NorthPass

INTELLIGENT ENERGY EUROPE

NorthPass – Promotion of the Very Low-Energy House Concept to the North European Building Market

National Roadmaps for promotion of very low-energy house concepts

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Sintef

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Table of contents

1 SUMMARY

This report is meant to contribute to the preparation of National Energy Efficiency Action Plans (NEEAPs), which are tools supporting the implementation of energy efficiency improvement policies. The NEEAPs are considered one of the cornerstones of the Energy End-use Efficiency and Energy Services Directive.

Previous publications from the NorthPass project report from studies of existing concepts and building standards in the participating countries, and analyses of main challenges in aiming to increase the market share of very low-energy houses. In this report a short overview of the current situation is given, and measures are proposed to support the implementation of the nearly Zero-Energy Building level, as described in the recast of the Energy Performance of Building Directive. Necessary steps towards a successful implementation will vary within the participating countries; involving technological, financial and policy implications in various degrees.

The eight North European countries, participating in the NorthPass project, have similarities and differences. The four Nordic countries have several similarities regarding market penetration of very low-energy houses, as well as activities implemented by the authorities. Poland and the Baltic States have similarities in terms of market situation which is different from the Nordic countries.

In the Nordic countries, the path towards the EU 2020 targets has, to a large extent, been chosen, focusing on step by step tightening of building codes, financial incentives and training of actors in the building sector. A discussion is going on about how to affect changes in customers' preferences, which would lead to a growing demand for very low-energy residential buildings.

The situation in Poland and the Baltic countries is more problematic, as only few very low-energy houses have been built so far. However, a growing interest in energy savings seems to arise, as the energy consumption is considerably high and the prices are increasing. It might therefore be assumed that a growing demand of very low-energy residential buildings will occur when affordable low-energy house solutions enter the market. Different actors should be trained in the very low-energy house production, some technological aspects of building tradition have to be developed, and major changes on the energy supply side should be addressed. Customers and contractors are hoping for financial incentives to be established by the authorities.

All countries have to tighten building codes to reach the EU targets, and address renewable energy production. Financial incentives may perhaps not be necessary regarding market penetration of very low-energy houses, but it will certainly contribute to a more rapid implementation. In all countries are education, training and dissemination of information listed as key issues to increase the interest of dwelling providers, tenants and buyers.

2 INTRODUCTION

The aim of the NorthPass project is to increase the market penetration of very low-energy houses in North European countries. The focus area for the project is new dwellings, both single family houses and apartments.

This report contains an overview of the market for each participating country, and proposals for some market uptake measures like legal, financial and informational measures. Some assumptive figures for the future market share of very low-energy buildings are included. The purpose of this report is to provide a platform for exchange of information between the participating countries, in order to contribute to policy development on energy efficiency and renewable energy sources.

Partners from all the participating countries in the NorthPass project have contributed to this report, providing information about the current situation of very low-energy houses in their countries, and compiled plans for market uptake measures. In cases where no official plans are available, the partners have, based on their experiences and expertise, proposed measures to increase the number of very low-energy houses.

3 EUROPEAN POLICY

The Energy Performance of Building Directive (EPBD) states the objectives and principles, but it is left to Member States to determine the concrete requirements, performance levels and ways of implementation.

The recast prescribes that all new buildings must be nearly zero-energy buildings by the end of 2020, that Member States should set intermediate targets for 2015, and that new buildings occupied and owned by public authorities have to be nearly zero-energy buildings by the end of 2018.

European energy policy is guided by several documents and initiatives, for example the Energy Action Plan of March 2011. A new Energy Savings Directive is currently being prepared by the Commission. One main point of discussion is if energy efficiency targets should be used on the national or EU levels.

Targets are used to motivate policymakers and consumers to save energy. Targets have been used for decades, and only now is there consideration for binding targets both at the EU level and for individual member states. As it stands now, there is a non-binding energy savings target for 2020 (confirmed by many Energy Council documents and other policy documents) that could become binding if sufficient progress is not achieved by 2013. This was discussed in the Energy Efficiency Plan 2011 (March), but has later been proposed to be postponed until 2014 as part of the preparation of the new Energy Savings Directive.

The counting down has started to achieve Europe's 20% energy efficiency target for 2020. If nothing changes in the coming years, the EU will achieve only half of the target. This threatens the EU's competitiveness, the fight for reducing CO_2 emissions and the security of supply.

In June 2011 the European Commission presented the legislative proposal for an Energy Efficiency Directive, to fill the gap and put the EU back on track. The proposal is built upon the existing Directives for Cogeneration and Energy Services and merges them into one comprehensive legal instrument addressing energy efficiency in energy supply and in final energy consumption. The proposal includes measures in three categories:

- Legal obligation to establish energy saving schemes in all Member States
- Public sector to lead by example
- Major energy savings for consumers

The proposal includes that the Commission, in 2014, will make an assessment of the progress made towards the EU's 20% energy efficiency objective for 2020 and, if necessary, brings forward a further legislative proposal to set mandatory national energy efficiency targets.

As mentioned; by 2018 new public buildings must be nearly zero energy buildings, and by 2020 this will apply to all new buildings. According to the European Buildings Directive, a «nearly zero energy building» is a building that has a very high energy performance and the very low amount of energy required is covered to a very significant extent by energy from renewable sources. Member States must draw up national plans for increasing the number of nearly zero energy buildings in new construction and renovation.

4 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN DENMARK

4.1 Current situation

There has been a remarkable decrease in building activities in Denmark since the peak in 2006 – 2007 and consequent recession in building industry. The number of annually built new dwellings has dropped from 30.177 in 2006 to 5.276 in 2009 [Andresen]. This has very likely delayed the market penetration of low energy buildings in Denmark despite the general positive attitude to energy efficient buildings.

4.1.1 Current building codes

Denmark had a clear official definition of a low energy building in 1985 – 1998: The heating energy demand should be less than 50% of a building according to the mandatory building code. The low energy building class was re-introduced in 2006 including also a very low energy class (Low energy class 1). The actual (2010) building code defines a standard class, which is mandatory, and 2 low energy classes [Danish Building Code]. The maximum energy demand allowed in the 2010 standard class is 25% lower than it was in 2005. The standard class 2010 is valid for refurbishment projects, too.

The maximum, purchased and weighted, primary energy use for space heating, ventilation, cooling and domestic hot water for residential buildings, including hotels etc is defined for BR10 (Standard class in 2010):

$$52{,}5 + 1650/A \text{ kWh/m}^2\text{/year}$$

where A is the heated gross floor area. These numbers are net energy use after deduction of production from an implemented renewable energy source on site or in the same or neighbouring municipality, e.g. photo voltaics or wind mills. In addition, there are several additional demands, e.g. for the maximum dimensioning transmissions losses for the thermal envelope and window energy balance.

The low energy classes are optional now but will become standard in 2015 and 2020, respectively.

4.1.2 Standard definitions and labelling

The building code classes for new buidlings are administrated by the municipalities. All buildings when sold or rented out are given the EPDB energy label (A-G) according to their energy performance [Energimærkning]. A building according to Class 2015 is given label A and according to standard class 2010 is given label B.

Other concepts and certification labels exists, too. The most common certificate in Denmark is the international passive house certificate [Passive House Certification]. No attempts are made to use the term “passive house” for other buildings than actual passive houses.

The Green Building Council in Denmark has decided to promote the German green building label DGNB with some national adjustment, but no residential buildings are yet certified with this label [dk-DGNB].The Nordic environmental Swan label [Swan label] has been existing for some years and there have been some initiatives and projects to promote it within residential buildings [Fremtidens parcelhuse].

4.1.3 Market share

Figure 1 shows a relative share of new low energy houses in 2007 – 2009 [Andresen]. There are distinquished between low energy Class 1 and 2 (Building Code 2006 – 2010). Class 2 is a low energy house and Class 1 is a very low energy house. The data is based on the definitions and the data from Energy Certificates Database and Statistics Denmark. These numbers show that the share of very low energy houses (Class 1) is about 2% and the share of low energy houses (Class 2) i almost 15% and that the share of both is increasing.

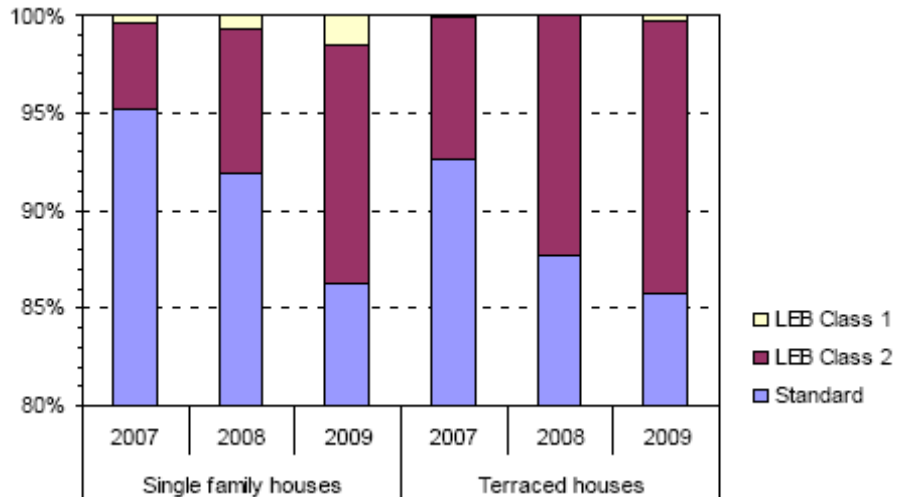


Figure 1:Relative distribution of houses completed in low energy class 1 and 2 in Denmark from 2007-2009. The figure is based on combining data from the Energy Certificate Database and Statistics Denmark. From [Andresen]. LEB = low energy building.

There exists an international database including the certified passive houses [Passive House Projects]. However, the database is based on voluntary efforts and therefore only few Danish projects are presented in it. There are appr. 400[1] finished and certified passive house dwelling units in Denmark now (2012). In addition there exist a number of individual projects with miscellaneous low energy strategies and standards. The labelling based on DGNB is still in the introductory phase. About 50 dwelling units have the Nordic Swan label in Denmark at the moment.

4.1.4 Incentives

In general there has not been given any special subsidies that would make it easier to choose a very low energy solution instead of a standard one. Some municipalities have given a discount in land prices if the building owner will build a low energy house.
There has been some non-public based incentives to promote very low energy buildings: For example the project “Comfort Houses”, where the aim was to design and build 10 passive houses in close collaboration with a large range of actors from the building sector and especially Isover in order to demonstrate the passive house concept in a Danish context [Komforthusene]. At least 8 of these 10 single-family-houses have got the Passive House certificate. Also other private initiatives like the first “active house” built in April 2009 [Active House] and a running process with a “Bolig+” concept have expanded the experience to the Danish building sector [BoligPlus].

[1] An estimate made by the Danish passive house certification body Passivhus.dk

The "Knowledge Centre for Energy Conservation in Buildings" is an initiative with public funding in order to disseminate interdisciplinary knowledge about energy saving measures in buildings. E.g. it offers a free database with refurbishment solutions for all most typical constructions in Denmark [Byggeri og Energi].

4.2 Proposal for market uptake measures

The overall path towards increasing low-energy buildings in Denmark is already clear. Relatively ambitious building regulations have been introduced and they are revised every five years. Therefore almost all the new buildings in the future should meet the tight energy efficiency requirements. The question is: how, and with the help of which mechanisms, this anticipated development should be obtained and eventually sped up.

4.2.1 Future building codes

The Danish building codes are among the most ambitious at the moment. Also, the future codes until 2020 have been discussed and defined. Therefore one of the most important drivers for market penetration of low-energy houses suggested by the expert surveys exists already [Ahveninen]. The low energy classes are optional now but will become standard in 2015 and 2020, respectively. The maximum, purchased and weighted, primary energy use for space heating, ventilation, cooling and domestic hot water for residential buildings, including hotels etc. is defined for

- Class 2015: 30 + 1000/A kWh/m²/year
- Class 2020: 20 kWh/m²/year

The great question for any further update of the regulation is most likely to be about the definition of the total energy demand and how to include sustainable energy sources in the building energy balance. The actual sketch of the Building Code 2020 makes it possible to include renewable energy production on site to the total primary energy use of the building. In this way it is possible to meet the EU 2020 goal of nearly zero energy buildings. However, there is a need for further investigations and definitions of this model from the energy system and building level point of view.

Nevertheless, by introducing the ambitious energy goals in the current and particularly in the future building codes, the Danish authorities have given the most powerful incentive to promote very low energy houses in Denmark.

Financial support

In Denmark, there is generally a positive attitude to energy savings and environmental friendly way of living. The energy prices have increased during the recent years and therefore energy efficient living is economically attractive in the long run. High energy taxes also contribute to high energy prices. However, the extra investment costs in energy efficient solutions must be economically feasible also in relatively short run in order to penetrate the market. At the moment, no subsidies or other financial support is given for energy efficient buildings.

Favourable loans for energy efficient buildings have been given for years in a number of countries (e.g. Germany, Austria) where the number of passive and other energy efficient buildings is now in tens of thousands. Therefore an effective way to boost the already arising market up to another level would be to offer this type of loans also in Denmark.

Another possibility for the financial support of low-energy construction, according to a recent survey among building professionals [Ahveninen], would be tax deductions for energy efficient buildings.

Guidelines

There is a need for both simple and detailed guidelines about energy efficient solutions in buildings for all parts of the building sector. General contractors, and the like, should include and provide all necessary information about the low energy building concepts and products. These "one-stop-shops" should be an offer both to the private home builders and to the established building professionals.

The already existing "Knowledge Centre for Energy Conservation in Buildings" should widen the scope also to include this interdisciplinary knowledge about *new buildings*.

Development of components

Building components which are needed when constructing an energy efficient building are now available in the market to a great extent. Until very recent, many of the specialized products for very low energy houses in Denmark were of German or Austrian origin.
The share of Danish products for energy efficient solutions is, however, rapidly increasing with increasing demand for energy efficient buildings and a demand for Danish products. In Denmark, there already exists financial support for manufacturers of energy efficient products and components [EUPD]. By targeting and increasing this support to components for energy efficient buildings and by assisting the market penetration of these products, there could be a remarkable, additional export effect in especially neighbouring countries and also even worldwide.

Pilot buildings

The main initiatives for promoting very low energy buildings in Denmark have been based on commercial projects, though they have been involving also some public funding for realization of the monitoring and evaluation programs. Apparently, the extent of low-energy building demonstration projects is still not enough in Denmark as most of the building professionals according to [Ahveninen] thought that more projects are still needed.
The idea of the state as a frontrunner in promoting low-energy buildings and solutions through public procurement was also supported by the majority of the respondents according to [Ahveninen].

Assessments and certificates

According to [Ahveninen], when making a decision about the construction project, durability of the house, indoor quality and low energy use were considered as most important criteria. Importance was given also to issues such as safety and aesthetic value of the house and low running, maintenance and repair costs. These same criteria were considered important also when assessing the resale value of a house. The question is how to ensure that these performance criteria for the building owner/user are fulfilled by the actual building.

The EBPD energy performance label is currently the only mandatory certificate in Denmark [Energimærkning]. Other certificates, like passive house and green building certificates are optional and not everybody is motivated to invest extra on an additional certificate. However, when considering how to guarantee the performance of any house and especially a very energy efficient house, external quality assurance is needed. And certification – when including serious assessment of the design and expected performance – could be one of the best ways to increase the added value of the low energy buildings. From the energy performance point of view, the already established passive house certification scheme is very powerful in guiding the design of a very energy efficient building. In some (pilot) projects it is wise to include a performance assessment of the operation phase in order to gather more experience and also to convince the building owners/users to get what they expect. Inclusion

of intelligent feedback systems for building performance during the operation phase may be the future trend for quality assurance.

Education and training

In Denmark, the political decision of tightening the Building Codes has already been met and a sketch of the future building codes until 2020 already exists. However, there is a large gap between the common building traditions and skills and the necessary solutions for these highly energy efficient buildings to be built in very near future. Therefore a huge effort on education and training of all building professional is needed in order to make it possible to realise the goals.

One of the already existing initiatives is the training of certified passive house designers. This education was initiated in Denmark by an IEE supported project [European Passive House Designer] and is now running on commercial basis [Ceph]. In Denmark, there are now (early 2012) almost 100 architects and engineers as certified passive house designers that are qualified to design a very low energy building. The number of trained designers, however, must be increased remarkably in order to match the needs in the building sector.

The basic education of all building professionals should – of course – include the principles of design and construction of a very low energy house as standard.

Awareness campaigns

Living environmental friendly has a positive image in Denmark, even though it is normally overruled by other concerns, like investment costs, design preferences and easy maintenance. Therefore, there is a need for increased awareness and knowledge about the total life cycle costs and increased property value of a low energy building compared to a standard one. Also a focus on the increased possibilities for good indoor air quality and comfort in an energy efficient building should be addressed.

4.2.2 Targets and timeline for market uptake measures

The official Danish target is to be CO_2 neutral in year 2050 which will demand a remarkable change in energy consumption in all buildings. This addresses a special focus on the deep energy renovations of all existing buildings.

5 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN NORWAY

5.1 Current situation

5.1.1 Current building codes

The current codes [Building code TEK 10] set requirement for total energy demand. There are separate requirements for 13 different building categories, calculated with Oslo climate and standardized use.

Examples:

- One family house: 120 kWh/m² per annum + 1600/m² heated floor area
- Apartment building: 115 kWh/m² per annum

As a general rule, for buildings less than 500 m^2, 40 % of heating demand has to be supplied by other sources than grid electricity or fossil fuels. For buildings over 500 m^2, 60 % of heating demand has to be covered by renewable energy sources. Exemptions are possible.

5.1.2 Standard definitions and labelling

Official definitions of low-energy and passive house standard for dwellings are now established [Standard Norge]. The energy labelling system includes requirements for calculated delivered energy for 13 different building categories, including dwellings.

5.1.3 Market share

There is no national register of low energy and passive houses, and there is virtually no information about the actual (measured) energy consumption of the alleged low-energy buildings [Andresen]. Estimations give a hint of the market share of new low-energy buildings to be round 10 % for residential buildings – both single family houses and apartment blocks. The interest, however, in very low-energy buildings is quite large, nowadays, and several projects are in the planning phase. Actors in the building sector expect higher requirements with respect to energy efficiency, from both authorities and costumers. For example; as a part of their local environmental policies, the authorities of Oslo have decided that all new public buildings in the capital city should be built according to the passive house standard from 2014.

5.1.4 Incentives

Incentives, such as advantageous grants, loans and information, are established to support implementation of low-energy buildings. Instruments are Enova (the state's energy agency: www.enova.no), and the Norwegian State Housing Bank (www.husbanken.no). Nevertheless; two recent studies estimate that a strongly increased emphasis on the construction and renovation of buildings is needed in order to reach the EU 2020 goals. The reports estimate such activities will create business opportunities and new jobs from 2010 to 2020 [Dokka. Arnstad].

5.2 Proposal for market uptake measures

Several strategies are to be implemented in parallel, to reduce the energy demand in buildings. Both the authorities, the actors in the building sector, house buyers and users can contribute to

enlarge the market for very low-energy buildings. Both comprehensive measures, like code revisions, and several smaller once, like training and campaigns, are necessary to reduce energy demand, and thereby reduce CO_2 emissions and secure energy supply. Some key factors are described in the following paragraphs.

5.2.1 Future building codes

According to climate conciliation of the Norwegian Parliament in January 2008 the government will consider imposing a passive house level for all new buildings by 2020. The term passive house refers to the concept of well insulated and airtight building envelope.

So far the building codes set requirements to total energy demand and U-values of components, not demanding a specific standard. It seems reasonable to keep the codes as functional requirements, and not change to require a standard. However, building codes should be designed to encourage very low-energy buildings, and should be revised in accordance with the technological development.

Coordination of policy instrument

There is a need for coordination of codes, energy labeling scheme, and the very low-energy building initiatives of Enova and the Norwegian State Housing Bank. A coordination of requirements will make it easier for buildings agents to relate to new and gradually more strict framework conditions [Arnstad].

5.2.2 Complementary initiatives to legislation

As legislation alone cannot achieve the full energy saving potential in buildings, several complementary initiatives should be implemented, such as:

- Call on the building sector to voluntarily speed up the implementation of very low-energy buildings.
- Financial incentives to accelerate the deployment of recommended efficient building technologies.
- Information and awareness raising campaigns aimed at building owners, and training campaigns targeted at all market agents in the building sector.
- Efforts to change attitudes and behaviour to energy consumption in buildings.

Guidelines

Design support and guidelines for very low-energy buildings should be further elaborated. Concepts should be developed for different geographical locations and cultural contexts.

Development of components

Research and development topics, that need to be addressed, are development of envelope components, ventilation systems and energy supply systems based on renewable energy sources.

Construction details for highly insulated and air tight building envelopes have been a focus area. New insulation and air tightness products have been applied, as well as new construction methods and increased use of verification procedures (blower door tests and thermo-photography).

Progress has been made in developing components. For example are passive house windows, heat recovery units and heat pump units available in Norway. There is a need, however, for

development of components with respect to reduction of costs. Financial support might be needed in the innovation phase, to reduce risks.

From the very low energy level to approach the zero-energy or zero-emission level, the efforts should be placed on the energy supply side, which mean local, renewable energy production. Technological development of elements for buildings, producing electricity, is expected to speed up (photovoltaic cells, co-generators, and mini wind turbines). So far, there is little experience with smart grid solutions for selling electricity, with favourable feed-in tariffs. Moreover, heat supply systems need to be developed to suit lower heat demands.

Pilot buildings

Well documented and successful pilot buildings can serve as lighthouses, when aiming for enlarging the very low energy building market. Also pilot building are important for testing new technologies and development of know-how.

Some pilot buildings have been erected, and these buildings play an important role as frontrunners for others to follow. New planning and design strategies, like partnering contracts and integrated energy design, have been implemented in various projects. However, the number of pilot buildings is still limited, and only a few of the buildings have been thoroughly measured and evaluated with respect to energy performance, indoor climate and user satisfaction. More exemplary buildings should be constructed, and experiences should be collected regarding planning and design strategies. The appropriateness of the chosen building layout, envelope design, and integrated energy technologies should be investigated. And construction, operation and maintenance issues should be addressed. Evaluations will increase the knowledge about processes, solutions and life cycle costs.

Assessments and certificates

Voluntary incentives, such as applying energy and environmental assessments for documentation and verification, would most likely result in a faster market growth for very low-energy buildings.

The building sector in Norway has chosen BREEAM, the British environmental assessment tool, to be the preferred tool. Adaptation is going on to make the tool suitable for Norwegian conditions.

A web-based tool that makes it possible to calculate the greenhouse gas emissions associated to buildings is in the process of being developed (www.klimagassregnskap.no) [Statsbygg]. The tool has so far been used in few projects, but will be used in all the pilot building projects of the program FutureBuilt (www.futurebuilt.no).

Education and training

The main barriers seem to be financing and lack of knowledge and competence. The first barrier quite often seems to be a result of the second barrier since the knowledge and use of life cycle cost analysis (LCC) is very limited within the real estate branch [Andresen].

With regard to one of the main barriers; lack of competence, the actors in the building production should be offered to undergo education and training programs leading to certificates. Such programs should contain information from well documented pilot buildings.

In Mars 2011 the minister of Local Government and Regional Development announced the establishment of a new forum for cooperation between the building industry and the authorities [Byggeindustrien]. The minister pointed out that an advisory group will focus on important issues like a holistic research and development strategy for the building sector, the construction training courses to be more focused in addressing future challenges, the building

industry and trade to take in more trainees, systematizing and coordinating of further education and courses, and a more efficient dissemination and competence building targeted at all relevant groups, not least buyers demanding for buildings.

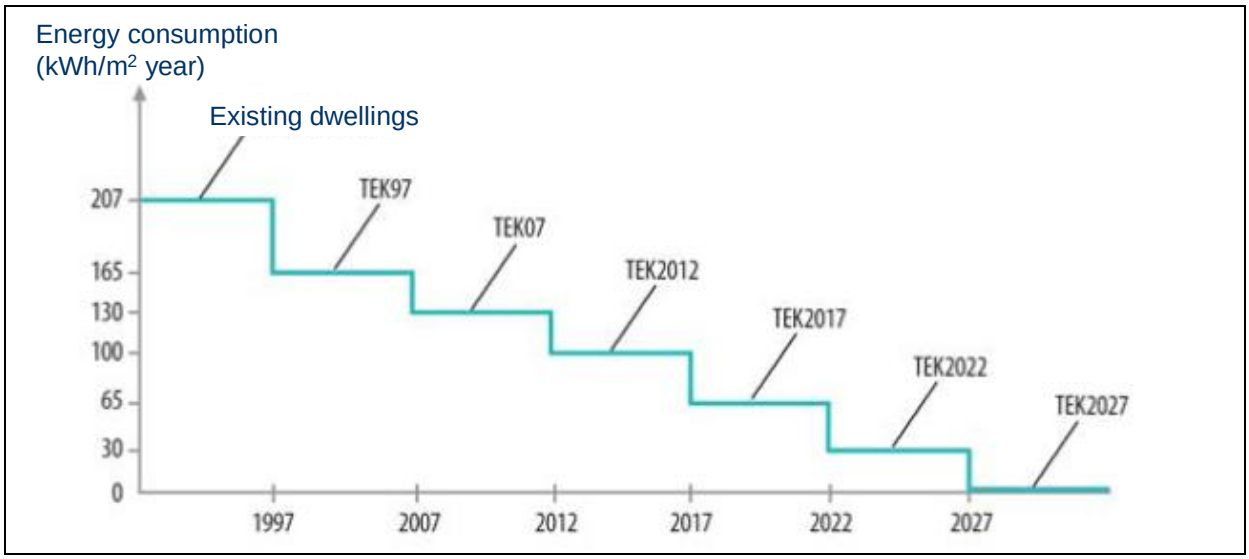
Awareness campaigns

70 % of the heating demand in Norwegian buildings is covered by electricity. The Norwegian electricity production is based on hydropower and is perceived to be clean, which may lead to the idea that we don't have to reduce the consumption of electricity in order to reduce the CO_2 emissions. However, if the demand for energy in buildings decrease and thermal energy replace high grade electric energy, where possible, the released power can be used in the transport sector, and that will certainly reduce CO_2 emissions.

5.2.3 Targets and timeline for market uptake measures

In the near future, 5–10 years, it seems reasonable to require very low energy buildings in the regulations. In the longer run, 10–20, it seems possible to require zero-energy / zero-emission buildings for new constructions.

«The Low Energy Commission» [Lavenergiutvalget], appointed by the Minister of Petroleum and Energy, presented in 2009 a recommendation for a stepwise tightening of the Building Code, shown in the figure below.



Schematic diagram showing the commission's recommendation for a stepwise tightening of the Building Code (TEK)

The commission recommended to announce a stepwise tightening of the Building Code and proposed for the authorities to consider requirements for low energy buildings from 2012, passive houses from 2017 and zero energy buildings from 2027. Further the commission recommended considering compulsory evaluation of energy consumption compared to the calculated values from 2012.

A working group [Arnstad] appointed by the Minister of Local Government and Regional Development presented in 2010 the goals of reducing total energy consumption for operating buildings with 10 TWh/year by 2020, and further gradually tightening actions to save 40 TWh/year, which is half of the contemporary yearly energy consumption in buildings. The working group also pointed at the necessity of focusing on renewable energy production, in addition to energy efficiency, to be able to reach the goal of «nearly zero energy buildings» og «zero energy buildings». The working group stated that we have the technology to build

«nearly zero energy buildings», but the energy supply systems are not prepared for receiving local produced heating and electricity. The working group has words of warning regarding sub-optimization within too narrow system boundaries, e.g. heat pumps and windmills on each single house. A community perspective should be employed to find the most efficient and environment friendly solution. The working group points at storing possibilities, even out energy use over a day and night period, and also seasonal periods, and make it possible to deliver local produced electricity to the grid.

6 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN SWEDEN

6.1 Current situation

6.1.1 Current building code

According to the Swedish building code of January 2012 (BBR 2012) buildings shall be designed in such a way that energy use is limited by low heat losses, low cooling demands, efficient use of heat and cooling and efficient use of electricity. General recommendations are made to the building regulations on ventilation, thermal comfort and moisture control. This typically results in well insulated buildings with heat recovery.

Dwellings shall be designed so that the specific energy use of the building does not exceed 90 kWh per m² of (heated) floor area and year in the Southern climate zone, 110 kWh per m² of floor area and year in the Central climate zone, and 130 kWh per m² of floor area and year in the Northern climate zone. For dwellings with electrical heating as the main source of heating, the specific energy use of the building must be 35 kWh per m² of floor area and year lower than above requirements. The energy use includes the energy delivered to a building (often referred to as purchased energy) for heating, comfort cooling, domestic hot water, fans and pumps. Household electricity is not included. The specific energy consumption of the buildings may be reduced with energy from thermal solar collectors and photovoltaic cells installed in the building.

If it is an apartment building it is likely to be heated by radiators and the heat is supplied by a district heating system. A one-family house is also likely to be heated by radiators, which are electric or if a heat pump is installed hot water central heating.

6.1.2 Low energy buildings

The low energy residential building is likely to be a passive dwelling or the like, which is likely to be built according to the performance specifications, issued by the Swedish "Forum for energy efficient buildings" [FEBY]. Space heating can be supplied by the balanced mechanical ventilation system with very efficient heat recovery. If space heating is supplied by the ventilating air the balanced ventilation system includes a heating coil in the supply air, which is either electric or connected to hot water central heating.

6.1.3 Market share

There is not yet any national register in Sweden of low energy and passive houses, and there is not very much information about the actual (measured) energy consumption of the alleged low-energy buildings.

A study from 2010 on "Nordic Analysis of Climate Friendly Buildings" [Andresen], financed by the Nordic Innovation Center, estimates that in Sweden less than 1% of all building categories could be accounted as low energy buildings. The figure is, however expected to rise considerably in the coming years. Housing was the most predominant building type that was built according to the voluntary passive house criteria. From the total number of constructed housing units only 0.6% of single family houses/terraced houses and 0.8% of apartment buildings were constructed as passive houses (1070 living units from a total of 145000 constructed housing units in the period 2005–2010). Two single family houses were built as plus energy buildings. During the same period four schools were constructed using the passive house technology. The introduction of very low-energy buildings on the Swedish

market has been slow, but the last two years the market share has increased shows a study from 2011 by Wahlström et al. [Wahlström]. Among the built residential buildings the percentage of low-energy buildings was approximately 0.7% in 2008, 2.2% in 2009 and 7.2% in 2010 according to the study. Most of the built low-energy residential buildings were apartments.

The interest in very low-energy buildings is quite large, nowadays, and several projects are in the planning phase. Actors in the building sector expect higher requirements with respect to energy efficiency, from both authorities and customers.

6.1.4 Incentives

In Sweden, at the beginning of 2011, there were very few government subsidies for building energy efficient buildings. Exceptions are subsidies for installing solar cells (max 60% of the investment cost, or 2 million SEK) and solar collectors (max 7500 SEK per apartment or 3 million SEK per project). In addition subsidies can be received for changing old oil-fired burners or electricity powered ones to more energy efficient heating systems. The Swedish Energy Agency has since 2006 through different programmes supported demonstration projects that can be used as an example for building energy efficient buildings and have a great mainstreaming potential. A recent program LÅGAN www.laganbygg.se for buildings with very low energy use was started in 2010 to:

- encourage energy efficient new construction and renovation
- highlight a national market for buildings with low energy consumption
- contribute to a broad range of national suppliers of products and services, and ensure clients of such

LÅGAN provides grants for demonstration projects and regional / local cooperation initiatives. It also focuses on providing support to the development of ideas by evaluating and disseminating information from the demonstration projects.

One example of a regional incentive for low-energy buildings can be found in the municipality of Östersund, in northern Sweden. The municipality has decided to support very low-energy houses with a financial incentive. If a house, within the municipality, is built in compliance with the Swedish Passive House definition the fees for building permit, building licence, town plan map and, if applicable, private sewer system will be refunded.

The Environmental Building Program South, developed by Malmö and neighbouring authorities, is a tool for speeding up the transition of the construction sector. Developers who want to build on municipal land have to follow the standards set up in the program. The program is included in the agreements signed between the parties in connection with land or other types of contracts.

The program is focusing on four core areas for ecologically sustainable construction: Energy, indoor environment - health and comfort, moisture protection and urban biodiversity.

6.1.5 Environmental labelling and certification programs

In Sweden, a number of different environmental labelling systems for buildings are used. The most common used are Miljöbyggnad (Eng. Environmental Building), BREEAM and LEED. During 2011 the market and interest for environmental classification and labelling systems for buildings and city neighbourhoods have increased tremendously. The different systems vary in scope and aspects that are considered to be important for securing good environmental performance. Building's energy performance is considered in all schemes, but the ambitions vary.

The Swedish environmental labelling system Miljöbyggnad is a certification system based on the Swedish building code, government regulations, and building practices. It is relatively simple and cost effective to use, yet efficient in advancing environmentally sustainable buildings, including buildings with low energy use.

Miljöbyggnad considers important qualities of a building to be energy, indoor environment, and materials. Miljöbyggnad is used for both new constructions and existing buildings regardless of size. The requirements regarding energy use in Miljöbyggnad are not as stringent as in the performance specifications issued by FEBY.

BREEAM and LEED provide certification schemes for design, construction and operation of high performance green buildings, homes and neighbourhoods. These international systems are two of the most comprehensive measures for assessing the building´s environmental performance and are widely used.

During the last few years interest in classification and certification systems for city areas and neighborhoods has increased. In Sweden, several projects have been initiated with the aim to classify and certify the areas as BREEAM Community or LEED Neighborhood. In order to be able to certify a city area with the BREEAM Community classification scheme all buildings built in the area should be classified and certified by building classifications systems BREEAM, LEED, or Code for Sustainable Homes. Besides having high goals for environmental performance, energy performance is also an important aspect.

6.2 Proposal for market uptake measures

6.2.1 Future building codes

The current building code was recently updated, in January of 2012. At present it is unknown when the next update will be made. As an advice in the current building code it stated that a low energy building is a building with an energy use of maximum 75 % of the building code requirement, and for a very low energy building the maximum energy use is 50 % of the building code requirement.

6.2.2 Complementary initiatives to legislation

In order to reach the EU 2020 target, market changes are also needed, not only legislative actions. The development can be attained by, for example, financial incentives, enhanced education and better dissemination of information.

Financial incentives

In order to fulfil the objectives of the Energy Performance of Buildings Directive (EPBD) it is important to strengthen the market for very low-energy buildings, e.g. by providing financial incentives. A suggestion is a reduction of the value-added tax (VAT) for building contractors that invest in very low-energy buildings. When the financial support is initiated the VAT reduction should be 50%, after that the reduction will stepwise be set to lower percentages. The state will most likely be compensated for the VAT reduction when the number of very low-energy building projects increase. This suggestion is based on a debate article where some of Sweden’s energy efficiency experts propose a reduction of the VAT by 50% for energy efficient renovations [Eek].

Education and training

Information on products and guidelines for the construction of low energy buildings are needed for consultants, architects, contractors and construction workers. An on-going EU-

project aims at increasing the number of highly-qualified on-site 'blue collar' workers through further education/training to increase their skills in building nearly zero energy building using renewable energy and low energy renovations of buildings: www.buildupskills.se

Spreading, collecting, obtaining information

An important activity is to demonstrate the feasibility of low energy buildings. This is preferably done by publishing a range of impartially and thoroughly evaluated successful demonstration projects. A contributor is the LÅGAN-project (see 6.1.4). The Swedish Energy Agency suggests establishing 500 demonstration projects of buildings, defined as nearly zero energy buildings by 2015, aiming to create and disseminate new knowledge and cheaper technology:

- 100 new premises
- 100 new apartment buildings
- 100 new single-family houses
- 100 renovated premises
- 100 renovated apartment buildings

Promoting life cycle perspective

There are several assessment tools that can provide useful information for building projects, e.g., Life Cycle Assessments and Life Cycle Costs assessments. Studies show that low-energy buildings have lower environmental impacts than conventional buildings [IVL]. It is important to promote life cycle thinking both when it comes to economic and environmental aspects.

Today there is a lack of methods that in an objective way assess energy use in terms of sustainability. Recently a new method has been developed called Energy Resource Index (ERI) that is based on the method Life Cycle Assessment (LCA). By using the method it is possible to consider different energy sources properties in terms of endurance and availability.

Energy Resource Index takes into account if the energy is renewable, which primary energy factors and calculated primary energy use do not. ERI therefore has the strength to be an important method to assess energy use in terms of sustainability and the method is a complement to other ecological aspects of sustainability such as climate change, acidification, eutrophication, and more.

One-stop-shop

Experiences from the Eracobild project "One Stop Shop" (*From demonstration projects towards volume market: innovations for one stop shop in sustainable renovation***)** can be used to facilitate the process of building low energy single family buildings. The project has the aim to create an "ideal" web model as a tool for steering decisions to implement thorough renovation of single family houses. The web model will be designed to be a meeting place for consumers (house owners), professionals (architects, energy specialists, engineers, etc), and suppliers of components and products, supporting innovation in thorough, integrated energy renovation [Mlecnik]. The web model will allow regional adjustments depending on the climate conditions, and professionals and products available. The same apporach can be applied in new construction where a unique web-portal can easily guide the consumer in choosing the housing producer of low energy buildings, component producers and suppliers, and professionals specialized in low energy buildings for different parts of Sweden.

6.2.3 Targets and timeline for market uptake measures

The Swedish Energy Agency suggests that 25 % of the new construction should meet the energy target of half the energy use compared with the current building code by year 2015. For renovation 50 % of the renovated buildings should use 30 % less energy than the current building code by year 2015.

7 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN FINLAND

7.1 Current situation

7.1.1 Current building codes

Since 2008, according to the Energy Performance of Buildings Directive (EPDB), all new buildings are required to have an energy performance certificate (EPC) and since 2009 the certificate is also required when selling or renting a building [Finlex]. The energy performance certificate refers to total energy use in buildings in 10 different building categories (e.g. single-family houses, blocks of flats, office buildings, hospitals.) A given maximum of total energy consumption is given as an ET-number depending on the building type. The EPC will be renewed according to new building code requirements for new buildings in the future.

The present Finnish Building Code part D3 Energy-Efficiency came into force 2010. The code bases on the following requirements [Ympäristöministeriö]:

- Specific heat loss (reference building method)
- Specific power demand of ventilation system
- Heat demand
- Room temperature in summer and cooling demand
- Energy performance certificate

7.1.2 Building standard definitions

The building code 2010 defines a low-energy building by specific heath loss compared to a reference building. In a low-energy building, specific heat loss should not exceed 85% of the level of heath loss of the reference. The reference building is defined according to requirements on U-values, ventilation heat recovery, airtightness of the building envelope, and total window area. A low-energy single family house is expected to consume no more than 30–50 kWh/brm² per year for space heating in the climate of Jyväskylä.

There is no official definition for a very low energy or a passive house. According to the definition by VTT, the space heating demand of a very low energy house or a passive house is 20 kWh/brm² per year in Southern Finland and 30 kWh/brm² per year in Northern Finland.

7.1.3 Market share

The interest in energy efficient buildings is increasing, and the number of low-energy and very low-energy houses is growing. Several pilot projects have illustrated the benefits of low-energy house construction. By an estimate provided by real estate experts, the share of low-energy houses in 2011 was approximately 30% and the share of very low-energy buildings 7% of newly built residential buildings. The number of low-energy construction is high (40%) in single-family buildings but fairly low (15%) in blocks of flats.

7.1.4 Incentives

The state supports energy efficiency improvements, low-CO_2 investments and the use of renewables in residential buildings by several means. It offers subsidies for housing companies for the renovation of buildings and subsidies for low-income households covering

25% of the material costs of an energy efficiency renovation project. It also offers a tax deduction possibility for households which are purchasing services and supports the costs when a household installs renewable energy sources. The Ministry of Environment has also launched an information campaign in 2008 in order to inform the general public, professionals and other interest groups about the energy certificate. Information is mainly provided through a web portal available on the website of the Ministry of the Environment but also through a helpdesk service centre maintained by Motiva [Maldonando].

7.2 Proposal for market uptake measures

7.2.1 Future building codes

New building code on energy efficiency in buildings will come into effect in July 2012 [Ympäristöministeriö]. The new code sets limits for a building's total energy use. The major change in 2012 concerns the calculation of total energy use in buildings. The total energy use will be defined using energy conversion factors referring to use of natural resources for energy production and supply. The energy conversion factors are:

- Electricity 1,7
- Fossil fuels 1,0
- District heat 0,7
- District cooling 0,4
- Renewable energy sources used in the building 0,5

7.2.2 Complementary initiatives to legislation

In order to reach the EU 2020 target, changes need to be pursued also market-led, not only by legislative actions. The development can be attained by, for example, financial incentives, enhanced education and better dissemination of information.

More funds for refurbishment

Energy refurbishment of buildings may have very high costs, although simple measures such as adjustment of heat distribution system in a block of flats can be very cost efficient. A long term refurbishment plan helps for timing of large refurbishment actions and simultaneous energy measures. Energy requirements for refurbishment are under preparation and they should take effect in 2013. There will probably be new incentives connected to energy refurbishment; however, the level and scope of these incentives have not been published yet. Availability of funding would encourage people to carry out take up more extensive refurbishment measures.

Education and training

Enhanced education is needed for all different actors who are involved with low-energy building production, especially to improve the know-how of the builders. Enhanced education regarding energy-efficiency of buildings is needed in vocational schools, polytechnics, universities as well as in supplementary education. Also facilitators or energy advisors who provide services at an early stage of a construction project could help in promoting energy efficiency [Ahvenniemi & Tuominen].

Spreading, collecting, obtaining information

Inadequate information among different stakeholders, especially house builders, constitutes a remarkable barrier in Finland, as in all countries, and improved processes of spreading information should be introduced. For example, for an individual builder it is difficult to obtain information about the building materials and techniques related to very low energy house construction. To improve this situation, the Finnish Innovation Fund, Sitra, has performed a study in cooperation with other actors from the field, aiming to analyse the possibility of creating an energy advising centre, which would provide objective counselling on the energy efficiency issues. The possibility to obtain information about low-energy construction from a single source will help the decision making [Ahvenniemi & Tuominen].

Increase the popularity of life cycle thinking

Awareness about the true cost benefits received from energy efficient buildings is still on a fairly low level. Life-cycle costs are not appreciated enough by stakeholders because they do not fully translate to the added-value. Therefore the appreciation of life cycle thinking should be promoted and more value should be given to long term costs and benefits [Ahvenniemi & Tuominen].

7.2.3 Targets and timeline for market uptake measures

The step-by-step renewal of the Finnish building code aims at fulfilling the EU 2020 targets. The energy efficiency requirements will probably be revised at least once after 2012. At the same time, the share of renewables in energy supply will be increased by 10 % up to 38% of the total supply. In buildings this will increase the use of ground source heating and cooling and use of solar especially in single-family and row houses. A realistic time frame towards very low-energy construction is 5 years. A very low energy building is the basis for nearly zero energy buildings required by the Energy Performance of Buildings Directive.

8 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN ESTONIA

8.1 Current situation

8.1.1 Current building codes

All new buildings and buildings being sold or rented need to have an energy performance certificate. This requirement is derived from the Energy Performance of Buildings Directive of the European Parliament and of the Council. A building is certified by conducting an energy calculation or by assessing the energy use (applies to buildings in use). In the calculation a predefined standard usage and a standard climate data (Estonian test reference year for energy calculations) must be used. [RT I 2002, 47, 297] All the predefined information is set in the code. The energy calculation must include all the following calculations [RT I 2007, 72, 445]:

- Calculation of net energy demand, which includes energy demand for space heating, ventilation heating, domestic water heating and space cooling
- Calculation of summer indoor temperatures
- Calculation of energy demand of technical systems
- An approximate calculation of the heating system
- An approximate calculation of the cooling system
- Calculation of the energy demand of electrical systems

As a result the building's primary energy use is given as the ET (Energia Tõhusus = energy efficiency) number (kWh/m^{2}a).

The energy conversion factors for this certification are:

- Biofuel (e.g. wood): 0,75
- District heating: 0,9
- Liquid fuel (oil and gas): 1,0
- Natural gas: 1,0
- Solid fossil fuel (e.g. coal): 1,0
- Peat briquette: 1,0
- Electricity: 1,5

8.1.2 Building standard definitions

In the current building code buildings are allocated into energy classes according to the ET number. For detached residential buildings the classes are as follows [RTL 2008, 100, 1428]:

Class	**ET**
A	< 120
B	121 - 130
C	131 - 150

D	151 - 190
E	191 - 250
F	251 - 320
G	> 321

At the moment buildings in the energy class A are unofficially referred to as low-energy buildings. There is no further official classification of low-energy or passive house buildings. Voluntarily designers and builders aim to achieve the passive house standard described by the German Passive House Institute.

8.1.3 Market share

Energy efficient buildings are becoming more and more popular in Estonia, however the market share of low-energy buildings is still small. Most people have the assumption that low-energy houses are too expensive and only few designers and builders have the skills and experience to build proper low-energy houses.

It is hard to determine the amount of very low energy buildings, but in the last few years, about 10% of new or renovated single family houses were in the energy class A which means that the ET number or primary energy according to the Estonian building code was equal to or less than 120 kWh/(m^2a) [Väli].

8.1.4 Incentives

There are measures to lighten loan conditions to support implementing energy efficiency solutions.

8.2 Proposal for market uptake measures

Estonian government follows the requirements and targets set by the European Union. This includes increasing energy efficiency and usage of renewable energy sources and decreasing CO_2 emissions.

The government plans to prepare a national definition of nearly zero energy buildings in Estonia.

Estonian government has developed guidelines for 2011–2015 in the field of energy efficiency. There are 4 main goals [Eesti 2020 tegevuskava 2011-2015]:

1. As of 2013, higher demands of energy efficiency for new and renovated buildings must be executed. The government will show a good example by building public buildings as energy efficient as possible.
2. Continuing investments for public and local authorities' buildings to increase energy efficiency.
3. Continuing the investment scheme for apartment houses and improving the measure using experience gained during the first application period.
4. Developing a subsidy scheme for private houses which should include measures for reconstruction and renewable energy solutions.

9 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN LATVIA

9.1 Current situation

9.1.1 Current building codes

The current building codes [LBN 002-01 - thermal characteristics of building envelope] set standards for design and construction, which apply to new buildings and many alterations and renovation of existing buildings. The Latvian building codes indicates that heat losses through the building envelope do not exceed specific level (H_T, W/K). The codes indicated minimum U-values for different construction parts (walls, windows, etc…). Buildings made according to these building codes typically consume between 70 and 120 kWh/m^2 year for space heating.

9.1.2 Standard definitions and labelling

The law on the Energy Performance of Buildings, which entered into force in January 2009, introduced a labelling system for existing buildings, new buildings and buildings undergoing major renovation with a total useful floor area over 1000 m^2. New buildings need to have an energy performance certificate indicating their total energy consumption, existing buildings need to have an energy performance certificate if they are sold or rented. The indicator used in labelling system is the annual specific total energy consumption (kWh/m^2 year), which includes energy for space heating, domestic hot water, air-cooling, ventilation and indoor lighting (lighting is excluded in case of dwelling houses).

In the current legislation there are not official definitions of low-energy and passive house standard for dwellings.

In the industry between the main stakeholders, like for example in the Latvian Passive House Association, often the German definition of passive houses is used.

9.1.3 Market share

At national level there is not a register of low energy and passive houses and monitoring of energy consumption. Estimates indicate that the market for new low energy buildings and passive houses is at a very early stage of development. Currently in Latvia there might be some five new buildings made focusing on very low energy demand [29].

However the interest between the building industry in very low-energy buildings is constantly increasing. Investors in the building sector are more and more asking for higher requirements with respect to energy efficiency. This is as well as a consequence of higher requirements expressed by potential customers.

9.1.4 Incentives

Energy efficiency in buildings is one of the priorities in Latvian energy policy therefore there is support from municipal and national government. Starting in 2009, EU structural funds and funds from CO_2 emission trading schemes (Green Investment Scheme) are providing very

significant financial support for investments of existing multifamily residential buildings. The support is up to 50% of the upfront investment in energy efficiency improvement measures. The main objective of this support is to lower building specific heat energy demand from an average of 215kWk/m^2 year to less than 150kWh/m^2 year.

Specific long term incentives for low energy buildings and passive houses have not been designed. The only programme was proposed by the Latvian Ministry of Environment and Regional Development under the Climate Change Instrument programme. The programme supported between 55% and 80% of the additional investment needed to reach low energy building standards. The programme indicates three categories of low energy buildings: under 15 kWh/m^2 year, from 15 to 25 kWh/m^2 year, from 25 to 35 kWh/m^2 year.

A number of Research and development projects have been supported by the Climate Change Instrument programme. Some of this project addressed the development of components for low energy buildings.

9.2 Proposal for market uptake measures

The vast majority of existing multi-family buildings in Latvia have not undergone any major energy conservation improvements and have the same energy infrastructure as when they were built. That was a time when energy was virtually a free commodity within the former Soviet Union.

In Latvia 36% of total final energy consumption goes to heating of residential buildings [30]. Multi-family buildings in Latvia consume 40%-60% more energy than renovated buildings.

Average consumption of heat in buildings in Latvia ranges from 200-230 kWh/m^2 year. Today in countries with similar climate conditions as Latvia, average consumption of heat in buildings is in the range of 110-140 kWh/m^2 year.

With this background in mind, the Latvian government should prioritise and support the implementation of energy efficiency improvement measures in the existing residential building stock, which will host the Latvian population at least for the next generation. In this building stock a number of renovation projects have shown that it is possible to reduce energy consumption to less than 75 kWh/ m^2 year.

However, strategies and programmes for supporting the development of very low energy buildings and passive houses should be implemented with the aim of providing good basis for a future and more sustainable housing market. In this context a revision of the building code for addressing low energy buildings, promotional campaign and training and further demonstration projects are needed.

9.2.1 Future building codes and policy measures

In Latvia the building codes (LBN 002-01) mainly set standards for normative heat losses from the building envelope (W/K) and minimum demand for U-values of components. The codes was developed in 2001 and for example normative U-value for windows were set to 1,8 W/m^2 K, which is far below today state of the art windows. In this way, the building codes do not really support the development of very low-energy buildings. The code should be updated to indicate and classify low energy building and their requirement in term of specific heat energy consumption, thereby clearing the market from misuse of definitions.

The code should be more dynamic in following market development, by tightening the energy requirements in the building regulation.

Policy instruments should be introduced that provide incentives for integrating a Renewable energy sources for heating and cooling (RES H/C) device into the heating/cooling system. But

since RES-H/C applications operate only effectively if they are fitted to the overall system design, the chosen policy instrument should create incentives for a good overall system performance. Hence, it should also support the reduction of a building's energy consumption (e.g. by improving its insulation) and motivate for an efficient use of the RES-H/C equipment.

As far as possible the policy instrument should motivate the utilization of high efficiency equipment, e.g. through linking the financial incentives to quality standards of a determined minimum rate of efficiency.

In parallel to future building codes, policy measure ensuring energy performances should be better developed. For example inspection scheme to target the quality assurance of energy efficiency measures.

9.2.2 Complementary initiatives to legislation

Persuading the actors in the building sector to take steps into low energy buildings is challenging. Specific programmes and measures are needed to create better and proper conditions for energy efficient buildings.

Given the very early stage of development of the market for low energy buildings in Latvia several complementary activities and initiatives should be implemented, such as:

- Provision of information on low energy buildings and passive houses
- Energy efficient investments through financial incentives
- Market based approaches
- Research and development

Provision of information on low energy buildings and passive houses

A major obstacle to energy efficiency in buildings and to market development for low energy buildings is the lack of knowledge and information among stakeholders (households, developers, architects, companies and public authorities). Thus, a core strategy is to effectively provide each target group with information and due training:

- Basic information: to track this problem cross-sectorial information and networking campaigns are needed. The campaign should include basic information and initial advice for public sector and innovative communication approaches following the example of the Austrian "klima:aktiv" campaign or the Irish "Power of One" campaign for all target groups.
- Training courses are needed for professionals in the building sector (consultants, architects, contractors, etc.) to address the lack of competence. In this training the lesson learned from demonstration projects and the state of the art technologies and solutions should be addressed.
- Vocational education and long life training: the implementation of energy efficiency improvement measures in buildings and even more the development of low energy buildings and passive house needs highly qualified work force (from brick layers, to carpenters, electricians, plumbers, etc.). Today in Latvia this work force is lacking. Programmes in vocational schools and long life training programmes should be further developed and adapted to track the very dynamic changes of the industry. An on-going EU-project aims at increasing the number of highly-qualified on-site blue collar workers through further education/training to increase their skills [31].

Energy efficient investments through financial incentives

Demonstration projects are important laboratories for developing new markets. These buildings can be used as example for replication and for testing new technologies. In Latvia the number of pilot buildings is very limited and not well documented with respect to energy performance, indoor climate and user satisfaction.

Support for more demonstration buildings should be budgeted and experiences should be collected regarding planning and design strategies. However, these demonstration projects should, as much as possible, be replicable and therefore implemented keeping economic and financial due diligence in mind. For this reason the spectrum of financial incentives should be based on soft loan or tax reduction.

The incentive should aim at reducing the additional costs for low energy buildings compared to standard investments.

However, in absolute terms, financial incentive should be prioritised for energy efficiency measures in the existing building stock and not for the construction of new low energy buildings.

Market based approaches

The Energy Services Directive calls for an important role of energy service companies (ESCOs) in achieving energy savings. In Latvia the ESCO model is currently used for renovation of multifamily buildings. The projects implemented by ESCO have achieved the best energy savings and most of all the best value for money (kWh saved per Euro invested).

Through the use of ESCO, low energy buildings could be further supported in the renovation process of the current building stock for residential buildings. In particular for large buildings made in series with today's technologies and the right support, ESCO could economically lower energy consumption below 60 kWh/m^2 year.

Research and development

The big energy saving potential of the Latvian building sector and the potential need of new housing is an outstanding window of opportunities for research and development programmes addressing low energy buildings. The programmes need to address and test the development of building envelope components, new ventilation systems and strategies, renewable energy systems and integrated building design options. A national research and development agenda for low energy buildings should be clearly formulated and financed including for example:

- Integrated performance based building design, construction and operation
- Low energy buildings and nearly zero energy building technologies, materials and strategies
- Material utilisation and LCA
- Occupant health
- Monitoring, verification procedures, analysis and dissemination of research results

9.2.3 Targets and timeline for market uptake measures

In short term (five years) Latvia should focus on measures targeting the provision of information on low energy buildings and passive houses. In the meantime a review of the building codes should be undertaken to include and set definitions for clearing the market and being in line with the transposition of the Directive on Energy Performance of Buildings. A stepwise tightening of the Building Codes should be agreed in short terms. In this period a

limited number of demonstration projects should be financially supported to prove the market about technologies and solutions.

In midterms (ten years) regulation on low energy buildings and nearly zero energy buildings should become a requirement.

10 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN LITHUANIA

10.1 Current situation

10.1.1 Current building codes

The main provisions regarding the energy performance of buildings and the certification are described in 'The Law Amending the Law on Construction' and 'The Law on Energy'. The energy performance requirements are described in the 'Building Technical Regulation STR 2.01.09:2005' and came into force on 4 January 2006. The energy performance class may not be:

- Lower than C for new buildings
- Lower than D for existing buildings with a floor area exceeding 1000 m² after renovation

The requirements are not obligatory for buildings for sale or rent, but an evaluation procedure is mandatory as of 1 January 2009.

Certification requirements for new buildings came into force on 1 January 2007. Certification requirements for existing buildings and refurbished existing buildings entered into force as of 1 January 2009.

Other building regulations regarding energy requirements: STR 2.01.03:2003 'Declared and Design Values of Thermal Technical Variables of Construction Materials and Products'; LST EN ISO 6946:2000 'Construction Components and Elements. Thermal Resistance and Thermal Transmittance. Method for Calculation (ISO 6946:1996)'; LST EN ISO 6946:2000/A1:2003 'Construction Components and Elements. Thermal Resistance and Thermal Transmittance. Method for Calculation (ISO 6946:1996/Amd. 1:2003)'; LST EN ISO 13370:2000 'Thermal Characteristics of Buildings. Thermal Transmittance by Soil. Methods for Calculation (ISO 13370:1998)'; Lithuanian Hygiene Standard on Microclimate in Residential and Public Buildings – HN 42:2009; Technical Regulation on Heating, Ventilation and Air Conditioning – STR 2.09.02:2005 [RICS; Energy Performance ...].

10.1.2 Building standard definitions

There is no official, national definition for low or very low energy buildings. There are unofficial definitions applied voluntarily. Lithuanian construction industry researchers and practitioners have agreed that a passive house (nonofficial passive house standards) is a building which meets the following requirements:

- The aggregate annual energy demand for heating and ventilation cannot exceed 15 kWh/m²
- The annual energy consumption for water heating, indoor air heating and ventilation cannot exceed 50 kWh/m²
- Air permeability coefficient $n_{50} \leq 0.6$ (at a pressure of 50 Pa, the loss of air in the premises does not exceed 0.6 of the total volume)
- The total annual energy consumption cannot exceed 120 kWh/ m²

10.1.3 Market share

The interest in energy efficient buildings is increasing and number of low-energy and very low-energy houses is growing. There is no national register and information of low energy and passive houses. Several pilot projects have illustrated the benefits of low-energy house construction.

10.1.4 Incentives

The National Energy Efficiency Programme for 2006–2010 is an inter-institutional program providing for organisational, legal, economic, and technological improvement and introduction, applied research, public education and awareness raising measures, aimed at increasing the efficient use of energy resources and energy. The Ministry of Environment prepared the Modernisation of Multifamily Buildings Program, using the JESSICA financial instrument. The energy efficiency measures supported by the State are: Modernisation of heating and hot water systems; replacement of windows and exterior doors; insulation of roofs; insulation of external walls; glazing of balconies; and installation of alternative energy sources (sun, wind, etc.) [NEEP; Program for the Modernisation ...].

The package of Financial Incentives of the Modernisation Program comprises of two elements: (i) reimbursement of 50% of the expenses for the planning of a Renovation Project and the technical supervision of the construction, achieving an energy efficiency level of at least "D"; and (ii) reimbursement of 15% of the investment for the measures that increase energy efficiency, as defined by the investment plan, in accordance with the Program for Renovation, achieving an energy efficiency level of at least "C" (the heating energy input is 80–115 kwh/m2/year). The latter is an incentive designed to encourage potential investors to go beyond the minimum loan qualification threshold of "D". Furthermore, according to the Law on Support for housing, the annual fixed interest rate on modernisation Loans granted to the Final Beneficiaries will not exceed 3% for the whole period until the Modernisation Loan is paid back. The state will compensate 100% of investment expenses for low-income households [EPBD in Lithuania].

The Lithuanian media fail to deliver sufficient information to stimulate interest in passive houses and to motivate professionals and decision makers.

10.2 Proposal for market uptake measures

Reduction of the energy demand in Lithuanian building life cycle is necessary. Different aspects (energy use, comfort, micro-climate, quality of life, technical, economic, legal/regulatory, educational, training, innovative, social, cultural, ethical, psychological, emotional and ethnic) should be analyzed by all interested parties in an integrated manner during the life time of a passive house in order to reduce the energy demand in buildings. According to the architect, an integrated assessment of the building and its systems in their entirety was of utmost importance, when designing and constructing the first Lithuanian passive house.

Administrative and public procurement procedures are too slow. In particular the process of obtaining decisions, permits, certificates and such from public authorities is too time-consuming causing it to be too slow for the commencement of large-scale public projects.

10.2.1 Future building codes

At present, Lithuania has started revising The Law on Construction and The Law on Energy, as well as a number of building technical regulations, in line with the requirements of the recast of the EPBD. At the end of 2012 all legal acts will be in place. The main aim is the

transposition of the requirements of the recast of the EPBD and the creation of a control system with predefined penalties [EPBD in Lithuania].

The requirement that all new buildings must be nearly zero energy buildings by 2020, and buildings occupied by public authorities by 2018, sets a difficult task for the Lithuanian industry and builders to construct such buildings. Approaching "near-zero energy buildings" means an even greater challenge for builders than what expected until now.

On the one hand, in order to achieve real energy savings in the building sector, significant incentives in relation to the improvement of existing buildings are needed and certification can play a fundamental role. The recommendations made by the experts in the certificate are important guidelines that the building owner can make good use of, either in the context of a renovation, or as an individual cost-effective measure. Financial concerns about the investment cost of using energy efficient technologies are a major barrier, though. On the other hand, additional training should be offered for qualified experts, in order to improve their skills in performing energy audits and regarding the best economic and technological building improvement solutions. The National Energy Efficiency Program for 2011–2016 already under execution.

It is foreseen to set a Regulation for the Lithuanian "passive" house. The practice of designing and constructing the first Lithuanian passive house was of major significance and helped in preparing this Regulation. The experience acquired until now will certainly be of great help in meeting these challenges and reaching the final goal of net zero energy new buildings by 2020 [EPBD in Lithuania].

10.2.2 Complementary initiatives to legislation

As legislation alone cannot achieve the full energy saving potential in building industry life cycle, other integrated initiatives also should be implemented.

Funding possibilities / financial incentives (also see 10.1.4 Incentives)

There are too *few financials incentives* (calls for projects, subsidies, energy labels and such) for developing lifelong learning about passive houses (web portal, seminars and workshops, technical publications presenting the codes, case studies). The *price* of equipment (e.g., recuperators) and structural solutions (e.g., windows) is quite high considering the salaries and the amount of energy saved. Savings, in relation to investments, are low. There are no land *tax* reductions, and land is not sold at a lower price for the construction of passive houses. The plot ratio is not higher in case of passive construction. Fees are not designed to reward designers and architects of passive houses that have low maintenance and low lifecycle costs. There are no available *subsidies* for research development on the energy consumption and on the most rational energy sources to be used for a passive house under consideration. The *VAT* level is too high on an entire list of equipment types that can increase energy efficiency in the domestic sector (efficient boilers, insulation and energy meters and such). There are no tax credit schemes in place to provide real estate owners who purchase energy saving or energy renewing equipment with an income tax refund. Furthermore there are no specific loans in place that would grant interest rate reductions in whole or in part. Banks are not accustomed to funding energy savings when issuing loans for a specific passive house. Stakeholders only agree on one key aspect. The cases of other countries teach a lesson – *only the state can put in motion the construction of energy efficient and environment-friendly houses.* In these countries the range of incentives is huge, from tax benefits to easy credit terms or even a substantial discount for fuels for a certain period.

Guidelines

Design support and guidelines for very low-energy buildings should be further elaborated. Concepts should be developed for different geographical locations and cultural contexts.

Development of components

Research and development topics, that need to be addressed, are development of envelope components, ventilation systems and energy supply systems based on renewable energy sources.

Pilot buildings

There is a shortage of feedback from previously known explicit and tacit information and from new low energy houses. There is a belief that building low energy houses is more expensive than the usual construction. Thus on-site problems can't always be solved.

The first action towards Energy savings in the housing sector dates from 1996. More than 1,100 homeowners associations participated in the project and over 650 investment proposals were prepared. More than 580 loan agreements were signed. Over 500 Homeowners associations implemented renovation projects, with investments exceeding LTL 60 million (17.4 M€), in the context of the Energy Efficiency Housing Pilot project [EEHP]. Data on 100 multi-apartment buildings were collected after the renovation: average comfort adjusted savings of 24%; the average simple payback period for 100 monitored buildings amounted to 10.5 years; over 60% of 250 surveyed households indicated that loan repayment represents an insignificant or negligible burden on their families' budgets [EPBD in Lithuania].

During the design and planning of technical solutions phase of the construction of the new generation house, it was calculated that the energy consumption of the Lithuanian passive house would not exceed 15 kWh/m^2 year. However, even better energy efficiency is now expected than what originally planned. The Lithuanian passive houses are quite simple, of minimalist architecture, with large south-oriented windows. A considerable amount of solar energy can enter the house through the windows, during the cold period of the year. During hot summer months, to avoid overheating, the owners of passive houses can install blinds, canopies, or pergolas with climbing plants over floor-to-ceiling windows.

Education and training

The main barriers are as follows:

- A tenants´ association does not always have the necessary competence. Real estate management organizations are often uninvolved. Too many prejudices from the energy saving measures from the eighties exist. Workmanship for thermal insulation has too low a status. Workers can be prejudiced regarding new methods. There are too few contractors, developers and property managers who are indoor climate and energy experts.
- The passive house and low energy design theory is not sufficiently introduced in Lithuanian bachelor and master degree study programs.
- Users lack knowledge to be able to assess the pluses of a low energy passive house (comfort, low noise, economic efficiency). As a result, the low energy, passive house remains unknown and demand fails to grow.
- Scientists lack knowledge about the needs of users and contractors. Therefore it becomes complicated for architects, designers and contractors to stay up-to-date about new energy saving products, materials and systems.

- Education faces a fragmentation problem. Each player (owner, user, developer, architect, designer, consultant, contractor, manufacturer, user, real estate and facilities manager) generally has highly narrow knowledge in his/her own field alone.

10.2.3 Targets and timeline for market uptake measures

At present, Lithuania has started revising The Law on Construction and The Law on Energy, as well as a number of building technical regulations, in line with the requirements of the recast of the EPBD. At the end of 2012 all legal acts will be in place. The main aim is the transposition of the requirements of the recast of the EPBD and the creation of a control system with predefined penalties [EPBD in Lithuania].

11 VERY LOW-ENERGY RESIDENTIAL BUILDINGS IN POLAND

11.1 Current situation

11.1.1 Current building codes

Polish regulations make provision for two alternative ways of fulfilling energy requirements. The first method is prescriptive and consists of a list of detailed requirements for different building components. The second method has a performance character and defines permissible values of specific non-renewable primary energy use (EP), expressed in kWh/(m²year). The second method offers more freedom for designers. For instance, lower quality thermal insulation can be compensated with better systems or utilization of a more environmentally friendly source of energy.

Both methods allow for lower quality energy performance of modernized buildings, in comparison to new buildings identical in form and use. In the first method, the mean heat transfer coefficient for the whole building envelope can be 15 % higher than in the new building. In the second method, modernized buildings can also have a 15% higher primary energy use.

11.1.2 Building standard definitions

There is no official, national definition for low or very low energy buildings. There are unofficial definitions applied voluntarily, e.g. low-energy or passive standard. A low-energy building is expected to consume no more than 70 kWh/m² per annum net energy for heating. There are no other requirements concerning delivered or primary energy use.

According to the definition of passive standard by PHI, the space heating demand is not higher than 15 kWh/m² per year and primary energy demand is not higher than 120 kWh/m² per annum. Both standards are not depending from localization of building.

11.1.3 Market share

In Poland, an increasing interest in low-energy residential buildings has been observed, which is due to the increase in energy prices, low energy consumption of these buildings, higher expectation of the internal environment, increase of ecological awareness and “trendiness” of sustainable buildings. However, Polish builders mostly do not yet consider energy-efficient construction as a realistic alternative and unfortunately there have so far been no government programs promoting the construction of energy-efficient buildings.

The number of low-energy dwellings in Poland is difficult to estimate but it can be assumed that for single-family and detached houses from 2 to 5% are energy efficient buildings, and of terraced and multi-family houses the amount is less than 2%. According to survey [Ahvenniemi] experts believe that in the foreseeable future the construction of energy efficient buildings will increase moderately. The additional cost of building low-energy house ranges is from 10 to 15% and it can be up to 35% in the case of a passive house.

11.1.4 Incentives

State policy does not lead to increase of energy efficiency in buildings or encouraged to save energy. There are no programs of promoting low energy buildings, subsidies or preferential credits. The government is not interested in developing this kind of market or raising the awareness of the people. This happens although membership in EU and international

obligations. In some situation there are subsidies for covering high heating cost instead of subsidies for modernization of the building. But from the other hand there is special thermo renovation fund for people and institutions who want to renovate their buildings. The minimum energy saving is 25 % and the maximum subsidy is 16 % of the investment cost. Unfortunately there are no higher subsidies for renovation to very low energy standard.

The second problem is that the system of energy certification does not work properly and have almost no influence on building market. Since there is no energy classes (most of the EU countries have them) it is very difficult to find if the building uses a lot of energy or a little energy. The energy certificate is not being verified and can be made by a person which was included in building process. In the result there is no relation between result visible on the certificate and the price of the real estate.

11.2 Proposal for market uptake measures

Without a doubt reducing of the energy demand in Polish buildings is necessary. This process requires the implementation of integrated programs for all participants in the building sector. It is not enough to tighten the requirements, awareness campaigns and training are needed in order to convince to very low-energy buildings. The strategy of justifying all the new requirements with the European Union with absence of any incentives will not be successful.

11.2.1 Future building codes

According to knowledge from January 2012 there are no official works on new building requirements regarding energy efficiency in Ministry of Infrastructure. There are also no national or official definitions of low or very low energy buildings.

11.2.2 Complementary initiatives to legislation

In order to promote very low energy buildings changes need to be pursued not only in legislative actions but also on the market. The following initiatives should be implemented:

- Funding possibilities/ financial incentives
- Focus should be on the refurbishment of old buildings to very low energy standard
- Cheaper solutions for very low energy buildings
- More model buildings

Funding possibilities/ financial incentives

In order to promote low-energy houses, not only changes in legislation are needed, but also creating better mechanisms to support low-energy construction is highly important. The state could have an important role here as it could provide financial incentives (such as tax relief and subsidies for the construction costs) for private builders or larger developers. Funding possibilities should also be offered to people who incorporate energy efficiency improvements when renovating a building.

Refurbishment of old buildings to very low energy standard

The old building stock holds a large potential for energy efficiency improvements. Because these buildings are in poor condition and are in need for renovation, improvements in energy efficiency should be incorporated in the refurbishment process. There is special thermo renovation fund for private and public owners who want to renovate their buildings. The minimum energy saving is 25 % and the maximum subsidy is 16 % of the investment cost. Unfortunately there are no higher subsidies for renovation to very low energy standard. In the

case of obtaining energy savings of more than 70% the subsidy could be 20% of the investment cost. In existing system the subsidy is decreasing with increase of energy savings.

Cheaper solutions for very low energy buildings

Even if an increasing interest in low-energy construction can be observed among house buyers, it is evident that an increase in demand will not take place before the prices of very low-energy houses have come down. Cheaper solutions need to be created soon. Single products which are required for low-energy construction already exist in the market but also comprehensive low-energy building concepts need to be developed.

More model buildings

The passive house example built by Lipincy Domy was a success and received attention across a large public. More similar examples are highly needed to illustrate the benefits of very low-energy construction and also to disseminate information and increase the interest of people. For example a housing fair (as in Finland) could provide a fine marketing channel for low-energy houses as the buildings would receive broad visibility. In Poland, the state has so far done only very little to promote low-energy construction but as the example of Lipincy Domy shows, the promotion can also take place through actions by private companies and state support might not necessarily be needed.

11.2.3 Targets and timeline for market uptake measures

According to knowledge from January 2012 there are no official works on new building requirements regarding energy efficiency in Ministry of Infrastructure. So officially Poland is doing nothing to fulfilling the EU 2020 targets, there is no road map, targets or market analysis. There are only some rapports made by NGO or experts. One of the reports [Szczechowiak] suggests how we should reach nearly zero energy building standard required by the Energy Performance of Buildings Directive. The proposed requirements and the time of their introduction are presented in Table 1. Unfortunately the suggested solutions are not the best because they are copying the errors which are made in existing regulations. One is that Polish regulations make provision for two alternative ways of fulfilling energy requirements. Second is that the minimum energy performance requirements are not calculated in accordance with the Directive regarding cost-optimal level but only authors' proposition based on literature study.

Table 1. Suggested changes in energy performance requirements and nearly zero energy buildings standard in Poland [Szczechowiak]

No	Element	Building code 2008	Building code 2012	Building code 2016	Building code 2020
1	external wall U-value, W/m^2K	0,30	0,25	0,20	0,15
2	roof U-value, W/m^2K	0,25	0,20	0,15	0,11
3	slab on ground U-value, W/m^2K	0,45	0,35	0,25	0,20
4	windows U-value, W/m^2K	1,8	1,3	1,3	0,9
5	n_{50}, 1/h	3,0	3,0	1,5	1,0/0,6
6	ventilation system	natural	hybrid	mechanical, heat recovery 60%	mechanical, heat recovery 70%
7	primary energy demand for heating, ventilation and DHW, kWh/m^2a	145 - 100	103 - 75	72 - 50	50 - 10

12 CONCLUDING REMARKS

The EU has committed to reducing greenhouse gas emissions to 80–95% below 1990 levels by 2050 in the context of necessary reductions by developed countries as a group. This commitment will require a revolution in energy systems. The Energy Roadmap 2050, providing the framework for the longer term action in the energy sectors, is part of the Resource Efficiency Flagship of the Europe 2020 strategy [EC COM 885/2].

Energy efficiency in the building sector is found to be very valuable in reducing the cost of decarbonisation. Necessary steps towards a successful implementation of the nearly Zero-Energy Building level by 2020, as described in the recast of the Energy Performance of Building Directive, will vary within the countries participating in the NorthPass project; involving technological, financial and policy implications in various degrees. The national roadmaps presented in this report include a number of aspects that are required to get on track to reduce energy consumption in new dwellings, pointing at regulatory push, incentives, information and training to overcome implementation challenges.

The social dimension of the energy roadmap is important in all countries. The transition to very low-energy houses will affect employment and jobs, requiring education and training and a more vigorous social dialogue. In order to efficiently manage change, involvement of all partners in the building sector, at all levels, will be necessary. Mechanisms are needed to help planners and workers confronted with job transitions to develop their know-how and skills.

Technology is an essential part of the solution to the decarbonisation challenge. Renewable heating and cooling are vital. Fuel mixes have to change significantly over time. Establishing energy markets fit for purpose will also require new grid technologies. Technological progress is expected to reduce costs and give economic benefits. All the NorthPass countries emphasise the need for research and demonstration.

Energy system developments in Europe will be driven by the need for energy security, sustainability and competitiveness in a changing global energy context. Reduction in energy consumption and a shift to renewable energy sources may bring along new job opportunities and involve business models like energy services companies and energy performance contracts. The very low-energy house production chain could thus offer additional values.

So far, the Nordic and Baltic countries have looked to Austria, Germany and Switzerland for know-how and technologies regarding very low energy buildings. However, the climate conditions are different, so there are great opportunities for the North European countries for innovation regarding development of building components. More cooperation within the Nordic and Baltic countries to harmonize codes, standards and documentation/certificates would make it easier for companies to adapt and market their products and services across borders [Andresen].

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