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DIRECTORATE D - New and Renewable Energy Sources, Energy Efficiency & Innovation

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LOW ENERGY BUILDINGS IN EUROPE: CURRENT STATE OF PLAY, DEFINITIONS AND BEST PRACTICE

The proposal for a recast of the **Directive on the energy performance of buildings** (EPBD)[1] at present suggests that all EU Member States endorse national plans and targets in order to promote the uptake of **very low and close to zero energy buildings**.

In low energy buildings, as much as 80% of the operational costs can be saved through integrated design solutions; however there is still a limited market uptake. So far, around 20.000 low energy houses have been built in Europe of which approximately 17.000 in Germany and Austria alone.[2] The present document is supposed to provide background information regarding definitions, calculation methods and MS policies, as well as best practice examples of low energy buildings in Europe.

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[1] COM (20008) 0223 final

[2] Bertez J.L., The passive stake. Strategic overview on a global, structured and sustainable way for "efficient building", Zenergie 2009.

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1. Concepts and definitions

Terms, concepts and calculation methodologies used for all types of low energy buildings vary significantly between EU Member States and beyond

Low energy building

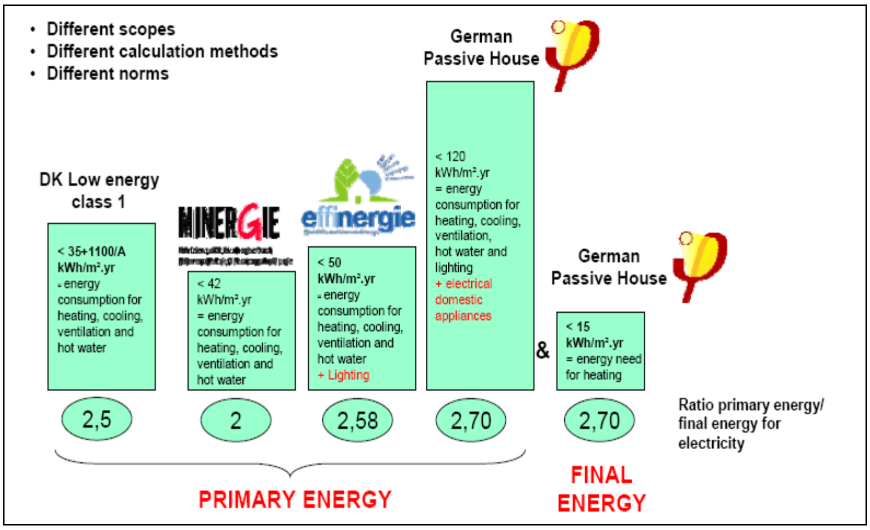
There is no global definition for low-energy buildings, but it generally indicates a building that has a better energy performance than the standard alternative/energy efficiency requirements in building codes. Low-energy buildings typically use high levels of insulation, energy efficient windows, low levels of air infiltration and heat recovery ventilation to lower heating and cooling energy. They may also use passive solar building design techniques or active solar technologies. These homes may also use hot water heat recycling technologies to recover heat from showers and dishwashers.

In fact, low energy buildings are known under different names across Europe. A survey carried out in 2008 by the Concerted Action supporting EPBD identified 17 different terms in use to describe such buildings used across Europe, among which the terms **low energy house**, **high-performance house**, **passive house**/**Passivhaus**, **zero carbon house, zero energy house, energy savings house, energy positive house, 3-litre house etc.** In the relevant literature additional terms such as **ultra-low energy house** can be found. Finally, concepts that take into account more parameters than energy demand again use special terms such as **eco-building** or **green building**.

Variations exist not only as regards the terms chosen, but also what energy use is included in the definition. Ideally, the minimum performance requirements should take into account all types of energy use that is demand for space heating (cooling), water heating, air conditioning as well as consumption of electricity. This is often not the case. On the contrary, the definition may cover only space heating ignoring all electricity demand that may cover most heating needs for instance in office buildings.

The following illustration on selected low energy performance standards shows the different scopes and calculation methods:

Illustration 1: Different scopes, calculation methods and norms for low energy and passive houses in selected countries



Source:
Thomsen/Wittchen, European national strategies to move towards very low energy buildings, SBI (Danish Building Research Institute) 2008

At present, seven EU MS have defined for themselves when a building is a low energy building (AT, CZ, DK, UK, FI, FR and DE, BE (Flanders), a few more (LUX, RO, SK, SE) plan to do so. Definitions typically target new buildings, but in some cases (AT, CZ, DK, DE, LUX) also cover existing buildings and apply in almost all cases to both residential and non-residential buildings[3]. Typically the required decrease in energy consumption will range from 30 to 50 % of what is defined for standard technology for new buildings. That would generally correspond to an annual energy demand of ≤ 40- 60 kWh/m² in Central European countries. In some countries such as France or Switzerland, labels have been introduced (MINERGIE in Switzerland, Effinergie in France) that help consumers identifying nationally standardised low energy buildings. The table below gives an overview of the definitions for low energy buildings used across Europe:

[3] For more info see: SBI (Danish Building Institute), European Strategies to move towards very low energy buildings, 2008

Table 1: Examples of definitions for low energy building standards	
Country	**Official definition**
Austria	• Low energy building = annual heating energy consumption below 60-40 KWh/m² gross area 30 % above standard performance) • Passive building = Feist passive house standard (15 kWh/m² per useful area (Styria) and per heated area (Tyrol)
Belgium (Flanders)	• Low Energy Class 1 for houses: 40 % lower than standard levels, 30 % lower for office and school buildings • Very low Energy class: 60 % reduction for houses, 45 % for schools and office buildings
Czech Republic	• Low energy class: 51 – 97 kWh/m2 p.a. • Very low energy class: below 51 kWh/m² p.a., also passive house standard of 15 kWh/m2 is used
Denmark	• Low Energy Class 1 = calculated energy performance is 50% lower than the minimum requirement for new buildings • Low Energy Class 2 = calculated energy performance is 25% lower than the minimum requirement for new buildings (i.e. for residential buildings = 70 + 2200/A kWh/m² per year where A is the heated gross floor area, and for other buildings = 95+2200/A kWh/m² per year (includes electricity for building-integrated lighting)
Finland	• Low energy standard: 40 % better than standard buildings
France	• New dwellings: the average annual requirement for heating, cooling, ventilation, hot water and lighting must be lower than 50 kWh/m² (in primary energy). This ranges from 40 kWh/m² to 65 kWh/m² depending on the climatic area and altitude. • Other buildings: the average annual requirement for heating, cooling, ventilation, hot water and lighting must be 50% lower than current Building Regulation requirements for new buildings • For renovation: 80 kWh/m² as of 2009
Germany	• Residential Low Energy Building requirements = kfW60 (60kWh/(m²·a) or KfW40 (40 kWh/(m²·a)) maximum energy consumption • Passive House = KfW-40 buildings with an annual heat demand lower than 15 kWh/m² and total consumption lower than 120 kWh/m²
England & Wales	Graduated minimum requirements over time: • 2010 level 3 (25% better than current regulations), • 2013 level 4 (44% better than current regulations and almost similar to PassivHaus) • 2016 level 5 (zero carbon for heating and lighting), • 2016 level 6 (zero carbon for all uses and appliances

Source:
SBI (Danish Building Institute), European Strategies to move towards very low energy buildings, 2008

Given the varying climatic and regulatory conditions across Europe, it is difficult to define exactly the concept of low energy building for the entire EU. National standards and methodologies vary so that 'low energy' developments in one country may not meet 'normal practice' in another. For example in the US, the Energy Star label indicates buildings that use only 15% less energy than what regulations define.

Passive house and equivalent concepts

The definitions for passive houses are even more heterogeneous, as in this case what is understood by the term differs from Central/ Northern Europe (Germany, Austria, Sweden etc.) to southern Europe (e.g. Spain, Italy, Portugal, Greece). In southern Europe it means that a house has been constructed in line with generic Passive Design, i.e. using passive technologies. In central Europe, the term Passive House refers to a certain standardised type of low energy buildings as developed in Germany. It is a special type of a low energy building for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass without a need for a conventional heating system. Passive house technologies typically include passive solar gain (also through south orientation), super glazing (U-value ≤ 0.75 W/(m^2K), airtight building envelope, thermal bridge free construction.[4] This reduces annual demand for space heating to 15 kWh/(m^2a) which means that they roughly use 85% less overall energy with the limit for total primary energy use being 120kWh/m^2 p.a.. In Switzerland a similar standard as the one in Germany, MINERGIE®-P is used. In the United States, a house built to the Passive House standard uses between 75 and 95% less energy for space heating and cooling than current new buildings that meet today's US energy efficiency codes.[5] The Passive-on project has based a more general definition on the above mentioned standards and indicates that a passive house or equivalent requires combined heating and cooling demand between 15 – 20 kWh/ (m^2,a).

At present more than 12.000 such houses have been built in Europe, however mostly located in Germany, Austria and Scandinavia[6].

Zero energy houses/zero carbon houses

The specificity of a zero energy house/zero carbon house is that the remaining energy needs are entirely covered with renewable sources/carbon free energy sources. A house with zero net energy consumption annually can be autonomous from the energy grid supply, but in practice that means that in some periods power is gained from the grid and in other periods power is returned to grid (renewable energy sources are often seasonal).

In the US, various definitions of zero energy buildings are used. [7]Japan is in the process of fixing the definition and preparing their zero energy policies in the coming months.

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[4] For more detailed information see: http://www.cepheus.de

[5] The application of the standard Passive House concept has some limitations for Southern climates where the problem of household energy use is one not only of providing warm houses in winter, but also, and in some cases more importantly, of providing cool houses in summer. In these regions, the definition of the *Passivhaus* Standard as applied in Central Europe needs to be modified as to take into account cooling loads and other end uses within the home. Passive-on, a Project funded by Intelligent Energy for Europe SAVE programme applied passive house standards in southern countries, for more information: http://www.passive-on.org

[6] Eceee, Net zero energy buildings: definitions, issues and Experience, Sept 2009

[7] For more info: Zero energy buildings: A critical look at the definition. To be found on: www.nrel.gov/docs/fy06osti/39833.pdf

Energy positive house

An energy positive house (also: plus energy house) is a house that on average over the year produces more energy from renewable energy sources than it imports from external sources. This is achieved using combination of small power generators and low-energy building techniques such as passive solar building design, insulation and careful site selection and placement.

2. Costs of Low Energy Buildings

> Additional costs for low energy buildings cannot be predicted with precision, in all cases they depend on specific conditions.
> Up to 10% extra upfront investment costs are reported, but with clearly declining trend.

The cost of building energy efficient is generally higher due to the extra costs associated with improved insulation of all building components such as windows. Another reason is that most entrepreneurs are not used to the new technologies and much time and resources are invested in planning, education and quality assurance – which brings up costs. This has also contributed to the idea that energy-efficient buildings are expensive. Exact information on these additional costs were difficult to find, in particular for countries with less developed low energy markets, but this chapter gives an overview of studies and the situation in several countries.

Indeed it can be shown that in Germany, Austria or Sweden it is now possible to construct Passivhaus buildings for costs that are no longer significantly higher than for normal standards because of increasing competition in the supply of the specifically designed and standardised Passivhaus building products. For these countries (one could add Switzerland), the extra cost of construction is generally indicated to be in the range of 4-6 % more than for the standard alternative[8]. For Switzerland, a range of 2-6 % of additional upfront cost is given for the Minergie® low energy standard and, depending on the design chosen, a range of 4-5 % but maximum 10 % for the Minergie® P passive house standard.[9] The Interessensgemeinschaft Passivhaus in Germany gives a similar estimation of a range of 0-14 % of extra upfront costs and with current energy prices a time span of up to ten years before energy savings neutralise the extra cost. The Passive-On project estimates the range of additional upfront costs across five involved countries (UK, FR, PT, ES, IT) to be in the range of 3-10 % for newly constructed buildings respecting passive house standards. [10] The cost difference between a low energy and the more ambitious passive house standard is indicated with 8 % (around 15.000 Euro) for Germany[11].

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[8] Source: Passive house Centre Sweden, also see Hamnhuset example in Chapter 4.

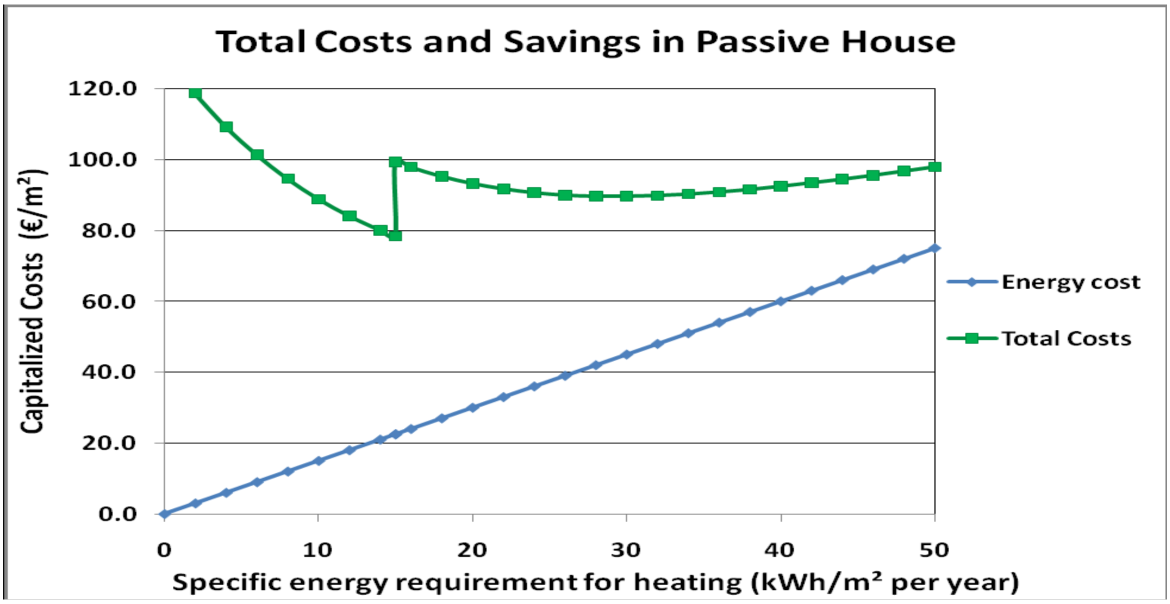
[9] www.cipra.org

[10] www.passive-on.org

[11] www.ig-passivhaus.de

Interestingly, the standardised labels as they are used in Switzerland and France can help to limit the surplus costs (10% for Minergie® S, 15% for Minergie® P) due to the special construction techniques employed and hence act as a safety net. The French study 'Construction durable'[12] has also demonstrated that the earlier the energy parameter is included in the project, the smaller this cost will be. The HQE association in France, reports an additional cost of only 5% if the 'High Environmental Quality' parameters are taken into account early enough. In other projects additional costs and payback time were still considerably higher. For example, the first low energy house in Ireland needed a reported price of 1.130 Euro/m²[13].

For the specific case of Passivehouse buildings, it should be noted that buildings bring a substantial reduction of total costs at around 15kWh/m² p.a., point at which a traditional heating system is no longer needed. If a house is built as a passive house, one can actually save money for not having to install a radiator system at all. At this level of energy efficiency, the gains form energy savings will also be significant. However marginal costs then rise steeply to achieve even higher savings as is shown below.



Source:
Laustsen, Jens: Energy Efficiency requirements in building codes and energy efficiency policies for new buildings. IEA, 2008.

One should be cautious in trying to transfer cost estimations from one country to another, as energy prices, labour cost, available experience and expertise differ significantly, as does the way in which each construction project is executed. In particular, it seems misleading to try to transfer the price estimations from countries which are already in their phase of rapid spread (Germany, Austria) to other countries where low energy buildings are not yet common (East and some southern European countries).

12 www.constructiondurable.com
13 Lenormand/Riahle, Very low energy houses, AERE 2006.

However, in general, the additional investment will be in the range of 100 EUR/m²[14] (more if expensive solutions are used) with returns of less than 20 years[15]. Costs are expected to further decrease in the future due to technological developments and it was assumed that they would decrease by 20% by 2030[16]. Low energy buildings offer considerable savings in energy bills over their lifetime compared to standard new constructions as they basically only use 15–25 % of the energy required to run a conventional one.

Crucial for a quickly decreasing cost curve in all EU countries will be the use of **methodologies to identify the cost optimal level** of energy saving investments. A Belgian study of 2008 for example identified the cost optimal combination of solutions for a Brussels office building to be at a reduction level of 30-40 % of energy use and costs of < 50 Euro/m² for new buildings and at 60-70 % reduced energy consumption for renovations[17]. These levels might be different for other EU MS.

Shorrock and Henderson at the UK's Building Research Establishment have calculated the cost effectiveness and carbon savings achieved by the 6 levels of the UK's Code for Sustainable Homes (CSH)[18] – see table below:

Code for Sustainable Homes	Level net annual cost of carbon saved per ton of $C0_2$ (in UK pounds)	Savings expressed in $MtC0_2$/year
Level 1	- 72.40	1.36
Level 2	79.21	2.45
Level 3	211.13	3.40
Level 4	213.06	5.98
Level 5	151.83	13.60
Level 6	213.83	23.60

It can be seen in this UK example that while the carbon savings increase at higher levels of the CSH, particularly for levels 5 and 6 (CSH 6 equates to Zero Carbon), the cost effectiveness does not change linearly. Indeed, CSH 5 is more cost effective than CSH 3 and 4, while delivering 2-4 times as much carbon saving.

What has finally also be taken into account are other indirect benefits that are more difficult to monetise such as the fact that building energy-efficient also ensures that you are protected from climbing energy prices and benefit from increased security and self-sufficiency.

14 Pascal Lenormand, Anne Rialhe, Very Low Energy Houses, AERE, 2006
15 www.passive-on.org
16 Energy Saving Potentials - http://www.eepotential.eu
17 www.3e.eu
18 www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/

In addition, a US study indicates that tenants and investors are willing to pay a premium for energy efficient buildings. It could be demonstrated that a 10%-decrease in energy consumption leads to an increase in rent of about 20 basis points and an increase in value of about two percent.[19] It will have to be seen whether this finding will also materialize in the real estate market in Europe. An ongoing EU project called IMMOVALUE could in its preliminary findings not yet show empirical data to demonstrate the existence of a green premium, but expects one in the future to be in the range of 5 – 15 % of the market value[20]. A Dutch study of 2009 could in fact find a statistically significant green premium for certified Dutch dwellings[21].

3. EU Member State policies on low energy buildings

Member States are moving ahead with their targets and strategies for low energy buildings

Several Member States have already set up long-term strategies and targets for achieving low energy standards for new houses. For example, in the Netherlands there is a voluntary agreement with industry to reduce energy consumption compared to the present building codes by 25% in 2011 and 50% in 2015 (which is close to passive house) and to have energy neutral buildings in 2020. In the UK the ambition is to have zero carbon homes by 2016. In France by 2012 all new buildings should comply with "low-consumption" standard, and by 2020 be energy positive, i.e. produce energy. Also several regions and municipalities (e.g. in Italy) are moving ahead. Outside Europe, similar developments can be observed with e.g. Japan currently discussing plans to adopt a goal for zero energy buildings by 2030 and some US states such as California.

[19] Eichholtz Piet, Kok Nils, Doing well by doing good? An analysis of the financial performance of the green office buildings in the US, March 2009.

[20] www.immovalue.org

[21] Brounen, Dirk; Kok, Niels; Menne, Jako: Energy performance certification in the housing market. Implementation and valuation in the EU. May 2009

Table 2: Selected national targets for low energy buildings	
Country	**Low energy target**
Austria	Planned: social housing subsidies only for passive buildings as of 2015
Denmark	By 2020 all new buildings use 75 % less energy than currently enshrined in code for new buildings. Interim steps: 50 % less by 2015 , 25 % les by 2010 (base year=2006)
Finland	30 – 40 % less by 2010; passive house standards by 2015
France	By 2012 all new buildings are low energy buildings (Effinergie standard), by 2020 new buildings are energy-positive
Germany	By 2020 buildings should be operating without fossil fuel
Hungary	New buildings to be zero emission buildings by 2020, for large investments already in 2012
Ireland	60 % less by 2010, Net zero energy buildings by 2013
Netherlands	50 % reduction by 2015, 25 % reduction by 2010 both compared to current code plans to build energy-neutral by 2020
UK (England and Wales)	44 % better in 2013 (equivalent to Passivhauslevel) and zero carbon as of 2016
Sweden	Total energy use / heated square metre in dwellings and non residential buildings should decrease. The decrease should amount to 20 per cent until 2020 and 50 per cent until 2050, compared to the corresponding use of energy in 1995.

Source:
SBI (Danish Building Institute), European Strategies to move towards very low energy buildings, 2008; plus other sources

Successful policies to move buildings towards low energy consumption level typically include, according to the Passive-On project, measures in the following categories[22]:

3.1. Financial incentives

The extra upfront cost of a low energy building can even with decreasing trends be an obstacle for further market uptake, especially for private owners. Therefore financial mechanisms have been developed in order to reduce the cost of land, technical solutions or capital. These can include instruments such as loans with lower interest rates, reduced taxes, $C0_2$ taxes and/or changes to the fee structure.

[22] For more information and additional policy examples, see: www.passive-on.org.

Successful policies from Member States:

Example: Loans for energy efficient buildings from KfW, Germany

Since 2001, the Kreditanstalt für Wiederaufbau (KfW) supports renovations in buildings with the aim of improved energy performance. The current provisions require for an "Effizienzhaus 70" 70 % of the standards enshrined in the building code and maximum primary energy use of 60 kWh per year per m²; for an "Effizienzhaus 55" 55 % of the energy demand as set in the building code with maximum of 40 kWh/m² p. a.. Loans are available both for renovations and for new constructions and can go up to 75.000 Euro and are interest-rate free during the first years.

In 2008, the KfW has supported 280.000 projects for a total 6.7 billion Euros and with this reduced $C0_2$ emissions by 760.000 tons of $C0_2$ and contributed to an estimated to securing for the relevant period around 220.000 jobs.

More info: www.kfw.de

Example: Variation of property tax in France

Since September 2005, new buildings respecting environmental criteria can be exempted of property tax for 15–30 years. Buildings should respect at least 4 of the 5 criteria: 1) environmental conception and implementation of an environmental management system 2) environmental nuisance and waste minimisation during the construction 3) energy consumption for space and water heating inferior to regulatory levels 4) use of renewable materials and energy sources 5) implementation of energy saving measures.

Décret n. 2005-1174 du 16 septembre 2005

More info: www. admi.net/jo/20050918/BUDF0520324D.html

3.2. CERTIFICATION

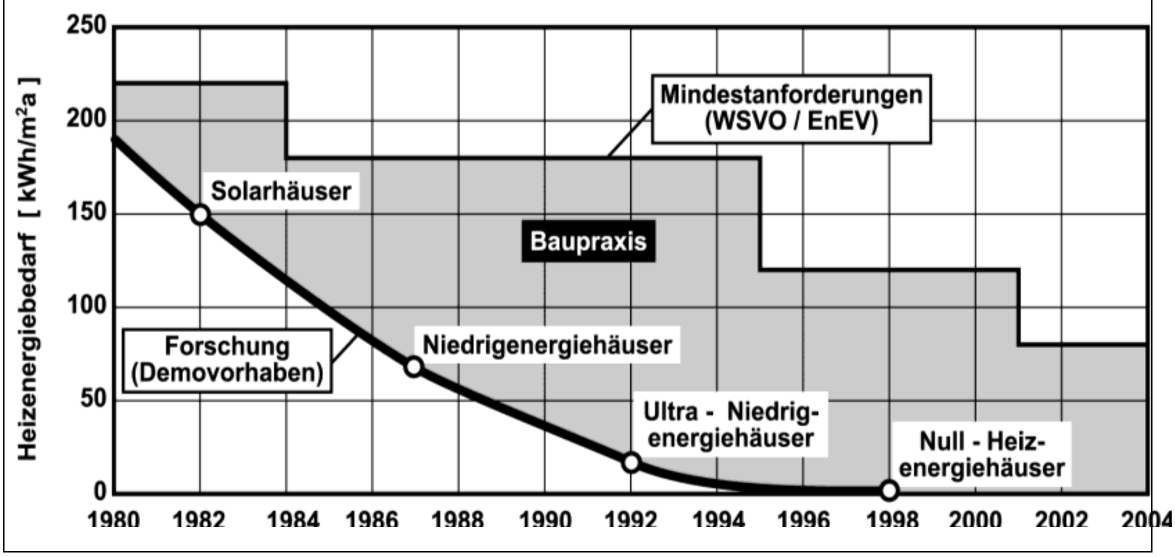
As was already elaborated in the chapter on costs, certification/labelling of low energy products, buildings and trained professionals can help to promote confidence of consumers, control costs and with this promote the uptake of low energy buildings. In fact, the development of the Passivhaus scheme in Germany or the MINERGIE standards in Switzerland was instrumental in the strong development in these years over the past decade.

3.3. Undertaking Pilot projects

Research and pilot projects can demonstrate technical and economic feasibility so that the market can then widely develop. The role of the public sector as an early adopter is also crucial.

Example: German pilot project frontier since the 1980ies

In Germany, research had developed since the early 80ies more and more efficient buildings which were used to develop, test and demonstrate new solutions. At the same time, Passive houses and other low energy buildings have been used and subsidised to move the most efficient buildings towards ever lower energy uses. This has created a small market for the most efficient buildings and helped the new standards to mature. It can be seen in the illustration below that the minimum standards of the building code have gradually followed the R&D frontier.



Source.
Fraunhofer Institut 2006 taken from: Laustsen, Jens: Energy Efficiency requirements in building codes and energy efficiency policies for new buildings. IEA, 2008.

3.4. Training activities, including integration in curricula and professional training

Experience shows that there is a need to offer training on low energy buildings to all operators in the construction chain, from academia and R&D to architects, engineers and builders (both public and private), but also real estate agents and contractors and homeowners. Low energy architecture has to be integrated in curricula and continuous professional training.

Example: CasaClima in the province of Bolzano, Italy

In the province of Bolzano in northern Italy, the Provincial Office in charge of the voluntary labelling scheme CasaClima runs basic and advanced courses for architects and traders for which certificates can be obtained. Participants in the specialist course also obtain the right to apply the CasaClima label. Both experts and specialist companies are listed on a website. Until mid 2006, already 183 companies and 346 designers had completed such a specialist training and nearly half of the participants came from regions outside Bolzano.

More info: www.agenziacasaclima.it

Example: CEPH project, Intelligent Energy Europe programme

The CEPH (Certified European Passive House Designer) project is a European pilot course for certified house designers which is currently implemented in nine different Member States. During the course, participants will be trained during the "train the trainers" course and approximately 380 architects, construction engineers and building designers will receive the certificate.

More info: http://www.passivehousedesigner.eu/

3.5. Supporting low energy buildings through regulation:

The transposition of the 2002 Energy Performance of Buildings Directive but also accompanying regulations (cover billing requirements, removal of an obligation to have public heat supply etc,) the existence of quality control systems, as well as the timely announcement of stricter energy performance requirements[23] matter for the final outcome.

3.6. Communication and information activities:

In order to stimulate demand for low energy buildings, information and communication has to target also the broader public, beyond building experts. This is in particular true for available financial aid and life cycle cost aspects. Also SMEs are important in this context.

Example: The carbon challenge in the UK

The Carbon Challenge aims at driving forward the development of zero and near zero carbon communities. "English Partnerships", a national agency supporting high quality sustainable growth, has invited expressions of interest from private sector house builders and housing associations to deliver these communities by 2008. Two sites have been identified, Hanham Hall in Bristol and Glebe Road in Petersborough.

More info: www.englishpartnerships.co.uk/carbonchallenge.htm

Example: PASS-NET and PEP projects financed by Intelligent Energy Europe

PASS-NET aims to spread the knowledge about Passive House standard within Europe via the creation of a network of European expert organisations, the creation of a large

[23] Jensen, Ole Michael; Wittchen, Kim; Thomsen Engelund, Kirsten; EurACE: Towards very low energy buldings. Danish Building Research Institute (SBI), 2009

Passive House database and the organisation of International Passive House Days (when the residents invite interested persons to visit their homes and tell them about their experiences about living in a Passive House). For instance, at the 5th International Passive House Days on 7th-9th November 2008 about 6.000 persons could visit 158 "opened" Passive House buildings in Austria.

The objective of PEP was to promote low energy buildings in Europe by the The PEP website has been visited by over 2 million visitors in two years. As a dissemination and promotion project it built directly on the demonstrated technologies of the CEPHEUS project and furthermore was instrumental in the formation of the first national passive house platforms.

More info: www. pass-net.net and http://erg.ucd.ie/pep/

4. Best practice examples for low energy Buildings in EU Member States

The following case studies show the technological and economic feasibility of above mentioned low energy concepts.

Example: Hamnhuset, Sweden – a BuildwithCaRe (Carbon Reduction) demonstration project (completed)

BuildwithCare, a project partly financed by the Interreg IV B North Sea Programme, aims to mainstream energy efficiency in construction. It started in 2008 and involves local and regional authorities, universities and institutes from 10 regions in 5 countries in the North Sea Region.

Hamnhuset, one of its demonstration projects for newly constructed multifamily houses is Sweden's largest apartment blocks built using passive house technology with 116 apartments. The project has been finalised in 2008.

Technology used:

Solar panels cover the hot water requirement during the summer months, i.e. 135,000 kWh/year. In winter, district heating with green electricity will be used. Life cycle calculations estimate heating and hot water consumption at 28 kWh/sq.m., and electricity consumption at 29 kWh/sq.m. per year.

Cost-effectiveness and energy savings:

The extra upfront investment costs for all energy-saving equipment was 4 % (approximately 800.000 euros) compared to conventional Swedish building standards. Cost differences will be converging with the development of building norms, but already in this project energy efficiency gains ensure that costs are gained back already in the third year of operation.

Hamnhuset could decrease carbon dioxide emissions by 75 % (despite the fact that more building material was needed and with that more transport-related emissions during the construction period).

Example: Loi 42, Brussels, Belgium – a project of "Bâtiment Bruxelles" competition (planning state)

"Bâtiment Bruxelles" is a competition of the Brussels region launched in 2007 that identifies and financially supports exemplary eco-construction projects, including very low energy buildings. So far more than 70 projects have been chosen, which represents already 16 % of the entire ongoing construction activity in the city. 3 % of construction activities in Brussels currently comply with passive house standards.

One of the chosen projects is Loi 42, a combined renovation and extension project currently in planning stage.

Technology used:

Both renovated and newly constructed building units will be compliant with passive house standards with heating consumption of 26, 8 kWh/m² per year (heating technology used: solar thermal panels, geothermal heat pump and condensating boilers). No additional active cooling system will be needed for this building mainly occupied with office space.

Cost-effectiveness and energy savings:

Extra costs for this project could be covered by subsidies so that with this the project is expected to become cost-effective from the beginning. In addition to that, the project also respects strict resource efficiency by trying to reuse as much as possible the existing building materials as well as a very efficient water use.

Example: Lodenareal Innsbruck, Austria – the so far largest passivehouse complex in Austria (building state)

Neu Heimat Tirol, a publicly owned building developer, is about to finalise the currently largest passive house project in Austria with 33.000 m² and 354 building units in early 2010. The project will comply with the strictest passive house standards and will be certified by the Passivhausinstitut Darmstadt.

Technology used:

Overall energy consumption p.a. and per square meter is respecting the 15/kWh passive house standard, with only a 7kW/h/m² p.a. consumed for heating purposes. Heating consumption will be to 80 % covered by a combination of one pellets and one gas boiler, to 20 % by 1050m² of solar panels that yield an annual 350 kmkWh/m². Also insulation and ventilation technologies comply with passive house standards.

Cost-effectiveness and energy savings:

The total project costs amount to 52 million Euro and it is estimated that the extra costs of bringing the performance up from a standard low energy building with an energy use of 35 kWh/m² to the 15 kWh/m² passive house norm is 11 %, of which 7 % are covered by subsidies and the remaining 4 % difference is expected to be neutralises within a short time span by the large energy savings.

The project is expected to reap an annual $C0_2$ emission savings of 680 tons and a reduction of 80 % of energy use as compared to standard buildings.

Example: Gothenburg, Sweden – a CEPHEUS project co-funded by the THERMIE programme of the European Commission

This is both an example of a very early cost-effective passive house solution and a showcase of the CEPHEUS project (Cost Efficient Passive Houses as European Standards) which ran from 1998 – 2001.

CEPHEUS helped to create 250 housing units into Passive House standards in five European countries, with in-process scientific back-up and with evaluation of building operation through systematic measurement programmes. The CEPHEUS received co-funding from the THERMIE programme of the European Commission.

The Gothenburg project was a building with 20 + 6 terraced units in 4 + 1 rows and 120 m² total floor space per unit.

Technology used:

Timber construction. Lightweight, super insulated exterior walls, partition walls and floors. Windows have a U-value of 0.85 W/m²K. Timber facade with traditional whitewash. Solar thermal systems for hot water (covering 50% of annual requirement). High-efficiency heat exchanger in ventilation system (90% temperature coefficient of performance). Energy-efficient household appliances (Class A) are installed. Power connection to wind energy facility in Gothenborg. One house reserved for demonstration and exhibition purposes.

Cost-effectiveness and energy savings:

No extra construction costs compared to conventional Swedish construction.

Example: Plus energy house in Weiz, Austria (in construction)

The Weiz project of which the first constructions phase is finished already, is the first energy positive project in Austria. It comprises 22 building units and is carried out by a public building developer.

Technology used:

The project is characterised by optimised technology used in passive house buildings with U values of 0.09 – 0. 11 W/m²K for different building components and optimised sun-orientation. The heating demand of 14,6 kWh/M² is covered to 40 % with biomass (pellets) and 60 % with solar thermal installations. Also an earth source heat exchanger is used. The photovoltaic installation covers a surface of 46.7 m² and has an installed capacity of 5.75 kWp. Electricity demand is covered both on-site (PV 3 kWh/m2) and off site (share of a wind turbine 22 kWh). Total energy demand is 68 kWh/m² and the PV installation yields 1100 kWh/a electricity overage.

Cost-effectiveness and energy savings:

As said above, the building yields a surplus of 1100 kWh per year per building unit. Costs are indicated to amount to 1100 Euro per m^2 without VAT, not including the photovoltaic installation which is indicated to cost 29,500 € per plant.

Example: Energon building in Ulm, Germany (completed)

The Energon building with 8,000m² floor area is the world's largest office building planned in accordance with the passive house standard. The building was completed in 2002.

Technology used:

A combination of heat exchangers (plastic tube heat exchangers with a surface area of around 5,000m² and 40 borehole heat exchangers) and ventilation regulate the building climate. Additional heating need is covered by waste heat and remote heating. 20-50 cm thick super insulation of foundation, façade and roof and thermally insulating triple glazing. 382 m² of photovoltaic yielding 12,000 kWh p.a.

Cost-effectiveness and energy savings:

In 2005, the final energy consumption was at 47.2 kWh/m² p.a., heating consumption 34.6 kWh/m² p.a. and primary energy consumption 81 kWh/m² p.a. In total, the project saves 175 tons of $C0_2$ annually. Implementation costs were 1.234 €/m² for construction plus 454€/m² for technical systems. At €12/m² per month, the rent is higher than for standard buildings, so that the rented office floor area was low at the beginning, but rose to 80% by 2006.