retrofits max. efficiency potential shall be used
Buildings in US consume more energy than any other sector

The building sector is the largest contributor to US CO₂ Emissions

Quelle: http://architecture2030.org/

US Climate Action Plan - 80% by 2050

Sustainable Passive Houses for old and new buildings
Annual endenergy requirement for buildings in kWh/m²a

Head demand max. 15 kWh/m²a = 4.75 kBTU/ft²a

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Austria</th>
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<tbody>
<tr>
<td>Passive house</td>
<td>0.06%</td>
<td>25%</td>
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<tr>
<td>Building America</td>
<td>10%</td>
<td>70%</td>
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<tr>
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<td>Energy Star</td>
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<td>IECC 2009 International Energy Conservation Code</td>
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<tr>
<td>Old buildings</td>
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</table>

End energy requirement in kBTU/ft²a

| 15.85 | 31.70 | 47.55 | 63.40 | 79.25 | 95.10 |
With Passive Houses in a safe future
With a sunny view

Plus energy house settlement, Weiz
Arch. Erwin Kaltenegger

Sustainable Passive Houses for old and new buildings
MFH Mühlweg, Wien 21

Dietrich / Untertrifaller Architekten
B.A.I. Bauträger Austria Immobilien

Heat demand: 13.1kWh/m²a = 4.15kBTU/ft²a
Heat load: 11.40 W/m² = 3.61BTU/ft²
Pressure test n₅₀ : 0.20 1/h

Floor area: 9,050.00 m²
97,400.00 ft²
Apartments: 70
Construction: Wood
Once Passive House standard – Always Passive House!

“Experience the fantastic air quality in our student house, and you will require it every time!”
Günther Jedliczka, ÖAD

Treated floor area 7,171.00 m²
77,200.00 ft²
133 student flats

Heat demand 12.20 kWh/m²a
= 3.87 kBTU/ft²a

Heat load 8.70 W/m²
2.8 Btu/h/ft²

Passivhaus Studentenheim, Wien, Arch. Baumschlager & Eberle

Sustainable Passive Houses for old and new buildings

International
PASSIVE HOUSE
Association

LANG
consulting
Günter Lang
passivehouse.at
WHA IMPULS Pernerstorfergasse
Architekt: Albert Wimmer ZT GmbH
Developer: GPA

8,314.9 m² = 89,500 ft² with 108 flats

Heat demand: 12 kWh/m²a = 3.8 kBTU/ft²a
Head load: 9 W/m² = 2.85 Btu/h/ft²
2nd Largest Passive House worldwide
Lodenareal / Innsbruck
Developer Neue Heimat Tirol
Architect: teamk2 / din a4
354 flats / 26,000 m² = 279,860 ft²

Pellets consumptions 246 m³/a = 8,690 ft³
like 6 single family home consumption
Inhabitant satisfaction result 95%
Largest Passive House worldwide
Multi-family-dwelling

Olympic Village 2012 in Innsbruck / Tyrol
Architect: Reitter - Eck & Reiter Architekten ZT GmbH & Architekturwerkstatt din a4

Apartments: 444 flats
Treated floor area: 32,229 m² = 346,920 ft²

Heat demand: Part 1 14.8 kWh/m²a = 4.69kBTU/ft²a
Part 2 18.2 kWh/m²a = 5.77kBTU/ft²a

Total primary energy demand: 108 kWh/m²a = 34.24 kBTU/ft²a

Heat load: Part 1 13.3 W/m² = 4.22BTU/ft²
Part 2 10.0 W/m² = 3.17BTU/ft²
How to handle 30 – 40 cm thick = 11.8 – 15.7 inch thick thermal insulation?
How to handle 30 – 40 cm = 11.8 – 15.7 inch thick thermal insulation?

Rear ventilated facade

Exemple Eurogate Bauplatz 6, Multi-family house  130 flats with 12,476 m² = 134,290 ft²

Developer: ARWAG Architect: Albert Wimmer ZT GmbH
Cost efficency buildings as european standards

More costs in procent between passive house standard and national minimum standard
Sustainable Passive Houses for old and new buildings

Analysis of construction costs in compare to low energy houses

Analysis of large-scaled dwellings in Austria of construction costs in €/m² regarding ÖNORM 1801-1

Quelle: Passivhaus Datenbank Analyse großvolumiger Wohnbau - LANG consulting / 2010 und Univ. Prof. Arch. DI Dr. Martin Treberspurg, DI Roman Smutny BOKU Wien – AG Ressourcenorientiertes Bauen

$/ft² | €/m²
--- | ---
273 | 2.100
247 | 1.900
221 | 1.700
195 | 1.500
169 | 1.300
143 | 1.100
117 | 0.900

A/V-Verhältnis

Passivhäuser
Niedrigenergiehäuser
Bei Errichtungskosten von 1.000.000,– Euro sind das Energiekosten von 2.667.000,– Euro (267%)!

Bei einer Energiekosteneinsparung von ca. 40% würde man die gesamten Errichtungskosten des Gebäudes einsparen!
Exhibition hall and burrow, Wels / ÖÖ

AT4 Architekten, Wels
Messe Wels

Heat demand: 16 kWh/m²a = 5.1 kBTU/ft²a
Cooling demand: 27 kWh/m²a = 8.1 kBTU/ft²a

Effective area: 17,500 m² = 188,000 ft²
Construction: Wood
Comercial building Steuer in Andelsbuch
Architect: Dipl. Ing. Architekt Hermann Kaufmann

Treated floor area: 1,400 m² = 15,070 ft²
Annual heat demand: 19 kWh/m²a = 6 kBTU/ft²a
Heat load: 11 W/m² = 3.5 Btu/h/ft²
Apple store
Treated floor area: 450 m² = 4,840 ft²
Heat demand: 16,00 kWh/m²a = 5 kBTU/ft²a
Heat load: 12,3 W/m² = 3.9 Btu/h/ft²
Pressure test n₅₀: 0,26 1/h
U-Value Wall / Roof: 0,10 W/m²K = 57 h ft² F/Btu

St. Andrä am Zicksee

Photo credits: Mathias Lang
Architect/Planer: Architects Collective ZT-GmbH / Wien

Sustainable Passive Houses for old and new buildings
Comercial building Factory Weissenseer in Greifenburg
Architect: architekten ronacher
Timber construction

Treated floor area: 3086 m²
Annual heat demand: 16.1 kWh/m²a
Heat load: 19 W/m²
Office building **Energy Base in Vienna**
Architect: pos architekten ZT keg
Treated floor area: 7,516 m² = 80,900 ft²
Annual heat demand: 10.83 kWh/m²a = 3.4 kBTU/ft²a
Heat load: 13.2 W/m² = 4.2 BTU/ft²
Diversity in wood, glass, metal, and stone

Passive house standard – a real straight thing

„Standort Niederösterreich“ in St. Pölten
Public administrative building
Four quarters at 7,900 m² = 85,000 ft²
Sustainable Passive Houses for old and new buildings

Communal centrum St. Gerold
Treated floor area 571 m² = 6,150 ft²
Heat demand 12,8 kWh/m²a = 4.0 kBTU/ft²a
Heat load 15 W/m² = 4.7 Btu/h/ft²
Primary energy 118 kWh/m²a = 37.4 kBTU/ft²a

cukrowicz nachbaur Architekten ZT GmbH / Bregenz
Photo credits Hanspeter Schiess
Treated floor area: 866 m\(^2\)  = 9.320 ft\(^2\)
Heat demand:  11 kWh/m\(^2\)a  = 3.5 kBTU/ft\(^2\)a
Heat load:  12 W/m\(^2\)  = 3.8 BTU/ft\(^2\)
Center of justice in Korneuburg
ARGE Architekturwerkstatt Din a4 und Dieter Mathoi Architekten, Innsbruck
Owner: Bundesimmobiliengesellschaft (BIG)

Best passive house standard also for prisoners – why not!

Regional and district court, public prosecution department and prison
Center of justice
Korneuburg
ARGE Architekturwerkstatt Din a4 and Dieter Mathoi Architekten, Innsbruck
Owner: Bundesimmobiliengesellschaft (BIG)

Floor space:
12,400m² = 133,500ft² court
10,000m² = 107,600ft² prison for 255 prisoners

Building costs: € 75 million = $ 105 million
Completion: 2011

Head demand 10.9 kWh/m²a = 3.4 kBTU/ft²a
Head load 16.0 W/m² = 5.1 BTU/ft²

Over all (incl. special electronic for prison)
Primary energy demand 243.8 kWh/m²a = 74.2 kBTU/ft²a
OPEC-Office
Constructed in 1972/1973
Domicile of OPEC since 1977

Property bought by
Raiffeisen Holding NÖ – Wien in 2007
Raiffeisen-Holding NÖ-Wien building
first Passive- Sykscrapper worldwide
Architects DI Dieter Hayde
and DI Ernst Maurer Vasko & Partner
IBO

20,000m² = 215,300ft² office space
for 800 employees

Additional costs of 6% of construction costs
for energy efficiency + renewable energy supply
amortises in 14 years
Raiffeisen-Holding NÖ-Wien office at Danube channel
First Passive-skyscraper worldwide
Architects DI Dieter Hayde and DI Ernst Maurer

Skyscraper benchmarks energy consumption in kWh/m²_{GFA\,a}

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Usual skyscraper</th>
<th>Raiffeisen climate save skyscraper</th>
</tr>
</thead>
<tbody>
<tr>
<td>District heating</td>
<td>95 kWh/m²a</td>
<td>50 kWh/m²a</td>
</tr>
<tr>
<td>Electricity</td>
<td>80 kWh/m²a</td>
<td>33 kWh/m²a</td>
</tr>
<tr>
<td>Cooling</td>
<td>55 kWh/m²a</td>
<td>8 kWh/m²a</td>
</tr>
<tr>
<td>Heating</td>
<td>82 kWh/m²a</td>
<td>5 kWh/m²a</td>
</tr>
</tbody>
</table>

Total energy consumption:
- Usual skyscraper: 312 kWh/m²a = 100 kBTU/ft²a
- Raiffeisen climate save skyscraper: 103 kWh/m²a = 32.6 kBTU/ft²a

Sustainable Passive Houses for old and new buildings
Life cycle tower
in Dornbirn/Austria

Hermann Kaufmann Architekten
Rhomberg Bau GmbH

Heat demand: 13kWh/m²a = 4.15kBTU/ft²a

Floor area: 2,355 m²
Construction: Wood Frame
Slab: Hybrid wood / concrete

Contact in USA:
Nabih Tahan, AIA
email: nabih.tahan@creebyrhomberg.com
Phone: 510-848-2514
God lives in a Passive House too

Treated floor area: 1,304 m² = 14,000 ft²
Heat demand:
14.47 kWh/m²a
= 4.6 kBTU/ft²a

St. Franziskus, Passivhaus Pfarrzentrum, Wels, Arch. Luger & Maul
Waste energy in old houses

Middle energy demand
150 kWh/m²a = 47.5 kBTU/ft²a

X

3 floors
Waste energy in old houses

Middle energy demand
150 kWh/m²a = 47.5 kBTU/ft²a

X

3 floors

= 450 kWh/m²a = 142.7 kBTU/ft²a

10% = 45 m gas volume tower
Waste energy in old houses

Middle energy demand
150 kWh/m²a = 47.5 kBTU/ft²a

- 95%

7,5 kWh/m²a = 2.4 kBTU/ft²a
CO₂ – potential of reduction in housing sector till 2050
At EVERY retrofit of a postwar building min. 85% savings have to be done!
CO₂ – potential of reduction in housing sector till 2050

At EVERY retrofit of a postwar building min. 85% savings have to be done!
First Multi-family house retrofit to Passive house standard
MFH Makartstraße, Linz

Head demand before: 179.00 kWh/m²a = 56.74 kBTU/ft²a
Head demand after: 14.70 kWh/m²a = 4.66 kBTU/ft²a

Nutzfläche vor: 2,860 m² = 30,780 ft²
Nutzfläche nach: 3,106 m² = 34,014 ft²

Baujahr 1957
Sanierung 2005

Developer: GIWOG

Planung: Arch & More Architekten

Sustainable Passive Houses for old and new buildings
**Retrofit cost** incl. tax:

- Convent. retrofit
  - € 608.-/m² = $ 79.-/ft²
- Passive house retrofit
  - € 774.-/m² = $ 100.-/ft²
- More costs
  - € 166.-/m² = $ 21.-/ft²

**Heat costs** incl. tax:

- Before 8.28 €/m²a = 1.08$/ft²a
- After 0.96 €/m²a = 0.12$/ft²a

**Energy cost saved:**

- 7.32 €/m²a = 0.95$/ft²a

ca. 15 – 20% from the gross rent

---

**Sustainable Passive Houses for old and new buildings**
Sustainable Passive Houses for old and new buildings

WHA Dieselweg Graz with 204 flats, over 10,000 m² = 107,640 ft² floor space

Developer: GIWOG

Dieselweg 3-19
142 kWh/m²a --> 13,6 kWh/m²a
45.01 kBTU/ft²a --> 4.31 kBTU/ft²a

Dieselweg 4, 6, 8
184 kWh/m²a --> 9,6 kWh/m²a
58.33 kBTU/ft²a --> 3.04 kBTU/ft²a

Dieselweg 12, 14
225 kWh/m²a --> 9,6 kWh/m²a
71.33 kBTU/ft²a --> 3.04 kBTU/ft²a
With an energy efficiency on factor 10 the passive house is the only right!

VOGEGOSI realises 45% of their renovations on passive house standard since 2008 – with accordance of the residents!

Renovation MFH Schleipfweg / Rankweil 18 flats
Energy demand before renovation 192kWh/m²a = 60.86kBTU/ft²a after renovation 14kWh/m²a = 4.44 kBTU/ft²a
€ 640.-/m² = 83.- $/ft²a renovation costs incl. modification to handicapped accessible staircase with lift
Oil consumption of heating and hot water before and after renovation

Savings of 181,600 l oil or 1,816,000 kWh energy per year. 930 single-family houses could get heated with that energy.
Healthcare center Bad Schallerbach
Owner: National health insurance agency for railroads and mining

Architect: Architects Collective

Retrofit and expansion of a therapy center with accommodation facility for 120 beds

Gross floor area 10,000 m² = 107,640 ft²

Heat demand: before 125.0 kWh/m²a = 39.6 kBTU/ft²a
after 17.5 kWh/m²a = 5.5 kBTU/ft²a
First passive house school renovation

Facelifting for old school  Individual ventilation units as compact units

Health points:
- Kohlenstoffdioxid, Radon, Schimmel
- Chemische Schadstoffe: Formaldehyd, VOC, Lindan, Pentachlorphenol, Polychlorierte Biphenyle PCB
- Noise from streets

Danger of indoor emissions
Super envelope for old school

New facade fixed to the old pillars

U-value = 0.08 W/m²K = 
R-value = 71 h ft² F/Btu 
58 cm = 1.9 ft insulation between wood construction
Sustainable Passive Houses for old and new buildings

4.47 kBTU/ft²a

38.9 kBTU/ft²a

25.4 kBTU/ft²a

-88.5%

1,956,000 ft³ Gas

55,400 m³ Gas

1,660 ft³ Wood pellet
Factor 10 reduction of head energy
650,000 kWh/a = 22,200 therm/a

Factor 7 reduction of artificial light using
58,500 kWh/a = 2,000 therm/a
Graph: Amortisation of renovation on Passive House standard within 5 or rather 11 years

Additional costs Passive House standard: ca. 8%
Day- and artificial-light management: ca. 2%
Ecologic sustainable actions: ca. 3%
Allgemeine Sonderschule Linz 06
Retrofit to passive house

Planer: Enzenhofer & Dornstädter ZT GesmbH
Nutzfläche: 2,098 m² = 22,580 ft²
HWB = 13.10 kWh/m²a = 4.15 kBTU/ft²a
Wall U-value: 0.10 W/m²K = R-value 57h ft² F/Btu
First retrofit of a multi family skyscraper

Freiburg / Buggingerstraße / Germany
Architecture office Rombch
Developer: Freiburger Stadtbau GmbH

8,582 m² = 92,375 ft² with 16 story
Before 90 flats    after 140 flats

Heat demand: before 80kWh/m²a = 25.4kBTU/ft²a
                 after 15kWh/m²a = 4.7kBTU/ft²a

Wall:    U-Wert = 0,189 W/m²K
Cellar ceiling: U-Wert = 0,183 W/m²K
Roof:    U-Wert = 0,204 W/m²K
Windows: Uₜ-Wert = 0,85 W/m²K

Central ventilation system with heat recovery each 5000 m³/h

Heating: district heating

Building costs: 1,260 €/m² = 164 $/ft²
Wohn-/Nutzfläche (Kostengruppe 300+400)
Retrofit investment 13,4 Millionen Euro
Hamburg, Reeperbahn / Germany
Architekt Georg W. Reinberg/Vienna
20-story multi family skyscraper

Heat demand: before 170kWh/m²a = 53.9 kBTU/ft²a
after 14kWh/m²a = 4.4 kBTU/ft²a

Retrofit to passive house standard,
Ventilation system with heat recovery,
passive solar recovery, photovoltaic,
solar collectors
Before Retrofit commercial building to Passive house
drexel und weiss energieeffiziente haustechniksysteme gmbh
Arch. Gerhard Zweier

Heat Energy demand: 10.0 kWh/m²a = 3.1 kBTU/ft²a
Heat load: 10.2 W/m² = 3.2 Btu/h/ft²
Treated floor area: 2,890 m² = 31,100 ft²

Sustainable Passive Houses for old and new buildings
Public Passive houses
EXPOST Bozen Administration building of the Autonom Province Bozen

Heating demand after renovation:
12.00 kWh/m²a = 3.8 kBtu/ft²a

Arch. Michael Tribus
First retrofit to Passive house / Single-family-home Tad Everhart in Portland
First evaluation results from the University of Portland

End energy demand before: 338 kWh/m²a = 107 kBTU/ft²a
End energy demand after: 42 kWh/m²a = 13 kBTU/ft²a

End energy demand – Passive house criteria < 42 kWh/m²a

Indoor temperature: 19°C 20°C 21°C 21°C

Household
Hotwater
Heating

It’s a real good feeling
Fronius International headquarter office, Wels
PAUAT ARCHITEKTEN
Retrofit brick fassade Industry building
Wall indoor 12 cm = 4.7in, Roof 60 cm = 2ft insulation
Passive house windows

Heat demand old 204 kWh/m²a = 65 kBTU/ft²a
Heat demand new 24 kWh/m²a = 7.3 kBTU/ft²a
Development of passive house flats in Austria

Quellen: Wohungsbewilligungen in Österreich 2009 [Statistik Austria, IIBW], Prognose [IIBW 2010]
Passivhauswohneinheiten Auswertung [IG PH A Passivhaus Objektdatenbank]
Amount of passive houses in Europe per October 2010

- Documented passive houses
- Built passive houses

<table>
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<tr>
<th>Country</th>
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<tr>
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Costs for gas-fired power plant Klagenfurt  € 300 Mio.
CO₂ certificate costs for 20 years (calc. € 30.-/t CO₂ + 10%/a)  € 1,500 Mio.
Energy costs (gas) for 20 years (calc. € 0.025/kWh + 10%/a)  € 5,200 Mio.

New Power Plant:
- 400 GWh/a  thermal energy production
- 2,250 GWh/a  electric energy production
- +1,000,000 t  increase of CO₂-emission

In whole Austria there shall be built 9 such new power plants
„To cover the energy demand of Austria till 2025 9 new gas-fired power plants are neccessary!“

[Source: E-controll /2007]
Sustainable Passive Houses for old and new buildings

Energy efficiency offensive costs just 20%

€ 100.-/m² = $ 13.-/ft² for thermal renovated with 85% savings

650,000 flats
5,000 public buildings
4,500 office buildings

650,000 electric equipment change A++
130,000 photovoltaic unit with 5 kWp
360,000 thermal solar collectors
Sustainable Passive Houses for old and new buildings

European Action Plan of Energy Change

€ 490 bn. = $ 686 bn. till 2025
100.- €/m² subsidy for retrofit
of all postwar buildings in EU

Result:
• 85% energy savings +
• rest 100% renewable energy
• 5,0 bn. m² living area
• 1.500 TWh/a energy saving
• 530 m. to CO₂ savings
• 12,25 mill. additional green jobs

Win – Win strategy against economic crises!
Maximum comfort - constant surface temperature

Cold surface temperature in badly insulated houses

Maximum of comfort, because always warm surface temperature in super insulated houses
CO$_2$ concentration in a sleeping room
CO₂ concentration in a sleeping room
Well sleep is always guaranteed in Passive Houses

With mechanical comfort ventilation

Dienstag   Mittwoch   Donnerstag   Freitag   Samstag   Sonntag   Montag

DIN 1946-2  Pettenkofergrenze

Sustainable Passive Houses for old and new buildings
Wien 3., EUROGATE – Aspanggründe
Multi family houses areal with 1,900 flats
around 156,000 m² = 1,679,000 ft²
Stadtentwicklung Projekt: Albert Wimmer ZT-GmbH
Visualisierung: beyer.co.at

Part of big city in Passive house standard
Complete city area in passive house standard!
Zero Emission City with energy autarkic supply for 20,000 inhabitants

**Wien 22** project „Seestadt“ in Aspern, Vienna

8,500 flats, student- and rest-home, schools, kindergartens, technology center, office and business buildings for 20,000 workstations

Masterplan from Tovatt Architects & Planners
Passive house front-runner regions
Zero-Emission-City areal **Heidelberg-Bahnstadt**
116 ha for 5,000 new job places + 1,700 flats
Passive house as Standard for urban development

Areal „**Permis de lotir Tivoli**“
in Brüssel North
3,8 ha with 500 flats in PH-Standard

*Sustainable Passive Houses for old and new buildings*
Passive house front-runner regions

Frankfurt Beschluss vom 06.09.2007:
Der Magistrat wird aufgefordert sicherzustellen, dass alle neuen Gebäude der Stadtverwaltung, städtische Einrichtungen und Eigenbetriebe sowie alle Gebäude, die im Rahmen von PPP-Modellen künftig für die Stadt Frankfurt errichtet werden, dem Passivhaus-Standard genügen und entsprechend konzeptioniert werden. Sollte dieser Standard nicht erreicht werden können, ist dies zu begründen. In allen Fällen gilt als Mindeststandard eine dreißig Prozent bessere Energieeffizienz, als die EnEV verlangt.

Europe has 28 Passive house front-runner regions with 25 Million inhabitants

Which city or state will be the first US Passive house front runner region?
Seattle 2030 District

High-performance building district that aims to dramatically reduce environmental impacts of building construction and operations

Obama Administration Announces 14 Initial Partners in the Better Buildings Challenge
June 30, 2011

• Existing Buildings 50% Energy Use and CO$_2$ reduction by 2030

• New Buildings and Major Renovations Energy Use 60% below the national average and CO$_2$ neutral by 2030
Passive house front-runner regions

Passive house Declaration for Brussels-Capital Region

Since 2010 all new public buildings have to be build in Passive house Standard

From 2015 all new buildings general build in PH-Standard

Research program from 2007-2010 with 117 pilot projects with 265,000m² = 2,852,000ft² floor space

bestätigte eindrucksvoll die Umsetzbarkeit des Beschlusses von 2007
Passive house front-runner regions

Vorarlberg Declaration since 01.01.2007:

- All new Multi-family buildings of nonprofit developers have to be build in Passive house Standard.
  Since this time over 75 MFH with 130,000m² = 1,400,000 ft² without higher rent

- Heat demand after retrofits max. 30 kWh/m²a = 9.5 kBTU/ft²a
- Since this time over 30 MFH with 25,000m² = 269,000ft² or 50% from all Passive house retrofits
"Energiehauptstadt" Wels 1. Stadt Österreichs 2008 Deklaration unterzeichnet: Der Magistrat der Stadt Wels wird beauftragt, bei allen neu zu errichtenden Gebäuden bzw. künftigen Sanierungen generell die Nutzung erneuerbarer Energien einzuplanen und besonders auf die Energieeffizienz zu achten.

Bei Neubauten Passivhaus-Standard
Bei Sanierungen Passivhaus-Standard anzustreben, jedenfalls zumindest mit Passivhaus-Komponenten (Dämmung, Fenster, Lüftung mit Wärmerückgewinnung)

60,000m² = 645,000ft² Passivhaus Standard bereits bei 60,000 Einwohner
European passive house development within 10 years

- 300 passive houses in 2001/05
- 32,000 passive houses in 2011/05

- 90,000 m² = 969,000 ft² in 2001/05
- 15,000,000 m² = 161,500,000 ft² in 2011/05

- 1,500 GWh = 51,200,000 therm energy savings per year
  180 Million Euro = 252 Million Dollar saving energy costs per year

- Savings of natural gas correlates a pipeline 7,5 times around the world
The only „unlimited“ energy source is energy efficiency!

- Energy efficiency never stops and future supply is 100 % sure
- Energy efficiency does not get more expensive (like fossil fuels)
- Energy efficiency is good for the environment and health
- Energy efficiency makes you independent

We need to use enormous amount of Energy Efficiency!
Passive house standard also in Antarctic

No limits!

Research base Princess Elisabeth Station on Antarktis
Thank you for your attention!

www.passivehouse.at

www.passivehouse-international.org

www.phnw.org
Five years evaluation with top results

EFH Schwarz in Pettenbach

<table>
<thead>
<tr>
<th>Year</th>
<th>Heat energy demand</th>
<th>End energy demand</th>
<th>Primary energy demand</th>
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<td>2010</td>
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</table>

End energy demand – Passive house criteria < 42 kWh/m²a

Indoor temperature:
- 19°C
- 20°C
- 21°C
- 22°C
Maximum ENERGY EFFICIENCY =

- Independent from rising prices
- Unlimited available
- Rentable from 1. day
- Best pension provision
- Carefree life
- Maximum of comfort

Sustainable Passive Houses for old and new buildings