D8.1 - Report on Non-Technical Barriers to the market placement

Development of Systemic Packages for Deep Energy Renovation of Residential and Tertiary Buildings including Envelope and Systems

iNSPiRe
Project Title: Non-Technical Barriers to the Market Placement

Project Acronym: iNSPiRe

Deliverable Title:
Report on Non-Technical Barriers to the Market Placement

Dissemination Level: PU

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Date: 30 September 2016

This document has been produced in the context of the iNSPiRe Project. The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 314461. All information in this document is provided "as is" and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and liability. For the avoidance of all doubts, the European Commission has no liability in respect of this document, which is merely representing the authors' view.
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1 Executive summary

The iNSPiRe project addresses the need for energy efficiency measures by focusing on making so-called deep renovations using multifunctional, industrialised kits in order to speed up the on-site installation process and reduce costs. Energy renovation investment is a multi-factor decision and many of these factors are not technical, which is why this report analyses the non-technical barriers to this investment decision. The study focuses on the kits developed within the iNSPiRe project, but many of the findings are relevant for other single stage deep renovation projects. Both the planning and implementation phases are considered. The aim was to develop suggestions for overcoming these non-technical barriers so that the iNSPiRe kits can more easily be deployed in the market.

The report is based on a study of policy documents, the experiences of European umbrella organisations for architects, property owners and local governments as well as on a large number of in-depth interviews with relevant stakeholders. Many of the 60 participants were made in conjunction with stakeholder workshops that were organised for specific focus groups such as architects, private property owners, public procurers and the stakeholders of the European Housing Forum. The non-technical barriers have been split into economic, political and social barriers, with most interviewed stakeholders emphasising the economic aspects.

Subsidies are considered by most as essential for property owners to take the decision to make a deep renovation, but stability of the subsidy programs is essential to have a good impact. Low-interest loans are not as favoured. Other key economic issues are the increase in the asset value of the property after such a renovation and the green value of the resulting low-energy building. These are both difficult to quantify, partly due to the fact that such renovated buildings are not as yet so common, and vary in the different property markets.

The EU has many policies on energy efficiency that are relevant for renovation of buildings, with the 2010 Energy Performance of Buildings Directive (EPBD recast) and the 2012 Energy Efficiency Directive (EED) being the most important. Many member states were late in implementing these and most have problems with forcing compliance with them. National tenancy laws can also make energy renovations difficult by restricting the possibility of raising rents for. For the iNSPiRe kits, regulations and standards are seen as a barrier in the short term as the kits combine several different functions into one product that are covered by several different regulations and/or standards.

The social barriers are mostly concerned with the tenants, while architectural considerations are also important. In buildings with owner-occupied flats, the decision process for renovation is difficult and even more so when deep renovation is to be considered. In rental properties the owners and tenants have different interests and incentives, leading to possible conflicts. All have uncertainties about the use of multifunctional kits and how well they will perform technically as well as about how much they will save economically.

The report makes a number of suggestions for overcoming these barriers. Especially important for the iNSPiRe kits is training of relevant installers and planners and use of Life Cycle Cost calculations to show the expected benefits over the lifetime of the products.

In each section of the report, in addition to the analysis of the specific barrier, there are sections with specific comments from the interviewed stakeholders.
2 Introduction

2.1 Background

The EU is working to reduce environmental impact in a number of ways and new targets for the period up to 2030 were decided in 2014. The binding objectives for 2030 are to reduce greenhouse gas emissions by 40% compared to 1990, to increase the share of renewable energy consumption to 27% and to increase energy efficiency by 27% (European Council, 2014). Moreover, clean energy is included as one of the 17 goals for sustainable development that the UN General Assembly set up in September 2015 (UN, 2015). Buildings are responsible for around 40% of the final energy consumption in the EU (Eurostat, 2016), and 50% of the existing buildings were constructed before 1970, with little or no thoughts to energy efficiency (Birchall et al., 2014). Renovation of the existing building stock is therefore key in the EU Climate and Energy strategy (European Commission, 2012).

Deep (Energy) renovation (or retrofit) is defined – in the European context – as “a renovation that captures the full economic energy efficiency potential of improvement works”, mainly focusing on the building envelope. A deep renovation should thereby lead to a very high energy performance of the building, reducing the energy consumption for heating, cooling, ventilation, hot water and lighting by at least 75% or result in a primary energy consumption below 60 kWh/(m²·y). The measures of a deep renovation could either be implemented all at once as a package, or sequentially (“staged deep renovation”). (GBPN, 2013).

The aim of the iNSPiRe project is to develop and present systemic solutions for deep energy renovation of both residential and office buildings. These solutions should lead to substantial reductions of the energy consumption – a specific target has been set at 50 kWh/(m²·y) primary energy consumption for heating, cooling, ventilation, and lighting – and at the same time ensure good comfort conditions for occupants and users. They should also be cost-effective and sustainable in a life cycle perspective, by reducing the energy and installation costs as well as the environmental impact compared to conventional alternatives.

Energy renovation investment is a multi-factor decision. The owners’ (either occupant or landlord) decision to invest in energy refurbishment, at least implicitly, considers

- The fossil energy price evolution that is anticipated,
- The guaranteed energy performance increase,
- The rental and patrimonial value that might be obtained after the investment,
- The right opportunity due to life cycle of the property existing elements,
- The cost reduction that can be obtained with subsidies and tax advantages,
- The budget available and how to finance.

Although other important factors are linked to the firm belief that there is a strong necessity to participate to the worldwide effort aiming to make the transition to a competitive, secure and sustainable energy system and for reducing greenhouse gas emissions, the final decision will often be taken on pure economic criteria: the payback time.
Energy renovation measures may prove beneficial from a technical point of view, leading to significant energy savings, there can still be barriers that stop them from being implemented. BPIE defined four categories of barriers to energy renovation (BPIE, 2013). In the present report, a classification with three categories of non-technical barriers is used: economic barriers, political barriers and social barriers. When it comes to energy efficiency measures, economic barriers are related to the cost of investment, installation and maintenance of new systems, political barriers are for example policies and regulations, while social barriers have to do with people's perception and understanding of the new systems. In order to successfully place new, innovative solutions on the market, it is important to not only consider the technical functionality of the systems, but to also address the non-technical barriers it could be faced with.

2.2 Contents of the report

This report treats the non-technical barriers to the market placement of the renovation solutions developed within iNSPiRe. First, the aim and scope of the study are specified, followed by a description of the methods used. The individual kits for renovation are presented in chapter 2, and the two demonstration projects are described in chapter 3. The non-technical barriers – divided into economic, political and social barriers – are presented and analysed in chapters 4 to 6.

In many of the sections, detailed comments from the stakeholders that have interviewed are given so that the reader can get a more nuanced view of their opinions. These are collected in separate sections entitled “comments from interviewed stakeholders”, and each comment is followed by a number referring to the person making the comment. There is no list of numbers and the actual stakeholder for reasons of anonymity.

2.3 Aim and scope

The aim of this report was to study the non-technical barriers that exists in the planning and implementation of energy efficiency measures in a renovation project of multi-family houses. Within the framework of the project iNSPiRe, the implementation of new technologies was investigated in two demonstration buildings was studied to determine the non-technical barriers towards the implementation of energy efficiency measures. The whole renovation process was examined, including the phases of planning and implementation. The main question of the study was, which barriers constitute an obstacle to the introduction of new energy-efficient products and systems. This report is limited to the analysis of the multifunctional kits developed within the iNSPiRe project. The aim was to develop suggestions for overcoming these non-technical barriers so that the iNSPiRe kits can more easily be deployed in the market. In order to find the barriers to market deployment of the solutions developed within iNSPiRe opportunities and obstacles in the different demonstration house cases were compared.

2.4 Methods used in this report

The method used in this report was mainly qualitative interviews with different stakeholders involved in each of the demonstration projects, such as the following: property owners, manufacturers, engineering offices, architects, technical researchers, European umbrella organizations and tenants. The interview guide that was used considered what changes were planned and why, what the obstacles and opportunities that come with the three main types of
barriers are and how the estimated effects relates to the energy efficiency goals. It is possible that different stakeholders within a project have different outlooks of these three barriers, hence, the empirical data were divided into three different categories of potential barriers: political, economic, and social.

There were several approaches to collect the empirical data.

First, stakeholder workshops have been organised with specific focus groups such as architects, private property owners, public procurers and the stakeholders of European Housing Forum. The project was here presented and then focus groups was held on various points of views that the stakeholder group addressed. One focus group was conducted in Brussels in February on 19, 2015 during a meeting at the European Housing Forum (EHF) (25 participants). The EHF is an informal platform gathering 15 representative organisations of the entire housing sector. Its members are all major international or European organisations representing consumers, providers, professionals and researchers having an interest on housing related issues. This was followed by a second focus group in Brussels in February 20, 2015 during a meeting at UIPI (international union of property owners) a consortium partner of iNSPiRe (14 participants). It gathered representatives from property owners associations from all over Europe. Both workshops were organised by UIPI and structured in a way to collect feedback about barriers and opportunities for the renovation of the European Building Stock. After a presentation of the iNSPiRe project, participants of the workshops were asked series of questions around: the strengths and weaknesses of the project, the technical, economic, legal and political as well as behavioural and organisational barriers and opportunities. At the end of the workshops, they were asked to name the most important barriers. In June 2015 a third focus group was conducted at ACE (Architects’ Council of Europe) another consortium partner of iNSPiRe with members of the Environment and Sustainable Architecture Work Group (16 participants). In June 2016 ICLEI, UIPI and EMVS (the Madrid public authority Empresa Municipal de Vivienda y Suelo) organised a joint workshop and study visit to the demonstration buildings for the above stakeholder groups. Finally, a workshop for property owners and public procurers was organised on 24 June 2016 in Madrid. It was co-organised by the UIPI and its Spanish member, the Confederation of Spanish Property Chambers (CCPU), the Local Governments for Sustainability (ICLEI) and EMVS. The objective was to present the iNSPiRe project and its goals as well as its concrete implementation through a presentation of a concrete project demo building in Madrid. This event was also the occasion to help to overcome the main non-technical barriers to energy efficiency renovation: the financial question, by providing information on how to do a renovation business plan and where to address for technical help and financial support. It was followed by a site-visit of the demo-case in a suburb of Madrid.

Secondly, in-depth interviews were conducted with iNSPiRe stakeholders in order to gain a deeper understanding of the three barriers. These seven in-depth interviews were conducted between spring 2014 and spring 2016. The types of stakeholders interviewed were: housing company, equipment manufacturer, researcher, architect, real estate manager and European umbrella organisation. Additionally, quantitative data were accumulated from questionnaires and via audience response system. An on-line questionnaire was first used in December 2015 regarding the non-technical barriers for iNSPiRe stakeholders. Additionally an audience response questionnaire was used during an iNSPiRe meeting in Madrid in April 2016 with questions based on the results from the on-line questionnaire. The participants of the in-depth interviews, focus group interviews, on-line questionnaire and audience response questionnaire are referred to with numbers (1-60) in the report text (see appendix 1).
Thirdly, two demonstration buildings (German and Spain) from the iNSPiRe project underwent significant appraisal. All phases of the renovation process were studied, including the phases of planning and implementation. Opportunities and obstacles in the different cases were compared and finally a comparison analysis between the demonstration cases was merged into the complete study.

Fourthly, tenants and homeowners living in demonstration buildings completed a customised questionnaire after the renovation phase was finished in 2016. This questionnaire was answered by three of the occupants in Madrid and four of the tenants in Ludwigsburg (see appendix 1). All interviews from stakeholders and tenants were transcribed verbatim and merged into a qualitative content-analysis.

Computer Assisted Qualitative Data Analysis Software (CAQDAS) was used in order to organize in a more efficient manner the large amount of empirical data. NVivo (NVivo Pro, 2016) was chosen over other qualitative software packages primarily, because it is relatively simple to use and it is possible to directly import the transcribed documents among other different types of documents such as audio record files, etc. Once the empirical data was merged with, NVivo, facilitating features allowed for the search of particular terms, and derivations of that term. With NVivo it was possible to gain an overall impression of the data whilst also providing a quick and simple way of counting who said what and when, thus providing a reliable, general picture of the data. Proponents of CAQDAS argue that it facilitates an accurate and transparent data analysis process (Welsh, 2002). However, the main function of CAQDAS is not to analyse data but rather to facilitate the analysis process. Underpinning the three concepts of non-technical barriers, nodes (a type of NVivo feature to denominate) were created in order to comprehend and gain a deeper understanding. Additionally, concept analysis explores and opens vague concepts and is a useful method for revealing words notion and their meanings. The qualitative data were therefore sorted, categorised and compared by way of a content analysis with the aim of highlighting the interviewees’ views and the descriptions of the concept of the three main non-technical barriers. Based on this analysis, a summary was made of the non-technical barriers to market deployment of the technical solution kits developed within iNSPiRe, and finally, suggestions for overcoming them were derived from this.
3 iNSPiRe kits

Five multifunctional renovation kits were developed within the iNSPiRe project. The aim of each of these kits is to reduce the primary energy consumption of a building in a cost-effective way compared to conventional solutions for deep retrofitting available on the market. The layouts and functions of the five kits are described below.

3.1 Kit 1: Wooden envelope with micro-heat pump

Mechanical ventilation systems are not always present in old dwellings. In order to achieve a healthy indoor climate with good air quality, which is essential in a state-of-the-art retrofit, large sets of ducts and other parts have to be introduced. Moreover, in order to achieve the required energy demand, it is often necessary to include a heat recovery feature.

Kit 1 is a prefabricated timber envelope retrofit solution which incorporates ventilation ducts, a unit for balanced, mechanical ventilation with heat recovery (MVHR) and a compact air-to-air heat pump. As shown in figure 1 all the technical installations as well as exhaust air ducts are placed in the façade, leaving only the supply air ducts to be installed in the dwelling. The evaporator of the heat pump is placed on the exhaust side of the heat recovery unit, extracting energy from the outgoing air, and the condenser adds heat to the incoming air on the supply side of the heat recovery unit. The heat pump is referred to as “micro-heat pump”, due to its low capacity (in the range of 1 kW). Figure 2 shows the installed unit.

![Diagram explaining the concept of the MVHR system with the integrated micro heat pump](Source: Gumpp & Maier GmbH)
3.2 Kit 2: Wooden envelope with pipes and ducts

Kit 2 was designed as a variation of Kit 1, without the integration of a micro-heat pump. Heating is therefore delivered by the central water based system through new radiators. This technology aims to save significant costs by integrating all the ductwork and components of the MVHR systems into the timber envelope off-site (see Figure 3).
Outlets and inlets can be integrated through the prefabricated window reveals (see Figure 4), minimizing the work needed inside the house, thus reducing the disturbance for the residents. By installing this decentralized system, the fire safety requirements are also reduced.

![Figure 4 – Picture of the finished reveal with an integrated ventilation outlet (Source: Gumpp & Maier GmbH)](image_url)

### 3.3 Kit 3: Wooden envelope with ST/PV

Kit 3 is a pre-fabricated wooden roof solution, which optimises the integration of solar collectors. Compared to the different integrated solar thermal (ST) and photovoltaic (PV) systems already available on the market, Kit 3 is intended to improve the architectural aesthetic of the integration, optimizing cost savings and simplifying the maintenance and replacement of the units. Figure 5 demonstrates a schematic of Kit 3 and Figure 6 shows the installed unit.

![Figure 5 – Section of the integration of the solar collector, detail below (Source: Gumpp & Maier GmbH)](image_url)
3.4 Kit 4: Energy Hub

The energy hub (EH) is a multi-functional hydronic modular unit, which:

- connects different components of a building’s heating and cooling system (heat pump, solar collectors, geothermal probes, oil/gas/pellet boiler radiant ceilings/floor/wall, radiators, fan-coils);
- can be used for the production of domestic hot water;
- performs low cost measurement of the thermal and electrical energy flows in the heating and cooling system;
- remotely optimizes and manages the heating and cooling system;
- incorporates “continuous commissioning” procedures to increase the reliability of the heating and cooling system.

The energy hub modules are coordinated by a central unit called energy manager. Figure 7 shows a conceptual diagram of how the energy hub and energy manager are connected.

In particular, the EH and energy manager concept helps the owners to solve the problem of integrating renewable energy sources in their building when performing an energy retrofitting action on their heating and cooling system. It also helps them in using the new resources more effectively.

An example of an installation with four energy hubs is shown in Figure 8.
3.5 Kit 5: The radiant ceiling panel

This technology is a modular ceiling panel which incorporates lighting, low temperature heating/high temperature cooling and ventilation distribution. The modular nature makes it flexible in size and permits the utilization of all distribution media (light, water and air), if needed.
Within the iNSPiRe project, two versions have been developed. The first distribution kit is specialized for residential applications. It integrates two components of artificial lighting systems into radiant ceiling panels.

The second distribution kit is designed for office applications. It integrates a set of LED lighting solutions into a radiant cooling/heating panel. It is not necessary to modify the building to allow for the use of this technology; only the water supply must be provided. Thanks to the lightweight construction of the panel, it can be installed in nearly all types of ceilings. Some examples are shown in Figure 9.

*Figure 9 – Different installations of Kit 5: Different moods/feelings/design/comfort*
4 Demonstration projects

This section gives a short description of the two residential demonstration cases, what the buildings were like before and what has been done. Each demonstration building underwent an energy audit to decide on suitable renovation measures.

4.1 Ludwigsburg

The demonstration case in Ludwigsburg, Germany, is a small multi-family house owned by Wohnungsbau Ludwigsburg, which co-funded the project. The house has four floors, including cellar and attic, with one dwelling per floor, and a total heated area (before renovation) of 303 m². Since the house was built in the early 1970s the façade has been insulated with 5 cm mineral wool on the outside and the original windows have been replaced with double-glazed windows with plastic frame. However, roof and basement floor were not insulated and some of the windows were damaged and no longer airtight. Moreover, the boiler was more than 20 years old, no ventilation system had been installed and the fresh water pipes were severely corroded. The total energy demand for space heating and hot water preparation was 188 kWh/(m²·y) before renovation [1]. Figure 10 shows the building before renovation.

Following the energy audit performed within iNSPiRe, it was recommended to:

- Insulate the roof, the façade and the perimeter of the cellar
- Replace the windows
- Install a ventilation system with heat recovery
- Replace the fuel boiler with a new centralised heating system
- Install a low-temperature heating distribution system
- Install solar thermal collectors on the south side of the roof

It was decided to use pre-fabricated wooden façade elements, with integrated ducts and pipes for ventilation, heating, water, sewage and electric cables. Compact units for air heating and
ventilation, consisting of a small heat pump and an air heat recovery unit, would also be integrated in the façade. Solar thermal collectors would be used for DHW preparation, complemented with a heat pump in the cellar and a storage tank. Figure 11 shows sketches of the pre-fabricated façade elements and installations, and the installation of the pre-fabricated façade and roof elements on the building.

Figure 11 – Left: The pre-fabricated envelope of the Ludwigsburg demonstration case; Right: Installation of the multifunctional façade elements.

Figure 12 shows the Ludwigsburg demonstration case after renovation. Comparing this picture to Figure 10, it can be seen that the balcony on the attic floor has been removed, and the balconies on the ground floor and the first floor have been included within the building envelope and added to the heated area.

Figure 12 – The Ludwigsburg demonstration case after renovation (south/west side)

4.2 Madrid

The demonstration case in Madrid, Spain, is a five-story multi-family house with 20 apartments and a total living area of 1000 m², built in 1960. Each apartment had individual heating systems, and the share of heated floor area of each dwelling varied between 20% and 100%. No improvements had been made to the thermal properties of the building envelope since the
construction of the building, and the total energy demand for heating and DHW preparation was 158 kWh/(m²·y) before renovation. No ventilation system was present, and the façade had started showing cracks due to movements in the foundation [2]. Figure 13 shows the building before renovation. The iNSPiRe renovation project concerns only the west half of the building (to the right in the picture).

Following the energy audit performed within iNSPiRe, it was recommended to:

- Insulate the roof, the façade and the perimeter of the cellar
- Replace the windows
- Install a centralised system for heating, cooling and DHW preparation
- Install a low-temperature heating distribution system
- Install solar thermal collectors on the south side of the roof
- Install shading elements in the windows on the south and west facades to avoid overheating in summer

The façade was insulated with 80 mm mineral wool insulation, while the thermal properties of the windows were improved by adding another glass to the existing windows. A centralised heating and cooling system was installed in a new technical room on the roof, and solar collectors were installed along the south side of the roof. Radiant ceiling panels were installed in each apartment for low-temperature heating and cooling distribution. In addition, the staircases were renovated and complemented with an elevator, to facilitate for the occupants, many of whom are elderly people. Figure 14 shows the renovation of the Madrid demonstration case.
Figure 14 – Left: Renovation of the façade and setup of the lift-shaft; Upper right: Installation of solar collectors and heat pump on the roof; Lower right: The façade of the demonstration case building in Madrid after renovation.
5 Economic Barriers

Economic barriers are regarded as one of the main obstacles, if not the main obstacle, to scale and quality energy efficiency renovation. In general there are many different types of economic factors, both pro and contra a decision for a single stage deep renovation. Grants, subsidies, subsidized loans and tax credits reduce investment costs, but may change fast due to political decisions. These short term opportunities are part of the owner’s decision.

- Tax rebates: various forms of personal tax reduction in response to building owners investing in energy efficiency. A range from personal income tax reductions to reduction of building transfer tax (stamp duty).
- Tax deductions: Deduction of personal income or corporate tax for amounts invested in energy efficiency.
- VAT reductions: Low VAT rate for energy efficiency products and materials.
- Subsidies and incentives are given by authorities through the “Eco-premium” distributed by municipalities, which can be “tapped” for energy renovations larger than mere replacement of a heating system. Combined with “additional aid” of the regions (premiums and/or partial or total exemption from property tax on buildings). Some benefits are subject to the requirement to achieve a “combination of work”. Subsidies and incentives change very fast and is nonetheless a part of the decision.
- The white certificate scheme is one of the key new instruments foreseen to support energy efficiency improvements and complement existing policies and measures. It aims to help achieving current or newly formulated energy efficiency targets in a cost-effective way.

Therefore a cost analysis of the iNSPiRe kits needs to be presented. The cross-disciplinary and integrated research proposed by the iNSPiRe consortium was expected to reduce these barriers and have an impact across the energy retrofit sector by providing well-founded solutions (iNSPiRe, 2015). However, financially viable energy efficiency investments are not being made today because of non-technical barriers (e.g. financial, regulatory, organizational).

5.1 Barriers for property owners

Renovating a building is an economic decision that requires a careful profitability assessment. In order for property owners to make the right decision about renovating their building, economic evaluation is an important method to see if it is profitable from a wider perspective. In a way, this is a macro perspective when a building owner is able to stretch out economical budget in time and at the same time expect and assess other parts that could play a role.

Typically, people have some kind of micro decisions to make when deciding on their own property when it is only one’s own reality that is a determining factor. It is however important to relate to external aspects such as laws, regulations and energy prices that constantly change. Most people, however, look at a medium to long-term estimate of the property. This provides a better foundation to make better financial decisions that will also make sense at a macro level.

Owners will tend to prioritize the most efficient measures, or the simplest to implement and are likely to choose an investment that might not be the more efficient because of its lower initial
cost, even if they are ensured they invest on a highly efficient device. It might not be wise, and might be costly in the long run.

The “so-called green value” of energy efficiency investments are not yet fully capitalised in the asset value of the building (European Commission Report, April 2013). It reduces the economic incentive to invest. Numerous studies have looked into the green value aspects. Some are focusing only on energy efficiency (European Commission Report, April 2013; RICS, 2014; Hyland, Lyons, & Lyons 2013) while others (World Green Building Council, 2013) have included additional green indicators (in-door conform, construction materials to waste and recycling, etc. Some of these studies (European Commission Report, April 2013; World Green Building Council, 2013: Institute for Market Transformation. Green Building and Property Value) seems to confirm a market trend in the commercial sector, where a green bonus can be expected. The top-end of the market has already fully integrated the green value aspect. In the rest of the commercial/office building sector, studies (World Green Building Council, 2013: NRDC, 2013) have already demonstrated some kind of green bonus.

Owners or renters of commercial buildings might have greater interest to occupy or invest in energy efficient building, interest linked to their own Corporate Social Responsibility criteria. In the residential sector however, evidence are more scarce and market actors are not yet fully convinced about a clear ‘business case’ for energy efficient buildings. The green commitment of individuals is still marginal and often undermined by financial considerations. New buyers might be willing to invest more for a more energy efficient property, but it is difficult to assess the potential bonus as it is very dependent from local property markets and additional building features and characteristics. Tenants’ decisions remain driven by the cost of the rent as well as the location of the dwelling and then its practical and aesthetic characteristics even if in the last few years, energy costs have become a growing concern.

Leicester and Stoye (2013) assert that unless landlords can appropriate the benefits from higher rents, they would not have the incentive to install energy efficiency measures. If rents were increased because of improved property condition and energy performance, tenants may stand to gain by saving on energy costs. But even so, this would depend on tenants being able to understand and interpret this trade-off between rent and energy, and to trust that it will indeed work to their financial benefit (Leicester and Stoye, 2013). Others state that low-income renters have the smallest amount of available or discretionary capital costs and income (Bird, & Hernandez, 202). The possibility of paying more in rent for a warmer, property with more affordable household costs and bills, then, is particularly problematic for low-income renters who are already juggling budgets simply to stay put in their current accommodation (Beatt, Cole, Powell, Kemp, Brewer, Browne, Emmerson, Hood, & Joyce. 2014).

Other studies confirm that tenants are not asking for energy efficiency improvements and sometimes reluctant to consent to energy efficiency improvements as they could lead to an increase in their rent (McCarthy, Ambrose, & Pinder, 2016; Department of Energy and Climate Change, 2011). Therefore, the evidence for a relationship between the financial performance and the energy performance of leased buildings seem to be embryonic and mainly focuses on non-domestic buildings.

It is likely that in the long-run, market will adjust to take into consideration energy efficiency in the asset value of the building. An array of leading valuation experts do consider that property owners who fail to improve energy efficiency may find that their buildings are likely to become obsolete in respect of minimum standard faster than those of property owners who adapt to these minimum. This will limit the leasing opportunities and increase vacancy periods. Therefore, real estate experts in the residential sector, and in particular in the private rental
sector, prefer to speak about the “grey value” of non-energy efficiency renovation. Table 1, summarises aspects in investors decision.

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<thead>
<tr>
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<td>Energy savings shared with tenants</td>
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<td>Electricite sold to the grid</td>
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<td>Rent lost during works or tenants outside accommodation</td>
<td>Vacancy reduction after works</td>
<td>Rent increase / market and rent control</td>
<td>No accommodation during works</td>
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5.2 Comments from interviewed stakeholders on economic barriers

In the analysis of the empirical data, the stakeholders have had many comments about economic barriers demonstrating how important these barriers are for building stakeholders. Main questions on economic barriers of the iNSPIRe solutions are

- whether the renovation of a building is really low-cost or whether that is only the case in comparison to tearing down and re-building? Challenges associated with this include lack of evidence to support a retrofit, a lack of public engagement and a lack of incentives for landlords in particular and owners in general (42).

- Economic barriers will often be linked to the capital and installation cost of the technology and uncertainty regarding capital costs and payback periods.

- Someone might wonder why they should pay more for an energy efficient measure of equipment, if the payback time is long and if there is a lack of evidence supporting the success.

- The fall in energy prices increases the payback period and can be identified as an economic barrier to energy renovation (44).

- Additionally, when servicing of a technology is available, it is often through the main contractor who charges this service at a premium. This is not economical viable over the lifespan of the building (42).
In the empirical analysis, the stakeholders have had many comments about barriers for property owners. The way people invest on renovation depends on the way they perceive their real estate investment.

For example, if people buy the house after long-term savings, as is common in some countries, they tend to stay there for some time and therefore are more prone to invest. Whereas people in other countries buy early and sell their property fast, so they move out easily and hence they have a more short-term view in that sense (34).

Type of ownership when calculating the investment and the payback period makes a difference and influence the decision: a home-owner will have a direct incentive to reduce his energy bill while a landlord, to get incentives, needs to be able to pass the costs of renovation on the rent (via rent increase, etc.) (34). This is often not possible. Convincing the owners, especially in multi-owner buildings, when it comes to the split incentive between landlords and tenants and disruption factor during renovation (22). Split incentives are a barrier to the deployment of energy efficiency measures in buildings. Split incentives occur when those responsible for paying energy bills (the tenant) are not the same entity as those making the capital investment decisions (landlord or building owner). An agreement between landlord and tenant to share the costs and savings of an efficiency upgrade, could help bridge the gap created by split incentives.

Another concern is about the high cost of implementing new technologies when renovating old buildings (31). Today it is economically difficult for property owners to invest in new technologies, because there is no visible cost effective result (31). The profits one can expect from rental income hardly reach a high percentage on average and could be less if the owners are subject to special tax regimes. So if a landlord invests in energy efficiency, the return on investment is often very low (32).

Other obstacles that is connected to different types of ownership and constitutes barriers is for example, that renters are far less likely to have energy-efficient appliances in their apartments than homeowners. In different places in Europe, blocks of flats are mostly publicly owned and the flat is rented while in other parts of Europe, large portion of residential stock is multifamily houses (or condominiums) that are privately owned.

To do renovation of the common part of the building all owners have to be persuaded of the importance of the renovation. That could be very challenging. It could be seen that in this type of ownership there is a lack of information about energy efficiency renovation and knowledge of this type of measures.

Even the energy performance certificate is ill-perceived and private owners believe it is a barrier (41).

The decision-making process is a key issue. Even if unanimity of owners in the dwelling is not required to do renovation, a majority is required in order to make a decision possible. Even times when the majority required is low, there is still a need to convince enough property owners if a decision is to be made. This is connected to legal issues but is also a behavioural issue that should be taken into serious consideration. Raising awareness is key to convincing owners to carry out renovations if they are, to understand the rules, etc. (1). Energy efficiency consultation is therefore an important issue, where external consultants are more trusted than the state when it comes to providing information on whether there are energy saving options. It is important that counselling experts take into account the cost of rehousing tenants to renovate vacant houses that are being renovated. This is evidently a cost for the social housing sector. What happens in practice is that property owners wait until tenants willingly move out
from the dwelling. The best time for renovations is when you buy a property and it has no occupants (34). However, most of the time, property owners need a combination of different incentives to get convinced to invest in energy efficiency.

One obstacle is that the European Commission is promoting cuts in grants and is instead pushing for low interest rate loans, which does not really work out (34). At the European level and also at the national level, the tendency is to diminish and abolish grants and to promote financial instruments and zero interest loans to finance energy efficiency (34). The broad experience of UIPI shows that property owners are not interested in subsidized loans, or this solution comes only on top of other financial means (such as grants, tax or VAT reductions) which are more attractive.

This means that the legislation will not only have a major impact on the construction sector, but will also impede deep renovations since there will be no chance of increasing rent after renovations are completed (UIPI, 2015). This also underlines the cost-optimal side of financing energy efficiency improvements with the emphasis on the life-cycle cost.

5.3 Comments of interviewed stakeholders on barriers to market introduction

Today’s markets are very fragmented with many different stakeholders who need to be convinced before they make purchases. It could be difficult to get iNSPiRe’s ideas across to the stakeholders and to get the construction companies to adapt iNSPiRe methods and kits. People are probably more prone to choosing proven technologies or technologies that are recommended to them (50).

In the UK, there is a government tax scheme. This initiative is known as the ECA (enhanced capital allowance) scheme. The most efficient products are listed on the ETL (energy technology list). A product is assessed, and if it meets the criteria it can be listed on the ETL. Businesses that buy a product listed in the ETL can benefit from a tax relief, which then makes the product economically more attractive (more details about the ETL and ECA scheme can be found at https://www.gov.uk/guidance/energy-technology-list (42, 44). So far the iNSPiRe kits do not have energy efficiency labels and standards, which would be good or sometimes even necessary for pre-qualification especially in terms of procurement.

Guidelines and regulations are required as a way of protection (45). However, different countries can have different regulations. Cabling, piping, and fire safety etc. are issues that differ from country to country. This makes it difficult to sell the same product throughout the EU. When a company sells a (new) product it has to provide cost and performance data, as well as instructions on how to install it and how to maintain it. Therefore, obstacles may well exist if innovative technical solutions are put on the market that are not covered by an existing product standards (47).

5.4 Subsidies

When referring to grants and subsidies, it is very important to note that there is a need for stability. Strong instability of policies regarding grants of subsidies prevent property owners from making long-term investment plans (34). For example, in the Spanish demo case a change of policy during the project, with an exceptional subsidy of 70% at the project start that was reduced to 25% by the end of the project. This results in a doubling of the pay-back period.
Regarding incentives and subsidies, stakeholders clearly talked about the fact that they are both a necessity and a precondition of a renovation project. In order to start a renovation, incentives and subsidies are necessary in order to make a decision for property owners. Subsidies help to reduce the costs and make the renovation cost-effective, though should be technology neutral, because each building requires different solutions (34). What works for property owners is the mix of subsidies, such as VAT reduction, tax rebates, grants, etc. (34). An existing barrier can be observed in the tax legislation in countries which allows for tax deduction, but over a too long period of time (10 years), meaning that you receive a tax reduction for renovation works done 10 years previously. This does make the system less attractive to owners (33). The European Commission to the Member States could reduce VAT for all extensive works, including renovations, but the European Commission has stated that it wants to decrease existing VAT discounts in the context of the European Semester (21).

Another example of conflicting national legislation with EU energy efficiency ambitions and objectives is national rental regulations. In cases where the rent control regulation conflicts with renovation rules it will have an impact on the renovation rate. This is generally the case in countries that implement rent control (34). This suggests that subsidies and grants are crucial financial mechanisms for the residential and non-residential sector, while ESCO, PPP and other third party finance schemes are more applicable for the public sector across the EU (iNSPIRE: EU-27, 2013).

5.5 EU funding scarce for renovating private properties

In its 2015 energy efficiency progress report, the European Commission states that the previous multi-annual financial framework (MFF, 2007-2013) set aside €3.4 billion for energy efficiency in public and residential buildings from the European Regional Development Fund (ERDF) and Cohesion Fund. The report estimates that in the current MFF (2014-2020), €13.3 billion will be used for this purpose. This time money will be available for projects addressing energy poverty and projects that do not offer a return on private investment in a reasonable time, but most private homeowners will still be expected to invest significant financial resources (Nikolina Šajn, 2016).

The European Regional Development Fund Regulation (ERDF) No 1301/2013 gives the possibility to include among the ERDF investment priorities the shift towards a low-carbon economy by, among other things, “supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector” (Article 5(4)(c)). The private housing sector is potentially part of the scope. But Member States and/or Regional Authorities are to decide if and which categories of housing can be eligible for ERDF expenditure when preparing and negotiating their Operational Programmes. Few are the regions and local authorities that consider that private housing to be eligible (despite the possibility offered by the regulation) and rare are those that open these opportunities to private owners.
6 Political Barriers

Public authorities play a key role in reducing the EU energy consumption and the increase of renewable energy capacity. Therefore, Member States must produce and implement National Energy Efficiency Action Plans (NEEAPs) and National Renewable Energy Action Plans. They are further obliged to produce detailed action plans in specific sectors such as the renovation of buildings or the application of high efficiency cogeneration and efficient district heating and cooling systems (Horizon 2020, 2015). To ensure implementation of policy measures, they must be fully supported by a government that incorporates awareness raising, training and development of key staff and that managing and evaluates the progress measures (GPBN, 2014).

The original Energy Performance of Buildings Directive (EPBD) was adopted in 2002. The adjustment of the policy on 18 May 2010 aims to reduce carbon emissions. But even new buildings have difficulties due to the latest regulations and do not meet their energy efficiency targets. The major focus is however on renovation of the existing building stock and improvement of energy efficiency, and savings are to be made through policies at the national level (iNSPiRe; EU-27, 2013). The 2010 Energy Performance of Buildings Directive (EPBD recast) and the 2012 Energy Efficiency Directive (EED) are the EU's main, though not sole, (see table 1) legislation when it comes to reducing the energy consumption of buildings.

Under the Energy Performance of Buildings Directive:

- energy performance certificates are to be included in all advertisements for the sale or rental of buildings
- EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect
- all new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings 31 December 2018)
- EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)
- EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings

Under the Energy Efficiency Directive:

- EU countries make energy efficient renovations to at least 3% of buildings owned and occupied by central government
- EU governments should only purchase buildings which are highly energy efficient
- EU countries must draw-up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans
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<td>Requires Member States to develop and apply a methodological framework for calculating the energy performance of buildings. This calculation method shall consider thermal building characteristics as well as the technological equipment for the thermal supply.</td>
<td>Obliges Member States to set up sector-specific targets for renewable heating and cooling.</td>
<td>Obliges Member States to establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private.</td>
<td>Sets minimum efficiency standards for technologies used in the building sector (e.g., boilers, hot water generators, pumps, ventilation, etc.).</td>
<td>Obliges Member States to establish efficiency labelling schemes for a number of technologies used in the building sector.</td>
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<td>Obliges Member States to take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set, applied and met with a view to achieving cost-optimal levels; this regulation applies to all new buildings and existing buildings that undergo major renovation.</td>
<td>Requires Member States to adopt support policies for RES-H (project to help Member States to examine heating and cooling in light of renewable energy sources) at least for new buildings and existing buildings that are subject to a major renovation.</td>
<td>Requires Member States to ensure a renovation rate of 3% per year related to the total floor area of all heated and/or cooled buildings (&gt; 500 m²) owned and occupied by their central governments (applying the standards set by the EPBD recast).</td>
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<td>Requires Member States to take measures that aim at optimising the performance, installation, appropriate dimensioning, adjustment and control of the technical building systems which are installed in existing buildings.</td>
<td>Defines technology specific restrictions (in view of target accounting) for heat pumps and bioliquids.</td>
<td>Requires Member States to establish energy efficiency obligation schemes (commonly known as White Certificate Schemes) or alternative measures with equivalent effect, aiming at providing efficiency measures that achieve energy savings of 1.5% per year on average.</td>
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<td>Obligees Member States to ensure that all new buildings are nZEB (nearly zero-energy building) by the end of 2020 and that all new public buildings reach this standard two years earlier; in addition, member states shall draw up national plans reporting on their plans for increasing the number of nZEBs, the definition of nZEB, the policies/measures to stimulate the transformation of buildings that are renovation into nZEBs, the interim steps towards nZEB and the implementation of Article 13(4).</td>
<td>Requires Member States to ensure that new public buildings and existing public buildings that are subject to major renovation, at national, regional and local levels fulfill an exemplary role in the context of the use of RES-H.</td>
<td>Obligates Member States to promote the availability of independent high quality energy audits to all final customers.</td>
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<td>Requires Member States to ensure that all accessible parts of the heating and air conditioning systems are regularly inspected and that heating installations older than 15 years are assessed with respect to their energy performance.</td>
<td>Obligates Member States to implement EPC schemes according to a number of minimum requirements (especially regarding content, display and disclosure, reliability, validity, quality) defined by the Directive.</td>
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6.1
6.2 Transposition challenges

According to researchers from the Institute for European Studies in Brussels (Dupont & Oberthuer, 2015), energy efficiency legislation for buildings has traditionally not been received with much enthusiasm by the Member States, which have generally preferred to keep the jurisdiction for construction standards and codes to themselves.

The implementation of the EPBD similarly stalled at the first stage: by the 2012 deadline no Member State had fully transposed the Directive. The European Commission responded by opening infringement procedures against all Member States and in 2014 it referred four of them to the Court of Justice of the EU (CJEU).

As of mid-January 2016, the European Commission led the procedures at the CJEU against Greece, while infringement procedures were still open against Bulgaria, France, Hungary, Lithuania, Portugal, Spain and the UK. Similar problems occurred with the transposition of the Energy Efficiency Directive. In 2015, the European Commission brought legal action against all Member States except Malta, and subsequently referred Greece and Hungary to the CJEU. In mid-January 2016, only Greece was still at the stage of referral to the Court, while 22 Member States were in various other stages of infringement procedures.

A Buildings Performance Institute Europe (BPIE) study (BPIE, 2012) looked at renovation strategies for existing buildings, which Member States were supposed to produce under this Directive by April 2014. Greece, Hungary, Luxembourg and Slovenia missed the deadline, and of the 18 strategies that were available in English, only four were deemed to meet minimum compliance with the Directive. Despite problems with transposition, in its 2015 energy efficiency progress report the European Commission states that final energy consumption in the residential sector decreased between 2005 and 2013 and that consumption per square metre decreased in all Member States (MSs), but stayed the same in Italy and increased by 10% in Estonia. The report (European Parliamentary Research, 2015) suggests this could perhaps be explained by the improved energy efficiency requirements for buildings, appliances and heating systems. Over the same period, energy consumption in the buildings used by the services sector increased (European Parliamentary Research, 2015).

There is a certain number of legal barriers that increases the difficulties for property owners to renovate their dwellings. The three main legal obstacles are:

1. tenancy law in the particular Member State,
2. legal requirements for building and
3. planning and special provisions applying to condominium or multi-apartment buildings.

Each of these legal impediments generates a certain type of consequence. National obligations stemming from national tenancy law often result in the split incentive phenomenon, which occurs when participants in an economic exchange have different goals or incentives. In most Member States, the initial amount of rent can be freely agreed among landlords and tenants, while future increases or decreases are often restricted by national rent control legislation. Some of these tenancy laws disincentives or even inhibit energy performance improvements being undertaken (e.g previous Portuguese Rent control system, modified in 2012 and now in the process of been partly reintroduced with Draft law 155/XIII: Almeida, 2016).
Another legal obstacle are the building and administrative requirements which obstruct investment in energy efficiency and the rate and ambition of such renovations. A number of regulatory and planning obstacles, such as delays in the implementation of energy efficiency regulations on national and local level (BPIE, 2011) complex patenting processes and delays as regards recognition of new technologies, burdensome administrative practices in order to get access to credit or financial incentives, and create the so-called “red tape” effect due to complex administrative and legal requirements for buildings and planning, have been identified which curbing the success of EU objectives in this field.

On top of that, various barriers exist in cases where there are multiple owners and/or occupiers of buildings. In such instances, the decision-making process might become very difficult, especially when it concerns agreements on the particular energy saving investment choice and related financial contributions of the various actors (UIPI, 2013. BPIE, 2011, p. 58)

6.3 Compliance and enforcement

The delivery of regulatory outcomes is not based only on how regulations are designed at national level, in this case it would be more particularly how the EPBD is designed. The major challenge is to how Member States (MSs) comply with it and how they have themselves developed and how they apply enforcement strategies that deliver the best possible outcomes by achieving the highest possible levels of compliance, while keeping regulatory costs and administrative burdens as low as possible. A well-formulated enforcement strategy is one that provides correct incentives for regulated subjects, as well as appropriate guidelines for enforcement staff, and minimises both the monitoring effort and the costs for the regulated subjects and the public sector.

The energy performance requirements for new and renovated buildings are one of the key elements of the Energy Performance of Buildings Directive (EPBD). Article 4, ‘Setting of minimum energy performance requirements’, states that “Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieve cost optimal levels”. According to Articles 6 and 7, “Member States shall take the necessary measures to ensure that new buildings and existing buildings that undergo a major renovation, meet the minimum energy performance requirements set in accordance with Article 4”. Member states will have to tighten the requirements in the coming years to reach Nearly Zero-Energy Buildings (NZEBs) by 2021.

Compliance checks of the energy performance requirements were already a reality in many Member States before the introduction of the EPBD. The implementation of sanctions is now formally required by Article 27 of the EPBD 2010/31/EU. This article states that MSs shall lay down penalties applicable to infringements of the regulation. According to Article 28, MSs shall adopt and publish, by July 2012 at the latest, the laws, regulations and administrative provisions necessary to comply with Article 27. Member States should apply penalties to infringements of their regulation implementing the EPBD by the latest January 2013.

Many Member States face or have faced barriers to developing and operating enforcement in practice. The most important barriers were lack of political support, and the absence of resources to develop, implement and operate the system. The enforcement system and related sanctions have to run in compliance with national rules. In some Member States, the regulatory framework is incomplete or unclear. This prohibits the practical and efficient functioning of the enforcement system.
Political support is one of the first keys to the success of enforcement. Some Member States experienced that media attention to data and figures on non-compliance with requirements of a statistically relevant set of new buildings or compliance problems in certain buildings could raise political support. Linking the compliance check with financial support mechanisms is another possibility: enforcement is then a control mechanism on efficient expenditure of public money.

Some Member States have put in place a practical and continuous financing scheme (e.g. an expert licence fee or a fee for each calculation/EPC) for enforcing the requirements and quality control. These schemes require an effective management, if they are to overcome the barriers that prevent the implementation of a compliance checking system. A central database, which contains an automatically generated indication of the compliance of the building with the energy performance requirements helps to build an efficient enforcement system.

In case the local authorities or communities are responsible for enforcement, training the competent staff is essential. The ability to check compliance in the software and in the EPC, or another document as part of the building permit process, is of great value when many different individuals are involved (Concerted Action Energy Performance of Buildings, 2014).

6.4 Public procurement

Public procurements can have a great potential to promote sustainable and energy efficient renovations. The recently adopted public procurement directives introduce a couple of novelties that have potential to promote the procurement of innovative solutions and to support the implementation of more sustainable public works. From our research point of view the most important novelties among others that can consider might be the introduction of life-cycle costing, the mandatory “MEAT” criteria (most-economically advantageous tender criteria) and the policy measures to strengthen the bidding ability of SMEs. The New Directives are aiming to tackle some of the obstacles of the procurement of energy efficient retrofitting solutions.

Main concerns on the demand side are the sometimes-higher initial costs of procuring innovation, the lack of available suppliers and legal challenges of the introduction of innovative requirements into the tender documents. In order to tackle the issue of the sometimes-higher purchase cost of innovative or sustainable solutions there is a need for a change in mind-set to consider the best value for public money along the whole lifespan of the products/services.

The public sector is definitely a great market for economic operators supplying innovative solutions. Engaging the market in the very early stage of the procurement has great relevance. By carrying out meet the market events, or market dialogues, there is a possibility to reach a broader private audience, such as SMEs, thus providing an early feedback to the public buyers whether there is a capacity on the supply side to provide the innovative solution. Good practices from the different Member States and EU level guidelines might be beneficiary to support the procurers in the application of innovation procurement practices. Good practices can have the possibility to encourage the procurers to go to this direction.

Since it is governments that should encourage the promotion and financing energy renovation projects. Energy Efficiency Directive demands that governments purchase only services, products and buildings that have energy efficiency implementations. The enforcement of regulations may be the most effective action for overcoming non-technical barriers (iNSPiRe: EU-27, 2013). The obstacle here relates to knowledge within the public sectors of sustainable energy, practical training and tailored guidelines and the lack of willingness to change procurement habits (Horizon, 2020).
While public authorities develop energy efficiency policies and plans, stakeholders and the society are needed for effective implementation to be deploy these. There is however a lack of coordination among stakeholders to effectively implement policies and plans (Horizon, 2020). Procurements are a public service and internal policy exists that states that it is not obligatory to make a procurement. Collaborations to other procurers in other cities and together with other ministries in other cities will bring procuring to a higher level. From this sense, policy is a very big help for procurers so as to raise awareness among procurers and show them it is possible to procure innovations and green technologies.

Political barriers are therefore found when renovating a building. The proposals needs to be enhanced to public authorities and national/regional/local procurement authorities if the best sustainable products are going to be able to be bought. Project proposals should therefore embrace the lack of professional procurement training, the lack of experience in implementing sustainable procurement practices and strategies, and/or the lack of sharing and co-operation among procurers (Horizon, 2020).

6.5 Comments of interviewed Stakeholders on regulations

Regulations and guidelines have to be present, otherwise it will not be possible to build buildings that are safe and reliable (44). Unfortunately, this also causes conflicts in terms of a number of different issues with new products. Regulations are made for technologies that are already on the market. For new technologies, this serves as a barrier, because the regulations are not adapted to them yet (51). Normally new regulations occur three to four years after a new product has been on the market.

The experts in the area of regulations are usually not involved in the development of new technology, and therefore there is need to find new experts to join the team and develop this expertise since they have the knowledge of regulations in different European countries (51).

In some countries there are different regulations between the country’s own provinces. What is allowed in one province is not allowed in another (18). Multi-functional technologies therefore causes issues in terms of regulations because technology is used in a new way or place. Even house insurance might be affected by this since they mostly are connected to existing technologies (48). For each new product developed, effort has to be made to comply with numerous regulations for the entire EU (49): the product itself disappears into the background and this leads to more work and more costs for manufacturers to deal with (49).

On the other hand, standards and regulations are very helpful to prepare the market for new technologies, whereas in the technical, planning and realization phase, they are not helpful. The market needs so to speak, to be prepared through policies and guidelines. And they give quantifiably goals that has to be achieved. Thus from this point of view, regulations are in a way helpful (55). Regulations and policies are therefore positive in the sense that the incentives set directions for new technologies. Regulations can also be positive because they ensure quality in performance, and they are necessary in that aspect. First, however, they need to be easy both to understand and to access and flexible enough to include new products (51).
7 Social Barriers

When owners of dwellings looking to find solutions and are in a decision phase before renovating, social barriers were found. Owners were unsure of the expected benefits in energy and economic terms. In addition, their lack of technical knowledge could make them even more hesitative. Therefore, there is currently a need of how to explain the operation of the technical solutions and thus achieve wider acceptance (56).

However, it is important to keep in mind the ownership structure in parts of Europe. Blocks of flats were rented under the socialist regimes, but in early 90s, there was a strong privatization of properties and the flats were sold. Currently there are areas where 30 to 50 families live in one block of flats, each owning their own flat. These people ended up randomly together and might have very different backgrounds, etc.

The real obstacle is that these communities of people do not function well when it comes to understanding the relevant legislation. It is very difficult to get their approval to do anything (23). Therefore, there is a clear need for an intervention of some kind, for instance a mediator could facilitate the decision-making process for a renovation.

7.1 Split incentives

Social barriers are multiple. They include soft barriers such as lack of awareness or information, perceived complexity or scepticism about new technologies. Other elements such as the split incentive can be classified as social barriers. The split incentive is probably the most complex and long-standing barrier relating to existing buildings, in particular in countries with a high share of rental dwellings in the residential sector (e.g. Germany) or a very large number of multifamily houses (e.g. in Italy or Eastern Europe) This barrier is sometimes considered a financial barrier, as there are financial implications, and other times it is considered to be an institutional barrier. Due to its importance for retrofit projects and strategies, this aspect is also categorised as a separate category of barrier in some studies (BPIE, 2011).

The origin of the barrier is the fact that the owner and the tenant of the dwelling are two separate actors with different interests and different incentives. An owner expects a return or benefits on a particular investment and this does not necessarily have to occur through energy savings, as often times the energy bills are paid directly by the tenant. Hence, any energy efficiency investments must be such as to lead to financial advantages for both parties. Often the party investing in the building is not the party which also reaps the financial returns. This can be caused by the fact, as mentioned before, that the tenant pays the energy bills and therefore any savings achieved will not benefit the investor; the same is true in cases where national rent control legislation or other legislative restrictions prevent the raise of rents after a renovation (BPIE, 2011).

The split incentive barrier can also refer to the different kind of incentives between various owners. Owners do not want to pay for energy efficiency improvements that they do not deem necessary or for which they will have little direct benefit. A typical example would be the owner of a ground floor apartment that would be asked to pay for the insolation of the roof that would according to him only benefit the owners of the last floor apartment.

Overcoming this problem has long been identified as one of the main challenges related to the uptake of energy efficiency renovation. This is not a surprise if the EU policy-makers in the Energy Efficiency Directive Article 19(1)(a) of the Energy Efficiency Directive (Directive
2012/27/EU) recognises the importance of addressing the barrier of split incentives in the building sector. It states:

“Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards: (a) the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments that they would otherwise have made by the fact that they will not individually obtain the full benefits or by the absence of rules for dividing the costs and benefits between them, including national rules and measures regulating decision-making processes in multi-owner properties”.

7.2 Value of Sustainability

The first tentative to estimate the “green value” took place in United States and in Europe has been estimated to 5% of the sales price. When the market is not highly tensed, the price difference can reach 10% for two equivalent properties, which have a letter difference in the energy classification. With few risk, it can be predicted that sales or rental of non-renovated existing properties will be more difficult and at a lower price compared to real estate that meets new standards for energy. In France, in 2012, rents increase of 9% when premises that had been refurbished, but decreased of 3% if not. Even though the prospects for return on investment are not excellent, the execution of renovations (not only energy efficiency renovations) allows landlords to meet the demand on quality requirements and helps reduce the risk of prolonged vacancy of property on an uncertain market. In a declining market (where offer is higher than demand), this vacancy can easily exceed six months and even up to 18 months, it is worthwhile to reduce it (Train rebuild, 2012).

The green value of a property is the variation of its value, price or rent, attributable to the environmental performance, in a larger sense. For the moment, it is focused on the energy consumption criteria. Sustainability can be the key to many issues, such as education. The energy transition will require the implementation of technological solutions and also a change in consumer behaviour that respects the application of energy efficiency solutions and the increasing use of renewable energy sources. Energy consumers have traditionally been seen as a passive user rather than an influential part (SET plan, 2014). Energy consumers should benefit from the innovative technologies, services and products offered by the market. However, with the increased use of renewable energy, consumers have an increasingly active role to play. Changes in their energy consumption patterns coming from energy efficiency or demand response solutions could provide such flexibility. In this aspect, there is a need to directly engage consumers in the energy system through better understanding and information (SET plan, 2014).

7.3 Comments of interviewed Stakeholders on sustainability

Different stakeholders talk about different kinds of values at different times and on different occasions. Comments from the interviewed stakeholders was about that sustainability is a core concept. The idea of renovation is about energy savings and contribution to the green imprint. It is a question of resource efficiency. When something is already in place, then it is good to use it instead of building new (29).
From the view of the whole project, the green value of sustainability is indeed very crucial. At the same time as the green quality increases the value of buildings through the investment of energy efficient technology is also raised. The debate on green bonus is interesting because the European Commission is working increasingly on financing studies, aiming at demonstrating the green value of energy efficiency renovation (34). Therefore it should be possible to valuate buildings into sustainable assessments that clearly shows that this types of investments saves money, no one should hesitate to put the effort in to do so. Hence money is still a barrier when it comes to this topic.

Another point to make is that the way people invest in renovation depends on the way they perceive the investment on their own house. For example, in some countries they buy the house using long-term savings, whereas in others, for example, people buy early and sell their property fast so they move out more readily (34). Also to be noticed is that in other countries, average property owners are older and do not necessarily care about the long-term future. Long-term investments are often not an option.

7.4 Architects point of view

As ACE (Architects’ Council of Europe) states in their position paper on the role of architecture in energy efficient construction, architecture plays an important role in achieving the cultural transformation required to create a sustainable built environment. Empowered by progressive legislation and investment, architecture’s reach goes well beyond individual building boundaries. ACE therefore calls on EU institutions and Member States to:

1. Implement legislative change that recognises the role of architecture to deliver a step change in building performance to reach EU greenhouse gas, renewables and energy savings targets by 2030.
2. Recognise and promote the contribution of architects to energy and resource efficient construction in all relevant legislation, standards and funding programmes.
3. Incentivise holistic retrofit solutions by interlinking financial instruments for energy efficiency with architectural renovation to significantly increase the uptake of energy efficiency measures.
4. Review research funding to better target Architecture SMEs and incentivise interdisciplinary collaboration across the construction industry.
5. Empower built environment professionals to reduce the energy consumption of buildings while improving indoor environmental quality by:
   - creating a transparent and harmonised reporting and benchmarking of building energy use and building performance indicators by Member States;
   - mandating the EU-wide disclosure of building operating performance across all sectors;
   - implementing the measurement and verification of energy performance in use (ACE, 2016).

7.5 Comments of interviewed Stakeholders on architectural perspective

Comments from the interviewed stakeholders in the empirical analysis connected to architectural issues where about design and acceptance. Technical solutions might not look very aesthetic and hence architects might not like to use them (47). The acceptance of an
architect is needed for these innovative technologies to be applied in more buildings (3). Here the design process is crucial and when and how to involve an architect is therefore a key issue. Architects need to feel free and independent of material and design choices in order to work free and creatively towards the best result (30, 7). It is shown that good building aesthetics lead to high levels of interest in deep renovations among neighbourhoods (POWER HOUSE nearly-Zero Energy Challenge, 2015). Furthermore the architect always looks first to solve energy efficiency issues by passive design solutions and tries to stay low-tech before applying high-tech solution kits, which might have difficult user interfaces and require high maintenance.

7.6 Tenants living in the demonstration buildings

All the tenants who were questioned about the renovation in Ludwigsburg were workers full-time during the renovation phase and all the homeowners who were questioned in the Madrid demonstration building were pensioners.

Several of the tenants living in demonstration buildings both in Germany and in the Spain were only moderately distracted by the construction workers during the renovation phase. While they did find the noise level from the construction work to be disturbing, the dust and other air pollution from the construction were only moderately disturbing. During the renovation phase the interviewees from both cases felt that the indoor temperature was fairly acceptable. These few answers regarding the renovation phase give us an idea as to how the tenants viewed the construction during their daily live.

Tenants of the Ludwigsburg demonstration building who were questioned were all full-time workers and between 30 to 70 years of age. They had been living in the building from one up to 13 years and their level of education was up to university level. Most of the tenants lived alone in their apartment apart from one tenant. The tenants of the Ludwigsburg demonstration building were satisfied with how the property management had been handled and they felt it was important to speak their mind during the renovation phase. Some of them thought it was most important to change and renovate the ventilation in both the bathroom and the kitchen. Others thought it was more important to renovate to improve sound insulation from outside noise. Additionally, for the most part tenants did not feel involved due to decisions relating to the property but on the other hand they thought it was not valuable to make proposals during the planning phase before the renovation. After the renovation was completed these tenants experienced a higher quality of air and indoor temperature and additionally a better level of insulated outside noise reduction. They were satisfied with the new ventilation system, heating system and the new façade.

Homeowners and tenants of the Madrid demonstration building who were questioned were all pensioners above the age of 61. They had been living in the house from between one to more than 70 years, and had a middle school up to secondary school level of education. Most of the occupants lived alone or were married. Half of the occupants questioned were renting their apartment and the other half was condominium owners. Some occupants thought it was important to invest and renovate the surface layer on the floor and roof inside the apartment, while others thought it was more important to improve the sound isolation to keep out outside noise. Their reflection on involvement in terms of decision-making of the property was divided: they had both positive and negative experiences. Additionally they felt it was important to be able to make proposals during the planning phase of the renovation.

After the renovation all the Madrid tenants and homeowners thought the daylight inside the apartment and the sound insulation between the individual living-units were good. Additionally, they thought indoor temperature, ventilation, façade and reduction in outside noise after
renovation was satisfying. Regarding the indoor quality of air and regulation of the newly installed heating system, they were moderately satisfied.

7.7 Value for tenants

The tenants are not directly a part of the iNSPiRe project but are important actors and cannot be ignored. It is crucial to remember this. These renovation that installed new technologies was made for the first time, and it cannot of course be perfect in all conditions for people living there. Different technologies were tested and is not optimal for the tenants living in demonstration buildings during the process. We can now move forward from our lessons, and it can only be better next time with the installation of these technologies.

In Madrid demonstration building the tenants did not know exactly what the technical staff were doing and it was therefore sometimes hard to communicate (58). Sometimes, however, the tenants were not addressed enough: they needed more information about the project than they received. They felt that they needed to have more information about the effects and the installations in the building. Additionally, the information given of the renovation was not perceived as easy to understand.

If the reflection of the tenants questioned from both of the demonstration buildings are put together, their general experience from the renovation phase could have been better. After the new technology was installed, the general sentiment was however, one of contentment.

Post-benefits of renovation for tenants and homeowners is better living standard due to a better quality of flat, although having the same costs as before. It is valuable when the new technology works well and the renovation goes quickly so they can stay in the flat during the installation phase.
8 Suggestions for overcoming obstacles

Each jurisdiction is different but a conclusion is that all jurisdictions should learn from each other and from the valuable insights provided by the GBPN Policy Tool for New Buildings.

Political consensus on the need for essential actions on building energy efficiency cannot be underestimated. The European Commission makes implementing assessments for products which have significant sales and trade in the EU and compelling environmental impact and potential for improvement (INSPiRe EU-27, 2013).

In order to ensure implementation of policy measures, they must be fully supported by governments that incorporates awareness raising, training and development of key staff and that managing and evaluates the progress measures (GPBN, 2014).

The energy system in Europe is in a process of profound transformation and the qualities of the energy system are strongly linked to its energy supply. The need for diverse, reliable and cost-effective energy supply technologies is crucial and the enforcement of regulations may be the most effective action for overcoming non-technical barriers. Policies and policy instruments are necessary in the future to shape and direct the energy efficiency priorities in society (SET plan 2014). This requires efforts from several directions to get a workable plan. A strong collaboration between several decision makers are jointly developing a base for the future of energy efficiency. Carefully considered strong energy efficiency investments can actively contribute to sustainable development in Europe. And subsidies that target specific technologies are not the best way to finance renovation (19).

It is important to increase the renewable technologies in the regulations and policies. It is otherwise a risk that old technologies will be used instead (54).

Buildings Performance Institute Europe (BPIE, 2013), created a checklist of strategic actions in six steps to underpin a renovation strategy. This is something that is still relevant and worth striving for: A, establish support across the political spectrum for deep renovation of the building stock. B, establish an independent committee to monitor and report progress on the strategy on an ongoing basis, including making recommendations for improvements and periodic updates. C, undertake systematic appraisal of barriers to renovation in each segment of the market and develop policy responses to address each barrier. D, establish objective to eradicate fuel poverty through energy performance improvements to the housing stock. Develop holistic cross-policy targets that integrate with and deliver on goals in related fields, e.g. sustainable urbanization, resource efficiency, sustainable construction etc. E, establish a wide stakeholder group as a forum for consultation, policy formulation and feedback on practical issues and barriers to renovation. F, demonstrate leadership through accelerated deep renovation of public buildings, thereby developing supply chain capacity and providing a knowledge base for private/commercial renovation activity (BPIE 2013).

In order to solve problems due to newly installed technology an “international on-line help/forum” would facilitate users to handle the new devices. This “on-line customized feedback tool” would make it easier to overcome language barriers from the supplier and at the same time would decrease the technical burden from users. This forum should facilitate buyers and operators with the new equipment. Feedback and quick answers on whom to contact or what to do when problems arise would make installation of new technical less uncertain.

Procurement procedures should include support for new technologies for the planning, installation and operation phases.
Public bodies should be further encouraged to take higher risk and choose (new) energy efficient technology. They have greater possibilities to make a fuller assessment of choices and risks. If public bodies do not have good outcomes it is certainly difficult for private investors. Good examples made by public bodies are a “carrot” to private investors.

LCC-perspective (Life Cycle Cost) makes it easier for decision makers to take a longer time frame into account and still keep investor economic targets. This method is already used beneficially in many cases, but needs to be more broadly implemented. Standard tools and methods are required in order to reduce the barrier for smaller companies to start using LCC.

Training is a very important activity for breaking down the barriers found in this project:

- Training of local suppliers/agents/partners is necessary to reduce language barriers and to understand the local regulations and praxis for the suppliers when entering a new market.
- Training of craftsmen is necessary for new technologies, and more specifically multi-functional technologies such as those in iNSPiRe.
- Training in the LCC method is needed for smaller companies that have not yet implemented it.

Reality-check of innovative technologies during development with architects is needed, as they are the ones who recommend technologies to building owners.

It is hard to justify the measures only by means of simple payback time based on energy savings. The property value needs to be considered, and actions are needed at EU and national level to assure that the value of the energy retrofit is effectively taken into consideration in the real estate market.
9 Literature references


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10 Appendix

All participated persons from the deep interviews have been numbered from one to seven.

All participated persons from the EHF meeting focus group interviews in February 2015 have been numbered from eight to thirty.

All participated persons from the UIPI meeting focus group interviews in February 2015 have been numbered from thirty-one to forty-one.

All participated persons from the on-line questionnaire and audience response questionnaire have been numbered as forty-two to sixty.

All participating people from the multifamily house in Ludwigsburg have been numbered as one to four.

All participating people from the multifamily house in Madrid have been numbered as one to three.