POWER HOUSE
NEARLY
ZERO
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CHALLENGE

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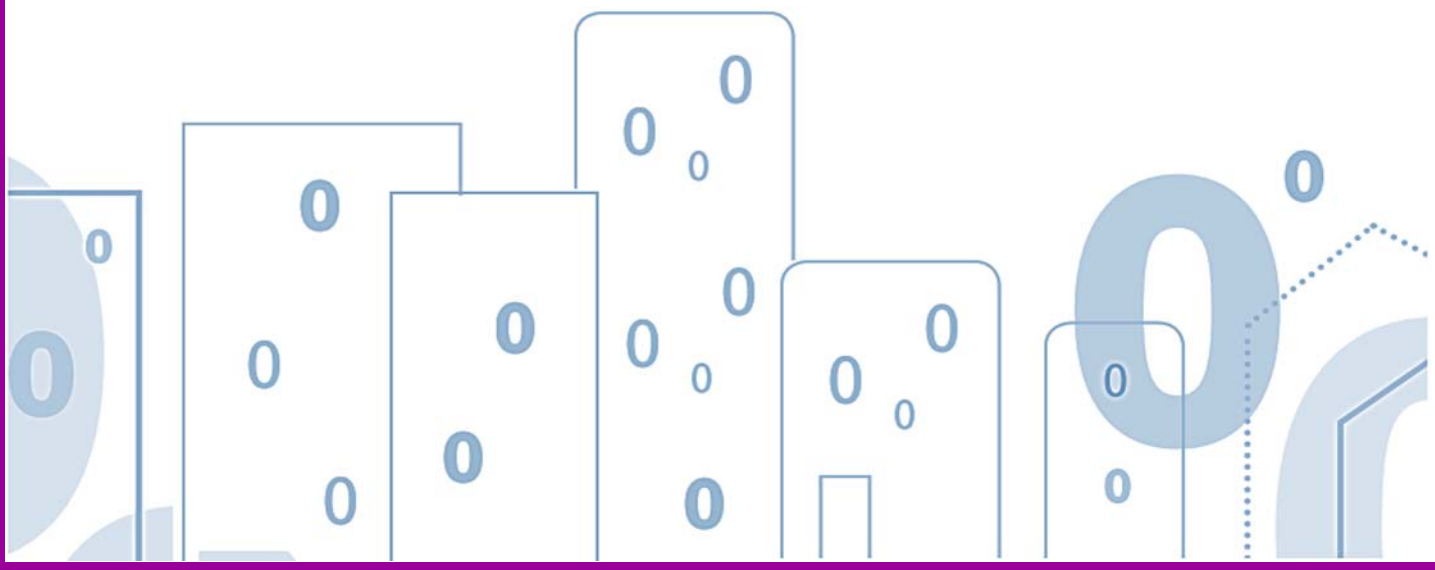
NEARLY
ZERO
ENERGY
HOUSING FOR
COLD/CONTINENTAL
CLIMATE ZONES

THE NEARLY-ZERO ENERGY CHALLENGE IN COLD AND CONTINENTAL CLIMATES

nZEB in Cold / Continental Climates:
TaskForce Findings, Conclusions and Recommendations



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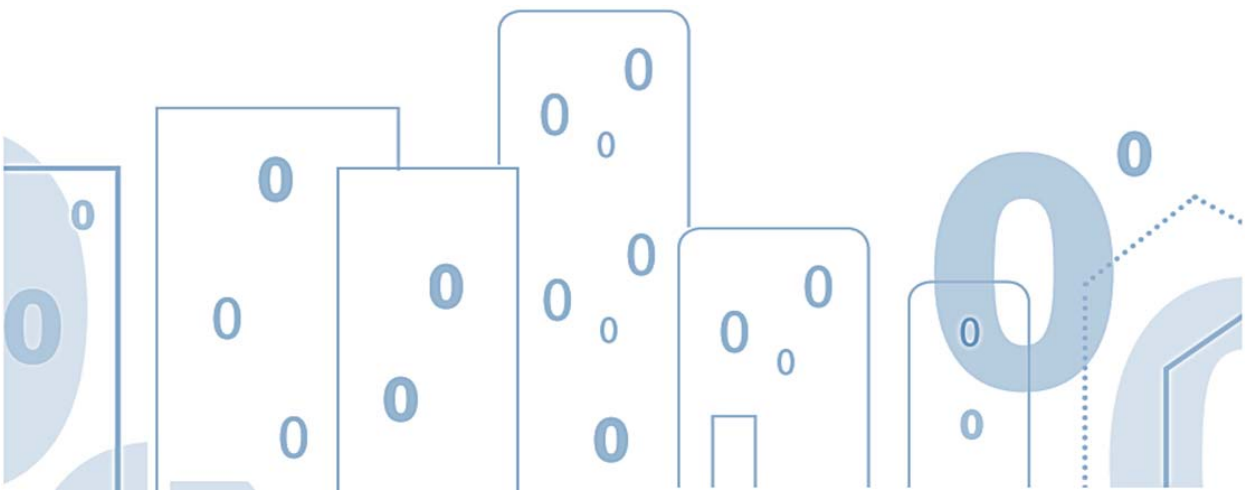

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1. Introduction

The following report is based on the different reports delivered by the TaskForce members from six different countries in the course of the project as well as on the outcomes of workshops, site visits and inspection of demonstration cases.

Energy efficiency of building is one of the priority issues in the European Union. The national frameworks are different as well as the status of low energy buildings. Nevertheless, there seems to be some convergence as regards the future definition of nearly-Zero Buildings from 2020. If that implies that future buildings standards really will converge within the European Union is another question. One of the findings of this work package is that there is a substantial amount of extra costs in very low energy buildings (new construction) as well as a gap between calculated demand and real consumption and thus an inconsistency between theoretical concepts of e.g. cost optimality and costs in reality. Moreover: The theoretical concept of cost optimality calculations is not in line with calculation from the position of landlords.

Since the processes of definition of nZEB and shaping the Roadmaps for the implementation are still in progress, this report tries to give an up to date picture for the end of the year 2014/beginning 2015. This will illustrate the more “theoretical” aspects of building Nearly Zero residential buildings in the future as well as some reality check.

The aim of this work package was not only to study the concepts of nearly-Zero Energy buildings but also was to set some practical experiences in contrast to these concepts (Deliverables 2.4 – 2.6). In addition, the workshops were dedicated to these tasks together with the study visits and involvement of local housing providers. As it turned out the number of realised (very) low energy buildings is limited yet. There is a quite sufficient number of passive houses in Austria and Germany as this building type has some strong backbone both from conceptualization as well as from adaptions in the building industry; moreover availability of public financial support in both countries seems to play an important role. Nevertheless there are “missing links” between this type and the actual level (compare report on cost optimality), which need further investigation.

Despite the fact that realised examples of (very) low energy residential buildings are not very numerous in member states yet the work package has brought remarkable results.

2. TaskForce Reports on National Roadmaps to 2020 and experiences Status 2014/15

2.1 Belgium (Flanders)

Legal (national/regional) framework and relevant stakeholders

In Belgium, the implementation of the EPBD is a regional responsibility.

The Flemish action plan "nearly zero energy" gives in terms of promoting low energy and nearly zero energy buildings an interpretation of:

- Pact 2020;
- the Flemish Government agreement;
- the policy document on Energy 2009 – 2014 and 2014-2019.

The coalition agreement sets: 'By 2020 all new buildings should meet the optimal energy performance norm.'

Since January 2006, there is an E-level requirement for new housing and new offices and schools. For dwellings with a building permission request from the 1st January 2010 the E-level requirement was tightened from E100 to E80. From January 2012, the maximum E-level requirement was tightened to E70 for both dwellings, offices and schools. From the 1st January 2014, this requirement is tightened to E60 (and E50 in 2016).

The level of insulation in new buildings in Flanders improved significantly since the introduction of the energy performance regulation.

	2004	2007	2009	2011	Evolution 2004-2011 (%)
Facade insulation (average thickness in mm)					
Mineral wool	53,5	57,7	69,7	96,6	80,6
Other insulation	40,4	47,8	63,3	78,8	95
Roof insulation(average thickness in mm)					
sloping roof	113,9	132,7	158	186,9	64,1
flat roof	76,1	81,1	105,2	116,2	52,7
high performance glazing (in %)					
HR++ (U < 1,2 W/m^{2}K)	42,8	57,3	99,6	100	

The number of new and renovated buildings is limited in comparison to the volume of existing buildings, but they largely determine the energy performance of the building stock in the long term. Buildings in Belgium have a long life (30 years until the first thorough renovation, the total life can reach over 100 years).

The Flemish Government has started the **Energy Renovation Program 2020**: "In 2020 there will be no more dwellings with single glazing, without roof insulation and without a high performance heating system." Roof insulation is progressively imposed by law for rental dwellings.

Several systems of premium must help to achieve this target. The social housing sector got different premium budgets (28.500.000 and 7.800.000 euro's), Each month between 250.000 and 500.000 euros are paid for double glazing, roof insulation, new heating systems, solar boilers, insulation of wall cavities and external wall insulation, floor insulation. Since 2010, every 2 years the VMSW is making an evaluation of the progress. In the next years a (very) large budget (3 billion euro's) will be needed for important renovations of the social building stock.

As indicated in the policy document on energy 2009-2014 and continued in 2014-2019, an implementation plan is drafted for a tightened Roadmap on long terms for residential and non-residential buildings and will be evaluated and adjusted in the actual legislature.

Relevant stakeholders in the policy process (most important = bold)

RELEVANT STAKEHOLDERS	
Agentschap voor Facilitair Management	KU Leuven
Agion	**Minaraad**
Agoria	NAV
ATIC	Passiefhuis-Platform
Bouwunie	Provinciale Hogeschool Limburg
CEDUBO	**Sociaal-Economische Raad van Vlaanderen (SERV)**
DAR - transitiearena DuWoBo	Ugent - Vakgroep Architectuur en Stedenbouw
De Nayer Instituut - Lessius Mechelen	UA - Institute of Environment & Sustainable Development
Departement LNE (Leefmilieu, Natuur en Energie)	VENTIBEL
Departement RWO - dienst Onroerend Erfgoed	Verbond van de Glasindustrie (VGI-FIV)
Departement RWO (ruimtelijke ordening, wonen en onroerend erfgoed)	Vereniging van Vlaamse Steden en Gemeenten (VVSG)
Eandis	VITO
Hogeschool Gent	Vlaams Infrastructuurfonds voor Persoonsgebonden Aangelegenheden (VIPA)
Infrax	**Vlaamse Confederatie Bouw**
Isolatie Raad (CIR)	**Vlaamse Maatschappij voor Sociaal Wonen (VMSW)**
IWT	Agentschap Ondernemen
Kabinet minister of energy Turtelboom	VUB
Kabinet minister of housing Homans	**WTCB**
KaHo Sint-Lieven	**VEA = implementing EPBD**
KHK	

The Flemish Energy Agency (VEA) should, according to the energy Decree, evaluate every two years the method of calculating the energy performance of buildings, the procedures to be followed, the EPB-standards and the administrative burden of the regulation. This happens after consulting the stakeholders.

The social housing sector, represented by the VMSW is one of the stakeholders.

The last evaluation was in June 2013: almost 1/3 of the new build dwellings are performing better than the minimal requirements (E60). About 10% are better than E40 (= 2018).

The calculation method is in constant evolution to remedy to many practical problems (eg internal heat of small buildings, like social houses) and to integrate innovations (collective heating systems, 'intelligent' ventilation systems, new rules for window ventilation, heat pumps,…).

Definition of Nearly Zero Energy Standard from 2020

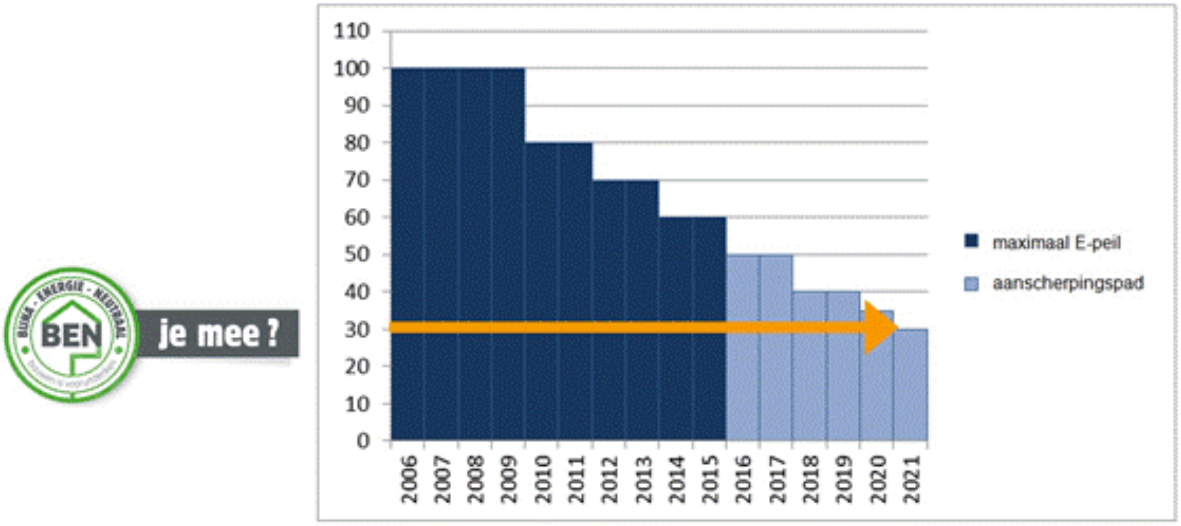
On 29 November 2013 the Flemish Government defined (by decree) nearly zero energy for dwellings for 2021:

- Minimum Energy performance level: E30 (2014 = E60)
- Maximum U-values:

Construction part	**Umax (W/m²K)**
Roofs and ceilings	0.24 (= 2014)
External walls	0.24 (= 2014)
Floors	0.24 (< 2014)
Windows (frame + glazing)	1.50 (< 2014)
Glazing	1.10 (= 2014)
Doors	2.00 (= 2014)

- Renewable energy: min 10 kWh/m² or application of a list of possible renewable techniques (= 2014) or an improved E-level by minimum 10% (E54 in 2015)
- Net energy demand: max 70 kWh/m² (= 2014) (m² heated floor area)
- Requirements for ventilation (= 2014). Matching the E-level requirements requires the use of balanced ventilation with heat recovery, but other systems are allowed.

The E-level (and other requirements) will progressively be adjusted to the maximum value of 2021.



VEA will evaluate the (cost optimal) nZEB requirements every 2 years (first evaluation in 2015) and refine the requirements.

Time schedule:

2012

- Third evaluation of the EPB
- Mai 2012: start study cost optimal level (8 months)
- Determine and fix minimum percentage of renewable energy in buildings.
- April-august: draw up national plan nearly zero energy buildings
- September: presentation of the national plan nearly zero energy buildings in European commission
- Start process to convert government buildings into nZEB buildings.

2013

- Fix cost optimal performance level
- Report to the European Commission about study on the cost-optimal performance levels
- Elaborating a proposal for the definition nZEB and the nZEB Roadmap.
- Set up national application of nZEB definition
- Set up energy level requirements 2021

2015

- First evaluation of nZEB
- Definition and implementation plan of nZEB for renovation (Renovation Pact 2050).

2006 **Energy performance: E100** **Thermal insulation: K45** **netto energy consumption heating: -**
2010 **Energy performance: E80** **Thermal insulation: K45** **netto energy consumption heating: -**
2012 **Energy performance: E70** **Thermal insulation: K40** **netto energy consumption heating: max70 kWh/m²**
2014 **Energy performance: E60** **Thermal insulation: K40** **Netto energy consumption heating: max70 kWh/m²** **Mandatory renewable energy target or E54**
2016 **Energy performance: E50** **Thermal insulation: K40** **Netto energy consumption heating: max70 kWh/m²** **Mandatory renewable energy target or E54**

2.2 Germany

Legal (national/regional) framework and relevant stakeholders

In Germany the relevant existing legal framework consists of:

- the Energy Saving Act and
- the Energy Saving Ordinance

In the ongoing amendment of both the requirements regarding nearly zero energy buildings will be implemented as legal authorization. The energy saving act says:

§ 2a Nearly zero-energy buildings to be constructed

(1) Who after December 31th 2020 will erect a building heated or cooled according to its purpose, must build the building in order to save energy as nearly zero-energy building in accordance with paragraph 2 of an ordinance, to be enacted. For non-residential buildings to be constructed, which are owned or used by public authorities, the obligation in Clause 1 begins after 31 December 2018. A nearly zero-energy building is a building that has a very good energy performance, the energy consumption of the building must be very low and should be covered as far as possible, to a very significant extent by energy from renewable sources.

Because of the economic efficiency of a 2012 building standard is not yet known, there is no exact definition in the energy saving act. But till 2021 the energy saving ordinance must have a definition.

The relevant stakeholders in Germany are:

- two ministries: the Federal Ministry of Environment and Building and the Federal Ministry of Economics and Technology
- the German Bundestag for agreeing with the Energy Saving Act and the Federal Council of Germany for agreeing with the Energy Saving Ordinance
- the German Länder because of the necessary implementation in the federal states of Germany.
- the associations of involved economic sectors are directly involved in the legislative procedure: for example building owners.

Is there a (public) evaluation procedure planned, involving interest groups like the housing sector?

There is no planned process known, but every change in the Energy Saving ordinance is accompanied by a wide spread public discussion.

Implementation of the nZEB process

The implementation of the EPBD in Germany is over the energy saving ordinance. So the institutional way to implement the EPBD is very clear. But there is no clarity regarding the concrete definition – how much energy, how much renewable? This is because of unknown economic feasibility in 2020 for nearly zero energy buildings. There is a very important principle in Germany:

In the ordinances established by the Energy Saving Act, the legal requirements must be achievable in an economically feasible way according to the state of the art and for buildings of the same type and use. Requirements are considered economically feasible if the general expenses incurred during normal life time can be generated by the entering savings. In existing buildings, yet the expected lifetime is to be considered.

Status of the process and time schedule

Current status: legislative embedding of the term "nearly zero energy building" in the energy saving act without exact definition. Before 2018 an exact definition of an economic feasible nearly zero energy building will be available because of a decision from the the Federal Council of Germany. Actual a study is commissioned. First results are expected for September 2015.

Preliminary results: nZEB definitions and cost optimality

A first report was published: "Study on amendment of the EU Energy Performance of Buildings Directive (EPBD) - Identification and analysis of barriers for new construction of high-efficiency (nearly zero energy) buildings and development of an approach to market penetration by 2020". In this study economic barriers were cited by the building owners as much strongest obstacles to constructions, which are better than required by the statutory requirements. Second place achieved the lack of information, than with approximately equal weights followed the technology and then the organizational barriers.

- A study from 2011 found that passive buildings better than KfW 70 buildings have advantages in the heating costs (7 cents per m² per month), but this cost advantage is nearly compensated by the heat recovery ventilation system. Reason is the higher cost of electricity and maintenance in additional amount of 4 cents per m² month (total: 13 cents per m² per month).
- First lifecycle calculations found that lifecycle costs can rise with increasing energy level because of increasing investment costs.

Economic feasibility studies regarding the requirements of the energy saving ordinance use the Amortization Method, the Net Present Value Method and the Annuity Method. Official calculations based on the cost optimality method are expected but not available yet.

German National Plan for increasing the number of nearly zero-energy buildings

According to Article 9 of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings Member States are required to draw up national plans for increasing the number of nearly zero energy buildings and to submit the plan to the Commission. Germany has drawn up its national plan with a communication dated 18.12.2012.

Regarding measures for increase energy efficiency Germany uses differentiated strategy. In the building sector the approach: "Encourage, Promote, Inform - strengthen market forces" stands in the foreground. With this mix of instruments, the number of nearly zero energy buildings will increase significantly by 2020. In view of the very different building and owner structure with a very high proportion of private ownership and considering the constitutional commandments of subsidiarity and proportionality of state action Germany focuses on voluntary, financial incentives and information. Therefore, a numerical specification of intermediate future targets regarding the number of nearly zero energy buildings is neither possible nor necessary.

Significant contributions to the increase in the number of nearly zero energy buildings will come from:

- KfW's funding " Energy Efficient New Buildings" (more than 450,000 subsidized homes since 2003) and "Energy Efficient Rehabilitation" (over 1 million founded homes since 2001);
- the market incentive program for renewable energy in heating;
- the promotion of combined heat and power;
- the KfW program "Energy Urban Renewal";
- the on-site energy consultancy in residential buildings.

The National Plan makes the following estimates:

- Regulatory requirements for increasing the number of nearly zero energy buildings in the portfolio are not possible, because they are not cost-effective in terms of the energy performance of buildings directive and do not comply with the economic efficiency principle;
- The primary aim of achieving the nearly zero energy buildings - standard is for new buildings in 2020. The building stock is not in focus;
- For future regulatory requirements currently no precedent can be made. There is an uncertain price trend for energy and construction materials and services;
- The concrete definition of the nearly zero energy building standard will be developed by the federal government with scientific support, taking into account economic aspects.

German Energy Performance Building Strategy (Energieeffizientstrategie Gebäude)[1]

Actual there is the "German Energy Performance Building Strategy" in preparation. It should be finished in December 2015. The strategy is closely locked to the "Acton plan climate saving"[2] and the "Alliance for affordable living and building"[3],

Promising is the proposed target range, see figure. The target range combines end energy savings in buildings (for example 40% or 60%) with the use of renewable energies (for example 67% or 50%) for 80 % primary saving over all.

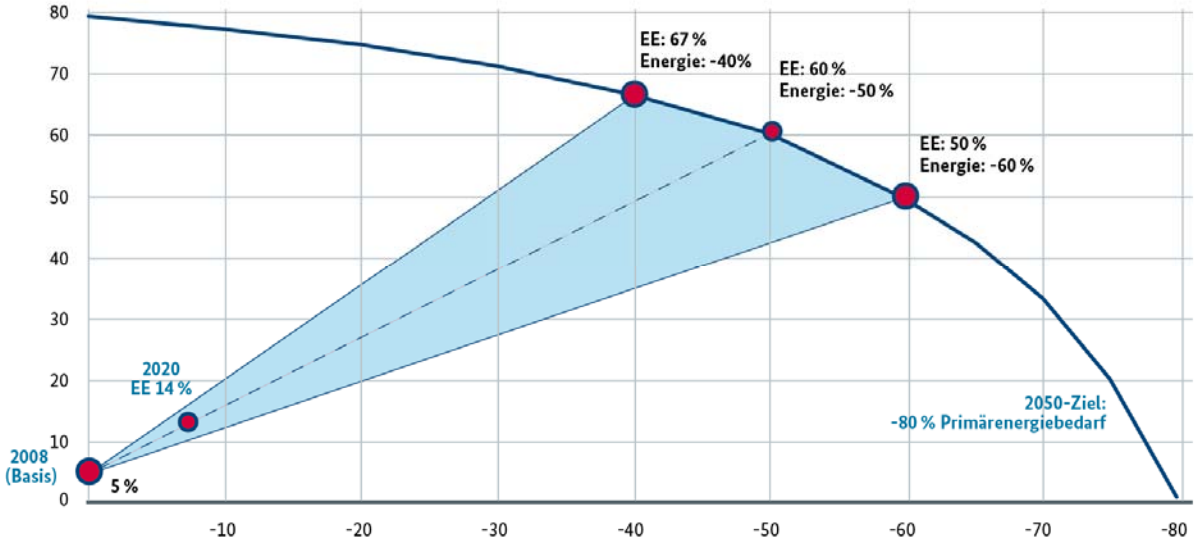


Fig. 1: Possible target range with energy saving and use of renewable energies from 2008 up to 2050

The Energy Performance Building Strategy bases on voluntary and economy, technology openness and target groups adaption. It also deals with fundamental points:

A too early energy refurbishment is not economical for the building owner if the full costs are incorporated or residual value in the balance sheet is included. In addition to the profitability of measures the amount of total investment is a key criterion. The best return of investment does not help if the resources for the investment are not available or not affordable. And: not every energy saving measure is economic, ecologic and social-society sustainable.

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[1] See http://www.bmwi.de/DE/Themen/Energie/Gebaeude/energieeffizienz-strategie-gebaeude,did=649912.html

[2] See http://www.bmub.bund.de/themen/stadt-wohnen/wohnungswirtschaft/buendnis-fuer-bezahlbares-wohnen-und-bauen/

[3] See http://www.bmub.bund.de/themen/klima-energie/klimaschutz/nationale-klimapolitik/aktionsprogramm-klimaschutz/

Accompanying study on the European Financial Reporting "cost-optimal level" - model calculations

An Ecofys study[4] came to the conclusion, that:

- For new construction: the requirements of EnEV2009 already represent the cost optimum.
- For existing buildings: In almost all components and boundary conditions can be stated that the existing requirements can be described as cost optimal.

There is following hint. Since the cost optimum is usually within a very flat curve range, even a (future) little change in the boundary conditions of the calculations can cause significant changes in the primary energy value at which the optimum cost (net present value minimum) occurs.

[4] See BMVBS-Online-Publikation, Nr. 26/2013

2.3 France

Legal Framework, nZEB-Roadmap 2020, Rough Definition nZEB

The French "Grenelle de l'Environnement" imposes the refurbishment of 800 000 accommodations dependent on public housing before 2020. In parallel, social housing organizations embarked on the production of new thermically-efficient accommodations. In that context, the French label for low-energy housing (BBC label), which is the standard for the new French thermal regulation (RT 2012), is used as a baseline by social housing organizations. In both cases, the aim is to reduce energy consumptions and greenhouse gas emissions, and to act on the reduction of tenants' global costs, limiting the impact of the increase of energy prices on the costs, while ensuring the same level of comfort.

During the autumn 2011, two studies financed by the Union Sociale pour l'Habitat and the Caisse des Dépôts et Consignations enabled to evaluate new operations as well as refurbishment projects based on high thermal performances in social housing.

The conclusions of these studies are interesting concerning the level of energy efficiency reached, which is lower than expected, but also concerning the high level of investments involved. In addition, apart from the fact that the energy goals are not reached, the increase of the other expenses seems significant and needs to be studied.

Different reasons can explained these conclusions: inadequate appropriation by the tenants, wrong instructions from the master builder, absence of energy efficiency guarantee agreement, technical equipment which is unadapted or wrongly-sized, maintenance costs which are not taken into account.

The "arrêté ministériel" from 8th May 2007 defines regulatory requirements for energy performance of buildings (with five levels). Among these levels, BBC means "Low energy consumption building" and for new dwellings the annual requirement for heating, cooling, ventilation, hot water and lighting must be around 50 kWh/m² in primary energy (depending on climate area and altitude).

The new thermal regulation (RT 2012) was set up in 1st January 2013 and requires for new buildings a limited consumption of primary energy to 50 kWh/m²/year.

2.4 Austria

Legal Framework, nZEB-Roadmap 2020, Rough Definition nZEB

In September 2014 the "National Plan" according to Article 9 (3) of directive 2010/31/EU has been released. Due to the specific legal situation in Austria this does not mean the legally binding implementation of the "National Plan". According to the constitution building regulations are a matter of provincial legislation (via ordinances). Different solutions have been developed to integrate provincial building strategies: According to the constitution there exists the model of a contract between provinces ("Article 15a-Contract") in order to define common targets, commitments and obligations regarding matters of provincial responsibility. Based on such a contract a central institution has been founded in the year 1993 – the Austrian Institute of Construction Engineering (OIB). The foundation of this institution was triggered by EU-legislation (construction products directive); its mission is to function as platform for coordination of provincial activities in building matters as well as being a voice of the stakeholders in the building industry on international level. It is this institution which also coordinates the process of implementation of the EPDB in Austria. That is done via "Guidelines" which have to be implemented in the provincial building ordinances. As next steps the "National Plan" has to be implemented as a "Guideline" and then integrated in legally binding ordinances of the 9 provinces. As the National Plan foresees a stepwise tightening of building regulations the legally binding implementation will also be take place in steps.

Even if that sounds complicated the "National Plan" as such is a "compact" regulation setting the steps towards nZEB from 2020 on national level.

The definition/calculation of energy requirements for residential buildings is a combination of different elements (see next section). The calculated end energy demand covering space heating/hot water/ventilation/lightening/domestic electricity will be reduced by about 20 % from 2014 to 2021: from about 115 to 95 kWh/m2a heated area (=useful floor space of dwelling) for a building of average compactness (= ration surface/volume: 0,4 = characteristic length: 2,5). The nZEB-Standard will not be the passive house standard since that level has not been identified as optimal level according to cost optimal calculations.

As regards social housing it has to be stated that the level 2021 is close to the actual energy performance required in subsidized housing from 2012 since respective regulations are tighter than general building requirements.

Definition /Calculation of Low Energy Buildings

The definition and calculations of the Austrian low energy/nZEB is based on a combination of:

- A fixed **low** value of **energy demand** for space heating – a basic datum which only depends on insulation and air tightness of building and way of ventilation and
- A total **end energy demand** for space heating/hot water/ventilation/ lightening/domestic electricity determined by a **reference value** for energy losses (depending on the heating system) and default values for hot water consumption and domestic electricity demand;

OR as another option:

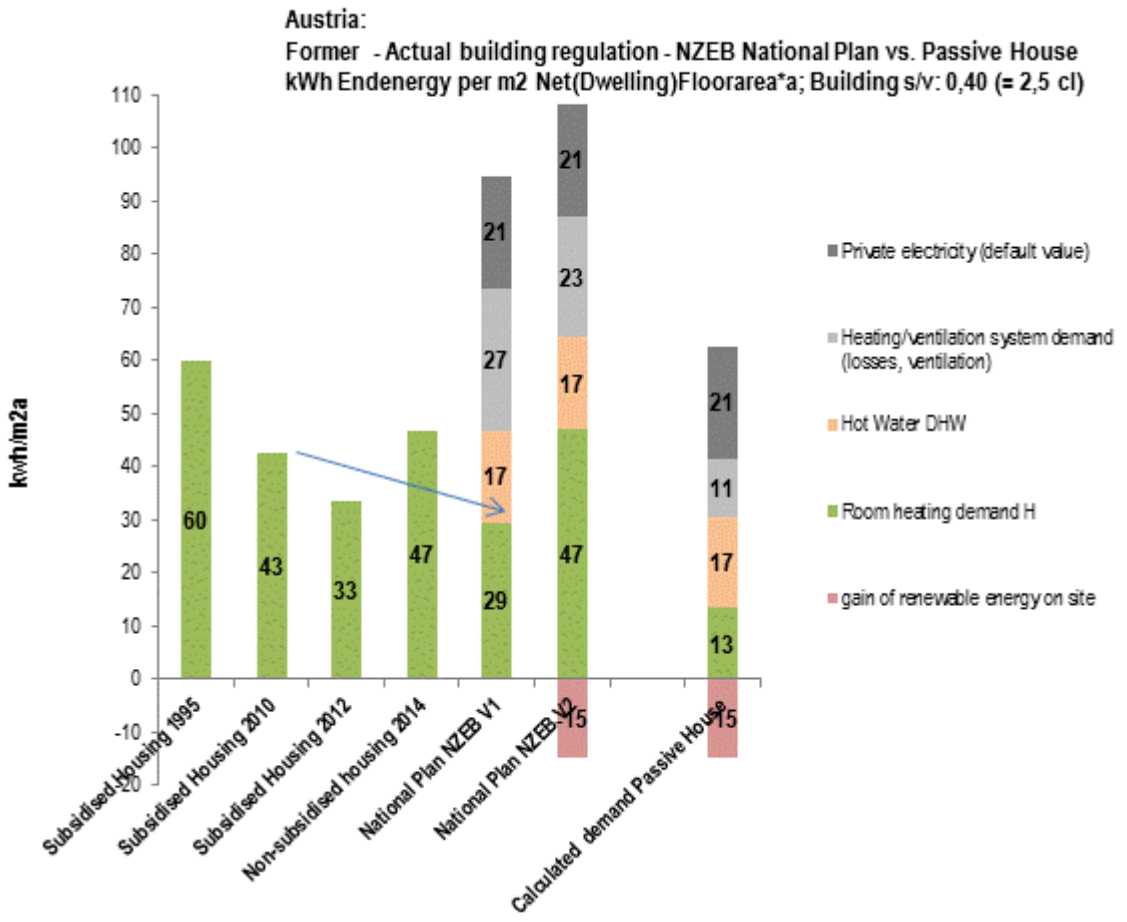
- A fixed **higher** value of **energy demand** for space heating – a basic datum which only depends on insulation and air tightness of building and way of ventilation; and
- a **"total energy-efficiency factor**" which calculates the end energy demand for the mentioned components in reference to a certain standard. That factor is constructed in a way to compensate less insulation by heating techniques and/or energy produced on site/renewables which may be deducted from end energy demand.

For both options there are maximum levels for primary energy demand and CO_2, but these maxima do not give much room for manoeuvre. For both options different maxima for the heating demand apply for buildings of different compactness.

A key question is the nZEB level applicable from 2021 (level 2020). As mentioned before that level is not the passive house standard – but from side of experts of housing associations it is assumed that in the variant with the low heating energy demand it only can be obtained by automatic ventilation systems to avoid ventilation losses – and those ventilation system are a costly and sensitive devices. Calculations of other experts come to the conclusion that in "plain" buildings (high compactness) the nZEB-Standard can be obtained without automatic ventilation system.

Compare national plan: http://www.oib.or.at/en/node/150035

The following graph gives an oversight of development of building regulations and National Plan. One can see that the margin between actual requirements and nZEB-standard is not huge (about 15kWh/m2a) especially when putting in contrast to former requirements. What is crucial: To obtain the standard of subsidised housing of the years 2010/11 12cm of insulation of the façade were sufficient (U-Value: 0,27 W/m2K), no automatic ventilation was required, of course windows needed to have a good quality and loft and basement also required insulation. To obtain the standard 2020 (nZEB) an insulation of 28cm plus triple-glazing windows need to be installed; most experts assume that for such buildings automatic ventilation is required to obtain sufficient air exchange and quality. If the ventilation alternatively would be equipped with a heat recovery system the insulation thickness could be reduced to 14cm. Nevertheless: those extra savings (calculated) are more expensive than those obtained by pure insulation. And taking into consideration that complex and sensitive technical systems are involved one might imagine that dysfunctionalities and improper handling can disturb the expected effects in energy consumption.



Experiences of housing providers and ongoing debate in Austria

As outlined in the monitoring reports in Austria there are existing buildings which correspond to future energy performance requirements. The results of this monitoring process can be summarized as follows: When taking actual energy consumption as base as well as real costs for cost optimal calculations it turns out that buildings without an automatic ventilation system are cost optimal – that is a result which is not in line with theoretical calculations defining energy performance levels in the Austrian National Plan. But the observations confirm what was said regarding the requirements to improve low energy buildings to very low energy buildings: there are extra costs for insulation and technical building services (ventilation) while the effects of these additional investments are below the predicted level.

The position of the Austrian Federation of Limited Profit Housing Providers is:

- energy performance requirements should be adapted (loosened) according to these results to avoid increasing housing costs;
- some more time should be taken for further monitoring of newer buildings since there is quite a sufficient number of passive houses (a vast majority of them subsidised by public means) but only a small number of buildings corresponding to the actual nZEB-level;

- the option of a less insulated building where energy demand can be compensated by energy produced on site (mainly by solar systems) is welcome – nevertheless the proof of cost optimality of the solar systems has to be checked first. Moreover solar systems cannot be installed with efficient results in every building/building site/area.
- Last but not least: Even if we leave aside the cost dimension and concentrate on ecological effects lowest energy houses are not (necessarily) superior to low energy houses; ventilation systems and pumps need electricity which has higher primary energy factors which may compensate for the small margin of lower energy consumption – of course depending on the heating system and fuel.

2.5 Sweden

Legal Framework, nZEB-Roadmap 2020, Rough Definition nZEB

The Swedish government introduced in 2011 Sweden's action plan for nearly-zero energy buildings. The overall aim of the action plan in Sweden is to obtain documentation to see how the building regulations regarding energy requirements can be set in the light of the demands of the EU, and to raise awareness about low energy buildings. A definition of nearly-zero energy building will be produced and will take effect from 31 December 2018. The Energy Agency and the Building and Planning Authority are working on this work together.

No later than 9 June 2015, the Swedish Energy Agency and the Building and Planning Authority, together have developed the basis for a checkpoint in 2015. The joint appointment relates, inter alia, to measure and evaluate existing low-energy buildings. The Building and Planning Authority is also responsible, in close dialogue with the Energy Agency, to propose the definition and quantitative guideline regarding energy requirements for nearly-zero energy buildings. The checkpoint in 2015 and also the longer-term mandate agree that the buildings should be of different types and geographical spread across the country to provide a solid basis for analysis and evaluation to the government.

The Energy Agency during the period give subsidies to the building owners to measure and demonstrate new low-energy buildings for the purchase, installation and operation of equipment. The measurements are planned to last until 2017, but the Energy Agency also intends to possibly pursue measurements over a longer time for the long term to monitor energy use in the conducted energy buildings. The Energy Agency also supports training and skills enhancement programs to increase awareness and knowledge of energy efficient buildings wide in the property and construction industry in Sweden.

Definition /Calculation of Low Energy Buildings

There are yet no decisions on the calculation method or the type of energy requirements to be imposed on near-zero energy buildings. This is under investigation and will be completed summer 2015th as described above. On March 1, 2015 the Swedish energy requirements of the building regulations were tightened by approximately ten percent. It also introduced a fourth climate zone. This is one first step towards the nearly zero energy building requirements. The new requirements are described in the table below.

Type of building	Climate zone I (the very north of Sweden)		Climate zone II (north of Sweden)		Climate zone III (middle of Sweden)		Climate zone IV (south of Sweden)	
	Other than electricity (bought energy, kWh/m2*)	Electricity	Other than electricity	Electricity	Other than electricity	Electricity	Other than electricity	Electricity
Single family house	130	95	110	75	90	55	80	50
Multy family house	115	85	100	65	80	50	75	45
Premises	105	85	90	65	70	50	65	45

* The kWh includes bought energy for heating, hot water and building electricity. The area (m2) is the all the inner area of the building including the basement and attic that is heated to more than 10 ° C.

In the energy regulations there are also requirements on average heat transfer coefficient.

Experiences of housing providers and ongoing debate in your country

To inspire the building and property to build more low-energy buildings there is a searchable website with good examples called LÅGAN; www.laganbygg.se. LÅGAN is funded by the Energy Agency. Here, developers and contractors themselves account for construction projects with low energy consumption. LÅGAN can introduce the energy and technology for over 150 buildings and links to more than 500 operators who have participated actively in the construction projects.

There is an ongoing debate about how the future energy requirements of the building regulations shall / should be in Sweden. Many owners think that the current method of purchased (bought) energy is good, but for example the district heating industry believes that the current Swedish building regulations do not take base on how much energy resources that really takes to heat the house or how much climate is affected, but only how much energy must be purchased outside the walls, and that the current regulations actually promote heat pumps. They argue that current regulations can lead to increasing energy consumption and carbon footprint instead of reducing it.

SABO think that there are some principles for energy requirements for new construction that are important to take into account:

1. There shall be only one building legislation in Sweden;

2. Building regulations should not control the choice of heating method, that shall other regulation instruments do;

3. The requirements shall be as ambitious as possible without increase the cost of construction;

4. Technology neutrality between forms of heating will prevail. This means that the houses should be well-insulated independent of the choice of heating method;

5. The rules should be designed so that the same houses can be built all over in Sweden;

6. The rules shall not be too complicated;

7. It is important that the regulations can be followed up in a standardized way;

8. The competition in the construction market must not be impeded;

9. The rules must not inhibit innovation and development.

2.6 United Kingdom

Legal (national/regional) framework and relevant stakeholders

Different legislation exists for new build properties and refurbishment of existing properties:

- **New Build:**

  The Building Regulations set out the legal requirements for new build properties, including specifications for energy efficiency. The Code for Sustainable Homes (CSH) is a voluntary standard but is a requirement for publicly funded affordable housing, which sets out how homes can be made sustainable taking into account not just energy efficiency but also the wider sustainability arena. The CSH is also incorporated into some Local Authority plans, which require social housing development proposals to aspire to particular minimum levels of the Code – this varies dependent on the local authority.

  The Government has consulted on possible changes to the energy requirements (Part L) in the Building Regulations, as part of its pathway to zero carbon new homes from 2016.

- **Existing Properties:**

  Building Regulations also apply to existing homes and when controlled work is undertaken cost-optimal energy efficiency standards are required. The Green Deal and Energy Company Obligation have been put in place to provide a framework for refurbishment, however these are not mandatory legal standards.

- The CSH is not part of the Government's proposed zero carbon definition but its energy requirements will be mainly incorporated into Building Regulations by 2016. The future of CSH is under consideration by Government.
- There is public consultation on any proposed changes to Building Regulations before they become legislation and the Government is currently considering the responses to its consultation on changes to Part L of the Regulations.

Status of the process and time schedule

The U.K. government has produced its Carbon Plan which sets out targets for 2020 and 2050.

The Climate Change Act 2008 requires 5 yearly 'carbon budgets' to be set, three budget periods ahead, to ensure clarity as to what the U.K. intends its emissions pathway to be for the 15 years ahead. The first of these carbon budgets ends this year and requires a 23% reduction from a 1990 baseline. The percentage reduction required for the second carbon

budget between 2013-17 is 29%, and the third carbon budget between 2018-22 requires a 35% reduction. The fourth carbon budget which is to run between 2023-2027 was set in June 2011 and requires a 50% reduction. Latest projections suggest that the U.K. is on track in regard to meeting the current target. A significant proportion of these reductions (which cover both the EU Emissions Trading System, and the non-traded sector which incorporates transport and housing) is intended to be achieved through ensuring that homes are far more energy efficient.

It is Government policy that from 2016 all new homes will be designed to be zero carbon. For building work existing homes, mandatory, cost-optimal energy efficiency requirements will be set through the Building Regulations but voluntary cost-optimal energy efficiency improvements will be encouraged through the Green Deal.

Preliminary results: nZEB definitions and cost optimality

U.K. carbon policy is currently carbon-based (measured in carbon tonnes), but the Energy Performance of Buildings Directive requirement is energy-based (kWh) – although the terms of the directive which state that 'reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures' could be fulfilled by either model. Both models begin with the requirement for fabric and on-site energy efficiency, and it seems that when compared currently the U.K. model will meet the requirement of the Directive that 'remaining energy demand is covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced onsite or nearby'.

The definition of zero carbon is currently being reviewed by the Zero Carbon Hub (a house building industry group) that has been reporting to the Department for Communities and Local Government on practical targets. The original definition of zero carbon was equivalent to the energy requirements of Level 6 of the CSH, however, this definition proved expensive and unattainable. Development of a new definition that will be technically achievable, cost optimal and underpinned by the Fabric Energy Efficiency Standard (FEES) and Building Regulations is currently underway.

The current definition established by the Budget in 2011 is that a zero carbon home is one where net carbon dioxide regulated emissions (resulting from space heating/cooling, hot water and fans/pumps) are zero or better. This does not take into account unregulated emissions (occupants' electrical appliances). The extent of the net carbon dioxide emissions to be achieved on site, both from the fabric of the building and also from on-site energy and heat supplies will be subject to further consultation. The remainder may be accrued through use of 'allowable solutions', which occur when the developer pays a set amount towards off-site mitigation of carbon emissions.

3. Summary workshops and study visits

Two Workshops were organized to enable a common discussion, exchanges with experts and housing providers as well as to inspect examples of (very) low energy buildings.

Workshop I Vienna, February 2013 hosted by gbv/Austria

The workshop was dedicated to discussion of core tasks including presentation of the Need Analysis Report (Del. 2.1). Presentations of e7 and gbv demonstrated methodology and first results of the monitoring for the cost optimality study (Del. 2.4 – 2.6). The study visits of two passive house projects (recently finalized resp. under construction) and one refurbishment projects should deepen the knowledge as regards building technologies, costs involved and concern for resident's needs. The case of the renovation project demonstrated that energy aspects are not all issues which are to be adapted in older buildings. The study visits were led by representatives of Viennese housing providers.

Details:

A. **Renovation Project 1020 Vienna, Zirkusgasse 47 2010 – 2012 (Cooperative BWS)**
   Built: 1951, 13.292m2 (roof: 2724), dwellings: 217 (32 new built on roof)
   - built in elevators + adaption of staircases to achieve barrier free level
   - connection to district heating /general piping, 65 dwellings
   - thermal insulation; heating demand before/after: 121/33,7 kWh
   - new balconies
   - new roof dwellings
   - 67 completely renovated/upgraded dwellings

   Total costs: 17,73 Mio Euro (1.330/m2; without additional dwellings, upgraded dwellings: 990/m2) (Detailed description + photos: see Deliverable 2.3)
   financial assistance by Viennese Housing Promotion Scheme

B. **Passive House under construction BUWOG Nordbahnhof 1020 Vienna**
   Vorgartenstrasse/Rabensburgerstrasse
   200 subsidised + 16 non-subsidised dwellings
   Rent non subsidised: € 13,45 /m2 total
   Rent subsidised: € 8,60 /m2 total + € 57,--/m2 financial contribution tenant
   Integrated ventilation + heating system, heat supply district heating
   Financial assistance by Viennese Housing Promotion Scheme

C. **Passive House Project Heimbau, Eurogate, 1030, Aspangstr.2**
   Built: 2010 - 2012; 71 subsidised rental dwellings
   rent subsidised: € 6,20/m2 total + € 500/m2 financial contribution tenant;
   Integrated ventilation + heating system, heat supply district heating

financial assistance by Viennese Housing Promotion Scheme (extra subsidy for passive house status)

These projects could not be taken into the monitoring process since they were finalized only recently respectively were still under construction.

Workshop II Wiesbaden, November 2013 hosted by GdW/Germany

This workshop provided opportunity of meeting with energy experts as well as a presentation/study visit of a remarkable project in Wiesbaden, where two identical buildings (then still under construction) should offer the possibility to monitor the differences between a passive house and “normal” low energy building in line with actual energy requirements.

While the representative from the German Passivhausinstitut Berthold Kaufmann underpinned the superiority of the passive house as regards total costs, the calculations of the housing provider GWW Wiesbadener Wohnbaugesellschaft presented different results. According to their calculations the additional costs of construction (+12%) and the respective additional component in the rent could not be compensated by the predicted saving of energy costs. According to the design of the project there is a three years-period of monitoring running costs, comfort etc. to draw final conclusions as regards economy and functionality of the buildings. Since the monitoring and evaluation process has not been finalized during the course of the project there were no results for operating costs to be used as input for the project.

A site visit at these buildings – nearly completed but yet not inhabited – provided opportunity to inspect details of different construction designs.

A film available on the Powerhouse Website provides also the opportunity of visiting these projects.

The workshop also gave insight into another current IEE-project (ENTRANZE) via a presentation of Mr. Clemens Rohde (Fraunhofer-Institut in Germany).

The workshop closed with a tour de table as regards actual trends and discussions in member states.

4. Lessons learned - Summary and Conclusions

The outcomes of the project seem to be in line with the process of implementing the nZEB targets: there is a comparably limited period of time left to set the Roadmaps towards the 2020 and after status while there are still open questions.

Actual reports – e.g. by Concerted Action – show that end of 2014/beginning of 2015 less than the half of member states have published definitions of the nZEB-status in a legal document and/or have submitted cost optimality calculations. The existing definitions are not directly comparable as they e.g. refer to different uses of energy, different types of reference buildings and need further calculations since the required energy demand depends on the type of the building (size/compactness). Renewables are not treated in the same way – respective requirements are stated either directly or indirectly which means that the use of renewables may compensate final energy (primary energy) demand. In the UK instead of energy consumption carbon emissions are the reference line for building and renovation.

Nevertheless, there are some facts that explain the uncertainness to some extent, even on the conceptual level that is somewhat less ambivalent than praxis: some parameters for calculation are not easy to predict (future primary factors, cost development, price trends), also security factors may play a role (compare discussion about polystyrol). Furthermore there is some competition factor between different components of energy efficient building: insulation vs. heating and ventilation technologies vs. renewables systems (heat pumps, solar plants, PV). The calibration between these components is challenging and for sure not only a matter of experts' calculations but also a matter of competition between different industry-branches including energy providers.

Examples of cost optimality calculations show very small margins between different types of low(est) energy buildings. That implies amongst other that small divergences between theory and praxis may lead to different results of cost optimal levels. And praxis shows that functionality and performance of airtight buildings and technical systems are not always in line with conception.

Housing providers are in a special position concerning the conception of the nZEB Roadmap and definition of nZEB. Neither are they amongst the experts which design energy efficient buildings nor do they provide the required building components nor are they end consumers of the buildings. But they bear the technical, legal and financial responsibility for housing projects; as regards social housing providers there are also social tasks involved. Residential buildings have a very long life span – longer than any other consumer good. That does not only involve long term financial calculation but also care for proper functioning in a long term perspective. Since energy efficient buildings require new technologies not only determining energy efficiency but also effecting indoor air quality and thus health aspects

and comfort of residents these technologies need very careful implementation and monitoring – not only on a short term base – before starting on a mass production level.

From the perspective of housing providers – and also (future) residents – this need of at least midterm monitoring seems to be neglected when setting the Building Directive's conception in contrast to reality. This conclusion can be drawn from the outcomes of the project:

- According to the monitoring of costs of construction, energy consumption and costs of service for a number of low energy test cases in Austria (which were selected out from a bigger sample of housing projects) it showed that:

- The predicted margin in energy demand between low energy buildings and very low energy buildings was bigger than the actual differences in energy consumption for heating (and hot water);
- Extra costs of construction for very low energy buildings and passive houses for additional/extra insulation, ventilation with heat exchange added up to 6,7% for small buildings and 9,7% for large (compact) buildings;
- And cannot be compensated by savings in energy in the long run;
- Also the cost optimal type according to Austrian calculations which is not the passive house did not prove to be below the cost level of a "normal" low energy house.

- These findings seem to be verified to some extent by examples in France where the measured energy consumption in very low energy buildings was higher than the predicted demand which also raises some questions in relation to cost optimality calculations.

- Concerning energy refurbishment, results are similar; since actual consumption before renovation is lower than estimated there is an additional deviation from assumptions in cost optimality calculations. Examples in Germany show that renovations to a moderate low energy level are the cost optimal variant, one has to be aware that that applies for a certain model of rent setting maybe not transferable to other models.

The issue of deviations between theoretical/predicted demand of (heating) energy and actual consumption is crucial and should be paid careful attention. Different explanations for the phenomenon exist:

- Dysfunctionalities of the systems, e.g. imperfect ventilation systems leading to mechanical ventilation by opening the windows;
- Imperfect planning: ventilation systems depend to a good deal on their construction and position of central units;

- Lack of accuracy in the building process: low energy buildings require not only exact planning but also exact execution and workmanship (e.g. to avoid thermal bridges);
- Also imperfect building materials play a role;
- Complicated handling of the systems: in lowest energy buildings and passive housing adaptions by residents are required; heating and ventilation need to be balanced, opening of windows in winter should be avoided; but housing providers/managers can only intervene to a certain degree.

All these explanations underpin the fact that determining the future optimal level of low energy buildings should be based on midterm monitoring of low energy buildings. Since the new technologies (including thick insulation) have only been introduced a couple of years ago and have been applied only in a smaller number of buildings some more time should be reserved to evaluate these buildings.

Last but not least the financial dimension has to be given some more reflections. For social housing providers this is a very sensitive question.

While cost optimality calculations follow the concept of a building exploited in a production process, (social) housing providers are in a different position. They have to rent their dwellings to low to mid-income households either at cost rent or a rent set by the income of the tenants; also market rent applies in some cases. Extra costs for low energy buildings have to be covered by housing providers or by rent components. These rents have limits – either determined by law and/or by financial power of potential residents. From Germany it is reported that passive houses are to be found in the upper price segment of market; in Austria in most passive buildings that is not the case since there are extra subsidies to compensate for the extra costs. If nZEB will lead to a (substantial) increase of rents – regardless to what extent they may be compensated by energy savings – that will have special effects in the social housing systems. From the side of (low income) consumers it may happen that they avoid those new buildings being uncertain about the energy effect and only taking the rent level into consideration. So that could lead either to exclusion effects or problems in the marketability of buildings.

If moreover the higher level of rents (plus higher costs for service and maintenance) cannot be compensated by energy savings affordability might be challenged in addition to above mentioned effects.

Please note that effects concerning the sale of (lowest energy) apartments in condominiums are not reflected here even if this type is part of social housing in some member states. Owner occupied housing requires some special reflections.

5. Core elements for National nZEB 2020 Roadmaps

The fact that in many member states the conception of nZEB Roadmaps is still in progress does not imply that they are behind the development; it is more likely an indicator for the fact, that conception of nZEB Roadmaps are more complex than assumed in the beginning.

For the year 2015 in many countries an evaluation of existing concept and buildings is foreseen. As the outcomes of this project show – in first instance the results of the monitoring activities in Austria, France and Germany – reality is in some contrast to concepts. Real energy consumption is above the predicted/calculated level in very low energy buildings; there are substantial extra costs of construction and extra service costs in lowest energy buildings. The results in Austria hint to the fact that the level which was mandatory in subsidized housing in the year 2010/11 is the cost optimal one – at least in large/compact buildings which is not in line with the foreseen level for nZEB after 2020. In Germany similar findings exist.

It has also been discussed that monitoring and evaluation of new technologies in (residential) buildings should be done at least on a mid-term base. It has to be stated that this requirement is not fulfilled yet and cannot be fulfilled in accordance with the requirements of the European Building Directive. The conclusions are that the process of conception of nZEB Roadmaps and definitions should be slowed down in favor of finding the optimal sustainable solution. It is also important that housing providers get a more prominent role in the process of designing the way to nZEB since they bear the technical, financial and also social responsibility for sustainable buildings. The new technologies are complex and sensitive; that requires specific care in the construction process; but also residents have to adapt to these systems. As long as there are divergences between theoretical calculations and practice these new building types should remain on the “monitoring status” rather than become the mandatory status of nZEB.

For further information, please visit www.powerhouseeurope.eu

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