Co-funded by the Intelligent Energy Europe Programme of the European Union

Promotion of smart and integrated NZEB renovation measures in the European renovation market (NeZeR)
Contract N°: IEE/13/763/ SI2.674877
01-03-2014 – 28-02-2017

Promoting implementation of Nearly Zero-Energy Building Renovation

Result Oriented Report of IEE NeZeR-project 2014-2017

3.5.2017
VTT

Table of contents

1 EXECUTIVE SUMMARY

This result-oriented report presents the main findings and lessons learnt of IEE NeZeR-project NeZeR project (2014-2017) promoted smart and integrated NZEB renovation measures in the European renovation market. The goal of this report is to guide also other countries to utilize the work done in IEE NeZeR by sharing best practices, results and lessons learned during the project.

Based on the work and results of IEE NeZeR-project, the project group has developed the *NeZeR-concept*. It is a comprehensive and co-creative procedure to promote country-specific implementation of Nearly Zero-Energy Building Renovation (NZEBR).

NeZeR-concept utilizes the NZEBR criteria, developed in NeZeR-project for four European Climatic Zones (North, East, Centre and South). The feasibility of NZEBR over traditional renovation is emphasized by feasibility studies and LCA, LCC and CBA calculations. Also appropriate fiscal incentives for the country are studied. NZEBR city action plans are constructed using the concrete guidelines developed in NeZeR-project. Stakeholder roadmaps include general descriptions of how to achieve mainstream NZEBR and utilization of RES from the perspectives of the different stakeholder groups: barriers, actions, impacts and indicators. Knowledge in the whole building chain with respect to NZEBR concepts is improved through design competitions. The results are disseminated efficiently.

This result report is complimented with the result-oriented video of NeZeR https://youtu.be/MAD7r-UpqGk

2 INTRODUCTION

This result-oriented report presents the main findings and lessons learnt of IEE NeZeR-project (2014-2017). It is aimed to all target groups of NeZeR-project: decision makers and property owners (cities, municipalities, social housing organizations, local building authorities and city politicians), actors in the building industry executing the renovation (architects, engineers, construction companies, maintenance organizations) and producers of technical components and solutions for Nearly Zero-Energy Building Renovation (NZEBR).

Main objectives of IEE NeZeR-project were following:

- To use existing knowledge about energy efficient building for concrete guidelines for NZEBR
- To increase knowledge in the whole building chain and among institutional housing owners of NZEBR concepts
- To increase awareness among all stakeholders (decision makers, building industry, general public) about potential advantages from NZEBR
- To disseminate the results to relevant stakeholders and collaborate with them in order to enable the efficient implementation
- To secure the implementation of NZEBR in the partner cities and beyond

To fulfil these objectives the project has produced following outputs:

- NZEBR criteria, technologies and solutions (component and packaged solution level) for increasing the energy performance of the existing residential buildings;
- Showing the feasibility of NZEBR over traditional renovation measures;
- Action plans and successful business models for the implementation of NZEBR
- National clusters which will secure the impact of the project during and beyond its duration
- Developing high quality NZEBR design concepts from 5 countries through national design competitions

These outputs have been used as a basis for the NeZeR-concept suggested in the conclusions of this report. The NeZeR-concept is meant to transfer the knowledge gained in NeZeR-project for other countries to follow. It is a co-creative concept involving research organizations, consultants and cities, and its long-term impact is secured by national clusters consisting of most relevant stakeholders.

3 SECURING THE LONG-TERM IMPACT WITH NATIONAL CLUSTERS

For ensuring co-creativity and long-term impact of NeZeR-project, national clusters were created in the beginning of the project. The clusters consisted of most relevant stakeholders, Key Players, which were identified with a stakeholder analysis. A stakeholder analysis is a technique that can be used in order to identify stakeholders and their interest in a project or a specific question. The aim of the NeZeR stakeholder analysis was to identify key target groups for NZEBR and deployment of RES on a national level. Representatives from the identified stakeholder organizations were invited to participate in the national NZEBR clusters as well as in tailored educational activities.

For the stakeholder analysis a step-wise assessment was performed:

1. In the first step the stakeholder groups are identified.
2. In the second step the level of power and interest of each stakeholder group for NZEBR and RES is assessed. The rating is made on a scale from 1- 5 (1=very low, 2=low, 3=neither high nor low, 4=high, 5=very high).
3. In the third step the stakeholder groups are divided into four categories: Key Players (KP), Meet Their Needs (MTN), Show Consideration (SC) and Least Important (LI).

Figure 1 presents an exemplary result of the stakeholder analysis. The stakeholder groups identified in all NeZeR partner countries as Key Players were authorities, manufacturers of NZEBR and RES components, networks and interest groups, public building owners and construction companies.

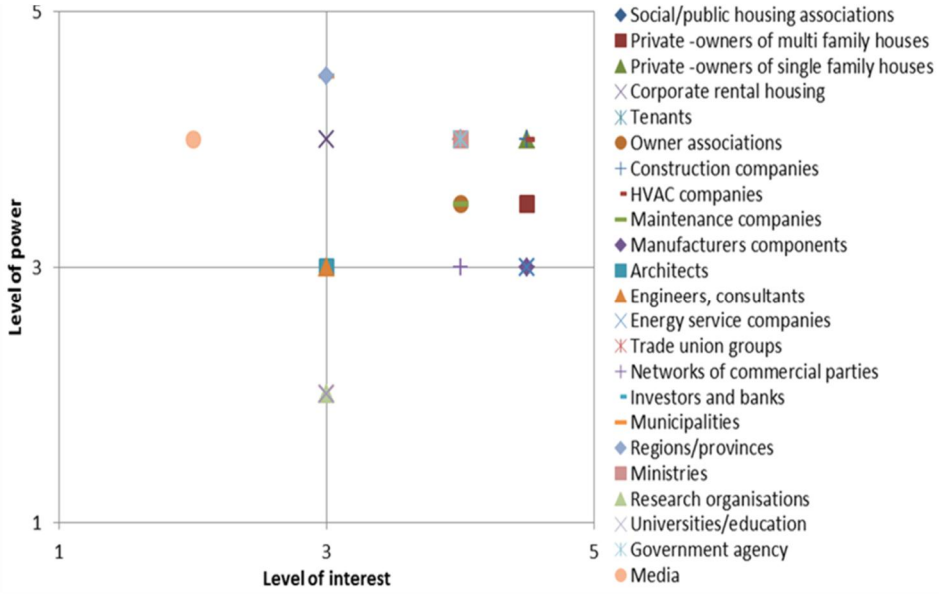

Figure 1. Example of the result of a NeZeR stakeholder analysis

The national clusters, formed based on the stakeholder analysis, reviewed and gave feedback for all central activities of the project including the city action plans and national stakeholder roadmaps. The national clusters also facilitated communication and cooperation between stakeholder groups serving as a platform for exchanging experiences and ideas; the real estate owners might be interested in concrete market solutions (individual solutions and package solutions) and availability of certain components. The component producers may be interested in specification of solutions that are needed for NZEBR. What is the market going to look for

in a few years? What kind of products should be developed? This information can drive innovation and cooperation.

The clusters had regular meetings and workshops including following topics:

- Collecting experiences and lessons learned of existing NZEBR solutions for reducing energy use and utilizing RES
- Discussing financing of NZEBR, relevant business models and existing/necessary fiscal incentives
- Creation of city action plans
- NZEBR and RES roadmaps for stakeholders
- Final results and feedback

4 SHOWING THE FEASIBILITY AND BEST PRACTISES OF NEARLY ZERO-ENERGY BUILDING RENOVATION

The building sector accounts for 40% of the energy use within EU. There is a great potential to reduce energy use and thereby greenhouse gas emissions and to make the building stock future-proof. With a more energy efficient building sector a country becomes less dependent on imported energy. Main reasons for renovating into Nearly Zero-Energy level instead of a traditional renovation are following:

- To significantly reduce the conventional energy consumption and lifecycle greenhouse gas emissions of buildings
- To increase the property value and the life time of the building and to ensure the affordability of the living costs on the long term
- To improve the comfort level

4.1 NZEBR intervention criteria and package solutions

NeZeR developed intervention criteria and packaged solutions for three levels of buildings renovation towards NZEBR in four European Climatic Zones (North, East, Centre and South). Best available NZEBR solutions and renewable energy sources (RES) for reduced energy use were selected resulting into a collection of 46 evaluated templates for technical solutions for energy reduced and renewable energy sources for optimal energy efficient renovation:

- Walls: 10 technical solutions
- Windows and shadow solutions: 10 technical solutions
- Roofs: 5 technical solutions
- HVAC systems: 11 technical solutions
- RES: 10 technical solutions

These solutions are presented in NeZeR report "Technical solutions for optimal energy efficient retrofitting". Package renovation solutions were defined for multifamily buildings built between 1960-1980 in different European climatic zones in NeZeR report "Intervention criteria and packaged solutions for buildings renovation towards a Nearly Zero-Energy Building Renovation". Apart from the differences between countries, the same package solutions can be implemented with some adaptations based on product characteristics, such as the glazing type, insulating material type and thickness. Based on this study there are still some gaps that should be overcome to reach NZEBR effectively, such as implementation of heat recovery ventilation and low temperature heating and availability of sufficient roof area for PV and/or solar thermal energy.

4.2 Analyse and collection of successful real NZEBR cases

Successful real NZEBR cases were analysed and collected in the NeZeR booklet "Success Cases of Near Zero Energy Building Rehabilitation (NZEBR)" with 36 real success cases of NZEBR across Europe from Austria, Bulgaria, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Romania, Spain and Sweden. The aspects included:

- General description
- Technologies
- Barriers

- Process
- Success & failure factors

The booklet is available also in Finnish, Swedish, Dutch, Romanian and Spanish.

4.3 Feasibility of Nearly Zero-Energy Building Renovation

NeZeR case studies compared traditional renovation with Nearly Zero-Energy Building Renovation (NZEBR). The case studies are presented in NeZeR reports "Report on technical and social feasibility studies" and "Report on environmental and economic advantages of NZEBR compared to traditional renovation". The case studies estimated the energy saving potential with a Nearly Zero-Energy Building Renovation around 60% - 90% and with a traditional renovation around 20% - 45% (Figure 2).

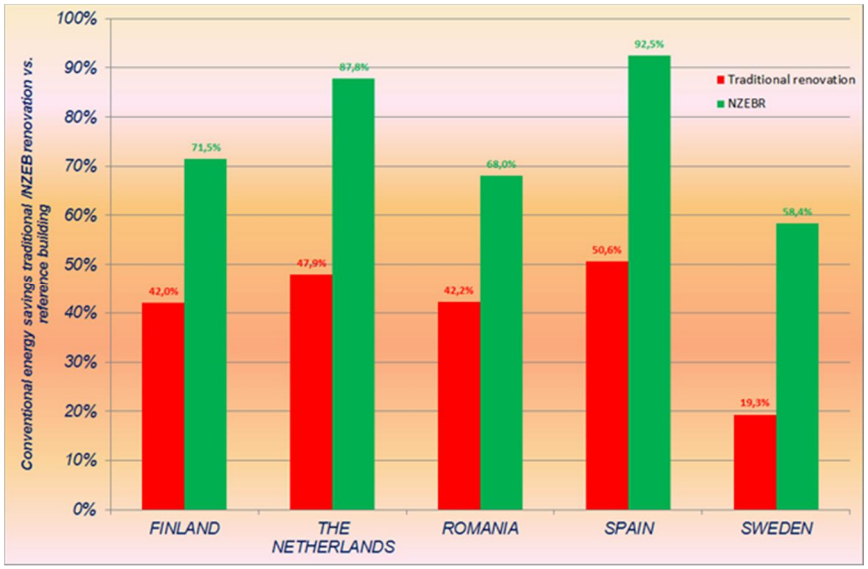

Figure 2. Energy saving potential with a Nearly Zero-Energy Building Renovation

NeZeR case studies estimated the reduction of greenhouse gas emissions with a Nearly Zero-Energy Building Renovation around 60% - 90% and with a traditional renovation around 20% - 50% (Figure 3). According to the case studies the total greenhouse gas emissions (for energy and material) during 30 years of operation are lower after a Nearly Zero-Energy Building Renovation than after a traditional renovation alternative in all partner countries.

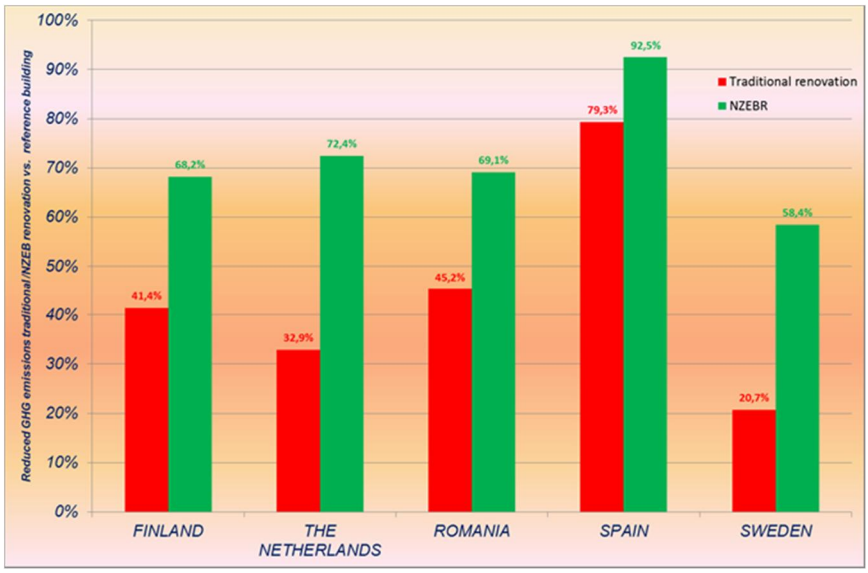

Figure 3. Reduction of greenhouse gas emissions with a Nearly Zero-Energy Building Renovation

Energy-efficient renovation can increase the property value and the life time of the building and ensure the affordability of the living costs on the long term. The renovation can also increase resale and user values through lower energy costs, better indoor climate and higher energy class.

Well insulated and airtight construction, minimized thermal bridges and energy-efficient windows reduce the feeling of draft and temperature variation during the day and year, and external noise from surroundings. A well-functioning ventilation system in the home and the property can reduce heating costs, increase the comfort of living by reducing the risk of odours, cold drafts, damp and mould damage and give a possibility to adjust ventilation rates according to the needs. Improved comfort levels and wider societal and health benefits increase the profitability of Nearly Zero-Energy Building Renovations from a societal perspective.

According to the economic assessment of NeZeR Case Studies, Nearly Zero-Energy Building Renovation is not always economically feasible from the owners' perspective at present price levels for building renovation and household energy consumption. However, there is good potential for cost reductions in NZEBR by technological and process improvements and when a higher market volume is reached. The revaluation of the building also increases economic profitability.

NeZeR report "Proposal of relevant fiscal incentives and other control instruments for supporting NZEBR" presents the current situation of economic incentives in Finland, Sweden, the Netherlands, Romania and Spain to support Nearly Zero-Energy Building Renovation, defines main barriers and proposes new incentives. Main points of the feasibility reports are collected into the booklet "Advantages of Nearly Zero-Energy Building Renovation", which is also available in Finnish, Swedish, Dutch, Romanian and Spanish.

4.4 Business models for Nearly Zero-Energy Building Renovation

An Energy Service Company (ESCO) is a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based wholly or in part on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria. In NeZeR report "Role of ESCO:s in Nearly

Zero Energy Building Renovation" we performed a market overview which shows the similarities and differences between participating countries regarding barriers and success factors for ESCOs on the market. In most of the countries the need for information and training is highlighted as a key factor to push the market development forward.

NeZeR also collected several relevant business models developed and assessed in other EU-funded research projects and analysed their suitability for Nearly Zero-Energy Building Renovation. The business models are presented in NeZeR-report "Successful business models for NZEBR". Deep renovation of privately owned multifamily buildings requires different business model concepts than public buildings. Country specific analyses show how conditions and challenges vary between different countries. For example, the ESCO model has been widely used in Sweden and Spain, whereas it is not very common yet in Finland, the Netherlands and Romania.

5 MAKING CONCRETE ACTIONS WITH CITY ACTION PLANS

5.1 Introduction to city action plans

Major renovations aiming for nearly zero energy performance have not yet had a market break through. How can public authorities and decision makers act as forerunners and facilitate more energy-efficient renovation?

NeZeR-project developed City Action Plans for Nearly Zero-Energy Renovation to foster the implementation of the Energy Performance of Buildings Directive and assist in transforming the existing building stock into more energy-efficient and ecologically sustainable with a reduced energy consumption and increased utilization of renewable energy leading to a reduction of total environmental impacts. The action plans were successfully made for eight European cities with specific targets and strategies for their cities or districts in the cities. The action plan is a good tool for a municipality to work with energy-efficient renovation of the existent buildings in the city. The numerous discussions and experience shared in the project group along the way made the basis for development of general guidelines for action plans.

These city-specific action plans include targets for reduction of energy consumption and CO_2-emissions when renovating buildings and descriptions about how the objectives shall be accomplished. The action plans describe how the process of achieving nearly zero energy renovation measures in existing buildings can be performed and they make a basis to convince politicians and citizens to approve more ambitious energy-efficient renovations. The action plans focus on the long-term transformation of the existing buildings, including measurable targets on energy use and the share of energy from renewable resources. A strong focus lies also on behavioural issues and the participation and cooperation with the inhabitants. The action plans can target all building types including residential, commercial and educational buildings. The target groups of the city action plans are decision makers including city authorities, private housing associations and municipality owned housing companies who work on improving the energy efficiency of the existing building stock.

5.2 Process for creation of a city action plan

The process for creation of the city action plan is divided into five steps: 1) Background, 2) Conditions, 3) Target Group, 4) Objectives and 5) Strategy. The most relevant stakeholders to be assigned in the development workshops are explained in Figure 4 under each step.

Figure 4. City action plan development process

Background: The background analysis is a basis for the development of the action plan. It describes the current situation in the community and main reasons for reducing the energy use in buildings. The background analysis includes descriptions about how the community has already been working with these issues and an investigation about the overall atmosphere in the city: How high or low is the awareness of energy- and environmental issues? What are the current trends in society? How do the decision makers react on questions concerning energy use and environmental issues? Driving forces for the development work are energy poverty (indicator of high energy consumption in combination with a low income), badly maintained buildings, public space that has to be improved. A specific area or building type in need for renovation could also be described here.

Conditions: The next step after the background analysis is to define the conditions for the action plan including e.g. economy, ownership of buildings and different kind of regulations in the city. Definition of the conditions of the economy include showing the profitability of different investments and the preconditions for the profitability calculations. It is also important to recognize that the profitability is not always the most significant incentive for this kind of renovation but instead e.g. the environmental target. The structure of ownership also affects the process of deciding and performing energy efficient measures. In privately owned buildings the focus lies mostly on the cost efficiency of the investments and the other positive effects of lower cost for energy consumption including a better indoor climate and higher “wow-factor”. In social housing, commercial or public owners the focus is more on economic business models where both the real estate owner and the tenants could get benefits of the renovation e.g. through raising the standard of the apartment to motivate a raised rent. It is beneficial to highlight the targets for the decrease of energy use in EU-, national and community level to create a better understanding among politicians, real estate owners and citizens. Other important issues are how energy fares are regulated in the municipality and energy billing issues including if the energy use is paid separately by the tenant or if it is included in the rent.

Target group: It is recommendable to define a clear group of buildings as the target of the action plan. However, the group of buildings can be within a certain area, of a certain age or of a certain type of building. This can be decided based on an invention of the housing stock including the statistics of the housing stock, measured energy consumption data and the need for renovation. Are there certain areas in the city or certain types of buildings that are in a great need for renovation? Other issues influencing the choice of the target group are e.g.

possible demands to decrease the use of certain energy plants running on fossil fuels and demands to improve the social situation in challenging areas with a total renovation.

Objectives: The level of mandate that the community has to set goals for energy efficient renovation decides how powerful the action plan will be. The earlier goals for reduction of energy use and experiences from projects with energy efficient renovation should be analysed to estimate the necessary additional support or funding for energy efficient renovation projects from the city council. Possible earlier good examples should also be highlighted. If there have been no earlier experiences the reasons (barriers) should be investigated such as lack of investment money, insufficient knowledge or the community has prioritized other issues. It may be possible to set goals and enforce real estate owners to perform measures e.g. demanding a specific decrease (%) in energy use when renovating buildings. Other alternative is to describe this specific decrease as a goal and combine it with support actions from the community. Here the proposed European definitions for Nearly Zero Energy Renovation developed within the NeZeR-project can be utilized (Tecnalia 2015).

Also other goals should be set besides energy related targets including objectives concerning social health, better indoor climate and certain areas in the community, which should be developed more harmoniously. A plan for the follow up of the activities should be made in the beginning of the project to ensure that the right parameters are measured. The follow up is used to verify fulfilment of the goals and reasons behind not fulfilling certain goals. Both technical, economic, health and social aspects must be followed up.

Strategy: The final part of the action plan is the strategy for how the goals and activities shall be performed. Here both the general strategy describing the comprehensive goals and also the activities leading to a successful reduction of energy use in buildings are presented. The collected results from all workshops during different steps of the action plan development process make a ground for the strategy. The person or group of persons implementing the strategy must be nominated. It is preferable that they have been already involved with the development work and have been handed over all necessary information including all defined goals, ambitions and results.

The communication plan is one of the most important strategy instruments and the successful communication methods in the specific community must be defined. Communication takes time and e.g. tenants of a building to be renovated must be informed very early so that they can get all the necessary arguments and they have enough time to reflect and make questions to clarify certain aspects. Communication should be differently targeted to different stakeholders. The tenants are mostly interested in parameters such as lower cost, better indoor climate and higher “wow-factor” while the real estate owner is more interested in long-term results and lower maintenance cost. Figure 5 presents an exemplary communication campaign scheme developed by the city of Rotterdam in NeZeR-project.

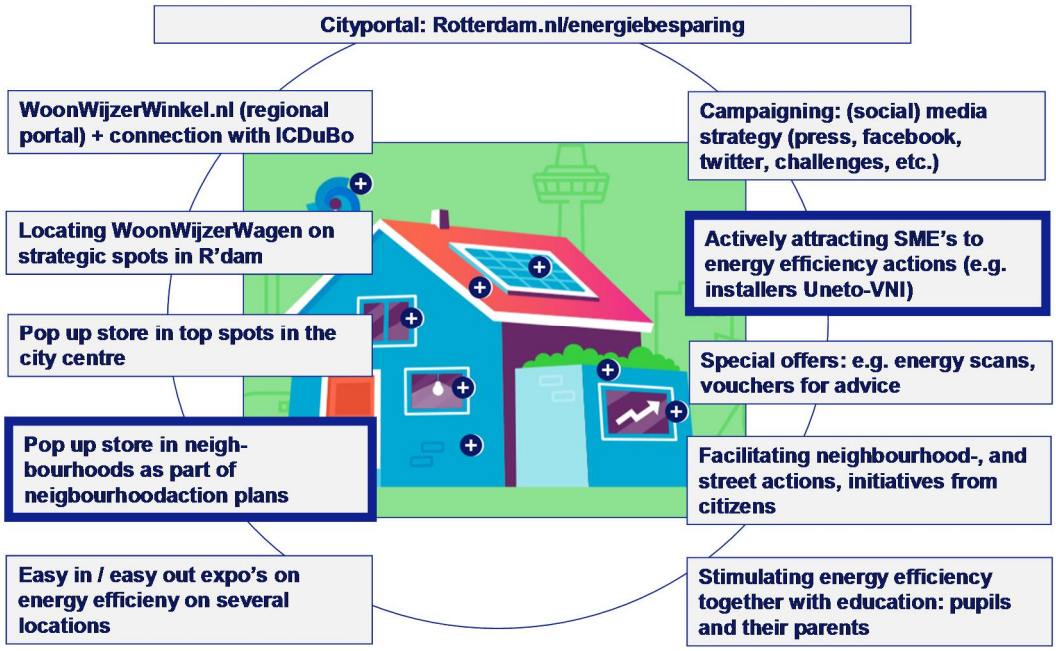

Figure 5. Communication campaign scheme by the city of Rotterdam

All partners must be involved in a renovation project early in the planning process. Here you can utilize e.g. Urban Living Lab methods. Urban Living Labs can be defined as development environments that integrate residents and other stakeholders to develop and test new solutions in their daily life. The users of the new services or solutions are active partners in the whole development process, which happens in the real urban context. Urban Living Labs utilize various co-design methods for understanding the needs, generating solution ideas, presenting ideas and evaluating the solutions in practice. In addition, citizen participation methods are used for participation in decision making and taking action.

The roadmap for implementation of the city action plan summarizes the time schedule and actors for the implementation of the action plan as presented in the exemplary roadmap created for the City of Stockholm in NeZeR-project (Figure 6).

Roadmap for Action Plan in Stockholm

Target: Achieve level Deep renovation for buildings built in 1930-1960 with a specific energy use higher than 200 kWh/m², year within the period 2017-2021.

Timeschedule / Stakeholders	Startpoint: Starting point	Year 1	Year 2	Year 3	Year 4	Final point: Year 5
Environmental department	Decision of project		Seminars and workshops about energy savings with the tenants		Seminars and workshops about energy savings with the tenants	Final report
Politicians from Municipality	Decision of budget					
Stockholmshem		Leading the renovation project				
Stockholmshem		warm water and property electricity. Establishing a website and sutable social media-accounts for the project.				Measurements and FollowUp
Social department and Stadsdelsförvaltning		Survey of the social situation		Projects concerning social sustainability		Follow Up of the social situation
Tenants		Giving opinions on the project				
Consultants			Planning of renovation			
Suppliers			Giving propositions of energy efficient solutions			
Construction companies, contractors			Construction, renovation			

Figure 6. Roadmap for the implementation of the city action plan

Supporting NeZeR reports are city-specific action plans and "General Guidelines for creation of action plans in all Europe". The city action plans have been made for Helsinki, Espoo and Porvoo (Finnish version), Stockholm (Swedish version), Amersfoort (Dutch version, Rotterdam (Dutch version), Timisoara (Romanian version) and Sestao (Spanish version).

6 OVERCOMING BARRIERS WITH STAKEHOLDER ROADMAPS

6.1 Introduction to Stakeholder Roadmaps

National clusters have been the main actors in developing Stakeholder Roadmaps, which facilitate the implementation of NZEBR taking into account the national technical, functional, and economic aspects. The roadmap provides recommendations on future actions for different stakeholders with special attention to the challenges and non-technological barriers identified for different Key Players.

Generally, a roadmap can be described as a strategic plan that describes the steps needed to achieve stated outcomes and goals. It can include tasks and priorities for action and suggestion of metrics that allow the tracking of the progress towards the final goals. The roadmap differs from the city action plans in the sense that they focus on the stakeholder perspective including the individual perspectives of different stakeholders. The city action plans are developed for the cities and the roadmaps, on the other hand, are created on the national level and for different stakeholders. However, the action plans should be used as input for creating the roadmaps.

The roadmap provides recommendations on future actions for different stakeholders with special attention to the challenges and non-technological barriers for NZEBR and RES identified for the main stakeholder groups identified as Key Players in the stakeholder analysis. The roadmaps include general descriptions of how to achieve mainstream NZEBR and utilization of RES from the perspectives of the most important stakeholder groups of the country. The purpose of the roadmap is also to complement the NeZeR city action plans by concretizing actions that various stakeholders need to take to make NZEBR the prevailing means for refurbishment. The roadmap may contribute to achieving the EU targets for existing buildings, mainstreaming NZEBR in the NeZeR countries and enable implementation of the action plan by guiding the stakeholders.

6.2 Developing the Stakeholder Roadmaps

The roadmap development process is divided into following phases:

1. Planning and preparation
2. Development of a roadmap document
3. Review and consultation with key stakeholders
4. Refining and launch of the roadmap

The roadmap is summarized as a table as presented in Figure 7. Here the gaps and barriers, action items, impacts and indicators are presented for all identified Key Players from the stakeholder analysis.

The roadmap can be launched in different ways, for example by press release(s) and/or selective electronic distribution of the roadmap. The final version of the roadmap contains a set of priorities such as policy advances, technology demonstrations; regulatory changes etc. In order to achieve the goals of the roadmap, it is important to define the actors for different actions and to produce a plan for implementation of the activities. The roadmap should be a living document and it can be useful, after the implementation of the roadmap, to conduct expert workshop(s) to reassess priorities and timelines as progress and new trends emerge.

Therefore it might be required to update the roadmap. For example it is important to track changes in energy factors as roadmaps are implemented.

	GAPS AND BARRIERS	ACTION ITEMS	IMPACT	INDICATOR
Government	Lack of continuity due to 4 yrs cycle	Make policies, adapt regulations, stimulate awareness	Long term perspective, stimulate all stakeholders	Energy demand and employment
Authorities	No comprehensive and independent information. Financial model.	National information center. Green loans.	Long-term renovation plans. Well informed building owners.	Valuation of properties with regard to energy demand.
Municipal Decision Makers	Financial model. Other requirements outcompete NZEBR.	Increased cooperation between departments. Green loans.	NZEBR more profitable, more NZEBR in practice.	Municipal energy demand, satisfied tenants.
Architects, Designers and Consultants	Lack of holistic view and responsibility. No def of NZEBR. Poor supervision.	Harmonized calculations. Define NZEBR. Add resources for supervision.	Better end results, more NZEBR in practice.	More good examples, more NZEBR being built.
Larger property Owners (Municipal)	Financial model, not raise rents. Evacuation of tenants. Tax on RES.	Harmonized calculations. Accumulate capital >12M.	Better end results, more NZEBR in practice.	Lower energy demand. Satisfied tenants.
Construction Companies	Financial model, not raise rents. Evacuation of tenants. Tax on RES.	Streamline the Swedish model"	Holistic view of building economy	More good examples, more NZEBR being built.
Tenants	Not interested in financing savings for property owners.	Mutual financial incentives. Dialogue. Longterm investments.	New models for cooperation. More NZEBR.	Satisfied tenants and citizens. More NZEBR,

Figure 7. Example of the national stakeholder roadmap summary for Sweden

NeZeR-reports present exemplary roadmaps for NZEBR and RES in Finland (in Finnish), Sweden (in Swedish), the Netherlands (in Dutch), Romania (in Romanian) and Spain (in Spanish).

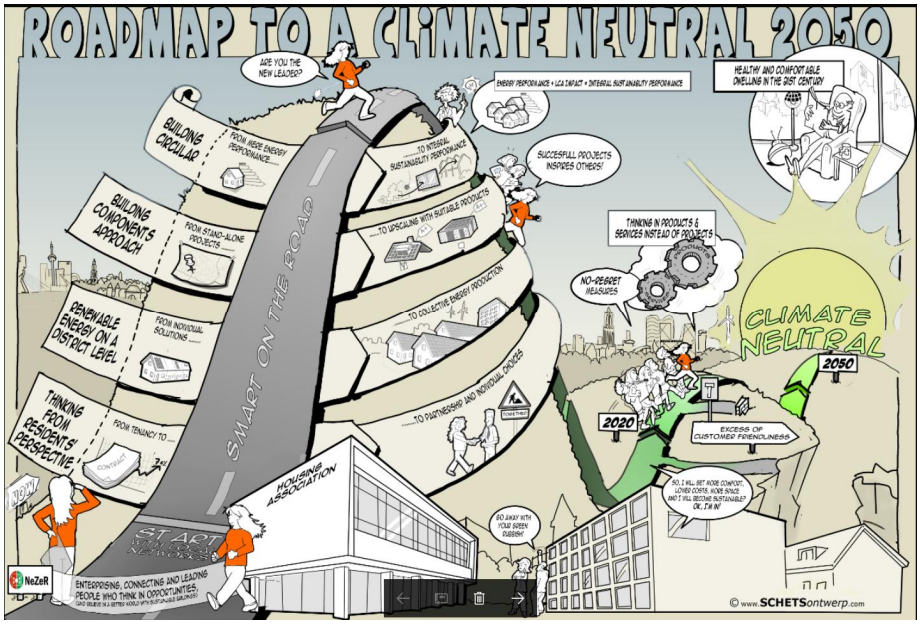

Figure 8: Visualisation of the roadmap, with a focus on the role for social housing associations. Example from the Dutch roadmap report.

7 INNOVATING WITH DESIGN COMPETITIONS

7.1 Organizing the competitions

NeZeR design competitions have improved knowledge in the building chain and among institutional housing owners with respect to Near Zero-Energy Building Renovation (NZEBR). Design competitions produced new NZEBR design approaches, made housing owners and the general public more aware of the possibilities of NZEBR and improved the knowledge of designers and other partners in the building chain with respect to challenges and solutions.

The competitions had following three aims:

1. Soliciting new design approaches for NZEBR of a common type of buildings in each country
2. Making housing owners and the general public more aware of the possibilities of NZEBR
3. Improving the knowledge of designers and other partners in the building chain with respect to challenges and solutions for NZEBR.

The competition were arranged either for teams of students or professionals. To maximize the impact of the competition they were linked with existing initiatives and events and involved a broad group of participants. It was advised to go for high ambition and aim for near-zero energy level in the competitions and building challenges with large replication potential were chosen. For high educational aspect the competition included workshops with presentations of intermediate plans, mutual feedback between teams and also feedback from a professional jury. The competitions used the evaluation criteria developed in NeZeR-project.

7.2 Competition criteria

Figure 9 presents the evaluation criteria for the competition proposals, developed in NeZeR-project.

		Criterion	Points (1-5)	Weight	Weighted score
1	Environment (Planet)	Energy Demand (building, MJ primary energy)		20%	
2		Energy Demand Reduction (%)		10%	
3		Renewable Energy Share (%)		10%	
4		Environmental Quality (materials)		10%	
5	People	User Quality, including • Comfort • Health • Disturbance *(how long have people to move out of their house?)* • User involvement • Communication		20%	
6		Aesthetics (outside and inside)		10%	
7	Profit	Market Appeal, including • Life Cycle Cost & Business case • Replication potential & Engineering		10% 10%	
		Total		100%	

Figure 9. Evaluation criteria for the competition proposals

The evaluation criteria are presented in detail in NeZeR-report "Report on the organisation, participation, and evaluation of the national contests". The brochures describing the winning concepts on national and European level are available in English, Finnish, Swedish, Dutch, Romanian and Spanish. The report "National plans for continuing the competitions after the end of the project" explains how the competitions will continue in each country after the IEE NeZeR-project.

Figure 10: Proposal for building renovation from the Spanish competition

Figure 11: Example of zero-energy renovation from the Dutch competition

Figure 12: Proposal for building renovation from Romanian competition

NeZeR-website includes links several videos from the national competitions.

8 DISSEMINATING EFFICIENTLY

8.1 Dissemination principles

Disseminating convincing information about the benefits of Nearly Zero-Energy Building Renovation (NZEBR), specifically targeted to different groups of stakeholders, builds confidence and understanding in the market, which is essential for the market growth. The stakeholder analysis carried out for identifying key target groups for NZEBR provided input for target tailored educational activities, with the aim of adjusting the content and level of knowledge to the target group for achieving the highest impact.

8.2 Website and media

NeZeR website www.nezer-project.eu presents clearly the main principles and results of the work. The project results were also disseminated through different online media including the LinkedIn group *NeZeR – Nearly zero energy building renovations (NZEBR) in Europe*, newsletters every 6 month and YouTube videos. A good channel for distributing the results was the Build-Up-portal, a European portal for energy efficiency in buildings, in http://www.buildup.eu/ . Several articles were written during the project for local and professional papers and scientific conferences.

8.3 Workshops, seminars, exhibitions and study visits

NZEBR and exchange of experiences were promoted through dissemination workshops and seminars arranged in cooperation with the representatives of the national clusters. At the end of the project common exhibitions and final seminars presenting main project results and showing local successful renovation cases were displayed in public places owned by the cities participating in the project. Also some "open days" on best practices cases studies were arranged in each city.

Connected to the project work meetings, five study visits were organised to local NZEBR success cases. The study visits started with a short seminar presenting national experiences and the specific success cases.

Seminar and study visit: Green deal for social housing - new approaches for industrial-scale, zero energy renovation concepts

The Dutch mini-symposium was arranged on 23rd of September 2014 at the Amersfoort Centre of Sustainable Renovation in connection of NeZeR work meeting. The mini-symposium presented Nearly Zero Energy Renovation concepts utilizing prefabricated elements. The Dutch programme "De Stroomversnelling" aims to renovate 111.000 rental houses to "zero-on-the meter" level until the year 2020. Four major construction companies have been invited to develop and demonstrate their technical solutions for this challenge. The mini-symposium included a site visit to Soesterberg "zero-on-the-meter" renovation demonstration project where the social housing company Portaal is renovating 109 row houses from the sixties towards "zero-on-the-meter" dwellings.

Seminar and study visit: "Sustainable Järva"

The Swedish seminar and study visit was arranged on May 19th 2015 at Järva, a suburb in the City of Stockholm. The seminar presented results and lessons learned in the Sustainable Järva-project during 2010-2014, which resulted in seven renovated energy efficient apartment blocks with 50% less heating energy consumption, 10 000 m2 of new PV panels, improved

biking lanes doubling the amount of bikers and 5 000 persons educated in sustainable lifestyles: energy, transportation and consumption. The residents were engaged in planning of the renovation actions by reporting existing problems and working together with the architects and housing company. A presentation was given about solar cells reducing energy consumption and carbon footprint. Renovation cases with energy performances before and after renovation were first presented by detail and then visited by the project participants.

Seminar and study visit "Sestao Berri 2010 and Sestao"

The Spanish seminar and study visit was arranged on November 4th 2015 in the Spanish City of Sestao, which used to be the economic engine of the Basque Country before the industrial crisis. Here the main barriers against ambitious building renovation are socio-economical: the current unemployment rate is 30 % and dwelling owners lack money for refurbishment. NeZeR-partner Sestao Berri 2010 is a refurbishment organization managed by the municipality to increase the renovation rate and improve the buildings in Sestao. In compliance with the Urban Sustainable Strategy of Sestao, Sestao Berri 2010 offers different types of funding grants for refurbishment projects.

Seminar and study visit "Timisoara"

The Romanian seminar and study visit was arranged on May 11th 2016 in Timisoara, Romania. The theme of the symposium was Steps towards NZEBR – from education to practice. The participants were NeZeR project partners, Timisoara representatives and students from the Politechnica University Timisoara. A new program for accelerating the increase of building energy performance using the ESCO system was introduced with an energy saving target of between 50-75%. The energy-efficient building concepts such as passive houses, NZEBs and active houses are still relatively new in Romania, and most people are sceptical towards them because of high investment costs. However, several passive house projects have been successfully implemented in different parts of Romania. The symposium continued with a study visit to a newly built passive house/NZEB house case study project at Dumbravita commune in Timis county, located near Timisoara. The project includes performance assessment of the designed systems through extensive monitoring of physical and hygrothermal parameters. Specific guidelines are compiled for design, detailing and execution of passive house- and NZEB systems. Monitoring strategy and monitoring system have been implemented to make the data available online. The measured values have also been analysed to evaluate the real performance of the building.

Seminar and study visit in Espoo

The Finnish mini-symposium and study visit were arranged in Espoo on November 22, 2016. The symposium presented main results of NeZeR by the leaders of different work packages. The presentations were taken into video and worked into a short result-oriented video presentation published in YouTube: https://youtu.be/MAD7r-UpqGk The symposium continued with a study visit at the Otaniemi campus area of Aalto University. Architect Pauliina Skyttä presented the renovated Aalto University main building, now serving as the Undergraduate Centre and the renovated library building currently called as the Harald Herlin Learning Centre.

9 CONCLUSIONS

9.1 Overall conclusions from the project work

The project group consisted of research partners and cities. This combination enabled to bring effectively existing research results into practical implementations. Project work meetings included also workshop sessions where the project partners were divided into two groups: research partners working together and city partners working together.

The participating countries: Finland, Sweden, the Netherlands, Romania and Spain, were all in different stages concerning the market uptake of nearly zero-energy building renovation. The project work therefore offered a good platform where experiences were shared between countries. The symposiums and study visits organized in all countries in connection of project meetings enabled further sharing of lessons learnt and included also visits to concrete examples of renovation projects.

Currently enough technological solutions are available in order to undertake Nearly Zero-Energy Building Renovation (NZEBR). The available technologies are similar across the different European countries and it is possible to adapt the features of common technologies to the requirements of the different climatic conditions.

The barriers to undertake NZEBR are mainly socio-economical instead of technical. Different NZEB intervention levels should be applied in order to adapt the intervention features to the different socio-economic conditions of each particular city and country. Here both one-step and step-by-step renovations should be considered. In step-by-step renovations the final goal of NZEB level should be clearly taken into account in a long term renovation plan and the steps should be designed so that there is no lock-in due to wrong decisions.

The main results of NeZeR-project are useful for all stakeholders of the whole building renovation value chain. The national clusters will continue to operate after the finalization of the project in many of the countries.

Regarding the **city action plans**, the City of Stockholm found performing the action plans together with the other participating countries very successful. The work showed how communication and information are more important than technical solutions. There was a great interest from all the cities involved and they had many interesting and fruitful discussions about the different conditions in their cities. They also learned how important it is to discuss the background and the conditions in the city before starting the discussions about target group and goals: otherwise the target group may be chosen on incorrect basis. It was interesting how the action plans of the participating cities differed from each other: one city chose a geographical area as a target group and another chose buildings of a certain age with high energy use. However, all cities agreed that the choice must be based on results from the discussions in the workshops. Another lesson learned was that it is difficult to implement the action plan - to convince decision makers and others of the importance of energy efficient renovation in existing buildings. One reason for this is the large problem with the financing of the renovation projects. However, the essential and fundamental work with the action plans has given right arguments in convincing the municipalities. The municipality of Amersfoort found it very valuable to exchange experiences in the approach of NZEBR renovation of several European cities - especially learning effective ways to activate the home-owners and other residents to take action in NZEBR renovations.

Regarding the **stakeholder roadmaps**, an important finding among all the countries was that there were no significant technical barriers to overcome. The technical solutions to renovate

buildings to NEZBR standard do exist already and are used in separate projects. However, combining the different technical solutions to one concept is more difficult. The key stakeholders were not the same in the different countries, because for example the ownership structure for large multifamily houses differs between countries. Even though there are many differences between the countries there were however some common gaps and barriers. Among all the participating countries following main three actions to overcome the barriers stood out:

1. *Education and information is needed*. There is a lack of knowledge among many stakeholders. NZEBR is seen as complicated and uncertain and this is hindering the development. With no one responsible for the holistic view, the solutions that are carried out do not always turn out to be as energy-efficient as planned. Also, there are too few reference cases and good examples available. The Dutch cluster therefore suggested creating local networks to share knowledge and good examples. The need for reference projects was pointed out by all the participating countries. Some of the stakeholders also pointed out that the supervision of the compliance to the existing regulations is not always fulfilling and sufficient.
2. *Varying working process, calculation methods and tools*: lack of a common definition of NZEBR, calculation methods and models create barriers. Suggested actions to address this are education and informative efforts as well as new calculation models.
3. *Financial grants or longer economic perspectives (LCC)*: Economic aspects as process play a relevant role when undertaking NZEB renovations. For multifamily buildings in private or mixed (private and social housing) ownership, the financing of investments as well as the decision making are major bottlenecks. The higher the upfront investment the more difficult is the intervention. Energy efficiency improvement measures are related to long term planning and the ownership turnover cycles are often shorter than the payback period for the measures. Post-war houses are expensive to retrofit to NZEB level since it requires extensive measures and the tenants come from socio-economical vulnerable part of the society with low ability to pay higher rent. Suggested actions range from financial grants, tax reduction to new business models with long-term pay-back calculations and shared investments among the stakeholders.

The **design competitions**, including a European round, created a substantial amount of enthusiasm and creative energy and led to the involvement of more 200 students and professionals. Organizing a design competition is also an attractive way to involve young professionals in the field of near-zero energy building renovation. On the other hand, the efforts needed for proper organisation should not be underestimated. As a result from the design competitions we can conclude following:

- More than 50 designs for NZEBR have been elaborated and presented among colleagues. Energy reductions (without Renewable Energy) of 47-88% were predicted for the renovated buildings. With Renewable Energy production accounted, some concepts came (close) to zero energy. One NZEB renovation has already been executed, others may follow.
- Design competitions have created enthusiasm and creative energy: More than 200 (young) professionals have been involved in NZEBR design and educational activities involved more than 100 university students.
- Some countries have concrete plans to organize these kinds of competitions also in coming years

9.2 Suggestions for further work: NeZeR-concept

The project group recommends NeZeR-concept (Figure 13) as a comprehensive and co-creative procedure to promote country-specific implementation of Nearly Zero-Energy Building Renovation (NZEBR) also in other countries. The concept consists of following tasks: 1) Showing the feasibility and best practises of NZEBR, 2) Making concrete actions with City Action Plans, 3) Overcoming barriers with Stakeholder Roadmaps, 4) Innovating with Design Competitions and 5) Disseminating the results effectively.

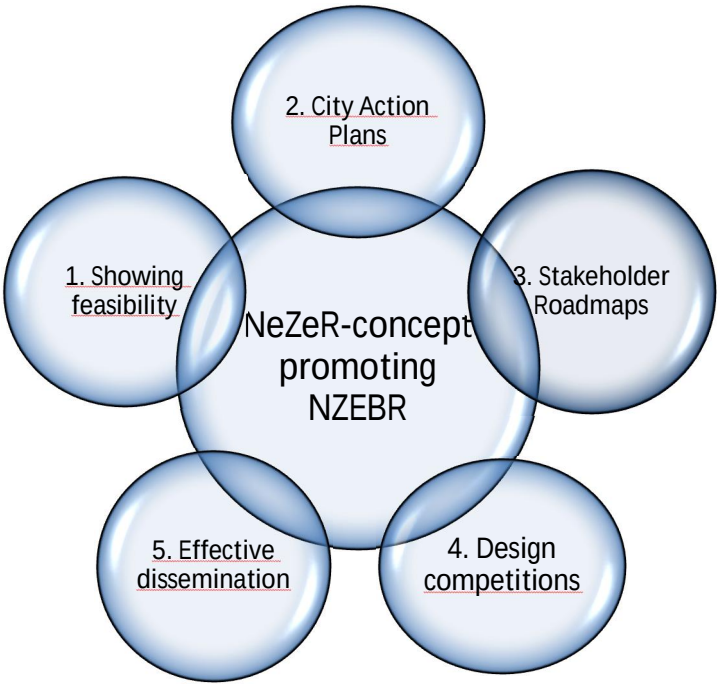

Figure 13. NeZeR-concept

Main actors of the concept are research organizations/consultants, cities and national clusters consisting of identified main stakeholder groups of NZEBR.

Research organizations bring into the concept the existing research results among ambitious renovation. They have the overall responsibility of leading the concept procedure and showing the economic, environmental and social feasibility of NZEBR over traditional renovation by feasibility studies including e.g. LCA and LCC calculations. They propose the country-specific NeZeR criteria utilizing the criteria developed in NeZeR-project for four European Climatic Zones (North, East, Centre and South). Successful examples are presented to show understandable and trustworthy information on the NZEB alternatives for renovation.

Cities act as forerunners for facilitating more energy-efficient renovation. They are main actors in developing City Action Plans, which focus on the long-term transformation of the existing buildings including targets for reduction of energy consumption and CO_2-emissions when renovating buildings. City Action Plans are constructed using the concrete guidelines developed in NeZeR-project. They describe how the process of achieving nearly zero-energy renovation measures in existing buildings can be performed. A strong focus lies on behavioural issues and the participation and cooperation with the inhabitants.

National clusters are formed based on the stakeholder analysis explained in Chapter 3. They review and give feedback for all central activities including the city action plans and national stakeholder roadmaps. The national clusters also facilitate communication and cooperation between stakeholder groups serving as a platform for exchanging experiences and ideas.

10 PUBLICATIONS

All NeZeR-project publications can be uploaded from the website www.nezer-project.eu. They are shortly presented below.

Advantages of Nearly Zero-Energy Building Renovation

This booklet gives reasons for renovating into Nearly Zero-Energy level instead of a traditional renovation. The booklet is available in English, Finnish, Swedish, Dutch, Romanian and Spanish.

Report on technical and social feasibility studies

This report evaluates and analyses the potential to achieve NZEBR and deploy renewable energy sources in the partner cities for the identified residential typologies and the related social aspects.

Proposal of relevant fiscal incentives and other control instruments for supporting NZEBR

The report presents the current situation of economic incentives in Finland, Sweden, the Netherlands, Romania and Spain to support Nearly Zero-Energy Building Renovation, defines main barriers and proposes new incentives.

Report on environmental and economic advantages of NZEBR compared to traditional renovation

This report presents environmental advantages of NZEBR analysed using Life Cycle Analysis (LCA) methodology and economic advantages of NZEBR analysed using Life Cycle Costing (LCC) and Cost Benefit Analysis (CBA) methodologies.

Technical solutions for optimal energy efficient retrofitting

There are plenty of both innovative and traditional technologies for energy renovation. In order to reach Nearly Zero Energy Buildings packaged solutions are needed. As a first step towards formulating packaged solutions we have presented existing and innovative technologies for walls, windows, roofs and HVAC systems renovation as well as implementation of RES. The technology data sheets include a general description of the solution as well as application possibilities, concept drafts and pictures, innovativeness level, advantages, disadvantages, potential problems, execution aspects, sustainability aspects and market aspects. We have also collected most representative building typologies in each partner country: constructive characteristic, energy performance, type of ownership/residents and location.

Intervention criteria and packaged solutions for buildings renovation towards a NZEBR

Package renovation solutions were defined for multifamily buildings built between 1960-1980 in different European climatic zones. Apart from the differences between countries, the same package solutions can be implemented with some adaptations based on product characteristics, such as the glazing type, insulating material type and thickness. Based on this study there are still some gaps that should be overcome to reach NZEBR effectively, such as implementation of heat recovery ventilation and low temperature heating and availability of sufficient roof area for PV and/or solar thermal energy.

Successful renovation cases

To produce understandable and trustworthy information on the alternatives for renovation we have collected and analysed 30 successful European renovation cases into a booklet. For each

case this booklet shows the general description, technologies before and after the renovation, possible barriers and success factors faced in the renovation, organization and process of the renovation and links to further information. The booklet is available in English, Finnish, Swedish, Dutch, Romanian and Spanish.

Role of ESCO:s in Nearly Zero Energy Building Renovation

An Energy Service Company (ESCO) is a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based wholly or in part on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria. For this report we have performed a market overview which shows the similarities and differences between participating countries regarding barriers and success factors for ESCOs on the market. In most of the countries the need for information and training is highlighted as a key factor to push the market development forward.

Successful business models for NZEBR

We have collected several relevant business models developed and assessed in other EU-funded research projects and analysed their suitability for Nearly Zero-Energy Building Renovation. Deep renovation of privately owned multifamily buildings requires different business model concepts than public buildings. Country specific analyses show how conditions and challenges vary between different countries. For example, the ESCO model has been widely used in Sweden and Spain, whereas it is not very common yet in Finland, the Netherlands and Romania.

Action plans for cities

How can decision makers facilitate Nearly Zero-Energy Building Renovation? We have developed city-specific action plans with targets for reduction of energy consumption and CO_2-emissions when renovating buildings and descriptions about how the objectives shall be accomplished. These action plans describe how the process of achieving NZEB renovation measures in existing buildings can be performed and they make a basis to convince politicians and citizens to approve more ambitious energy-efficient renovations. You can find city action plans for Stockholm, Rotterdam, Amersfoort, Helsinki, Porvoo, Espoo, Sestao and Timisoara in NeZeR website under Publications.

General Guidelines for creation of action plans in all Europe

The discussions and experience shared in the project group along the way of developing city action plans made the basis for development of general guidelines for city action plans.

Stakeholder analysis and national Nearly Zero Energy Building Renovation clusters

We have identified key target groups for Nearly Zero Energy Building Renovation on a national level by performing a stakeholder analysis in Finland, Sweden, the Netherlands, Romania and Spain. The stakeholder groups have been identified and assessed into following categories according to their level of power and interest: Key Players, Meet Their Needs, Show Consideration and Least Important. Based on this stakeholder analysis we have established national clusters in Finland, Sweden, the Netherlands, Romania and Spain. These national clusters will secure the impact of NeZeR-project both during and beyond its duration.

Roadmaps for NZEBR and RES in Finland, Sweden, the Netherlands, Romania and Spain.

National stakeholder roadmaps were created in each participating country (Finland, Netherlands, Sweden, Spain and Romania). The roadmaps are strategic plans describing the

steps needed to increase NZEBR in all countries including tasks and priorities for actions and suggestion of metrics allowing the tracking of the progress towards the final goals.

Report of the cluster workshops organised per country

This report presents the five cluster workshops organized in each country.

5 Continuation plans for the national clusters organised in Finland, Sweden, the Netherlands, Romania, Spain

This report presents national plans for continuing the national clusters after the completion of the project.

Report on the organisation, participation, and evaluation of the national contests

This report presents how the NZEBR design competitions were organized in different countries including results and experiences.

Brochure describing the winning concepts on national and European level

This booklet presents the winning proposals from the country-specific competitions and the main lessons learned from the competitions. The booklet is available in English, Finnish, Swedish, Dutch, Romanian and Spanish.

National plans for continuing the competitions after the end of the project

This report presents national plans for continuing the design competitions after the completion of the project.

Seminar and study visit: Green deal for social housing - new approaches for industrial-scale, zero energy renovation concepts

This electronic article presents the mini-symposium arranged on 23rd of September 2014 at the Amersfoort Centre of Sustainable Renovation. The mini-symposium included a site visit to Soesterberg “zero-on-the-meter” renovation demonstration project.

Seminar and study visit: “Sustainable Järva“

This electronic article presents the seminar and study visit arranged on May 19th 2015 at Järva, a suburb in the City of Stockholm.

Seminar and study visit “Sestao Berri 2010 and Sestao”

This electronic article presents the seminar and study visit arranged on November 4th 2015 in the Spanish City of Sestao.

Seminar and study visit “Timisoara”

This electronic article presents the seminar and study visit arranged on May 11th 2016 in Timisoara, Romania. The symposium continued with a study visit to a newly built passive house/NZEB house case study project.

Seminar and study visit in Espoo

This electronic article presents the Finnish mini-symposium and study visit arranged in Espoo on November 22, 2016. The symposium continued with a study visit at the Otaniemi campus area of Aalto University.

IEE NeZeR-dissemination and communication report

This report gives a complete overview about all dissemination and communication actions during the project, following the original plan drafted in the beginning of the project.

Reports of the stakeholder dissemination workshops, including the feedback on project results

This report presents how the dissemination workshops were arranged in each country.

Reports of the common exhibitions in each country showing local successful renovation cases

This report presents the common exhibitions arranged in each country at the end of the project.

Reports of the final seminars

This report presents the final seminars arranged in each country at the end of the project.