The Future is Massive: Big Buildings from Vienna to Beijing and beyond
Ing. Günter Lang / LANG consulting
New York, 2014-06-17
Information of European Commission from 2011-03-08

**Road map for lean CO₂ economy until 2050**

- Reduction of CO₂-emissions at 80 – 95% until 2050

**Building sector:**
- Reduction of CO₂-emissions at 53% until 2030
- Reduction of CO₂-emissions at 91% until 2050

Sustainable Passive Houses for old and new buildings
Resolution of European Commission from 2009-12-18
Official journal of EU published on 2010-06-18

“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. In New York, buildings need 75% of all energy consumption!

The building sector is the largest contributor to US CO₂ Emissions.

US Climate Action Plan
- 80% by 2050

http://architecture2030.org/
Annual end energy requirement for buildings in kWh/m²a

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

<table>
<thead>
<tr>
<th>Category</th>
<th>USA</th>
<th>Austria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive house</td>
<td>0.06%</td>
<td>25%</td>
</tr>
<tr>
<td>Building America Programm DOE</td>
<td>10%</td>
<td>70%</td>
</tr>
<tr>
<td>Energy Star</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>IECC 2009 International Energy Conservation Code</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>Old buildings</td>
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</tbody>
</table>

End energy requirement in kBTU/ft² a

<table>
<thead>
<tr>
<th>Category</th>
<th>15.85</th>
<th>31.70</th>
<th>47.55</th>
<th>63.40</th>
<th>79.25</th>
<th>95.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive house</td>
<td></td>
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<td></td>
<td></td>
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<td>Building America Programm DOE</td>
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</tbody>
</table>

Sustainable Passive Houses for old and new buildings

www.langconsulting.at  www.passivhaus-austria.org
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 $n_{50}$ : 0.20 1/h

Floor area: 9,050.00 m²
97,400.00 ft²
Apartments: 70
Construction: Wood

Sustainable Passive Houses for old and new buildings
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 m²
77,200 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

Building costs 1,202 €/m²
151 €/ft²

Passive House students home, Wien, Arch. Baumschlager & Eberle
WHA IMPULS Pernerstorfergasse
Architect: 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 246m³/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

Building costs: 1,489 €/m² = 187 $/ft²
Apartment complex 1220 Vienna, Kaisermühlenstrasse
Third largest Passive House appartment complex in Austria
264 flats, 4 offices, 4 stores
Developer: BWS
Arch.: Treberspurg & Partner Architekten Ziviltechniker GmbH

Floor space:
24,585 m² = 264,600 ft²
Year of construction:
2014
Building costs:
1,403 €/m² = 176 $/ft²
Residential and commercial building
Raxstrasse, 1100 Vienna (element L)
Rüdiger Lainer + Partner Architekten
Win4Win Bauträger

128 flats floor space: 10,730m² = 115,500ft²
Doctor's practice: 750 m² = 8,070ft²
Kindergarten: 1,285 m² = 13,800ft²
Year of construction: 2013

Building costs: 1,450 €/m² = 182 $/ft²
Apartment complex 1220 Vienna, Aspernsstrasse
Architects: s&s architekten – C. Schindler & R. Szedenik
Developer: Pro Wohnbau AG

Floor space: 19,366 m² = 208,500 ft²
Building costs: 1,451 €/m² = 183 $/ft²
Heat demand: 15 kWh/m²a = 4.75 kBTU/ft²a

Flats: 220
Year of construction: 2012
“Life-cycle costs” for different Building standards
Cost transparency - calculated with the same energy costs over 40 years!

In Passive houses the saved „life-cycle costs“ are the double as the construction costs of a building according to minimum standard!

Sustainable Passive Houses for old and new buildings
Analysis of construction costs in compare to low energy houses

<table>
<thead>
<tr>
<th>$/ft²</th>
<th>€/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>273</td>
<td>2.100</td>
</tr>
<tr>
<td>247</td>
<td>1.900</td>
</tr>
<tr>
<td>221</td>
<td>1.700</td>
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<td>195</td>
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<tr>
<td>169</td>
<td>1.300</td>
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<tr>
<td>143</td>
<td>1.100</td>
</tr>
<tr>
<td>117</td>
<td>0.900</td>
</tr>
</tbody>
</table>

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

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

Sustainable Passive Houses for old and new buildings
Xolar fabric building in 4653 Eberstalzell
Design Hörndler Bauplanung
Heat demand 9 kWh /m²a = 2.85 kBTU/ft²a

Floor space: 16,926m² = 182,200ft²
Construction: mixed
Year of construction: 2008
Heat load: 18 W/m² = 5.7 BTU/ft²
η₅₀ : 0.08/h
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
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
<table>
<thead>
<tr>
<th>Communal center</th>
<th>St. Gerold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated floor area</td>
<td>571 m²</td>
</tr>
<tr>
<td>Heat demand</td>
<td>12.8 kWh/m²a</td>
</tr>
<tr>
<td>Heat load</td>
<td>15 W/m²</td>
</tr>
<tr>
<td>Primary energy</td>
<td>118 kWh/m²a</td>
</tr>
<tr>
<td></td>
<td>= 6,150 ft²</td>
</tr>
<tr>
<td></td>
<td>= 4.0 kBTU/ft²a</td>
</tr>
<tr>
<td></td>
<td>= 4.7 Btu/h/ft²</td>
</tr>
<tr>
<td></td>
<td>= 37.4 kBTU/ft²a</td>
</tr>
</tbody>
</table>

Sustainable Passive Houses for old and new buildings

Cukrowicz Nachbaur Architekten ZT GmbH / Bregenz

Photo credits Hanspeter Schiess
Center of justice Korneuburg Court
Architekturwerkstatt Din a4, Innsbruck
Owner: Bundesimmobiliengesellschaft (BIG)

Floor space: 16,850 m² = 181,200 ft²
Working places: 180 employees
Head demand: 11.7 kWh/m²a = 3.7 kBTU/ft²a
Head load 16.0 W/m² = 5.07 BTU/ft²
Primary energy demand: 103.0 kWh/m²a = 32.6 kBTU/ft²a

Airtightness: 0.20 1/h
Completion: 2012
Center of justice Korneuburg Prison
Dieter Mathoi Architekten, Innsbruck
Owner: Bundesimmobiliengesellschaft (BIG)
Passive house design: Herz&Lang/Airoptima
Prison for 255 prisoners
Floor space: 16,700 m² = 179,800 ft²
Heat demand: 9.3kWh/m²a = 2.95kBTU/ft²a
Primary energy demand 366 kWh/m²a = 116 kBTU/ft²a (incl. electronic for prison, workshops, kitchen)
Airtightness: 0.43 1/h
New Plus Energi Headquarters for Syd Energi

Esbjerg / Denmark

Architecture GPP Arkitekter A/S
Building physics Esbensen A/S

Treated Floor Area 10,952 m² = 117,900 ft²
Year of construction 2013

Annual heating demand 8 kWh /m²a = 2.53 BTU/ft²a
Primary energy requirement 217.0 kWh /m²a = 68.8 BTU/ft²a

Heat pump using both heat recovery from the server room as a geothermal system
Life cycle tower
in Dornbirn/Austria

Hermann Kaufmann Architekten
Rhomberg Bau GmbH

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

Floor area: 2,355 m² = 25,400 ft²
Construction: Wood Frame
Slab: Hybrid wood / concrete

Contact in USA:
Nabih Tahan, AIA
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- Skyscraper worldwide
Architects DI Dieter Hayde
and DI Ernst Maurer Vasko & Partner
IBO

24,000m² = 258,300ft² office space
for 800 employees
Building costs 2,000 €/m² = 252$/ft²
Additional costs of 6%
of construction costs
for energy efficiency +
renewable energy supply
amortises in 14 years

Sustainable Passive Houses for old and new buildings
Raiffeisen-Holding NÖ-Wien office at Danube channel
World’s first Passive-skyscraper
Architects DI Dieter Hayde and DI Ernst Maurer

Skyscraper benchmarks energy consumption in kWh/m²\textsubscript{GFA} a

- 520 kWh/m²\textsubscript{a} = 165 kBTU/ft²\textsubscript{a}
- 312 kWh/m²\textsubscript{a} = 100 kBTU/ft²\textsubscript{a}
- 117 kWh/m²\textsubscript{a} = 37 kBTU/ft²\textsubscript{a}

from bio gas

<table>
<thead>
<tr>
<th></th>
<th>User</th>
<th>Building equipment</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>US skyscraper</td>
<td>130</td>
<td>82</td>
<td>160</td>
<td>17</td>
</tr>
<tr>
<td>AT skyscraper</td>
<td>110</td>
<td>55</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>RHW.2 skyscraper</td>
<td>56</td>
<td>39</td>
<td>80</td>
<td>14</td>
</tr>
</tbody>
</table>

Sustainable Passive Houses for old and new buildings
• 300 conventional skyscrapers in China under construction
  400 further conventional skyscrapers are planned
• Operating costs of skyscrapers are very expensive

Operating and energy costs can be **reduced by 70%**!

**The first Passive House skyscrapers in Europe**

- Raiffeisen-Tower  
  1020 Wien/Austria
- Donau Marina  
  1020 Wien/Austria
- Police headquarter  
  Charleroi/Belgium
- Bureaux pour la CEE  
  Brussels/Belgium

**Sustainable Passive Houses for old and new buildings**
Passive House trends in Europe from 2010 to 2021

- 2010: 12.8 Mio. m² (138 Mill. ft²)
- 2011: 17.8 Mio. m² (192 Mill. ft²)
- 2012: 25.2 Mio. m² (271 Mill. ft²)
- 2013: 35.4 Mio. m² (381 Mill. ft²)
- 2014: 381 Mio. m² (4,120 Mill. ft²)
- 2015: 540.0 Mio. m² (5,810 Mill. ft²)

Countries: BIH, LV, SRB, GR, EST, PT, BG, LT, FI, PL, HR, RO, IR, ES, HU, FL, LU, NO, SK, NL, SI, DK, IT, SE, UK, FR, CZ, BE

Sustainable Passive Houses for old and new buildings
In China first Passive House projects are developed.
The green Austrian Embassy in Indonesia

Pos architekten, Fritz Oettl

So in terms of healthy and fine indoor comfort and environmentally friendly design the New Austrian Embassy may be a big leap forward for office buildings in hot and humid climates.

Reduction demand: *shading*, low-E

Comfortable cooling and *fresh air provision*

Minimization of *transmission load*

*Airtight* building shell

Energy efficient climatic guidelines

Careful planning and simulation

Energy *efficient ventilation* and *dehumidification* device
Waste energy in old houses

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

- 95%

7.5 kWh/m²a = 2.4 kBTU/ft²a
First Multi-family house retrofit to Passive house standard
MFH Makartstraße, Linz
Head demand before: \(179.0 \text{ kWh/m}^2\text{a} = 56.74 \text{ kBTU/ft}^2\text{a}\)
Head demand after: \(14.7 \text{ kWh/m}^2\text{a} = 4.66 \text{ kBTU/ft}^2\text{a}\)
Nutzfläche vor: \(2,860 \text{ m}^2 = 30,780 \text{ ft}^2\)
Nutzfläche nach: \(3,106 \text{ m}^2 = 34,014 \text{ ft}^2\)

Construction 1957
Retrofit 2005

Developer:
GIWOG

Architect:
Arch & More Architekten
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
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 125.0kWh/m²a = 39.6 kBTU/ft²a
               after 17.5kWh/m²a = 5.5 kBTU/ft²a
First Austrian school retrofitting to Passive House
HSII + Polytech school
Schwanenstadt/Upper Austria
PAUAT architekten
Obermayr Holzkonstruktionen
LANG consulting

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
Graph: Amortization 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

Designer: Enzenhofer & Dornstädtler ZT GesmbH
Floor space: 2,098 m² = 22,580 ft²
Heat demand = 13.10 kWh/m²a = 4.15 kBTU/ft²a
Wall U-value: 0.10 W/m²K = R-value 57h ft² F/Btu
Hamburg, Reeperbahn / Germany
Architect 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
Retrofitting Public Passive Houses
EXPOST Bolzano Administration building of the Autonom Province
Bolzano/Italy
110 workplaces

Arch. Michael Tribus

Heating demand after renovation:
12.00 kWh/m²a = 3.8 kBTU/ft²a
Treated floor area:
2,800 m² = 31,000 ft²
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

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

Sustainable Passive Houses for old and new buildings
Master plan for North American energy revolution

€ 500 billion = 690 billion $ subsidy by 2030
€ 100.- /m² = 13.- $/ft² subsidy for retrofits with 85% EE

Result:
- 85% energy savings +
- remainder 100% coverable by RES
- 5.0 billion m² living area
- 1,000 TWh in energy savings per year
- 530 million ton CO₂ reduction per year
- 2.2 million additional green jobs per year

Win – Win – Win strategy against economic crises !
Master plan for North American energy revolution

€ 500 billion = 690 billion $ subsidy by 2030
€ 100.- /m² = 13.- $/ft² subsidy for retrofits with 85% EE

Economic facts for the next 20 years:
- 690 billion $ subsidy
- 950 billion $ VAT + taxes
- 260 billion $ benefit for national budgets
- 4,900 billion $ investment
- 6,200 billion $ energy saving costs
- 1,300 billion $ benefit for the EU population

Win – Win – Win strategy against economic crises!
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
World’s largest Passive House city area
Zero-Emission-City areal Heidelberg-Bahnstadt
116 ha for 5,000 new job places + 1,700 flats
Passive House as Standard for urban development

www.heidelberg-bahnstadt.de

• Wohnen: 9 Hektar
• Gewerbe: 16,5 Hektar
• Campus: 4,5 Hektar
• öffentliche Einrichtungen:
  2 Kindertagesstätten, 1 Grundschule,
  1 Bürgerzentrum
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 30 Passive House front-runner regions with 39 Million inhabitants

Which city or state will be the first US Passive House front runner region?
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 Antarctica

Sustainable Passive Houses for old and new buildings
The future challenges are big
The targets are very high

Big Passive Houses
for Big Apple!

With visions and the Passive House
we can master the future!

www.passiv.de
www.langconsulting.at
www.passivhaus-austria.org
www.passivehouse-international.org