



## Deliverable D3.2 Existing renovation solutions towards NZEB

GA N° 649865

Project acronym:

REFURB

Project's coordinator:

Dieter Cuypers (VITO)

E-mail:

[dieter.cuypers@vito.be](mailto:dieter.cuypers@vito.be)

Work Package leader:

Anne Goidts

E-mail:

[anne.goidts@bosto.be](mailto:anne.goidts@bosto.be)

Dissemination level

Public

June 2016



# Contents

<b>CONTENTS</b> .....	<b>2</b>
<b>SUMMARY</b> .....	<b>4</b>
<b>1 INTRODUCTION</b> .....	<b>7</b>
1.1 Objectives and structure .....	7
1.2 Research question .....	8
1.3 Method / Approach.....	8
<b>2 COUNTRY CONTEXT</b> .....	<b>9</b>
2.1 Country context for renovation to NZEB.....	9
2.2 Potential market growth.....	17
2.3 Mapping the non-technological solutions for renovation to NZEB.....	25
2.4 Technological Solutions for renovation to NZEB .....	37
<b>3 IN DEPTH ANALYSIS OF NON-TECHNICAL SOLUTIONS FOR NZEB RENOVATION</b> .....	<b>42</b>
<b>4 CONCLUSIONS AND RECOMMENDATIONS</b> .....	<b>55</b>
4.1 Involvement and organisation of supply.....	55
4.2 Renovation packages: one-stop-shop-solutions.....	56
4.3 Financial constructions for deep or NZEB renovations.....	58
4.4 Quality assurance for deep or NZEB renovations .....	59
<b>5 REFERENCES</b> .....	<b>61</b>
<b>6 ANNEXES</b> .....	<b>62</b>

**Main contributors and editors**

Tine Steen Larsen (Aalborg University, DK)  
Lotte Lindgaard Andersen (Clean, DK)  
Gerk Jan Kuipers (Fryslan/Municipality of Leeuwarden, NL)  
Alan Laws (Fryslan/Municipality of Leeuwarden, NL)  
Mario Kremling (ISW, DE)  
Ida Hucklebrink (ISW, DE)  
Fiene Grieger (ISW, DE)  
Kalle Virkus (TREA, EE)  
Jelena Vidović (BSC, SI)  
Anne Goidts (Bostoën, BE)  
Christophe Debrabander (Bostoën, BE)  
Nele Ameye (Recticel, BE)  
Ighor Van de Vyver (VITO, BE)  
Dieter Cuypers (VITO, BE)

**Contributors**

Peter Rathje (Project Zero, DK)  
Dominiek Vandewiele (Intermunicipal Company Leiedal, BE)  
Bruno Verbeke (Recticel, BE)

[www.go-refurb.eu](http://www.go-refurb.eu)

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649865

Version	Date	Author	Description
1.0	25/03/2016	Bostoën	Draft general report to VITO
2.0	18/05/2016	Bostoën	Corrected general report to VITO
2.1	25/05/2016	VITO	Edited report to Bostoën for finalisation
3.0	08/06/2016	VITO	Final version

## Summary

In this report a market research on the existing solutions for renovation (to NZEB if available) is conducted.

By looking at the state of the renovation market and listing the solutions for renovation to NZEB that are (near-)available on the market, this research determines **which existing renovation solutions can be used in renovation packages that are offered to homeowners to stimulate them to renovate their house to NZEB. Which aspects of those solutions are important to know and to use when developing new renovation packages?**

Therefore, the objectives of this report are to formulate recommendations for offering renovation packages based upon an analysis of currently offered renovation solutions, both technological as non-technological, and the country contexts in which they are offered. Special attention is being paid to one-stop-shop solutions as they are a promising non-technological solution for such renovation packages to be offered in the market.

A clear understanding of the **country context** is required in order to estimate the replication potential of renovation packages on a national and EU level. Therefore, in this report the local conditions that influence the supply side are explored.

These country contexts differ on many aspects.

The country context is shaped by the policies in place and those under development as a national translation of EU directives. If the more complex NZEB renovations are to be stimulated, specific support policies and subsequent financial incentives have to be put in place.

Second, the country contexts are shaped by the housing market, i.e. the housing stock and its tenure.

Third, the general building practice and more specifically the roles of key-actors, like energy advisors and architects, which can be involved either obligatory or on a voluntary basis. These key-actors have the necessary knowledge or skills to support the homeowner, though in many cases the advantage of involving them is hindered by the (perceived) high upfront cost.

Which directly touches upon a fourth important aspect, which is the readiness of the building sector itself. Due to the more complex challenge of deep or NZEB renovations, it is to be expected that the building sector in which turnkey solution providers are present make faster progress than where a more fragmented construction sector is present.

Some of these aspects of the country context appear again when a first idea of the **potential market growth for deep or NZEB renovations** is to be made.

There is ample technical potential, but as REFURB partners' experience shows, it is not the technical or financial potential alone that will determine the take-up of NZEB renovation packages. For the other components of the full potential no studies are available.

Still, experiences in customer relationship management which are being built-up throughout the EU in local renovation programmes can be valuable. These approaches take into account the final decision-makers. This is part of the so-called non-technological solutions which have more attention for the demand side.

In section 2.3 a selection of **relevant existing renovation solutions** or initiatives are presented in tables per REFURB partner country. In general two categories of solutions can be distinguished: technological solutions and non-technological solutions.

The **technological solutions** are less country-specific and are listed in section 2.4 in three categories (building envelop, technical installations and renewable energy sources) and linked to the building typologies in each country.

Looking at the **non-technological solutions** listed in chapter 2.3, the following categories can be distinguished:

- Innovative financial models (new ways of financing)
- Online tools for management or decision making (which are partially applied by one-stop-shops either as a lead-producing tool or as a first information tool)
- Demonstration projects or showcases visible to other homeowners
- New approaches to organising the supply side through building teams of smaller craftsmen
- Quality assurance
- Renovation packages = One-stop-shop-solutions
- Other solutions (such as innovative communication and marketing)

Though, it is important to notice that multiple categories can be assigned to one solution for renovation to NZEB. Good solutions will likely cover multiple aspects. Taking into account the drivers that can convince homeowners to renovate to NZEB (as mapped in report D2.2), the **non-technological solutions are more important than the technological solutions to seduce homeowners to renovate to NZEB.**

Section 3 further elaborates on **one-stop-shop concepts**, as one-stop-shop-solutions or renovation packages seem to have the highest potential to convince the homeowner to renovate to NZEB, because they offer a holistic approach. For the purpose of this project the term '**renovation package**' is meant to be: *"An easy-to-understand commercial offer to an end-user, written in non-technical language which satisfies his/her requirement for comfortable living but at a higher energy-efficiency of his/her dwelling. The offer comprises the optimum combination of technologies to be installed in the most logical sequence, tailored to the type of dwelling, the state of the building, the geography in which the dwelling is located and socio-economic parameters. Offers are understood to entail the unburdening of the end-user, so he/she is assured of an agreed higher energy efficiency without having to worry about individual technology choices."*

Out of the examples of one-stop-shop concepts in Europe analysed, these **common characteristics of existing one-stop-shop-solutions** can be distinguished:

- Targeting individual homeowners.
- Initiative from government or supply side.
- Personal approach of the homeowner.
- Tailored integrated masterplan is offered to the homeowner to avoid lock-ins.

- Step-by -step approach is possible: homeowner has choice between one deep renovation or a stepwise renovation
- Organisation of the supply side with one single-point-of-contact for the homeowner
- Marketing is important to get the offer well-known, but is often missing.

It is clear that the country context of the different countries involved is determinative for the success of one-stop-shop solutions. Furthermore, many of the analysed one-stop-shop-solutions are not isolated initiatives. Most of them are embedded in a much broader programme, project or campaign, for example with clear demonstration projects.

Finally, section 4 summarises the findings and formulates key recommendations related to the involvement and organisation of the supply-side, financial constructions, quality assurance and composing the “compelling offer you cannot refuse”, i.e. the renovation packages.

With regards to the **involvement and organisation of the supply** side to better fit the drivers of the demand side in relation to energy saving and NZEB renovation measures, it is important to notice that the building sector or supply side is traditionally very diverse and fragmented, especially when renovation measures are concerned. This acts as a barrier to more cooperation to provide one-stop-shop services.

Moreover, to provide one-stop-shop solutions smaller contractors would need to work together, but working with firms who coordinate the supply side costs both time and money. An improved organisation of the supply side will probably result in a collaboration structure in which an additional person is leading a whole team. One-stop-shop concepts often include an extra person as single point of contact and few take advantage of existing channels, such as an architect or a general contractor. The limited demand for one-stop-shop solutions provides insufficient incentive for the industry to reorganise and provide one-stop-shop services aimed at deep or NZEB renovations.

Next step is for the supply sides to better understand the demand side, to change their behaviour towards the demand side and certainly to focus on the communication with them on a level where it also moves the homeowner to a renovation situation. A supply involvement strategy then is useful.

There are currently no widespread specific **financial constructions for deep renovations for privately owned dwellings**. Current financial incentive systems stimulate shallow and in some cases slightly deeper renovations but not deep renovations aimed at 60% energy savings. Many publications and reports on improving energy efficiency finance in buildings are available, but little attention is being paid to the sector of residential buildings, and even more so privately-owned dwellings. On the other hand it is clear that the simple availability of subsidies or other incentives can really move people to renovate their homes and especially to hire a professional craftsman, but it is unclear whether the incentive systems available also lead to deeper renovations. Short-term incentives like subsidies with limited availability or temporary reduction in taxes, form a barrier to long-term investments in offering qualitative one-stop-shops. Suppliers of attractive, new, financial services linked to energy saving generally absent. It is thought that to be a success more cooperation between builders and financiers to provide integrated guarantee services is needed.

**Quality assurance for one-stop-shop solutions for renovations** are not or hardly available so the quality of their advice and the implementation can only depend upon the experts involved and their education and expertise. The key issue here is that quality assurance measures are available for the physical quality of work carried out, but not for the long-term effect of the renovation on the energy consumption during the lifetime of the renovated dwelling.

# 1 Introduction

## 1.1 OBJECTIVES AND STRUCTURE

This report contains the results of the work performed by the partners of the REFURB project for task 3.2 of Work package (WP) 3. In work package 3 the supply side of the dwelling renovation market is analysed. In task 3.2 of WP3 a market research on the existing solutions for renovation (to NZEB if available) is conducted.

The objectives of this report are to formulate recommendations for offering renovation packages based upon an analysis of currently offered renovation solutions, both technological as non-technological, and the country contexts in which they are offered. Special attention is being paid to one-stop-shop solutions as they are a promising non-technological solution for such renovation packages to be offered in the market.

The overviews generated and recommendations drawn will then be confronted with the analyses conducted for WP2 which focuses on the demand side of the dwelling renovation market, or more precisely the households. Based upon this 'confrontation' of the demand and supply side ideal renovation solutions packages will be developed in WP4. In WP5 the potential for delivery and quality assurance of the solutions offered will be assessed.

In order to get to this overview and recommendations the report has the following structure:

Chapter 2 sketches the country contexts, the potential market growth for NZEB renovation solutions in the countries of the REFURB partners and inventories the non-technological renovation solutions available there. These country contexts for renovation to NZEB are described to better understand the origin and context of the solutions mentioned. Besides this, the potential market growth for (NZEB) renovation solutions is described to be able to distinguish the solutions with the highest potential to trigger a renovation wave in Europe. The last section of the chapter is dedicated to the (near-)available technological solutions for renovation to NZEB. These are listed and presented in a matrix with the technological solutions on one axis and the dwelling typologies on the other axis in order to see their applicability per dwelling type.

In chapter 2.3 the identified relevant non-technological solutions are analysed more into depth. As the first quick overview of both technological and non-technological solutions reveals, the non-technological ones are more diverse and vary among countries. Second, they appear to be a far more important feature for renovation packages than the technological solutions. The most relevant ones are being discussed. These are the most interesting ones to share with partners in other European countries. These are also solutions from which components are likely to be integrated into compelling offers of renovation packages or which will have to complement such packages.

Chapter 4 concludes with recommendations for other tasks in the REFURB project about:

- the involvement and organisation of the supply side;
- the common characteristics of one-stop-shops as a promising solution;
- financial support or constructions; and
- quality assurance and quality control.

In the remainder of this introductory chapter the research question for the task is defined and the method and approach to the research is set out.

## 1.2 RESEARCH QUESTION

The REFURB project focuses on renovation of dwellings to NZEB as renovation in the sector towards increased energy efficiency is seriously lagging behind. The need for an upscaling of the number of NZEB renovations arises. In the REFURB project attractive renovation packages will be developed to trigger this upscaling.

The final research question of the REFURB project is: How to stimulate private homeowners to renovate their house to NZEB?

To resolve this question, this report offers part of the answer by looking at the state of the renovation market and listing the solutions for renovation to NZEB that are (near-)available on the market. It determines **which existing renovation solutions can be used in renovation packages that are offered to homeowners to stimulate them to renovate their house to NZEB. Which aspects of those solutions are important to know and to use when developing new renovation packages?**

## 1.3 METHOD / APPROACH

On the basis of desktop research and their expertise REFURB partners gathered all relevant solutions for renovation to NZEB in a template for their respective countries. The **(near-) available solutions for renovation to NZEB were listed in an inventory for each country**. In this inventory it is also determined whether the listed renovation solutions include technological solutions and non-technological solutions such as new ways of financing, online management or decision-making tools, new approaches to organising the supply side, quality assurance or other solutions.

Secondly, REFURB partners from each country describe their **country context for renovation to NZEB** to better understand the origin and context of the solutions mentioned. This includes policy or public initiatives, building practice and, if relevant, other aspects such as legal or financial context and general building practice.

The **potential market growth for (NZEB) renovation** solutions is also described to be able to distinguish the solutions with the most potential to trigger a renovation wave in Europe.

Then, the **most relevant non-technological renovation solutions** listed in the inventory, interesting to share with partners in other European countries and to insert in renovation packages, are **analysed more into depth**.

Finally, a matrix with the technological solutions on one axis and the dwelling typologies on the other axis is established. One overall list of technological solutions is developed for all countries and mapped against dwelling typologies. This results in one **technology matrix for each country**.

The result is a report which gives an overview of (near-)available solutions for NZEB renovation, including a technology matrix for each country as mentioned above.

For Belgium, Denmark and The Netherlands an extensive country report was made to illustrate the context, solutions and recommendations for these countries. These are available in the annexes.



## 2 Country context

In this chapter the country contexts with regards to renovations and NZEB renovations are sketched. This country contexts consist of:

- the general context for renovation such as policies and building practice;
- the potential for NZEB renovation market growth;
- an overview of existing renovation solutions

These aspects are assessed for the partner countries of the REFURB project: Belgium (Flanders), Denmark, Estonia, Germany and the Netherlands. For Flanders, Denmark and the Netherlands these country context descriptions are based upon more extensive reports provided in the Annexes to this report.

### 2.1 COUNTRY CONTEXT FOR RENOVATION TO NZEB

A clear understanding of the local conditions is required in order to estimate the replication potential of renovation packages on a national and EU level. REFURB's WP2 focuses on these local conditions from a demand-side perspective (Task T2.4: Tailoring demand side drivers and organisation of demand to local conditions). In contrast to WP2, in this country report, the local conditions that influence the supply side in the countries involved are explored. First, the policy context is screened. This not only includes current regulation related to building quality standards, energy performance and building permitting but also the renovation strategy of the government concerned and related initiatives that are on-going. Next, the professional building context is considered: which actors are typically involved during renovation works and which kind of collaboration structures can be expected in the countries involved? The REFURB partners have, based on their own experiences, focussed on different aspects of their country contexts. While this might be confusing at first sight, these different foci put together give an overall picture of relevant issues when assessing the potential for NZEB renovation of any country.

#### 2.1.1 Country context for renovation to NZEB in Belgium

##### 2.1.1.1 Policy context

When considering the policy context in Flanders, the evolutions of the different working groups "**Renovation Pact**" have to be closely monitored. The Renovation Pact is an initiative of the Flemish Minister for Energy to increase energy efficiency in the residential sector in which the many stakeholders of the construction sector are involved. In particular the (intermediate) results of the working groups focussing on the topics long-term objective (NZEB definition for renovation), dwelling ID, renovation advice, business models and financial support have to be taken into account when composing the renovation packages for the Flemish Region.

##### 2.1.1.2 Building practice

Regarding the current building practice in Flanders, in particular the independent role of **the architect** needs careful consideration during the development of the renovation packages, as the cooperation with an architect is mandatory for renovation works that require a building permit. For NZEB renovations and

especially deep renovations such permits will be necessary, but not for smaller interventions. Other required actors (safety coordinator, energy and ventilation expert) need to be considered as well. It should be noted that existing collaboration structures specialized in NZEB renovations are almost non-existing and present a good opportunity for REFURB.

The deeper analysis of the country context for renovation to NZEB in Belgium is to be found in Annex 3.

## 2.1.2 Country context for renovation to NZEB in Denmark

### 2.1.2.1 Policy context

In Denmark the Energy Agreement 2012-20 prepared and agreed by the Danish Parliament has resulted in a lot of actions. The 2012 agreement includes the 'EnergiStrategi 2050' (energy strategy 2050) with an aim of a Danish energy distribution in 2050 fully based on renewable energy. This agreement will continue to push the market into energy renovations and NZEB.

The energy agreement has an impact on the market (currently and in the future) and has set up an amount of instruments such as **energy performance policy, subsidies, renovation programs etc.** to reach the goals.

Energy renovation is an important part to reach this goal. The energy saving potential is huge in Denmark. Therefore a goal of **35 % reduction of the energy used in dwellings was set for 2050 compared to 2011**. In order to reach this goal NZEB energy renovation with best-practice examples and shallow renovation are important. It is believed that the goal can be reached if initiatives for fulfilling the building energy regulation on insulation and renovation are taken. Furthermore there is a need for a revision of the building regulation will special focus on windows. Finally an optimization of the maintenance and automatization of big buildings is needed.

For the legal part, the building regulation for **new buildings** has tightened the building requirements stepwise every 5th year towards NZEB's, the technical solutions for this part have influenced a lot on renovations and shown possibilities for deep renovations.

### 2.1.2.2 Building practice

The Danish Building Research Institute<sup>1</sup> concluded that municipalities' and energy supply companies' understanding of homeowners is important to gain the market and that the direct contact with homeowners is resource-demanding, but also the approach with the highest effect. Nevertheless more collective and network approaches can be relevant. It is also mentioned, that energy politics seldom pay attention to the user behaviour and this is just as important to the actual energy use as the technical condition for the houses.

The deeper analysis of the country context for renovation to NZEB in Denmark is to be found in Annex 4.

## 2.1.3 Country context for renovation to NZEB in Estonia

### 2.1.3.1 Policy context.

#### Energy performance policy

---

<sup>1</sup> SBI, 2014, Gram-Hanssen et.al.

Energy performance certificates are mandatory for new buildings and substantial renovations. Different requirements are applied for different categories of buildings. For residential buildings there are two categories:

1. single family, two family or semi-detached houses, and
2. apartment houses with three or more apartments. EPC is a precursor for building permit which includes also deep renovation.

### **Subsidies and renovation programmes**

As 75% of Estonian population lives in apartment buildings of which the majority was built between 1960 and 1990, which are poorly equipped and insulated, the most important segment for renovation is this stock. There is an ongoing renovation programme aimed precisely at this segment. The programme's main feature is subsidies for renovation which are eligible if specific goals are achieved. The main feature of the set of goals is requirement for deep renovation i.e. an apartment requires a fully insulated envelope and has to be equipped with a modernized heating system and heat recovery ventilation.

The whole renovation process is set up as to not block further renovation of these apartment buildings into NZEB. Best practice examples have shown that if an apartment house is renovated according to requirements for subsidies these houses are easy to turn into NZEB just by applying RES like PV panels or solar collectors.

#### *2.1.3.2 Building practice and tenure*

Building practice in the segment relevant to the abovementioned programme is based on tendering and inspecting. Renovation contracts and construction design under the subsidy programme have to be tendered. All works are mandatorily inspected **by independent building inspectors**. There are specific strict requirements for insulation characteristics and HVAC equipment which has stimulated competition and generated a need for training among contractors and equipment suppliers. Also, final inspection on HVAC system is mandatory for receiving a subsidy, so there is almost no possibility for under grade contracting.

More than 95% of the Estonian housing stock is privately owned and mainly occupied by owners themselves. This poses an additional challenge in renovating apartment buildings with 60 or more owners. There is a legal body that represents owners of one apartment building - Association of Home Owners. This type of legal body has a set of specific rules and is represented by a board. Problems arise when financial obligations are taken by majority vote. Another problem is the lack of expertise on construction and renovation among these legal bodies. To encounter these problems it is mandatory for an Association to hire an especially trained technical expert to interact between an Association of Home Owners and building professionals.

For some reasons there is a rather low awareness in the building sector about NZEB standards set in the EPBD. Specifically there are problems with achieving airtightness which requires all subcontractors to cooperate closely. This might pose a larger problem in the near future when NZEB requirements become universal.

## **2.1.4 Country context for renovation to NZEB in Germany**

### *2.1.4.1 Policy context*

**Energy performance in Germany – strict legal framework and generous subsidies**

In Germany, the so-called 'Energiestandard' describes the degree of energy performance. It determines the maximum energy consumption per m<sup>2</sup> reference surface per year in a building. In general, this value can be reached by structural measures and housing technologies. User behaviour is not included. The legal context of the Energiestandard is given by EnEV<sup>2</sup> (Energieeinsparverordnung = energy saving regulation) that defines basic standards. The EnEV applies for almost all buildings with heating or cooling systems. EnEV primarily refers to **new buildings** and should help to reduce the energy demand. Two parameters are central: 1) the primary energy demand and 2) the heating demand. The regulations are referring to heating appliances and insulation standards as well. Using renewables gains leverage in balancing compared with fossil fuels. Determining the energy footprint considers room heating, cooling, water heating, ventilation systems, auxiliary power for pumping etc. The EnEV is updated from time to time. The latest update applies up from 2016. The primary energy demand for new buildings has to be decreased from 62 to 45 kWh/m<sup>2</sup>/a; the current insulation standard referring to the transmission heat loss is increased by 20%.

EnEV secondly refers to energetic standards of the **existing building stock**. On the one hand, standard heating appliances installed before 1978 have to be replaced, steam and hot water pipes in unheated rooms have to be insulated, as well as the top floor resp. the upper floor ceilings or the roof by December 2015 ('replacement and retrofit obligations'). These necessary steps will be examined by the chimney sweep. In case of default, the municipal public order office will take measures. On the other hand, there are minimum standards for the replacement of single or a few parts of the building ('renewal and refurbishment requirements'). If one only wants to insulate the facade or to replace the windows, one has to observe certain U-value limits, regulated by EnEV. In these cases, the compliance with the EnEV regulations has to be confirmed by the contractor of the construction project. If one wants to perform a wholesale refurbishment (similar to new built), one has to carry out an energy balancing. The primary energy demand of the refurbished building is limited to 40% above the new building standard, up to 66% from 2016 on (because the new building standards increase).

Basically, the energetic requirements and regulations of EnEV are associated with **public subsidies and loans, provided by the development bank (KfW-Bank)**, that developed specific standards ('KfW-Effizienzhaus'). The basic principle is to undercut the baseline of primary energy demand (QP) and transmission heat loss (H'T) of a reference building in a couple of stages. E.g., 'KfW-Effizienzhaus 55' means that QP amounts to maximum 55% and the H'T amounts to maximum 70% of the reference building (EnEV2009); 'KfW-Effizienzhaus 70' QP<70%, H'T<85%. There are higher levels possible for refurbishment of existing buildings (KfW 85, KfW 115). In very tight connection, KfW developed a system of loans or subsidies that one can receive either for the achievement of a certain KfW level (new buildings, refurbishment) or single appliances/measures (refurbishment only). To sum this up, the ENEV provides a strict regulatory framework for newbuilt houses but also for renovation measures in existing buildings. Combined with the funding system provided by KfW, these are the framework conditions for energy efficiency renovation in Germany, which also include the possibility of NZEB renovation. The focus of German policy is on a widespread uptake of renovation measures and a general increase of the energy performance of the building stock. **NZEB is only a small part of that, since it is usually connected with relatively high costs, while the same overall savings (energy and greenhouse gas) can be reached by implementing basic renovation measures in many houses.**

---

<sup>2</sup> <http://www.vz-nrw.de/enev>

#### 2.1.4.2 Building practice

For small-scale renovation measures it is not mandatory to involve any experts; they can be conducted by craftsmen. Comprehensive renovations such as **NZEB renovations require a technical expert** is, in particular when KfW funding is pursued. The KfW provides a list of experts for energy efficiency, homeowners can choose an expert in their region. The expertise includes four different aspects:

- Initial inventory,
- Recommendations to implement energy saving measures and improve the energy performance of the buildings,
- Detailed energetic specialist planning (incl. legal conditions, cost planning and funding opportunities),
- Construction support and supervision.

The first two steps are funded by the Federal Office for Economic Affairs and Export Control, a superior federal authority subordinated to the Federal Ministry for Economic Affairs and Energy (BMWi). The last two steps are funded by a KfW instrument called "Energyefficient Construction and Rehabilitation" (non-repayable grant no. 431 for construction support, funded up to 50% of eligible costs, max. € 4,000 per investment project).

### 2.1.5 Country context for renovation to NZEB in Slovenia

#### 2.1.5.1 Policy context

The most important policy initiative with regards to energy renovations in Slovenia is the **Eco Fund**, a fund that promotes investments complying with the National Environmental Action Plan and the Environmental Policy of the European Union. The fund subsidizes a whole range of environmentally beneficial actions, amongst which actions regarding energy-efficiency and renewable energies. For the period 2008 – 2013 the fund awarded 31,606 incentives on renewable energy and 27,321 incentives for efficient energy use. Currently, an analysis is being carried out to determine the efficiency and rate of renovation of residential buildings, based on these financial incentives. Table 1 presents the existing and future measures in accordance with the long-term strategy to stimulate investments in energy renovation of buildings for residential buildings.

*Table 1 Overview of existing and future policy measures for the residential sector in Slovenia*

Measure	Status
ECOFUND: Financial incentives for energy-efficient renovation and sustainable construction of residential buildings (Scheme feedback and grants, demonstration projects)	Existing measure, with possibility for extension
Aid scheme for energy renewal for deprived households	Existing measure, with possibility for extension
Aid scheme for energy renewal for deprived households	Existing measure, with possibility for extension
Compulsory division and calculation of heating costs in residential and other buildings according to actual consumption	Existing measure

ENSJET: Energy FREE advice network for citizens	Existing measure, with possibility for extension
Instruments for financing the renovation of buildings with multiple owners	Not implemented yet
Division of incentives between owners and tenants in apartment buildings	Not implemented yet

### 2.1.5.2 Building practice

The most common dwelling type in Slovenia is a single family house. These are mainly built by young families, who lived in apartments before taking a loan in banks and before deciding to invest in buying the property for building. Building an own house is one of the largest projects which individuals encounter in the course of their life.

At this level the different jobs that can be performed in a specific order can easily lead to mistakes and consequently to loss of time and money. Therefore, it is necessary to plan the project strategically correct. In terms of building energy efficient house, some of the households are interested in getting an energy advice on building, which is possible to get by **ENSJET advisors** which are involved in Regional energy agencies, but this kind of advice is not obligatory to receive, it is done by investor's initiative.

Looking at sustainable building practice, until now Slovenia did not have such instructions regarding the building specifics for private homeowners. Currently investors involve architects for construction planning. Sustainable solutions are only considered when the investor asks the **architect** to do so. **Very rarely homeowners involve one of the energy advisers for buildings.** Mostly information for private sustainable buildings, comes from architects or from highly educated groups of people, but it is not mandatory to involve them.

## 2.1.6 Country context for renovation to NZEB in The Netherlands

### 2.1.6.1 Policy context

The Dutch Government has, together with many key organisations, agreed to far-reaching energy savings and sustainable energy production. In the 2013 Energy Agreement for Sustainable Growth, the Netherlands committed to having a sustainable energy supply system in place by 2050, to reducing CO<sub>2</sub> emissions by 80-95% by 2050, and to achieving 16% renewable energy generation by 2023. This is also known as the '**national energy agreement**' (Nationaal Energieakkoord) in the Netherlands. Energy saving in the built environment is one of the sectoral goals. The Association of Dutch municipalities, the associated companies of the building industry and also the national environmental organizations joined the approach of energy saving in the built environment. The Dutch government developed financial solutions like subsidies and mortgages specially designed to improve the energy savings for step-by-step renovations and NZEB renovations. By the bottom-up approach 'Stroomversnelling Koop' the government tries to stimulate a faster and cheaper manner to realise zero energy concepts.

The Dutch Government stimulates the solutions with financial solutions like subsidies, loans and/or money for the innovative processes.

The **social Housing sector** in the Netherlands has about 30% of the housing market. Because of the relatively clear ownership and the relatively huge mass of dwellings owned by just a small group of decision-makers, this sector is able to set an example for energy renovations. Process optimisation and cost

reductions can be more easily obtained in this sector which is determined by turnkey solution providers. The sector of privately owned dwellings, however, is a lot more complex as it is characterised by the large amount of decision-makers with dramatically different priorities, financial leverage, knowledge and trust in the supply side of the building sector. On the other hand this sector can directly benefit from the progress made in the social housing sector.

#### 2.1.6.2 *Building practice*

The Netherlands has a long tradition of constructing houses with stone, concrete and wood. There are large companies (more than 1,000 staff) to small construction companies with only a few employees. The bigger companies are building the major projects/large scale, the smaller companies deliver de more locally small numbers of houses. The larger companies have budgets for innovation. The smaller companies are working powerfully to show their own solutions and to sustain them.

In The Netherlands, before conducting an NZEB renovation with structural changes or changes on the outside of the dwelling, a **permit** is necessary. It is recommended to appoint an architect to get this permit, but working with an architect is not mandatory. For adding insulation on the outside of buildings standing on the alignment, special procedures have to be followed. These procedures can be very time-consuming at this moment.

The deeper analysis of the country context for renovation to NZEB in The Netherlands is to be found in Annex 5.

#### 2.1.7 **Country context aspects**

From the above it is clear that country contexts differ on many aspects.

The country context is shaped by the **policies in place and those under development** as a national translation of EU directives. While national targets, either already translated up to the sector buildings or even up to the sector residential buildings have been set, specific incentives to stimulate deep or NZEB renovations are not existent yet, under development or in an embryonic stage. Especially the existing financial solutions through specific subsidies and loans have incentivised renovations, though not specifically deep or NZEB renovations. If these more complex renovations are to be stimulated, specific support policies and subsequent financial incentives have to be put in place. These policies and financial incentives will have to carefully take into account the specific challenges in organisation, process and considerably higher investments needed for deep and NZEB renovations. Otherwise these policies will continue to result in potentially locking-in shallow renovations.

Second, the country contexts are shaped by the **housing market, i.e. the housing stock and its tenure**. These aspects determine the focus of policies, but also the pace in which progress can be made, for example the context in the Netherlands with a huge social housing sector, the stock of apartment buildings in Estonia or the situation in which households live in apartment buildings until a single family house can be purchased in Slovenia.

Third, the **general building practice and more specifically the roles of key-actors** like energy advisors, and architects, which can be involved either obligatory or on a voluntary basis. These key-actors have the necessary knowledge or skills to support the homeowner, though in many cases the advantage of involving them is hindered by the (perceived) high upfront cost. Additionally in some countries it is not mandatory to involve them, in some cases not for shallow renovations but yes for NZEB renovations, in particular when financial support through subsidies is being sought. This means that households do not always meet the

necessary key-actors. A such households with an intention to go for a shallow renovation might never meet experts with the necessary knowledge about NZEB renovations and can easily end up in a lock-in.

Which directly touches upon a fourth important aspect, which is the **readiness of the building sector itself**. From the above it is clear that expertise is increasing, though not yet up to the level needed. Due to the more complex challenge of deep or NZEB renovations, it is to be expected that the building sector in which turnkey solution providers are present make faster progress than where a more fragmented construction sector is present.



## 2.2 POTENTIAL MARKET GROWTH

In this section the potential market growth for NZEB renovation is described for each REFURB partner country.

Possible questions to be answered are:

- Which are the different market players?
- What is the state of the built residential environment in the country?
- What is the size and breakdown of the market of dwellings to renovate?
- What is the distribution in terms of coverage and size?
- What is the potential market growth till 2020 and beyond?

### 2.2.1 Potential market growth in Belgium (Flanders)

The findings from 'Groot Woononderzoek 2013' (Steunpunt Wonen, 2013) provide a good indication of the market potential for renovation packages in the Flemish Region: 70% of residential dwellings are owner-occupied. When looking at renovation measures for the building envelope, there is a limited improvement potential for double glazing (23%) and roof insulation (30%) but a larger potential for wall insulation (55%) and floor insulation (60%). 82% of the dwellings have central heating installed, however, the presence of Renewable Energy Sources (RES) is very limited (10,5%).

When looking at the facts and figures in this research, one can conclude that there is still ample scope for energy saving actions and NZEB renovations. The residential building stock is quite outdated and in many cases, only small renovation interventions have been done.

Although the above studies provide us with a plethora of data on the existence of renovated building envelope parts and technical installations, they do not provide any information on the **quality** thereof and especially about the existence of **thermal bridges** in between all these partial renovations, nor the **real performance of technical installations** in the field nor possible **lock-in** effects. The latter information is important to assess market potential for (partial) NZEB renovations, not just the market potential of improving the energy efficiency of part of a building envelope or technical installations.

Regarding the **building envelope**, roof insulation and insulating glazing are becoming mainstream in both apartments and single family houses. Based upon those numbers in 2013 there is a potential of about 30% of these solutions. For wall/facade, floor insulation and insulation of pipes, however, there seems to be more room for improvement. Those interventions are present in less than half of the Flemish dwellings. So, the insulation of dwellings in Flanders is improving, but there is still room for much more energy gains through insulating (**Error! Reference source not found.**). Bearing the above remarks in mind, this might mean that NZEB or deep renovation packages don't necessarily need to offer the whole package as, for example, the roof could already be well insulated. Quality checks will have to point out whether the already existing measures are already NZEB-renovation compliant or not.



Figuur 1- Presence of insulation in dwellings in Flanders in 2005 and 2013 (Source: 2005: Woonsurvey, 2013: Groot Woononderzoek (both based on interviews))

The same goes for already replaced and thus improved **technical installations**. The above data demonstrate that especially in houses with heating oil installations there still is a lot of room for improvement. In case of replacement of old, energy-inefficient boilers, most work is to be done in dwellings with heating oil boilers. While there is less work in the category with natural gas boilers, it still is possible that the existing installations are not NZEB-renovation compliant. Apart from these two types of boilers used for central heating systems, there are also still dwellings without central heating.

There is still a huge potential for integrating **renewable energy** in Flemish dwellings. Solar PV panels are present in 8% of the Flemish dwellings. Other types of renewable energies installed in Flemish dwellings barely reach 1% of the total housing stock.

When the types of dwellings are considered, **older dwellings (< 1970), private/social rental houses and rooms or studios** have a higher technical potential for renovations as these categories are generally less insulated and some of these categories do also underperform on the level of upgrade of technical installations. But at the same time these categories might coincide with the **socio-economical categories** which have less improved dwellings due to their payment capacities and/or awareness on the issue. The reason of their lower involvement in the implementation of renovation measures now might be exactly the same reasons for which they will not be involved in future NZEB renovation programs. So, these socio-economic background characteristics of households have a very big influence on the presence of insulation and sustainable technical insulations in dwellings. This survey indicates that households with the highest income, the highest training level and the highest activity status have executed energy saving interventions way above the Flemish average. Therefore, those households will be the most easy to involve in future pilot NZEB programs. The share of this dweller segment which has not yet done so can be considered as high potential. It is, however, to be seen up to which extent the already reaped low-hanging fruits could

jeopardize further improvements (lock-in) in the already renovated dwellings of this high-potential segment.

The deeper analysis of the potential market growth in Belgium is to be found in Annex 3.

## 2.2.2 Potential market growth in Denmark

The Danish Building Research Institute has analysed the potential market growth until 2020 and later (Wittchen, 2009). According to the study there is a potential for profitable energy savings between 20-50% depending on the age of the buildings and condition of the building envelope. Other studies have shown that there is a technical energy saving potential between 65-75%. In these studies, however, no attention was paid to non-technical barriers and preservation value of the project. (Danish Building Association, 2012).

For **shallow energy renovation** of the building envelope in Danish buildings an energy saving potential of DKK 198 billion (EUR 26,4 billion) and 10 TWh (20-30% energy reduction and a payback time at 15-25 years) was calculated. For this scenario the cost can be minimized to 20% of the total costs if the energy investments are carried out at the same time as the rest of reconstruction and renewal initiatives in the house.

For **deep energy renovation** (super low energy) in Danish buildings the energy saving potential has been calculated at DKK 561 billion (EUR 75 billion) and 21 TWh (47% energy reduction). For this scenario the cost can be minimized to 40 % of the total costs if the energy investments are carried out at the same time as the rest of reconstruction and renewal initiatives in the house.

The potential for energy savings in improving the technical installation of dwellings is DKK 36 billion (EUR 5 billion). (Wittchen, 2009).

The deeper analysis of the potential market growth in Denmark is to be found in Annex 4.

## 2.2.3 Potential market growth in Estonia

### 2.2.3.1 Market players

Considering specifics of the Estonian housing stock, any initiative related to **apartment buildings** will have a huge impact. About 75% of people live in owner-occupied apartments and they are organised in Associations of Homeowners. A large share of these associations are members of the Union of Associations of Home Owners. The Union has a significant role in renovation activities in Estonia. They represent their member associations legally if necessary, organize trainings and awareness raising campaigns and they cooperate with other stakeholders.

The **Ministry of Economy and Communications** is the coordinating body of renovation activities in Estonia. The Ministry initiates all necessary updates of legal background for renovation and allocates the appropriate funds.

The **KredEx Fund** with its Housing Division is the implementing agency of all state-wide renovation measures. KredEx supervises the implementation of legislation concerning financing and renovation. The

KredEx Fund also initiates training courses necessary for the implementation of these measures and conducts surveys and follow-ups of renovation activities.

When the renovation subsidies were launched a few **construction companies** have started to specialize in particular in the renovation of apartment buildings. Several of these companies also offer maintenance services after construction works are finished.

The **knowledge partners** in this process are TTK University of Applied Sciences and especially Tallinn Technical University. These institutions carry out most surveys initiated by the KredEx Fund and make suggestions for further development.

#### *2.2.3.2 State of Built environment*

As mentioned above 50% of the housing stock consists of **apartment buildings built between 1960 and 1990**. These are concrete buildings with similar or only slightly differing floor plans according to the once progressive ideas of Le Corbusier. These buildings were built when oil was cheap and thus are **insufficiently insulated** according to present needs. Buildings built in the 1960s and 1970s show signs of concrete corrosion and are in need of urgent repair. Insulating them would not only make them more energy efficient but would also stop concrete corrosion (carbonization) and prolong their lifetime. Additionally the similarity in morphology of such a big share of the housing market offers a huge opportunity for standardized renovation solutions and scalability.

Another 25% of residents live in other types of apartment buildings. These are also in need of renovation but they do not constitute a group with common characteristics. Some of them are brick buildings with massive walls from 1945 to 1960. Some are wooden three-storied houses from the Interbellum and some are built after 1990 with varying quality.

Up to now close to 700 apartment buildings have been renovated with the help of subsidies.

#### *2.2.3.3 Size and breakdown of the market of dwellings to renovate*

Since 2009 1.4 million m<sup>2</sup> of dwellings have been renovated representing about 7% of the target market. This renovation reduced CO<sub>2</sub> emissions by 15 000 tons per year and energy consumption by 70 GWh per year. about the amount of **dwellings (living units) in this apartment block segment is estimated at 10 000** .

Besides the apartment buildings, 25% of the population is living in single family and semi-detached houses. There have been some pilot projects renovating those houses but there the need to renovate apartment buildings has priority.

#### *2.2.3.4 Potential market growth till 2020 and later*

As 7% of the renovation market has been completed in 7 years there is much work ahead to be done. It is considered that the renovation rate can be at least doubled. In any case there is a potential for 930 GWh of reduction in energy use and over 200 000 tons of CO<sub>2</sub> reduction per year. **Estimated renovation from now to 2020 is another 7% of the targeted segment** - 15 000 tons of CO<sub>2</sub> reduction per year and 70 GWh of reduction in energy consumption per year.

## 2.2.4 Potential market growth in Germany

### 2.2.4.1 Market players

The supply side of the market for (NZEB) renovation in Germany is dominated by **manufacturers of heating appliances** on the one hand and by **manufacturers of insulation materials and systems** on the other hand. There are basically a few dominant market players in each category. Some of them also produce solar energy appliances, but in this special field there are additional important market players.

Next to manufacturers, the supply side additionally consists of **craftsmen and contractors** who are responsible for the installation of the products the manufacturers provide. These are usually many small companies who work locally and regionally and do not hold dominant market positions.

### 2.2.4.2 Description of the German housing stock

The housing stock in Germany consists of approx. 41 M dwellings in 18 M residential buildings. Most of the residential buildings (85%) and also most of the dwellings (58%) are in the ownership of private individuals. A second amount are the residential buildings resp. dwellings that are property of community associations, which means a group of private individuals, mostly managed by property professionals. The 3 types of housing companies (private, municipal, cooperative) have almost the same share in residential buildings (app. 1.7%) and dwellings (5-6%). Owner and tenant rates show a characteristic share in Germany (app. 45%/55%). These rates differ between East and West Germany and between urban and rural areas. In Saxony-Anhalt the share is 42%/58%.

Almost  $\frac{3}{4}$  of the residential buildings were built after 1950, predominantly during the 1960s and the 1970s in both parts of Germany. Considering the age of the building stock, there is a significant gradient between East and West Germany. The share of the dwellings in older buildings (built before 1949, so called "Altbauten") in East Germany incl. Berlin is about 40%, in West Germany 20%. Most dwellings that were built between 1950 and 1990 in West Germany are single-family houses, while in East Germany larger multi-family houses became dominant. After 1990, the differences between East and West disappeared. The share of the dwellings built after 1990 is app. 17% (East) and 20% (West).

When one would like to determine the predominant type of housing, the point of view is important. Considering the number of houses, single- and double-family houses dominate the housing stock (83%), the remaining share is dominated by residential buildings with 3 dwellings and more. Considering the number of dwellings, only a share of 47% is located in the single- or double-family houses, almost 52% are in multi-family houses. By the number of dwellings, there is obviously a distinct difference between East and West Germany: In the East almost  $\frac{2}{3}$  of the dwellings are located in multi-family houses,  $\frac{1}{3}$  in single- and double-family houses (Sachsen-Anhalt 43%/56%).

The predominant share of the dwellings is heated by central heating systems (70%), widespread all over urban and rural areas in Germany. So called „Einzel- oder Mehrraumöfen“, enclosing electric storage heating systems (Nachtspeicherheizungen) are mainly located in southwestern Germany. Self-contained central heatings (Etagenheizungen) are mainly located in urban areas in West Germany. District heating systems are mainly located in East Germany.

The energy consumption of the housing stock has been decreasing for a couple of years. For room heating in private households, on average 147 kWh/m<sup>2</sup>/y were consumed in 2012. The energy performance of the various building parts is quite different. A little more than 40% of the exterior walls are insulated. The insulation rate of the top floor resp. the upper floor ceilings is about 76%, the insulation of the basement

floor ceilings is only about 37%. All these insulation rates also depend on the year of construction (older buildings with lower rates). Most residential buildings are equipped with at least double glazing (94%), ca. 3% even with triple glazing. Only a small number of buildings is equipped with single glazing windows (2.5%). Ventilation systems are not very widespread in the housing stock. Only 1.5% of all residential buildings are equipped with these systems, ca. 50% of them with heat recovery. Ca. 9% of buildings constructed after 2005 are equipped with a ventilation system, most of them with heat recovery. The main energy sources of room and water heating are natural gas (50%/43%), heating oil (29%/24%), district heating (13%/11%), electricity (6%/22%) and wood (16%/3%). Only a small share is solar powered (2%/4%) or uses geothermal/environmental energy (1%/1%).

#### 2.2.4.3 Potential market growth until 2020 and later

The estimated annual renovation rates range between 1% and 2%, with reference to the insulation of the outer walls, roofs/top floors and basement floor ceilings. The annual replacement ratio of the heating supplies in residential buildings is about 3%. The average annual renovation rate, referred to residential buildings in Germany, is about 1%. Power generation equipment that uses renewable energy sources is not widespread yet. Only 6% of residential buildings were powered exclusively by renewables, furthermore 13% are partially powered by renewables.

Assuming that renovation rates stay constant until 2020, **insulation measures will be undertaken in up to 10% of the buildings. Heating appliances will be replaced in about 15% of the buildings.** Depending on the building types that are subject to renovation, the share of dwellings affected by these measures can be much higher. The spread of renewables will probably increase further in the near future, as the combination of standard appliances with technology that uses renewables is establishing further. The intense or exclusive use of renewables only works for very well insulated houses (NZEB) and will be an exception in the next few years.

## 2.2.5 Potential market growth in Slovenia

### 2.2.5.1 Different market players

Apart from the building sector itself, the important market players who can support deep dwelling renovations in Slovenia are listed below:

Market Players	Role
Slovenian Energy Agency	Building Regulations, Building guide with ENSVET ADVISORS, Energy performance declarations
Municipalities	They have local climate and energy plans and want to support initiatives that can boost green growth and energy savings, but with limited resources.
Energy consultants, ENSVET	Educated to carry out Energy Performance certificates from the Slovenian Energy Agency

### 2.2.5.2 The state of the built environment

There are no systematic analyses of the quality of Slovenian housing stock available. Different studies focus particularly on problem areas in the local environment. One very important area of quality is energy efficiency, because Slovenia is a rather cold country.

**Residential buildings in Slovenia, built before 1980** are considerable energy consumers, because of the poor thermal insulation of the building envelope and therefore offer an immense energy saving potential.

Buildings from early post war period are built without of thermal insulation. The situation was slightly improved after 1967, when new regulations, defining minimum requirements, came into force, but the first serious regulations regarding only the building envelope was put into force in 1980. The effect of building practice in the past is clearly demonstrated in Table 2.

*Table 2 Yearly energy demand for room heating according to building periods in Slovenia*

Yearly need of heat (kWh/m <sup>2</sup> a)									
Year of construction of the building	by1965	by 1968	by1977	by 1983	by 1990	by 1995	After 2002	Low energy building	
Single family house	> 200	150	140	120	120	90	60 - 80	< 60	

(information in table provided by ZRMK; Slovenian national building institute)

Calculation of the annual efficiency of existing and new modern boiler showed that the application of enhanced thermal insulation alone does not produce the desired energy savings if the outdated heating system remains. In older residential buildings constructed before 1980, it is technically possible to reduce energy consumption for heating by 50 to 60%. It is possible to reduce up to 30% the energy use with investments with payback times of less than 10 years. As seen in the table the yearly need of heat is extremely connected to the façade insulation of the buildings, since the energy performance of the building envelope is determined by the building period. Achieved energy measures are largely dependent upon the attitude of the owners of buildings to energy efficiency. Since the country is expected to outline more incentive programs, such as mainly financial incentives for residents to energy-efficient, cost-effective decisions in the reconstruction and maintenance of their buildings. The above data show a large technical potential with clear financial returns.

## 2.2.6 Potential market growth in The Netherlands

In the Netherlands, according to the Environmental Assessment Agency, the goal set means that 80% of the 7,5 million dwellings (6 million) are to be renovated to energy-neutral levels in the next 35 years, which equals to 170 000 homes per year. This means there is an enormous potential growth possible to the supply side for NZEB solutions in the existing dwellings. Especially the **bigger companies** who are specialised in prefabricated solutions in a one-step approach are tapping this potential. The **smaller companies** are more likely to support the more staged approaches.

A lot of **buildings realised between 1950/60 and 1980/90** can be qualified as poorly insulated, noisy and subject to moisture problems. These types of buildings represent a huge quantity. For the supply side these dwellings are a big opportunity to apply the NZEB-approaches.

The deeper analysis of the potential market growth in The Netherlands is to be found in Annex 5.

### 2.2.7 Parameters of potential market growth

In section 2.1.7 important aspects regarding the country contexts which allow a better appraisal of the scope for deep or NZEB renovations were shown. While the former aspects sketch the contexts to be taken into account, some of these aspects appear again when a first idea of the potential market growth for deep or NZEB renovations is to be made. For example the composition of the housing stock combined with a more qualitative evaluation of the state of this housing stock.

However, most of the available studies or numbers should be looked at with the necessary precaution. There is **ample technical potential and clear benefits from an environmental and financial point of view** have been calculated or can be estimated starting from the state of the stock. The real potential, unfortunately, cannot be assessed on a technical basis alone, neither a purely rational financial cost-benefit analysis with payback times. Second, a state of a building stock cannot be completely assessed on the basis of the presence or absence of certain measures in the building envelope or technical installations. Such a binary approach doesn't say anything about the quality of these measures, the possible obstruction they might cause (lock-ins) to further improvements and full or partial renovation packages. Third, a macro-level assessment can be valuable at a national policy level and it is difficult to translate this to a potential at decision-maker or household level.

There is ample technical potential, but as REFURB partners' experience shows, it is not the technical or financial potential alone that will determine the take-up of NZEB renovation packages. For the other components of the full potential no studies are available.

Still, experiences in **customer relationship management** which are being built-up throughout the EU in local renovation programmes can be valuable. The concept of customer journeys from awareness raising up to the actual realisation of a renovation, and a follow-up of the drop-out numbers and motivations can shed further light on the matter. These approaches take into account the **final decision-makers**, those who'll decide to go for it or not, all the optimistic technical and financial cost-benefit appraisals aside. This is part of the so-called non-technological solutions which have more attention for the demand side.



## 2.3 MAPPING THE NON-TECHNOLOGICAL SOLUTIONS FOR RENOVATION TO NZEB

This section presents renovation solutions or initiatives in tables per REFURB partner country. The tables contain a selection of relevant solutions identified by REFURB partners in their country. The solutions contain either important aspects which should be taken into account when renovation packages are composed or are initiatives upon which attractive NZEB renovation packages can be built. Some are country-specific and then others can be inspiring for other countries. Both existing solutions and solutions close to market introduction are considered. A complete list of identified solutions for renovation to NZEB for all countries concerned, can be found in Annex 1.

In general two categories of solutions can be distinguished: **technological solutions and non-technological solutions**. While the final reduction of energy consumption and the increase of renewable energy production in a dwelling are a result of technological solutions (use behaviour aside), the non-technological solutions shape a package. The latter make the package compelling, more easily attainable or digestible, affordable etc. A compelling offer or renovation package cannot solely consist of technological solutions.

The technological solutions are less country-specific and are listed in section 2.4.

### 2.3.1 Mapping non-technological solutions for renovation to NZEB in Belgium

Table 3.1 – Selected best practices for renovation solutions in Belgium

Name of solution	Brief description or key features	Example(s)
Advanced renovation loans	Loans for (NZEB) renovations by local authorities or other parties (such as financial parties). These loans could be linked to energy performance (e.g. NZEB-level) in order to profit from the conditions (low rate, long term loan)	Example(s): Revolving Fund (Dutch: 'Rollend Fonds') Limburg, TRIODOS
Demonstration projects	Demonstration projects of building renovation in Flanders	Example(s): VLAIO Living Labs such as RenBen, Renoseec, Werfgoed, Samen bouwen aan een duurzame (t)huis/Blekerijstraat
One-stop-shop concepts	<b>Error! Reference source not found.</b>	Example(s): Turnkey Bostoën, RenBEN
Demonstration building of NZEB renovation	Demonstration buildings to showcase NZEB solutions and to prove its feasibility	Example(s): Villa Sanseveria; Living Lab Think!e; FutureFantastic; Spiere
Online website and community	Website and community initiated and administered by an independent organization (NGO) to offer independent advice and to disseminate activities	Example: Website Ecobouwers, VIBE
Renovation coaching, either public initiatives (local authorities and/or independent organizations) or private initiatives (commercial/market players as part of their service/product)	Assisting and coaching homeowners for installing renovation solutions (such as roof insulation) or advice (such as info points)	Example(s) public initiatives: roof insulation coach LEVANTO; social roof insulation project 'Energiesnoeiers' and KOMOSIE; ECO-housedoctor Antwerp; regional service points sustainable building; Energy coach Gezinsbond Example(s) private initiatives: Lampiris, Van Marcke (Big Blue), Verelst
Decision-making tools for building professionals, specifically for (NZEB) renovations	<b>Error! Reference source not found.</b>	Example(s): RENOFASE tools (design guidelines, diagnosis tool, CashFlowSimulator)
Supply side workshops	Training workshops or coaching sessions with building professionals to exchange experience and knowledge in order to form new collaboration structures and business models	Example(s): Business Zoo COHERENO

### 2.3.2 Mapping non-technological solutions for renovation to NZEB in Denmark

Table 3.2 – Selected best practices for renovation solutions in Denmark

Name	Brief description or key features	Example(s)
<p>'Bygningsguiden' Building guide WIKI - a online tool for building professionals and the "do-it-yourself"-type with technical insight</p>	<p>A new online tool from December 2015. Managed by the Danish Energy Agency. Divides Danish single-family houses into typologies and for each type describes typical energy saving solutions and maintenance features. The tool is found at <a href="http://www.spareenergi.dk/forbruger/vaerktoejer/bygningsguiden">www.spareenergi.dk/forbruger/vaerktoejer/bygningsguiden</a> Evaluations of the usage of the tool are not yet available..</p>	<p><a href="http://www.spareenergi.dk">www.spareenergi.dk</a></p>
<p>'Videnscenter for energibesparelser (VEC)' Knowledge centre for energy renovation of buildings</p>	<p>A huge collection of energy solutions, advises, legislations for each building part or type, calculation tools and films. The centre started in 2008 by Energy Agency and always updated to newest solutions and latest building code.</p>	<p><a href="http://www.byggeriogenergi.dk/media/1556/efterisolering-af-loft-ok.pdf">www.byggeriogenergi.dk/media/1556/efterisolering-af-loft-ok.pdf</a> PDF-files with solutions</p>
<p>'BetterHome' Step by step technology</p>	<p>3 types of packet solutions (energy packet, comfort packet, refurbishment packet). The home owner can, after carrying out an on-line energy check of his house, be contacted by a craftsman.</p>	<p><a href="http://www.betterhome.today">www.betterhome.today</a></p>
<p>'Grøn Erhvervsækst' (Green Business Growth) Public private partnership</p>	<p>Green growth through partnership, network, education of craftsmen, energy event and visualisation</p>	<p>Educated 230 energy master craftsmen in energy saving possibilities, business options and marketing/sale and the master craftsmen have achieved a growth rate at 29 %, which is quite impressive compared with a zero growth rate for other master craftsmen.</p>
<p>'BedreBolig' BetterHouses by the Danish National Energy Agency.</p>	<p>A one stop-shop initiative, where BetterHouses Consultants are educated to guide homeowners in prioritizing a holistic and hopefully deep refurbishment, step by step and provide homeowners with a BetterHouses Plan in order to get the project financed. The initiative will continue until the middle of 2016 with marketing's campaign and supporting local events.</p>	<p>Better Houses adviser offers a BetterHouses Plan (based upon an energy check and calculation of energy savings in a very well recognized on-line tool.) Education of more BetterHouses advisers will from the end of 2015 be on market conditions.</p>
<p>'Husets energi' The energy of the house provided by Scan Energy</p>	<p>Renovation advisor tools for building clients (simulation/calculation models). Can only be used in 14 municipalities, that has a contract with Scan Energy</p>	<p><a href="http://www.husetsenergi.dk">www.husetsenergi.dk</a> Owned by Scan Energy (an energy supply company).</p>

Energy Performance Certificates (EPCs)	Certificates that indicate the energy performance of existing residential buildings with a label, colour and numeric result. EPCs are required by legislation when selling or renting residential buildings	Energy label is successfully pushing energy renovation in DK, since 2011, where law has regulated it. Real estate dealers are obligated to advertise with the energy label and demand for houses with a good energy label had expanded. Reports have shown, that every time the energy label rises one-step the value of the house increase with 8.000-15.000 EUR. <a href="http://www.ens.dk/forbrug-besparelser/byggeriets-energiforbrug/energimaerkning">www.ens.dk/forbrug-besparelser/byggeriets-energiforbrug/energimaerkning</a>
Passive house certificate for renovation of existing buildings (EnerPHit)	Certificate for existing buildings renovated to passive house level by using passive house components	The passive house certificate follows the German standard/PHPP. A few houses in DK have been certified.
Renovation class 1 and 2 in the Danish Building Regulation	The building regulation has set two levels of renovation - class 1 and 2	In Building Regulation 2015 (transition time from 1/1-1/7 2016) it is possible to choose to renovate after one of the two levels. The regulations are similar to new building but on a lower level.
Product solutions to improve the building envelope of existing buildings - in situ	Some solutions are invented for renovation but can also be used for new building	Example(s): Flat roof ('ISOVER Lameltag or Taurus', 'Rockwool Hardrock', ); ETICS external insulation of walls; Wall ('ISOVER PLUS', 'RW RedAir Flex', 'Paroc Panel system', 'Paroc Cortex', vacuum insulation); Inside wall ('Skamol Skamolplus (calcium silicate board)'); Cavity walls (Granulate); Deck/floor ('ISOVER Duo', 'RW Rockorbit System', 'Jackopor' vacuum insulation); Pipe insulation
Product solutions to improve the building envelope of existing buildings - prefabricated with integration of technical installations	Prefabricated building components/elements are often developed and produced to a project by the prefab-producer often implemented with doors and windows more seldom with installations. The elements are often divided in facade, installation and bathroom-elements.	Examples: 'Paroc Innova', 'NCC skakten', 'Modulbad' <a href="http://www.paroc.dk/koncepter/Innovaprojektet">www.paroc.dk/koncepter/Innovaprojektet</a> ; <a href="http://www.ncc.dk/produkter-og-services/energirenovering/teknik/teknik-skakt/">www.ncc.dk/produkter-og-services/energirenovering/teknik/teknik-skakt/</a> ; <a href="http://www.modulbad.dk/badekabiner/">www.modulbad.dk/badekabiner/</a> ; Taasinge og Enemærke&Pedersen (see references below) can do elements with installations but it is not seen yet.
Prefab building module	A prefabricated module (with internal and external finishing) that is inserted in a building or placed as an extension to the existing building	Example(s): Enemærke&Pedersen and Taasinge <a href="http://www.eogp.dk/Kompetencer/Renovering/Klimaskaerm.aspx">www.eogp.dk/Kompetencer/Renovering/Klimaskaerm.aspx</a> or <a href="http://www.taasinge.dk/energirenovering/forsatsfacader-betonhuse/">www.taasinge.dk/energirenovering/forsatsfacader-betonhuse/</a>
Collective renovations	Collective approach to organize renovations, either on a district level, building stock level or multiple dwellings	Example: 'Føns', 'mdbl.dk'

<b>Demonstration building of NZEB renovation</b>	Demonstration buildings to showcase NZEB solutions and to prove its feasibility and	7 cases are mentioned on: <a href="http://www.go-refurb.eu/cases/">www.go-refurb.eu/cases/</a> ex. 4 houses renovated with a reduction of energy cost at 40-70 %, <a href="http://www.realdania.dk/samlet-projektliste/energiparcel">www.realdania.dk/samlet-projektliste/energiparcel</a> . and Project LowEnergy with 70 % energy education (selected best case in the tailored Danish brochure for REFURB). <a href="http://www.innobyg.dk/media/4m-ver-%201.pdf7993/case-adsb%C3%B8ll-bf">www.innobyg.dk/media/4m-ver-%201.pdf7993/case-adsb%C3%B8ll-bf</a>
<b>BuildUp Skills</b>	A plan for how to remove barriers and lack of competences by the building actors to reduce the energy consumption in buildings and improve the use of RE in buildings.	<a href="http://www.ens.dk/forbrug-besparelser/byggeriets-energiforbrug/build-skills-0">www.ens.dk/forbrug-besparelser/byggeriets-energiforbrug/build-skills-0</a>
<b>Energy loans from banks</b>	Banks offers loans with interest rate for energy-related investments from 5-6 % p.a. for investment lower than 13.000 EUR. For bigger investment for deep energy renovation is needed, it is possible to get a mortgage loan with security in the house with interest rates ranging from less than 1% to 3%	Loan Calculator on the National Energy Agency homepage <a href="http://www.spareenergi.dk/forbruger/boligen/renove">www.spareenergi.dk/forbruger/boligen/renove</a> ring mortgage loan calculator at <a href="http://www.rd.dk">www.rd.dk</a> bank loan combines with mortgage loan calculator at <a href="http://www.nykredit.dk/#/dit-liv/bolig/boligberegner/hvad-koster-laen-til-ny-bolig">www.nykredit.dk/#/dit-liv/bolig/boligberegner/hvad-koster-laen-til-ny-bolig</a>

### 2.3.3 Mapping non-technological solutions for renovation to NZEB in Estonia

Table 3.3 – Selected best practices for renovation solutions in Estonia

Name of solution	Brief description or key features	Example(s)
<b>Energy Performance Certificates (EPCs)</b>	Certificates that indicate the energy performance of existing residential buildings with a label, colour and numeric result. EPCs are required by legislation when selling or renting residential buildings. All new build and substantially renovated buildings are required to have EPC	EPC Estonia
<b>Energy agencies in Tallinn and Tartu</b>	Unbiased energy agencies provide free consultation for renovators both for private persons and professionals	Energy agencies in Tallinn and Tartu
<b>Renovation subsidies for apartment houses</b>	Representatives of apartment houses are eligible to apply for subsidies on renovation up to 40% of total cost of construction and 50% of cost of design, energy audit and building inspection if a house is deep renovated with good indoor climate. Subsidising includes several other services like free consulting mandatory inspection etc.	Close to 700 buildings in Estonia
<b>Founding of competence centers</b>	Competence centers are or will be founded to further knowledge and raise public awareness on NZEB and related topics	Smart House Competence centre in Rakvere; Passive House competence centre in Põlva

### 2.3.4 Mapping non-technological solutions for renovation to NZEB in Germany

Table 3.4 – Selected best practices for renovation solutions in Germany

Name of solution	Brief description or key features	Example(s)
Energy Consulting (Energieberatung) "Vor-Ort-Beratung"	Online database ( <a href="http://www.energie-effizienz-experten.de">www.energie-effizienz-experten.de</a> ) to find an approved independent energy consultant for creating an individual concept.	For either deep or staged renovation, including technical and financial aspects (e.g. subsidies). Up to 60% of the consulting costs are subsidized by the BAFA (Bundesamt für Wirtschaft und Ausfuhrkontrolle).
"ecohome" one-stop-shop	Steps in this one-stop-shop-concept: 1) visit of an approved energy consultant; 2) 'planning': consulting results are interpreted and the renovation measures are planned; 3) company assigns their partners (master craftsmen) with actual renovation measures; 4) control and certification - consultant tests the renovation success and issues energy performance certificate. In addition, the energy consultant applies for subsidies.	Energetic refurbishment of listed buildings in Halle (wilhelminian era), combination of insulation measures (walls inside/outside; new windows) and new heating system; energy saving 75%
Renovation Guide (Sanierungsleitfaden Baden-Württemberg)	online based information platform that guides the homeowner through a complete renovation process (10 steps including central information, planning the process, financing, finding approved experts, building process issues)	
Online tool "Sanierungsrechner effizienzhaus-online"	Online tool: You input the main facts and figures of the house you want to refurbish and get information about the different possibilities of insulation (cellar, walls, roof), new heating systems and the use of renewables, including the approx. costs of the measures, the annual savings and the amortisation time. you can compare different configurations. short information about possible subsidies, referring to the single measure; you can directly request offers from craftsmen via online template	
KfW programmes: loans and grants/subsidies for energy efficient renovation (Kreditanstalt für Wiederaufbau)	KfW is a government-owned development bank in Germany, which is, amongst others, active in the field of housing and environment and specialises in supporting energy efficient renovation and building. The bank provides loans at reduced interest rates or grants/subsidies to homeowners for energy efficient renovation (deep or staged), loans for converting the heating system towards renewable energies and grants/subsidies for having your energy efficient renovation supervised	KfW programme 430 "energy efficient renovation": Investment grant up to € 30.000 per dwelling for insulation (walls, roof, ceilings), new windows, new heating system, solar thermic and PV panels



	<p>by a professional. In addition, loans are provided for using solar energy for power generation and for using storing technologies.</p>	
<p><b>"Energieausweis": Energy Performance Certificate for Buildings</b></p>	<p>When building, changing or expanding a building, the 'Energieausweis' has to be issued and presented by request. The EnEV (Energieeinsparverordnung) is a law in Germany, that regulates the requirements buildings have to meet regarding energetic standards and it also contains the duty for issuing 'Energieausweise' for buildings. For existing buildings, the 'Energieausweis' can be issued based on either a calculation of the energy demand or a measurement of the energy consumption, depending mainly on the year of construction and the use of the building. Publicly accessible buildings have to display their 'Energieausweis' visibly. Each 'Energieausweis' contains tips for cost-efficient renovation measures.</p>	<p>If you want to sell a house, it is compulsory to hand out the EPC of that building to the prospective customer. Unrefurbished single family homes often are assigned to EPC classes G (200-250 kWh/m<sup>2</sup>/a) or H (&gt;250)</p>



### 2.3.5 Mapping non-technological solutions for renovation to NZEB in Slovenia

Table 3.5 – Selected best practices for renovation solutions in Slovenia

Name of solution	Brief description or key features	Example(s)
Favourable subsidies for energy efficiency of private households and blocks of flats (ECO FUND)	<p>Yearly call for energy efficiency measures in the private households and blocks of flats (based on nature friendly materials). There are two different kinds of calls:</p> <ul style="list-style-type: none"> <li>• Call for efficient use of energy (outside furniture, insulation of facade, roof, floor and basement systems for ventilation, heat pumps, )</li> <li>• Call fro renewable energy; heating on biomass, sun collectors, small solar, wind and water power plants, micro production of heat and electric energy, ...</li> </ul> <p>Max subsidy is 50 %, average 20-30 % of investment</p> <p>It is the only specialised institution in Slovenia that provides financial supports for environmental projects. The financial assistance is offered mainly through soft loans from revolving funds and since the year 2008 through grants. In comparison with commercial banks, Eco Fund’s principal advantages in the market for environmental financing are that it provides soft loans at lower interest rates than prevailing commercial market rates and it is able to lend for significantly longer periods than commercial banks.</p>	Kranj Planina area – blocks of flats
Network of the counsellors (EN SVET)	National network of counsellors for support to citizens (mostly located in city communities in the state), giving daily support to answer to questions of the inhabitants regarding energy efficiency and renewables	Counsellors in Kranj, Tržič, Škofja Loka, Jesenice (in our region)
National concession for the energy audit (based on the law and under jurisdiction of the National ministry for environment)	National scheme; special concessions- certificate gained based on the special training; special experts evaluating the houses regarding the energy consumption and then the houses are divided into classes (based on the special evaluation criteria)	National scheme – obligatory for all the houses that are on the market (by the law after 2020 the certificate will be necessary for all the houses (not only for those on the market)

### 2.3.6 Mapping non-technological solutions for renovation to NZEB in The Netherlands

Table 3.6 – Selected best practices for renovation solutions in The Netherlands

Name of solution	Brief description or key features	Example(s)
<b>Slim Wonen In Leeuwarden</b>	<p>Slim Wonen In Leeuwarden aims to help and advise home owners and offer special deals at selected moments. The key difference to many other ‘one stop shops’, or marketing in general, is that a customer management system is used. This based on tailoring the provision of information or offers to the stage of awareness or demand in which the customer is. Therefore the ‘customer journey’ is central. As well as this, the scheme works with firms that offer en one stop shop service and a unique quality assurance promise.</p> <p>All home owners who live in the council area have in one way or another received information about the one stop shop. Detailed monitoring has been carried on the effect. This has provided valuable information about the effectiveness of the customer contact moments and offers. The results are quantitative in nature. An in depth qualitative analysis of the value of the scheme would add to a knowledge about the effectiveness of the scheme in terms of the added value to home owners. From conversations, and from the views of the buildings firms involved, it is believed that home owners have more trust in the scheme because of the involvement of the local council.</p>	<p>One stop shop counter in Leeuwarden (Fryslân) and Groningen</p>
<b>Stroomversnelling Koop</b>	<p>Stroomversnelling is a Dutch-based cooperation that strives to combine supply and demand, regarding the refurbishment of private terraced houses (building period: 1950-1980), on a large scale and quick manner. In this way zero-energy building can be realised, which results in savings and a more comfortable way of living for the homeowner. The cooperation consists of 200 parties, including municipalities, energy cooperatives, construction companies, distribution channels, financial institutions and real estate agencies. The founders concluded that with an investment of € 45.000,- the monthly repayment and interest costs are equal to or lower than the energy usage costs prior to the refurbishment. The renovation can be financed by the homeowner’s private money or with the use of a loan or additional mortgage. The affiliated financial institutions are willing to explore an additional loan construction, making use of the energy costs savings of the homeowner. Several pilots have already been completed and communicated, and multiple municipalities are currently developing their first pilots.</p>	<p>Apeldoorn, Soesterberg, Gorredijk (Fijn Wonen)</p>



<p>Lokaal alle lichten op groen (demand + supply approach)</p>	<p>This initiative derived from Energiesprong and strives to improve the market conditions in regards to zero-energy renovations. This is being executed by 20 pilots wherein houses are being renovated into zero-energy buildings. As a result of this, several stakeholders, such as homeowners, municipalities, builders, contractors and banks will gain practical experiences that can help them in detecting barriers and finding solutions to overcome them. The programme supports them in this process.</p> <p>‘Special treatments’ are being offered to homeowners in the form of additional support, a technical consultant, excursion trips. The municipality of Amersfoort implemented a crowdsource initiative, wherein a group of people (professionals and amateurs) try to come up with a product or innovation that can be used for a ‘show house’. They also activated an innovation team and a marketing plan to ensure new building renovations. Besides that they gathered street ambassadors. Several homeowners already committed to a zero-energy renovation</p>	<p>Helmond, <a href="http://allelichtenopgroen.nl/projecten/pilot-nom-afttrap/">http://allelichtenopgroen.nl/projecten/pilot-nom-afttrap/</a></p>
<p>Meer met minder</p>	<p>Meer Met Minder is a cooperate initiative of construction and utility companies. People can approach the organization if they would like to be consulted on personal energy-saving measurements. Several companies are linked with Meer Met Minder. They execute the measurements after a homeowner has given order to do so. In this way an incremental approach is being used to improve energy labels. This approach gives municipalities, business consortia a current and historical overview in the improvements of energy labels on a wider perspective. The modules makes it possible to measure packages for the improvement of energy-saving indexes of buildings</p>	<p>Several examples</p>
<p>Blok voor Blok</p>	<p>In blok voor blok market players took the initiative to develop concepts that can result in largescale energy savings in the existing housing stock. It concerns the development of marketing strategies, financial constructions and quality insurances. Between 2012-2014 14 projects were launched, monitored by the Dutch Ministry of the Interior and Kingdom Relations. A ‘block-to-block’ approach was used to gain experience in renovations that will lead to energy efficient houses. Around 20.000 houses were renovated. It led to the following conclusions:</p> <ul style="list-style-type: none"> <li>- a uniform renovation model is not possible in the private housing market</li> <li>- a personal approach to homeowners will lead to the highest demand</li> <li>- projected in the private housing market are rarely profitable</li> <li>- construction companies are still restrained</li> </ul>	<p>Groningen, Slim Wonen met Energie</p>

<b>Reimarkt   renovation shop (demand + supply approach)</b>	Reimarkt developed a concept with pop-up stores wherein you can buy ready to use products for keeping your home more comfortable and energy efficient. Besides the brick-and-mortar shops there is also an online presence where people can orientate themselves. Several market players are linked to the concept. This concept enables the selling of products for a fixed price. The interactive online and offline communication results in a faster customer's decision-making process. Furthermore this concept is easy scalable.	Enschede, The Netherlands
<b>Woning concepten (supply approach)</b>	This is an online platform of several building concepts related to energy efficient renovations. The concepts are being presented based on their main features. It clusters the most frequent dwellings and prototypes. For each model the costs, timespan and specifics are being outlined. It provides interesting information for constructors.	Stroomversnelling Koop, prototyping

### 2.3.7 Categories of non-technological solutions

Looking at the non-technological solutions listed in the sections above, different categories of solutions can be distinguished:

- Innovative financial models (new ways of financing)
- Online tools for management or decision making (which are partially applied by one-stop-shops either as a lead-producing tool or as a first information tool)
- Demonstration projects or showcases visible to other homeowners
- New approaches to organising the supply side through building teams of smaller craftsmen
- Quality assurance
- Renovation packages = One-stop-shop-solutions
- Other solutions (such as innovative communication and marketing)

These seem to be the most relevant categories of non-technological solutions.

Though, it is important to notice that multiple categories can be assigned to one solution for renovation to NZEB. Good solutions will likely cover multiple aspects.

## 2.4 TECHNOLOGICAL SOLUTIONS FOR RENOVATION TO NZEB

The preceding section presented the most relevant non-technological solutions per REFURB country as identified by the REFURB partners. In this section the technological solutions for renovation to NZEB are listed. The combination of these technological solutions can shape the technological aspect of a renovation package.

### 2.4.1 Technological solutions and dwelling typologies

Table 3 presents an overview of the technological solutions subdivided into three broad categories: measures in the building envelope, technical installations and renewable energy sources.

Table 3 – Overview of existing technological solutions energy renovations of dwellings.

<b>Technological solutions</b>	<b>Building Envelope</b>	Improving air tightness
		Eliminating thermal bridges
		Thermal mass
		Insulation of flat roof
		Insulation of sloped roof
		External insulation
		Core insulation
		Interior insulation
		Super insulating materials (SIMs)
		(Re)placement of windows and doors (incl. frame)
		Replacement of high-performance glazing (excl. frame)
		Super insulating glazing
		Solar shades
		Insulation of floor on soil
	Insulation of floor bordering unheated space	
	<b>Technical installations</b>	Replace heat generator with condensing boiler
		Hybrid heat-pump
		Optimize distribution/piping system
		Replace individual with collective heating system
		Integrate DHW in condensing combi-boiler
		Drain water heat recovery
		Heat pump for DHW
		Exhaust air mechanical ventilation system
		Mechanical ventilation system
		Mechanical ventilation system with heat recuperation
	LED lighting	
	<b>Renewable Energy Sources (RES)</b>	PV panels
		Thermal Collector for DHW
		Thermal Collector for DHW and heating
		PVT solar collectors
		Heat pump (air/air)
		Heat pump (air/water)
		Heat pump (soil/water)
Heat pump (water/water)		
Biomass		
Micro CHP		
Wind turbine		
Connection with DHC		
Connection with smart grid		

The applicability of some of the solutions listed above are somehow determined by the dwelling typology of the dwelling at hand. Consequently they can also be visually represented in a matrix with the solutions on one axis and the dwelling typology on the other axis. This exercise was done for every REFURB country separately and the results thereof can be consulted in Annex 2. A consolidated version for all the countries is presented in Table 4. However, some remarks have to be taken into account prior to looking at the consolidated version:

- The table gives an indication of the relation between a technical measure and a dwelling typology. However, the real applicability will always be case-specific.
- The table lists not only measures that can be assessed using conventional energy simulation tools but also measures that relate to user behaviour, lighting, infrastructure on district scale etc.
- Not only conventional solutions are mentioned but innovative solutions are listed as well.
- Eliminating thermal bridges is difficult in as-built situations (e.g. thermal bridge of a balcony in multi-family houses), aside from installing external insulation. Nevertheless, when executing a renovation by following an integrated step-by-step approach with the steps (e.g. roof insulation, replacing windows, ventilation etc.) in the right order and by taking care of certain details, lock-ins like and thermal bridges can be avoided as much as possible. Improving the thermal mass is also limited without major interventions and is in most cases limited to removing/replacing floor, wall or ceiling finishing.
- Installing floor insulation on soil requires a relatively high effort compared to installing floor insulation on the ceiling of a basement or crawlspace. After all, the existing floor on soil should be removed and replaced and often will have higher floor level afterwards what makes that several other elements (like doors, electricity, stairways, door sills,...) should be adapted to the new floor level.
- Improvements to the technical installations (such as the optimization of the distribution system (of heating and/or DHW), installing a drain water recovery, installing a heat pump for DHW) are case-specific and need an integrated approach (for instance taking into account the energy performance of the building envelope)
- Ducts needed for new mechanical ventilation systems in existing dwellings can have a considerable impact and depend on the organization of the building spaces.
- It will be more difficult to apply soil/water or water/water heat pumps to semi-detached and terraced houses as these need a considerable ground surface. Moreover, for terraced houses it will be difficult to reach the backyard with the drilling equipment to perform the geothermal drilling.
- Some items specifically relate to multi-family housing (for instance, micro CHP or replacing the individual heating system with a collective one).

Table 4 – Generic technology matrix for all countries involved

## Legend

0 = default (solution not relevant for this typology)

1 = low relevance or difficult to apply;

2 = medium relevance and

3 = high relevance or easy to apply;

		Building typologies				
		Generic				
		SFH - detached	SFH - semi-detached	SFH - terraced	MFH	
Technical solutions	Building Envelope	Improving air tightness	2	2	2	2
		Eliminating thermal bridges	2	2	2	3
		Thermal mass	1	1	1	2
		Insulation of flat roof	3	3	3	2
		Insulation of sloped roof	3	3	3	2
		External insulation	3	3	2	3
		Core insulation	2	2	2	1
		Interior insulation	1	1	1	1
		Super insulating materials (SIMs)	1	1	1	2
		(Re)placement of windows and doors (incl. frame)	3	3	3	3
		Replacement of high-performance glazing (excl. frame)	3	3	3	3
		Super insulating glazing	3	3	3	3
		Solar shades	2	2	2	3
		Insulation of floor on soil	3	3	3	2
		Insulation of floor bordering unheated space	3	3	3	2
	Technical installations	Replace heat generator with condensing boiler	3	3	3	1
		Hybrid heat-pump	3	3	3	1
		Optimize distribution/piping system	2	2	2	3
		Replace individual with collective heating system	0	0	0	3
		Integrate DHW in condensing combi-boiler	3	3	3	1
		Drain water heat recovery	2	2	2	2
		Heat pump for DHW	1	1	1	2
		Exhaust air mechanical ventilation system	3	3	3	3
		Mechanical ventilation system	3	3	3	1
		Mechanical ventilation system with heat recuperation	3	3	3	1
	LED lighting	3	3	3	3	
	Renewable Energy Sources (RES)	PV panels	3	2	2	3
		Thermal Collector for DHW	3	2	2	3
		Thermal Collector for DHW and heating	3	2	2	3
		PVT solar collectors	3	2	2	3
		Heat pump (air/air)	3	2	2	3
		Heat pump (air/water)	3	2	2	3
		Heat pump (soil/water)	2	1	0	2
Heat pump (water/water)		2	1	0	2	
Biomass		2	2	2	3	
Micro CHP		1	1	1	3	
Wind turbine		1	1	1	2	
Connection with DHC		1	1	1	2	
Connection with smart grid		1	1	1	2	

## 2.4.2 Link with building typologies - Example: Building Wiki (Denmark)

An example in which this kind of technology matrix has been used in an online tool for renovation of single family houses.

'Bygningsguiden'<sup>3</sup> is an online tool for single-family houses. The tool divides the Danish single-family house into 9 typical typologies (first roll-out was in December 2015 – final version will contain 13 typologies) and for each type an idea of the typical energy consumption, explanation of time-specific construction and installation methodology etc. is given.

From the 'front page' the typologies are pictured so the homeowner is able to find a familiar housing type of his own and by clicking on the building see typical problems and areas where to start a renovation (**Error! Reference source not found.**). The houses are described with the characteristics of the construction type at the time it was built, with solutions on how to refurbish the house but it also gives ideas of what typically can have been refurbished over time and solutions for these options.

### Find din hustype på listen



Figur 2 - Front page of the Danish building wiki ([www.sparenergi.dk/forbruger/vaerktoejer/bygningsguide](http://www.sparenergi.dk/forbruger/vaerktoejer/bygningsguide))

Solutions for the renovation of the roof, wall, windows/doors, basement/foundation, installation (heating, domestic hot water, ventilation) are described, visualised with small videos and links to potential craftsmen nearby are included. For each solution a generic calculation of energy savings is provided (**Error! Reference source not found.**).

There are also generic chapters about sustainability, architecture, indoor climate and health, security, climate adaption etc.

<sup>3</sup> Building WIKI 'Bygningsguiden': [www.sparenergi.dk/forbruger/vaerktoejer/bygningsguide](http://www.sparenergi.dk/forbruger/vaerktoejer/bygningsguide)





*Figur 3 - Example of the Danish building wiki*

The Danish Energy Agency launched the first version of the tool in December 2015, they own and maintain the tool. The target groups are craftsmen and homeowners with a certain level of background knowledge regarding buildings, who want to know more about possible energy solutions in their house.

The tool is new and there are no documented evaluations about the tool but from a subjective view and from experiences from a lot of similar tools on a lower level this tool seems to be very easy to operate and with reliable solutions and is built on top of earlier tools.

## 3 In depth analysis of non-technical solutions for NZEB renovation

In this chapter the most relevant and promising non-technological solutions identified in previous chapter are analysed in-depth.

**The main question is: how can these solutions be embedded in or support the uptake of deep or NZEB renovation packages?** Related questions are: Are the solutions related to a specific dweller- and/or dwelling typology? What is the target audience of each solution? What are negative and positive aspects of the described solutions? What is already compelling (positive aspects)? How could it be improved (negative aspects)? Which drivers are triggered with this solution? Which barriers are overcome with this solution?

Taking into account the drivers that can convince homeowners to renovate to NZEB (as mapped in report D2.2), the **non-technological solutions are more important than the technological solutions to seduce homeowners to renovate to NZEB**. Especially the renovation packages or one-stop-shop-solutions seem to be important for the homeowners. The supply side has to offer the homeowners a solution in which he is being unburdened from the task of choosing and evaluating the technological solutions. This can be done by supporting the homeowner in his decision about the best technical solution for renovating his house to NZEB, taking into account the general preferences and motivations of the homeowner.

**One-stop-shop-solutions** seem to have the highest potential to convince the homeowner to renovate to NZEB, because they offer a holistic approach.

Therefore, examples of one-stop-shop concepts in Europe are analysed in this chapter. Additionally, best-practices that can potentially be integrated in one-stop-shop concepts or renovation packages offered are elaborated.

For the purpose of this project the term ‘**renovation package**’ is meant to be: **“An easy-to-understand commercial offer to an end-user, written in non-technical language which satisfies his/her requirement for comfortable living but at a higher energy-efficiency of his/her dwelling. The offer comprises the optimum combination of technologies to be installed in the most logical sequence, tailored to the type of dwelling, the state of the building, the geography in which the dwelling is located and socio-economic parameters. Offers are understood to entail the unburdening of the end-user, so he/she is assured of an agreed higher energy efficiency without having to worry about individual technology choices.”**

### 3.1.1 One-stop-shop concepts

#### 3.1.1.1 Turnkey Renovation by Bostoën –private initiative (Belgium)

Bostoën developed a turnkey solution for renovation to unburden the homeowners in their renovation process.

This turnkey renovation is responding to five drivers and barriers of the homeowner:

- Budget control. (Guarantee for cost)
- Participation of the homeowner before and during the building process. (Comfort in process)

- One single-point-of-contact for the homeowner (for all questions about the renovation). (Comfort in process + Communication tailored to the individual homeowner)
- Clarity about the process and planning (roadmap). (Support in organisation/planning + Trust in planning)
- Masterplan. Audit on dwelling to set up a masterplan for an energy efficient renovation. This renovation can be conducted in different phases, spread over a couple of years. (Support in getting tailored advice)

To unburden the client in his or her renovation process, Bostoer determined a roadmap for renovations:

1. First acquaintance: Bostoer gathers info on the project on the site.
2. Sketch & estimate: Answer to ideas/questions of the homeowner.
3. Study agreement: Together with an architect a calculation and technical studies are executed for the renovation.
4. Proposition: Detailed offer and plans are presented to the client.
5. Contract: Starting date of the construction work is fixed/determined.
6. Final plans: The client chooses the finishing materials.
7. Execution: The construction work for the renovation is started.
8. Provisional acceptance/delivery: Termination of the construction work.
9. Service guarantees: Unburdening of the client after the execution of the renovation.

In this process communication tailored to the homeowner is a very important factor to succeed the renovation. Bostoer for example also gives tailored information on grants and other side issues to the homeowner. By this approach of overall support, tailored to the specific homeowner, the homeowners are given comfort in their renovation process. This reinforces their trust in the Bostoer (or the supply side) and assures thus the success of the turnkey renovation.

So, financial as well as technical, behavioural and contextual barriers are overcome with a turnkey approach.

The target group for these renovations are people with expected investment costs for renovations of € 100,000 or more on their renovation in one go.

#### *3.1.1.2 Better Houses (BedreBolig) seen from the supply-side perspective – public initiative (Denmark)*

**"Better Houses" is a one-stop-shop initiative from the Danish Energy Agency 2013-2016**, which includes a free education of Better Houses Consultants to guide homeowners in prioritizing a holistic and hopefully deep refurbishment, step-by-step.

The scheme also includes a national marketing campaign and meeting/workshops with stakeholders to support the initiative. The stakeholders are financial consultants, real estate consultants, municipalities, DIY etc. The supply side thinks the demand side needs **more qualified advice**. Better Houses is based on principles that make it easier for the homeowner to take decisions and to get through the energy renovation process. The homeowner has the possibility to find an educated and qualified Better Houses Consultant, which can guide the homeowner through the renovation process. The Better Houses Consultant offers a Better Houses Plan based upon an energy check and calculation of energy savings in a very well documented and tested online tool. The initiative will continue until the mid-2016 with marketing campaigns and supporting local events. Since mid-2015 the financial support for the education program of Better House Consultants stopped and is now to be paid for as the benefits of this additional education should now translate into commercial contracts.

Today 145 building companies are registered with 1 or more Better Houses Consultants (Sparenergi, 2016). In total 450 Better Houses Consultants have been educated for free (CLEAN, 2016) and the consultants are present in 66 out of 98 Danish municipalities, although more than 50% of the renovations carried out with Better Houses Consultants happened in 2 municipalities, suggesting a slightly more positive context in those two. 120.000 visitors have visited the website and 370 Better Houses Plans have been registered. The plans can be considered as “large plans” since the average budget has been energy improvements for € 32,000 (Energijtjenesten, aug. 2015). However, there is not specific focus for NZEB renovations.

The solutions in the BetterHouses Scheme are related to **detached houses (single-family houses)**. In Denmark there are 1 mio. single-family houses and 51% of all the energy used in buildings in Denmark are related to single-family houses. Mostly young families with children and empty nesters are living in these kinds of houses. The age of the dwellers in these house are between 30-75 years old.

The BetterHouses concept is targeting the **private homeowner**. The concept is targeting the drivers for feeling secure and getting help for the decisions by including a professional consultant. Also the return on investment will become clear here based on the BetterHouses Plan developed for the project.

The BetterHouses concept is a “one-stop-shop solution” as that the homeowner only has to contact one person, who can guide the homeowner through the whole energy renovation process. These persons are the educated Better Houses Consultants. The supply side has access to the scheme in an open platform and there are marketing materials for both the Better Houses Consultants, and other actors such as Building Materials Suppliers, energy supply companies, real estate dealers, financial institutions etc. It is up to them to market themselves at a locally.

The scheme does not include an offer from the supply side upfront, but the technical solutions for 9 building types and 124 cases in ‘Bygningsguiden’ (Sparenergi, 2016). The Better Houses Consultants are responsible to act professionally and holistic in their guidance of the homeowners. They do not have to be independent, but they are obliged to tell the costumer, when they act as independent advisor and when they are not. The Better Houses Consultants can have different backgrounds and agendas such as energy craftsmen, energy consultants, architects, engineers, building suppliers, energy advisors in energy supply companies.

There is no follow up on investment and CO<sub>2</sub> saved possible in the program, because of the idea, that the concept should be on voluntary and free market conditions. The Danish Energy Agency does not get the results of the Better Houses Plans or the renovation project actually carried out.

The results from 2 test municipalities showed that 35 % of the homeowners, with a Better Houses Plan, choose to carry out a refurbishment project with investments € 10,000-25,000. This is 30-80 % of the recommendations for investments in the Better Houses Plans, which in average is € 32,000.

### **3.1.1.3 Better Home – private initiative (Denmark)**

A private initiative called Better Home, started mid-2014, where 4 producers (Danfoss (energy management/thermostats), Rockwool (insulation), Grundfoss (water/pumps) and VELUX (windows)) of different kinds of energy efficient equipment for private houses are offering 3 types of package solutions (energy package, comfort package, refurbishment package).

The entrance to Better Home is through an online tool found at <http://www.betterhome.today>. On this page the homeowner enters his address and the tool collects data from a national building register (BBR) regarding building area, year of construction, construction material and heating source. The homeowner

then enters his expenses for heating, number of people living in the house and, if possible, the energy label of the house and the tool calculates the “energy loss” (high or low on a 15 points scale). From here you can then order a craftsman to contact you for relevant offers of energy improvements for your home. According to Niels Kåre Bruun, CEO at Better Home, the companies behind Better Home had incoming orders for 40.6 M DKK (app. € 5.5 M) in 2015. The average renovation project had a budget of 370,000 DKK (app. € 49,300).

As it was the case for Better Houses, also the Better Home project will have the possibility for tax reduction due to the energy savings carried out in the projects. When the two concepts are compared, they seem to have the same target but with Better Houses being promoted by the Danish Energy Agency and Better Home being promoted by private companies, it is the opinion of the authors, that Better Houses would appeal more to the drivers regarding trust and feeling secure.

#### 3.1.1.4 Ecohome – private initiative (Germany)<sup>4</sup>

There are companies, which offer one-stop-shop concepts for energy refurbishments to private home owners. Ecohome is a typical one-stop-shop. The first step is the visit of an approved energy consultant. In the second phase ('planning') the results of the energy consulting are interpreted and the renovation measures are planned. In the third phase the company assigns their partners (master craftsmen) with the actual renovation measures. The last step is control and certification. The energy consultant tests the success of the renovation and issues the energy performance certificate. In addition, the energy consultant applies for subsidies.

Ecohome creates offers to private owners of single and multi-family houses, including condominium owners associations.

#### **The four step approach in more detail (Figure 1):**

First step is **energy consultation**, starting with the visit of an approved energy consultant. During the first visit at the house to refurbish, a thermal imager shows the current status of insulation. An analysis of the main heat loss points of the house and the explanation of the steps on the individual way to become an Ecohome follows. A special feature is that Ecohome operates in the same workflow in each single project to keep transparency. Due to this individually configured way, the appropriate partner firms are introduced.

Second step is the **planning process**, according to the interpretation of results of the energy consultation. The single measures or the deep renovation are planned and calculated by an expert. Ecohome promises to stay within the budget, the schedule and the agreed result.

Third step is the **implementation of the planned measures**. Ecohome promises to assign experienced firms and master craftsmen exclusively. The whole refurbishment process takes between 4 to 6 weeks. The Ecohome energy consultant is available during the implementation process and supports the homeowner. Ecohome explains to avoid inconveniences during the process (“tidy and cleaned up building site is a quality characteristic”). It should be possible to “keep on living” in the house immediately after the terminated implementation.

Forth and last step is the **control of the results and certification of the new EPC**. On the day after the finalisation, the energy consultant visits the premises. He supports the building inspection, performs

---

<sup>4</sup> <http://Ecohome.de>

relevant tests and issues the new EPC. As a last step, he supports the homeowner to apply for the appropriate energy loans or subsidies from KfW bank.

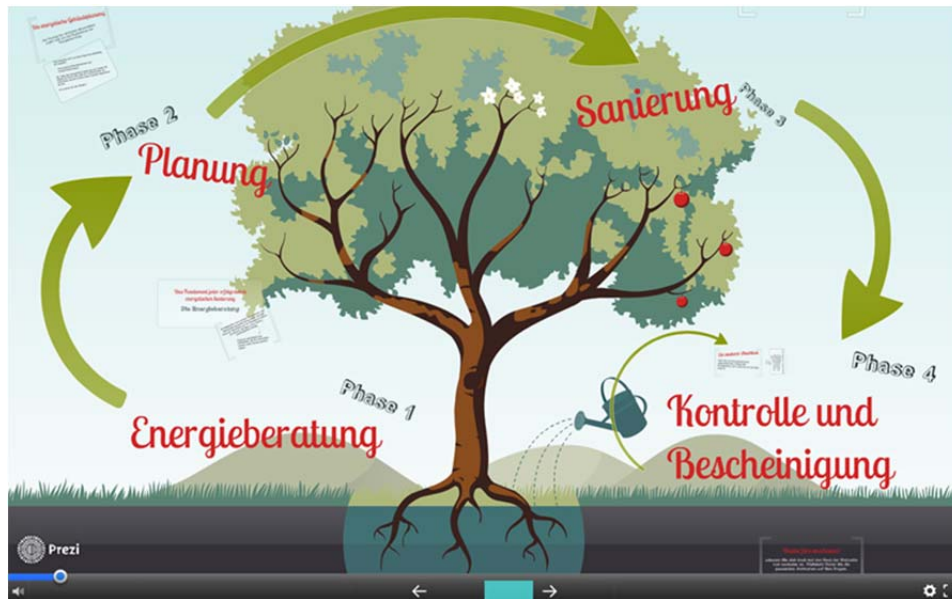


Figure 1 - Ecohome: four step approach

#### Characteristic features of Ecohome:

- The energetic renovation solutions are related to single-family houses and multi-family houses as well; the offer is not limited to a special kind of ownership, all private home owners, COA, housing companies can apply
- The target audience are mainly owners who want to save money resp. a quick return of investment, an independent advice linked with a professional, short-term implementation.
- The clearly structured and comprehensible concept (4 steps) is already a compelling characteristic. Key words that can be taken as success factors are included in each step (independent advice, convenience due to short-term realization, experienced craftsmen, control of the results etc.). The holistic approach combines insulation measures (façade, windows, roof) with the renewal of the heating system. Key information about the legal framework, KfW subsidies and special info about energy renovation of listed buildings can be obtained. The success factor “incentives” is also served, e.g. with new information (thermal photo) and a tailored renovation concept. The communication to the potential customer via the homepage is not a personal approach, though once the consultant performs the first visit it can become more personal. The information on the website remains unclear about who is behind the initiative (who are the Ecohome advisors, experienced craftsmen, etc.).

#### 3.1.1.5 RENEWA - private initiative (Germany)

RENEWA<sup>5</sup> is a one-stop-shop concept with the slogan “Energetisch sinnvoll sanieren” (“Meaningful energy renovations”), combined with a very useful homepage, promises the whole bandwidth of energy measures, while taking into account the financial aspects. Both a holistic approach as single measures are promoted.

<sup>5</sup> <https://www.renewa.de/>

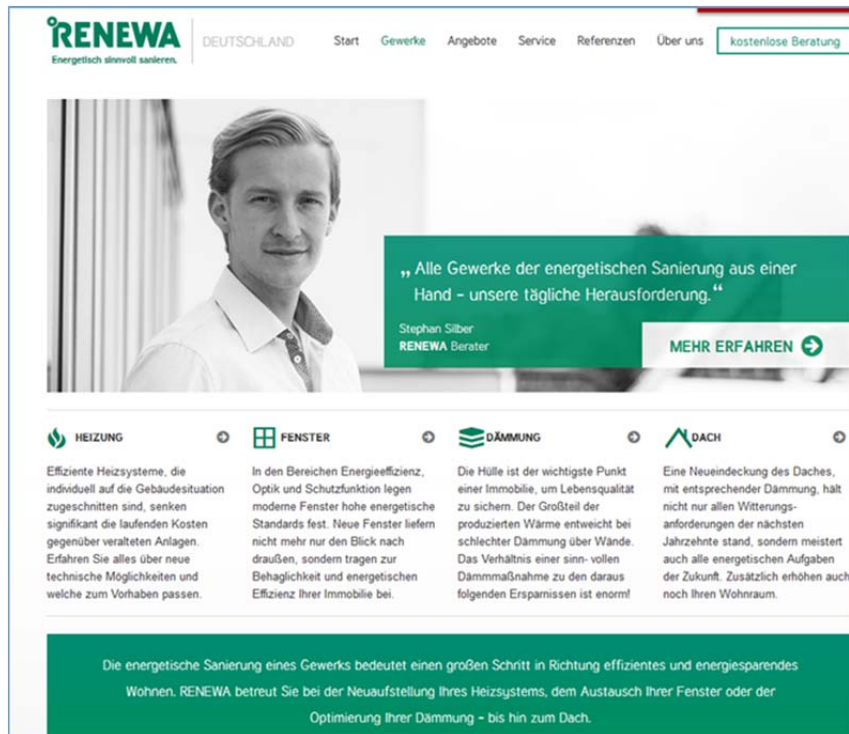


Figure 2 - RENEWA homepage – single measure fields (trades) heating system, windows, insulation, roof

### Characteristic features of RENEWA

- The energy renovation solutions are mainly aimed at to private owners of single-family houses.
- The target audience is obviously the group of homeowners who still have “old fashioned” oil-fired heating systems or electric night storage heating. The incentive to replace old technical appliances by state-of-the-art systems is in the foreground. The aspect of saving energy resp. a lower energy bill is described as a follow-up of a general renovation.
- Compared with ecohome.de, the RENEWA concept is more oriented to the single measure fields, but holistic approaches are possible. The advice of an energy consultant is central.
- It is interesting that RENEWA offers renovation packages, based on the single measure fields, for a fixed price. For instance, a heating system including a condense gas boiler, installation of the whole system and disposal of the old appliance. The offer is extending to different power stages, different suppliers, fossil/renewable combined systems (gas/solar), renewable-only systems (wood pellets) etc.
- An interesting feature is related to the credentials, presented as personal testimonials: only a few homeowners describe their successful holistic renovation, implemented by RENEWA; the big majority has only replaced the old heating system (oil-fired or electric night storage heating systems) by a modern system (condense gas boilers) or even single-glazing by double-glazing windows.
- Another characteristic feature of the testimonials is that the customers praise the competence and the reliability of the RENEWA team. They act as ambassadors. If it’s true or not, the RENEWA PR focuses on that approach, promising a high-professional implementation. The communication to the potential customer via the homepage is strongly personalized, every message is linked to a real person (company or customer).
- The information that RENEWA has the know-how is in the foreground; the limitation to only a few holistic renovation examples is in the background. On the one hand, there is no information about

how much energy is saved by these measures. On the other hand, typical problems of old-fashioned heating systems are analysed, and the new solution (by RENEWA) is described in detail. Obviously, in that way RENEWA is looking for a direct point of contact to the potential customers (problem-solving competence). This approach is compelling, but limited to long-time homeowners.

- “Independent advice” is a success factor of best practices all over Europe and frequently mentioned advantage of the RENEWA approach. Independence means that there is a well-defined set of suppliers with their high quality products from which the appropriate solution is chosen by the RENEWA experts. In the first view, the real “independence” is doubtful; in a second the limitation to only a few premium class suppliers guarantees a certain level of quality.

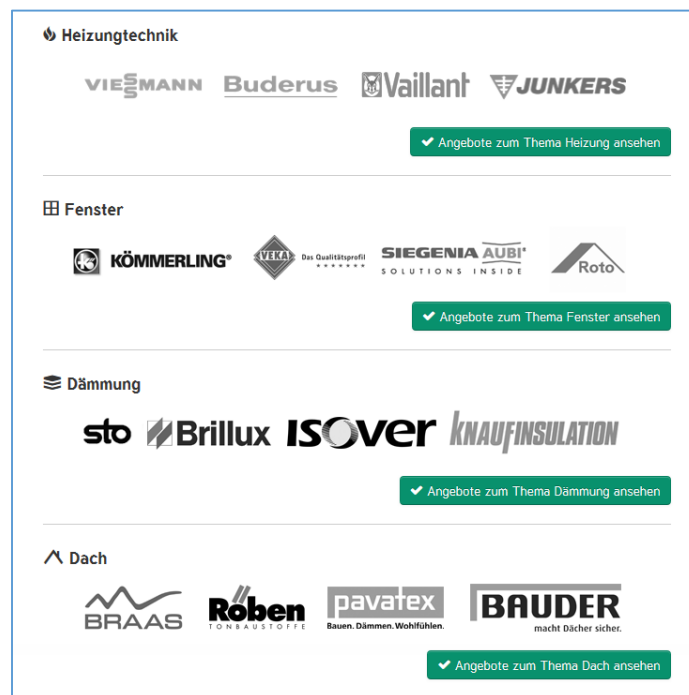


Figure 3 - RENEWA homepage – selection of partner suppliers, ordered by single measure fields

### 3.1.1.6 Slim Wonen in Leeuwarden approach – public initiative (The Netherlands)

Slim Wonen in Leeuwarden is a one-stop-shop concept, in a marketing-driven approach consisting of a digital energy office with a back office to help the homeowner. The approach provides technological and non-technological solutions. Slim Wonen in Leeuwarden is initiated by the Leeuwarden city council in cooperation with an association of buildings firms (the association ‘SLIM’), and local active volunteers. The scheme was also run parallel in the city of Groningen with an almost identical set up.

Basically it is designed as a one-stop-shop principle, mainly aimed at home renovation/ energy saving investments up to €20.000,-.

The scheme aims to help and advise homeowners and offer special deals at selected moments. The key difference to many other ‘one-stop-shops’, or marketing in general, is that a **customer management system** is used. This is based on tailoring the provision of information or offers to the stage of awareness or demand in which the customer is. Therefore the ‘customer journey’ is central. Additionally, the scheme works with firms that offer a one-stop-shop service and a unique quality assurance promise.



All homeowners who live in the council area have in one way or another received information about the one-stop-shop (30.000 homes). Detailed monitoring has been carried out on the effect of this communication. This has provided valuable information about the effectiveness of the customer contact moments and offers. About 2.500 homeowners have carried out renovations after having contacted the service. The results are quantitative in nature. An in-depth qualitative analysis of the value of the scheme would add to the knowledge about the effectiveness of the scheme in terms of the added value to homeowners. From conversations, and from the views of the buildings firms involved, it is believed that homeowners have more trust in the scheme because of the involvement of the local council.

The scheme is part of an integrated strategy and does not only provide a helpdesk. Cooperation with local groups (volunteers) and energy co-operations active in the districts is important, as well as general publicity, Facebook, calls to action, specific renovation offers etc.

For NZEB renovations the scheme can provide lessons on which marketing strategies are effective in persuading homeowners to invest. The decision-making process for homeowners for NZEB renovations is in essence the same as other investment decisions about their homes. Key factors are trust, quality assurance, providing the right information at the right time and effective marketing.

An important footnote is that the project is being scaled up from the end of 2015. A cooperation between all Frisian councils, as part of a national program, has resulted in a regional project. The nature of this project is similar, but not exactly the same as the Leeuwarden project. It is relevant because it is thought that scaling up is necessary to provide a viable one-stop-shop concept that the market will be able to run by itself at a later stage.

#### *3.1.1.7 The Dutch 'Stroomversnelling Koop' approach: holistic-hybrid - public-private initiative (The Netherlands)*

Stroomversnelling Koop provides turnkey solutions for zero-on-the-meter dwelling renovations with technological concepts that have been tested at a larger scale in the social rental market (Stroomversnelling Huur).

**Key features** of the Stroomversnelling Project are:

- Renovation to net zero energy of the buildings is achieved within 10 days;
- The amount that tenants pay for housing costs (rent + energy) remains the same before and after renovation;
- An energy performance guarantee of 30 years is provided;
- To decrease costs while achieving constantly high standards of quality and to minimize time spent working on the property, a high degree of off-site industrial prefabrication is used;
- Tenants are offered an appealing proposition that highlights the comfort, liveability and affordability of the renovated home.

Stroomversnelling represents a **disruptive new business model** for the renovation sector that involves a longer-term, holistic approach to delivering a single "product", i.e. the zero energy renovation along with the financing arrangement as a fully integrated solution.

The dwellings targeted by this project were built in the 1950s, 60s, 70s and 80s and often have moisture, draft and noise problems coupled with high-energy bills. Additionally, the sanitary facilities are often outdated and in need of replacement. The project offers tenants better, healthier and more comfortable homes with attractive façades, solar panels and smart metering, thus improving the habitability of the

home and also the look of the neighbourhood/district. New kitchens and bathrooms are also included within the deal and sometimes for needy people an extra unit in (for example) the garden to stay longer in the own house instead of moving houses.

### Technical features

The biggest difference between a 'Stroomversnelling' renovation and a normal renovation is that almost everything is produced off-site in a factory, with only a small percentage of the work required in the on-site installation phase. This approach, requires a certain morphological standardisation of the dwellings which is the case for the Netherlands where complete districts of dwellings can be retraced to one single building plan.

Achieving a zero energy renovation requires a holistic solution that minimizes the heat loss and energy consumption of the building, produces the needed energy in the most efficient manner, and generates renewable energy to meet the remaining (small) demand. Note, however, that the building is not designed to be self-sufficient in energy terms. Rather, the renewable electricity generation is designed to be roughly equivalent to the electrical energy use of the renovated building when averaged over the year.

#### 3.1.1.8 *Step-by-step* approach by the RenBEN project (Belgium)

In the **RenBEN**-project (one of the VLAIO Living Labs on renovation) an **integrated renovation approach** tailored to the specific dwelling is proposed to the homeowner. The central ambition of this project is to stir up the renovation of **terraced houses for private rental**.

One **single-point-of-contact** (called the 'renovation supervisor') coordinates the complete renovation process for the homeowner. In this way the project looks for a solution to unburden the homeowners as much as possible to assure their comfort in the process. So the RenBEN-project investigates a kind of **one-stop-shop solution** for the homeowners.

The advice for the homeowner includes a **masterplan** for each dwelling to renovate their house to NZEB (or 'BEN' in Dutch). A **step-by-step approach** is proposed for homeowners who do not want to execute this deep renovation in one go. Both technical and cost-optimal reasons are taken into account in the determined order of the different steps to renovation to NZEB. By following the proposed order of steps (in one deep renovation or in a staged renovation) lock-ins are avoided. This means that homeowners do not start doing partial renovations which might jeopardise renovation to NZEB or which that make further steps impossible without tearing down the earlier renovations.

Also urgently needed adaptations of the dwelling for safety reasons are mentioned in the advice.

This integrated working method to come to a NZEB-renovation is now being tested on 30 terraced dwellings for private rental.

#### 3.1.1.9 *Collective approaches*

In this paragraph existing projects with a collective approach are described. Apart from the potential economy of scale that can be realised, collective approaches can also foster cooperation among homeowners, and can in some cases stimulate technological solutions at a level which goes beyond the walls of a single building, i.e. at street or district scale. At that scale, especially with innovative technological solutions, additional benefits can be reaped.

**Example 1: VLAIO Living Labs (Belgium)**

Flanders Innovation & Entrepreneurship (VLAIO, in Dutch: Agentschap Innoveren & Ondernemen) is a government agency, charged with implementing the economic, innovation and enterprise policy in Flanders.

The Living Lab projects on dwelling renovation want to stimulate renovation concepts which can lead to scalable affordable solutions. Concepts are tested and researched while the renovations take place. 10 of these projects are currently running throughout Flanders. Concepts not only include technical solutions but business models and customer relations as well.

For each of these projects<sup>6</sup>, a set of solutions is studied. These solutions are meant to be applicable for collective renovations, if possible NZEB-renovations.

As demonstration projects (e.g. Spiere, FutureFantastic, Villa Sanseveria,...), these renovations have the intention to convince individual homeowners to renovate to NZEB. Moreover, these projects are looking for solutions for collective renovations.. Additionally these projects can be used as showcase or trigger.

**Example 2: KfW-programme Energy-efficient Urban Redevelopment (number 432)**

The KfW programme Energy-efficient Urban Redevelopment (number 432) extends the energy upgrading of individual buildings to **entire neighbourhoods**. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety provides financing from the Special Energy and Climate Fund to support integrated neighbourhood strategies for energy efficiency and their implementation management. The Energy-efficient Urban Redevelopment Programme facilitates flexible strategies which can be tailored to local conditions.

The programme combines standards for energy upgrades in buildings, efficient energy supply systems and the increased use of renewables with demographic, economic, urban design and housing considerations (Figure 4). A cooperative management process oversees implementation.

The **main components** of the Energy-efficient Urban Redevelopment Programme are integrated neighbourhood strategies for energy efficiency and implementation management which oversees realisation of the energy efficiency goals in the participating neighbourhood.

Integrated neighbourhood strategies define the goals and implementation strategies for energy-efficient cities. A coordinated plan of action is an important foundation for making towns and cities more future-proof. Integrating all relevant actors - citizens, the housing sector, property owners, tenants and energy supply companies - makes collaborative approaches possible.

---

<sup>6</sup> An overview of the 10 VLAIO Living Labs on renovation can be found on [www.kennisplatform-renovatie.be/kennisplatform/](http://www.kennisplatform-renovatie.be/kennisplatform/)

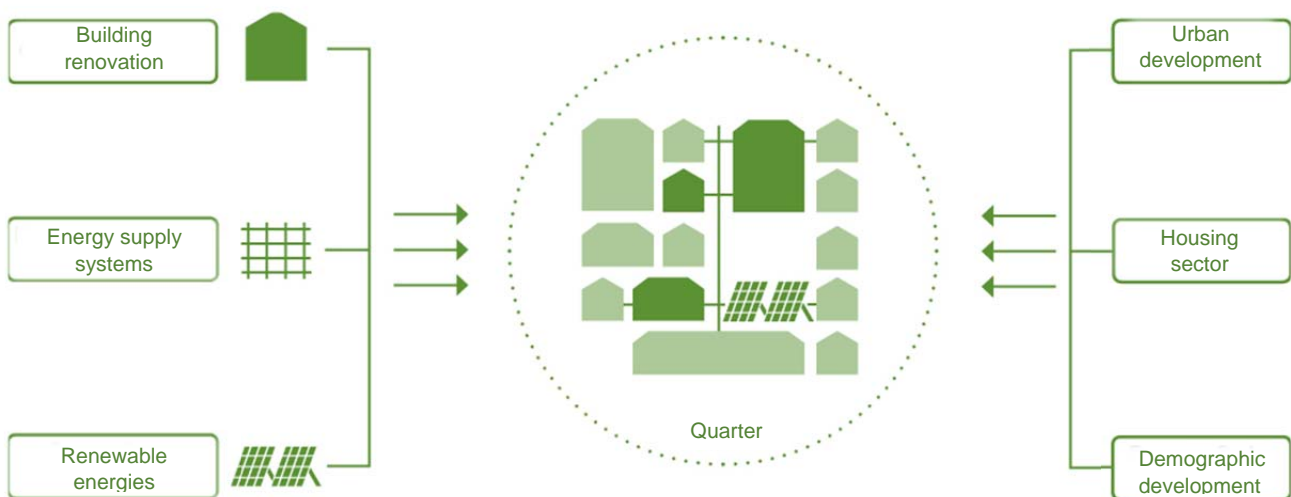


Figure 4 - Energy-efficient Urban Redevelopment Programme (<http://www.energetische-stadtsanierung.info/energetische-stadtsanierung/>).

#### Elements of integrated neighbourhood strategies:

- Analysis of status quo and potential: Who consumes energy in the neighbourhood and how much? What is the capacity of energy infrastructures and distribution systems? Where is there potential for saving energy and enhancing efficiency?
- Plan of action: What are the goals and when will they be reached (e.g. timeframe 2025)? What specific measures are planned?
- Costs and financing: What are the expected costs? What is the financing strategy?
- Performance evaluation: How is the achievement of goals verified? How are quality objectives secured during implementation?
- Implementation strategy: What strategies will be used to move forward on implementation in the short, medium and long term? How are actors mobilised and incorporated into the strategy?
- Information, consulting and public relations: How can the relevant partners be motivated to act? What information, consulting and public relations measures are needed?

Energy-efficient redevelopment at neighbourhood level not only requires a sound neighbourhood strategy, it also needs long-term coordination of implementation. The task management this calls for is a field of action in its own right. One of the keys to success is convincing all stakeholder groups to support the goals of energy-efficient redevelopment. The proposed measures should be fleshed out in a collaborative process involving municipalities, citizens, housing providers, property owners, utility companies and interest groups.

**Implementation management** allows long-term processes to be monitored as well. The tasks of implementation management include:

- Providing energy efficiency expertise for inter-agency administration.
- Coordinating key players such as energy supply companies, housing developers and municipalities.
- Offering energy consultancy services to win over and mobilise private homeowners.
- Fostering civic participation, information and public relations work to anchor the project firmly in the neighbourhood.

- Integrating urban redevelopment into broad-based climate management at local level.

The flexible KfW programme allows project implementation management to be tailored precisely to the needs of the respective municipality. It can either be organised autonomously or incorporated into the work of municipal administrations, utilities, redevelopment officers or housing providers.

Using a mix of **funding instruments** is particularly effective for promoting neighbourhood-based energy-efficient urban redevelopment. The KfW programme 432 for energy-efficient urban redevelopment – integrated neighbourhood strategies and their implementation management provides an interface for the useful combination of different instruments.

Grants programme 432 funds the development of an integrated neighbourhood strategy for energy efficiency. Material and personnel expenditures incurred for engaging qualified third parties for the project (for instance energy technology specialists and planners) are all eligible for funding. The implementation management can be funded for up to three years. From 1 December 2015, it has also been possible to extend the support period for a further two years, so that the total support period can be as much as five years. Funding covers staff costs for specialised personnel and material expenditures of up to 10% of the personnel costs.

**The two objects of support** - the integrated neighbourhood strategy and the implementation management – are 65% subsidised from federal funds via the KfW. The remaining 35% must be provided by the municipalities. Some of this remainder can also be covered by third parties (e.g. public utilities, housing companies, private owners, energy providers) and up to 20% of the costs eligible for funding can be financed from EU or Länder funds. Funding from Federation and/or Länder sources must not exceed 85%. In individual cases, the contribution of financially weak municipalities with budgetary consolidation plans can be reduced to 5% of the eligible costs.

Municipalities can pass on the funding to third parties, e.g. private-sector or non-profit players such as public utilities, housing companies or redevelopment agencies.

KfW grants programme 432 for energy-efficient urban redevelopment is uniquely placed to support the effective combination of different funding instruments. Various other KfW funding is also available for implementing the investment measures set out in the strategies, for instance through the programmes for neighbourhood supply infrastructure or the energy-efficient refurbishment of residential buildings and commercial properties. Furthermore, programme 432 can be used in conjunction with urban development promotion programme and other EU, Federation and Länder programmes.

The characteristic feature of the program is that a holistic concept can be subsidized including improvement of the living environment, accessibility, rain water management, and resident involvement. From the energy point of view, you can reach upscaling effects by including a greater number of dwellings. It is interesting for energetic refurbishment of German building stock because there are lots of interwar and post-war period living quarters owned by housing companies or COA (Condominium Owners' Association).

### 3.1.2 Common characteristics of one-stop-shop-solutions

Out of the examples of one-stop-shop concepts in Europe analysed in the sections above, these common characteristics of existing one-stop-shop-solutions can be distinguished:

- Targeting **individual homeowners**.

- Initiative from government or supply side.
- **Personal approach** of the homeowner.
- **Tailored masterplan** is offered to the homeowner.
- **Step-by -step approach** is possible: homeowner has choice between one deep renovation or a stepwise renovation
- Organisation of the supply side with **one single-point-of-contact** for the homeowner
- **Marketing** is important to get the offer well-known, but is often missing.

It is clear that the **country context** of the different countries involved is **determinative for the success of one-stop-shop solutions**. For example, the organisation and role of the different building actors can make it more easy or more difficult to work together in one team.

Another important issue is the **advice** offered by the one-stop-shop-solution. This advice has to be **an integrated masterplan** to **avoid lock-ins** by executing the renovation in a logical sequence that enable following steps to renovation to NZEB in a **stepwise renovation**. This is especially important when doing a staged renovation.

As financing a deep renovation in one go is not achievable for every homeowner a lot of homeowners decide to do partial renovation, which can be a step of a total deep renovation. Quite often, however, such renovations will be executed without the total renovation in mind. It is important to start each renovation with a masterplan including a step-by-step approach for a staged deep renovation. This way, the goal of renovating to NZEB can still be reached in the long-term<sup>7</sup>. In this step-by-step masterplan the connections between the different building parts and the order of execution have to be taken in account to avoid lock-ins.

A lot of energy saving solutions provide 'quick wins' and are not aimed at deep or NZEB solutions. When only these 'quick wins' are promoted, it could be difficult to convince homeowners afterwards to carry out a complete NZEB-renovation.

**Many of the analysed one-stop-shop-solutions are not isolated initiatives. Most of them are embedded in a much broader programme, project or campaign, for example with clear demonstration projects.** This broader embedment should not be neglected and is composed of valuable complements to the pure one-stop-shop. A one-stop-shop which is not part of a scheme in which the homeowner is drawn towards the shop through the right communication and incentives will be left without costumers.

---

<sup>7</sup> Another example of such an approach is given by The *Sanierungsfahrplan* in Baden-Württemberg (DE) <https://um.baden-wuerttemberg.de/de/energie/beratung-und-foerderung/sanierungsfahrplan-bw/>

## 4 Conclusions and recommendations

Below the conclusions of the research in this report are listed and some recommendations for the next reports for the REFURB project are formulated. These conclusions are directly aimed at specific dependent tasks and deliverables of the REFURB project:

- Section 4.1 gives recommendations for the next report of WP3 D3.3: 'Involvement and organisation of supply'. In this report will be described how a change of behaviour should be realised on the supply side to better fit the nature (and drivers) of the demand side.
- Section 4.2 gives recommendations for the next reports of WP4(D4.1, D4.2 and D4.3) in which a renovation package constituting 'the most compelling offer' for homeowners to renovate their dwelling to NZEB, will be developed for each region.
- Section 4.3 gives recommendations for report D4.5 of WP4 ('Supportive financial constructions'). In this report different options for financing NZEB renovations of private homeowners will be further analysed.
- Section 4.4 gives recommendations for WP5 (reports D5.1 and D5.2: 'Delivery and Quality Assurance') which focuses on defining methods to ensure the high quality and delivery standards of renovation packages for renovation to NZEB, starting from the point of view of the customer.

### 4.1 INVOLVEMENT AND ORGANISATION OF SUPPLY

The following issues are considered important with regards to the involvement and organisation of the supply side to better fit the drivers of the demand side in relation to energy saving and NZEB renovation measures.

In all countries involved, there are a number of actors that have to be involved in the renovating process as a result of regional and national regulations. The building sector or **supply side is traditionally very diverse and fragmented, especially when renovation measures are concerned**. This acts as a barrier to more cooperation to provide one-stop-shop services. This is especially the case for contractors that carry out most renovation works for private homeowners. There are separate suppliers for heating systems, windows, floor insulation etc. To provide one-stop-shop solutions smaller contractors would need to work together, but **working with firms who coordinate the supply side costs both time and money**. The increase in interest in energy saving has also resulted in highly specialized large firms developing attractive offers for just one step of the whole process, for example floor insulation or solar panels. Some of these firms are large players in the market. They have little incentive to provide an integrated service and to some extent this might lead to cherry-picking, leaving the less interesting components of an integrated solution in a lock-in situation. The larger building firms who are able to offer a complete service prefer to concentrate on large orders, new homes, or large social housing contracts.

An improved **organisation of the supply side will probably result in a collaboration structure** in which an additional person is leading a whole team. One-stop-shop concepts often include an extra person as single point of contact and few take advantage of existing channels, such as an architect or a general contractor. Providing the collaboration structure to avoid the fragmented process and provide for a single point of contact towards the homeowner comes with a price. A price which most homeowners are not ready to pay

for as it is perceived as an additional high upfront investment. On the other hand there seems to be enough interest in shallow energy renovation measures, though the households willing to go for a shallow renovation will not easily come in contact with the channels that can offer deeper or NZEB renovations.

The **limited demand for one-stop-shop solutions provides insufficient incentive for the industry to reorganise and provide one-stop-shop services aimed at deep or NZEB renovations. This is because partial shallow renovations are still more interesting for the demand side, whether it be from a household psychological point of view or through the financial incentives currently available.** Consequently the supply side has to content itself with selling single, or at least a limited number of energy saving measures.

Government or local participation can act as an incentive to encourage one-stop-shop services. Where government gets involved locally, or neighbourhoods organize collective demand, this does provide an incentive for building firms to improve their services offering solutions which go further. The trust element of a local authority and financial stimuli created by the (local) government can create demand and motivates the building firms to participate and improve their services.

Still, experiences in customer relationship management which are being built-up throughout the EU in local renovation programmes, albeit still for shallow renovation measures, can be valuable. The concept of customer journeys from awareness raising up to the actual realisation of a renovation, and a follow-up of the drop-out numbers and motivations can shed further light on the matter. These approaches take into account the final decision-makers, those who'll decide to go for it or not.

Next step is **for the supply sides to better understand the demand side, to change their behaviour towards the demand side** and certainly to **focus on the communication** with them on a level where it also moves the homeowner to a renovation situation. A supply involvement strategy then is useful.

## 4.2 RENOVATION PACKAGES: ONE-STOP-SHOP-SOLUTIONS

In this report the **(near-)available solutions for renovation of private houses to NZEB** are mapped. A distinction is made between **technological solutions** and **non-technological solutions**. Technological solutions are measures related to the improvement of the building performance, whereas non-technological solutions are understood to be measures relating to for instance financial, communicative or process aspects. Table 5 shows the categories of technological and non-technological solutions that are described.

*Table 5 – Categories of solutions for renovation to NZEB*

SUPPLY SOLUTIONS FOR RENOVATION TO NZEB	
NON-TECHNOLOGICAL SOLUTIONS	Innovative financial models
	Online tools for management or decision making
	New approaches to organising the supply side
	Quality assurance
	Renovation packages = One-stop-shop-solutions
TECHNOLOGICAL SOLUTIONS	Building envelope improvement



## Technical installations

## Renewable energy sources

The potential of these solutions as a component of a renovation package is evaluated. **The main question is: how can these solutions be embedded in or support the uptake of a deep or an NZEB renovation package? Or What are the most promising ones and which are their important aspects?**

Therefore, this report results in a number of recommendations for developing renovation packages for NZEB renovation in the REFURB project.

It is important to note that **complete solutions for renovation of privately owned dwellings into NZEB are scarce, even more so for directly scalable and successful ones.** Therefore any assessment of existing schemes or solutions can only be done mainly for solutions which do not yet have the objective of stimulating NZEB renovations as such. Looking at the categories of solutions in Table 5 an ideal NZEB renovation package will most probably have to contain a combination of all these categories. It will need the 3 technological solution categories to attain the necessary performance, and it will need a combination of the non-technological solutions for homeowners to be willing to implement them.

Taking into account the drivers that can convince homeowners to renovate to NZEB (as mapped in report D2.2), the **non-technological solutions are more important than the technological solutions to seduce homeowners to renovate to NZEB.** Especially the renovation packages or one-stop-shop-solutions seem to be important for the homeowners. The supply side has to offer the homeowner a solution in which he is being unburdened from the task of choosing and evaluating the technological solutions. This can be done by supporting the homeowner in his decision about the best technical solution for renovating his house to NZEB, taking into account the general preferences and motivations of the homeowner.

For the purpose of this project the term **'renovation package' or 'one-stop-shop-solution'** is meant to be: *"An easy-to-understand commercial offer to an end-user, written in non-technical language which satisfies his/her requirement for comfortable living but at a higher energy-efficiency of his/her dwelling. The offer comprises the optimum combination of technologies to be installed in the most logical sequence, tailored to the type of dwelling, the state of the building, the geography in which the dwelling is located and socio-economic parameters. Offers are understood to entail the unburdening of the end-user, so he/she is assured of an agreed higher energy efficiency without having to worry about individual technology choices."*

Out of the examples of one-stop-shop concepts in Europe analysed in the sections above, these common characteristics of existing one-stop-shop-solutions can be distinguished:

- Targeting **individual homeowners.**
- Initiative from government or supply side.
- **Personal approach** of the homeowner.
- **Tailored masterplan** is offered to the homeowner.
- **Step-by-step approach** is possible: homeowner has choice between one deep renovation or a stepwise renovation
- Organisation of the supply side with **one single-point-of-contact** for the homeowner
- **Marketing** is important to get the offer well-known, but is often missing.

It is clear that the **country context** of the different countries involved is **determinative for the success of one-stop-shop solutions**. For example, the organisation and role of the different building actors can make it more easy or more difficult to work together in one team.

Another important issue is the **advice** offered by the one-stop-shop-solution. This advice has to be **an integrated masterplan to avoid lock-ins** by executing the renovation in a logical sequence that enable following steps to renovation to NZEB in a **stepwise renovation**. This is especially important when doing a staged renovation.

As financing a deep renovation in one go is not achievable for every homeowner a lot of homeowners decide to do partial renovation, which can be a step of a total deep renovation. Quite often, however, such renovations will be executed without the total renovation in mind. It is important to start each renovation with a masterplan including a step-by-step approach for a staged deep renovation. This way, the goal of renovating to NZEB can still be reached in the long-term<sup>8</sup>. In this step-by-step masterplan the connections between the different building parts and the order of execution have to be taken in account to avoid lock-ins.

A lot of energy saving solutions provide 'quick wins' and are not aimed at deep or NZEB solutions. When only these 'quick wins' are promoted, it could be difficult to convince homeowners afterwards to carry out a complete NZEB-renovation.

**Many of the analysed one-stop-shop-solutions are not isolated initiatives. Most of them are embedded in a much broader programme, project or campaign, for example with clear demonstration projects.** This broader embedment should not be neglected and is composed of valuable complements to the pure one-stop-shop. A one-stop-shop which is not part of a scheme in which the homeowner is drawn towards the shop through the right communication and incentives will be left without costumers.

Another important aspect which can be very supportive for one-stop-shops offering renovation packages are financial incentives and innovative financing mechanisms.

### 4.3 FINANCIAL CONSTRUCTIONS FOR DEEP OR NZEB RENOVATIONS

There are currently **no widespread specific financial constructions for deep renovations for privately owned dwellings**. The existing financial solutions for renovation in general have to be solicited and where possible combined into an appropriate package. In many cases one will have to rely upon the necessary subsidies, loans etc. which are offered and combine them optimally. Whether the additional effort of going beyond the minimum energy saving targets required by the available financing schemes is more or less compensated financially, that is yet to be seen.

The KfW Energy-Efficient Refurbishment scheme encourages deeper renovations through a **progressive incentive system in which better energy performance is being promoted through higher financial incentives**. However, even in this case the highest standard for refurbishment is KfW *Effizienzhaus* 55. An incentive system in line with the EU definition of deep renovations (60% energy savings in comparison to the current performance) would require a KfW *Effizienzhaus* 40 standard for refurbishments.

---

<sup>8</sup> Another example of such an approach is given by The *Sanierungsfahrplan* in Baden-Württemberg (DE) <https://um.baden-wuerttemberg.de/de/energie/beratung-und-foerderung/sanierungsfahrplan-bw/>

Consequently **current financial incentive systems stimulate shallow and in some cases slightly deeper renovations** but not deep renovations aimed at 60% energy savings. While this is not necessarily a negative situation it could become one as shallow renovations can lead to lock-ins especially when the very first measures implemented are the ones yielding the low-hanging fruits, making the next steps less interesting.

Many publications and reports on improving energy efficiency finance in buildings are available, but **little attention is being paid to the sector of residential buildings, and even more so privately-owned dwellings**. It appears that it is believed that the financial mechanisms and constructions applied in the tertiary sector (private or public) can be more or less applied to the residential sector in the future, though that is yet to be seen. While the other sectors are characterised by rational economic calculations and payback times, the private residential sector doesn't function that way.

Even **Energy Performance Contracting through ESCOs** which are gaining momentum in the non-residential part of the building sector might lead to the lock-in phenomenon. The involvement of ESCo financing in the residential sector doesn't necessarily promote deep renovations but might lead to cream-skimming for projects with higher financial returns (for example apartment buildings with very old boilers) and cherry-picking within such projects (only going for the boiler replacement instead of including improvements in the building envelope as well).

On the other hand it is clear that the simple **availability of subsidies** or other incentives can really move people to renovate their homes and especially to hire a professional craftsman, but it is unclear whether the incentive systems available also lead to deeper renovations.

**Short-term incentives like subsidies with limited availability or temporary reduction in taxes**, form a barrier to long-term investments in offering qualitative one-stop-shops. As the finance schemes support the one-stop-shops the actors in the market (public and private) have to be able to rely on them and use them as a component of their one-stop-shop concept. Creating market peaks and troughs doesn't encourage market stability or long term investment in quality.

Suppliers of **attractive, new, financial services linked to energy saving generally absent**. A separate supply side issue is the involvement (or lack) of finance suppliers. General finance is available to the homeowner, but specific financial products effectively linked to energy savings are not widely available. It is thought that to be a success **more cooperation between builders and financiers to provide integrated guarantee services is needed**.

## 4.4 QUALITY ASSURANCE FOR DEEP OR NZEB RENOVATIONS

Many quality assurance schemes or labels are available for individual measures and for general building measures, but even for small renovation measures it is unclear whether they are always applied. Apart from the quality assurance of products also the quality of the service needs to be ensured as good products can be badly applied. As quality comes at a higher upfront cost it is good that **most of the financial incentive schemes require the involvement of qualified experts**. As deep or NZEB renovations are defined by the performance level to be obtained it is quite likely that any incentive scheme related to such renovations will require the involvement of technical experts.

**Quality assurance for one-stop-shop solutions for renovations are not or hardly available so the quality of their advice and the implementation can only depend upon the experts involved and their education and expertise**. There are some attempts to implement schemes.

The key issue here is that quality assurance measures are available for the physical quality of work carried out, but not for the long-term effect of the renovation on the energy consumption during the lifetime of the renovated dwelling. On that account it must be noted that the definitions of both NZEB or deep renovations are based upon theoretical energy use values. **Energy Performance Contracting** in the residential sector could provide quality assurance as the one providing it is contractually bound by the performance promised, however due to many reasons ESCOs do not yet enter the residential market and where they do, they do not necessarily choose the path of deep renovations (see 4.3). Amongst the important reasons for the low interest of ESCOs in this market is exactly the large influence of occupant behaviour influencing the actual energy consumption.

## 5 References

Mlecnik, E., Straub, A. (2014), COHERENO – Deliverable report D3.2: Barriers and opportunities for business collaboration in the nZEB single-family housing renovation market,

Mlecnik, E. (2012), One Stop Shop – Deliverable report WP 3.1: Methodology for innovations in supply side for sustainable renovation

COHERENO (2013 – 2016), Collaboration for housing nearly zero-energy renovation, project co-funded by the Intelligent Energy Europe (IEE) program by the European Commission, <http://www.cohereno.eu/>

ONE STOP SHOP (2010 – 2012), From demonstration projects towards volume market: innovations for one stop shop in sustainable renovation, an ERA-NET Eracobuild project, <http://www.one-stop-shop.org/>

## 6 Annexes

Annex 1 – List of solutions for renovation to NZEB

Annex 2 – Technology matrix

Annex 3 – Country report Belgium

Annex 4 – Country report Denmark

Annex 5 – Country report The Netherlands