nearly-Zero Energy Buildings overview:

Status, Cost Optimality and Key Conditions for nZEB

Impressum

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1 Introduction

Reducing the energy consumtion and GHG emissions from new and existing buildings is a major goal within the EU 2020 targets. The recast of the EPBD 2010 introduced nearly-zero-energy buildings (nZEB) as political target together with the concept of cost-optimality which should secure cost-optimal building standards in all member states.

Core of the “nearly zero challenge” which is going to be tackled now in all member states and what this project is all about is bringing together technical and economic feasibility and securing affordable housing in this wide ranging energy transition.

Regarding to practical implementation of nZEB the research and evaluation of demonstration projects, exchange of practical experience and matter of fact analysis should lead to country specific adequate time lines and buildings standards.

This report should provide insight to the status of nZEB within countries involved in this project and describe favorable conditions for bringing nZE standards into practice. Furthermore, the concept of cost-optimality is described and tested for the case of Austria, based on both theoretical calculation and evidence based data from a broad sample of buildings. The conclusions from both the descriptive and the analytical part are formulated as key challenges on the way to nZE buildings.

2 nZEB Country Status and Favorable Conditions

Regarding the status of nZE buildings the project partners provided information on the situation in their country based on surveys of social housing providers as well as external sources. Needs and barriers were analyzed and in detail described in the task force papers.[1] The overall picture shows that there is a wide difference between experiences in the participating countries which can be regarded as representative for the situation in all member states. A closer view reveals significant differences in national policies and building culture which opens a broad perspective for exchange of experiences within this project. The aim of this chapter is to identify favorable conditions in different countries which create an innovation friendly environment and lead to a considerable number of innovative projects.

In her task force paper for cold/continental climates Eva Bauer summarized the quantitative country-by-country overview, showing that in the majority of partner countries only a “handful” or quite limited number of nZE buildings is existing today.[2] Identifying best practice examples and favorable legal and financing conditions in countries with a considerable share of nZE buildings to date is one of the tasks within the NZC project. Based on the analysis of needs and barriers within the three taskforce areas “warm/Mediterranean climates”, “cold/continental climates” and “divided ownership and cooperative housing” the exchange of experience on good practice solutions – technical, financial, legal and organizational – will be a major part of the following work in the NZC project.

Austria

According to voluntary reporting schemes from the federal program “klima:aktiv” and IG Passivhaus there exist about 120 multi-family residential buildings in passive house or lowest energy standard (< 25 kWh/m²a energy heating demand) and about 100 in “klima:aktiv” standard according to the criteria of the voluntary federal program. [3] About 5% of annual new construction of cooperative housing associations are built in passive house standard (600 of 12.000), the rest in low energy standard according regional building codes. Beneficial factors for this development have been so far:

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[1] Source task force papers and paper Diana

[2] Eva Bauer task force cold/continental Deliverable D2.1

[3] http://www.klimaaktiv-gebaut.at/ and http://www.passivhausdatenbank.at/statistics.php

The research and development program "Building of Tomorrow" launched in 1999 and resulted in more than 50 demonstration projects to date, nearly half of them new or refurbished large residential buildings. Demonstration projects are documented and monitored (usually 2 years). Through the program a network of innovative researchers, planners and building experts was initiated, which serves as know-how pool and platform for formal as well as informal exchange of experiences.

As a second key factor, the energy standards in the housing promotion schemes of the nine federal provinces are higher than those of the building ordinances. Since 80% of housing construction in Austria is built with public promotion, this has proven to be a very strong instrument to induce innovative energy standards.

Furthermore, the definition and promotion of voluntary standards like klima:aktiv and passive-house had positive effects on the market development of nZE buildings in Austria.

Belgium-Flanders (incl. Brussels)

Within the project survey the number of existing nZE buildings in Belgium-Flanders was described as "a handful". Furthermore a considerable number of nZE buildings (new and refurbishment) are already listed on the website of Bruxelles Environment.[4] According to BIBE new building regulations will come into force from 2015 on, requiring the level of passive house standard for new buildings.

The steady process of tightening the building requirements since 2006 in two-years steps gives a good example of successful step-by-step policy. It could be observed that the average thickness of insulation on facades and roofs improved significantly over the last years.

A crucial element within this step-by-step policy is the periodical evaluation of calculation methods, procedures, current building standards and the administrative burden of the energy regulation. This happens every two years, done by the Flemish Energy Agency, after consulting the relevant stakeholders, among them the housing sector represented by the Flemish Social Housing Society.

Bulgaria

Although there is no nZEB definition actually proposed Bulgaria there are no nZE examples reported to date but Bulgaria has a detailed and well structured general implementation plan

4 http://www.bruxellesenvironnement.be/uploadedFiles/Contenu_du_site/News/Batex_Liste_Laureats_2011_FR.pdf?langtype=2060

for the increase of nZE buildings, setting national intermediate targets and following a stepwise approach for the periods 2011-2013, 2013-2016 and 2016-2020. Part of the action plan is implementing pilot projects for nZE buildings in the public sector within the first period from 2011-2013.

Estonia

There has been only one very low-energy building in Estonia although this case serves as a successful example. The kindergarten Kaseke, situated in the municipality of Valga in the Southern Estonia, is being reconstructed by using the principles of energy efficiency criteria and best possible indoor climate. All the solutions are economically feasible and they correspond to the passive house standard. The energy consumption of the building has dropped from 250 kWh/m²a to 15-17 kWh/m²a. The project has received a grant of 1,08 Mio EUR from KOIT (Investment Donations Program for Local Municipalities), a program of the Estonian government while the total cost of the project is estimated to reach 1,45 Mio EUR.

This pilot project has received a great deal of attention and many different actors have shown interest and asked for information about the project. Some other developers already have started to plan their own low-energy project inspired by this pilot.

Germany

According to GdW about 20-30% of new construction in social housing can be regarded as nZE buildings. Furthermore, the international database on passive houses reports a number of 84 multi-family residential passiv-houses for Germany.[5] About 40% of new constructions are built in a better standard than actual building regulations.

One of the main drivers in Germany is the KfW program, which promotes the construction of new energy-efficient homes and the energy-efficient refurbishment of older residential buildings in particular with grants or loans at favourable conditions. KfW also supports measures to improve the quality of life through the creation of barrier-free housing.

The energy standards are laid out in the Energy Conservation Ordinance (Energiesparverordnung/EnEV). These standards apply to new buildings. KfW promotes new buildings if better than EnEV (40/55/70) and the refurbishment of houses if after refurbishment they do not exceed a specific energy requirement for a comparable new house (55/70/85/100/115). Simply put, the figures indicate in per cent how much of the maximum primary energy requirement specified by the EnEV the house consumes. The best standard

[5] http://www.passivhausdatenbank.at/statistics.php#statistik5

receives the highest support. The KfW promotion scheme can be regarded as good example since it is uniform for the whole country and easy to communicate.[6]

Research programs play also an important role as trigger for innovative buildings, namely the Research programs “Zukunft Bau” and “EnOB – Resarch for Energy Optimized Building” with subprograms “EnBau” for new buildings and “EnSan” for refurbishment. A considerable number of demonstration projects was launched within these programs, including documentation and evaluation of the buildings.[7]

Last but not least had the clear definition of the passive-house concept as building standard together with a calculation tool, certification of buildings and certified planners, a network of passive-house interest groups and hundreds of training courses, workshops and conferences a considerable impact on the market development of nZE buildings in Germany. According to the International Passive House Database the total number of passive house buildings in Germany amounts to about 1.300, 84 of them multi-family residential building.

France

The progress of France toward nZE buildings can be indicated by the impressing number of energy plus buildings which are already listed on the “Bâtiments à énergie positive” website by ADEME.[8] According to this database the number of plus-energy buildings in France is 192, most of them already in use and about 20 of them multi-family residential buildings.

[6] http://www.kfw.de/kfw/en/Domestic_Promotion/Our_offers/Housing.jsp#Energy-efficientConstruction

[7] http://www.forschungsinitiative.de/ and http://www.enob.info/en/

[8] http://www.ewatchservices.com/accueil_bepos.html

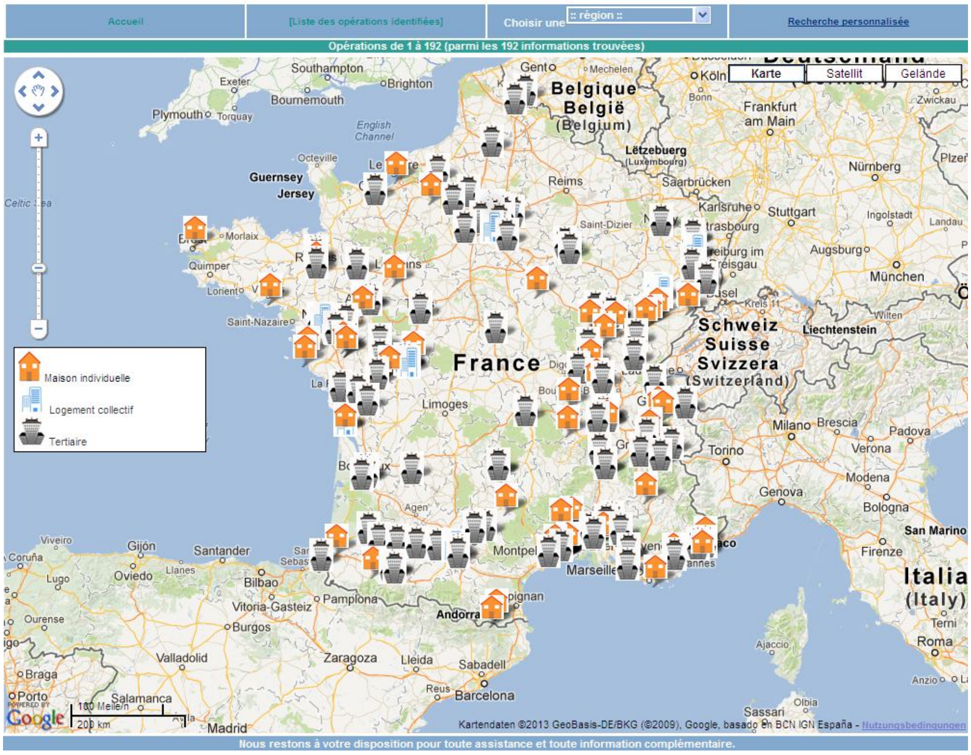

Fig 1: Energy plus buildings listed on the “Bâtiments à énergie positive” website by ADEME

France follows a quite ambitious way with the new thermal regulation (RT 2012) which was set up in 1st January 2013 and requires for new buildings a limited consumption of primary energy to 50 kWh/m²a.

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. 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.

Furthermore, the Union Sociale pour l’Habitat together with the Caisse des Dépôts et Consignations financed evaluation studies of existing new buildings and refurbishment projects.

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 explain 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.

In order to improve the coming operations, it is urgent to optimize the investments relying on the background of previous operations. This is the aim of the observatory of energy efficiency launched by the Union Sociale de l'Habitat and which is still under construction. This observatory focuses on the question of tenants' global costs.

Italy

Regarding new construction, there exist eight certificated passive houses in Italy in total, five of them built in Südtirol, one is located in Lombardia (Lonato), one in Veneto and one in Sicily. No subsidies were provided, they were all realized from private initiatives, only the one located in Lombardia is owned by a social housing cooperative.

There are also examples of nearly zero buildings from refurbishment, but they are pilot projects, such as the so called "Casa Kyoto" of ANIT association, which is located in Gavirate (Lombardia).

This survey with experts done by FINABITA confirms that in Italy the nZEB concept is assimilated to the CasaClima approach. Another example is the analysis of the existing publications about nZEB: all of these are presenting buildings designed with the CasaClima approach.[9]

In total more than 3.700 buildings were certified according to CasaClima standards in Italy to date (minimum standard less than 50 kWh/m².a energy heating demand). CasaClima defines quality standards which can be met on a voluntary basis, provides certification and training of professionals and is so constantly developing a professional network of planners, consultants, auditors and craftsman.[10]

Main driving forces for innovative construction are the positive/stringent local legislation framework that is stimulating all the building stakeholders to innovate and a strong voluntary effort to provide innovative and competitive solutions to the actual building. The proposers of these advanced projects are often well informed and courageous and invest own resources to go beyond the actual building market. There is no relevant public financing assistance for nZE buildings available, the main national incentive is a tax credit program to promote energy efficiency in Italy.

[9] TF paper warm/Med based on data from ZEPHIR http://www.zephir.ph/

[10] www.klimahaus.it/en/

Spain

Although there is no official database available there are some new constructed nZE buildings all around Spain, most of them as demonstration projects, others are official public buildings. No information about any samples of nZEB renovation is reported in the country survey.

Due to the economical crisis, cuttings have seriously impacted the energy efficiency sector. There is no kind of funding for nZEB buildings, moreover the grants concerning the energy saving, at national, regional and local level have been eliminated.

However, on the regional level the I.D.A.E. (Institute for the Diversification and Saving of Energy) of the Ministry of Economy of Spain provides direct aid as repayable grant through the Autonomous Communities (ACs) for investments in certain types of projects that promote energy efficiency or renewable energy. These aids include those actions that are part of the Renewable Energy Plan 2005-2010 (PER) and the 2008-2012 Action Plan of the Strategy of Energy Saving and Efficiency in Spain (E4). The respective Autonomous Communities are responsible for the development of public aid programs, but to date no program was developed for the construction or rehabilitation of nZE buildings.

Sweden

A certain number of nZE buildings already exist in Sweden: 43 new built multi-family buildings with about 3.200 dwellings were built in low energy standard, 1 building was renovated to nZE standard. Main drivers behind these projects are innovative housing associations wanting to strengthen their brand and public funding from EU funds. In case of EU funding project report in English are available.

Financial support for demonstration projects and local/regional collaboration initiatives is provided by the LÅGAN program focusing on buildings with very low energy use. It also encourages new thinking by evaluating and disseminating information from demonstration projects and supporting development projects. LÅGAN is collaborative program between the Swedish Construction Federation, the Swedish Energy Agency, Region Västra Götaland, Formas and others.[11] An important feature of this program is the sustainability and credibility of the action based on a 5-year program (2010-2014) and a total budget of 60 Mio SEK. LÅGAN offers not only support for demonstration projects but also for cooperation and networking initiatives on the regional and local level. Furthermore, the LÅGAN program website is also providing a best practice database with realized projects all over Sweden, including 78 multi-family residential buildings.

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[11] www.laganbygg.se

UK

Currently there is no database of nZEB projects and although various collections of case studies for new build and retrofitting of existing homes exist, the exact number of projects already completed or planned is not known. The main drivers behind nZEB projects currently vary, depending on the developer. However, at the current time they generally fall into the categories of fuel poverty, improved quality of assets, planning requirements, funding and (increasingly) legislation.

The implementation of the Green Deal in October 2012 has inspired some pilot projects, allowing comparison of predicted energy savings in comparison to actual achieved savings. Use of the current financial incentives of Community Energy Saving Program (CESP) and Carbon Emissions Reduction Target (CERT) supplier obligations, Feed in Tariffs and the Renewable Heat Incentive have had an impact in terms of driving projects (although not necessarily in terms of reaching nZEB); but the Green Deal and Energy Company Obligation – which is paid for through a levy on all electricity bills – should see higher numbers of refurbishment projects taking place if they work in the way they are intended to.

2.1 Benficial conditions: Summary

As a brief summary from the country by country survey the following elements could be identified as beneficial for market development toward nZE buildings:

AT: R&D, promotion schemes, voluntary standards: certification, training, networking

BE-FL: step-by-step approach, 2-year evaluation

BG: structured plan, nZE interim targets, as starting point although nZEB definition missing

DE: R&D, KfW promotion easy to understand, voluntary standard (PH)

FR: ambitious legal standard from 2013 on, evaluation studies commissioned by USH

EE: single pilot project has received a great deal of attention

ES: I.D.A.E. provides direct aid as repayable grant through the Autonomous Communities

IT: tax credit program, CasaClima: standard, certification, training

SE: LÅGAN program: financial incentives for demonstration projects, networking activities

UK: voluntary programs with financial incentives

As a general conclusion it turns out, that in the more nZE experienced countries it is not a single factor that proved to be beneficial for the development of know-how, demonstration projects and broader market impact. As a general recommendation it can be said, that an adequate mixture of different instruments – R&D programs, voluntary standards, promotion schemes and financial incentives and last but not least the intense exchange of experience accompanied by training and networking can be regarded as beneficial core strategies towards nZE buildings. Worth mentioning that it is not a question of either this or that but the intelligent, time consuming and hard work on the ground demanding interlinking of those elements.

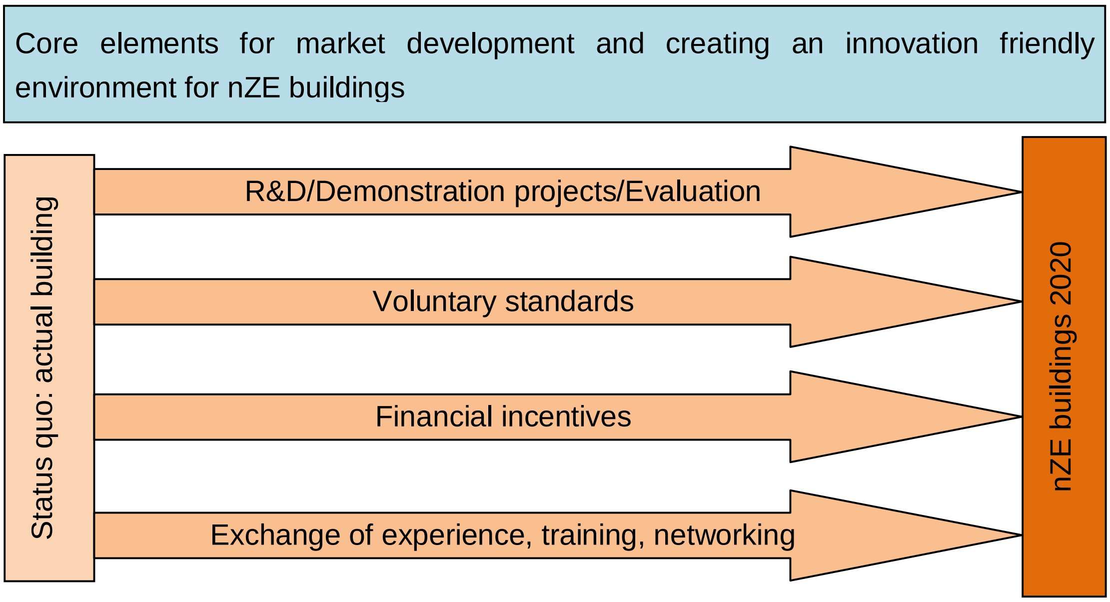

Fig 2: Core elements for market development and creating an innovation friendly environment. Source e7

3 nZEB and Cost Optimality – a Path to affordable Housing?

3.1 Legal and methodical background

The recast of the Energy Performance of Buildings Directive (EPBD) introduced, in Article 9, “nearly Zero -Energy Buildings” (nZEB) as a future requirement to be implemented from 2019 onwards for public buildings and from 2021 onwards for all new buildings. The EPBD defines a nearly zero energy building as follows: A nearly zero energy building is a “building that has a very high energy performance… . The nearly zero or very low amount of energy required should to a very significant extent be covered by energy from renewable sources, including renewable energy produced on-site or nearby.”[12]

Acknowledging the variety in building culture and climate throughout the EU, the EPBD does not prescribe a uniform approach for implementing nZE Buildings and neither does it describe a calculation methodology for the energy balance. To add flexibility, it requires Member States to draw up specifically designed national plans for increasing the number of nZE Buildings reflecting national, regional or local conditions. The national plans will have to translate the concept of nZE Buildings into practical and applicable measures and definitions to steadily increase the number of nZE Buildings.[13]

Furthermore, the new EU Directive requires that the cost optimum over the life cycle of buildings is taken into account when requirements for the energy performance of buildings are established. National minimum standards should be set by the Member States based on the cost optimum for construction costs and operational costs. Therefore, the European Commission has submitted the regulation No. 244/2012 in accordance with the objective clause of the EPBD in March 2012. Within the scope of this EU regulation, the methodological approach for the analysis of cost optimality of requirement levels is determined bindingly.[14]

[12] EU Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (EPBD)

[13] BPIE (2011) Principles for Nearly Zero Energy Buildings - Paving the way for effective implementation of policy requirements.

[14] COMMISSION DELEGATED REGULATION (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

The cost optimality principle acts as a bridge between the standard energy performance – as it is usual on today's markets – and the intended goal of reaching nearly zero energy buildings by 2020 (at least for new construction). In this sense the period between now and 2020 can be interpreted as a "transition period" during which the markets are forced to adapt and to apply a life-cycle cost perspective instead of the usual construction cost perspective.[15]

It has to be stressed, however, that the cost optimality principle as defined in the EPBD offers high degrees of freedom when it comes to applying it in the building regulations. Although the EU regulation on cost optimality provides uniform regulations in some respects – e.g. concerning included cost elements, calculation algorithms and analysis period – it allows room for national stipulations in many key areas, such as:

- Definition of the reference building related to important assumption such as size, form, compactness, share of window areas etc.;
- Selection of variants (packages of measures) which are assessed;
- construction costs (and most important construction cost differences for different qualities);
- maintenance costs of relevant building elements and related inflation rates;
- the assumed (technical resp. economical) life-time of building elements;
- discount rates;
- starting level of energy prices;
- energy price trends (although the regulation includes a recommendation to use the "official EU forecast member states are allowed to use other forecasts for their assessments).

According to a survey done in the frame of the EPBD concerted action in 2011 (before the EU regulation was submitted in March 2012) most of the member states intended to follow a microeconomic approach instead of or together with a macroeconomic approach (which would mainly include GHG emissions as externalities).[16] Up to now, the number of available cost-optimal calculations for different reference buildings according to the EU regulation is quite limited, although considerable work has been done during the last years in developing the application of life-cost-analysis in building practice. As far as available for the NZC

[15] Leutgöb, Pagliano, Zahgheri (2013): Cost optimality – Brake or accelerator on the way towards nearly zero energy buildings. Paper submitted for the eceee 2013.

[16] Cost-optimal levels for energy performance requirements - The Concerted Action's input to the Framework Methodology. April 2011.

project, cost-optimal calculations for multi-family-residential buildings were already done for Estonia and Austria.[17]

3.2 nZE Buildings in practice – the case of Austria[18]

A crucial question regarding the cost-efficiency of nZE buildings is whether calculated energy demand and costs are corresponding with measured energy consumption and real cost data from buildings in use. Up to now there is little empirical evidence to answer this question on a broad basis, even in those countries where a considerable number of nZE is already realized. If any, it is mostly data for single objects, primarily focusing on measured energy consumption. Even worse is a reliable data basis when it comes to real costs: so called “additional investment costs” for nZE buildings depend on the actual building standard in the respective country and the availability of cost competitive building components like triple glazing windows. Costs for energy consumption, maintenance and replacement costs are further the crucial elements when it comes to the question of life-cycle-costs.

Although there is a certain number of nZE demonstration projects well documented in Austria, the evaluation of these buildings focus on energy consumption and give little or no indication on running costs or life-cycle-costs.[19] This was one of the reasons, that in 2011 the Austrian Federation of Limited-Profit Housing Associations (gbv) together with e7 launched a broad survey in order to collect energy consumption AND cost data from innovative multi-family-residential buildings which can be regarded as nZE buildings in order to analyze the cost-effectiveness of those buildings.[20] In the frame of this project we focused on lowest-energy and passive-houses with (calculated) energy heating demands lower than 30 kWh/m².a and compared the data with low-energy buildings with energy heating demands between 30 and 50 kWh/m².a (which is the building code standard from 2012 on, but this standard was already introduced on a broad basis during the last years with the housing

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[17] Kurnitski et al. (2011): Cost optimal and nZEB energy performance levels for buildings (study for Estonia). Bednar et al. (TU Vienna / 2012) and Leutgöb et al. (e7 / 2012) (studies for Austria).

[18] Since Austria is the first country for which theoretical cost-optimality calculations as well as evidence based analysis for a broader sample of buildings are available, the empirical part of this chapter is focusing on this country.

[19] Innovative Buildings in Austria - Austrian demonstration buildings and flagship projects within the research programme “Building of tomorrow” http://download.nachhaltigwirtschaften.at/hdz_pdf/innovative_gebaeude_in_oesterreich_2012_technical_guide.pdf

Treberspurg et al. (2009): Nachhaltigkeitsmonitoring ausgewählter Passivhäuser in Wien. http://www.wohnbauforschung.at/de/Projekt_Namap.htm

[20] Hüttler, Rammerstorfer, Tudiwer (e7 / 2013): InnoCost – Cost-effectiveness of innovative multi-family-residential buildings in Austria (final report will be available in Mai 2013).

subsidy schemes of the federal provinces). Since the analysis of data and interpretation is still ongoing the results are preliminary, but important trends can already be observed.

The focus of this project was on multi-family-residential buildings with (calculated) heating energy demand lower than 50 kWh/m².a, covering the range from low-energy buildings to lowest-energy buildings to passive-house standard.[21] Energy consumption data were provided by the housing associations for at least two or three years for each building. First results derived from a broad sample of 55 buildings indicate that the measured energy consumption for heating in NZE-buildings is in reality significantly lower than in low-energy-buildings. Data show also a broad variance of real consumption data of about factor three within each group (appr. 15-50 kWh/m².a passive-house / 20-70 lowest-energy / 30-90 low-energy-buildings). Therefore it could be quite misleading to draw far-ranging conclusions from single objects or a very limited number of buildings.

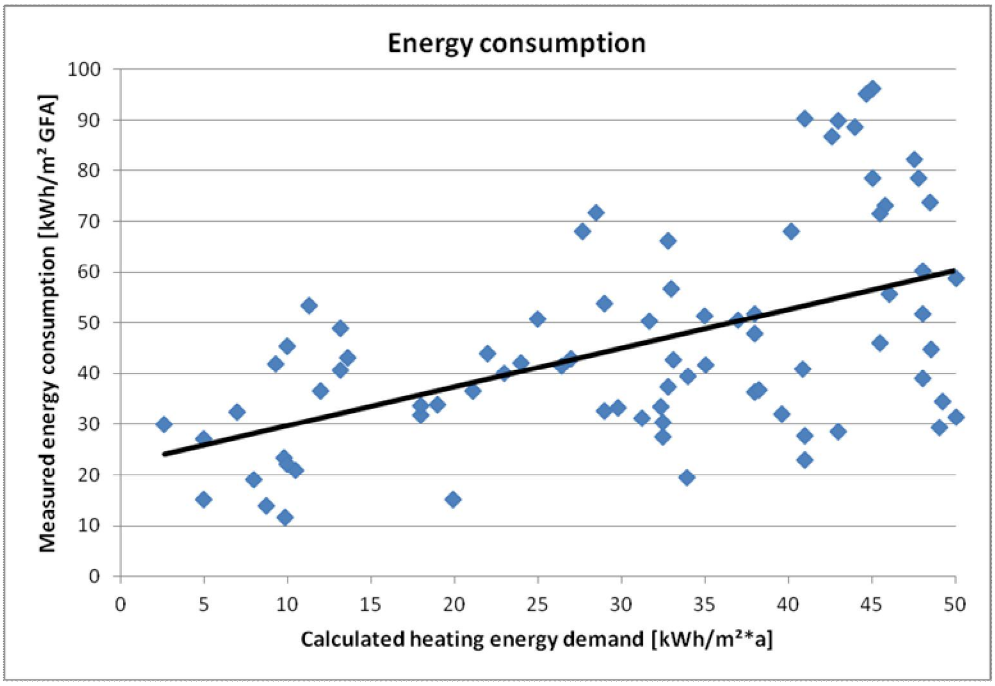

Fig 3: Energy consumption for heating vs. calculated heating energy demand in nZE multi-family-residential buildings. Source e7 / Hüttler, Rammerstorfer, Tudiwer (2013)

More difficult is the matter of running costs. Costs for energy consumption for heating are easily available only for those buildings with central heating systems. Furthermore it has to be differentiated between heating and hot water. Maintenance costs were becoming an increasingly important issue mainly due to mechanical ventilation systems, which are a

[21] According to heating energy demand: passive house < 10 kWh/m²a, lowest energy kWh/m²a < 25-30 kWh/m²a (depending on compactness of the building) low energy standard < 50 kWh/m²a.

crucial element of the passive-house-concept but also more and more frequently installed in lowest-energy buildings due to air-tight construction. Not surprisingly there can also be observed a broad variety of maintenance costs in practice. Maintenance costs for ventilation systems range from 0,8 till 18 ct/m².month with an average of about 9 ct/m²m.month, depending mainly on the system (central or decentralized ventilation, frequency of filter exchange, quality of filters and adequate contracts with external maintenance contractors. Best practice studies for a limited number of 6 buildings show that the maintenance costs for central mechanical ventilation systems can be limited to a range from 3 to 4 ct/m².month, whereas decentralized ventilation systems result in maintenance costs of 10 ct/m².month on average.[22]

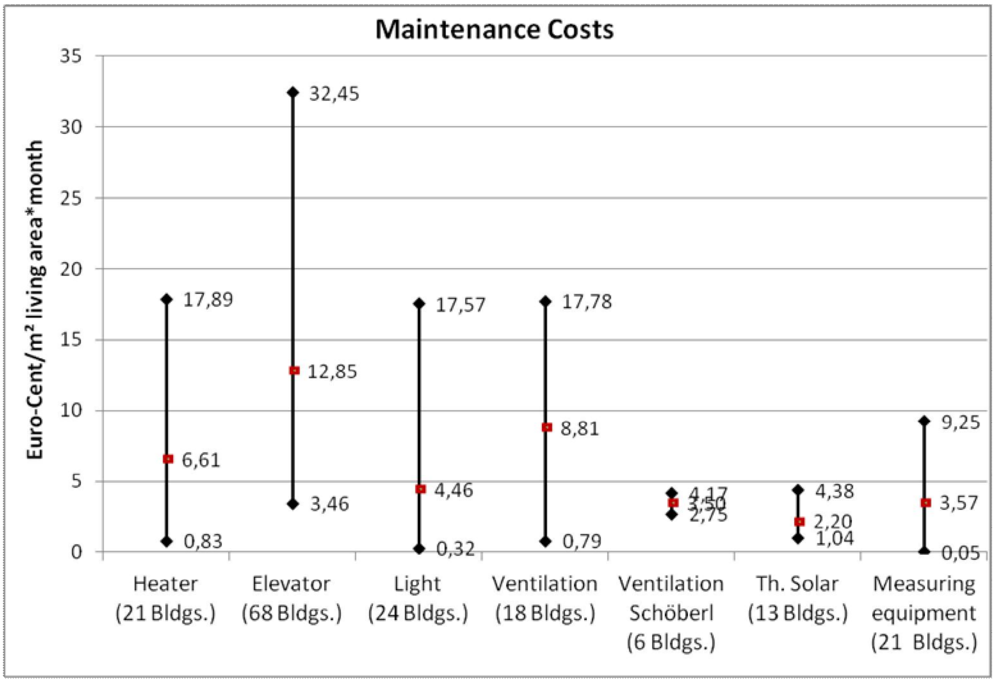

Fig 4: Maintenance costs in nZE multi-family-residential buildings. Source e7 / Hüttler, Rammerstorfer, Tudiwer (2013)

Buildings with ventilation systems trend to have higher maintenance costs compared to buildings without ventilation systems. Consequently, lower energy costs for heating which can observed in lowest-energy and passive-house-buildings are tending to be partly compensated by higher costs for maintenance.

[22] Schöberl, H (2011): Wartungskosten Minus - Reduktion der Wartungskosten von Lüftungsanlagen in Plus-Energiehäusern. Final report within the R&D program „Building of tomorrow", Vienna.

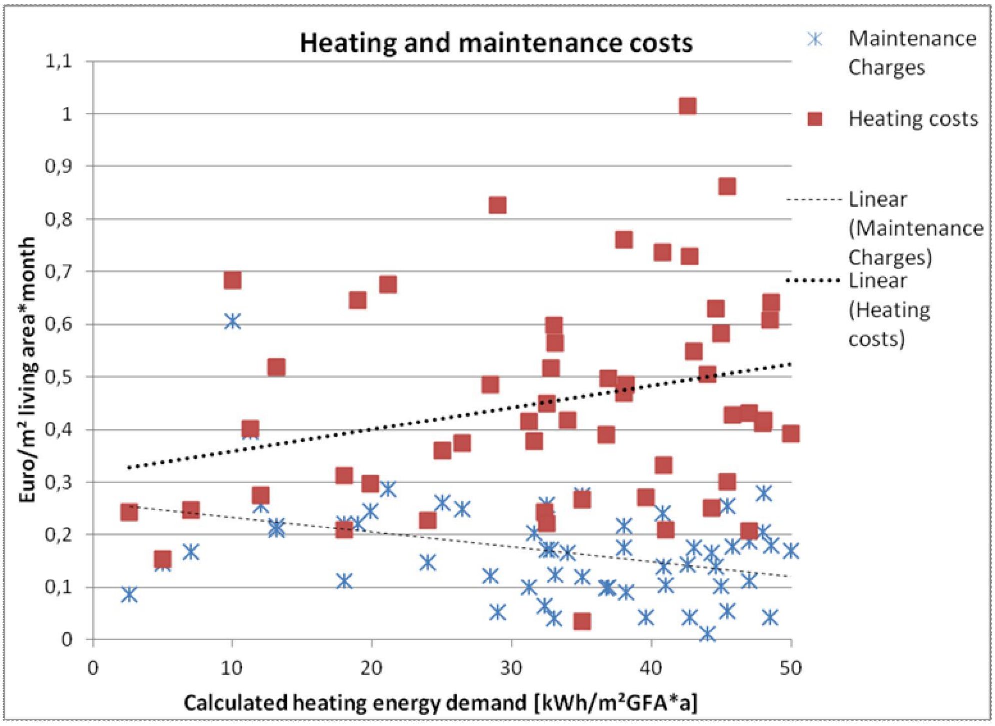

Fig 5: Energy costs for heating and maintenance costs in nZE multi-family-residential buildings. Source e7 / Hüttler, Rammerstorfer, Tudiwer (2013)

Specific investment costs (€/m² used floor area) are depending on different factors: most important of them the size of a building, since small and less compact buildings have significantly higher specific costs than large and very compact buildings. Further cost components which influence the comparability of building costs are the number of elevators and if there is an underground garage for each dwelling or not. Furthermore regional differences in building cost levels can be generally observed. So one has to be very careful when it comes to comparison of investment costs with regard to different energy standards.

The following graph shows a sample of 40 nZE buildings with (calculated) energy heating demand lower than 50 kWh/m².a. Whereas the specific investment costs for individual buildings vary considerably due to factors mentioned above (regional cost differences etc.) the trend line results in additional specific costs for passive-house buildings of about 100 €/m² compared to low-energy standard (which is mandatory in Austria since 2012). A more detailed analysis show, that the additional costs for passive-house standard seems to be significantly lower for large and compact buildings (appr. 40-80 €/m²) compared to additional costs for small and less com pact buildings (appr. 120-200 €/m²).[23]

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[23] Eva Bauer, preliminary analysis, January 2013.

One has to mention that the economic ratio of the passive-house according to the (initially) strictly reduced concept based on the idea that additional investment costs for the improved building shell and mechanical ventilation are partly compensated since there is no need for a conventional heating system. This has been successfully proven in practice for a number of buildings but it turned out that in practice (at least in Austria) most of the multi-family-passive houses are built with mechanical ventilation AND a more or less conventional heating system. Decoupling heating and ventilation allows lower air-change rates and reduces the risk of unhealthy dry air indoor conditions during the winter and is therefore state of the art in passive-house technology. Consequently, to have both mechanical ventilation AND a conventional heating system is questioning the initial idea of cost-effective passive-houses.

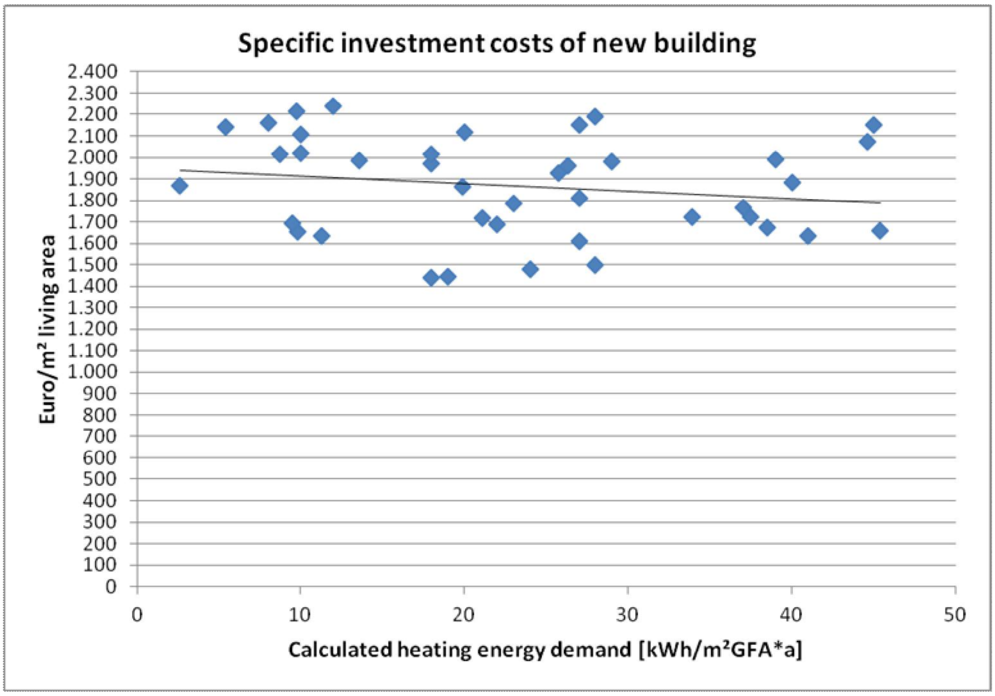

Fig 6: Specific investment costs for nZE multi-family-residential buildings depending on the energy standard. Source e7 / Hüttler, Rammerstorfer, Tudiwer (2013)

Finally, putting together the data on running costs and investment costs in a simplified total cost calculation over 20 years (net present value, without reinvestments for technical installation and without declining-balance, 3% energy cost increase per year) the results show that lower costs for energy heating do not compensate the higher investment costs for passive-house standard in general. At least for the specific situation in Austria it seems, that lowest-energy standard (energy heating demand about 25-30 kWh/m².a) turns out to be a cost-optimal building standard.

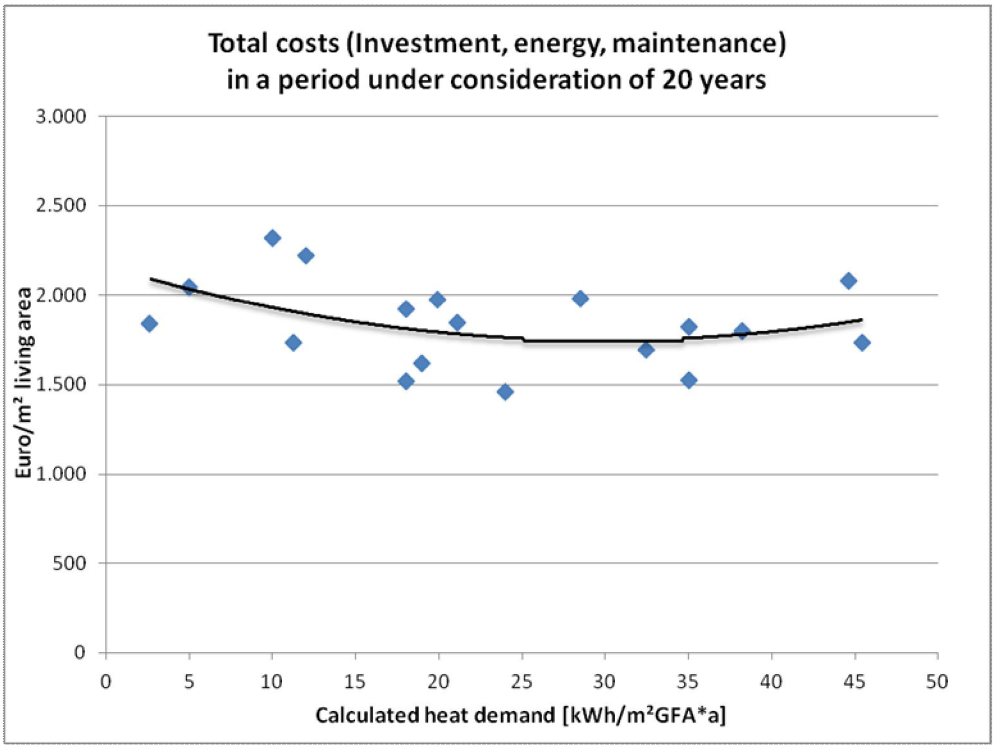

Fig 7: Total costs (investment, energy, maintenance) in nZE multi-family-residential buildings depending on the energy standard (simplified calculation without reinvestments for technical installation, 3% energy cost increase per year). Source e7 / Hüttler, Rammerstorfer, Tudiwer (2013)

Approximately, this seems to be in line with theoretical calculations on cost-optimal building standards for multi-family-residential buildings in 2012[24]. Results from different organizations based on three different data sets lead to comparable results.

The results of Bednar et al. from the Technical University Vienna was made for two different reference buildings and show an "cost-optimal" heating energy demand of about 20 kWh/m².a for large residential buildings (80 dwelling) whereas the "cost-optimal" heating energy demand for a small residential buildings (6 dwellings) is about 40 kWh/m².a.

[24] Bednar et al. (TU Vienna / 2012): Studie zur Analyse der österreichischen Anforderungen an die Gesamtenergieeffizienz von Gebäuden in Bezug auf das kostenoptimale Niveau (interim report).

Leutgöb et al. (e7 / 2012) Analyse des kostenoptimalen Anforderungsniveaus für Wohnungsneubauten (final report). http://www.e-sieben.at/de/download/CostOpt_WOHN_Endbericht.pdf

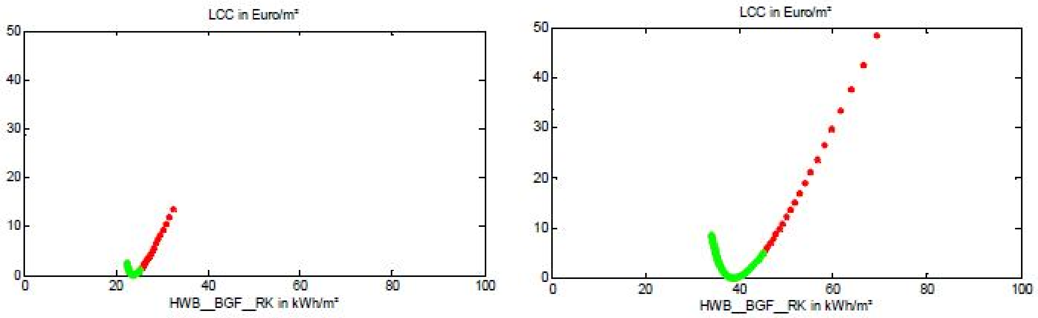

Fig 8: Cost-optimal building standards for multi-family-residential buildings: large (80 dwellings) left and small building (6 dwelings) right graph. Source: Bednar et al. (2012) The y-axis describes the global cost difference between the different standards in €/m².

Cost-optimality calculation for a residential building with 30 dwellings done by e7 show an optimum around 25 kWh/m².a which is in line as well with our empirical data (Fig 7) as well with the calculations of the Technical University Vienna (Fig 8).

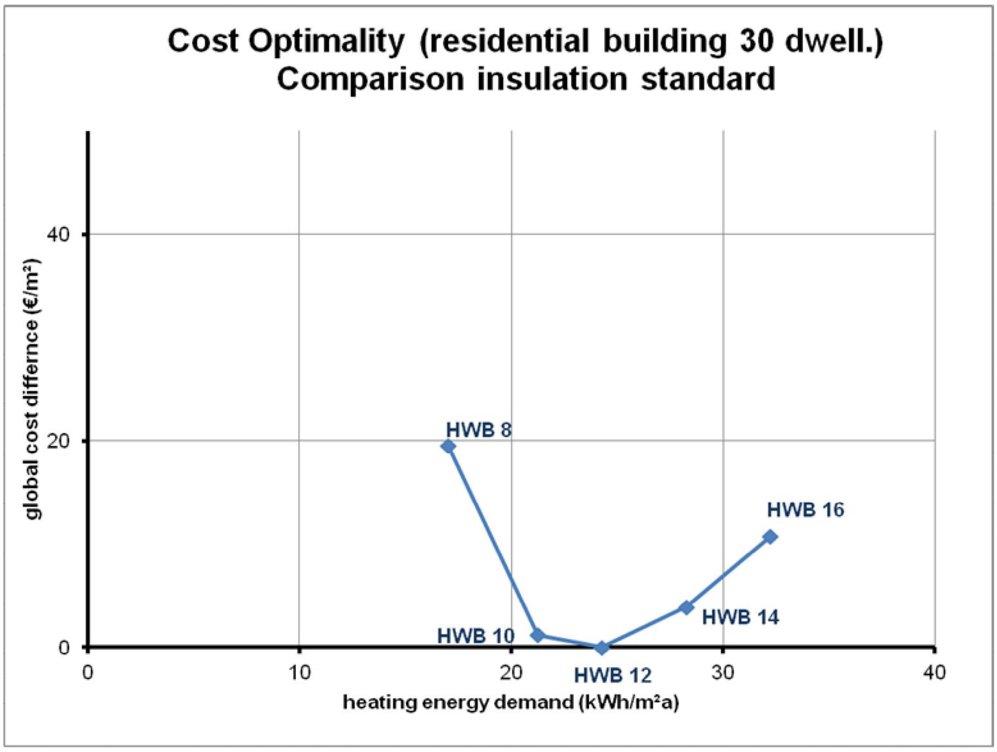

Fig 9: Cost-optimal levels for multi-family-residential buildings (30 dwellings). The y-axis describes the global cost difference between the different standards in €/m². Source: e7

Based on these calculations it is obvious that the passive-house standard seems actually not to be the cost-optimum for residential buildings. One of the main reasons, why a considerable number of passive-house buildings in Austria were realized during the last years is financial incentives integrated in the housing subsidy schemes of the federal regions. For example, the additional subsidy for building a residential passive-house is 120 €/m² in Tyrol. Consequently, the housing association "Neue Heimat Tirol" is able to offer dwellings in passive-house standard at the same rent conditions as usual low-energy buildings for their tenants.[25]

3.3 Preliminary Conclusions

Theoretical calculation and the analysis of evidence based data give a first impression on possible ways to define nZE buildings based on cost-optimal levels, although the results are preliminary. Furthermore, this reflects only the sheer economic perspective, not including other important parameters like living comfort or practical usability. The results of this analysis may be applied in general to other countries, results in details are very country specific. Therefore, theoretical calculations and analysis based on real data from practice have to be done for each country.

[25] Spiss / Neue Heimat Tirol, Madrid presentation (2012).

4 Summary: Key conditions on the way to nZEB

The following conclusions refer to the needs and barriers analysis and good practice examples as provided by all partner countries in the NZC project in detail, collected in the reports of the three taskforces and summarized in Diane's paper. Beneficial conditions for market development and creating an innovation friendly environment towards nZE buildings are described in chapter 2 of this report, thus providing the empirical basis for this summary.

4.1 Stepwise approaches and periodical evaluation

Tightening their building requirements a step-by-step approach followed by many countries has proven to be successful over the last years. Stepwise implementation takes time but allows building on experiences gathered on a smaller scale.

A crucial element within a stepwise approach to nZE standard should be the periodical evaluation of building standards with regard to cost-optimality, calculation methods and procedures as well as administrative burden. Relevant stakeholders from the real estate and housing sector should be consulted or formally involved in such evaluation (as for example in Belgium).

4.2 R&D buildings programs

The needs and barriers analysis from the taskforces showed clearly the urgent need for more practical and well documented examples of nZE buildings. Research & development programs play an important role in developing innovative building solutions and proving their feasibility in demonstration projects (as for example "Building of Tomorrow" in Austria, "Zukunft Bau" and "EnOB – Resarch for Energy Optimized Building" in Germany or the LÅGAN program in Sweden). To realize a considerable number of demonstration projects with high visibility, decent documentation and evaluation of real energy consumption, costs and usability is one of the core benefits of an application-oriented building program.

Furthermore, R&D programs can foster the development of innovation networks, bringing together researchers, planners and real estate experts not only on project level but also in continuous workshops series. Considering a minimum duration of 3 to 5 years a national R&D buildings program can be a core element of creating an innovation friendly environment and thus bringing nZE buildings into practice.

4.3 Promotion schemes and financial incentives

The survey among partner countries has clearly shown a beneficial impact on market development when national or regional promotion schemes for energy efficient new buildings or refurbishment projects are available. Promotion schemes as part of an integrated subsidy system for social housing (as for example in Austria) or as stand-alone promotion schemes for improved energy-efficiency-standards (as for example the KfW program in Germany) have proven to be effective instruments in order to support front runners within the real estate and housing sector. Promotion schemes play an important role in bridging the innovation gap between single demonstration projects resulting from R&D programs and broader application in daily practice.

Good practice examples of promotion schemes cover the additional costs for low-energy or passive house standard and/or the integration of renewable energy and thus enable housing companies to provide higher energy and comfort standards at same rent conditions to their tenants. Tax credit programs (as in the case of Italy) may also play a beneficial role for the market development of energy efficient buildings.

A major challenge of promotion schemes – against the background of financial crisis and budget restrictions – is keeping up continuity in a middle-term perspective (foreseeable 2-3 years) in order to providing planning reliability for investors and housing associations. Practice has shown that the additional administrative burden of accessing promotion schemes may turn out as barrier. Therefore, an adequate balance between easy to understand and to administer and quality assurance has to be found.

4.4 Voluntary standards

Voluntary buildings standards (as for example CasaClima in Italy, klima:aktiv in Austria or the passive-house-standard) have shown significant power for market development of innovative buildings towards nZE standards. Core elements in order to create a new brand with high credibility on the market are a clear technical definition of the standard, adequate and easy to use calculation tools, the possibility of certification or declaration of a building and the continuous training of building professionals (planners, craftsman). Based on this, the convincing reasons for building owners are not only lower energy costs or environmental friendly buildings but the higher overall quality of the building.

4.5 Evaluation of all innovative projects

In order to make use of the experience of innovative projects on a broader basis a decent project documentation of what was the initial plan, what has been constructed and how the building is functioning in practice is indispensable. A proper evaluation should cover detailed monitoring of energy consumption (at least heating, hot water, ventilation separated) over at least two years and include also practicability aspects as well as post occupancy evaluation involving the users. In order to make results from post occupancy evaluations better comparable, standard questionnaires or interview guidelines should be standardized or at least have a common standard core.

A critical issue is to what extent the evaluation results are publicly available. Usual practice in demonstration projects within R&D programs is to include monitoring and evaluation as one obligatory task within the contracts with the housing owner, together with the commitment to make the monitoring and evaluation results publicly available. A minimum documentation and evaluation standard should also become usual practice within national or regional promotion schemes. This includes for example collecting the basic data and design parameters on each building within a (publicly accessible) database and the overall energy consumption compared to the design values for e.g. the first 3-5 years of operation.

4.6 Exchange of experience – on all levels

A general outcome of the needs and barriers analysis within the NZC project was the necessity for intensified exchange of experience on all levels: within member states, on the national and regional level and within housing companies.

Initiatives and projects launched within the IEE (such as the BUILDUP portal or the POWER HOUSE EUROPE project coordinated by CECODHAS) have proven to serve effectively as platforms for information exchange and address certain communities in the real estate sector.

Transfer on the country level is significantly fostered by involving not also the “usual” research and expert community but consequently involve stakeholders from the real estate and housing sector. A critical point is providing the adequate frame for not only telling the success stories but also create “protected” or more informal environments, which allow talking about inevitable difficulties and failures.

When it comes to the company level, it’s again all about a culture of creating learning environments, based on regularly – not only financial – evaluation of each project and providing the (time!) resources for internal exchange of experiences and learning. Practice has shown that there is a significant learning curve within the first three to five nZE projects. Making use of the increasing experience from project to project results in considerable lower additional planning efforts for nZE buildings and reduces the risk of non-adequate or expensive design solutions.

4.7 Real data on energy consumption for all buildings

Getting reliable energy consumption and renewable energy delivered data for buildings in use is precondition for the evaluation of state of the art buildings but also for the proper operation and optimization of existing buildings (new and refurbishment). Optimization covers not only the comprehensive refurbishment of a whole building but also simple measures regarding the heating, hot water and ventilation systems. On the average the energy consumption of a building can be reduced by about 10-15% applying low-cost or no-cost measures like proper adjustment of control systems according to the actual demand or exchange of pumps in favor of high-efficient equipment.

Putting together the consumption data of the whole stock within a company allows to creating individual benchmarks and identifying priorities for action. Consumption data may also be cross-checked with the calculated or measured data from the energy performance certificates in order to identify runaway values.

Furthermore, setting up the procedures for collecting and analyzing energy consumption data will be required by the national implementation of the new energy efficiency directive which requires that Member States shall encourage … social housing bodies governed by public law … to … adopt energy efficiency plans and … put in place an energy management systems.

4.8 Real cost data for all buildings

Having reliable cost data from existing buildings at hand is a precondition when it comes to calculating evidence based cost-optimal building standards. Collecting cost data for investments, energy consumption and maintenance turns out to be a major effort when those data are not collected on a regularly basis.

Therefore, national federations can play a key role by providing a standard format for there member organizations in order to collect cost data on a comparable basis. Reliable cost data provide the basis for company internal benchmarks and identifying potential for optimization (e.g. maintenance contracts). Gathered on the level of national federations anonymized and aggregated cost data can be used for benchmarking on the national level and life-cycle-cost calculations for reference buildings thus providing valuable input for country and sector specific calculations of cost-optimal building standards.

4.9 Training of building professionals

All countries involved in the NZC project emphasized the importance of improved and reliable know-how in all stages of the building process. Training programs should involve the relevant national and regional professional associations of planners and designers and craftsmen in order to secure common standards and wide ranging impact. Certification of planners and craftsmen may be an important element to provide visibility, credibility and confidence on the market.

Demand for training is also a task for the housing associations' staff. Whereas the technical staff is confronted with increasingly complex tasks regarding the supervision of ongoing construction works and the procedures of commissioning the housing administrations is facing new tasks with tenant communication, particularly when it comes to adequate use of low-energy and passive-house buildings with ventilation systems. Some housing associations already developed standard information sheets, user handbooks and personal information guidelines in order to meet this challenge in an both effective and efficient way.

4.10 Cost-optimal building requirements – evidence based!

Finally, the most challenging task is to secure that cost-optimal building requirements on the way to nZE buildings go in line with the affordability of housing. In theory the concept of cost-optimality should be perfectly suited to secure both environmental friendly and affordable building standards. In practice it's mainly a matter of reliable input data based on empirical evidence. Calculation results significantly depend on the chosen reference building (small/large) and the assumed life-time of building elements whereas sensitivity analysis show, that the chosen discount rate and energy price index (based on realistic assumptions) have rather small impact on the results. In general the results of cost-optimality calculations so far show rather flat cost-curves which means in practice, that the risk of making a major economic mistake by defining a too ambitious building standard is limited.

National and regional housing federations should therefore be actively involved or involve themselves respectively in the process of establishing road maps toward nZE buildings 2020. The process will benefit from the practical know-how, evidenced based data and should secure affordable housing within the ongoing energy transition.