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D4.2 ENSURING SUCCESSFUL REPLICABILITY IN EE RENOVATION BUSINESS SCHEMES

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Author(s)	Hugo Grasset, Solintel				
Editor	Karine Laffont-Eloire, DOWEL Management				
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Glossary

Acronym	Full name
AEC	Architects engineers and construction
EC	European Commission
EE	Energy efficiency
EED	Energy efficiency directive
EnPCs	Energy Performance Certificates
EPBD	Directive on Energy Performance in Buildings
EPC	Energy Performance Contracts
ESCO	Energy Service Company
EU	European Union
Iot	Internet of Things
MS	Member States
NEEAP	Second National Energy Efficiency Action Plan
nZEB	Nearly Zero-Energy Buildings
ROI	Return on Investment
SME	Small Medium Enterprise
TPF	Third party financing

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1. Introduction

This document is focused on the provision of solutions dedicated towards the alleviation of the multiple micro level barriers to the energy efficient renovation market presented in the previous deliverable D4.1 of the STUNNING project.

The deliverable will focus on providing solutions that foster SME participation in the market and value chain. In order to do so, a simplified value chain of the EE renovation process was presented in order to understand which SMEs intervene at which moment and in order to then map the identified barriers within this model so that it is possible to understand which actors are most affected, during which process and how.

In STUNNING, it has been decided to focus on a global and generalist 5 phase model which provides enough flexibility so that it~~n~~ can be applicable to all EU member states. Potential specificities and particularities in terms of barriers or solutions that pertain to country level standard operating procedures (SOPs) or societal configurations are rather addressed in the respective sections that ensue on barriers and solutions. Moreover, this process mapping is also loosely applicable to different building typologies, notably public. It was important to employ such a generalist approach in order to maintain simplicity and understand barriers through one set of lenses.

Combining this information with the sectorial information, case studies, empirical findings and stakeholder feedback gathered during the course of the STUNNING project will enable the recognition of potential solutions in order to alleviate the barriers in question. Solutions will always be aimed at maintaining active participation of SMEs, a crucial element and player of the EE renovation sector due to the dominance in numbers of such companies within the industry as well as their potential to tackle smaller scale projects representing an important portion of the EU building stock.

Some offered solutions are vertical in nature and only aimed at tackling one precise barrier. Nevertheless, the report also explores potential horizontal initiatives that present the potential to alleviate more than one barrier at once, namely in the form of national energy efficient renovation sector SME clusters. Other potential implements are drawn from the experience of precise member states. For instance, Germany´s comparative regional rent index system could be transposable to other member states in order to alleviate issues related to the lack of correlation between property values and energy performance certificate improvements which in turn could reduce imbalances in incentives, costs and benefits between tenants and owners during renovation processes.

Each barrier is treated individually with an explanation on barrier placement, which SMEs are most affected along with other stakeholders and finally discussing potential solutions and potential MS variations in applying these solutions due to specific societal or regulatory configurations.

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2. Methodology for the identification of solutions directed towards the alleviation of market barriers in the EE renovations market place

A clear methodology must be established in order to tackle the objectives of this deliverable. As stated in the objectives of the work program, this report shall explore solutions in order to address the barriers that were described in the previous report D4.1.

In order to do so, a set of different steps must be performed. Firstly, it is necessary to perform a general simplified mapping of the renovation process and value chain. A global model will be introduced as research proves that in most EU member states and especially the ones which have been the subject of focus in STUNNING, the process is relatively similar and replicable. This mapping process will enable to identify the different phases in EE renovations and where most SMEs extract their value. This ultimately will be supplement by a clearer segmentation of the different SMEs intervening in different areas of the value chain as prescribed by the STUNNING project initially for the relevant tasks.

Furthermore, this mapping of the renovation process or value chain will open the possibility of positioning the different barriers we have identified and characterized in D4.1. This will enable a clear understanding of when these barriers interfere in the renovation process and value chain and according to the SME identification process that will have been performed previously this will also give a clearer understanding of which SMEs are most effected by which set of barriers. This report will focus on the barriers that were formally characterized in D4.1.

When mapping these barriers and situating them within the mapped EE renovation process, solutions will be offered in line with the previous characterization of barriers in D4.1 and the sensitivity assessments and key variables that were established in that same deliverable as well. EU wide but also member state specific solutions, if relevant, for tackling the identified barriers in order to foster the unlocking of the EE renovation sector in Europe will be offered in these sections.

The following figure provides a breakdown of the analytical process that will take place during the course of this report in order to provide sound conclusions on how to spur the EE renovation market throughout Europe. The outline of this report will follow the structure of these main building blocks.

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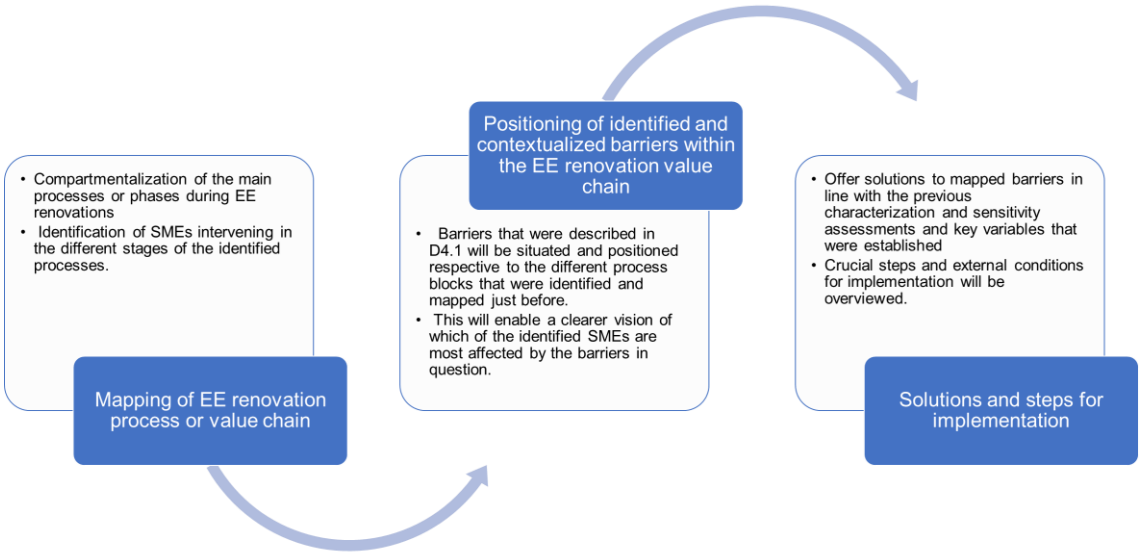

Figure 1 General report methodology and ensuing structure

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3. Mapping of EE renovation Value Chain

As the purpose of this report is to offer solutions to alleviate the identified barriers towards the EE renovation market while also fostering active participation of SMEs in the EE renovation value chain, it is necessary to start out by developing a clear understanding of the EE renovation process and value chain.

Value chains are defined by a clear set of activities that firms in a specific industry perform in order to deliver valuable products or services to the market in question. Taking into consideration this definition, it becomes clear that if the EE renovation value chain is to be mapped effectively, two main duties must be undertaken, the identification of the different activities or processes that define the different phases of the renovation process in which different companies and organizations derive value and secondly the identification of the companies and in this specific case the typical SMEs that intervene in these different phases.

In the framework of STUNNING, for the work relevant to the mapping of the different activities that compose the value chain, it has been decided to focus on a global and generalist 5 phase model which provides enough flexibility so that in can be applicable to all EU member states. Potential specificities and particularities in terms of barriers or solutions that pertain to country level standard operating procedures (SOPs) or societal configurations will be addressed in the respective sections on barriers and solutions if necessary or pertinent. Moreover, this process mapping is also generally applicable to different building typologies.

The following mapping of activities provides an overview of the main activities which compose the EE renovation value chain in the EU currently.

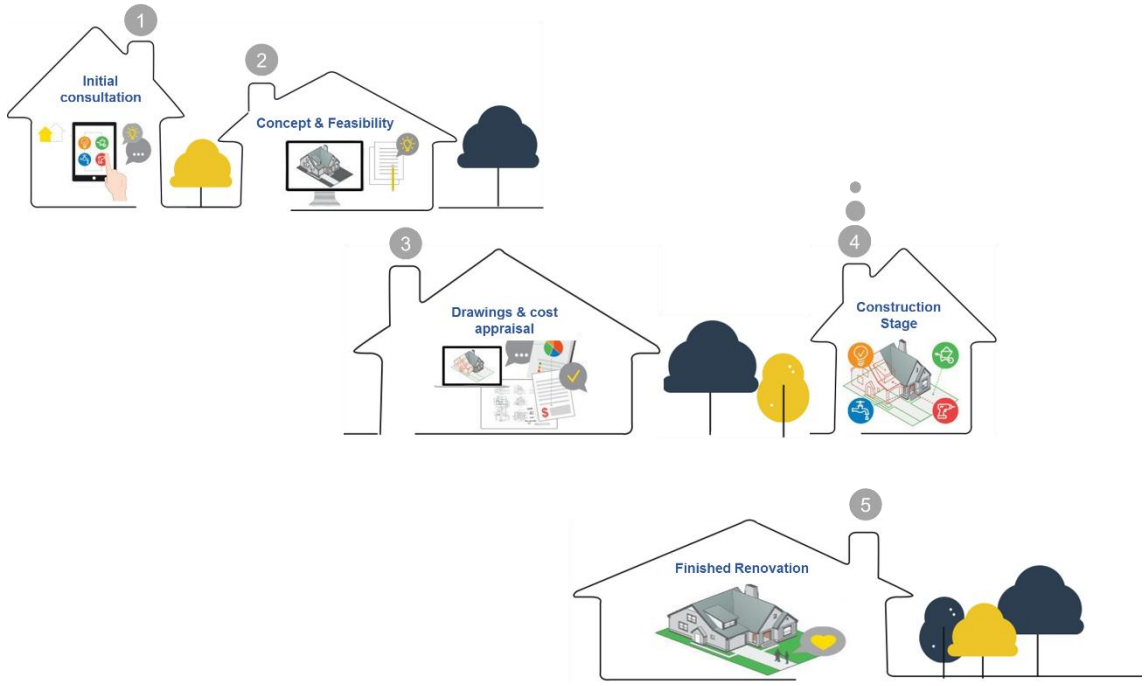

Figure 2 Mapping of the main activities and phases contained in the EE renovation value chain

The following sections will be dedicated towards providing more detailed explanations and descriptions

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of the 5 phase scheme presented above. An overview of the activities in question will be offered as well as the SMEs that generally intervene in each phase.

In the following section also will be described the procedures and aspects of the renovation process that are necessary to ensure its proper development. The procedure begins with the diagnosis of the state of the property, established by the competent agent, and ends, in its most formal aspect, with the execution of the works. Taking into consideration what follows may serve to reduce the scope of the problems that inevitably arise in this type of action: poor construction practices, delays in the execution of works, penalties for failure to comply with the duty of conservation, budgetary deviations, etc...

3.1. Initial consultation

The first step in the established EE renovation processes is to recognize the condition of a property, establishing a diagnosis and proposing the necessary rehabilitation actions, these functions can only be taken over by technicians with the appropriate professional and academic qualifications. Also understanding exactly what building owners, occupants and other stakeholders of the end-user category are trying to achieve with their building or home including the reasons for enacting a potential renovation. The main objective is to design and deliver the optimal EE renovation solution down the line given a set of relevant constraints defined by the end user such as time and money.

3.1.1. Description of activities and stakeholders

This step of the renovation process is crucial as it is the part where the actual home or building owners provide most of their inputs during the renovation process, establishing a set of constraints around which the relevant actors and stakeholders must work and take into consideration when making preliminary planning for the renovation. These constraints or criteria will live throughout the extent of the project.

The most common themes and building owner constraints or criteria as well as needs that are explored in this first process step are listed as follows:

- Budget and wishes: First and foremost, the owner's actual budget must be determined in order to understand the potential limitations on the amount of work able to be done, or the dispositions that must be put in place such as structuring work over a number of years to make it affordable.

- Preliminary assessment of existing layout and structure of the building: It is important to do a careful measure-up and document the existing layout and construction and the condition of the building – cladding, roofing, framing wiring, plumbing and so on. Identify:

    - what work must be addressed as part of the renovation, for example, roofing at the end of its serviceable life

    - explore the opportunities and the limitations offered by the existing building

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- load-bearing elements of structure
- Framing sizes, spacing, materials and so on.

All of these tasks are performed in order to determine what is possible given the existing structure, for example, installing new double-glazed windows into framing timbers that are not straight and level may be extremely difficult, if not impossible.

- Time frame requirements on part of the building owners: It is important to understand what time frame the building owners have in mind for the implementation of the renovation. This has impacts on potential interventions and solutions that may be used as well as the planning of the renovation as a whole.

- Zoning and applicable regulations: It is important to perform a preliminary assessment of the building codes and regulations which may be specific to that zone and understand whether the building is affected by a particular set of regulatory constraints in its modification.

- Preliminary design and orientation of potential renovation approach: The stakeholders involved with the project design will use their expertise in order to offer the most optimal set of renovation solutions according to the identified constraints and elements above providing energy simulation and modelling.

3.1.2. SMEs intervening during the initial consultation

The SMEs intervening at this point are mostly SMEs involved in building design processes with a specific expertise in EE renovations, solutions and approaches providing consultancy at this stage.

SMEs most often involved (main players at this stage are set in **bold**):

- **Specialized architects in EE renovations and refurbishments**
- **Green building design and construction experts**
- **ESCOs**
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Engineers

On the side of this, financial entities may intervene at the initial stages of this process for loan assessments affecting activities related to budgets.

Furthermore, cities and local authorities may be consulted as well for the establishment of relevant building codes to respect.

3.2. Concept feasibility

The second step 2 of the value chain is to translate requirements into a set of architectural concepts and investigate the feasibility of the projected build. During this stage, Step 1 will provide inputs in order to create a first concept or renovation pathway. Using this initial concept, a preliminary feasibility study

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will ensue factoring in budgets and other factors endogenous and exogenous to the project. Initial concept drawings are presented at this stage giving the opportunity for the building owners as well as other involved stakeholders to make necessary or desired changes.

3.2.1. Description of activities

As design stakeholders have taken a brief from their clients in the previous steps it is now possible for them to analyse the line-by-line costs of the alternative development scenarios. This enables the production of a bespoke and detailed cost analysis to enable clients and building owners to make informed decisions on how best to approach their project.

It's best to carry out this type of feasibility study in the very early stage of a building project. If a project is large or complex, or where there is some doubt regarding the best approach to the proposed development, carrying out a feasibility study in the preliminary stages can save both time and money.

Feasibility studies often contain two major sections. One on the most adapted and relevant systems and materials to be used given key criteria that define their fit with the current layout and structure of the building. The other on actual projected implementation costs.
In addition to this, for the case of EE renovations, it is important to factor in long term costs and savings of concepts and envisioned refurbishments for the calculation of paybacks and return on investments (ROI). This implies inputs in terms of current electricity and energy prices depending on envisioned energy sources used by the new building.

These studies can be performed through a mix of experience, use of similar projects and data as well as more sophisticated modelling.

By the end of this step, it should be possible for the owners under the guidance of the relevant consultants to choose their favourite course of action according to a precise set of KPIs.

3.2.2. SMEs intervening during the concept feasibility

The SMEs intervening in this process are similar to the ones intervening before. They are involved in building design processes and have specific expertise in EE renovations in order to be able to assess the technical fit of the singular prescribed solutions as well as their cost and savings potential. In the case where initial steps were taken mainly by specialized architectural practices, ESCOs or design specialists with little to no construction capacity, the process may be defined by a mutual exchange with several SME actors with construction stakeholders intervening for budgeting and costing of certain interventions. Moreover, if it has been decided to assess the possibility of integrating particular materials or systems such as prefabricated envelope implements for instance, it may be necessary to include producers of such implements within the process as the singularity of their solutions may require their specific know how for evaluating fit and cost.

SMEs most often involved (main players at this stage are set in **bold**):

- **Specialized architects in EE renovations and refurbishments**
- **Green building design and construction experts**

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- **ESCOs**
- **Vertically integrated construction companies with capacity in energy modeling of buildings**
- **Construction companies and SMEs**
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.
- Engineers

3.3. Drawings and cost appraisal

The third step of the process map provided referring to drawing and cost appraisal activities relates to the development of an extremely detailed project design, cost appraisal and contract of the previously selected alternative on the basis of the initial feasibility studies of step 2.

3.3.1. Description of activities

This step will take account of the engineering, structural, design and aesthetic decisions made. As part of any renovation, structural issues can be uncovered unexpectedly during the course of the work. The contract will explain how these will be dealt with and accounted for in your renovation. If required, the cost can be refined or brought down by making modifications to the design.

This step of the renovation value chain concerns 3 main sub-steps.

- Once a design alternative has been selected in the previous phases, a more detailed 3D model of the proposed renovation will be provided with clear prescriptions in materials and accounting for all the building semantics as well as building codes.

- Precise cost appraisals based on this model will be produced. Within these cost appraisals consideration will be given towards the labour, services and equipment, materials and systems involving consultation of all involved stakeholders that will participate in the renovation. Moreover, similarly to the feasibility studies performed previously, particular focus will also be brought to the building performance and relevant energy simulations. Indeed, cost and savings potential must be calculated in order for the building owners to obtain payback periods and ROIs for their own use or to present to potential third party financiers (TPF) if their budget is in part being financed externally. Moreover, such assessments are also extremely important in the case of larger buildings prescribing to EPC´s which would require precise base lining of energy consumption, potential savings and benchmarks against which to compare the regular measurement and verification of building performance that would ensue.

- Contracting refers to drafting contracts between the main parties of the renovation project. This makes reference to the service engagements of intervening party and also the financing clause and amounts that will be given by the building owners. Moreover, contracting can include certain contingency measures when the renovation process encounters unexpected issues during the course of the works. Parallel contracting processes in terms of TPF financing and EPCs can also be performed at this stage.

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3.3.2. SMEs intervening during the drawing and costing

The SMEs involved at this stage cover the whole spectrum of companies intervening in the actual renovation works as cost appraisals need to cover the totality of offered services, materials and equipment. Moreover, potential financial entities and TPFs may intervene in parallel as building owners and ESCOs may negotiate financing and EPCs depending on the project scale.

SMEs most often involved (main players at this stage are set in **bold**):

- **Specialized architects in EE renovations and refurbishments**
- **Green building design and construction experts**
- **ESCOs**
- **Vertically integrated construction companies with capacity in energy modeling of buildings**
- **Construction companies and SMEs**
- **Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.**
- Engineers
- TPF entities

3.4. Construction stage

Step 4 Renovating is a multi-layered process, and trades need to be carefully scheduled to keep the job moving forward smoothly.

It is very important that each trade has completed their work to the correct standard. It can also impact the next stage of the job.

This stage begins with a pre-construction meeting to ensure that everyone is on the same page when the construction starts. This meeting normally includes information about how to access the job site, the quality control of the project, how and where to store all the materials (procurement), and the hours that everyone will be working.

The pre-construction begins when the contractor has been chosen to do the work. The contract administrator, project manager, superintendent, and field engineer are chosen and a site examination is completed.

The procurement stage is when the project really gets going because the equipment and materials are ordered and delivered. This is when the labourers are hired as well so that everything is ready for the project start date. All this work is usually performed by the general contractor, however, there are times when subcontractors will be in charge of certain parts. The subcontractors may be responsible for hiring their own workers or obtaining their own materials so that they know that they have exactly what they need to complete their portion of the job.

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3.4.1. Description of activities

There are several streams of information that need organization and management in any renovation construction project. These are the most business-critical:

Records Management: Record management controls the distribution, storage, and retrieval of project records, both hard copies and electronic, in a safe, secure manner. Project managers must make sure that all incoming and outgoing documents are transmitted through the records management specialist, who uses software to track the records (this method will also create a central library of all project documents and information).

Contract Management: It is important to clearly define the roles and responsibilities for the project team members who are managing the project and the project staff responsible for managing contracts and documents. The contract management plan is designed to set expectations and procedures around this by addressing who has the authority to direct and approve the contractors to work, how the contractor's work is monitored and reported, how they are paid and approved, how contracts are modified, which financial audits are necessary, etc.

Contract Procurement Planning: Project managers also have to ensure that procurement activities fit with the project plan. Some of the tasks they have to manage include:

- Setting expected contract price
- Creating the scope of work for each contract
- Standardizing procurement documents and any other necessary documents
- Adding completion dates to contracts that align with the project schedule

Commissioning Plan and List: The commissioning plan and list should be started early in the design phase and continually updated as the project progresses. The commissioning plan is designed to provide direction for the commissioning process during renovation; to resolve issues related to scheduling, roles, and responsibilities; and to aid in the reporting, approvals, and coordination. It is a systematic process to ensure that buildings perform according to the design and to the owner's operational requirements.

Project Control Process: The project control process tracks and manages the scope, cost, and schedule of a construction project. The goals of this process are to establish a baseline, track performance against the baseline, forecast performance at completion and compare to the baseline, and identify changes and monitor the effects to the baseline.

Project Requirement Definition: Also known as the statement of work, this document details the project deliverables. In the project requirement definition (PRD), the project manager explains the scope of work and what the project will accomplish. It helps stakeholders, team members, and external parties all understand the goal of the project and acts as a record of initial expectations.

As-Built Drawings: Also known as record drawings, these are edited drawings submitted by a contractor at the end of a project. They reflect all the changes made in the working drawings during the construction process and show the dimensions, geometry, and location of all elements included in the contract. As-built drawings provide a quick visual into the existing design and capture deviations from the original documents.

Daily Documentation: Keeping diaries, logs, and daily reports of project activities acts as a reference guide after the work is completed and can mitigate any damages. This kind of documentation can show how questions were answered, how problems were solved, and tracks any unusual conditions on a certain day. By keeping these daily logs, you are leaving a paper trail throughout the whole project in case anything goes awry later on.

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And finally, the working drawings are created. These are the project's final specifications and illustrations that builders use for construction and that contractors add to their bid.

Organizing your documents helps you categorize and prioritize important project information, and once you have everything stored in a central location, you can build out your project schedule.

A well-defined schedule provides a structured approach to planning, identifies problems before they arise, forecasts cash flows, and assesses resource requirements.

Here are the fundamental and advanced scheduling techniques:

- **Gantt Charts**: A Gantt chart is the easiest way to create a construction schedule. It lets you visualize your project timeline by transforming task names, dates, durations, and end dates into cascading horizontal bar charts.
- **Critical Path Scheduling**: The most widely used scheduling technique is the critical path method. This method calculates the minimum project completion time and the start and end dates for all project tasks. It identifies the critical tasks that, if delayed, will delay your entire project. The critical path method helps you reduce timelines, manage resources, and compare planned with actual.
- **Line of Balance**: This scheduling technique is best suited for repetitive work and is often employed in road construction. It is a management control process for collecting, measuring, and presenting facts relating to time, all measured against a specific plan. With a Line of Balance schedule, you must allocate resources for each step, so you can make sure the next step is not delayed.
- **Q Scheduling**: This form of construction scheduling addresses the sequence of activities, relationships between tasks, and the total cost of finishing the project. It includes the overall construction site and prevents two competing activities from happening at the same time at the same location. While this technique is the closest to reality, it requires special software and can take more effort from the project manager to evaluate cost analyses for the different schedule alternatives generated.

Construction projects are always changing, and the constant level of uncertainty can often bring conflict to project teams. Construction project managers are often tasked with resolving disputes, identifying and mitigating risks, and understanding legal ramifications.

Conflicts will inevitably arise in any construction project. It's the project manager's job to resolve the disputes, so the team can stay productive and work well together. Possible conflicts in a project could include poor communication, lack of clarity, conflicts of interest, limited resources, or power struggles. While every conflict is different, there are several resolution strategies that you may employ:

- **Mediation**: A third-party mediator will be hired to resolve the disputes between the two parties. This strategy is the cheapest and least time-consuming.
- **Mini-Trial**: A mini-trial is held in an informal setting with an advisor or an attorney who must be paid. The agreement is nonbinding and can be broken. A mini-trial takes more time and more money than mediation.
- **Arbitration**: Arbitration is the most expensive and time-consuming way to resolve a conflict. Each party is represented by an attorney while witnesses and evidence are presented. Then, the arbitrator makes a ruling and his final decision is a binding agreement

By focusing on prevention, project managers can spend less time dealing with spontaneous problems and more time on reducing their impact. A risk management plan is used to manage all project risks, defines the roles of project staff in risk management, and identifies potential risks and categorizes them in terms of probability and impact.

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3.4.2. SMEs intervening during the construction stage

The SMEs involved at this stage are mainly concerned with contract work and implementation of the foreseen and planned work. Nevertheless, design parties are still heavily involved for information and coordination purposes as the contractors are building to drawing specifications. Indeed, architects generally handle construction administration, review submittals, oversee work progress and site walkthroughs, RFIs, change orders, review and request for payment, etc. Material providers are also involved as procurement is an important aspect during this project phase.

SMEs most often involved (main players at this stage are set in **bold**):

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- **Vertically integrated construction companies with capacity in energy modeling of buildings**
- **Construction companies and SMEs/ Contractors**
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.
- Engineers

3.5. Finished renovation

The **final Step** is for ensuring that all Council documentation is completed and you have the necessary Code of Compliance documentation.The Law establishes the responsibilities and guarantees, as well as the limitation periods for actions, which affect the agents who intervene in the renovation process. Without prejudice to their contractual responsibilities, the natural or legal persons involved in the building process shall be liable to the owners for the following material damage caused to the building. As an example, Spanish law enforces the following:

a) For 10 years, for material damage caused to the building by vices or defects that have their origin or affect the structural elements and that directly compromise their stability.

b) For 3 years, material damage caused by faults or defects in the constructive elements or installations that cause non-compliance with habitability conditions.

c) For 1 year, damage caused by faults or defects in execution that affect elements of completion or finishing of the works.

3.5.1. Description of activities

Once all the work on the job site has been completed, the project will soon come to a close. However, there are still a few steps that need to be done before the keys to the building can be handed over and the doors opened for good.

First, an inspection of the whole building needs to be done. Most of the time, these inspections are fairly simple to pass, because other inspections should have been completed during the entire project. It is during those previous inspections that issues should have been found and corrected.

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Once the inspections are completed, the paperwork needs a few last signatures, documentation needs to be finalized, and the final payment to the contractor needs to be made.

3.5.2. SMEs intervening during the finished renovation

The SMEs involved at this stage cover the entirety of the renovation process considering the extent of the final inspection processes. Even TPF parties can be involved for the last round of payments.

SMEs most often involved (main players at this stage are set in **bold**):

- **Specialized architects in EE renovations and refurbishments**
- **Green building design and construction experts**
- **ESCOs**
- **Vertically integrated construction companies with capacity in energy modeling of buildings**
- **Construction companies and SMEs/ Contractors**
- **Engineers**
- **TPF entities**

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4. Positioning of contextualized barriers within the EE renovation value chain

Now that we have a generalized renovation process/value chain established, it is possible for us to start mapping the key market barriers that we have identified in the previous deliverable (D4.1). The possibility of positioning the different barriers we have identified and characterized in D4.1 will bring a clear understanding on the level at which these barriers interfere and leading to a failure in the renovation process and value chain. Moreover, by having a segmentation of where different types of SMEs intervene, understanding the barriers with respect to this 5 phase model will enable a clearer view on the SMEs that are most effected by which set of barriers.

This report will focus on the barriers that were formally characterized in D4.1. As a refresher, the report covering the identification and contextualization of EE renovation barriers followed a precise classification process. Firstly, barriers were segmented into two main categories relevant barriers that affected decision making processes mainly on part of the building owners and then barriers affecting the actual renovation or implementation process. Then, barrier typologies for each category were established along with the identified and analysed barriers composing each typology.-The following figure provides an overview of the classification process.

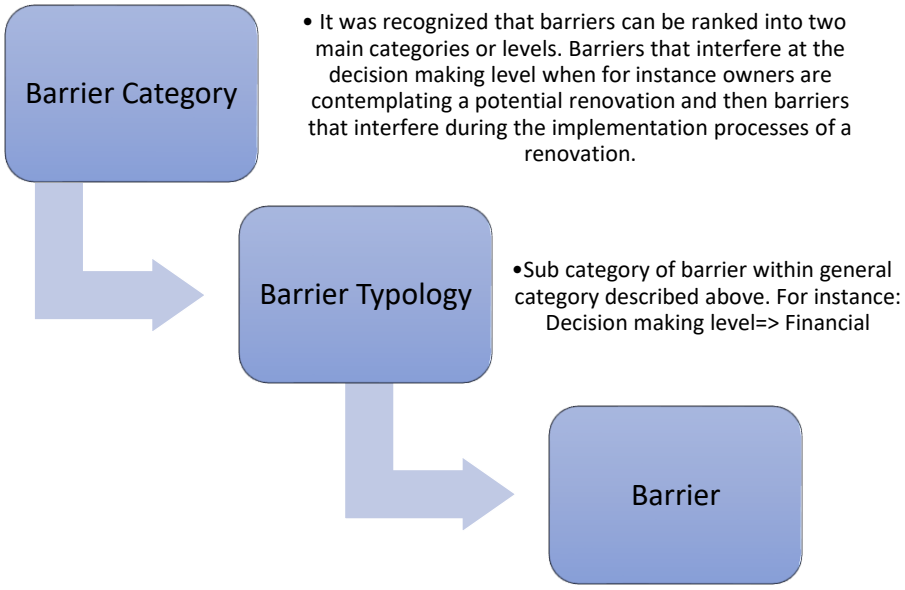

Figure 3 Barrier nomenclature

The analytical process which took place in D4.1 ended by bringing focus and contextualizing the barriers represented in the table below. It was assessed during the course of the STUNNING project mainly through interactions with the advisory board that, for reasons of analytical focus and effective insight, the work in D4.1 and D4.2 should concentrate on a narrowly defined set of barriers. These barriers were chosen in terms of the significance scores obtained during the course of questionnaires and the frequency at which they appeared in observed case studies. Moreover they were also chosen for their relevance in relation to certain objectives established in the project and the call; for instance the inclusion

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of issues around private public partnerships and procurement schemes. Nevertheless, a wide set of other barriers that are ranked within these typologies were included in D4.1.

Barrier Category	Barrier typology	Barrier
Barriers that limit uptake of refurbishment solutions at the decision making level for homeowners, buyers or end-users. (likely to be found in most regions in some form or another)	Technical	Performance Gap and uncertainty
		Lack of technological and product developments
	Embedded market inefficiencies	Split Incentives and conflicts of interest
	Informative	Lack of knowledge dissemination and convincing end users of the benefits of deep renovations
		Difficulties in conveying non-energy benefits of retrofits
	Financial	Limited financing options offered by ESCOS and limited TPF involvement
		Limited impact of Energy Performance Certificate improvements on property value
		Limited financing/ insufficient budgets
Barriers that prevent stakeholders taking part in the renovation process (architects, ESCOS, construction companies...) to implement with ease successful business models.	Organization and structure of the EE renovation market	Difficulties in coordinating communication with other involved stakeholders
		Insufficient resources on part of SMEs to tender for public procurement schemes
	Regulatory	Lack of continuity in regulations
		Limited government subsidies and programs
	Knowledge-informative based	Lack of skills/ Lack of training

Table 1 Contextualized barriers

Many of the barriers included in the same typology will appear in different phases of the value chain. Therefore, in order to provide a clear visual account of where they are positioned, each typology will be given a particular symbol which can then be positioned in different areas. The following symbols will be used for each barrier typology.

Technical

Embedded market inefficiencies

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Informative

Financial

Organization and structure of the EE renovation market

Regulatory

Knowledge-informative based

Figure 4 Legend for barrier typologies

Taking the figure we presented (Figure 2) of the renovation value chain, these symbols will be placed wherever the listed barriers appear providing descriptions of the precise barrier as these symbols relate to typologies only. The result of this process can be seen in Figure 5. One barrier does not appear in the described value chain; that is the “lack of continuity in regulations”. The reason for this is that this barrier is a more generalized or horizontal barrier which affects SME business models throughout the value chain as a whole. It is therefore impossible to pinpoint its location.

The next section will build on this mapping explaining the reasons behind barrier placement, which SMEs are most affected along with other stakeholders and exploring solutions.

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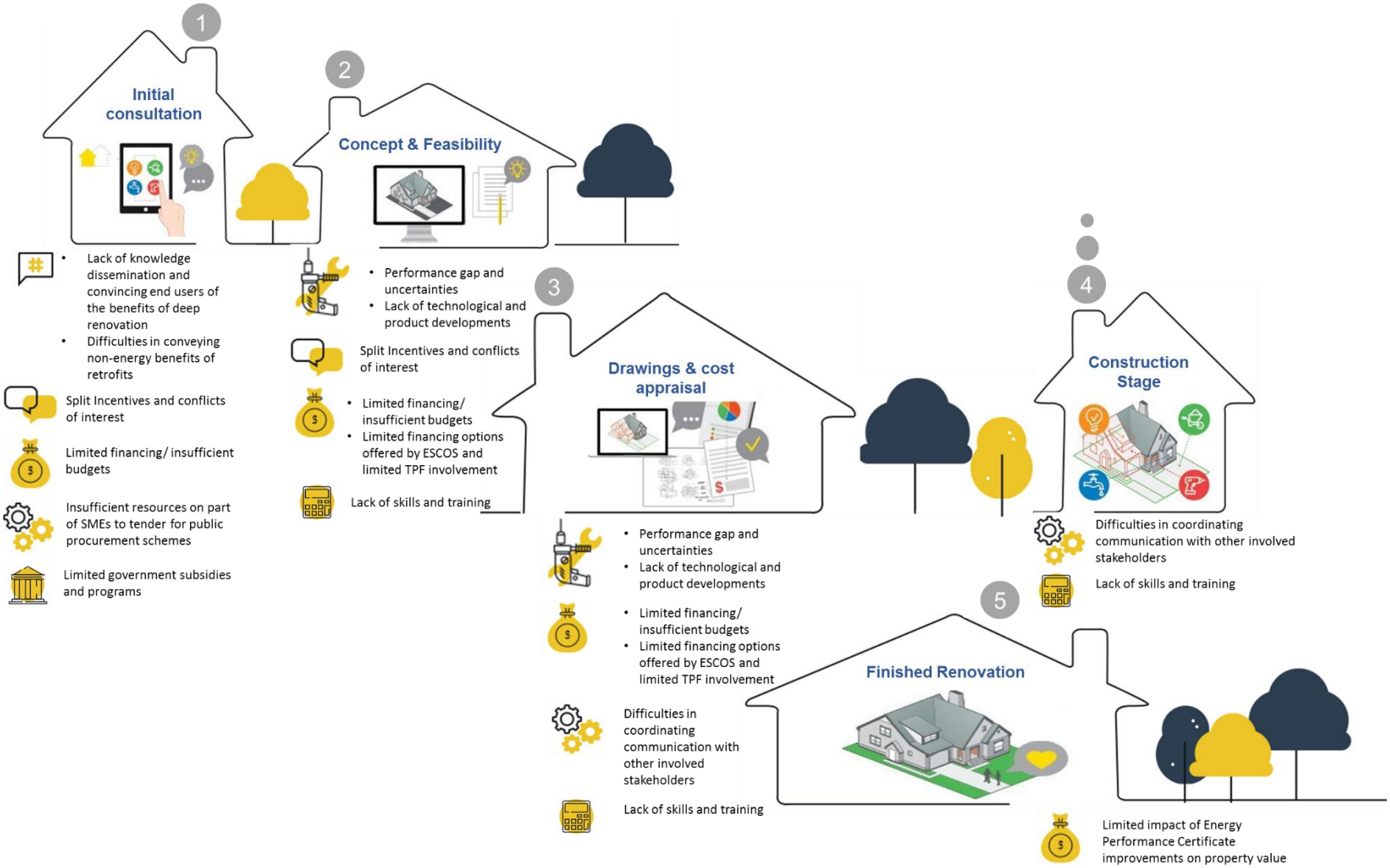

Figure 5 Mapping of Contextualized barriers

5. Contextualized barriers and exploring solutions

This section consists in the final step of the methodology for D4.2 described in Figure 1. The objective is to offer solutions to the mapped barriers in line with the previous characterization and sensitivity assessments and key variables that were established in D4.1.

In order to do this, barriers will be explored individually with an explanation on barrier placement, which SMEs are most affected along with other stakeholders and finally discussing potential solutions and potential MS variations in applying these solutions due to specific societal or regulatory configurations.

We have focused our analysis on bringing solutions to barriers where SMEs are most affected and where solutions are bound to integrate them more within the EE renovation value chain. For this reason, the barriers related to budgetary constraints of building owners and the lack of subsidies were not discussed in this report as they are not directly or operationally affecting the EE renovation SME ecosystem.

Moreover, the last barrier relative to lack of skills and knowledge was used as a starting point to present a section on the creation of national EE renovation clusters as a solution. The creation of SME clusters can potentially be a horizontal solution, targeted towards the alleviation of more than one of the mentioned barriers.

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5.1. Performance gaps and uncertainty – Technical typology

Performance gaps relate to performance gaps that emerge between simulated savings and the savings obtained during the actual operation of the building. It has been claimed that one of the principal factors that hinder fast growth and do not allow for the vast exploitation of the unleashed energy efficiency potential, especially in the building sector, lie in the fundamental technical weaknesses of current ESCO practices and models which can be plagued with uncertainty in actual operational post retrofit savings and deceiving payback periods (which become even bigger in case of non-subsidized projects). This is partly the consequence of the inability of current methods, techniques and tools used by ESCOs to provide accurate estimates and guaranteed savings to their clients, while eliminating risks and removing additional services that are integrated in such project to mitigate uncertainties about the effectiveness and efficiency of EE measures and associated contracts. This is often referred to as the performance gap and can sometimes amount to more than 40% difference in relation to the BEPSM model having extremely negative impacts on payback periods and ROI calculations that were used during project assessment.

5.1.1. Barrier placement and affected SMEs

Barriers related to performance gaps are most common during the “Concept and feasibility” and the “Drawings and cost appraisal” stages of the renovation process. During both of these stages, alternative scenarios for the renovations including the final chosen alternative are modeled and assessed.

One of the important inputs during these processes is the precise cost appraisals based on the models and the estimated savings. As building owners will very often drive their decision partly in terms of the ROI and payback periods that are estimated in the project, having doubts on the veracity or validity of certain projections presents a clear barrier when decisions are being made.

Moreover, contracting with potential TPF most often takes place during both of these phases. Potential energy performance gaps will be even more scrutinized in the case of TPF or EPCs as generally they involve performance guarantees within the contractual frameworks. Large energy performance gaps will put in jeopardy the base lining of energy consumption, potential savings and benchmarks used in drafting contracts or to compare the regular measurement and verification of building performance that would ensue.

The SMEs in question that will most be affected by this barrier are the ones providing the building energy performance simulations based on their envisioned renovation plans as well as potential small structure TPF entities making estimates for contractual drafting on the basis of these projections:

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Small TPF entities

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5.1.2. Solutions and alleviating factors

It was determined that this barrier was most sensitive to the following major factors: nature of the building stock, implementation of new technologies for simulation and modelling and finally the dominance of SMEs in the AEC sector which are generally defined by very low advanced ICT adoption rates.

It was discussed that regions with larger quantities of ageing non-residential buildings may be more affected by this issue since the unpredictability of occupant behaviour, a driving force behind this issue, is much harder to control in tertiary and public buildings with differing motivations of these occupants since they are not covering energy expenses. Moreover, tertiary and public buildings more often than not present architectural singularities which are harder to account for and require solutions that are not backed up by the same depth of data, monitoring and testing.

The two variables related to new simulation technologies, processes and SMEs' digitalization and pick up of ICT technologies can be acted upon.

Performance gaps can be affected upstream through better simulation and modelling as well as downstream with better quality checks during the construction process. Therefore, the development of technologies and processes capable of tackling both of these challenges could alleviate this gap. For this reason investments should be dedicated towards the development of new modelling techniques capable of surpassing traditional models which contain generic assumptions about building use and internal heat gains, and often simplistic methods of calculating system performance along with investments and diffusion efforts in methodologies and sop´s which foster communication and enhanced quality checks during and after the construction process.

New technologies and integrated processes should factor in human behaviour within the modelling of energy performance at the initial upstream level of the design process as well as promote further cooperation and communication during the implementation of the renovation for higher quality inputs. As seen in D4.1 and briefly above, one of the driving factors in savings deviations is too much attention focused on fixed use variables and savings solely unlocked through technical implements. Until now, it has been common practice for the construction value chain to approach energy efficiency or NZEb buildings focusing solely on some aspects of operational energy whilst overlooking user related energy demand and the role of occupants.

It seems as though investing resources in developing such upstream and downstream ICT solutions and processes have already been enacted. Indeed, through Horizon 2020, many projects developing tools and methodologies have been specifically dedicated towards the reduction of the energy performance gap in order to reduce uncertainty levels related to EE renovations and the contractual financing and TPF frameworks that are often associated.

An example of such a project in terms of upstream mitigation is MOEEBIUS. MOEEBIUS introduces a Holistic Energy Performance Optimization Framework that enhances current modelling approaches and delivers innovative simulation tools which deeply grasp and describe real-life building operation complexities through behavioural KPIs in accurate simulation predictions that significantly reduce the "performance gap" and enhance multi-fold, continuous optimization of building energy performance as a means to further mitigate and reduce the identified "performance gap" in real-time or through retrofitting.

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As an example of downstream developments, the Build2Spec project aims to reduce the energy gap for both new builds and retrofits with new and innovative on-site quality assurance tools. In order to achieve this ambitious objective, the B2S project will deliver a new set of break-through self-inspection tools to be used on site even by untrained workers such as:

- 3D and Imagery Tools
- Building Information Modeling (BIM)
- Smart Building Components
- Energy Efficiency Quality Checks
- Indoor Air Quality (IAQ) Tools
- Airtightness Test Tools with air-pulse checks
- Thermal Imaging Tools
- Acoustic Tools

All of the mentioned technologies are connected to a BIM-enabled and Cloud-based Virtual Construction Management Platform (VCMP) supporting the collection and sharing of all project data, from initial design to the delivery by using a Web Portal along with a proper App.

Some implementation steps for such solutions must be respected in order to maximize the effect of such projects. The solutions must be easy to use and easily implemented within current processes even for the untrained worker, guidelines must be publicized and workshops must be organized in order to gain traction with specific focus on SMEs. Moreover, SME participation is key for such projects.

SME market composition is another driving factor behind this barrier. 95% of the architecture, engineering and construction market is composed of SMEs. Nevertheless, it is a known fact that SMEs have more difficulties in implementing these new methodologies mainly due to lack of trained personnel or possibilities of training, lack of resources and time. Therefore, this limits the potential for an immense part of market actors to implement the previously described modelling technologies and construction quality assurance processes ultimately inhibiting the EE renovation market as a whole. It is for this reason that we have insisted on the importance of including SMEs within the development process and also providing low cost training for companies possessing lower levels of resources during the development of new methods and technologies tackling these issues. In fact, the greater challenge for alleviating this barrier at this stage is not found in technical and procedural deficiencies, which have been treated through R&D projects such as the two described previously, but in creating opportunities for a large number of SMEs inside and outside the circle of project participants to effectively learn and implement these methodologies. One potential solution for this is the creation of SME clusters enabling SMEs to enhance these abilities with opportunities for skill sharing and cooperation as well as training programs. This solution will be further discussed in the ending section devoted to this subject.

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5.2. Lack of technological and product developments – Technical typology

Within the framework of this project, the lack of technological and product developments refer specifically to technologies capable of addressing issues related to singular building typologies in the EE renovation market in Europe.

These technological shortcomings can take many forms some of which can relate to the speed of implementation as well as specific building typologies.

It is often claimed that one of the great challenges in terms of new innovations is limiting the obstructiveness of renovations through the implementation of modular solutions such as prefab implements. It is possible that current retrofitting approaches and technologies do not take into account enough the obstructiveness of the renovation process. The market may still be in need of certain modular plug and play systems capable of limiting intervention time and displacement. as well as costs for deep renovations which could potentially reduce payback periods. This can be particularly relevant for advancing renovation rates of lower income areas with occupants having less means to find housing alternatives during deep renovations.

Moreover, lack of technologies and product developments can also potentially be observed for buildings with unusual typologies mostly observed in historical and certain tertiary buildings. This argument tends to be supported by the scoring of the STUNNING survey which indicated a higher significance for stakeholders working on such buildings.

5.2.1. Barrier placement and affected SMEs

This barrier is observed most commonly during the “Concept and feasibility” and the “Drawings and cost appraisal” stages of the renovation process similarly to the other observed technical barrier.

During the initial consultation stage, information is gathered in terms of existing layout and structure of the building such as cladding, roofing, framing wiring, plumbing and so on. Considering the relative uniqueness of these features which may necessitate out of the box solutions in order to perform EE renovations, this barrier may then appear in phases 2 and 3 as mentioned above when actors such as architects, ESCOs or green building specialists are called in to offer a number of different renovation scenarios taking into consideration the mentioned building typologies as well as the other constraints expressed by the building owner namely in terms of budgets and time frames.

The SMEs in question that will most be affected by this barrier are the ones in charge of providing initial design and renovation alternatives involving different materials and technological components. Construction companies implementing the actual planned renovations will be affected if they fnd themselves obliged to work with technologies and products that are new to them and which may involve specific training and know how. Moreover, considering the potential need for specialized or niche materials and products to overcome such barriers, materials and equipment manufacturers and suppliers are also involved and affected:

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts

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- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Construction companies and SMEs
- Engineers
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.

5.2.2. Solutions and alleviating factors

From the information collected in D4.1, it seems as though this barrier may be most pertinent in settings with stringent building codes and preservation orders where unique building typologies require specific refurbishment packages as well as specialized companies.

It seems that from a general point of view and in terms of the feedback we have obtained in D4.1, the lack of adequate renovation alternatives, materials or technologies during unique or singular renovation processes is an issue that resides more in a lack of cooperation opportunities for intervening SMEs with other companies capable of bringing about such solutions.

Another probable effect is simply the fact that many SMEs in the sector do not possess the adequate skills or training in order to safely and effectively work with certain refurbishment solutions. Improving the skills of middle- and senior-level building professionals, as well as the various trade professionals in the area of sustainable energy efficient construction and familiarizing them with the most advanced solutions is therefore of key importance.

In light of these challenges, one of the most straight forward solutions for the mitigation of such barriers across different MSs is the development of national and transnational qualification and cooperation platforms or clusters uniting diverse types of companies all evolving in the field of energy efficiency and the EE renovation value chain. Specific attention is to be given to challenges relating to the use of new materials and products, the integration of renewable energy sources, new systems or processes, such as standardisation and common voluntary certification of buildings, and the use of Building Information Modelling (BIM) tools. Such learning platforms could also bring solutions in terms of cooperation opportunities where material and equipment suppliers of unique innovative solutions could have direct contact with designers and other AEC professionals who could make use of their solutions.

Similar to the previous barrier, clusters and learning and cooperation platforms are subjects that will be explored individually at the end of this barrier as it is a solution applicable to many of the contextualized barriers of this report and is thus best treated as such.

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5.3. Split incentives and conflicts of interest – Embedded market inefficiencies typology

The split incentives barrier is most prevalent in countries where energy performance certificates have not yet been normalized and thus do not provide a compensation towards the property owner in real estate value gains or where there is no incentives or legal requirements for private landlords to provide minimum backstop standards for building performance. As tenants reap most of the benefits that come from a potential renovation, there are no proper incentive systems put in place forcing landlords to renovate their property.

Moreover, there are many inefficiencies in the market as well in terms of general conflicts of interest. Tenants can sometimes be against renovations as they involve disturbances and complications. It can also be troublesome when property owners in multifamily buildings do not see eye to eye on potential renovations with tenants as tenant protection laws often establish strict legal obligations requiring majority approval by tenants.

5.3.1. Barrier placement and affected SMEs

It comes as no surprise that this barrier is mostly present at the beginning of the renovation process during the Initial Consultation and the Concept Feasibility. During these phases, building owners are evaluating the possibilities of performing a renovation or not. The lack of benefits or returns for them will be a decisive factor in terms of whether or not they will pursue the renovation. It is less likely they pursue such renovations if most returns go towards their tenants and are insufficient to justify initial capital expenses.

Furthermore, conflicts of interest can emerge when tenants do not agree with certain renovation alternatives that are proposed during the concept feasibility stage.

It is important that during the initial consultation, the building owner communicates constraints and criteria that reflects the preoccupations and interests of his tenants as well.

The stakeholders that are most likely to be affected by such barriers beyond the building owners themselves are the ones responsible for designing renovation alternatives capable or not of taking into consideration tenant and owner interests.

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Construction companies and SMEs
- Engineers

5.3.2. Solutions and alleviating factors

Considering the nature of the issue in question, it is logical that solutions meant to alleviate this problem should attempt to balance costs and benefits effectively between building owners and tenants.

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The most efficient way to balance these costs at this stage is to allow building owners to use a share of energy cost savings in investment repayments. Traditional forms of leases create asymmetries in the relationship between landlords and tenants and therefore do not set the ground for energy efficiency investments. Balancing costs inevitably means that tenants could be subject to a repayment fee in their utility bills. In order to minimize these payments, enforcement mechanisms for energy performance certificates of buildings should be closely followed and respected in order for property value increases as a result of the energy efficiency upgrade to compensate owners for their initial investment; requiring lesser repayment fees in tenant utility bills. Ultimately, this set up is similar to an EC contract with everyone benefitting from the savings. Italy was one of the first movers in allowing the passing of costs to tenants in order to finance energy renovations. When done appropriately, the tenants will still benefit from the energy savings.

It should also be strictly forbidden for landlords to be able to rent properties of very low energy efficiency levels which could send a clear signal to the market and create incentives at least to the owners of the most energy inefficient buildings. The United Kingdom has use such an approach making it unlawful to lease F rated properties by 2018. A transition period provide tax breaks to these landlords in order to pursue the required renovations.

It was demonstrated in D4.1 that the usefulness and impact on value of energy performance certificates are considered low to inexistent by the real estate market. There is a true problem of lack of enforcement and poor implementation in practice. Moreover, one of the key deficiencies of the current system of certificates is that they focus solely on the operational/building efficiency without any consideration given to user behaviour which is another enormous factor in energy consumption. If we are to balance costs between landlords and tenants, it is important to implement a system of certificates which reflects landlord responsibilities (i.e. the building performance) and tenant responsibilities (i.e. behaviour and consumption). Indeed, contractual set ups will have to perform measurement and verification as well as base lining activities similar to conventional EPC contracts where behaviour is an influential factor. Moreover, this dual certificate system could greatly help SMEs in terms of performance guarantees and risks during the drafting of EPCs when relevant.

Finally, using the example of Germany, one other solution that could be combined with the possibility of sharing costs of energy renovations in the creation of a rent index enforced by local public authorities. By creating an index listing average rental prices per zone/area/city, you indirectly create a form of rent control with the aim to protect tenants against large rent increases as well as eviction. In this way landlords are not able to abruptly increase the price of rent. Nevertheless, if the index is based on the right set of criteria incorporating energy efficiency standards, landlords are able to reflect the cost of renovations within their rent if they achieve a significant improvement. In Germany, they have been paying attention to energy certificates within rent indexes since 2014 officially. It is no surprise that in D4.1 they came out as the country attributing most favourable scores towards the existence of a correlation between certificates and real estate value. Rather than creating incentives, this concept is designed to reduce disincentives by allowing landlords to reflect energy efficiency improvements abusively at the level of the market. The result is protected tenants and minimizing disincentives for building owners.

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5.4. Lack of knowledge dissemination and convincing end users of the benefits of deep renovations and difficulties in conveying non-energy benefits of retrofits – Informative (owners and tenants) typology

We have grouped both informative barriers affecting building owners during the decision making process together as they tend to overlap. Many stakeholders in the EE renovation market still consider informative barriers to some of the most significant. Building owners are still insufficiently informed on the benefits, processes and programs related to EE renovations. Deficiencies in information can be found at all level in terms of the expected savings, financing options and approaches, health/comfort and wellbeing impacts.

5.4.1. Barrier placement and affected SMEs

It comes as no surprise that these barriers are positioned during the Initial Consultation phase of the value chain. In fact, these barriers most likely take effect upstream from this phase before building owners even get to the step of considering a renovation. Considering how upstream these barriers are they impact all SMEs contained within the EE renovation value chain as they inhibit the renovation process as a whole.

5.4.2. Solutions and alleviating factors

It comes as no surprise that the most straight forward and obvious approach towards raising awareness around EE renovations and green buildings are public information campaigns. Indeed, public environmental awareness creation through workshops, seminars, and conferences diffused through competent and proactive EE renovation and green building promotion teams and local authorities can be tools used to raise demand amongst building owners for EE renovations.

One of the important issues for the success of such measures is the design of such initiatives. Of course the main goals are to Increase public awareness of the benefits of green building practices in existing buildings as well as awareness and understanding of green building ratings systems which should increase the importance of energy performance certificates overtime and result in more renovations overtime. Nevertheless, two trends seem to be observed in public awareness efforts so far which are reflected in the comments of the panel of experts that have responded to the STUNNING survey and participated in case studies. The first one is the general imprecision in financial benefits that are given to participants in informational efforts and workshops and the second is the overwhelming emphasis that is given to financial benefits and motives over other drivers during such initiatives.

Currently in most informational pieces available online, for instance documents distributed through the national institutes involved in designing national strategies meant to comply with the EPBD and EED directives, readers are given general information and averaged data on potential savings that can come from the implementation of certain materials and equipment such as new windows. Nevertheless, there are still very few databases with case studies for different building typologies, in a multitude of environments and climates with a breakdown of technologies, equipment and materials as well as their post monitoring performance and other relevant savings and financial KPIs presented in a way that is easily understandable by potential building owners who are not technically inclined or informed with regard to green building technologies. It would be extremely beneficial for the diffusion of awareness on EE renovations to have easily accessible databases at a regional, climatic or environmental level of

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successful EE renovation case studies for different building typologies, encompassing the inventory of materials used, the time of intervention and a cost benefit analysis so that the owners of buildings presenting the same overall characteristics can get a true and more precise representation of the benefits that can be achieved through EE renovations. Moreover, within the same platform, relevant SMEs that are registered and qualified to take on these types of works should be directly referenced with the relevant cases on a regional basis in order to provide an easy starting point for building owners to start the Initial Consultation process while also promoting local economies and the inclusion of SMEs within the EE renovation value chain. Construction21 is an example of an online ecosystem that offers such approaches. However, the focus is mainly on knowledge sharing between professionals and specific sectoral stakeholders. Furthermore, little insight is given in terms of financing approaches or participation of TPFs and other financial entities.

On the other hand, one other trend so far has been too great of an emphasis on financial benefits and KPIs when trying to inform the public on the benefits of EE renovations. In D4.1, it was discussed that that building owners derive utility from other factors and are not always acting like rational utility maximizers solely looking at the profitability of their investment. Such factors can be the increase in comfort, air quality, health benefits, luminescence, acoustics, esthetics and other such variables. In fact, if building owners were exclusively looking at their bottom line, it would be more logical for them to investigate investments outside the realm of EE renovations considering large opportunity costs and the existence of higher alternative investment returns as discussed in D4.1. This highlights even more the importance of promoting EE renovations through lenses that go beyond that of financial returns. This is also supported by the McGraw Hill SmartMarket Report *"Business Case for Energy Efficient Building Retrofit and Renovation"* which investigated drivers influencing decision makers to invest in energy efficiency retrofits: "Larger firms have greater expectations for high returns on their efficiency investments in multiple measures beyond just cost savings. Being able to demonstrate strong results for efficiency gains is particularly important when marketing to this group. This is particularly true with productivity gains. Therefore, emphasizing those gains to this audience may reinforce the business case beyond utility cost savings."

From a business model perspective, the one stop shop solution has the advantage of centralizing the information gathering process for building owners or investor potentially interested in a renovation. This makes it easier to overcome barriers related to information asymmetry. Indeed, the approach offers a solution to the lack of a structured way for homeowners to obtain information for the purpose of decisions on renovation solutions

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5.5. Limited financing options offered by ESCOS and limited TPF involvement – Financial typology

This barrier refers to energy performance contracts and whether or not an energy service company has the ability to offer different forms of contracting by leveraging itself through third parties or through direct financing. Considering the complication of EPCs and the majority of SMEs with limited amounts of resources in the EE renovation market, it is extremely difficult for such players to offer such contracts which involve exposing themselves technically or financially.

5.5.1. Barrier placement and affected SMEs

This barrier tends to appear during phase 2 and 3 of the EE renovation process: Concept and Feasibility and Drawing & Cost appraisal. It is during these phases that initial cost studies for design alternatives with sufficient precision are produced and can be used as a point of reference for discussing contractual and financing options that are available to the building owner. Naturally, the topic of EPCs, if relevant to the type of renovation, set of stakeholders and building typology, will be discussed during these phases.

It comes as no surprise that the main stakeholders affected by this barrier are:

- ESCOs
- Engineers
- TPF entities

Our main concern in alleviating this barrier is of course the integration of small and medium ESCOs and giving them the possibility to participate in the generally larger scale renovations implied by EPCs.

5.5.2. Solutions and alleviating factors

As discussed in D4.1, the fact that some smaller sized ESCOs miss out on the opportunity to partake or offer EPCs is a downfall to the market. The ESCO market is in majority composed of SMEs that may be deprived from the opportunity of offering or assuming shared savings EPCs. The shared savings approach is a good model in developing markets because customers assume no financial risk, thereby making it an efficient vehicle at promoting higher renovation rates. Even if small ESCOs are able to obtain loans, there is an important barrier as they can become too highly leveraged and unable to contract further debt for subsequent projects hindering the market and national renovation rates as a whole. ESCOs financing EPCs through TPFs could impose itself as a solution to the insufficient budgets of stakeholders with the example of social housing operators that have limited possibilities or inclinations for obtaining TPF financing themselves and offer lower scale projects that are of little interest to larger ESCOs with funding capacity. In fact, ESCO/TPF financing approaches are mentioned in the FRESH project (Financing energy REfurbishment for Social Housing) as a viable solution to these issues.

It is clear that these barriers are especially pertinent for smaller or new ESCOs with SME profiles with no previous experience in borrowing, poorly documented credit history and little resources for collateral. Generally speaking, this barrier will also be easier to alleviate in countries having already a number of ongoing EPCs with established standards, processes and contracts through which SMEs and TPF entities can base themselves in order to develop expertise and grow the EE renovations market. A number of efforts have been led in order to create a uniform European wide model contract for EPCs in the form of the Eurocontract Project Development Models.

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The most direct solutions to this barrier is to foster a favorable banking environment to shared savings EPC financing involving certification or associative backbones capable of vouching for the quality and professionalism of SMEs and smaller sized ESCOs in order to minimize credit risk perceptions accompanied with the implementation of standardized EPC processes.

In Germany, ESCOs and energy supply companies are organized in several associations, such as:

- Association of Heat Suppliers (VfW-Verband für Wärmelieferung: https://www.energiecontracting.de/7-mitglieder/nach-status-partner-2.php?ssid=82117501)
- ESCO Forum in ZVEI (Zentral Elektronik-und Elektronikindustrie e.V.: https://www.zvei.org/en/),
- Arbeitsgemeinschaft für sparsame Energie-und Wasserverwendung (ASEW) : https://www.asew.de/asew,
- Energieeffizienzverband für Wärme, Kälte und KWK e.V. (AGFW): https://www.agfw.de/ and
- Bundesverband Kraft-Wärme-Koppling e.V. (B.KWK): https://www.bkwk.de/der-bkwk/aufgaben-ziele/.

Not only are these associations capable of bringing support towards ESCOs, in EPC contract modelling among other aspects, but their members benefit from training programs and exchange workshops and seminars which can then be used as demonstrators towards TPFs for their know how and quality of their work potentially reducing lightly risk perceptions of financiers. It would perhaps be even more beneficial with regard to this if certifications and official qualification seals where distributed through such associations and that these associations established closer ties with the financial and banking sector.

In addition to this and more importantly, it is crucial that national and transnational standards be established for the efficient creation of EPCs as required by the EED. Initiatives like Transparense have tackled such challenges with issuance of the European Code of Coduct for EPC which defines the basic values and principles that are considered fundamental for the successful preparation and implementation of EPC projects. It went through two year stakeholder process to make sure market players, on the TPF and ESCO side, accept their principles. The more EPC processes are standardized the more we will have a financial environment that is equipped with the technical know-how to evaluate the viability of energy-efficiency projects which is still inexistent in many countries.

In certain member states such as France, ESCO contracting is still very much focused on energy supply contracts (ESC) which tend to favor large established utilities and their supply methods rather than SMEs. France is known for its Chauffage Contracts in existence since more than 60 years and on which most modern ESCO contracts have based themselves. These contracts ensure that the ESCO takes charge of the operations and maintenance of the systems and then sells the output from these systems (heating, cooling, and lighting) at an agreed rate (generally an agreed comfort level). The ESCOS are then able to increase their profits by implementing the most efficient systems thus creating the right set of incentives for energy efficiency.

The problem with this is that ESCs, on top of favouring larger established utilities and their ESCO subsidiaries, tend to favor supply side solutions for energy efficiency (efficiency of supplying the energy) rather than demand side solutions (efficient buildings) meaning that less resources are allocated towards EE renovations of buildings. Promoting certain established models such as the foundations of the Eurocontract EPC model in all member states should be further advocated in order to have clearer, already used and implemented processes on which to base future ones. Moreover, the Eurocontract

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model allows for shared savings provisions which as mentioned before is efficient at spurring nascent ESCO and EE renovation markets.

The following figure sums up the Eurocontract EPC provisions:

Payment Processes, Schedules, Terms and Recourse	
Eurocontract	*Remuneration for the ESCO* • Assumes a shared savings agreement between both parties whereby percentage breakdown of the savings is negotiated between the parties. • ESCO is paid a separate percentage savings if performance target is exceeded. *Timing of Payments* • ESCO is paid on a monthly basis a negotiated amount in anticipation of savings achieved. Any additional ESCO claims for payment exceeding the performance guarantee is subject to review and approval by the customer. • ESCO shall also provide collateral equal to 5% of total project cost no later than 30 days after the commencement of the contract. *Surplus/Deficit* • A deficit in savings relative to expected savings shall partially/wholly offset ESCO's fee (fraction of savings). • A surplus is shared between the two parties according to a negotiated percentage breakdown. *Allowable Savings Sources* • ESCO is remunerated for savings calculated upon reductions in either energy consumption and/or power demand, based on contractually agreed upon reference prices: tariff at the end of the baseline year, current tariff, or an assumed tariff escalation schedule. In other words, adjustment calculations are made for changes in energy prices, climate, or building utilization for the settlement period to ensure that only those savings directly attributable to the ESCO's improvement measures enter the performance calculation. *Term of Performance Guarantee* • The start of the performance guarantee shall be determined by mutual agreement of both parties and continue until a negotiated termination date. *Pricing* • Cost transparency is required for equipment to be installed even though fees are based on shared savings model.

Table 2 Eurocontract provisions (Institute for Building Efficiency)

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5.6. Limited impact of Energy Performance Certificate improvements on property value

This barrier is concerned with the effects on property value of the improvement of energy performance certificates that could be brought about by EE refurbishments and renovations.

It is commonly stated that linking energy performance certificate improvements to property value could be an effective mechanism at promoting EE refurbishments across Europe. Real estate investors could be interested in harnessing the power of EE renovations to revalue an asset.

5.6.1. Barrier placement and affected SMEs

Within the EE renovation value chain we have used thus far, this barrier was positioned in the last phase of the process: Finished renovation. Of course, the lack of connection in property value and EE improvements is something that affect building owners and investors during the initial phases of the value chain and even before starting the latter. However, we have positioned this barrier at the end of the process since it is at this stage and beyond that the lack of connection is most observed. This barrier does not affect a precise set of SMEs considering how upstream it is. Nevertheless, it inevitably impacts all SMEs contained within the EE renovation value chain as it inhibits the renovation process as a whole.

5.6.2. Solutions and alleviating factors

It has already been described in the section on embedded market inefficiencies and split incentives that having a clear connection between energy performance certificates and property value could be an efficient way of dividing costs and benefits of EE renovations between tenants and owners.

Part of the EPBD and EED national plan requirements is the implementation of obligatory energy performance certificates for every building which should inevitably create incentives for renovations and strengthen the feedback effects between energy performance and value. Nevertheless, currently the enforcement of energy performance certificates is not uniform throughout member states as is the perception associated to them as demonstrated by the work on these certificates presented in the ZEBRA2020 project and also discussed in the beginning of this report.

The factor that will most affect this barrier is the implementation of true enforcement mechanisms for energy performance certificates of buildings. Currently, such mechanisms are heterogeneous throughout member states explaining certain differences in the perception of their importance, reliability and usefulness as demonstrated in ZEBRA2020.

Beyond enforcement mechanisms, one solution we have already discussed in the section on split incentives is the creation of public regional rent control indexes similar to Germany. By creating an index listing average rental prices per zone/area/city which also factors in building criteria including energy efficiency, landlords and building owners are able to reflect the cost of renovations within their rent if they achieve a significant improvement on par with other rents of buildings with equivalent certificates.

This system is of course most directly applicable to valuation for property investors rather than owner/occupant stakeholders. Nevertheless, enforcing this system should have beneficial correlating effects as well for these types of stakeholders when selling off their property as it becomes a more interesting investment piece for outside investors.

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5.7. Difficulties in coordinating and communicating with other involved stakeholders – organizational and structural typology

Generally, the construction industry is characterized by high fragmentation levels and a lack of communication and mutual understanding among the involved professional disciplines in a project. Energy efficient refurbishments and renovations involve a plethora of different stakeholders intervening. This combined with the current standards in the industry being subcontracting with new teams of designers, builders, and suppliers for every new project means coordination and learning are inhibited and there are no possibilities to develop integrated teams of professionals who are used to working with each other and can have mutual trust in each other's expertise and quality of work.

5.7.1. Barrier placement and affected SMEs

This barrier is most present in the 3rd and 4th stages of our value chain model: Drawings & cost appraisal and Construction stage. This is instinctive as the 3rd stage of the value chain requires higher levels of coordination between involved parties when preparing a more detailed design of the envisioned renovation as well as cost appraisals. In terms of phase 4, it is when this barrier will manifest itself the most as the whole construction process involves a multitude of stakeholders, SMEs and contractors who often have never worked together and must organize their work sequentially.

The most affected SMEs in terms of these coordination and fragmentation issues are the following:

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Construction companies and SMEs/ Contractors
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.
- Engineers

All design and implementation players are affected by this barrier as project management has to organize all of their work and inputs without any potential conflicts. Of course, the most affected will be architects and SMEs in the construction space actually performing designed interventions and among which mutual understanding is vital.

5.7.2. Solutions and alleviating factors

This issue or barrier is equally prevalent in all member states of the European Union as the industry in general throughout Europe is characterized by high levels of fragmentation and sub-contracting practices with little exchange in information and high pressure on margins of each stakeholder pursuing individual interest. Nevertheless, and as discussed within the solutions to be brought forward in order to alleviate many of the technical barriers and issues recognized earlier in the report, this barrier can be mitigated through the implementation of digital ICT and software based integrated design protocols and processes where information is centralized and shared. One of the obvious tools for centralization of information and meant to overcome such barriers is of course BIM. BIM allows for multidisciplinary collaboration in real-time. All parties have access to all the information relating to a project in its current

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phase and are able to communicate with all other parties simultaneously via the building information model. The advantages of this process are centred around improved communication and coordination and include early detection or reduced risk of mistakes or discrepancies resulting in less rework, reduced costs and improved quality. BIM is of course not the only solution. Other software tools with features in project management and centralization of information will have alleviating effects. Nevertheless, BIM is the new standards towards which the industry is turning itself.

Implementing such processes is extremely challenging. As represented by the following graph coming from KPMG´s study Building a Technology Advantage; Global Construction Survey, 64% of construction companies in EMEA (Europe, Middle East, Asia) regions are either behind the curve in terms of technology adoption or simply industry followers.

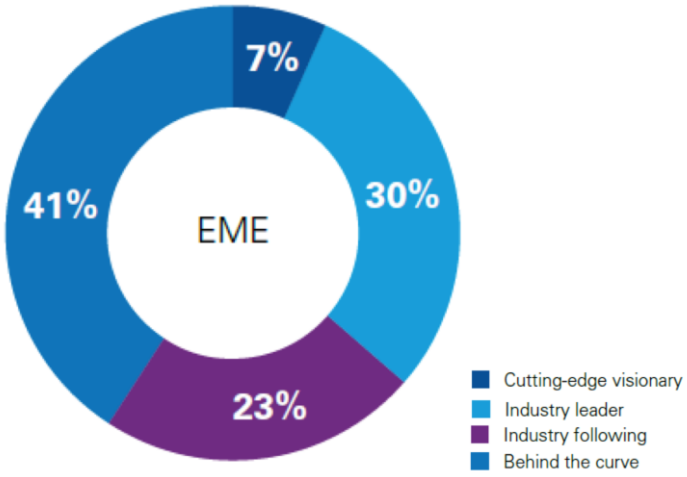

Figure 6 Technology adoption spectrum (KPMG Building a Technology Advantage; Global Construction Survey)

Indeed, the EU construction industry has been criticized for having been extremely sluggish at leveraging the productivity, precision and quality benefits that can come from the integration of such digital tools. This effect is even more pronounced for construction and architecture SMEs since they are generally the ones with the least available resources to train and implement new methodologies of this nature. This is extremely problematic given that they represent 95% of companies in the market.

Similar to the associations listed earlier in terms of the German ESCO market where training is organized for members, an effective way of overcoming such barriers is the creation of associations and clusters that regroup the right combination of stakeholders in order to dispense training, workshops and courses for SMEs who do not necessarily have the time and resources to always perform the research and stay up to date on such matters to update the skills and competencies of their staff at a minimal cost. As this solution was introduced as a horizontal approach capable of alleviating multiple barriers that will be presented at the end of this section, we will refer the reader to that section.

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As a last contribution, it can be said that from a business model perspective, one stop shops are perhaps the most adapted approach at minimizing these types of barriers as they imply already formed teams of stakeholders and SMEs with pre-contractual agreements and experience.

The main objectives of the one stop shop approach is in fact to overcome barriers such as the major fragmentation of the renovation business on the supply side and the lack of a structured way for homeowners to obtain information for the purpose of decisions on renovation solutions.

One of the strategies for attaining this goal is to cluster innovative technologies so as to reduce fragmentation of the renovation process and, specifically, for SMEs to increase their knowledge, skills, capacity and competitiveness with a view to offering holistic, cost-effective renovation solutions.

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5.8. Insufficient resources on part of SMEs to tender for public procurement schemes

This barrier refers to the difficulties encountered by SMEs in competing on public tenders due to their limited resources. Indeed, many SMEs from certain countries have mentioned that currently the configuration of the market means that they are disadvantaged especially faced with larger players in competing on public procurement and partnership schemes or EPCs for the renovation of public buildings.

5.8.1. Barrier placement and affected SMEs

The placement of this barrier comes at the very beginning of the building renovation life cycle if the model used was to be applied to public buildings. Public Procurement in the EU is generally structured in a way that when central governments require supplies or services above a threshold of €130,000, or works to be carried out above a cap of €5m, the tender must be published in the Official Journal of the EU (OJEU) and follow all applicable requirements of the directives. The European Directive 2014/24/EU provides 4 procedures: open, restricted, negotiated and competitive dialogue procedures for procurement of goods, works, or services.
Therefore, this would logically be positioned upstream of step 1: Concept and Feasibility. Indeed, step 1 would logically initiate once the intervening stakeholders have won the tender.

All SMEs within the value chain are affected since they are all susceptible of offering a service or supplies which could qualify under a public tender for a large scale building renovation:

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Construction companies and SMEs
- Engineers
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.

5.8.2. Solutions and alleviating factors

Barriers to SME participation in public procurement schemes have been overviewed in D4.1 and are generally two fold.

- The first difficulty identified is the large size of contracts which require a large amount of resources. Indeed, SMEs which only have the resources to only provide one part of the tender also face excessively high fixed costs which are easier to face for larger companies.

- The lack of resources on part of SMEs is also not solely a question of technical ability or finances. Indeed, it is hard for these actors to access the relevant information because they do not have enough resources to allocate to information collection or administrative capacity to prepare a quality tender response.

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One of the commonly cited solutions to the first challenge is the sub-division of contracts into lots. Procurers could take advantage of the possibility for SMEs to form groups and rely on their combined economic and technical ability. This could also foster cooperation between larger players and SMEs helping the latter develop. Procurers are claimed to often ask for disproportionate qualification levels and financial and certification requirements. To help SMEs to participate to public procurement they should keep selection criteria proportionate and take advantage of the possibility for SMEs or a group of SMEs to prove their combined economic and financial standing and technical ability. In addition to this, they should require only proportionate financial guarantees.

This approach is of course implemented in certain countries. In Germany, the Regulation on Contract Awards for Public Supplies and Services (Vergabeverordnung) is applicable for awarding of contracts for energy services (particularly for EPC). Their procurement rules establish that the lowest tender price alone is not the sole decisive criterion". Special account shall be taken to consider the interests of small and medium-sized enterprises when awarding public contracts. Contracts shall be subdivided into partial lots and by type or trade (technical lots). Several partial or technical lots may be awarded together if required on economic or technical grounds.

Nevertheless, as the division of public tenders into sub lots is not common practice on all contract types, especially for EPCs, it seems as though promoting this system would be efficient at alleviating the barriers in question. France is an example of a country where public EPC tenders are not automatically divided into lots favouring SME integration. Indeed, the Grenelle 2 law of 2010 has given the possibility for central and local administrations to now have access to "EPC type" global contractual agreements (Marche Public de Performance Energétique – MPPE) bypassing the obligation of allotment.

For the second barrier or issue related to knowledge in guidelines and processes of public tenders, e-procurement websites could be improved to offer more information, contracting authorities should work on information centers, and on feedback to tenderers which can help SMEs. SMEs find it difficult to understand the information provided. This could be improved by developing more training and guidance for contracting authorities, and training and guidance for SMEs on drawing up tenders.

The multiple associations regrouping almost all the ESCOs in Germany as described before could be used as a model system for integrating both of these solutions with relevant EE stakeholders and actors that provide cooperation opportunities on public EPCs and public tenders of all sorts as well as information and guidelines on how to proceed and respond to these tenders. In Germany, the same public and professional associations listed in the section Limited financing options offered by ESCOS and limited TPF involvement – Financial typology have developed guidelines, manuals and standard procedures for public procurement of energy services in order to standardize and simplify public procurement of energy services, several public institutions and professional associations have developed guidelines, manuals and standard procedures for public procurement of energy services.

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5.9. Lack of continuity in regulations

During the information gathering process through surveys and case studies, a common barrier was mentioned by multiple stakeholder types intervening in the renovation process in terms of regulation. Many players and companies seem to be affected by the evolving and changing nature of the regulations that affect the EE renovations sector. Indeed, a constantly changing environment implies the necessity to adapt business models and standard operating procedures which can be taxing, especially on small companies with less resources.

5.9.1. Barrier placement and affected SMEs

This barrier does not intervene at any specific time during the renovation process or value chain but is rather a horizontal barrier affecting the market as a whole especially in terms of the solutions that will be offered.

Therefore, all SMEs within the value chain are affected since they are all susceptible of offering a service or supplies which could be affected by a certain set of regulations affecting building codes, certain sets of products and systems, etc.:

- Specialized architects in EE renovations and refurbishments
- Green building design and construction experts
- ESCOs
- Vertically integrated construction companies with capacity in energy modeling of buildings
- Construction companies and SMEs
- Engineers
- Materials and equipment manufacturers and suppliers: Producers and providers of singular EE renovations materials, systems and technical implements.

5.9.2. Solutions and alleviating factors

An important number of stakeholders and case studies have highlighted the lack of continuity in government support programs and regulations in general. This has forced stakeholders and economic actors from the EE renovation sector to continually adapt their business models as well as technical know-how. A resource intensive process which makes it hard for SMEs with fewer resources to continually adapt themselves to the regulatory landscape compared to larger companies in the sector.

Such changes are most penalizing in instances where certain types of implements, systems or products become unviable options for EE renovations. This tends to happen with integrated RES generation systems for passive house during the last couple of years. For instance, in Spain in 2016 the government implemented a new deficit reduction measure called the ‘sun tax’ that increases the price of self-generated solar power, largely based around photovoltaic technology. According to Spain’s Photovoltaic Union (UNEF), the new law requires self-consumption photovoltaic system owners to pay the same grid fees that all electricity consumers in Spain pay, plus the so-called ‘sun tax‘. This made planned PV installations significantly less attractive. On the other hand, in Denmark in 2016, it was announced that the financial incentive for open-door wind turbines will end in 2018. Only the wind turbines connected to the national grid by 21 February 2018 are entitled to receive the incentive.

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As such regulations tend to nullify the business case for certain renovation projects or at least part of the involved renovation packages especially in the passive house and nZEB sectors where RES integration is a key component, many specialized SMEs find themselves in extremely complex situations requiring extensive resources for adaptation and survival. Indeed, specializing in such sectors (and the EE renovation sector in general) generally requires investment in highly specialized productive assets and systems which makes it hard for these actors to reinvent themselves or their modus operandi.

It is important to maintain continuous communication bridges between public authorities and EE renovation SMEs and ESCOs in order to foresee certain regulatory changes and how they could be mitigated for the affected actors in certain cases. Considering the specificity of the assets and specializations of many of these SMEs, abrupt changes in regulation can render their line of business obsolete or misaligned. This once again could be set through public and private associations. Through such structures or organizations, assistance could be provided in the form of training and cooperation opportunities for concerned SMEs to be able to react and transform accordingly to regulatory changes that put in peril the services and products they offer.

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5.10. Lack of skills and training – Knowledge/informative based typology

The last barrier in question is one that will be used for introducing a more global solution which has the potential of horizontally alleviating multiple barriers listed prior to this one. A recurring theme and driver in many of the previously described barriers is the lack of training opportunities and knowledge sharing whether it be in terms of technical abilities, education on contractual arrangements, the integration of integrated design processes and digital technologies, or even regulatory evolutions and transformations. Despite the fact that within this specific setting this barrier typology is specifically intended to describe skills deficiencies that affect mainly the technical parts of renovations projects (steps 2, 3 and 4 in the model life cycle), it presents the perfect opportunity to present multi stakeholder, multidisciplinary, cooperative based solutions which are able to tackle more than one barrier.

Fostering the creation of additional national or even transnational clusters of SMEs or associations with structures that truly favor multilateral interaction between all relevant stakeholders in the EE renovation value chain could present itself as a viable driver towards increased EE renovation rates. Currently, associations and clusters do exist but are generally more compartmentalized by discipline rather than being comprehensive and including all elements and actors of the EE renovation value chain. It has been demonstrated that generally speaking, barriers are not one dimensional and can be resolved through enhanced cross-sectoral and cross disciplinary collaboration favoring synergies, learning opportunities and long term cooperation in the EE renovation and AEC sector. For instance, as discussed in the relevant section on this barrier, coordination issues in the construction and EE renovation sectors can be solved through enhanced cooperation between AEC stakeholders and players from the digital and ICT sector capable of providing teaching and workshops. Moreover, opportunities for synergies could also emerge between these players offering new innovations and technologies, tackling for instance some of the technical barriers investigated. Multi-stakeholder organizations of this nature can also bring about cooperation opportunities where SMEs can identify potential partners to team up with on projects and tenders enhancing mutual learning opportunities, fostering the participation of SMEs in larger projects through the creation of groups of SMEs that can rely on their combined economic and technical ability or even cooperation between larger players and SMEs helping the latter develop. Including public authorities in some form is also an important element in order to create support mechanisms and guidelines for tendering and EPC processes helping overcome the resource barrier certain SMEs have while also creating forums for direct consultation on policies and regulation which may affect them. Finally, this could be an ideal point of entry for building owners and investors to obtain detailed information on renovation cases and potential benefits as well as precise costs in line with their building type.

The aim of such clusters would be to promote the competitiveness of associate, enhancing collaborations among SMEs and other agents to pool financial and technical resources and provide integrated and innovative solutions in the energy efficiency renovation market, joining SME product and service expertise from the dispersed EE renovation value chain and providing solutions in service and product packages.

Clusters should aim for the:

- Development of competitive new packages or integrated solutions
- Identification of complementarities among companies and encouragement of collaborative projects
- Promotion of knowledge exchange for the implementation of innovation and new development and business and professional exchange

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- Enhancement of access to public assistance and potential investments in R&D
- Promotion of the participation of associates in the energy efficiency renovation market through information on tenders, commercial contracts, EPCs etc.
- Dissemination and promotion of capabilities, products or services offered by associates towards other industry professionals as well as building owners and users (training courses, participation in trade fairs, conventions, promotional campaigns, etc.)

The objectives are to tackle the following barriers through the means of enhanced networking, innovation projects, training and workshops, consultations and the above stated aims:

- Technical barriers and fragmentation and coordination issues

Performance gap issues and lack of adequate technological solutions for building singularities could be alleviated by fostering cooperation and interaction as well as training and learning opportunities between a plethora of stakeholders from the EE renovation sector. Innovative materials and equipment manufacturers could present their products and solutions, experts in building performance simulation modeling and BIM can assist construction SMEs and architects in the first phases of the building renovation value chain and many more. Moreover, comprehensive teams of SMEs with complementary capacities can team up. As stated in the report, innovation and knowledge sharing is also an efficient way to tackle fragmentation and coordination issues within the construction sector through integrated design and improved communication.

- Informative (building owners and tenants)

SMEs and companies in general from the EE renovation sector should be able to showcase their renovations and products towards building owners. KPIs presented must be user friendly with clear cost benefits. If local authorities are effectively integrated within the ecosystem, efficient communication towards building owners on subsidies and regulatory support can be performed.

- Financial – EPCs and public procurement

With the integration of local authorities and cities as well as public authorities in general, support for EPC guidelines and contracting rules as well as tendering guidelines could be implemented. Moreover, as stated above, if local authorities are effectively integrated within the ecosystem, efficient communication towards building owners on subsidies and regulatory support can be performed tackling barriers related to insufficient budget and regulatory support. Combined with the participation of TPF and banking stakeholders, financing tools could be devised informing potential end users on the possibilities at hand.

- Lack of continuity in regulations

With the integration of local authorities and cities as well as public authorities in general, continuous feedback processes and a point of liaison can be established in order to foresee the impacts of regulatory change and collaboratively research and develop support actions for continuous adaptation of more vulnerable industry stakeholders and SMEs.

Of course, from a business model perspective, the creation of such clusters are in line with the one stop shop approach. Such models can be attractive to clients because they reduce the problems that can arise with dealing with multiple parties by providing a turn-key product. Additionally, established models or packages are characterized by stakeholders having experience of working together between disciplines, increasing the likelihood of efficiency and reducing the risk of errors.

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6. Conclusion

This report has focused on mapping the EE renovation value chain, positioning the relevant SME stakeholders and barriers within this value chain and then offering observations on how the barriers, previously recognized in D4.1, affecting the EE renovation sector can be overcome.

To conclude this report, it is possible to segment the drivers and solutions described in this report in two different categories, one that is more concerned with the SMEs/stakeholders themselves and how they operate and a second which is more concerned with external configurations of the market.

In terms of SMEs and stakeholders, a common theme found across many of the barriers that affect the EE renovation market is the lack of training opportunities and knowledge sharing whether it be in terms of technical abilities, education on contractual arrangements, the integration of integrated design processes and digital technologies, or even regulatory evolutions and transformations. The bulk of observations described above tend to favor collaborative models and solutions which most resemble one stop shop business models whereby coordination between multidisciplinary parties and entities is smoothened reducing fragmentation problems whilst also creating more cohesive teams with opportunities for skills and knowledge sharing and long-term collaborations.

Nevertheless, many of the barriers in the market are also due to external societal configurations and evolutions. The most obvious example of this is the lack of continuity in certain regulatory measures affecting EE renovation markets in different member states, forcing SMEs with limited resources to change their business models and focus repeatedly as well as certain unfavorable rules in public procurement schemes and tenant – owner relationships and tenancy protection laws amongst others. The most viable solutions seem to be the establishment of consultation avenues between public and private players in the EE renovation sector and potentially certain regulatory provisions such ensuring the division of contracts or EPCs into lots when possible and the creation of rent indexes. What is noteworthy is that once again these possible solutions tend to favor collaborative models for the structuring of the EE renovation market as consultation and regulatory discussion is easier done through groups of stakeholders while allotment is conducive towards consolidated packaged services and products from diverse SMEs pooling technical and financial resources together.

It therefore comes as no surprise that one of the main drivers for the alleviation of many of the identified barriers is the creation of additional national or even transnational clusters of SMEs or associations with structures that truly favor multilateral interaction between all relevant stakeholders in the EE renovation value chain including public authorities and financial entities enabling:

- Development of new packages or solutions through cross sectoral synergies
- Identification of complementarities among companies and encouragement of collaborative projects
- Promotion of knowledge exchange for the implementation of innovation and new development and business and professional exchange
- Enhancement of access to public assistance and potential investments in R&D
- Promotion of the participation through support of public authorities of associates in the energy efficiency renovation market through information on tenders, commercial contracts, EPCs etc.

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- Dissemination and promotion of capabilities, products or services offered by associates towards other industry professionals as well as building owners and users (training courses, participation in trade fairs, conventions, promotional campaigns, etc.)

In terms of actual EE renovation business models, these insights and solutions tend to align most with one stop shop approaches which would logically result from the creation of SME clusters of this sort through modular packaged solutions and multi-disciplinary participation.

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