bigEE — building energy efficiency as part of eco city development

Presentation at CSUS Salon
July 2012

Wuppertal Institute
for Climate, Environment
and Energy

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The bigEE project

bigEE is a web portal aiming to bridge the information gap on energy efficiency in the building sector:

- **Raise greater awareness and attention**...
  ... for the variety of benefits of increased energy efficiency in new and existing buildings.
- **Close the gaps of scattered information and material on energy efficiency** ...
  ... by providing latest know-how in a target group oriented, consistent, comprehensive, easily accessible, and transparent way.
- **Manage and communicate available knowledge** ...
  ... especially for emerging economies

Target groups of bigEE

Decision-makers worldwide ...

... **Investors**
(e.g., manufacturers, large building owners, developers, energy companies, ESCOs, development banks, etc.)

... **Policy-Makers**
(politicians, high ministry ranks, regulatory agencies)

... **Policy Implementers**
(staff in ministries and regulatory agencies),
… and **business and policy consultancy** actors
(including institutions such as UNEP, UNDP, GEF, etc.)

Currently bigEE cooperates with **partners in three emerging economies: China, South Africa, India.**

bigEE: a worldwide network of experts

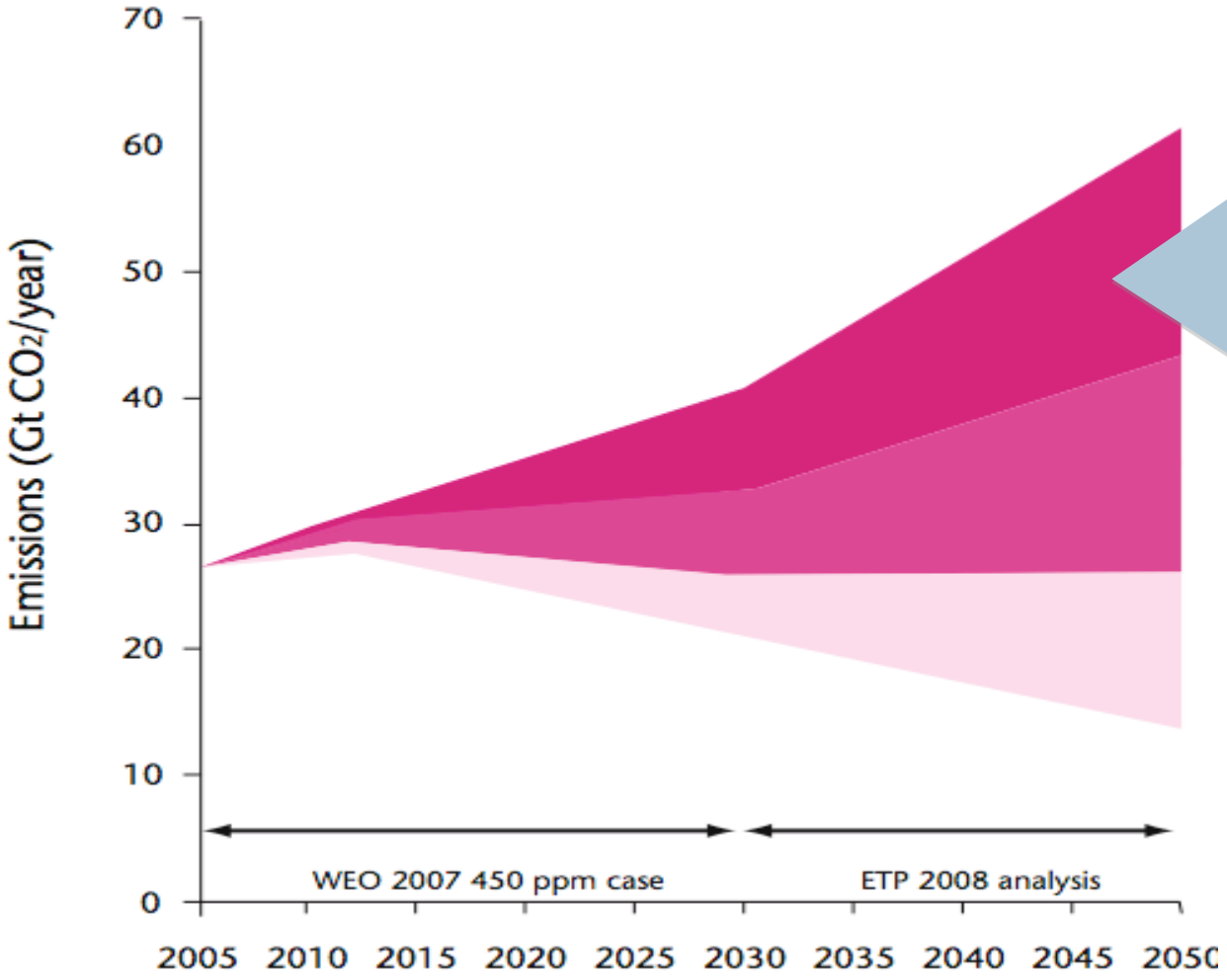
Cooperation currently with:

- The Sustainable Buildings Network (SBN) under the IPEEC
- The United Nations Environmental Programme (UNEP), i.a. UNEP's SBCI – Sustainable Buildings and Construction Initiative
- The World Business Council for Sustainable Development (WBCSD)
- Regional platforms such as www.buildup.eu
- Scientific institutes and experts on energy efficiency in buildings worldwide

2 Background

Why building efficiency is so important

40% of the global energy consumption is related to buildings



Alarming trend of rising energy related CO_2 emissions (IEA 2008) "Business as Usual"

Buildings have to contribute 38% of CO_2 reduction in 2050 "IEA Blue Map Scenario"

Source: UNEP 2009, IEA 2008

2 Background

Addressing energy & resource consumption

- Decoupling the growth of the **building sector** from **energy and resource consumption** requires
    - fostering energy efficiency
    - to go for **low, ultra low and zero/plus energy buildings**
    - to go for **green buildings**
- Most of the **building concepts and technologies** to achieve this emission reduction are **already available** on the market and are **cost effective**
- **Energy efficient** and **green buildings** can contribute to **huge economic benefits** (e.g. saving costs, security of supply, higher rents, jobs)

The approaches to encourage energy and resource efficiency in buildings differ among countries and climate zones, e.g

- **Emerging countries** such as India concentrate on **green buildings**
- The **European Union** concentrates on **energy efficient buildings**

3 Scope of the bigEE platform

What: fostering energy efficiency in the building sector

"The bigEE platform is designed to motivate and enable people to realise the full potential of building energy efficiency in their respective field."

Why and **how** to do that is presented using 3 guides:

- 2 guides on technical saving potentials in 1) buildings and 2) appliances worldwide
- 1 policy guide on how to create a policy framework to enable the realization of the technical saving potentials

Good practice examples illustrate the benefits of building energy efficiency and how to best achieve them.

Country pages highlight country specific circumstances, policies, potentials and good practice cases for the partner countries China, South Africa and India.

3 Scope of the bigEE platform

Buildings Guide

This guide covers all four major world climate zones:

- Strategic approach to reach energy efficiency in buildings
- Efficient Building techniques and technologies:
  - Passive options
  - Active options
  - Behavioural options
- Good Practice cases worldwide for all building sectors (starting with new buildings in the residential sector)
  - Building type: Single family/Multi-family/Highrises
  - Building conditioning types: Closed/Hybrid/Zoned/Open
- Costs and saving potentials

This guide covers information for different appliance types (cold appliances, washing machines, cooking stoves and ovens and electrical equipment):

- Types and Technologies
- Test procedures and measures
- Global and regional saving potentials

Policy Guide

This guide covers new and existing buildings, as well as appliances:

- Thorough information on policies (e.g. on advantages/disadvantages, design and implementation tipps, impact and costs and benefits) to promote energy efficiency including GP examples across the world

- Thorough information on policy packages ((e.g. on advantages/ disadvantages, design and implementation tipps, impact and costs and benefits) to promote energy efficiency including GP examples across the world

4 bigEE country focus

Emerging economies – Key for outreach

Special attention to emerging economies due to high savings potentials and opportunity window to address building efficiency

Disseminating knowledge through country partners

- Using existing national channels to market actors
- Providing customised international input
- Joint dissemination activities (e.g. workshops)

Country-specific pages (English) on the bigEE website

- Addressing investors and policy-makers/implementers
- Presenting comprehensive country-specific data on technologies, potentials, markets, policies and measures
- Comparing with others and providing good practice examples for world-wide pages (e.g. South-South)

4 bigEE country focus

Partners of the first country projects

Partners in China:

Supported by the Ministry of Housing and Urban-Rural Development (MoHURD,中华人民共和国住房和城乡建设部)

Scientific cooperation with Beijing China Society for Urban Studies and Shenzhen Institute for Building Research Eco Technology Co., Ltd. (CSUS-IBR,北京市中城深科生态科技有限公司)

Partners in India (advanced discussion)**:**

Supported by the Bureau of Energy Efficiency (BEE, Ministry of Power)

Scientific cooperation with the Energy and Resources Institute (TERI)

Partners in South Africa:

Supported by the Department of Energy (DoE)

Scientific cooperation with the National Energy Efficiency Agency (NEEA), South African National Energy Development Institute

4 bigEE country focus

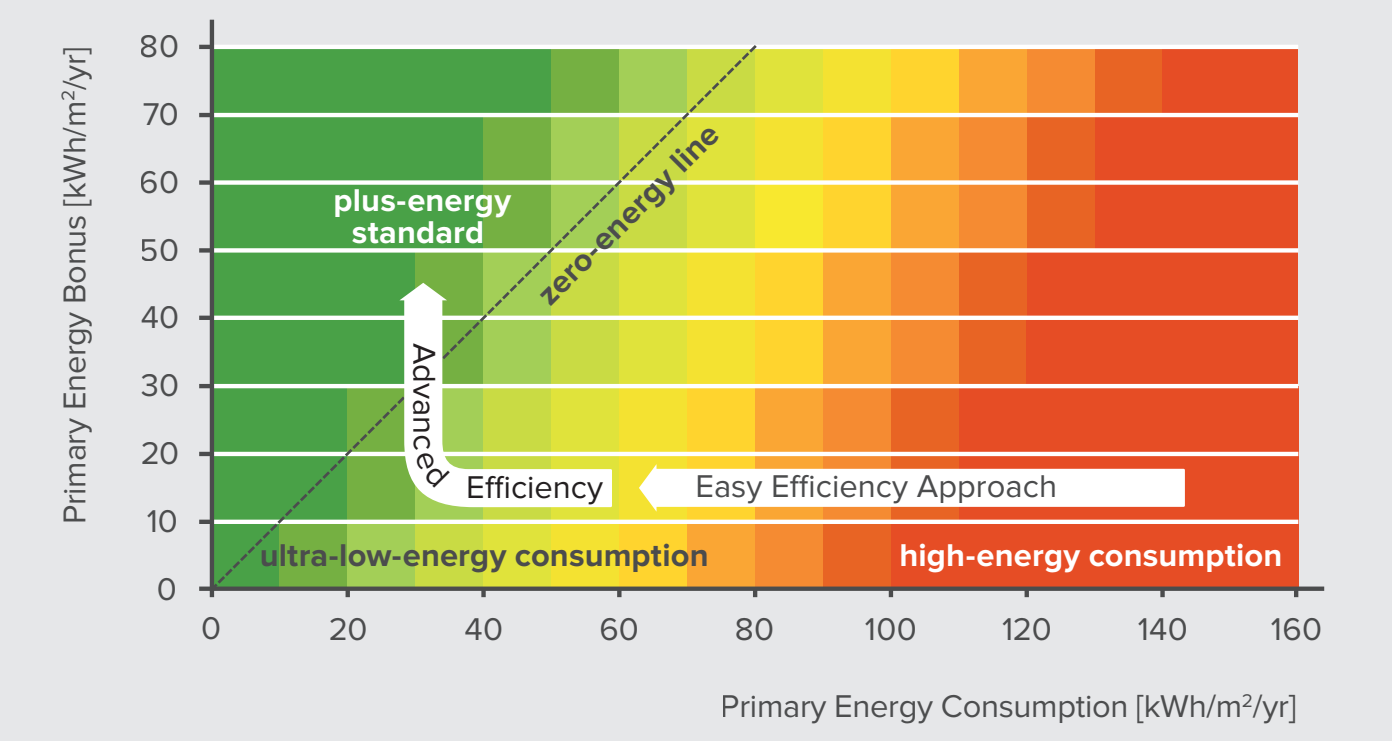
Content of the China Country Page

- Strategic Approach to improving energy efficiency in China
- Actor constellation in China
- Detailed quantitative data on 5 good practice examples for residential building energy efficiency (to be expanded to commercial buildings)
- Presentation of 5 good practice (GP) policy sets and 4 stand-alone policies

GP Policy Sets	GP Policies
• EE Building Design and Operation • Energy Management in Public Sector Buildings • Civil Buildings Evaluation and Labeling • Green Buildings Technologies • Existing Buildings Retrofit	• Green Building Demonstration Programme • Energy Performance Contracting • Energy Efficient Lighting • Renewable Energy Use in Buildings

5 Strategic approach to energy efficient buildings

2-step strategy towards highly-efficient building performance with net surplus energy:



1. Reduce final (and primary) energy demand from a high to a low level by designing a highly-efficient demand and supply performance (Easy Efficiency)

2. Set more ambitious standards and implement onsite power generation systems to deliver surplus energy within an annual energy balance (Advanced)

Energy performance

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Easy Efficiency Strategy (→ Low Energy Buildings)

A combination of intelligent building design and an appropriate choice of efficient technologies for heating, cooling, hot water production

LEB: $Q_{PE,max}$ **= 40 - 60 kWh/m$_{TFA}^2$/yr**

Advanced Approach (→ ULEB and ZEB/PEB)

The remaining energy demand should preferably be covered by renewable energy sources (solar radiation, ambient and geothermal energy, sustainable biomass)

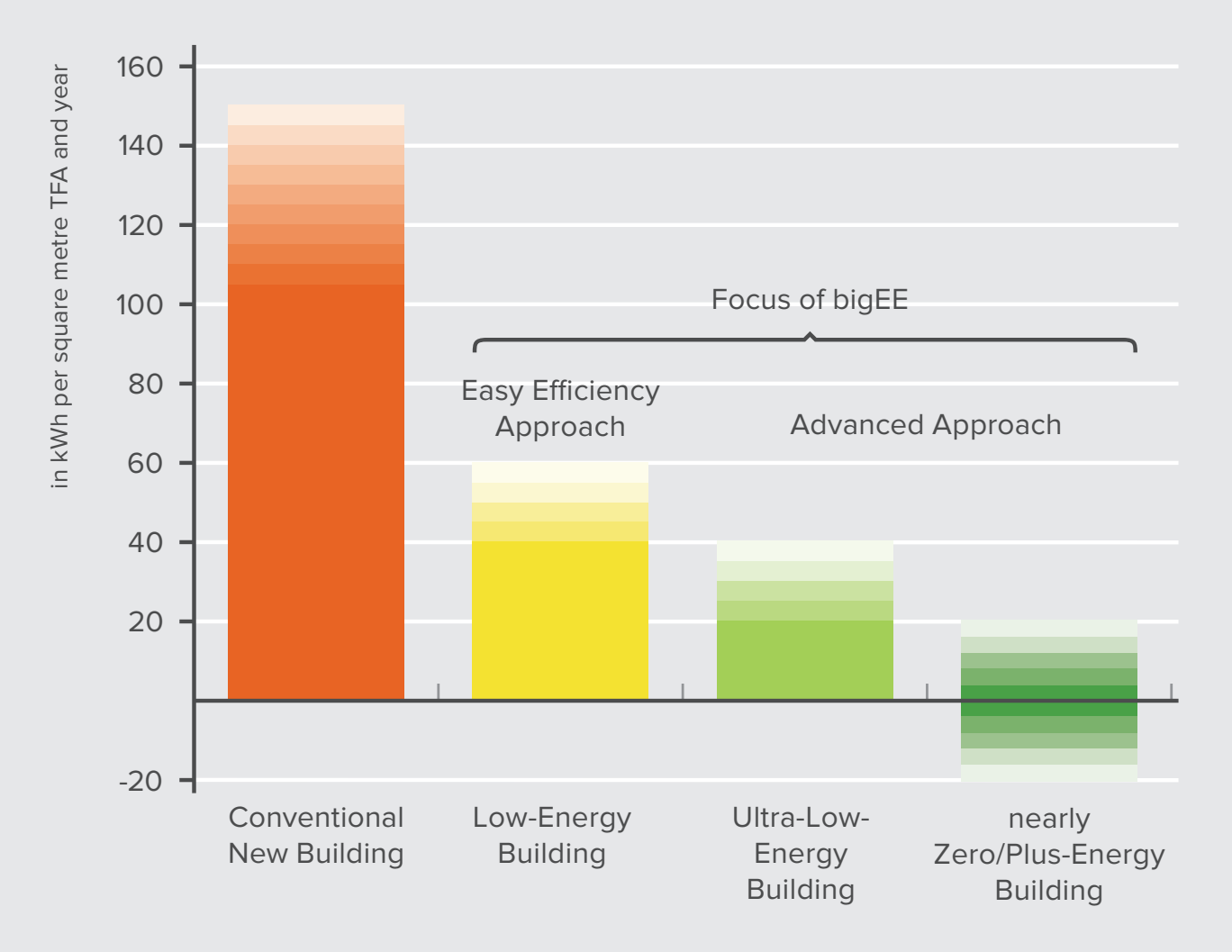
- **ULEB**: $Q_{PE,max}$ **= 20 - 40 kWh/m$_{TFA}^2$/yr** (Energy saving potential of about 90 %)

Supplemented with on-site or building integrated renewable electricity generation systems, those buildings can even transform to (net) zero energy and/or energy producers (Plus Energy Buildings)

- **ZEB/PEB:** $Q_{PE,max}$ **≈ 0 - 20 kWh/m$_{TFA}^2$/yr** (Minimize the carbon footprint up to 100%)

5 Strategic approach

Criteria for energy efficient buildings

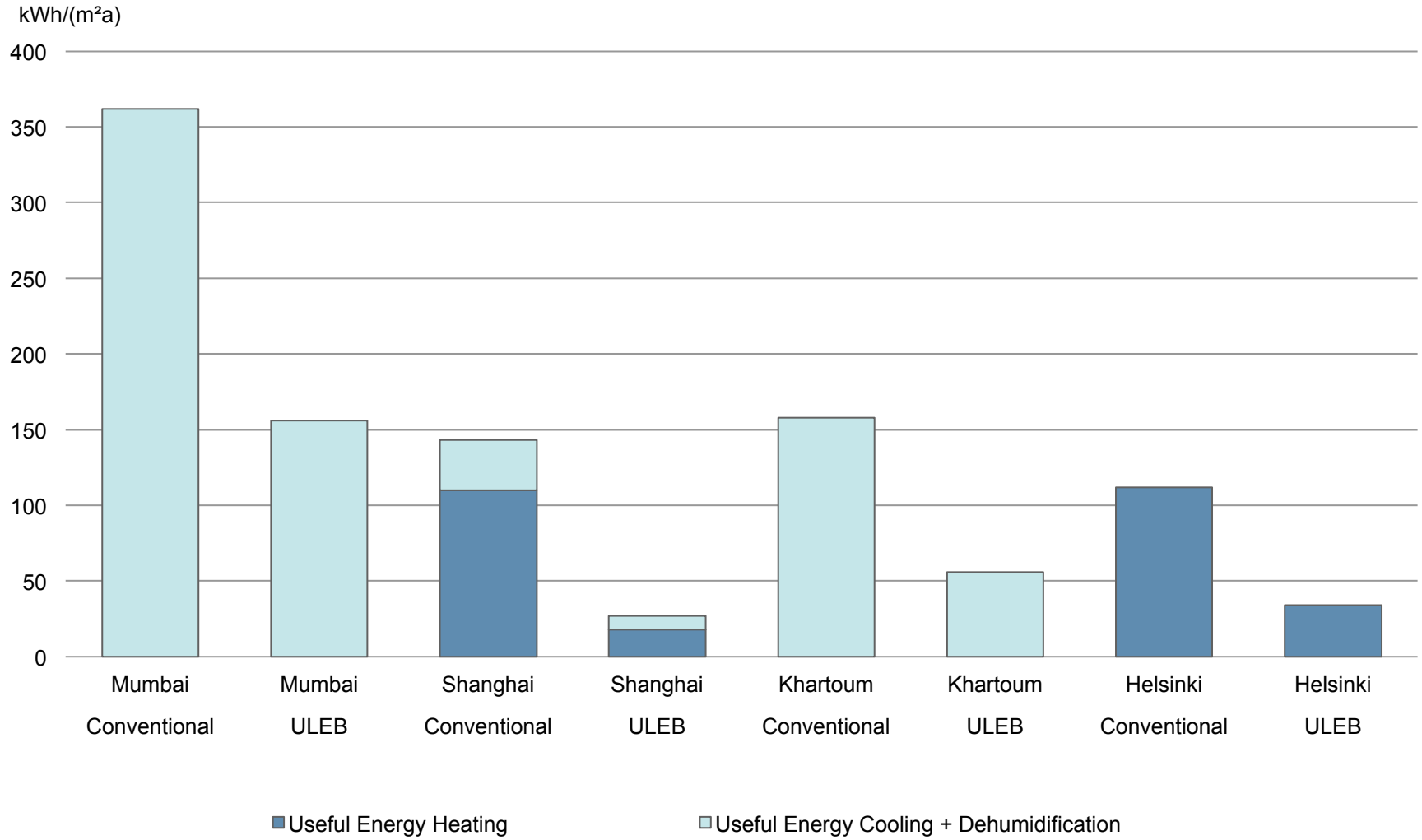


Note: Specific Energy Consumption Targets are under validation and may vary according to the climate zone!

Source: bigEE

Comparison of useful energy consumption

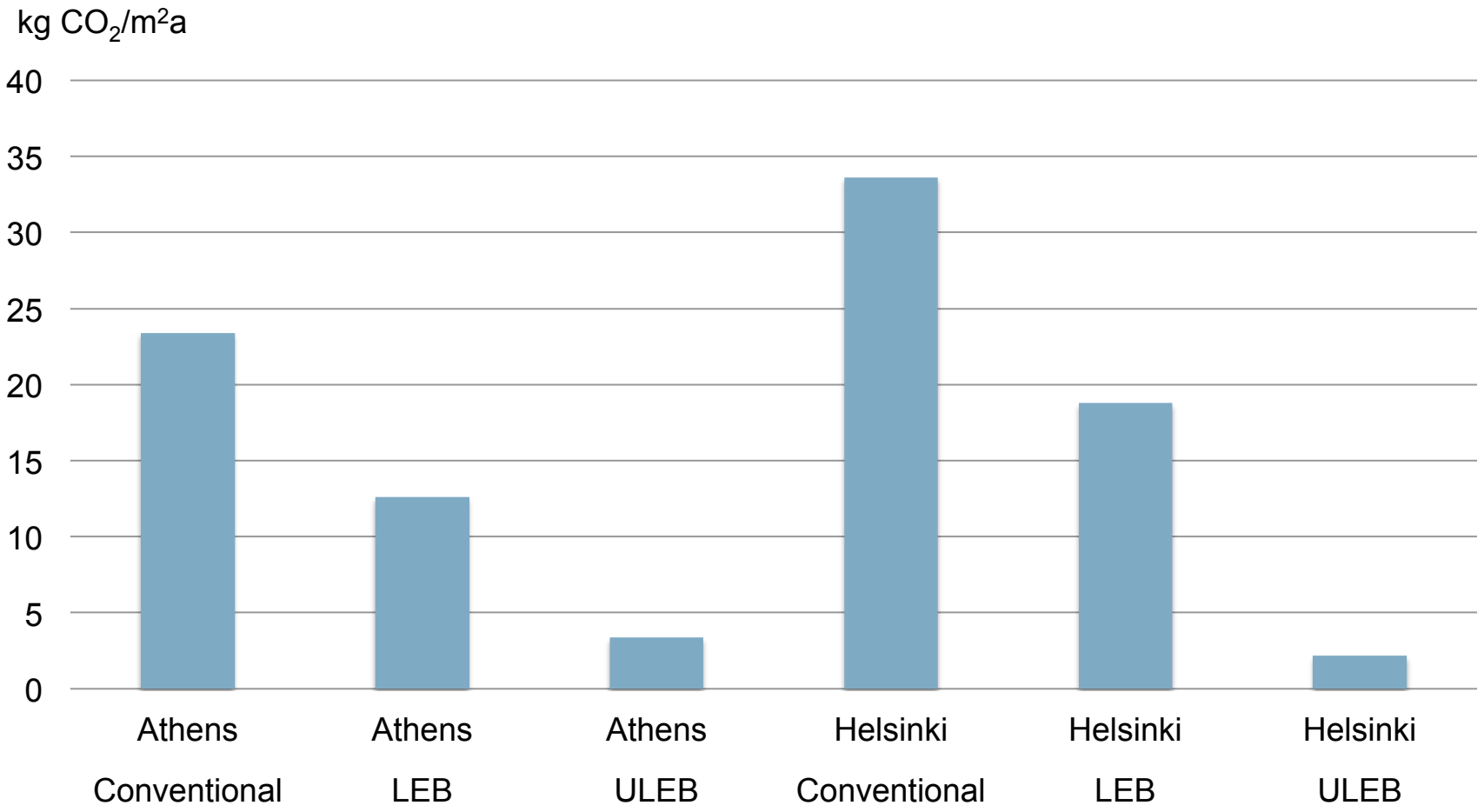
(simulations by ECOFYS and Wuppertal Institute)



(ULEB = Ultra Low Energy Buildings)

Source: bigEE

Reduction of CO_2 emissions in low energy housing



Source: BigEE 2012

6 Energy efficency in buildings in Europe

Very **intensive development** in the last years in **whole Europe**

- Energy performance, **ultra low energy, passive design and zero energy buildings** on the agenda
- **All countries** have agreed that all new buildings should **move** fast towards **zero energy** consumption
- Many of these new initiatives takes place on an European level and have to be implemented on the national level, but countries can also act themselves (and go beyond European requirements)

Energy efficiency targets in Europe

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Selected National Targets for New Buildings

Country	Target
Denmark	75% by 2020 (c.f. base year 2006)
Finland	Passive house standards by 2015
France	By 2020 new buildings are energy-positive
Germany	By 2020 buildings should be operating without fossil fuel
Hungary	Zero emissions by 2020
Ireland	Net zero energy buildings by 2013
Netherlands	Energy-neutral by 2020 (proposed)
Norway	Passive house standards by 2017
UK (England &Wales)	Zero carbon as of 2016 (see box overleaf)

Source: SBi, (2008) European National Strategies to move towards very low energy buildings

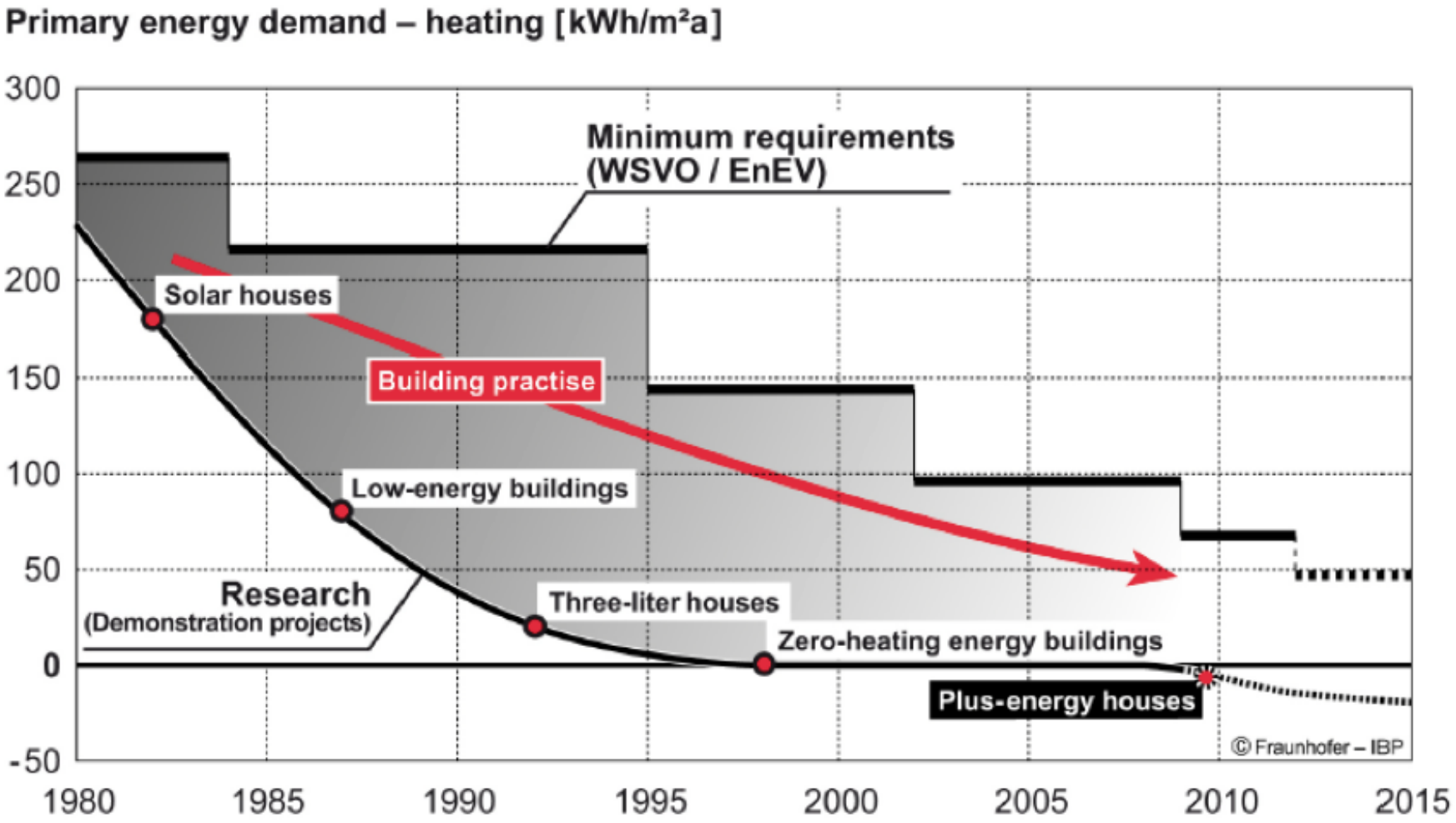
Primary energy levels for heating

Austria	Annual heating energy consumption below 60-40 KWh/m²
Belgium	Low Energy Class 1 for houses: 40 % lower than standard levels, Very low Energy class: 60 % reduction for houses,
Denmark	Low Energy Class 1 = 50% lower than standard levels
Finland	Low energy standard: 40 % better than standard buildings
France	New dwellings: than 50 kWh/m² (in primary energy). (40 kWh/m² to 65 kWh/m²
Germany	Between 60kWh/(m²•a) and 40 kWh/(m²•a Passive House = ca. 40 kWh/(m²•a)

Source:SBi (Danish Building Research Institute),

6 Energy efficency in buildings in Europe

Roadmap for energy efficiency in Germany



Source: Erhorn / Erhorn-Kluttig 2009

7 Energy efficient and green buildings

- Buildings (responsible for 30-40% energy consumption and 40-50% material consumption) should be eco-efficient
- In high energy efficient buildings / plus energy buildings, in the operational phase with low energy cost, the decrease in embodied energy plays an important role
- Green buildings (e.g. LEED) do not address energy efficiency effectively whereas Ultra Low Energy and Zero/Plus energy buildings do not address ecological aspects directly
- In hot climates (e.g. India) the strategy should be first energy efficient green buildings to be followed by ULEB/ Passive house
- Green buildings reinforced through ULEB can be a stepping stone in reaching higher energy efficiency (complement each other)
- Barriers - higher upfront cost- removed through learning effects and cost degression fostered by effective policy package (e.g. BigEE project)

7 Energy efficient and green buildings

Low Energy Buildings and Green Buildings

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Environmental aspect

	Ultra Low Energy Building	Green Buildings
Operating Energy	**High energy saving – factor 3 - 4 in total energy reduction**	Energy saving baseline depends on countries energy standard (ASHRAE for LEED, EnEV for DGNB) < PH standard
Embodied Energy	Can be higher than green buildings – due to additional sophisticated construction materials	**Low - due to stringent material selection**

Climate influence

	Ultra Low Energy Building	Green Buildings
Cold and Temperate Climates	Well known Space conditioning easily met with BAT	Well known Quite common outside of Europe
Warmer climates	Not well known Extreme climates such as Mumbai Space cooling standard not easily met with BAT	Quite common

7 Energy efficient and green buildings

Low Energy Buildings and Green Buildings

Economical aspect

	Ultra Low Energy Building	Green Buildings
Initial investment	• 3 -10% in different European countries • Influenced by increased working time as high workmanship required	• Depends on the level of certification (e.g. 2 -7% for US (LEED) and UK (BREEAM) and for India 6 - 18%)
Economical benefits	• **25 - 65% energy saving** • **Payback time 4-19 years** • **Cost effectiveness related to energy price growth rates**	• The higher the performance level the higher the cost effectiveness and relative payback time

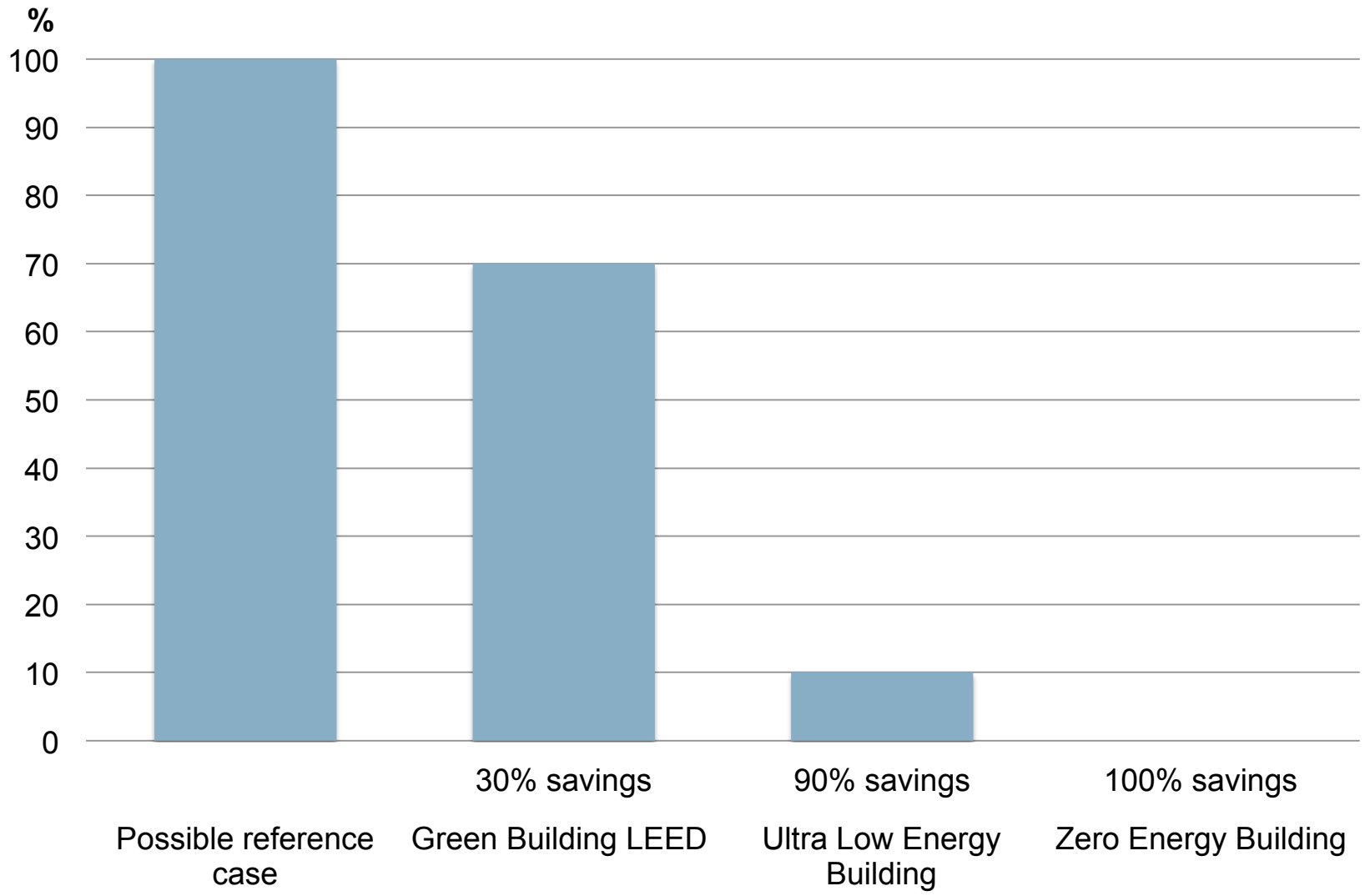
Indoor quality, Materials and Workmanship

	Ultra Low Energy Building	Green Buildings
High indoor quality	• Mechanical ventilation or Heat Recovery Ventilation Systems (HRVS)	• Natural and mechanical ventilations (if taken into account)
Material	• Ecological sounder than conventional buildings - high quality material • BAT not always easily available	• Low embodied energy, ecological materials
High quality workmanship	• Requires trained designers and workers	• Requires trained designers and workers

Source: UNEP 2009, IEA 2008

7 Energy efficient and green buildings

Comparison of possible energy savings



Source: bigEE

8 Good practice examples

New apartment building Lodenareal

Lodenareal Innsbruck, Austria

Location	Austria
Type of building	Apartments
Treated floor area (TFA)	ca. 26.000 m²
Building volume	ca. 167.000 m³
Number of apartments	354
Year of completion	2009

→ **Large energy savings** are possible in practice with an 80% lower energy demand achieved by a well designed building and a **holistic approach.**

Source: Neue Heimat Tirol

8 Good practice examples

New apartment building Lodenareal cont'd

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Building Services

- Energy consumption < 15 kWh/m^2/a
  - 80% through a pellet and gas boiler,
  - 20% through 1050 m^2 of solar panels outputting 350 kmkWh/m^2
- Blower Door-Test n_{50} = 0,20 (required was n_{50} = 0,60)
- Ventilation system with heat recovery.

Building Envelope

- Triple Glazing U-Value ca. 0.8 W/m^{2}K
- 300 mm Façade Insulation

Costs and Energy Consumption

- The total project costs amounts to 52 million Euros.
- 11% more expensive than standard new buildings
  - 7% are covered by subsidies and remaining 4% to be covered by the inherent energy savings.

Source: Neue Heimat Tirol

8 Good practice examples

Renovated apartment building Freiburg

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Freiburg, Germany

Location	Germany
Type of building	Social Housing
Treated floor area (TFA)	ca. 7200 m²
Surface/Volume ratio	0,26 m^{-1}
Number of apartments	before 90
	after 139
Year of completion	1968
Year of refurbishement	2009

→ **Large energy savings** are possible in practice with an 80% lower energy demand achieved by a well designed building and a **holistic approach.**

Source: Freiburger Stadtbau Verbund

Renovated apartment building cont'd

Building Services Before

- Heating Consumption ca. 15 kWh/m^2/a
  - 100 % through a combined heat and power unit (gas) for district heating
- Ventilation system with heat recovery (83%)
- Photovoltaics on the roof ca. 25 kWp

Building Envelope

- Triple Glazing U-Value ca. 0.7 W/m^{2}K
- 200 mm Façade Insulation U-Value ca. 0.15 W/m^{2}K

Costs and Energy Consumption

- The total building costs amount to €13,440,000
  - per m2 € 1,680 /m2
  - thereof € 600 /m2 energy saving measures
  - total costs € 240 /m2 other modernisation
- Subsidies by programme „Social City" and credit at reduced interest .

Source: Freiburger Stadtbau Verbund

8 Good practice examples

New apartment building Jun Yue Hai Tang

Jun Yue Hai Tang, Xinjiang, China

Location	China
Type of building	Apartments
Treated floor area (TFA)	ca. 15880 m²
Surface/Volume ratio	0,35 m^{-1}
Number of apartments	175
Year of completion	2009

→ **Large energy savings** are possible in practice with an 80% lower energy demand achieved by a well designed building and a **holistic approach.**

Source: bigEE

New apartment building Jun Yue Hai Tang

Building Services

- Heating Consumption ca. 55,85 kWh/m^2/a.

  Heating through gas low temperature boiler,

  Hot water through evacuated tube solar thermal collector

Costs and Energy Consumption

- The total project cost amounts to 3,2 million Euros.

Source: bigEE

9 Conclusion

- Decoupling the growth of the **building sector** from **energy and resource consumption can contribute at least 30 % to GHG emissions reductions by 2050** in most countries and ***save* money.**
- **BUT:** although **knowlegde exists, it is not easily available.**
  In particular for emerging economies and developing countries
- The market penetration of these energy efficient solutions is currently low

  → We are facing an implementation gap

  → Innovative policies and measures are required to push the market transformation

→ **bigEE addresses the implementation gap by coherently providing existing and new information on building energy efficiency in a one-stop-shop!**

Launching Q1/2013

Please contact us at: bigEE@wupperinst.org