Deliverable D2.1
Demand side segmentation in EU and regions

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Summary

Renovation in the EU's residential sector towards increased energy efficiency is seriously lagging behind. As more than sufficient technological solutions are available, focus must be on removing non-technological barriers. The main barriers relate to fragmentation of the renovation offer, resulting in inefficient or only partial solutions. One way to solve this is the use of a 'one-stop-shop concept'. Many have been put in practice. Some were successful, others not. They often lack an understanding of the concerns and demands of homeowners.

The REFURB project focusses on the complex interplay of barriers through coordinated process organization, innovation and optimization to improve this one-stop-shop concept. Work package 2 and work package 3 are dedicated to analyse demand and supply side drivers. This report is part of work package 2 ("demand side mapping"), and the result of task 2.1 establishes a **segmentation of the demand side** (dwellings and dweller typologies). This segmentation is the first step to better understand the homeowners, which is a diverse group of decision makers in energy efficiency investments. A segmentation that is relevant for NZEB-renovation and demand aggregation schemes is created. This type of segmentation of the demand side is not commonplace. Usually market segmentation is very much technology driven from the point of view of the supply side of the renovation market. Based upon REFURB partners' experience and research it was, however, possible to create such a segmentation based upon dwelling but also – and more importantly- upon dweller characteristics.

With this report the REFURB project offers a **framework to create a tailor-made segmentation** or define a set of segments that fit a certain context in a country, rather than fix a pan-European set of segments to cover the entire demand side.

Market or customer segmentation has proven its value in concepts such as the Business Model Canvas as to avoid targeting heterogeneous groups with value propositions which are too general and customers cannot identify with at all.

A **multidisciplinary view** to the creation of this segmentation is essential. For the purpose of the segmentation, many different points of view have to be explored to fully gain understanding of how homeowners decide, plan and think, and more in particular how this could affect their choice to either invest in NZEB-renovation or not. Behaviour study, psychology, sociology, economics, technology, legislation, architecture, building physics, urbanism are all relevant research fields and the list of them illustrates the complexity of the task.

With a single technical, architectural or financial approach it appears hard to generate segments to design successful one-stop-shops for. Likewise it is not useful to develop such a segmentation purely based upon the building typology as -after all- it is not the building which decides to go for a renovation, but its owner or occupant.

In task 2.1, the segmentation of the demand side was developed for the purpose of the REFURB project. A segment is a group in the market with similar characteristics. For the segmentation in the REFURB project the following categories of characteristics were used:

- dwelling characteristics (e.g. flat/houses, year of construction, energy efficiency, neighbourhood, architectural characteristics, building techniques and materials etc.), and

- dweller characteristics, the decision makers (e.g. owner vs tenant, financial possibilities, stage in life of inhabitant, household composition, technical building skills and knowledge etc.).

In the REFURB project, 2x3 clusters of characteristics that are relevant to underpin the segmentation were identified:

Three clusters of dwelling characteristics, which are important to design consistent NZEB-renovation packages (Figure 1):

- Cluster 1: **similar dwellings**, with the interlinked characteristics "neighbourhood type", "construction type", "dwelling typology", "construction era", and "historical value".

- Cluster 2: **state of the dwelling**, with the interlinked characteristics "urgency for renovation", "inconvenience linked with the renovation", "inconvenience and defects" and "value of the house".

- Cluster 3: **energy saving potential**, with the characteristic "energy performance".
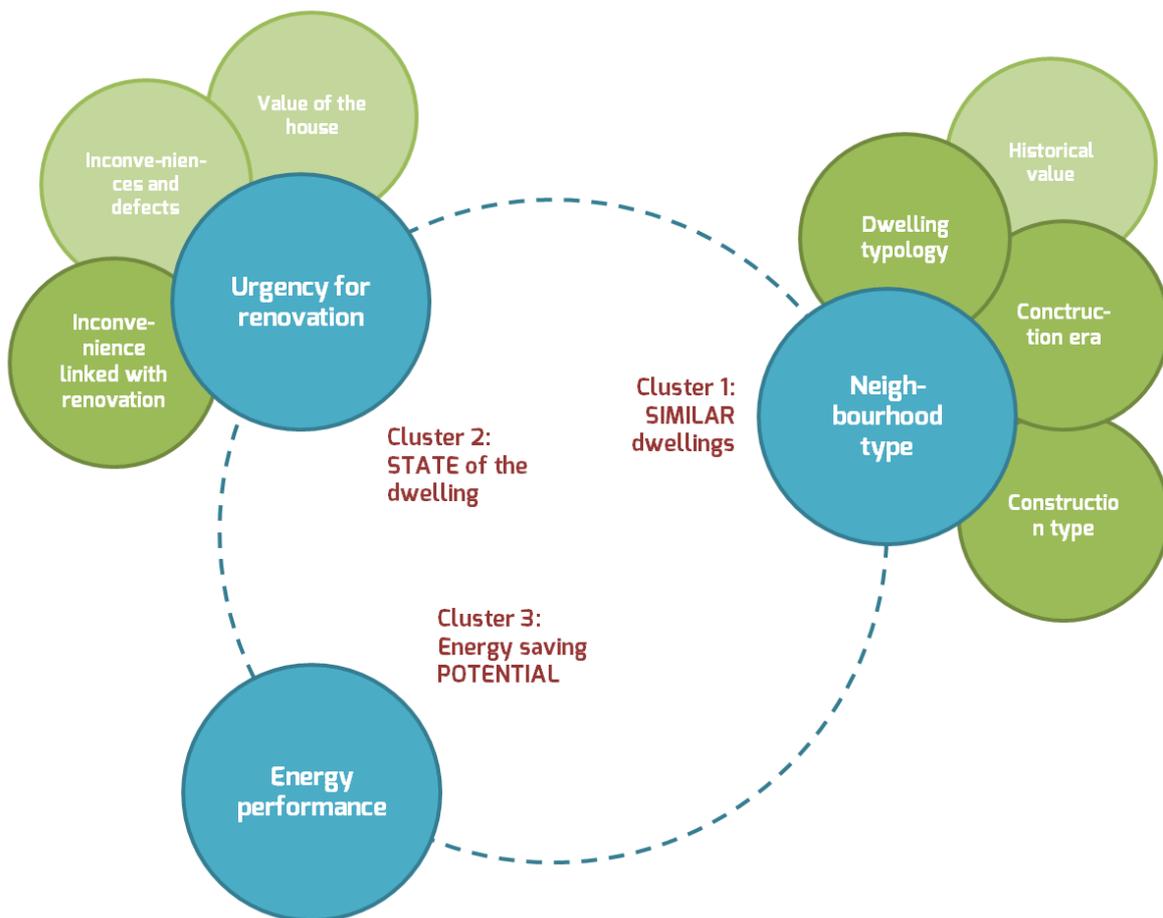
Figure 1: Clusters of relevant dwelling characteristics

Three clusters of dweller characteristics, which are important to design consistent demand aggregation schemes (Figure 2):

- Cluster 1: **the right moment for NZEB-renovation for the dweller**, with the interlinked characteristics "stage of life", "expected period to own the house", "available time to manage renovation project", "age of dweller", "energy use pattern" and "home occupation pattern".

- Cluster 2: **possibilities and intentions of the dweller**, with the interlinked characteristics "financial possibilities", "owner status", "intentions to renovate", "environmental values and attitudes", "willingness to invest in energy efficiency".

- Cluster 3: **the different personalities of the dweller**, with the interlinked characteristics "type of decision maker", "renovation needs", "access to information", "male/female", "general knowledge level" and "technical knowledge level".
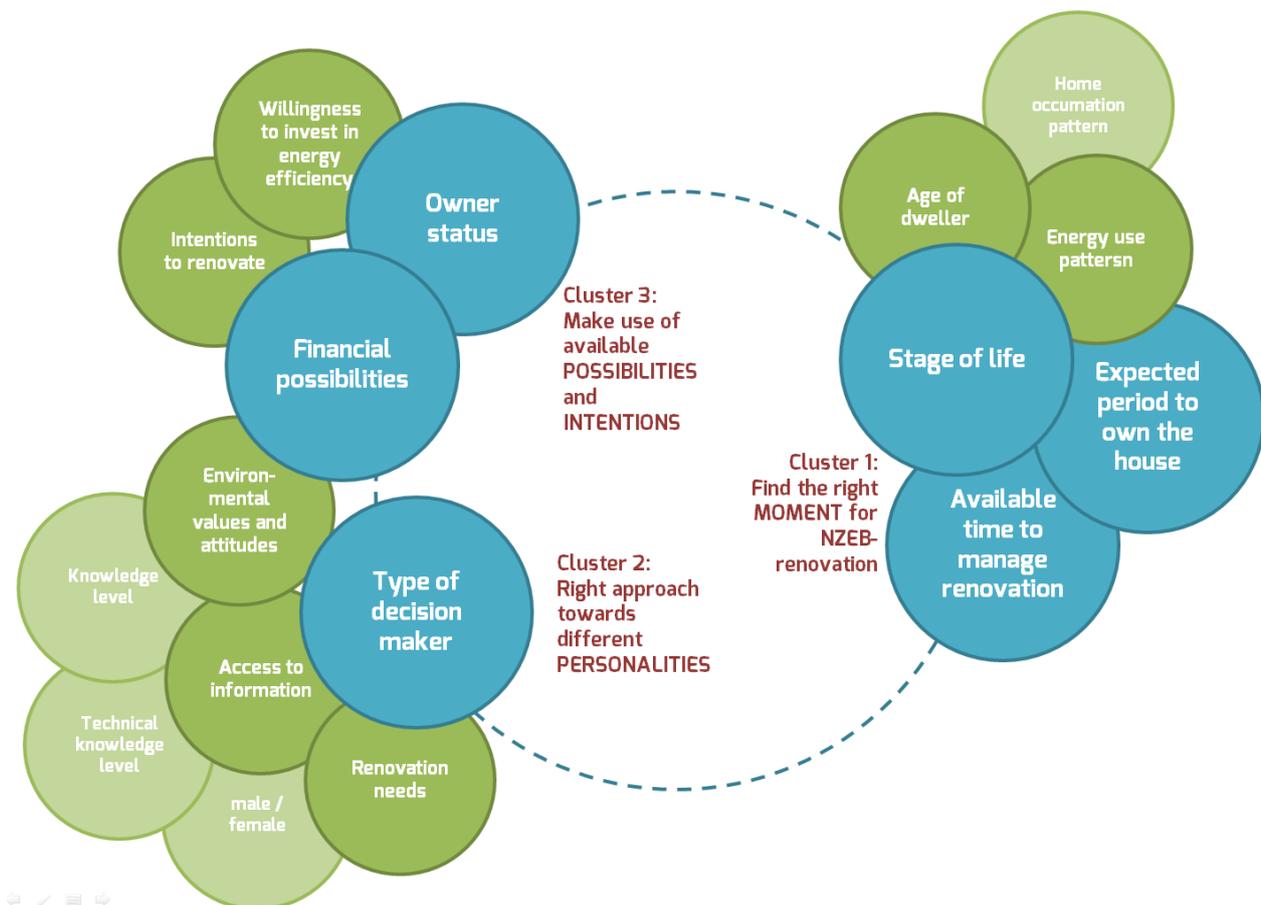
Figure 2: Clusters of relevant dweller characteristics

Based on these characteristics and insights from studies, best practices and experiences, the REFURB partners created **a matrix as a tool to design tailor-made segments**. This matrix organizes the interplay of dweller characteristics (interesting for demand aggregation schemes) and dwelling characteristics (interesting for NZEB-renovation). The set of 3x3 clusters with dwelling and dweller characteristics offer a framework for a balanced design of segments.

The tool can be used in different contexts to help to define tailor-made segments. This is necessary as it is shown in chapter 2 that in different EU-countries or regions housing markets can be very different. As a consequence, the REFURB project does not propose generic, pan-EU-valid segments for housing renovation.

Table 1: Matrix as a tool to segment for demand aggregation schemes for NZEB- renovation in the residential sector

	Clusters of dwelling characteristics			
		SIMILAR dwellings • Neighbourhood type • Dwelling type • Construction era • Construction type • Historical value	**STATE of the dwelling** • Urgency for renovation • Inconvenience linked with renovation • Inconveniences and defects • Value of the house	**energy saving POTENTIAL** • Energy performance
Clusters of dweller characteristics	**The right MOMENT** • Stage of life • Time to manage renovation project • Expected period to own the house • Age of dweller • Energy use patters • Home occupation pattern			
	Different PERSONALITIES • Type of decision maker • Renovation needs • Access to information • General knowledge level • Technical knowledge level • Male/female			
	Available POSSIBILITIES and INTENTIONS • Financial possibilities • Owner status • Willingness to invest in energy efficiency • Intentions to renovate • Environmental values and attitudes			

The matrix offers flexibility to focus on mainly dwelling or dweller characteristics, or a combination of both. To illustrate this matrix, a set of 5 high-potential segments for integrated NZEB-renovation packages and demand aggregation schemes were described:

- "young families",

- "Post-war suburbs with detached houses",
- "Empty nesters",
- "Terraced houses with a high energy bill" and
- "convinced energy savers".

Next to these 5 high-potential segments, other segments can be defined and designed, relevant for specific countries, regions or contexts. E.g. Germany has a large private rental sector, the Netherlands have a large social housing sector, Estonia a majority of apartments. These conditions are important to design appropriate segments.

Based on the segmentation of this report, drivers and barriers (financial, social, psychological…) will be linked with different segments (report D2.2), better ways to organise the demand side will be examined (report D2.3), local differences in demand side drivers and barriers will be examined (report D2.4), and improved approaches to seduce homeowners to integrate NZEB-ambitions within their renovation will be designed (report D2.5).

1. Introduction

Renovation by the private sector towards increased energy efficiency is seriously lagging behind. As more than sufficient technological solutions are available, focus must be on removing non-technological barriers. The main barriers relate to fragmentation of the renovation offer, resulting in inefficient or only partial solutions. One way to solve this is the use of a 'one-stop-shop concept'. Many have been put in practice. Some were successful, others not. They often lack an understanding of the concerns and demands of homeowners.

The REFURB-project focuses on the complex interplay of barriers through coordinated process organization, innovation and optimization. Work package 2 and work package 3 are dedicated to analyse demand and supply side drivers. This report is part of work package 2 ("demand side mapping"), and establishes a segmentation of the demand side. This segmentation is the first step to better understand the homeowners, which is a diverse group of decision makers in energy efficiency investments.

The demand side of the REFURB project refers to private homeowners, which is a diverse group of decision makers in energy efficiency investments that is not well organised and has a limited capacity and ambition to inform themselves on technical details of energy efficiency solutions.

In Work Package 2, a segmentation of the demand side is being established, and insights are gained into the wishes, needs and motives of homeowners (not) to invest in energy efficiency measures. This improves the understanding of the possible ways to better organise the fragmented demand side, and define improved approaches to seduce homeowners to integrate NZEB-ambitions within their renovation, with energy saving translated to their 'language'.

In task 2.1 the segmentation of the demand side is being developed. A segment is a group of different types of dwellings with similar characteristics, based on:

- dwelling characteristics: typology/morphology of various private houses (e.g. flat/houses, year of construction, energy efficiency, neighbourhood, architectural characteristics, building techniques and materials etc.), and
- Dweller characteristics of decision makers (e.g. owner vs tenant, financial possibilities, stage in life of inhabitant, household composition, technical building skills and knowledge etc.).

1.1 INTERPLAY BETWEEN SEGMENTATION, DWELLING AND DWELLER CHARACTERISTICS, DRIVERS AND BARRIERS

To segment the demand side (homeowners) and the housing market, characteristics need to be defined which make the distinction between the different groups (segments).

There are 2 main types of characteristics to define segments: dwelling-related characteristics and dweller-related characteristics. But not all potential or interesting characteristics to define these segments can be clearly attributed to a dweller or a dwelling characteristic: sometimes it is a mixture, e.g.:

- The building era is a dwelling characteristic
- The stage of life is a dweller characteristic
- The energy bill is the result of the energy performance of the building, the energy use pattern of the dweller, and the energy prices (external agent).

The segmentation (report D 2.1) also interferes with the listing of the drivers and barriers of homeowners to decide on NZEB-renovation (report D 2.2). Segments are groups of dwellings and/or dwellers that have similar characteristics and meet similar barriers and drivers. The characteristics to segment can be a driver or barrier at the same time, but not necessarily always, e.g.:

- People with high access to financing can be a separate segment, as they do not face similar financial barriers as people with low access e.g. people in energy poverty , which can be a second segment. For people in energy poverty, the access to financing is a major barrier. As a result, different (financial) solutions and persuasion strategies are needed to tackle the specific barriers of these two segments separately. Here access to finance is a feature to design segments as well as a barrier for the two segments of homeowners.
- For different construction types of a dwelling (massive masonry, cavity walls, timber frame, cassette façade etc.) different NZEB-renovation concepts are needed. So the construction type is an obvious characteristic to segment the dwellings. But the construction type as such is not a barrier for NZEB-renovation.

The relationship between dwelling characteristics, dweller characteristics, drivers and barriers is shown schematically in Figure 3.
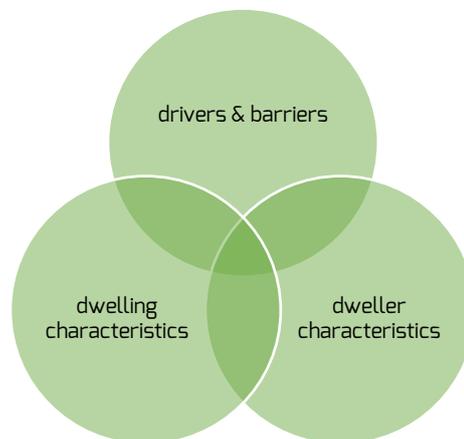
Figure 3: The relationship between dwelling characteristics, dweller characteristics, drivers and barriers

1.2   SEGMENTATIONS FOR ENERGY EFFICIENCY

"Market segmentation can be defined as the subdividing of a market, or population, into distinct, but possibly overlapping, subsets, where any subset may be selected as a target for tailored marketing efforts. In this sense, segmentation falls into the broad category of procedures for taxonomic

classification which enable enterprises to better understand how best to interact with populations of interest. "[1]

The basic assumption is that the process of segmentation will generate a number of individual segments whose behaviour is endogenously homogeneous, with maximum heterogeneity between segments.

Literature shows that segmentation can be done from the view of different disciplines. These all describe the pathways by which new ideas, behaviours, technologies, products and services are absorbed into the marketplace. The concept of market segmentation, in particular, is broadly based on studies of how innovations in goods, services, and behaviours diffuse through different populations, as partially informed by social psychology and sociology.

As an example, Table 1 shows some different methodological options to segment for energy efficiency programs. The table shows the relation between the approach of the segmentation, such as classical traditional economics, and the approach of consumers, marketing and technology diffusion. This implies that the methodological approach for segmentation influences the approach of consumers. This relation is also elaborated in report D2.5 of the REFURB project and elsewhere in the REFUB project, for the adoption of NZEB-renovation in the residential sector. For example, some homeowners will be convinced to invest in NZEB-renovation because of the benefits it brings such as a lower energy bill (arguments originating in classical traditional economics), others will only be convinced because of the advice of intimates (behaviour economics).

Table 2: Approaches to segment a market, from CIEE, 2008, Market Segmentation and Energy Efficiency Program Design, Oakland

Methodological Approach	Basis for Segmentation	Examples
Classical Traditional Economics	Preferences, usually exhibited through supply-demand equilibriums	Traditional way of marketing energy efficiency programs, in which incentives (e.g., subsidies) are provided to lower costs and information about the benefits of adoption is provided. In depth segmentation is often not conducted, under the assumption that rational consumers will respond appropriately to price signals if they are provided with sufficient explanatory information
Behavioural Economics	Same as classical economics, modified by understanding decision heuristics and context dependent preferences	Typical of consumer products segmenting approaches, in which the product is linked with trusted messengers or deep emotions/desires, and marketing is tailored based on triggering an attachment to the product based on the identified linkages.
Technology Diffusion	Patterns of technological adoption	Dominant in agricultural marketing, in which key change agents are identified to be early adopters of a technology, signalling to others that it's worth purchasing. Now embedded in a host of products which are linked to celebrities, hipsters, or techno-savvy consumers, in which segmenting focuses on catering to early adopters first, and then linking these with follower population
Social Psychology	Psychological and demographic characteristics	Applied in product areas in which there is a multiple of niches (e.g. beverages). Intermittently popular as a basis for energy efficiency marketing, though it's unclear how successful it's been.

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[1] CIEE, "Market Segmentation and Energy Efficiency Program Design", Oakland, 2008

Sociology	Institutional/group context in which preferences are formulated	Used as part of broad campaigns to change behaviours of large groups of people (e.g., health care habits; environmental attitudes).

Segments might be developed around a host of different characteristics, for example demographics, geographic (e.g. neighbourhoods), decision pathways, knowledge, needs, values, attitudes, motivations, preferences, energy use patterns, access to financing, access to information, trust levels, competing products etc.

1.3   EXISTING GENERIC TYPOLOGIES

In order to target the information and thereby increase the level of new deep renovation projects, it is necessary to consider the different dweller typologies. The following section will describe some of the results found in recent European research projects.

One approach is to divide the homeowners into three **segments/typologies** as suggested by Aune (2007). She describes the three typologies as "home as haven", "home as project" and "home as arena for activities" and also suggests how the approach for energy savings in the three groups should be handled. As seen in Table 2 the communication will highly depend on the typologies.

Table 3: Description of the three dweller typologies as suggested by (Aune 2007).

Typology	Description of the typology	Communication regarding energy savings for this typology
"Home as haven"	Prefers the home as a cosy and comfortable home. Examples are the right lighting, a comfortable indoor temperature or an open fireplace. The use of hot water is also mentioned but not seen as an energy consumption or possibility for saving but instead seen as rest and meditation. This typology prefers a personal and private home.	The important parameters for this typology are privacy, cosiness and stability. The communication need to take this into consideration in order to change their energy consumption. Aune suggests: *"High energy costs, new energy-efficient technologies, information champagnes and other instruments implemented to reduce private energy consumption should probably not challenge ''the home as haven'' mentality, but rather try to address it."* (Aune, 2007)
"Home as project"	"The home as project'' is a typology where the dwellers like retrofitting and designing the home, which they see as a material and symbolic expression of themselves. They are motivated by improved comfort rather than energy saving, but still, aiming for improved energy-saving measures in this type of home can be the highly effective because the house is constantly being rebuild.	For this group the design, functionality, availability and usability are important factors for energy saving products and these are the parameters that should be enhanced in the communication for this group.

They value products in the market that fulfil both the demand for low energy and high aesthetic value and Aune suggests that *"It is possible to influence the domestication of this home in a more sustainable direction by specifically developing and marketing energy-saving technologies towards this group."* (Aune, 2007) |

| "Home as arena for activities" | This typology finds the feeling of home from the unity of people and activities going on in the home. They do not see style or materials as important in order to create a home.

The span of family typologies in this category is large and goes from a more intentional ''alternative and green'' lifestyle to a traditional way of life. But common for all in this typology is that they are non-spending, non-wasting and environmental friendly.

As Aune writes: *"No big rebuilding activities are performed unless they are necessary. The artefacts in these homes, whether it is a couch, a television or a refrigerator, are worn out before they are replaced."* (Aune, 2007) | As the span in this group is large, the communication also needs to be varied. A ''green message'' will interest some. A message of responsibility and common interest will catch the interest of others.

For this typology economy is a very important parameter, and besides the economic savings caused by energy savings they will also feel a moral obligation for saving energy. When promoting new technology to this group, it is important to point out both the practical and the financial factors.

The dilemma for this typology is the fact that even though they seem to live a simple life, old technologies are more energy demanding and old houses often require more energy for heating. They thereby can end up with a large consumption. |

The importance of targeting the information at specific dweller typologies is also stressed by Haines & Mitchell (2014), who have developed **personas** for this specific aim. The personas are developed based on a qualitative study with interviews of 33 owner-occupier householders in the East Midlands region of the UK. All householders are living in solid-wall-houses, which hold a great potential for energy renovation.

The overall difference between segments and personas is the amount of data behind the development. While segments are derived based upon large data samples which result in a general description of each segment, personas are based on small and very target-specific data samples. The advantage of the personas is the more personal description which makes it easier for the designer or developer to target a specific design or offer towards the persona.

The personas developed by Haines and Mitchell (2014) are described in Table 3 together with the opportunities to get them to renovate their building.

Table 4: Description of the personas developed by Haines and Mitchell for building renovations in solid-wall-houses. Table is cited from (Haines & Mitchell, 2014).

Persona (including subtype)	Key features	Opportunities for retrofit
The Idealist Restorer: *The property is a project*	Motivated to live in an older property because of the character and the opportunity it provides for restoration and improvement. Values the aesthetic period features and space afforded by older homes.

Wants to restore as many original features within the home as possible but not at the expense of aesthetics, comfort and convenience. Although they wish to keep the sash windows, they have replaced the quarry tile floor in the hallway with laminate flooring. | Very open to retrofitting and energy efficiency measures and in an optimal order if the aesthetics of the home are respected.

Interested in "clever" energy saving technologies but only if the character of the home can be maintained. |

	Motivated to learn new DIY skills and wants to do things thoroughly. Energy efficiency is perceived as a construct of quality but aesthetics and comfort are valued higher..	
The Affluent Service Seeker: *The property is a pleasure*	Motivated to live in an older property because of the character, idyllic rural location, large garden and useful outbuildings. Accepts that older properties are expensive to maintain and views spending on the property as a way to preserve and add value to the investment in the property. Seeks luxury and quality but also value for money. Known to be financially savvy. Values comfort over financial saving. Carries out very little DIY through choice but likely to be less physically able than when they were younger. Energy efficiency is perceived as difficult to achieve in a large old property but this persona is keen to take advantage of any grants or incentive schemes available.	Open to incentive schemes and polices that generate income for the homeowner or add value to the property. Will choose to use specialist professionals to ensure a quality job.
The Property Ladder Climber: *The property is a step up*	Motivated to live in an older property by the potential it offers to add value to its resale value through renovation. Happy to borrow money in the short term to finance home improvements, paying these back when the property is sold. Enjoys developing his/her DIY skills as the projects get bigger with each property they buy. Open to consequential improvements as they are thinking at a whole-house level but these improvements must lead to financial gain at the point of resale. Energy saving beyond current building regulations is not a priority.	Open to the use of finance schemes if these are cost-effective within the context of 'improving to sell'. Unlikely to consider technologies with long payback times unless the cost of installation is passed on.
The Pragmatist: *Subtype - Functional The property is a place to live*	Motivated to live in an older property because of the layout and room size that accommodates a full and active family life. Home improvements are seen as a hassle rather than a hobby; the latter are considered time-consuming, reducing time for more important things - hobbies and family time. Not particularly interested in keeping older features of the property, but places greater value on convenience. Concerned about the environment and climate change, as a result of their family values.	When things wear out or go wrong. At the time of purchasing the property. When re-purposing a space or extending the home. When finance becomes available.

The Pragmatist: *Subtype - Aesthetic The property is a home*	Motivated to live in an older property because of the character and space it offers. Enjoys having a project on-the-go but improving or updating the decoration, furniture and appliances within the home will be of higher priority than repurposing of space or non-essential maintenance. Likely to cover up some issues like damp through frequent redecoration rather than fix the underlying cause. Values 'on the shelf' solutions, preferring to finance these from savings or windfalls rather than loans. Want a neat and tidy job to be done, with a good-quality finish.	When they first purchase the property or within the regular cycle of decorating and refurbishment. The order of retrofit will be driven by aesthetic priorities, e.g. the desire for new kitchen may lead to a new boiler.
The Stalled: *Subtype - Lack of Finance, The property is a shelter*	Wants a warm, comfortable home, but is not extravagant in his/her requirements. Wants to feel safe and secure in his/her home and be assured that any work undertaken by tradespeople is not exploiting them financially or putting them in danger. Frugal and interested in saving energy primarily to save money. They are positive towards opportunities to improve the warmth and security of their home. Leaves parts of the property unheated through the winter, but uses draught proofing to increase comfort.	Limited to when grants are available. Will undertake consequential improvements if dictated by grant scheme.
The Stalled: *Subtype - Pressures of Life, The property is a necessity*	Does not have the time, emotional energy or financial resource to undertake home improvements at present. Will use a trusted, known professional to help with any essential jobs around the property but won't undertake any major projects. May consider taking a loan to fund essential maintenance but they prefer to wait and use savings when they can afford.	Almost none at present.

1.4 TOWARDS A REFURB-TAILORED SEGMENTATION

The academic insights described in part 1.2 and the examples of chapter 1.3 show that segmentation of the demand side can be made in multiple ways. Every type of segmentation serves a certain goal, e.g. social research, economic research, market research, social policy, energy policy etc.

For example, very commonly segmentations focus on the dwelling typology (single family house, semi-detached single family house, terraced house, apartment), the age of the house (categories of construction year), the type of ownership (private ownership, social housing company, private rental), the size of the house (studio, one-room dwelling, 2-room dwelling). But segmentations also make use of dweller

typologies (young family, elderly, high income, low income), the neighbourhood (suburbia, rural, city centre, along busy roads) etc.

In the REFURB project a segmentation that is relevant for NZEB-renovation and to design demand aggregation schemes is being made. There is research available which allows creating this segmentation. Also on EU level there is material available, e.g. the Tabula typology (see 3.1). Which aspects will be taken into account for a segmentation?

1.4.1   A segmentation based on dwelling and dweller characteristics

The segmentation makes use of a set of relevant and distinctive characteristics. In the REFURB project, 2 main categories of distinctive characteristics are being distinguished:

- Dwelling characteristics: typology like flats/houses, year of construction, energy efficiency, neighbourhood, architectural characteristics, building techniques and materials etc.
- Dweller characteristics (decision makers, homeowners): e.g. owner vs tenant, financial possibilities, stage in life of inhabitant, household composition, technical building skills and knowledge etc.

1.4.2   A demand-side perspective to underpin demand aggregation schemes

Two main options to tailor a segmentation which is relevant for NZEB-renovation remain: from a demand-side perspective and from a supply-side perspective. Both perspectives lead to different segmentations, e.g.:

- For the supply side an interesting segmentation is based upon building traditions, e.g. houses with a cavity wall, or houses with single glazing etc. The supply side could make a direct link with their NZEB-renovation solutions, e.g. cavity wall filling insulation. This mapping of the supply side solutions is used in work package 3 ("supply side mapping"), e.g. in report D3.2. ("mapping existing renovation solutions according to housing and homeowner typology")
- For the demand side an interesting segmentation is for example based on stage of life. Elderly people with no intentions to renovate and that stick to ancient standards have a very different attitude towards NZEB renovation than a young family that just wants to start a renovation and has NZEB-ambitions. For both segments, a different one-stop-shop offer can be developed, tailored to their particular needs.

The central perspective in the REFURB project is the demand-side perspective. This is essential: **in the REFURB project it is acknowledged that there is too little known about the motives of the demand side, the heterogeneous group of homeowners, for (not) integrating NZEB-ambitions in renovation concepts. Most NZEB-implementation strategies nowadays concentrate on the supply side and technological solutions in particular. In the REFURB project this perspective is largely abandoned, and replaced by a demand-side perspective.**

1.4.3   Overlapping segments

The segmentation of the REFURB project does not have the ambition to cover the entire demand side, and create a segmentation to fit the entire demand side into juxtaposed categories (Figure 4).
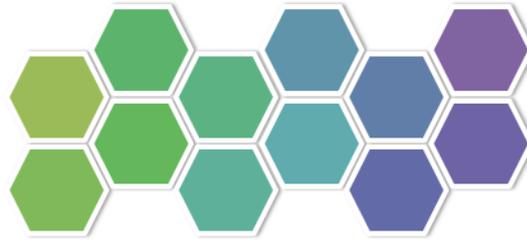
Figure 4: Juxtaposed segments, e.g. Terraced houses pre 1980; terraced house post 1980; detached house pre 1970; detached house post 1970;

The ambition is to identify some high potential segments for deep NZEB-renovation to design demand aggregation for. Based on the academic insights (multiple perspectives to segment), it is chosen to allow segments to overlap. Different segments can share similar characteristics, but differ because of a different perspective they have been designed for (Figure 5).
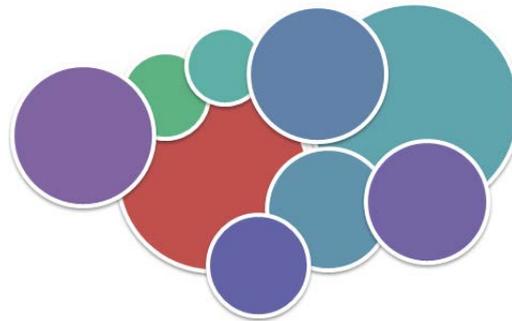
Figure 5: Segments with overlap, e.g. "Post-war suburbs with detached houses" overlaps with "houses with high energy bill"

2. Regional housing markets in the EU

Buildings account for the most significant CO_2 emissions sources in Europe. Unfortunately, the energy performance of our buildings is generally poor in relation to the ambitions of the European Energy Performance Building Directive (EPBD). While new buildings can be constructed with high performance levels, it is the older buildings, representing the vast majority of the building stock, which are predominantly of low energy performance and subsequently in need of renovation.

The different EU countries have different housing markets with different characteristics like building tradition, building age, share of protected heritage, ownership, typologies, building and renovation dynamics, energy mix etc. In the REFURB project, 6 EU countries are represented. To understand their REFURB solutions, their housing markets need to be understood. In this chapter, a brief overview of a few relevant parameters is given. These are based upon country reports provided by the REFURB partners. Examples can be found in the annexes to this report.

The information in this chapter is based on Eurostat[2], the statistical office of the European Union, the Data Hub[3] of the Building Performance Institute Europe (BPIE) and underlying data sources of the Data Hub. The Data Hub collects data on energy efficiency in European buildings, and is (partly) the result of several IEE and FP7-projects of the European Commission, e.g. Episcope, Tabula and Entranze.

2.1 SHARE OF SINGLE FAMILY HOUSES

In 2008 in the EU, the share of single family houses ranged between 25% (Estonia) and 89% (Ireland).[4] For REFURB partners, the share of single family houses ranges from 25% (Estonia), 46% (Germany), 73% (Belgium), 59% (Denmark), 36% (Slovenia) to 70% (the Netherlands) (Figure 6).
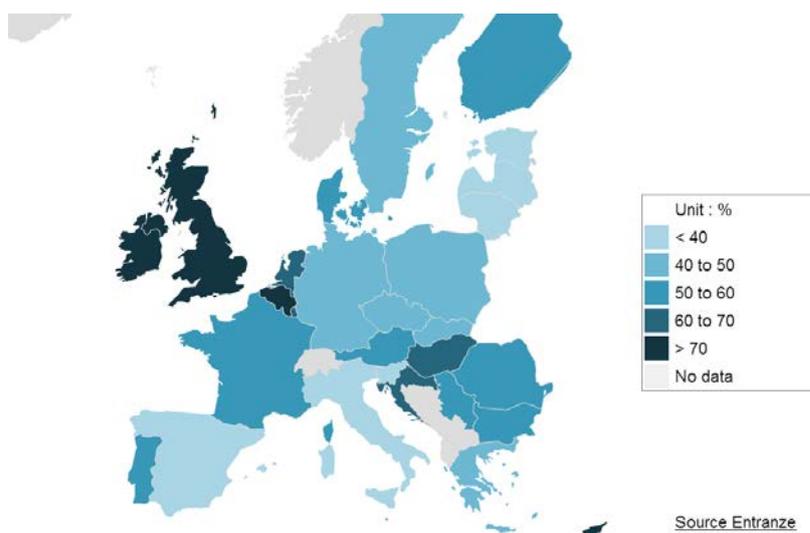
Figure 6: Share of single-family dwellings in total stock. Source: http://www.entranze.enerdata.eu/

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[2] http://www.eurostat.eu

[3] http://www.buildingsdata.eu

[4] http://www.entranze.enerdata.eu/

2.2 OWNERSHIP

In the EU, the majority of dwellings are privately owned. Private ownership in all EU countries is higher than 68% (Netherlands), up to 94% (Belgium, Denmark) and even 100% like in Spain.[5] In REFURB countries Estonia and Slovenia, the private ownership was installed in the early nineties, after privatisation of the residential sector.

Most of the dwellings are owner-occupied, on an average 74% in EU, varying between 46% (Germany) and 97% (Bulgaria). In the other REFURB countries, this ranges from 52% (Netherlands), 58% (Denmark), 73% (Belgium), 81% (Slovenia) to 89% (Estonia)[6](Figure 7).
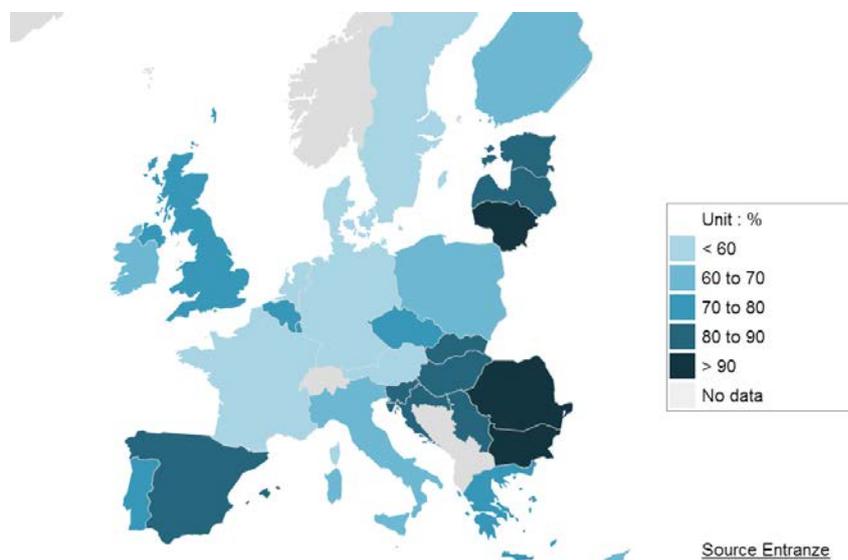
Figure 7: Share of owner occupied dwellings in residential stock. Source: http://www.entranze.enerdata.eu/

Other homes are private rented or public rented. The private rental sector accounts on an average for 13% in EU-countries, but differs per country. Some countries have a large private rental sector, like Germany (54%), Austria (31%) and Finland (30%), whereas this sector (almost) doesn't exist in Estonia, Hungary, Lithuania, Malta, Poland, and Romania. The social rental sector accounts on an average for 10% in EU-countries, is very large in the Netherlands (36%) and Poland (31%), but (almost) inexistent in Germany, Italy, Romania and Slovakia. [7]

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[5] BPIE, "Europe's Buildings under the Microscope", Brussels, 2011

[6] http://www.entranze.enerdata.eu/

[7] http://www.entranze.enerdata.eu/. However, this depends on the definition of "social rental sector". E.g. in Germany the public sector plays to a certain extent a role in the private rental market.

2.3 AGE OF HOUSES

Of all the single family houses in the EU (not the apartments), 28% was constructed before 1945, and 25% between 1945-1969. Thus more than half of the EU single family houses are over 45 years old. [8]

In some EU countries, the share of old single family houses is significantly higher. In Belgium, Estonia and the UK, more than 40% of is built before 1945. The Netherlands have a relatively lower share of pre 1945-houses (23%), but not as low as Portugal or Romania (around 17%). In many countries, the share of pre 1970-houses is over 60% (Belgium, Cyprus, Denmark, Estonia, Italy, Lithuania, Luxemburg, Sweden, and UK). Cyprus, Ireland, Poland and Spain have many recently constructed houses (after 2000).
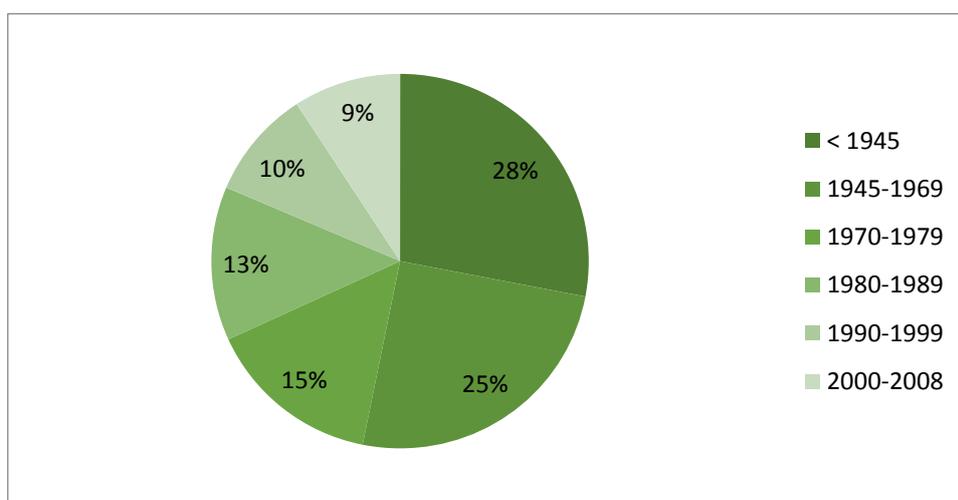
Figure 8: Single family dwellings in EU according to construction date. Source: based on http://www.entranze.enerdata.eu/

Estonia has a very particular building stock: family homes only account for 25% of the total housing stock but are older; most of the Estonian houses are built as apartments in the period 1960-1990. And Estonia also has a limited number of recent buildings (after 1990): less than 10%. [9]

2.4 ENERGY USE AND CO2 EMISSIONS

The residential sector is responsible for 27% of the final energy consumption in the EU (2013)[10], and is one of the 3 large sectors that use energy. The other important sectors are transport (32%) and industry (25%) (Figure 9).

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[8] http://www.entranze.enerdata.eu/

[9] BPIE, "Europe's Buildings under the Microscope", Brussels, 2011

[10] http://ec.europa.eu/eurostat, Final energy consumption per sector (GWH)
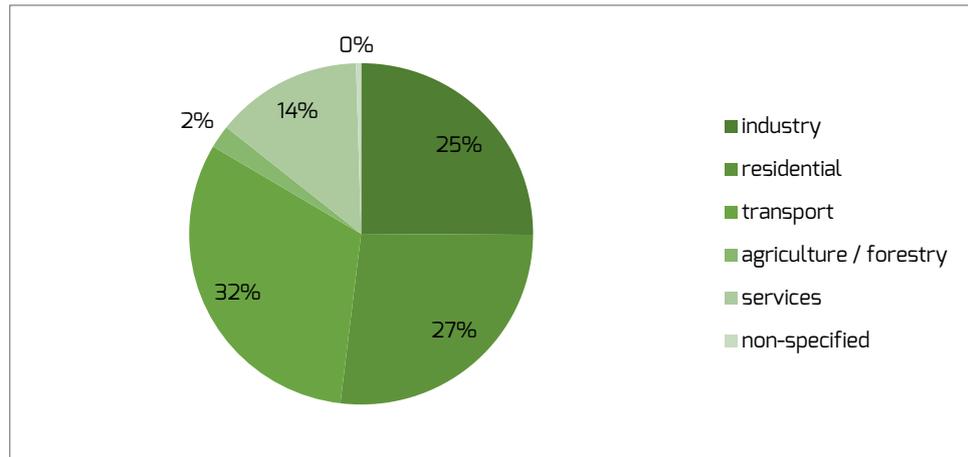
Figure 9: Energy use per sector in EU, 2013. Based on http://ec.europa.eu/eurostat, Final energy consumption per sector (GWH)

In the EU residential sector, the use of electricity accounts for 24% of the total residential energy use (Final energy consumption in GWh). Electricity is mainly used for electrical appliances, but in some countries electricity is commonly used for heating (e.g. France). In most countries non-electric energy sources (at the dwelling level) are being used for heating. Gas is the most important source for households (37%), as well as renewable energies (15%), petroleum products like heating oil (13%) and derived heat like district heating (8%) (Figure 10).
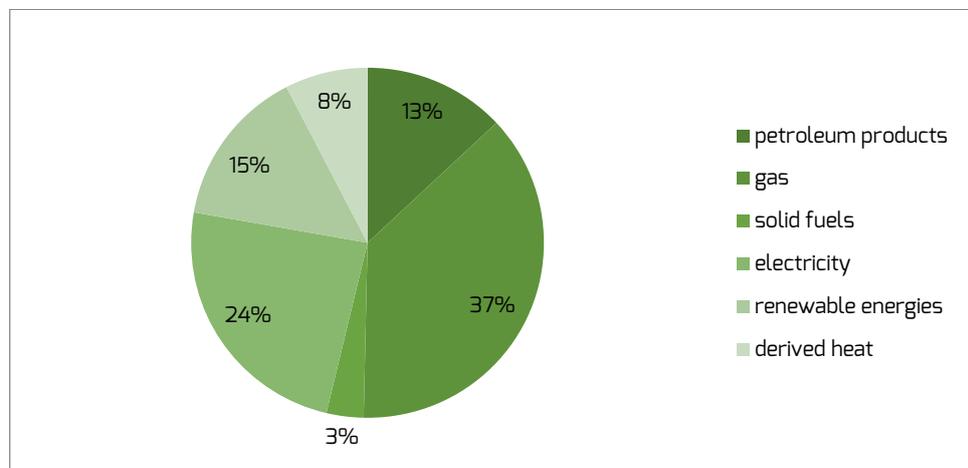
Figure 10: Final energy consumption in households by fuel (%), 2013. Based on http://ec.europa.eu/eurostat

This energy mix in the residential sector differs country by country.

- Gas is very important in Holland (+70%), but not in Estonia and Slovenia (less than 10%) and Denmark (15%).
- Electricity can be very important, e.g. in non-REFURB countries like Sweden and Bulgaria (+40%).

- Petroleum products have an EU average share of 13%, and are significantly more important in some countries like Belgium (30%) and Germany (23%), and are less important in e.g. Estonia and the Netherlands (1%).
- Renewable energies account for 15% in the EU, with higher shares in Estonia and Slovenia (+40%) and lower shares in Netherlands (3%) and Belgium (7%).

Between the EU-countries, there is a big difference in energy use per m² living space in the residential sector[11] (kWh/m²/year), but we have to be careful with comparisons between countries[12]. In Malta, the energy use is 69 kWh/m²/year, in Luxemburg it is 5,5 times more: 381 kWh/m²/year.[13] As the map below shows (Figure 11), there seems to be little correlation between the climatic zone and the energy consumption: both in Northern and Southern countries, the energy intensity can be high. From the REFURB countries, Estonia (325 kWh/m²/year) and Belgium (288 kWh/m²/year) have the most energy intense residential sector. In Denmark and the Netherlands the figure is lowest: around 190 kWh/m²/year. Germany (232 kWh/m²/year) and Slovenia (218 kWh/m²/year) are in between.
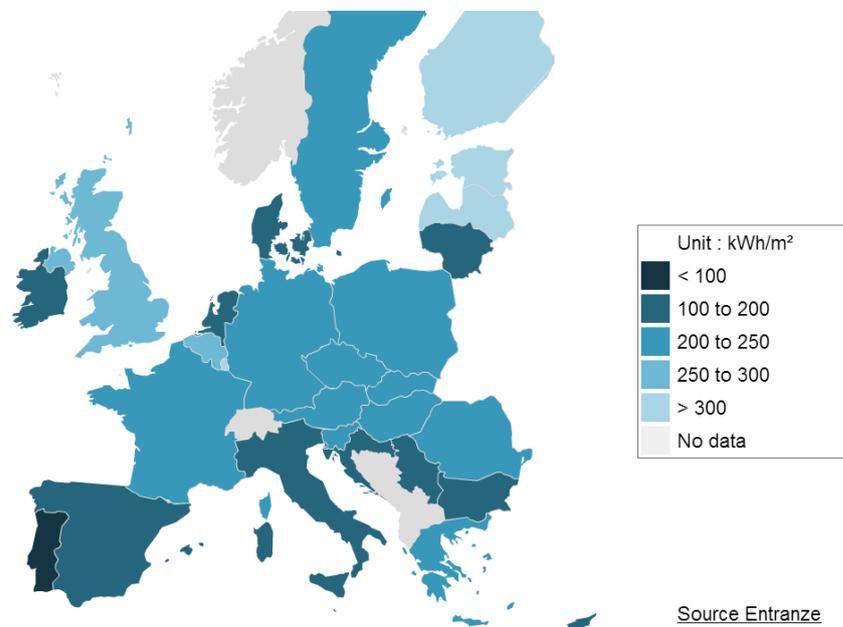
Figure 11: Total unit consumption per m² in residential sector (at normal climate). Source: http://www.entranze.enerdata.eu/

The energy use and energy mix of the residential sector is closely linked with the emissions of CO_2 of the residential sector. Electricity has high emissions of CO_2 per energy unit, for renewables the emission is very low (up to zero). For example, the extent to which renewable energy is used in the residential buildings, the use of district heating and cogeneration and the electricity mix in each country heavily affect the CO_2 emissions related to residential buildings.

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[11] The total energy use for electricity, space heating and water heating.

[12] It is a major challenge to compare the energy requirements between several Member States, even when they are expressed in the same units (e.g. kWh/m²). Source: Asiepi-project, http://www.asiepi.eu/

[13] http://www.entranze.enerdata.eu/

The amount of CO_2 emission per useful floor area differs a lot in the EU: from 15 kg CO_2/m²/year(Sweden) to 125 kg CO_2/m²/year (Ireland).[14] The average CO_2 emission in Europe is 54 kg CO_2/m²/year. The building performance and heating source are key components.

For REFURB partners Belgium, Denmark, Estonia, Germany and Netherlands, the CO_2 emissions per useful floor area are about 60-70 kg CO_2/m²/year.

2.5 ENERGY PERFORMANCE

The age of a building is strongly linked to the energy performance for the majority of buildings that have not undergone an energy renovation. For example, in Germany it is quite clear that the average heating consumption levels in terms of final energy use of single family homes decreases by construction year (Figure 12).
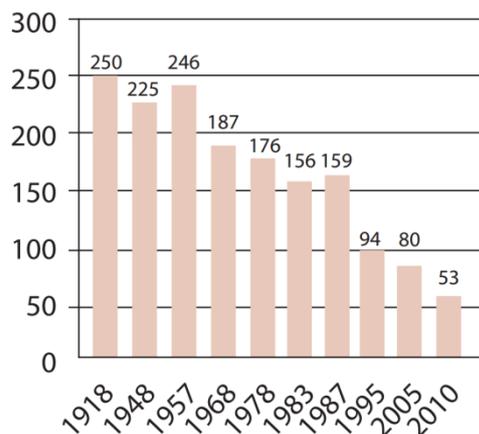
Figure 12: Average heating consumption levels in terms of final energy use (kwh/(m2 a) of single family homes by construction year, Germany (source: BPIE, "Europe's Buildings under the Microscope", Brussels, 2011

Building traditions and energy performance regulations differ from country to country. This had a major effect on the energy performance of buildings in the different EU countries. The scheme below illustrates the path of improvement of the thermal resistance of external walls in different EU-countries (Figure 12).

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[14] BPIE, "Europe's Buildings under the Microscope", Brussels, 2011
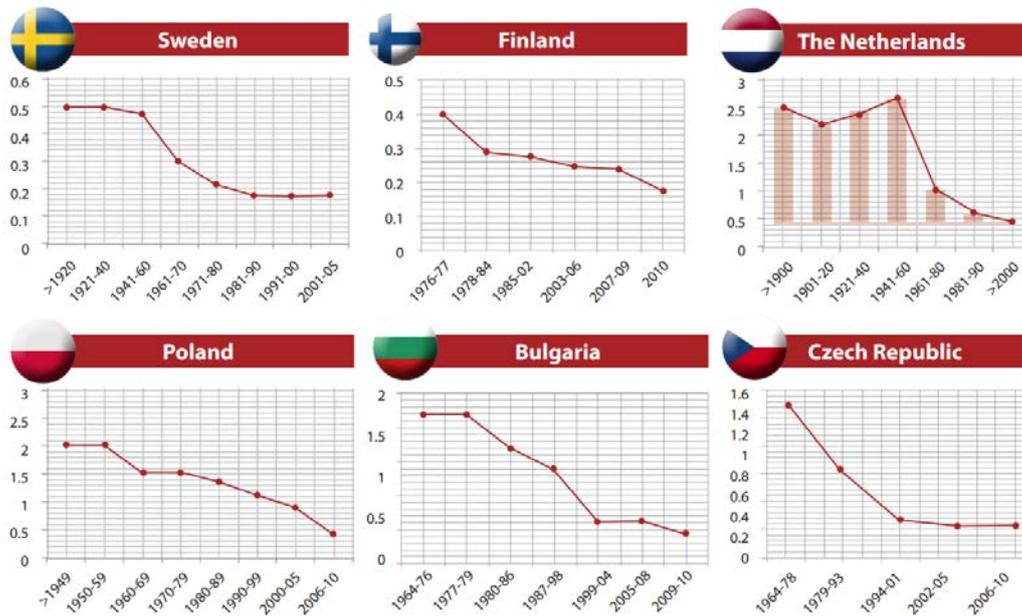
Figure 13: U-values (W/(m²K)for external walls in different countries for different construction periods, (source: BPIE, "Europe's Buildings under the Microscope, Brussels, 2011)

As a result, building parts like walls, floors, roofs and windows do not have the same thermal performance in the EU-countries. This is illustrated in the map below (Figure 14): the thermal resistance of a wall (the U-value), the weighted average based on the existing residential building stock, varies between 2,23 W/m²K in Malta (which is the worst) and 0,38 W/m²K in Estonia (which is the best).[15] For other REFURB countries, this value is very good in Denmark (0,70 W/m²K), average in Germany (1,11 W/m²K), Slovenia (1,25 W/m²K) and the Netherlands (1,26 W/m²K) and worst in Belgium (1,64 W/m²K).
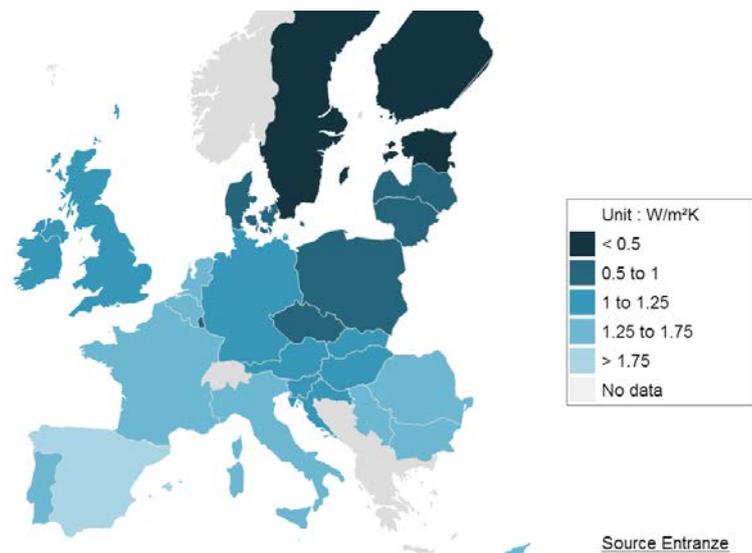
Figure 14: Wall U-values (weighted average based on stock). Source: http://www.entranze.enerdata.eu/

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[15] http://www.entranze.enerdata.eu/

2.6 CONCLUSION

It is clear from the above illustrations that characteristics of the housing markets in the EU clearly differ regionally. That's why there are no "one-size-fits-all solutions" for the EU market as a whole. Only a general method for segmentation can be proposed and needs to be applied to the market at hand, the target market for the market player who wishes to introduce his solutions into the market.

3. A generic housing market segmentation: dwelling typology

It is the objective of the REFURB project to develop a dwelling typology to set up housing market segmentation, based on existing material. Some efforts have already been made and it is preferable to start from this basis and evaluate what can be used, rather than to develop a completely new typology. An interesting dwelling typology is the so-called TABULA typology.

3.1 THE TABULA TYPOLOGY

Tabula and Episcope are Intelligent Energy Europe (IEE) projects, funded by the European Commission. The **Tabula project developed a concept of residential building typologies** which is continued and expanded in the Episcope project towards the elaboration of building stock models to assess refurbishment processes[16].

The Tabula typology is designed for modelling purposes, in order to assess refurbishment processes and project the future energy consumption. The question is whether this typology is useful for the REFURB project.

Starting from the common Tabula concept national building typologies have been designed, representing the residential building stock. The typologies consist of the following elements:

- a classification concept for existing residential buildings according to age, size and further parameters,
- a set of example buildings which represent specific building types of the national stocks,
- typical energy consumption values for the example buildings,
- showcase calculations of the possible energy savings,
- Statistical data for buildings and supply systems.

The parameters for classification of residential buildings according to the Tabula concept are:

- the country
- the region or climate zone, if available
- the construction year class
- the building size class
- an additional parameter

An overview of the national building typology is given by the "Building Type Matrix". The columns of the matrix are representing different building sizes, the rows represent different construction periods. The cells of the grid define the "Building Types" of a country. According to the general Tabula concept there are 4 building size classes and a certain number of construction year classes.

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[16] http://episcope.eu/

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (nationaal)	... 1964	generic (generiek)	NL.N.SFH.01.Gen	NL.N.TH.01.Gen	NL.N.MFH.01.Gen	NL.N.AB.01.Gen
2	national (nationaal)	1965 ... 1974	generic (generiek)	NL.N.SFH.02.Gen	NL.N.TH.02.Gen	NL.N.MFH.02.Gen	NL.N.AB.02.Gen
3	national (nationaal)	1975 ... 1991	generic (generiek)	NL.N.SFH.03.Gen	NL.N.TH.03.Gen	NL.N.MFH.03.Gen	NL.N.AB.03.Gen
4	national (nationaal)	1992 ... 2005	generic (generiek)	NL.N.SFH.04.Gen	NL.N.TH.04.Gen	NL.N.MFH.04.Gen	NL.N.AB.04.Gen
5	national (nationaal)	2006 ...	generic (generiek)	NL.N.SFH.05.Gen	NL.N.TH.05.Gen	NL.N.MFH.05.Gen	NL.N.AB.05.Gen

Figure 15: Example of a TABULA national matrix

The Tabula typology definitely is useful as a starting point to segment the housing market. It offers insights into the relevant housing characteristics to segment, and how they relate to energy performance and energy saving potential. The Tabula typology proves to be generic, applicable in all EU-countries. But, due to its specific intended use (modelling, pan-EU-applicability), it is not designed to reveal the subtleties in the housing market in all EU-countries, to detect the high potential NZEB-renovation segments. Within REFURB, it was concluded a further refinement of segmentation is needed.

3.2 DWELLING CHARACTERISTICS FOR MARKET SEGMENTATION FOR NZEB-RENOVATION

In all six REFURB countries, partners assessed the Tabula typology and conducted a desktop research on the available studies within the country. Based on the Tabula typology, the desktop study of the partners and the expertise of the project partners, a set of dwelling characteristics was listed to base the segmentations on.

In order to prioritize the importance of the different characteristics they were scored on their relevance for dwelling segmentation to define the housing categories for NZEB-renovation in all countries / regions. The scoring was done through a semi-quantitative assessment of every characteristic: a figure between 0 (not important) and 3 (very important), and a motivation for the score. The central questions for the REFURB project are:

- Is a separate NZEB-renovation concept required for these groups of dwellings? (Group needs similar energetic-technical solutions, faces similar barriers, and is interesting for a grouped approach…)

- Which are the interesting categories for NZEB-renovation? (Energy efficiency & renewable energy potential, significant size of the group…)

The characteristics are grouped in order to be able to identify the high-potential segments (Table 5).

Table 5: Dwelling characteristics for market segmentation for NZEB renovations

Very high relevance	High relevance	Medium relevance
• urgency for renovation (beyond energy) • neighbourhood type • energy performance (EPC-value)	• dwelling type • construction era • construction type • inconvenience linked to the renovation	• inconveniences and defects • historical value • value of the house

Below the listed characteristics are further explained starting with the characteristics which were identified by the REFURB consortium as most relevant.

3.2.1 Urgency for renovation (beyond energy)

Examples of categories: no urgent renovation, small non-urgent renovation required, urgent renovations required, deep renovation required, re-build required

Relevance for segmentation: very high

Relation with NZEB-renovation:

- Create win-wins: integrate the energy renovation with other renovations in one process.
- The full/staged NZEB-renovation concept depends highly on the state of the dwelling and its components. E.g. are only HVAC-installations to be re-installed but is the building envelope OK?
- For some dwellings, demolition and re-building can be the best solution.

Most interesting categories for NZEB-renovation

- Dwellings with shortcomings (condensation, moisture, noise, cracking floors, colds etc.), dwellings that need refurbishment (e.g. new kitchen, painting, flooring, bathroom etc.), dwellings with safety and/or sanitary issues (e.g. risk for CO-intoxication, moisture, mould), worn-out doors and windows, leaking roof, sagging timbers, end-of-lifetime heating etc.

- Any moment is the right moment for NZEB-renovation; but other needed renovations offer opportunities for NZEB-renovation; but NZEB-investment compete with other investments either home investments or other needs or desires of dwellers.

3.2.2 Energy performance certificates -value (EPC)

Examples of categories: 25% worst EPC-values; 26-50%; 51-75%; 76-100%

Relevance for segmentation: very high

Relation with NZEB-renovation:

- The EPC-value is the result of many (objective) parameters. The EPC value represents a calculated or theoretical value.
- Indicates the potential for energy reduction and cost saving
- The EPC is not known for all buildings, but can be estimated by most important parameters that define an EPC-value: building type, building era, and surface and condition of the building envelope.

Most interesting categories for NZEB-renovation

- 25% worst EPC-values: highest potential for energy reduction and cost saving. Theoretically, because in practice the energy use pattern of the dweller also is very important and can highly influence the actual energy performance of a dwelling.

3.2.3 Neighbourhood type

Examples of categories: centre, rural, suburban, high-rise, identical housing types, heterogeneous

Relevance for segmentation: very high

Relation with NZEB-renovation:

- Analysis in Denmark[17] reveals the first and easiest steps towards deep renovations by pointing out geographical areas with houses with a certain age and thereby an energy-saving potential, high concentration of families with children which are typical first-time buyers (who most often carry out the deep renovations), and finally the analysis also shows where the income also can promote the choice.
- concentration of building types & building era ⇒clusters with similar energy performance & NZEB-solutions
- sometimes identical houses ⇒upscaling of renovation : replication or scalability and standardisation of technical solutions
- Other possibilities for renewables (e.g. heat pump, solar thermal, solar PV, district heating etc.)
- interesting for neighbourhood aggregation schemes

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[17] Gram-Hanssen et al. (2015). The socio-economic values are pointing towards the greatest possibilities to renovate in the urban areas around the larger Danish cities. The rural areas also have the energy saving potential but the other parameters do not indicate potential for energy renovation. The analysis also shows that other strategies in rural areas might be necessary to promote energy efficiency and renovation of the Danish single-family houses.

Most interesting categories for NZEB-renovation

- Consistent neighbourhoods (dwelling and dweller characteristics) with low energy performing dwellings (see for example Figure 16).
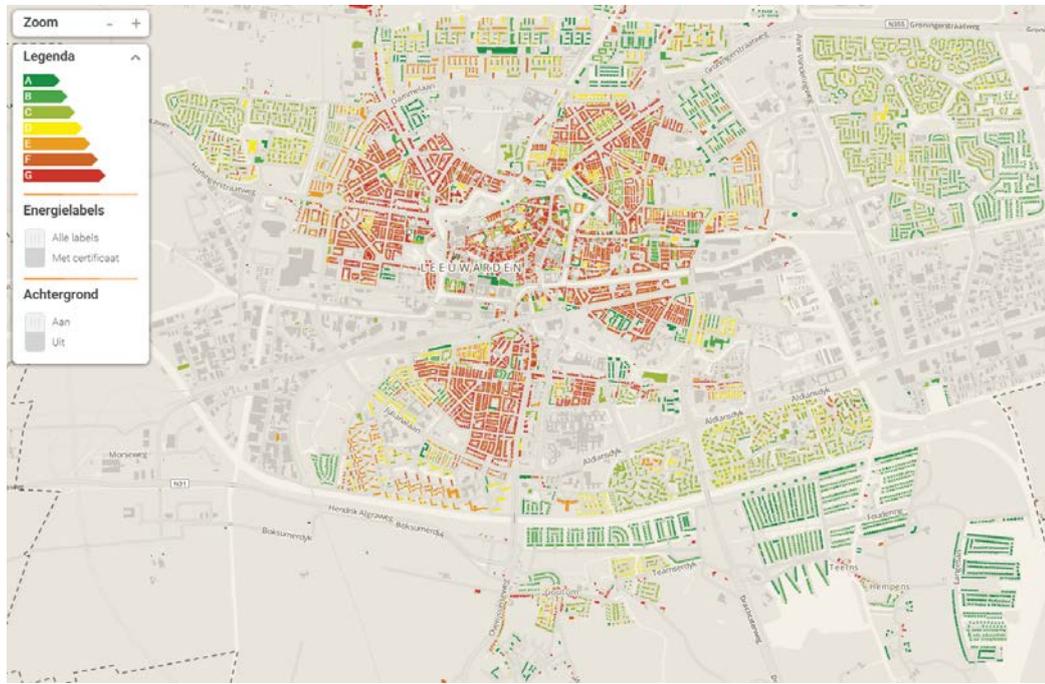
Figure 16: Neighbourhoods can be very homogeneous in terms of energy performance, illustrated for Leeuwarden (the Netherlands). source: www.energielabelatlas.nl

3.2.4 Dwelling typology

Examples of categories: detached, semi-detached, terraced, apartment, other

Relevance for segmentation: high

Relation with NZEB-renovation:

- There is a strong link with energy performance. Detached houses have relatively the worst energy performance compared to other building types with similar insulation and airtightness levels. This has to do with compactness and heat loss surface. The heat loss surface is a major parameter in the energy performance: the more heat loss surfaces versus usable area, the worse the energy performance. The larger surface also allows more wind leaks: the air tightness is less performing.
- Other opportunities in renewable energy production, e.g. heat pump (ground-water type) is difficult in terraced houses, renewables like solar-photovoltaic (PV) or solar thermal are difficult with apartments if legislation doesn't allow for collective PV-schemes.

Most interesting categories for NZEB-renovation

- Detached houses, because of great energy saving potential per dwelling.

- Terraced houses, because they have a good ratio between NZEB-renovation cost and energy saving. This is due to the smaller heat loss surface.

3.2.5 Construction era

Examples of categories: >2005, 1980-2004, 1945-1980, <1945...

Relevance for segmentation: high

Relation with NZEB-renovation:

- Interesting years to partition into categories are related with the introduction of new legislation, e.g. EPC or earlier energy performance legislation.
- There is a strong link with construction type. Construction era is a second best option if there is no insight in the construction type.
- The age of the building indicates the urgency for renovation: older buildings are usually more in need of a renovation.
- Relevant because of its correlation with energy performance. Statistically speaking: the older the dwelling, the less energy performing.
- Dominant building tradition at a certain era, and dominant insulation techniques & standards (e.g. single glazing, double glazing, cavity wall etc.)
- Renovation cycle. At least the first 30 years, a profound (energy) renovation is unlikely. For older buildings this is more likely, and even urgent. Although new houses can add extra techniques like renewable energy production, to improve the energy performance to NZEB-standards.

Most interesting categories for NZEB-renovation

- For older dwellings deep renovation can be more appropriate.
- For recent buildings, e.g. built after introduction of recent energy performance regulations, building envelope renovation is not appropriate but sustainable energy techniques could be more relevant as the costs of envelope renovation might outweigh the financial benefits for the dweller.
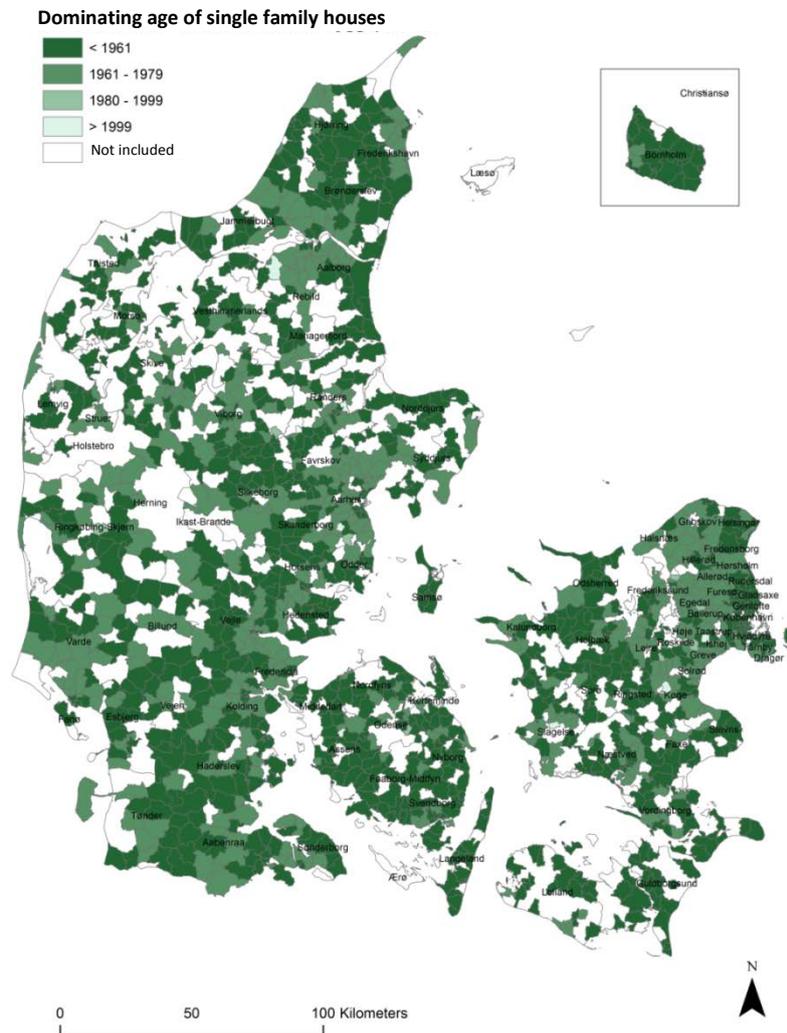
Figure 17: The construction era also has a geographical component. The map of Denmark shows the dominating age of single-family houses in Danish parishes with more than 100 single-family houses. Gram-Hanssen et al., 2015.

3.2.6 Construction type

Examples of categories: masonry - non-cavity walls, massive masonry, wood-skeleton structure, concrete frame construction, flat roof, pitched roof...

Relevance for segmentation: high

Relation with NZEB-renovation:

- There is a strong link with the technical options for NZEB-renovations: for these groups very homogeneous solutions can be applied and a similar renovation concept can be put in place, e.g. cavity wall insulation is only an option in cavity walls.
- Strongly linked with the building era

Most interesting categories for NZEB-renovation

- Many categories are interesting, as different NZEB-renovation concepts are needed, but especially those with a large share in the housing stock due to the high market potential.

3.2.7 Inconvenience linked to the renovation

Examples of categories: 1 day / 2 days / 1 week / 1 month interventions, (im)possible to continue living in the house during the renovation...

Relevance for segmentation: high

Relation with NZEB-renovation:

- Renovating an occupied dwelling is not always obvious. Some measures can be implemented while the house is inhabited (e.g. cavity wall insulation, PV solar cells…), for other measures a temporary moving out of the house is appropriate (e.g. floor isolation). Some measurements take a long time (e.g. integrated building envelope renovation); others can be done in a short time. Some bring a lot of dust and inconvenience, others can be done neatly. The renovation concept will depend on what is possible for the dwellers.
- Important for phasing of renovation

Most interesting categories for NZEB-renovation

- low-inconvenience renovations
- no-moving-out needed
- short renovations

3.2.8 Less relevant dwelling characteristics

3 characteristics are scored as less relevant for NZEB-renovation:

- Inconveniences and defects of the dwelling, e.g. wind leaks, condensation on windows, moisture problems, noise, creaky floors, etc. are drivers for non-energetic renovations (to link with energetic renovations), but have little influence on the NZEB renovation concept. It can be expected that a part of the problem will be solved because of the NZEB-renovation measurements.
- Historical value. A dwelling with a historical valuable facade, interior, plan, in a conservation area… needs very different NZEB-concepts in order to preserve these valuable characteristics. But the share of these buildings is too small to define a separate segment. A neighbourhood-oriented approach can overcome this issue, since there is usually a spatial concentration of historical buildings.
- Value of the house. The value of the house does not relate to a different NZEB-renovation concept.

3.3   CLUSTERING THE DWELLING CHARACTERISTICS

There are many options to segment the housing market, too many to be workable within the REFURB segmentation. Based on the interrelations between different characteristics the above-listed characteristics can be clustered into 3 clusters with strong links (Figure 18).
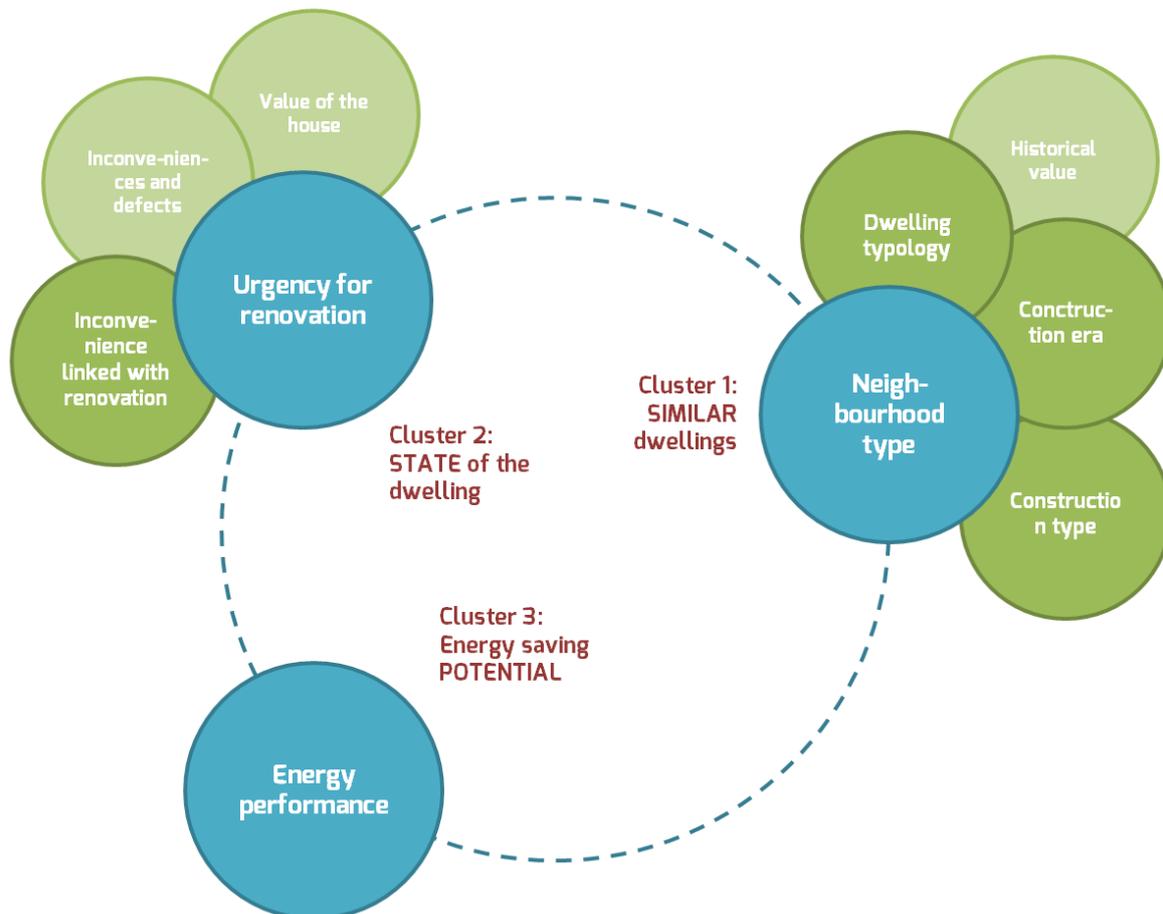
Figure 18: Clusters of relevant dwelling characteristics

3.3.1   Cluster 1: SIMILAR dwellings

NZEB-integrated renovation packages should be designed towards similar dwellings, if the goal is to provide similar technical solutions. For example, terraced houses with full masonry walls and pitched roof, dating from the same era in the same climatic zone will need very similar solutions for insulating the building envelope and for technical installations. A terraced house differs from a detached house, because e.g. the ratio between habitable floor surface and building envelope surface is much more advantageous in a terraced house (cost to insulate building envelope is lower), but the insulation of exterior walls is more complex due to adjacent buildings.

There are very strong links between neighbourhood, building era, construction type, dwelling type and historical value. The expansion of the built environment happens via new neighbourhoods that were built in a certain era when certain building traditions were dominant. Historically valuable buildings need tailor-made solutions (e.g. insulation of a protected facade is not obvious), but they also are very often concentrated in historical city centres, neighbourhoods, or protected areas.

3.3.2 Cluster 2: STATE of the dwelling

A house in good condition needs other solutions than a house in poor conditions. NZEB-renovations can be done at any time, both staged deep renovations[18] and full deep renovations, but the state of the building is very relevant to design the NZEB-packages. It is important to understand that energy renovation is not the main argument to start a renovation project, but mostly needs to be integrated with other home improvements, small and major, like changing the architectural concept, restyling, repairing defects, improve comfort etc. The necessity for these renovations may be an opportunity to apply other NZEB-solutions. A typical entry point for offering renovation solutions, for example, is upon buying an old dwelling as many decide to start renovating at that point in time.

The state of the dwelling is linked with the inconvenience the renovation will cause. For dwellings in good state, the inconvenience is supposed to be limited, so the NZEB-packages must be different.

3.3.3 Cluster 3: energy saving POTENTIAL

The investment cost of an NZEB renovation is very often balanced with the energy savings and the energy bill reduction.

It is logical that the main focus for NZEB-renovation is on dwellings with a high saving potential. A very bad energy performance is of course a very good indicator. Dwellings with a poor energy performance require deep renovations. Recent dwellings with a pretty good energy performance can be improved with a different type of renovation package, e.g. focussing on more performant heating and ventilation installations.

The actual energy bill also indicates the energy saving potential. A high bill indicates a high energy saving potential. But dwellings with a poor EPC can have an unexpectedly low energy bill, e.g. due to low energy use of the dwelling. This is commonly known as the prebound and rebound effects[19]. Price awareness, next to way of living determines what is perceived by the dweller as good. If the anticipated level of comfort requires too much energy –and as a consequence increases energy bills- dwellers tend to be content with less and thus renounce that level of comfort. In those cases the cost of the investment will not be in balance with the return (reduction of the energy bill) as those dwellers, after renovation, will usually not decrease their energy use as much as expected and theoretical calculations on savings usually heavily overestimate possible gains.

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[18] A renovation that is carried out in different phases over a longer period, in which the house is most of the time in use (e.g. 3 phases in 10 years)

[19] The prebound effect is the effect that causes actual energy consumption prior to renovation to be lower than can be expected. The rebound effect causes the calculated savings after a renovation to be lower (as people adapt to the increased comfort and might consume more than expected. Both effects require adaptation factors to theoretical energy consumption calculations.

4. A generic housing market segmentation: dweller typology

4.1 DWELLER CHARACTERISTICS FOR MARKET SEGMENTATION FOR DEMAND-SIDE AGGREGATION SCHEMES

In all six REFURB countries, partners conducted a desktop research on the available studies within the country on market segmentation, from different points of view: behaviour studies, classic economic studies, decision making psychology etc. Based on this desktop study and the expertise of the project partners, a set of dwelling characteristics was listed to base the segmentations on.

In order to prioritize the importance of the different characteristics they were scored on the relevance for segmentation to define the homeowner categories to design demand aggregation schemes in all countries or regions. The scoring was done through a semi- quantitative assessment of every characteristic: a figure between 0 (not important) and 3 (very important), and a motivation for the score. The central questions for the REFURB project are:

- Is a separate demand aggregation scheme required for the homeowners? (Group needs similar persuasive arguments, financial solutions, faces similar barriers, are interesting for a grouped approach etc.)
- Which are the interesting categories for demand-side aggregation? (Significant size of the group etc.)
  The characteristics are grouped in order to identify the high-potential segments (Table 6). As financial characteristics are considered to be a specific category, the characteristics were spilt-up in financial characteristics and non-financial characteristics.

Table 6: Dweller characteristics for demand aggregation schemes for NZEB renovations

Very high relevance	High relevance	Medium relevance
financial characteristics		
- Availability of financial possibilities to invest	- Willingness to invest in energy efficiency	
non-financial characteristics		
- Stage of life / household type - The expected period to own the house - Owner status - Decision making - Available time to manage renovation project	- Values (ideas) and attitudes (behaviour) towards environmental issues, sustainability and climate - renovation needs: increase comfort level, cosiness, personalization, taste, adjust architectural concept	- General knowledge level - Technical knowledge level - Home occupation pattern - Male / female

	• Access to accurate & reliable information • Age of dweller • Intentions to renovate • Energy use patterns	

4.1.1 Availability of financial possibilities to invest

Examples of categories: high income, medium income, low income; high access to finance, medium access to finance, low access to finance; energy poverty

Relevance for segmentation: very high

Relation with demand-side aggregation:

- Investments in energy efficiency and NZEB-renovation require investments. The homeowner needs funding, e.g. own saving, a bank loan etc.

Most interesting demand-side aggregation segments

- Homeowners with high financial possibilities

4.1.2 Owner status of dweller

Examples of categories: individual or institution owner (small-large); owner-occupier, tenant vs landlord); co-ownership (e.g. apartment building or house owned by several owners); etc.

Relevance for segmentation: very high

Relation with demand-side aggregation:

- The different groups encounter very different barriers, e.g. with rented houses there is a split-incentive issue (the landlord needs to finance, the tenant saves on the energy bill), with co-ownership the decision making processes are very different.
- There is a need for different (non-technical) solutions, e.g. financial and legal (to solve split incentive).

Most interesting demand-side aggregation segments

- owners-occupiers
- landlords in regions with high percentage of tenancy
- co-owners in regions with high percentage of co-ownership

4.1.3 Stage of life / household type

Examples of categories: first-time-buyers, young family growing children, empty-nesters, retired, singles, elderly

Relevance for segmentation: very high

Relation with demand-side aggregation:

- Stage of life combines several relevant dweller characteristics, such as the age, the availability of time to manage a renovation project, the availability of finances, and the expected time to own the house...
- The typical "first-time-buyers" are families with small children, and the typical time for larger renovations is when the house is bought. The other typical type of renovation is the step-by-step renovation which goes on during a longer period. It is only for the older group of people that the age is expected to minimize the initiation of renovation projects[20].
- Danish research[21] showed that deep energy renovations are most likely to happen as long as children under the age of 18 years are living in the house, because the homeowners here have a higher than average interest in conducting similar project, hence a higher investment limit.

Most interesting demand-side aggregation segments

- Empty nesters (age 40-65, children left the house) usually have money and time available for a renovation project.
- Young families will own the house for a long period, have a more intensive energy use pattern, but have limited time and finances for NZEB-renovations.

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[20] Gram-Hanssen et al., 2015
[21] Mortensen et al., 2015
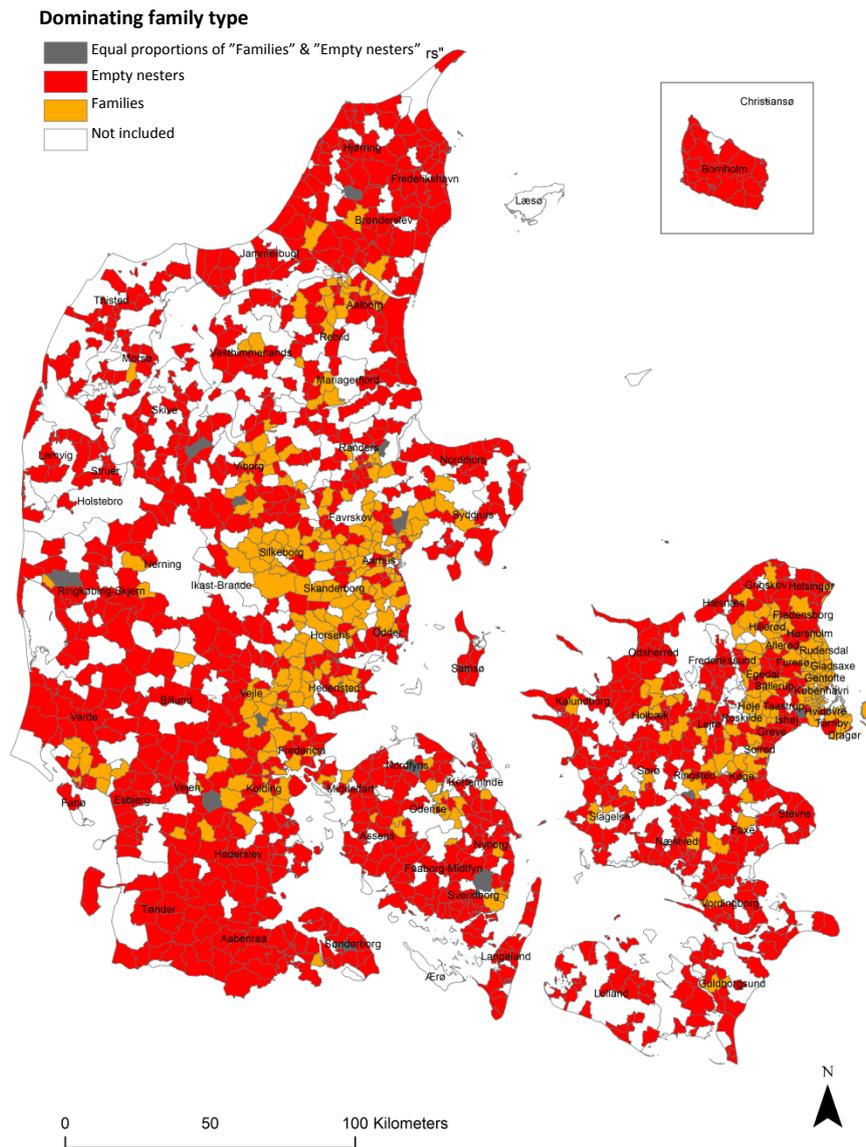
Figure 19: The map of Denmark shows the dominating family type in Danish parishes with more than 100 single-family houses, so there is also a geographical dimension. Gram-Hanssen et al., 2015.

4.1.4 The expected period to own the house

Examples of categories: less than 3 years, 4-9 years, 10-19 years, 20-29 years, 30 years or longer

Relevance for segmentation: very high

Relation with demand-side aggregation:

- Danish research[22] showed that deep energy renovations are most likely to happen before the homeowners have lived for one year in their house, since the investment limit is lowered as time

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[22] Mortensen et al., 2015

goes on, and these homeowners have proven willing to pay more than average for the same benefits and savings.

- This is linked with the intention and the exact motivation to invest in energy renovation. Owners with a short-term perspective are less motivated ("needs to be decided by the next owner"), or can have financial motives (e.g. increased dwelling value). For people with long-term perspective, the financial element is of minor interest (e.g. increasing the comfort level is more important).
- E.g. people who intend to sell the house, elderly with short-term perspective, young families who intend to live in the house for 30 years etc.
- Is linked with stage of life and age e.g. young families have a long-term perspective of living in the dwelling, elderly (75+ years) have a very short-term perspective for their own time living in the dwelling but might have other long-term perspectives for inheritance.

Most interesting demand-side aggregation segments

- People who expect to own the house for a period longer than the expected payback time (indicative: at least 10 years): their motivation will not only be for short-term financial gains, but also for e.g. increase of comfort.

4.1.5   Availability of time to manage a renovation project

Examples of categories: no time available, not willing to invest time in renovation project, plenty of time…

Relevance for segmentation: very high

Relation with demand-side aggregation:

- The organization of a renovation process requires time of the homeowner. The lack of time availability is a major barrier for homeowners to start renovating the dwelling. Some people do not have the time available; others do not want to spend their time to this (want to do more "interesting" things).
- The demand aggregation schemes for people with time and people without time available can be totally different, e.g. different marketing, a service to assist homeowners in the renovation process (unburdening) etc.

Most interesting demand-side aggregation segments

- Homeowners with little time are a very interesting segment to design unburdening processes for. This barrier should become irrelevant with a good renovation package.

4.1.6   Decision-making

Examples of categories: Constrained Strugglers, Consciously Unengaged, Worried Indecisives, Traditional Value seekers, Leading Edgers (illustrated in Table 7)

Relevance for segmentation: very high

Relation with demand-side aggregation:

- This relates to the psychology of decision making. Decision-making is a process which can be more or less rational or irrational and can be based on explicit knowledge or tacit knowledge. The way homeowners make decisions is different and has a very high impact on the way to compose and market integrated renovation packages.
- E.g. importance of social network, friends and family, internet, experts, etc... to convince to take decisions.
- Importance of the confidence level: people who consider a renovation as too complex, people who do not know where to start a renovation process, etc.

Most interesting demand-side aggregation segments

- Leading Edgers as early adapters for NZEB and their potential to convince others, Worried Indecisives can be activated if they get the right support.

Table 7: Illustration of consumer style segmentation. Based on "Consumer Empowerment Survey Report" (Williams et al., 2015)

Constrained Strugglers	Constrained Strugglers are the least empowered segment, who may be constrained by their personal traits and attitudes as well as their financial situation. As consumers they lack confidence in their ability to find the best products and services, and don't feel comfortable making decisions. They do not like shopping around or actively seek out the best deals. They lack confidence in their negotiation skills and ability to understand terms and conditions. 17% of population
Consciously Unengaged	Consciously Unengaged do not share their enthusiasm for shopping around or getting good deals. This lack of interest is a conscious choice rather than linked to any particular financial or personal constraints and they say they would make the same decisions in the future. They just do not want to spend time shopping. They therefore prefer to stick with their current supplier, even if it means they aren't on the best deals. 15% of population
Worried Indecisives	While their confidence and lack of decisiveness may hold them back, the Worried Indecisives do engage with the market to some extent but it appears that members of this segment may need more support to empower them further as consumers. This segment like to spend time shopping around but tend to find it hard to make decisions and worry about making the right choice. They tend to have low levels of confidence as consumers: they like to seek advice from trusted sources (e.g. friends, family and consumer experts), and they don't like to negotiate or feel confident understanding terms and conditions or making complaints. 22% of population
Traditional Value seekers	Traditional Value-seekers are highly engaged and confident consumers, who enjoy shopping around and are prepared to spend the time to find the best value. They have willingness to invest the time, and to negotiate for the best deal. Members of this segment are doing well financially. They feel confident making decisions and with all aspects of their consumer experience (e.g. making complaints, negotiating, understanding terms and conditions). They appear to feel satisfied with the outcome of their purchases as they would make the same decision again. They are inclined to be more conservative:

	they tend not to be early adopters, like to stick with the brands they know and like to visit physical shops. 24% of population
Leading Edgers	Leading Edgers are one of the most empowered of all the segments in terms of their consumer behaviour and personal attributes. They have the willingness to try new things and lead the opinion of others. Leading Edgers tend to have higher qualifications and be getting on well financially. They are not particularly brand loyal, but are instead early adopters who are happy to switch around and try something new. They like to share their views on their purchases. Members of this segment are confident consumers: successful negotiators and confident finding the best deals and products for them, negotiating and making complaints. 22% of population

4.1.7 Willingness to invest in energy efficiency

Examples of categories: no willingness, medium willingness, high willingness

Relevance for segmentation: very high

Relation with demand side aggregation:

- It is not only the availability of financial possibilities to invest that is relevant, but especially the degree in which homeowners are willing to invest in energy efficiency. It is possible they prefer not to invest, or prefer to invest in competing products, like a new car, a new kitchen, etc. Or, they want to invest in comfort improvement but do not recognize the link with energy renovation.
- A positive experience in energy efficiency investment can increase the willingness to invest more.

Most interesting demand-side aggregation segments

- High willingness to invest in energy efficiency

4.1.8 Age of dweller

Examples of categories: 18-25; 26-35; 36-45; 46-65; 66-75; 75+

Relevance for segmentation: high

Relation with demand-side aggregation:

- Research demonstrated strong links with stage of life, environmental values and attitude, available time, decision making, financial possibilities, etc.
- Danish research[23] revealed that the older the homeowner gets, the lower the interest in renovation (Figure 20).

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[23] Mortensen et al., 2015

Most interesting demand-side aggregation segments

- The categories of 25-44 years and 45-65 appear to be the most interesting, mainly due to the stage of life these homeowners are in (see 4.1.3), and have the highest willingness to renovate
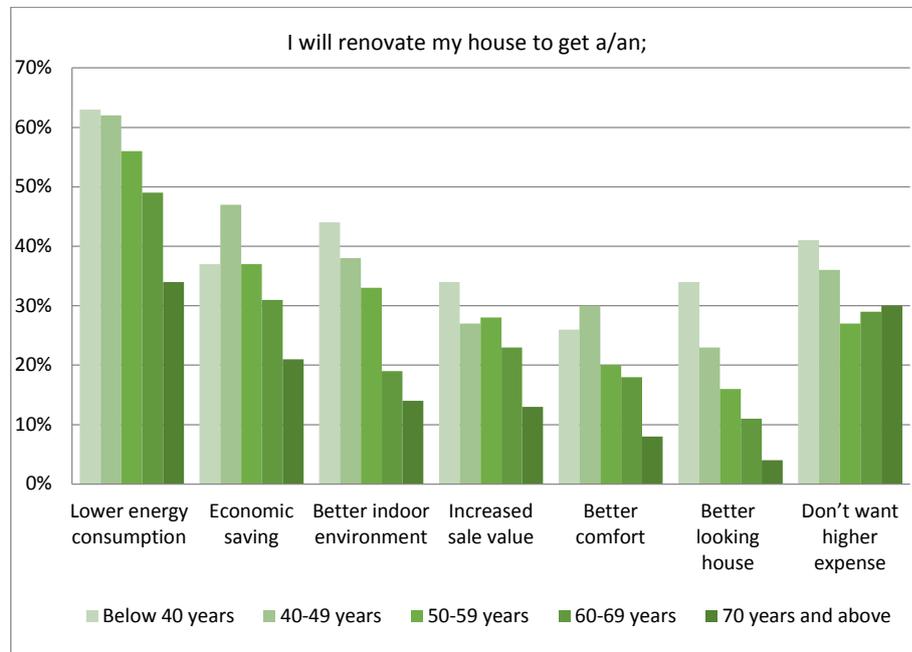
Figure 20: The willingness and reasons for conducting renovation divided according to the age of the respondents (Mortensen, 2015)

4.1.9 Values (ideas) and attitudes (behaviour) towards environmental issues, sustainability and climate

Examples of categories: many theories and models are available, e.g. the Transtheoretical Model (Stages of Change) which contains following categories: precontemplation, contemplation, preparation, action, maintenance, termination (Table 8)

Relevance for segmentation: high

Relation with demand-side aggregation:

- The willingness to accept NZEB-renovations requires a positive attitude and behaviour towards NZEB, environmental issues, sustainability and climate in general. This insight originates from behaviour science, in which several theories have been developed to describe behaviour change[24].
- The marketing strategy of the renovation packages and one-stop shop concepts towards homeowners should / can differ for the groups with a different values and attitudes towards environmental issues. People with no intention to change behaviour need a different approach than people who have developed a positive behaviour towards environmental issues.

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[24] Described in e.g. "Theories of Behaviour Change" (World Bank), and in GSR Behaviour Change Knowledge Review

Most interesting demand-side aggregation segments

- Homeowners that already maintain an environmentally-friendly behaviour e.g. by purchasing energy efficient electric appliances will be easier to convince for NZEB-renovation.

Table 8: The transtheoretical model proposes change as a process of six stages. Source: World Bank

1. Pre-Contemplation	People are not intending to change or take action in the near future (next 6 months).
2. Contemplation	People are intending to take action within the near future, but are not ready to take action; doubts about the effectiveness of action and of uneven costs and benefits may stall people at this stage for some time (in a state of "chronic contemplation").
3. Preparation	People are intending to take action in the near future; they are very aware of the costs and benefits of change and some behaviour change may already have taken place, including having a plan of action.
4. Action	People have made or are making specific overt modifications to their behaviour.
5. Maintenance	People are actively working to prevent a relapse to the previous behaviour.
6. Termination	Changed behaviour has become normative; there is no chance of relapse.

4.1.10 (Energy) use patterns

Examples of categories: economical, high energy users, moderate energy users...

Relevance for segmentation: high

Relation with demand-side aggregation:

- The interpretation of the energy use pattern is complex: it can be the result of a certain need (e.g. comfort: high temperatures for elderly, illness, babies…), the pursuit of a low energy bill (e.g. people in energy poverty), a positive attitude towards climate, the compensation of the thermal characteristics of the dwelling (e.g. permanent heating because of a slow warm-up time), a behaviour (open windows while heating, not to turn off heat while absence) etc.
- Has a strong relation with the house occupation pattern (e.g. all day at home, often away)
- After NZEB-renovation, the energy use pattern should be irrelevant.

Most interesting demand-side aggregation segments

- High energy users have the largest energy saving potential; with economical users there is a higher ambition to reduce energy consumption.

4.1.11 Intentions to renovate

Examples of categories: no intentions, considering small/large investments, decided on renovation, decided on renovation concept and budget, preparing execution of works, carrying out a renovation project, just renovated

Relevance for segmentation: high

Relation with demand-side aggregation:

- NZEB-renovation can happen any time, but is more likely if intentions and plans are present.
- Create win-wins: integrate the energy renovation with other renovations in one process.

Most interesting demand-side aggregation

- Homeowners with intentions and plans to renovate

4.1.12 Renovation needs: increase comfort level, cosiness, personalization, taste, adjust architectural concept

Examples of categories: homeowners with renovation needs, homeowners with no renovation needs

Relevance for segmentation: high

Relation with demand-side aggregation:

- Existing renovation needs offer an opportunity to integrate those with energetic ambitions. They can be a driver (technically easy to integrate), but also a barrier (no extra budget available, already fixed concept...)
- Homeowners with no renovation needs need to be approached differently.
- However, every moment can be the right moment for an energy renovation, the existence of renovation needs is not a condition for energy renovation.

Most interesting demand side aggregation segments

- all segments

4.1.13 Access to accurate & reliable information

Examples of categories: hard to find access to information, can easily find information

Relevance for segmentation: high

Relation with demand-side aggregation:

- Is related with the personality and education of the home-owner. Some people easily find information on the internet and can assess the value of the information; others are suspicious about information and rely on family and friends, others on experts etc.
- Is important for the marketing of the renovation packages and the means of communication. E.g. professional advisors (like consultants) could be part of the solution.

Most interesting demand-side aggregation

- All categories are relevant.

4.1.14 Less relevant dweller characteristics

7 characteristics were scored as less relevant for segmenting for demand aggregation. Some of these are identified as an important driver or barrier.

- Subsidies, tax deductions etc.
- availability of financing schemes
- General knowledge level
- home occupation pattern
- Technical knowledge level
- Demographics: male / female

4.2 CLUSTERING THE DWELLER CHARACTERISTICS

As exemplified above there are many options to segment the demand side, too many to be workable within the REFURB segmentation. Based on the interrelations between different characteristics the above-listed characteristics can be clustered into 3 clusters with strong links (Figure 22).
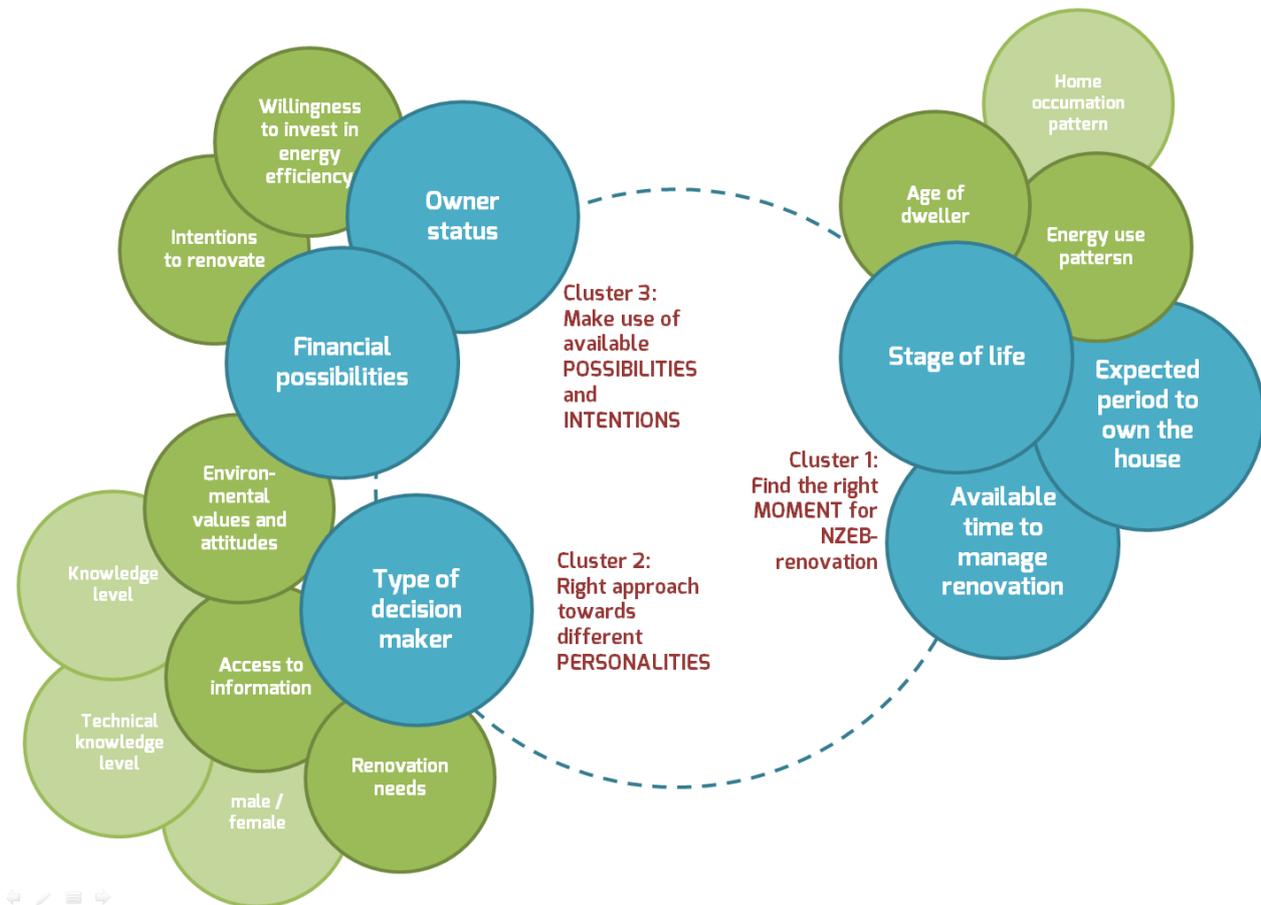
Figure 21: Clusters of relevant dweller characteristics

4.2.1 Cluster 1: the right MOMENT for NZEB renovation

Not every moment is the right moment for NZEB-renovation for the homeowner. A demand aggregation scheme needs to serve the needs and challenges the homeowners face in their stage of life.

The stage of life is a central idea in this cluster: e.g. elderly with a short-term perspective to live in the house often consider that energy renovation is for the next generation, although they might have intense energy use patterns due to a high home occupation pattern. Whereas "empty nesters", 40-65 years old have the time and financial possibilities to manage a renovation project. Young families often lack the time but often have intensive energy use patterns and are usually first time buyers which are rebuilding and renovating their new home.

In the different stages of life of homeowners, different drivers and barriers need to be met. Demand aggregation schemes can be developed for these different segments, coping with shared challenges within these groups.

4.2.2 Cluster 2: the right approach towards different PERSONALITIES

Homeowners need to decide on an NZEB-renovation project. But people take decisions in a different way and should be convinced in a different way. They have different values and attitudes. Some act very rationally, others very intuitively, others copy the decision of their neighbour, others rely on what intimates say (social proof, peer pressure). People also have different needs for renovation (e.g. increase comfort, increase cosiness, reduce the energy bill, or simply to brag), and have a different knowledge levels.

Demand aggregation schemes need to convince many different kinds of people for NZEB-renovation, and the success of the scheme will lie in the match between a customized marketing and personality segmentation thereof.

4.2.3 Cluster 3: make use of available POSSIBILITIES and INTENTIONS

A set of conditions is already available for the homeowners to build upon for the design of demand aggregation schemes. People have possibilities and intentions. This is a capital to build on, and can offer many opportunities.

People have financial possibilities, e.g. a high income or savings. For others, innovative financial solutions like partial ESCO constructions[25] must be part of the integrated renovation package.

People can have a positive attitude towards environmental issues, or had good experiences (e.g. happy to have invested in solar photovoltaics). People can already have the intention to renovate; then the challenge is to integrate this with NZEB-ambitions.

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[25] ESCO constructions: Energy Service Companies constructions usually refer to the upfront financing by a third party and payback on the energy bill. These constructions are becoming more and more commonplace in office buildings in both the private and public sector. However, for the residential sector the scope is still limited mainly because of the lack of knowledge on the rebound effect which increases financial risk.

5. REFURB segments for NZEB-renovation through demand-side aggregation

A range of characteristics to segment the NZEB renovation market from the demand-side point of view has been defined in the chapters above. These characteristics will allow for demand-side aggregation. They were either

- based upon the dwelling characteristics (chapter 3); and
- Based upon the dweller characteristics (chapter 4).

5.1 A MATRIX AS FRAMEWORK FOR SEGMENTATION

Based on the characteristics and insights from studies, best practices and their own experiences, the REFURB partners propose a framework as a tool to define segments. This framework is a matrix-style combination to organize the interplay of dweller characteristics (interesting for demand aggregation schemes) and dwelling characteristics (interesting for NZEB-renovation).

The tool can be used in different contexts to help to define tailor-made segments. This is necessary as it is shown in chapter 2 that in different EU-countries or regions housing markets can be very different. E.g. in Estonia the housing market is dominated by privately owned apartment buildings, whereas in Germany the private rental housing sector is very important. As a consequence, the REFURB project does not propose generic, pan-EU-valid segments for housing renovation.

The matrix (Table 10) combines the 2 main dimensions to segment for NZEB demand aggregation schemes: dwelling characteristics and dweller characteristics. In order to avoid an explosion of possible combination, the matrix makes use of the clustered characteristics as described in sections 3.3 and 4.2. This results in a 3x3 matrix, with 9 fields in total.

With this matrix, segments can be designed. The matrix offers flexibility to focus on mainly dwelling or dweller characteristics, or a combination of both. For instance the post-war suburb houses can easily host both empty nesters, young families and convinced energy savers but the approach for them to renovate will be different. It can be an option to focus on all post-war suburban houses, or on just these post-war suburban houses owned by convinced energy savers.

It should be taken in to account that segments are either dweller or dwelling focused. This makes them still 'broad'. Basically the dwelling-focussed typologies need technical solutions, the dweller-focussed typologies need different types of approach (e.g. communication and marketing) to initiate the renovations. For example: within the segment young families still a number of technical solutions is needed for all the different housetypes these young families live in. It might be necessary later on to subsegment even more.

Table 9: Matrix as a tool to segment for demand aggregation schemes for NZEB- renovation in the residential sector

Clusters of dwelling characteristics			
	SIMILAR dwellings • Neighbourhood type • Dwelling type • Construction era • Construction type • Historical value	**STATE of the dwelling** • Urgency for renovation • Inconvenience linked with renovation • Inconveniences and defects • Value of the house	**energy saving POTENTIAL** • Energy performance
The right MOMENT • Stage of life • Time to manage renovation project • Expected period to own the house • Age of dweller • Energy use patters • Home occupation pattern			
Different PERSONALITIES • Type of decision maker • Renovation needs • Access to information • General knowledge level • Technical knowledge level • Male/female			
Available POSSIBILITIES and INTENTIONS • Financial possibilities • Owner status • Willingness to invest in energy efficiency • Intentions to renovate • Environmental values and attitudes			

(Left side vertical label: Clusters of dweller characteristics)

5.2 EXAMPLES OF HIGH POTENTIAL SEGMENTS

To illustrate the matrix, a set of 5 high-potential segments for integrated NZEB-renovation packages and demand aggregation schemes is described.

- Segment 1: young families (dweller segment)
- Segment 2: Post-war suburbs with detached houses (dwelling segment)
- Segment 3: Empty nesters (dweller segment)
- Segment 4: terraced houses with a high energy bill (dwelling segment)

- Segment 5: convinced energy savers (dweller segment)

The segments do overlap to some extent, so a homeowner can belong to multiple segments which indicate a higher potential for NZEB-renovation but with limited numbers of homeowners. Interesting sub segments can be defined, e.g. empty nesters living in terraced houses, combining segment 3 and segment 4.

The selection of these 5 segments is based on a longlist of potential segments, compiled by input of the REFURB D2.1 country reports (illustrated in the Annexes to this report). In order to prioritize the potential segments, they were scored on their relevance for NZEB-renovation (dwelling perspective) and for demand aggregation schemes (dweller perspective). The scoring was done through semi- quantitative assessment of every characteristic: a figure between 0 (not important) and 3 (very important), and a motivation for the score. Below these segments are described in more detail.

5.2.1   Segment 1: Young families

This segment is mainly defined by dweller characteristics. Their main characteristic is their stage of life. These homeowners typically are **25-45 years old and have young children or planning to have them**. This stage lasts about 20 years, until the children leave the house.

Young families need a home to raise their children. This means their dwelling has to be large enough and offer the right comfort, e.g. enough rooms, well-equipped kitchen and bathroom, and they love to have a garden. They remodel their own house to fit **future needs**, or they buy a house and remodel it (young families that build a new house are out of the scope for REFURB), with the intention to live for a long time in the house. So there is a "momentum" for a major renovation, an opportunity to integrate their needs with deep NZEB-renovation.

Their **home occupation pattern and energy use pattern can be very intensive**. In a house with a poor energy performance, the energy bill will be high. But young families are more aware of environmental issues, and they are more willing to reduce their energy consumption. Unfortunately, often due to limited budgets, they buy a house with a poor energy performance.

Their **financial possibilities are limited**, as they are at the beginning of their careers. Energy investments compete with other investments, such as improving the comfort and architecture of the house, family holidays or a family car. A staged renovation offers a solution.

Although they have intentions and needs to renovate, they have very **limited time to manage a renovation project.** Their agenda is full. Time is spent on their career and family life. So there are strong arguments needed to also add a renovation to their agenda. Energy renovation is not convincing enough, multiple advantages should be obtained in one renovation project: more comfort, more cosiness, more personalisation, lower energy use etc.

5.2.2   Segment 2: Post-war suburbs with detached houses

This segment is mainly defined by dwelling characteristics. From 1945 on, suburbanization is gaining ground in Europe. In more and more countries suburban neighbourhoods with detached houses were built in the vicinity of cities and villages.

These neighbourhoods are interesting because of their **homogeneity of dwellings** (thus have similar NZEB-solutions). Not only in building type, also in construction type and construction era they are very homogeneous. Before 1970, the first oil crisis, the thermal performance of these buildings was poor; afterwards there was a limited improvement. The detached house is conceptually the worst when the energy performance is considered: they have a disadvantageous ratio between many energy loss surfaces (external walls, roof, and floor) and living space surface. They have high energy bills.

The houses built before 1965 to 1985 (country-dependent) offer opportunities to integrate NZEB-ambitions in renovation projects. These **houses enter in a first big renovation cycle**. The building envelope (walls, floors, roof, and windows) needs to be renovated for construction-technical reasons. Moreover, some of these neighbourhoods are changing homeowners. The first generation owners gets older, their housing needs do not match their dwelling anymore, and they sell to younger generations. It is observed that the younger generation sometimes aims at adapting the house to their needs, e.g. improving the comfort and architecture to contemporary standards.

In contrast, **the cost for (energy) renovation is high in detached houses** due to the large building envelope. As a consequence the return on investment is limited. This may be a problem for both the old owners (not willing to renovate the house because having little perspective to live in it), and for the new owners (limited renovation budget after buying the house).

Post-war neighbourhoods offer **opportunities to create a "renovation dynamic"**. Because of the similarities between the dwellings, the dwellers and social networks in the neighbourhood, homeowners can copy solutions from pioneers, influence each other, share knowledge, cooperate, or even compete.

5.2.3   Segment 3: Empty nesters

Like the young families, this segment is also mainly defined by dweller characteristics. Their main characteristic is their stage of life. These homeowners typically are **45-65 years old**, and the grown-up children have left the house: the nest is empty now.

Empty nesters inhabit a dwelling designed to raise the children, but now need to remodel it to their new future needs. **Their home occupation pattern and energy use pattern becomes less intensive**. They have the intention to live for a period in the dwelling, but maybe not as long as the young families.

Empty nesters are aware of environmental issues, and have two important features to bring their concerns into practice and manage an energy renovation. Because the children left the house, they have **more time**. They also have **more financial possibilities**, because the dwelling is completely paid for (sometimes this means they even have to look for other investments because of fiscal regimes), their income is higher due to their career and/or they have a financial windfall (e.g. a legacy, life insurance).

Their house does **not always offer high potential for energy savings**. In some cases energy investments have always been postponed before becoming empty nesters. But many empty nesters have a 20 to 30 year-old dwelling with a building envelope in good condition and medium energy performance, so little prospect of large energy savings and return on investment. Then a refurbishment of the installations (heating, ventilation, and renewables) can be most promising.

So with empty nesters, energy investments do not necessarily need to be integrated with other planned renovations, there can be other reasons to start them.

5.2.4 Segment 4: terraced houses with a high energy bill

This segment is mainly based on dwelling characteristics.

In most EU countries, terraced houses represent an older part of the building stock. A large majority is over 40 years old, up to 100 years and older. They have a **high energy saving potential** due to their low energy performance as they were built in an era when energy saving techniques were not commonplace. When grouped in neighbourhoods, their construction type is quite homogeneous (e.g. full masonry, pitched roof), and very often the houses are identical or have similar architecture.

Due to their age, other **renovations become urgent and desirable**: structural renovations (roof, floors, walls, windows etc.), upgrade the architecture to contemporary standards, improve the comfort of the house, improve the style etc. Very often these houses deal with inconveniences and defects like wind leaks, condensation on windows, moisture problems, noise, creaky floors etc.

Terraced houses are interesting for NZEB-renovation because the **cost for NZEB-renovation is lower** than for detached or semi-detached houses, due to a smaller building envelope surface.

In neighbourhoods with homogeneous houses, very **similar solutions can be applied**. So neighbourhood approaches are possible, thus creating a positive vibe (like in the segment "post war suburbs with detached houses"). Terraced houses share some technical complexities, e.g. on insulation of the facade: how to connect with the (non-)insulated neighbouring houses, can a part of the sidewalk be taken if external insulation is applied (building alignment issues)? etc.

A high energy bill is a very good indicator for the energy saving potential. A high energy bill (e.g. >€180/month[26]) indicates a bad energy performance of the house (EPC) and/or an intensive energy use pattern. But this high energy bill also creates **prospect of a considerable financial return after NZEB-renovation**, due to a potentially high reduction of the energy bill.

But, the high energy bill can also indicate some barriers for NZEB-renovation, like an **intensive home occupation pattern** (not evident for deep renovation works), little awareness on environmental issues and little willingness and intentions to invest in energy saving. A high energy bill can also indicate the lack of financial possibilities, time and/or knowledge of the homeowner to manage a renovation project.

5.2.5 Segment 5: Convinced energy savers

This segment is based on dweller characteristics.

This is a small segment, but an essential one. To start a transition towards NZEB-renovation, there is a need for pioneers, frontrunners. Convinced energy savers offer the fertile ground to become early adaptors within the city, village or neighbourhood, and to be followed and copied by other homeowners.

They have the **right environmental values (good ideas), and have the right attitude and good experience** (e.g. they are very happy with their solar PV or thermal solar system). They are convinced of doing the right things. They find access to the right information, and want to make decisions that differ from the current

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[26] The definition of a high energy bill is contextual and will differ in countries, regions and over time.

general standard. They are willing to invest in NZEB, and the return on investment is not a decisive criterion.

They might have **a low potential on energy saving**, as they already have increased their energy efficiency and constantly optimize their energy use pattern. They might face some lock-ins (e.g. a medium insulated roof in perfect state), so it is difficult to link energy renovation with other urgent renovations or to realize an interesting return on investment. Consequently a distinct phase in life with increased potential for this group is the moment a new dwelling is purchased.

Some can make decisions easily; others will hesitate to take the decision for an NZEB-renovation. This depends on their personality. They are the first ones to meet all kinds of barriers, before these get solved when NZEB-renovation mainstreams (e.g. find craftsmen with the right skills). They will encounter a lot of resistance with all stakeholders who want to stick with the ancient (non-NZEB) renovation standards. They might not have enough time or skills to manage a renovation project. But they can also make use of subsidies, tax deductions and other financial incentives in which they find confirmation in what they do.

A small but interesting **subsegment** are the pioneers within the convinced energy savers. These are very valuable homeowners because they are able to overcome some barriers. They have the **access to the right information and are not depending on the building sector**. DIY's (do-it-yourself) are **willing to invest time to renovate the house**. They can reduce the renovation cost, which increases the chance they can/will invest and improve return of investments.

5.2.6   Other segments

Next to this set of the 5 high-potential segments for integrated NZEB-renovation packages and demand aggregation schemes, other segments can be defined and designed making use of the matrix (Table 10), relevant for specific countries, regions or contexts. The set of clusters with dwelling and dweller characteristics offers a framework for a balanced design.

In the REFURB project, some additional segments were discussed. Some of these segments were identified to be very relevant in some countries but less relevant in other countries.

- The private rental sector, with very specific barriers on the tenant-homeowner issue (Who invests? How to deal with return on investment? What about split incentives? When to renovate? etc.)
- Social housing corporations, as owners of large housing stocks, but with different decision-making procedures, other views on financial issues etc.
- Privately owned apartment blocks with 1 owner or 1 management authority, but with multiple dwellers.
- Low income homeowners searching to reduce energy cost, but with little financial capacity to invest. Typically homeowners who managed to escape the rental market by spending their last money to become homeowner.
- Open-minded sceptics who are difficult to convince.
- Homeowners who renovate without any energy ambition, but are triggered to renovate to increase the comfort of their home (new bathroom, kitchen, change the architecture of the house etc.)
- Multi-decision makers, for example apartment buildings owned by a condominium owner association. Financing and decision-making processes can be very complex.

6. General conclusions and use of segments within the REFURB project

This report is part of work package 2 ("demand side mapping") of the REFURB project, and establishes a segmentation of the demand side for the renovation market. This segmentation is the first step to better understand the homeowners, a diverse group of decision makers in energy efficiency investments. A segment is a group in the market with similar characteristics.

In the REFURB project a tailored segmentation is created that is relevant for NZEB-renovation and demand aggregation schemes. This type of segmentation of the demand side is not commonplace. Usually market segmentation is very much technology-driven from the point of view of the supply side of the renovation market. Based upon REFURB partners' experience and research it was, however, possible to create such segmentation.

It is important to acknowledge that the REFURB project offers a **framework to create a tailor-made segmentation** or define a set of segments that fits a certain context in a country, rather than fix a pan-European set of segments to cover the entire demand side. It is not the ambition of the project to divide the entire demand side into juxtaposed categories.

In the REFURB project, it is concluded that **a multidisciplinary view** to the creation of the segmentation is essential. For the purpose of the segmentation, very different points of view must be explored to fully gain understanding of how homeowners can be convinced to invest in NZEB-renovation: behaviour study, psychology, sociology, economics, technology, legislation, architecture, urbanism etc. With a single technical, architectural or financial approach it seems hard to generate segments to design successful one-stop-shops for, as the homeowner profile risks to be too heterogeneous.

For the segmentation in the REFURB project it was possible to describe in short a set of most relevant categories of characteristics for segmenting, without describing these into detail. For each characteristic, the REFURB partnership indicated the importance. This assessment was done from a holistic perspective and based on literature study, practical experience and ongoing insights. An in-depth study was beyond the scope of the project. These six clusters of characteristics are described:

    I.   Three clusters of dwelling characteristics, which are important to design consistent NZEB-renovation packages:
- Cluster 1: similar dwellings,
- Cluster 2: state of the dwelling,
- Cluster 3: energy saving potential,

    II.   Three clusters of dweller characteristics, which are important to design consistent demand aggregation schemes:
- Cluster 1: the right moment for NZEB-renovation for the dweller
- Cluster 2: possibilities and intentions of the dweller
- Cluster 3: the different personalities of the dweller

Based on these characteristics and insights from studies, best practices and experiences, the REFURB partners created **a matrix as a tool to design tailor-made segments** in different contexts. The set of 3x3 clusters with dwelling and dweller characteristics offer a framework for a balanced design.

To illustrate this matrix, a set of 5 high-potential segments for integrated NZEB-renovation packages and demand aggregation schemes were described:

- "young families",

- "Post-war suburbs with detached houses",

- "Empty nesters",

- "Terraced houses with a high energy bill" and

- "Convinced energy savers".

Next to these 5 high-potential segments, other segments can be defined and designed, relevant for specific countries, regions or contexts.

Based on the segmentation of this report, drivers and barriers (financial, social, psychological etc.) will be linked with different segments (report 2.2), better ways to organise the demand side will be examined (report 2.3), local differences in demand side drivers and barriers will be examined (report 2.4), and improved approaches to seduce homeowners to integrate NZEB-ambitions within their renovation will be designed (report 2.5).

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Annexes

Annex 1 – example of Regional Housing market analysis for Belgium – region South-West Flanders

Annex 2 – example of Regional Housing market analysis for Denmark

Annex 3 – example of Regional Housing market analysis for Estonia – Tartu region

Annex 4 – example of Regional Housing market analysis for Germany – Halle region