A global strategic approach to energy efficiency in the building sector

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Abstract

Conventional new buildings in OECD countries with a history of building codes save about 50 % of energy compared to average buildings in the building stock. This improvement, however, is not enough to create a building standard with low lifetime costs nor to reach long-term climate protection targets. Much higher energy savings can already be achieved through proven high-efficiency building concepts bringing net economic benefits among other advantages.

A strategic approach to integrated building design is the key to achieving these high-energy savings at low or no extra cost in residential buildings. In our paper we describe the 'Easy Efficiency Approach', which can reduce primary energy consumption by 40 to 60 % compared to conventional new building standards, or by 70 % to 80 % when compared to the primary energy consumption of the existing building stock, and should be regarded as the minimum. This strategy focuses on low-cost options, mainly passive options. Although it can already significantly reduce energy consumption, this first step will not be sufficient to reach long-term climate protection goals. It is thus necessary to implement and support what we call an 'Advanced Efficiency Approach', with savings up to 90 % , as compared to new building standards, as soon as possible to avoid lock-in effects. Further improvements, especially through the active use of renewable energies, reduce the net primary energy demand to 0 % and beyond.

According to the chosen strategy clearly defined energy performance ranges, with reference to possible savings, for different climate zones worldwide are given. In verifying this approach simulations with BAT (Best Available Technologies) buildings of different types (single family, multi family, high rise) were carried out in close cooperation with project partners. This data has also been verified through an empirical database of built examples both for energy consumption as well their economic soundness.

Introduction

Numerous studies (e.g., Ürge-Vorsatz et al. 2012; Laustsen 2008; WBCSD 2009; Passive House Institute 2012a) are confirming that enormous energy saving potentials – up to 80, 90 % – can be realised by improving building and appliance energy efficiency, and also that most of the available improvement options are cost-effective from a life-cycle perspective as long as they are done in new built or in line with normal reinvestment cycles. An important starting point for our work was the hypothesis, often found in literature, that highly energy efficient buildings need a strategic approach of integrated design, combining different design options in an intelligent way to achieve higher energy savings at lower investment costs.

In our research (within the bigEE (Bridging the Information Gap on Energy Efficiency in Buildings) project, see acknowledgements) we however found that there are no worldwide consistent standards, in terms of primary thermal energy consumption, in defining Low-Energy and Ultra-Low-Energy Buildings in different climate zones. Therefore, a strategic two-level approach to energy-efficient building design in a consistent manner for the four main climate zones in the world has been developed. The two levels are (1) an 'Easy Efficiency Strategy', which can reduce primary thermal energy consumption by 40 to 60 % compared to conventional new building standards and focuses on low-cost options, mainly passive options, and (2) an 'Advanced Strategy', with savings up to 90 % as soon as possible to avoid lock-in effects. In verifying this approach simulations with low-energy and ultra-low-energy buildings of different types (single family, multi family, high rise) were carried out in close cooperation with project partners and with the consultancy Ecofys. This data has also been verified through an empirical database of built examples both for energy consumption as well their economic soundness. In this paper, we will briefly describe our Strategic Approach to reducing energy consumption through the example of new residential buildings. This is given in clearly defined energy performance ranges, with reference to possible savings, according to strategy for different climate zones worldwide.

The Strategic Approach to energy-efficient building design

WHY IS A STRATEGIC APPROACH NEEDED?

The approaches to foster energy efficiency targets and priorities for both new buildings and renovations differ among the world regions. While more developed economies such as the European Union focus on energy efficient buildings within a mandatory framework directive (Energy Performance of Buildings Directive/EPBD (European Parliament, Council 2010)), emerging economies such as India concentrate mainly on a voluntary certification scheme for green buildings. Whereby it must be noted that energy efficiency plays a secondary role in the green building certification schemes.

For energy savings in the building sector in the developed economies of Western Europe, North America and Pacific OECD, the focus should be on the renovation of the large existing building stock. New buildings are clearly the main challenge in Centrally Planned Asia, South Asia, Latin America, Middle East, Africa and Non-OECD Pacific Asia. These regions are characterised by rapid rates of new construction and rapidly increasing energy demand for cooling. In Eastern Europe and the former Soviet Union there is equal potential for both new and existing buildings (GEA 2012).

In the above-mentioned developed economies, especially those of the European Union (EU), there has already been a strong movement, especially over the last 20 years, to foster approaches of energy efficiency through performance standards. An important driver for the EU buildings market is the fact that some countries in Northern Europe (e.g. Sweden, Denmark) and later Germany strengthened their performance standards stepwise. Hence, EU markets for new buildings have already been pushed towards a better energy performance during the last 20 years. The EU, not as single countries but now as a whole, provides a mandatory framework directive with the obligation for its member states to set minimum energy performance standards (MEPS). By setting an upper limit for the allowed energy consumption of a building, MEPS can be used to exclude the most inefficient buildings, technologies, components, etc. from the market. It is a prerequisite for MEPS that a valid and accepted methodology for measuring energy consumption and efficiency is either in place or being established. While MEPS at cost-effective levels should be made compulsory by law, higher standards (up to Zero Energy Buildings) can first be established on a voluntary basis. As these higher standards become common practice and cost-effective, these then should be made the new MEPS.

The first European building directive on energy efficiency went into force in 2002: The Energy Performance of Buildings Directive ((European Parliament, Council 2002). During the following years the member countries started to implement energy efficiency standards as well as energy performance certificates (EPC). The EPBD have been steadily improved upon with the recast Directive stipulating that by the end of December 2020 all new buildings constructed within the European Union must reach nearly zero-energy levels and that for non-domestic buildings, occupied and owned by public authorities, this goal must be reached by the end of December 2018.

Germany, for example, implemented its energy saving ordinance (Energieeinsparverordnung, EnEV) setting mandatory performance standards and establishing an energy performance certificate (EPC) called 'Energieausweis'. The first EnEV requirement in 2002 pushed the specific thermal primary energy requirements residential buildings under the 100 kWh/m^2/year threshold, the latest recast in the year 2009 to 70 kWh/m^2/year and another tightening of 12,5 % is planned in 2014 and another 12,5 % in 2016.

Already many new buildings within the European Union have reached Ultra-Low-Energy levels. Studies (e.g. Passive House 2012a) have shown that these new Ultra-Low-Energy buildings, such as those built to the Passive House Standard, need 60 to 90 % less primary energy for heating and cooling than conventional new buildings, and can be constructed cost-effectively in most parts of the world.

Conventional new buildings in OECD countries and China with existing building energy codes already save about 50 % of the heating and cooling energy compared to the existing building stock. These improvements, however, are neither enough to create a building standard with low lifetime costs nor to reach long-term climate change mitigation targets. Much higher energy savings can be achieved through proven high-efficiency building concepts worldwide.

Retrofitting existing buildings can bring significant improvements. The existing building stock provides the larger potential for cost-effective energy savings compared to new construction not only in OECD countries but increasingly also in countries like China (GEA 2012). However, it is also a bigger challenge to holistically retrofit the walls, roofs, windows, and heating and cooling systems of existing buildings to highest energy performance levels and to ensure the savings through optimal operation. Every year, many existing buildings undergo renovation for maintenance or beautification anyway. These opportunities should be utilized to improve energy efficiency by adding thermal insulation or shading and using more energy-efficient windows, heating, and cooling systems, instead of just replacing paint, styles, or windows as they were before. They should always be at the least as stringent as the energy performance level leading to least life cycle costs. The operational goal for energy efficiency in existing buildings thus has two dimensions: Achieving very energy-efficient and comprehensive, "extensive" retrofits whenever a building is renovated, and

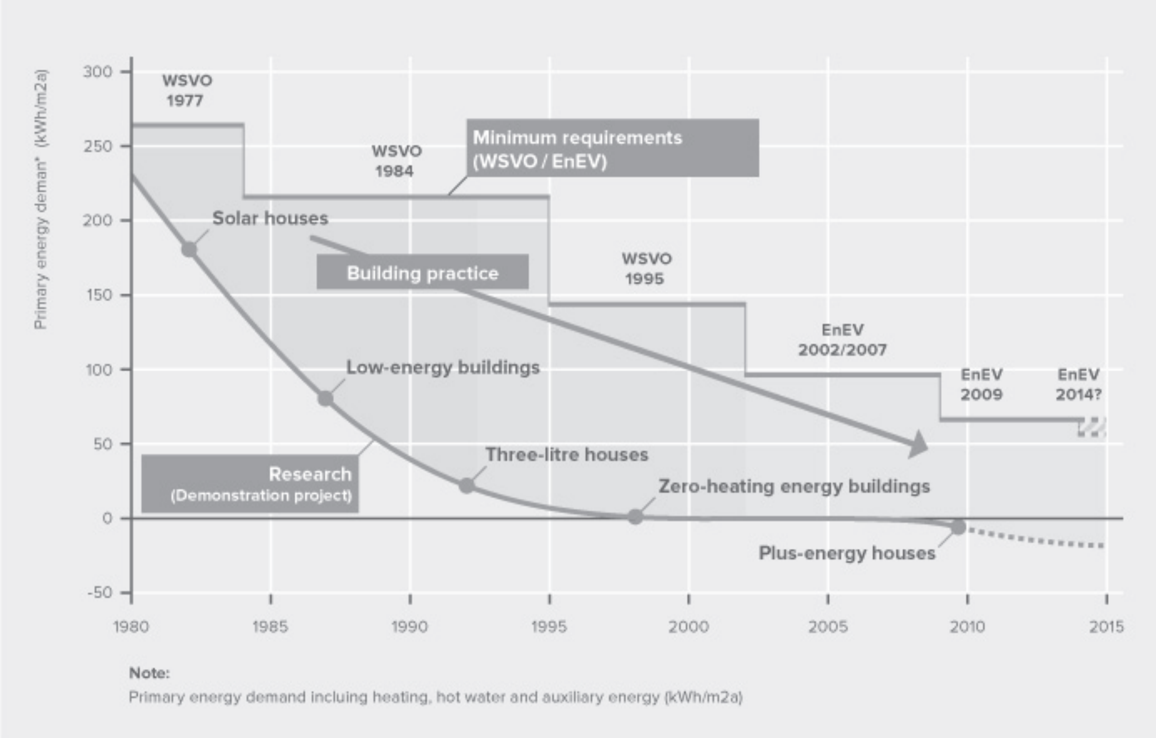

Figure 1. Stepwise evolution of Minimum Energy Performance Standards, demonstration projects and building practice in Germany. Source: Wuppertal Institute (2012), adapted from Fraunhofer IBP (2012)

increasing the rate at which buildings undergo such “extensive” renovations. Extensive energy-efficient renovation measures can achieve primary energy savings of 50 to 90 % (GEA 2012).

Many tools and guidelines offered to policy and decision makers, to aid in reaching energy efficiency targets and priorities by defining energy consumption levels, are however often too complex and not comparable across regions. Net and nearly Zero Energy Buildings for example have been defined in various forms quite often and Plus-Energy Buildings can be quite easily defined. For Low-Energy Buildings and Ultra-Low-Energy Buildings however there is no standard definition. Different countries use different values resulting in some confusion as buildings can be defined as being in a certain standard such as an Ultra-Low-Energy Building in one country but are defined as a Low-Energy Building in another.

The Strategic Approach of bigEE aims to alleviate this by defining energy consumption by a common set of parameters, which determine energy consumption in combination with the climatic conditions. Each climatic region will require its own approaches to reaching (nearly) Zero/Plus-Energy buildings and must deal with existing building stock and new buildings in different ways. The most important factor determining the approach for achieving energy efficiency is the climate. This common denominator will allow a comparison of buildings irrelevant of country but rather on the climate, which is one of the most important factors and defines the energy consumption of a building. This as well as other factors including the availability of local construction materials, efficient technology, know-how in the industry, existing policies as well as the price of energy will determine the path taken to reaching these goals. These paths need not be the same but can differ vastly across climate and region. However, the analysis and many built examples have shown that all the paths are able to attain the same goal, i.e. the same range of energy consumption levels for a given climate.

INTEGRATED DESIGN PROCESS

Buildings are extremely complex. Each component can be improved upon but none can bring about energy efficiency in buildings on their own. There are combinations of different options for improving energy efficiency in buildings. The Strategic Approach follows the premise of first implementing load-reducing “Passive Options” for building design, followed by energy-efficient “Active Options” for thermal conditioning and ventilation as needed and then fine-tuning building operation through “User Behaviour and Energy Management”. At first glance they all seem independent of each other. However all energy efficiency options are interdependent to some degree and therefore an integrated design approach is indispensable to ensure that the architectural elements and the engineering systems work effectively together. Changing or improving one aspect might have great impact on another. Focusing on individual pieces of equipment or design features generally only brings limited improvements. Analysing the building as an entire system can however lead to altogether different design solutions. This can result in new buildings that use much less energy but are no more expensive than conventional buildings (Levine et al. 2007). This integrated design process can achieve improved building performance at lower costs and ensures fewer troublesome changes during the later stages of the project. The sum of the whole is more than the sum of the single components. This integrated three-part process can reduce the primary thermal energy demand of a building to low or even ultra-low levels, depending on the levels at which these are implemented at. Adding on-site renewable energy technologies for heating and cooling and/or for power generation (CHP/CHCP, PV cells etc.) can turn the primary energy balance of a building to the positive side, with the building becoming a net producer of energy over the year.

THE STEP-BY-STEP PATH TO ENERGY EFFICIENCY

A step-by-step path is needed to utilise this integrated design processes (IDP), with each step representing a more stringent implementation of the IDP, to effectively reach energy efficiency in new building projects and the building sector overall. This strategic approach is ultimately the key to comfortable, competitive and energy-efficient buildings as well as a sustainable development.

In general the path (Figure 2) to reach energy efficiency can be seen as a continuous one, albeit divided into numerous small improvements to eventually reaching zero-energy buildings and beyond. It can however be seen that the path is divided into two major parts or steps: firstly to reduce the final energy (Figure 2) and thus the primary thermal energy consumption from a high (red area) to a low level (yellow/green area) by designing a highly efficient consumption and supply performance. Secondly by setting even more ambitious energy efficiency standards and implementing onsite power generation systems to deliver surplus energy within an annual energy balance.

By using this path (Figure 2) a step-by-step Strategic Approach (Figure 3) can be developed which describes the energy saving potential, the Easy Efficiency Approach and the Advanced Efficiency Approach, with a total of three levels of ambition. The Easy Approach has the Low-Energy Building (LEB) level of ambition, which can be seen as the "low hanging fruit" of building energy efficiency. This is then followed by the Advanced Efficiency Approach, which is divided into Ultra-Low-Energy Buildings (ULEB) and (Nearly) Zero and Plus-Energy Buildings (nZEB/PEB). In the short-term, the Easy Efficiency Approach should be regarded as the minimum. It focuses on low-cost options, mainly passive options. Although it can already significantly reduce energy consumption, this first step will not be sufficient to reach long-term climate protection goals. It is thus necessary to implement and support an Advanced Efficiency Approach at the earliest to avoid lock-in effects, which result in new, inefficient houses continuing in use for decades because of long building lifetimes. The choice between these three concepts (LEB, ULEB and nZEB/PEB) will depend not only on an investor's ambition but also on the cost and benefit situation, the design and building skills, material, and technologies available in a country.

THE EASY EFFICIENCY APPROACH TO LOW-ENERGY BUILDINGS

Low-Energy Building (LEB) can be designed by what we call an Easy Efficiency Approach. This can achieve primary thermal energy savings for cooling, heating, ventilation and domestic hot water in a range of about 40 % to 60 % compared to conventional new buildings. The base or reference value for the strategic approach of each climate zone being based on current business as usual energy standards for conventional new buildings and the most common technologies. The Easy-Efficiency Approach to Low-Energy Buildings (LEB) is characterised by an intelligent (holistic/integrated) building design in combination with an appropriate choice of efficient technologies for heating, cooling, hot water production, ventilation and air conditioning, lighting etc. By fulfilling basic rules of energy-efficient design especially passive options, any incremental capital costs incurred are compensated by energy cost savings within a few years and certainly provide returns over the lifetime of the buildings. Thus the most important advantage of these buildings is that they are – as a rule – economically attractive over their lifetime as they make use of the

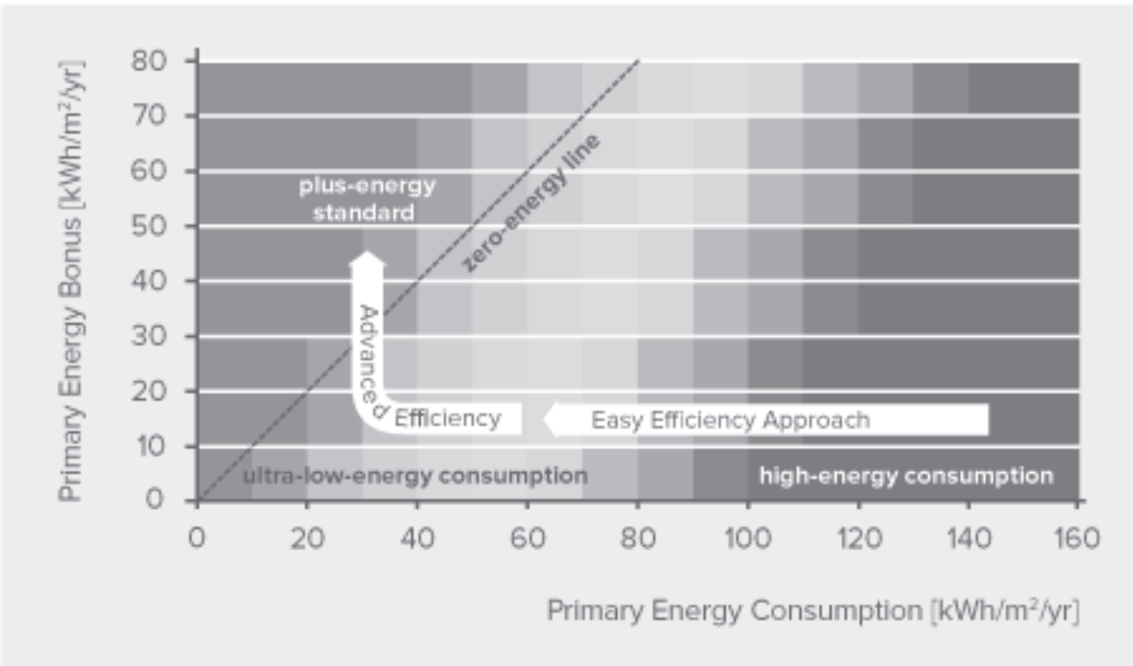

Figure 2. The path to energy efficiency through a strategic approach. Source: Developed by Wuppertal Institute for bigEE (2012).

'low hanging fruits' of energy efficiency options (e.g. Harvey, L.D.D. 2006; Passive House Institute 2012b)

THE ADVANCED EFFICIENCY APPROACH TO ULTRA-LOW-ENERGY BUILDINGS

The Advanced-Efficiency Approach is divided into two more steps with Ultra-Low-Energy Buildings (ULEB) and (Nearly) Zero and Plus-Energy Buildings (nZEB/PEB) each representing a further step in the Strategic Approach.

Ultra-Low-Energy Buildings

Ultra-Low-Energy Buildings (ULEB) is a further development of a Low-Energy Building, requiring up to 90 % less primary thermal energy consumption than a conventional new building. The Ultra-Low-Energy Building maximises a building's energy efficiency potential.

An Advanced-Efficiency Approach is needed to attain these low levels of energy consumption. Ultra-Low-Energy Buildings set more ambitious energy efficiency standards, using higher levels of thermal insulation and the most-energy-efficient components and systems available to reduce the energy consumption. This energy consumption should preferably be covered by renewable energy sources such as solar energy, ambient and geothermal energy, sustainable biomass etc. It can be cost-effective, depending on the trade-off between incremental capital costs and long-term energy cost savings but this may not always be the case.

In the context of the bigEE project, an Ultra-Low-Energy Building is defined to achieve a primary energy savings of 60 % to 90 % compared to conventional new buildings for cooling, dehumidification, heating, ventilation and domestic hot water.

(Nearly) Zero Energy Buildings and Plus Energy Buildings

(Nearly) Zero and Plus-Energy Buildings take the concept of Ultra-Low-Energy Buildings a step further. In addition to a highly energy-efficient building performance, the (nearly) Zero-Energy Building and the Plus-Energy Building concepts include on-site renewable energy technologies for generating power and also meeting cooling and heating requirements of the buildings. Supplemented with on-site or building integrated renewable energy systems and other technologies such as Combined Heating (or Cooling) and Power (CHP or CHCP), those buildings can be transformed from energy consumers to (net or nearly) zero-energy and/or energy producers at least in annual balance.

As on-site generation is normally more expensive than reducing energy consumption, advanced levels of energy efficiency should be achieved first (Barthel et al 2006). If the amount of produced energy throughout the year is roughly equivalent to the annual primary energy consumption, the building can be described as a nearly Zero-Energy Building (nZEB). If the energy production exceeds the consumption, the term Plus-Energy Building (PEB) will be used.

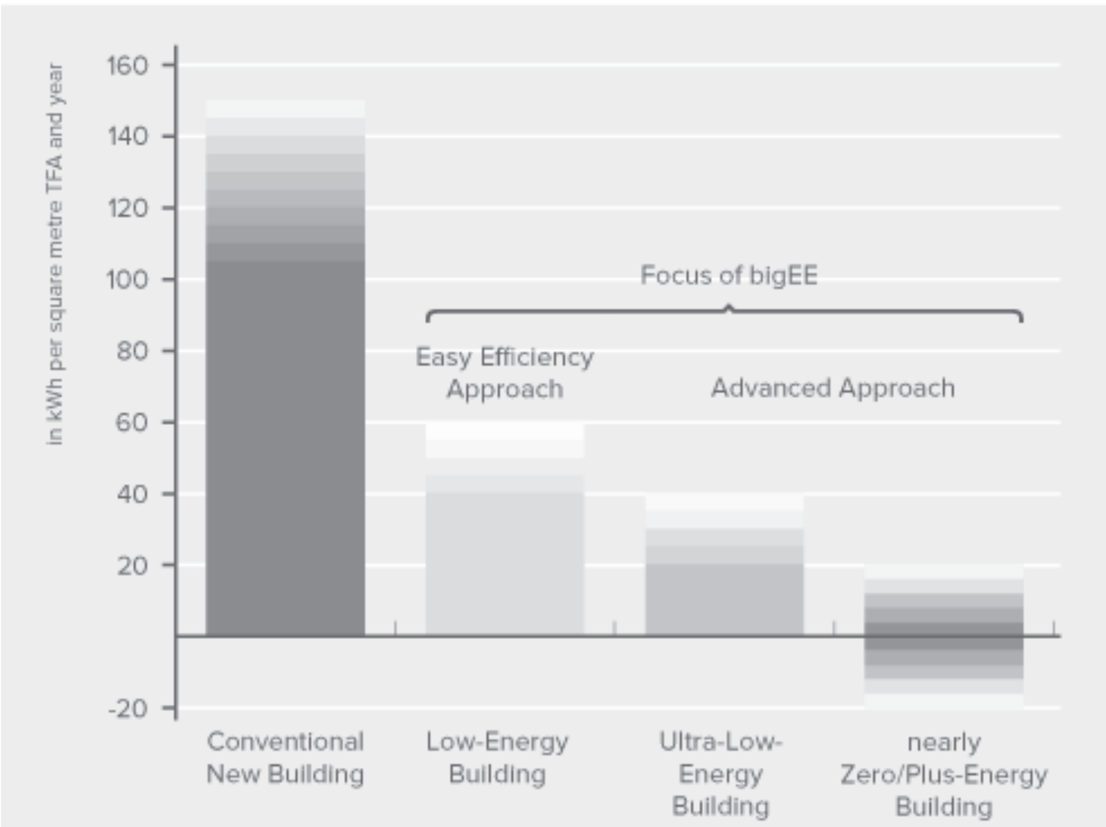

Figure 3. The steps to energy efficiency through a Strategic Approach for new residential buildings. Source: Developed by Wuppertal Institute for bigEE (2012).

DEFINITION OF ENERGY-EFFICIENT BUILDINGS ACCORDING TO ENERGY CONSUMPTION

In defining the Strategic Approach however absolute and clearly defined energy performance ranges according to strategy for different climate zones worldwide are needed. These clearly defined energy performance ranges being based on the specific thermal primary energy consumption for heating, cooling, dehumidification, ventilation, and water heating of a building.

The energy consumption of a building is highly dependent on numerous factors, the most important being that of the climate. For simplicity the world's climate, within the Strategic Approach, was divided into four major climatic zones: Cool, Temperate, Hot and Humid and Hot and Arid. Each of these regions or zones has different requirements with respect to heating and cooling energy needs and can be defined as follows:

- **Cold** climates have a high heating demand for all or part of the year and no or little cooling demand. Heating Degree Days 18 °C ≥ 1000, Cooling Degree Days 10 °C < 1000
- **Temperate** climates have both a heating and cooling demand for all or part of the year. Heating Degree Days 18 °C ≥ 1000, Cooling Degree Days 10 °C ≥ 1000
- **Hot and Humid** climates have a cooling and no or little heating demand throughout the year as well as a high humidity level throughout the year, with a humidity level of over 50 % in the hottest month. Heating Degree Days 18 °C < 1000, Cooling Degree Days 10 °C ≥ 1000
- **Hot and Arid** climates have a cooling and no or little heating demand throughout the year as well as low relative humidity levels throughout the year with a humidity level of less than 50 % in the hottest month. Heating Degree Days 18 °C < 1000, Cooling Degree Days 10 °C ≥ 1000

In further defining the standard for energy consumption in buildings, buildings within the bigEE project have been divided into four distinct design types defined on whether they are passively or actively conditioned. These building design types are closed, hybrid, zoned and open buildings:

- **Closed** buildings: These buildings mainly use active technologies (e.g. heating or cooling system and equipment) to condition the internal environment throughout the year. This allows for a greater control within stricter thermal comfort levels.
- **Hybrid** buildings: Hybrid buildings use both passive and active technologies to maintain thermal comfort. These buildings are designed so that for the greater part of the year the passive design options maintain the thermal comfort and only under extreme climatic conditions where this is not possible the active option is used.
- **Zoned** buildings: Zoned buildings are a combination of both passive and active building models. Here the building is divided into different zones, which are conditioned accordingly to their needs. Passive zones are usually found on the buildings perimeter and active zones in the buildings interior. This allows for the passive options such as natural light, solar insolation as well as natural ventilation to be used to the optimum.
- **Open** buildings: These buildings are open and have no active technologies. These are also known as free running buildings. Temperatures can be to some extent controlled through passive options. Indoor temperatures follow the outside temperature. Internal temperatures ranging at best from the lowest temperature to the outside shade temperature in the tropics. In Hot Climates and Temperate Summer Climates the internal loads e.g. persons or technologies can cause a significant increase in the internal temperatures.

These building-conditioning concepts determine the energy consumption of a building. In general it can be said that completely conditioned closed buildings consume the most energy. In less extreme climates however, where the outdoor temperatures are within or near the thermal comfort zone, using one of the other three design types, hybrid, zoned and open buildings, can reduce energy consumption.

These building design types have thus been used as the basis for the limits in determining the energy consumption for each climate zone within the bigEE project. The total energy consumption of a building is however insufficient in comparing energy consumption between buildings as size varies and larger buildings will naturally have higher total consumption. In comparing buildings the energy consumption should be thus independent of the buildings size. The definition of energy consumption levels in the bigEE project is thus that of specific energy consumption. Heating, cooling, dehumidification, ventilation as well as hot water consumption are used as the defining basis for the energy consumption of the building on the basis of the treated floor area (whereby for the open concept only the hot water consumption was considered). The energy consumption for lighting and for appliances is not included in this building specific Strategic Approach for residential buildings, because – as a rule – both end uses are not building integrated but come as a procurement of the habitants. However, we recommend energy-efficient lighting (using ca. 2 kWh_{el}/m^2/year) and energy efficient household appliances (max. total consumption ca. 1,650 kWh_{el}/year for a European household with a treated floor area of 120 m^2). These values were also assumed in the simulations as part of the internal loads and in setting the thermal energy consumption ranges by climate in the Strategic Approach. Other factors such as building form, orientation, insulation etc. have not been included in the definition either. This allows decision makers and actors to plan buildings according to their needs and local conditions. To achieve the optimum energy efficiency in buildings a holistic planning is however a must. For this to work effectively, performance targets need to be defined for the various types of buildings and climates. BigEE has developed them using a combination of building simulation for single family, multi family, and high rise buildings (in co-operation with Ecofys) with real built good practice examples of such buildings in these climates.

TIMELINE FOR STANDARDS

In the short-term, the Easy Efficiency Approach should be regarded as the minimum. It focuses on low-cost options, mainly passive options. Although it can already significantly reduce energy consumption, this first step will not be sufficient to reach long-term climate protection goals. It is thus necessary

Table 1. Specific primary energy consumption levels, for heating, cooling, dehumidification, ventilation and hot water, of the bigEE Strategic Approach according to Climate: values recommended for closed new building concepts.

	Cold (e.g. Helsinki)	Temperate (e.g. Shanghai)	Hot and Humid (e.g. Mumbai)	Hot and Arid (e.g. Khartoum)
	$kWh/m^2_{TFA}yr$	$kWh/m^2_{TFA}yr$	$kWh/m^2_{TFA}yr$	$kWh/m^2_{TFA}yr$
LEB	40 – 80	40 – 80	100 – 150	50 - 100
ULEB	20 – 40	20 – 40	50 – 100	25 - 50
nZEB	0 – 20	0 – 20	0 – 50	0 - 25
PEB	++	++	++	++

(TFA: Treated floor area)

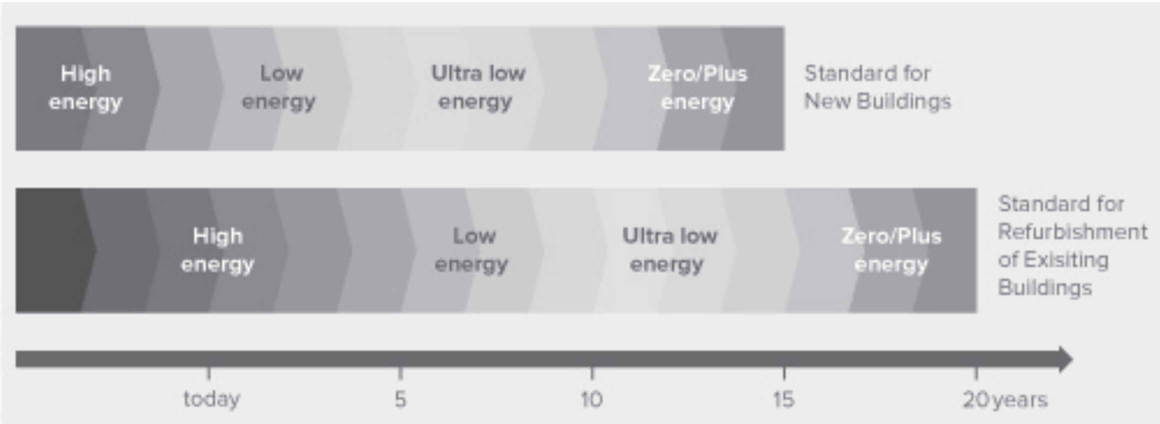

Figure 4. Exemplary schedule for the introduction of increasingly ambitious levels for energy-efficient buildings. Source: Developed by Wuppertal Institute for bigEE (2012).

to implement and support an Advanced Efficiency Approach at the earliest to avoid lock-in effects, which result in new, inefficient houses continuing in use for decades because of long building lifetimes.

The differences between new buildings and existing buildings must however also be taken into account. Highly energy efficient technologies are usually available first for new buildings and later disseminated to existing buildings, because more effort is required for refurbishment than for new built. A possible schedule for a step-by-step introduction of increasing building performance standards for new and existing buildings is illustrated in Figure 4.

COST AND COST-EFFECTIVENESS OF ENERGY EFFICIENT BUILDINGS

Energy-efficient buildings are often still seen as being more expensive than a conventional building. This is mainly due to high performance building components.

As mentioned above the step-by-step path of the Strategic Approach is ultimately the key to comfortable, competitive and energy-efficient buildings as well as a sustainable development. The choice between these three concepts will depend not only on an investor's ambition but also on the cost and benefit situation, the design and building skills, material, and technologies available in a country.

Examples of holistically planned Ultra-Low-Energy and (nearly) Zero and Plus-Energy Buildings, such as the Aqaba Residence Energy Efficiency House in Jordan highlighted on the bigEE website, already exist and it has been shown that these can be achieved economically. Harvey (2006) as well as Öhlinger (2006) among others have shown that buildings can be built at high levels of energy efficiency (80 % of thermal energy savings and above) at little or no extra cost.

Additional capital costs for an Ultra-Low-Energy Building (in this case a Passive House) are for example between 3 and 10 % in European countries (residential buildings) (Passive-On Project 2007). Total useful energy savings lie however between 25–65 % compared to buildings meeting Minimum Energy Performance Standards (MEPS) in these European countries, which often already are Low-Energy Buildings (Passive-On Project 2007).

This additional capital cost can often be offset through the reduced operational energy cost for mechanical heating and cooling as well for electricity systems. Once such low energy demand levels have been achieved, it is also not so expensive to cover them with buildings-integrated renewable energies. In European countries, the discounted payback time for Passive Houses varies from 4 to 19 years (Passive-On Project 2007). The cost effectiveness of course depends on the energy prices. In some cases, highly energy-efficient buildings can even cost less than buildings built according to standard practice (Harvey 2006).

With increasing demand for energy efficient buildings and technologies the market will help to drive these prices down even further (Figure 5). Studies for example, have shown that for residential buildings in Germany, the additional investment can decrease with time (from 8 % in 2010 to less than 7 % in

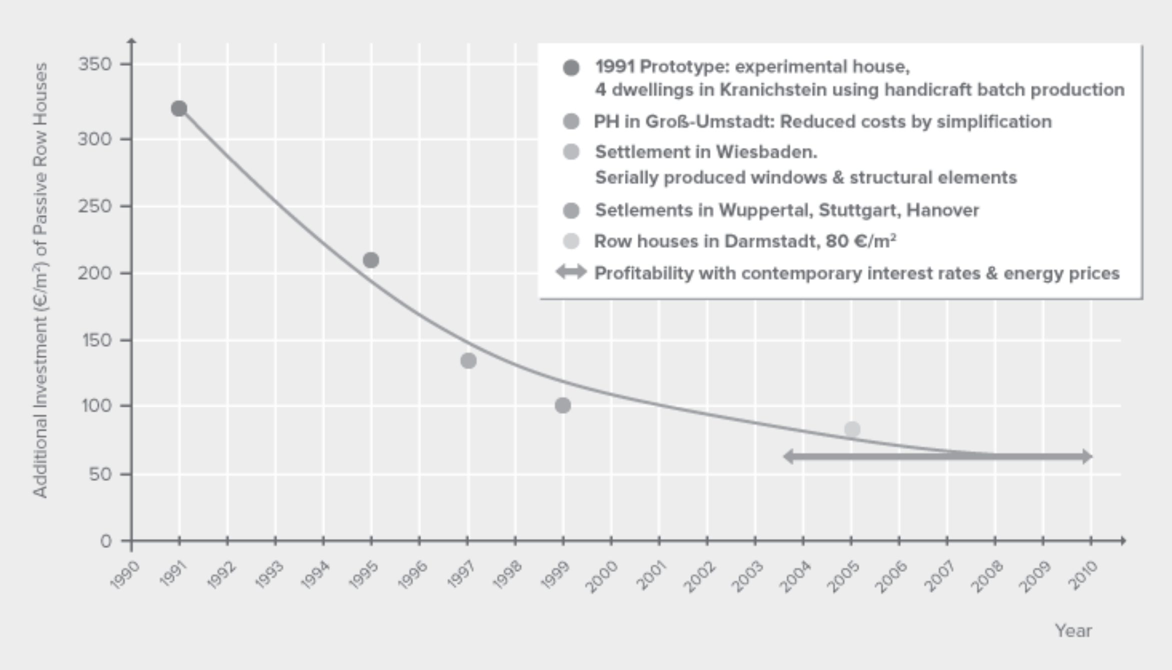

Figure 5. Learning curve showing the progressive decrease (the increased energy performance of new buildings being taken into account) in the incremental cost of meeting the passive house standard for the central unit of row houses in Germany. These compare to costs for conventional buildings of ca. €1,250 to 1,750 per m². Energy prices and interest rates being set for 2005. Source: Feist (2005).

2011) (Passive House 2012b). Even now at unsubsidised energy prices, at the least the buildings of the easy efficiency approach are globally normally cost-effective unless energy prices to final users are heavily subsidised.

Discussion and conclusions

With the strategic approach to energy-efficient building design, bigEE has created the first worldwide consistent approach to defining Low-Energy and Ultra-Low-Energy Buildings in different climate zones. This goes further than previous attempts for Net Zero Energy or Plus Energy Buildings, which are relatively easy to define, and the Passive House Institute's definition, which only covers closed building concepts of Ultra-Low-Energy Buildings.

Our approach also differentiates target value ranges for the specific thermal primary energy consumption by climate zone, in order to allow comparable efforts, whereas a single energy target range would require too high efforts in the hot climates. On the other hand, the target ranges should be seen as maximum values. There are "lucky climates" in the temperate zones (such as in Lisbon) or in mountain regions of the tropics that allow real Zero-Energy Buildings using the Easy Efficiency Approach.

Looking at policy targets, countries starting efforts to improve building energy efficiency should at least start with the Easy Efficiency Approach to Low-Energy Buildings and aim to advance to Ultra-Low-Energy Buildings as soon as possible. However, as far as possible, leapfrogging to very high energy efficiencies of whole buildings or components, building on the experiences of others, would even be more preferable, given the need to limit global warming as well as the geopolitical aspects of energy markets and resources.

As it is the first worldwide consistent approach to defining Low-Energy and Ultra-Low-Energy Buildings in different climate zones, our results leave room for further improvement. We consider extending the number of climate zones to provide for better differentiation of target values and design recommendations. Also, we hope that more good practice buildings examples confirming the design and results will become available during the next years. Currently, particularly in hot climate zone, many energy-efficient buildings are still prototypes with the corresponding high costs. As more experience is gained also in these climates, cost-effectiveness should improve further. Nevertheless further research, simulations and pilot buildings are needed to create learning effects, especially for emerging economies, which have the largest potential energy saving.

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A WEB-BASED KNOWLEDGE PLATFORM TO DEMONSTRATE GOOD PRACTICE BUILDINGS AND POLICIES

This strategic approach was developed at the Wuppertal Institute within the bigEE (Bridging the Information Gap on Energy Efficiency in Buildings) project to address these challenges and to give some global guidelines for ranges of energy consumption. The bigEE project, started from the finding that information on energy efficiency technologies and policies is, albeit abundant, very scattered and decision makers find it difficult to access. The project seeks to address this problem by summarising knowledge and presenting comprehensive, independent and high-quality information on energy efficiency in buildings on its international website. It addresses the needs of decision-makers in businesses and policy; a structured presentation makes it easy to find the information required. Three comprehensive guides – for building design and technologies, for appliance energy efficiency and for policy implementation present detailed information about how to increase energy efficiency and how policy can support those savings. A further task for bigEE is collecting and updating information on best available technologies (BAT) on a comparable basis, as well as the gathering of energy saving potentials, net economic benefits, and good practice policies. In particular, the project aims to make the information about existing policies and buildings/technologies throughout the world comparable and present it in a targeted way so as to support investors and policy makers in making the right – energy-efficient – choices. Apart from information being universally applicable, up to five partner countries will be addressed, starting with China, South Africa and Mexico. The platform is online at bigee.net.

To achieve the required quality of information, the bigEE team collaborates with scientific institutes and with existing initiatives and platforms – international and in partner countries, including UNEP and IEA. Furthermore, bigEE engages in the active dissemination of information relevant for investors and policy-makers in the partner countries, by setting up and co-operating with a network of local partners.

"bigEE – bridging the information gap on energy efficiency in buildings" is a project by the Wuppertal Institute and its international partners, with financial support from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

bigEE
Your guide to energy efficiency in buildings.