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PLUG-AND-USE RENOVATION WITH ADAPTABLE LIGHTWEIGHT SYSTEMS



D8.7 Market Assessment

Version: 1.0

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Terms, definitions, and abbreviated terms

GA	Grant agreement
IPR	Intellectual property rights
PEST analysis	Political, Economic, Social, Technological analysis
SWOT analysis	Analysis of Strengths, Weaknesses, Opportunities, and Threats
ER	Exploitable results
WP	Work package
T.	Task
D.	Deliverable

1 Summary

1.1 Publishable summary

This Preliminary market assessment for the PLURAL project aims to evaluate the renovation and prefabricated markets in Europe to ensure that the technical solutions developed by the project will be accepted by end-users and enable successful market uptake. Besides, the assessment intends to define the target countries for the market uptake and provide a reliable evaluation of the market size, so the size of the business opportunity is determined. The assessment includes information on basic marketing theoretical terms and frameworks, the current situation in the renovation and prefabricated markets in Europe and EU strategy, including the latest Renovation Wave for Europe issued in October 2020. Then, the document studies the PLURAL project, including its definition, objectives, products, demo sites and competitive advantages. The most significant part of the assessment is devoted to the market and business model analysis. The section provides information on market identification, market barriers, preliminary details of the ‘Go-to-Market’ strategy and business model in the form of CANVAS. The last part lists similar projects that could become PLURAL’s competitors for the market uptake. The authors also carried out PEST and SWOT analysis of the deep renovation industry, highlighted strengths, and weaknesses of prefabrication.

1.2 Executive summary

This Preliminary market assessment for the PLURAL project aims to evaluate the renovation and prefabricated markets in Europe to ensure that the technical solutions developed by the project will be accepted by end-users and enable successful market uptake. Besides, the assessment intends to define the target countries for the market uptake and provide a reliable evaluation of the market size, so the size of the business opportunity is determined. The assessment includes information on basic marketing theoretical terms and frameworks, the current situation in the renovation and prefabricated markets in Europe and EU strategy, including the latest Renovation Wave for Europe issued in October 2020. Then, the document studies the PLURAL project, including its definition, objectives, products, demo sites and competitive advantages. The most significant part of the assessment is devoted to the market and business model analysis. The section provides information on market identification, market barriers, preliminary details of the ‘Go-to-Market’ strategy and business model in the form of CANVAS. The last part lists similar projects that could become PLURAL’s competitors for the market uptake. The authors also carried out PEST and SWOT analysis of the deep renovation industry, highlighted strengths, and weaknesses of prefabrication. The document provides details on interconnection with other project work packages, tasks and deliverables defined in the Grant agreement 958218.

2 Introduction

The preliminary market assessment reported in **D8.7** aims to evaluate the renovation market primarily of residential and then non-residential buildings and prefabricated smart retrofitting systems in Europe to ensure that the technical solutions developed by the project will be accepted by end-users and enable successful market uptake. Besides, the assessment intends to finalise the target countries for the market uptake and provide a reliable evaluation of the market size, so the size of the business opportunity is determined. The market assessment will be regularly updated throughout the project. The document will be used as a basis for creating deliverables **D8.8 “Initial Exploitation Plan and IPR manual” in M18, D8.9 “Final Exploitation Plan and IPR strategy” in M48.**

The market assessment provides an explanation of basic marketing theoretical terms and frameworks. It then discusses the current situation in the renovation and prefabricated markets in Europe and EU strategy regarding them. There is provided PEST and SWOT analysis on the renovation industry; features of the offsite construction industry are described. The deliverable provides detailed information on the PLURAL project, including the project definition, its objectives, products, demo sites and competitive advantages. The most significant part of the assessment is devoted to the market and business model analysis. The last part lists similar projects that could become PLURAL’s competitors for the market uptake.

3 Theoretical understanding

3.1 Market assessment

Market assessment is a detailed evaluation of the new product's potential; it is a comprehensive analysis that comprises industry, market, customer, and competitive analysis. Due to the fact this market assessment will subsequently serve as basis for other Deliverables such as Exploitation Plan or Business models and plans, it is essential to comprehend market assessment definition, its purpose and significance. As the upcoming deliverables will be dealing with business plan and strategy, a market assessment must be done prior as a crucial factor.

The following sub-sections provide definitions of common terms from the theoretical point of view.

3.2 Industry analysis

Industry analysis facilitates a company's understanding of its position relative to other companies that produce similar products or services. Understanding the operational forces in the overall industry is an important component of effective strategic planning. Industry analysis enables small business owners to identify the threats and opportunities facing their businesses, and to focus their resources on developing unique capabilities that could lead to a competitive advantage. An industry analysis consists of three major elements: the underlying forces at work in the industry; the overall attractiveness of the industry; and the critical factors that determine a company's success within the industry. Industry forces could be evaluated by Porter's analysis.

3.3 Market analysis

Market analysis closely examines the performance, dynamism, and attractiveness of the market with a view to suggesting future trends. Market analysis presents information regarding the market in which a company or a product is operating in and thus serves as a core instrument for creating a business plan for a company or a product. The market analysis includes clear definition of the market, potential customers, determines its size, speed of the growth and sustainability of the new product's competitive advantages. Finally, with the help of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and PESTEL analysis (Political, Economic, Social, Technological, Environmental, Legal), adequate business strategy is defined.

3.3.1 Competitive advantage/Value proposition

Competitive advantages are conditions that makes the entity better than the competition in its customers' minds. The term was first applied to businesses, but it works for anyone, from employees to countries. Competitive advantages are attributed to a variety of factors, including cost structure, brand, quality of product offerings, distribution network, intellectual property, and customer support. Whether it is a good or service, it must be clear what benefit the product or service provides. It must be something that the customers truly need and that offers real value. It is essential to know not only the product's features, but also how its advantages benefit the customers. That means being constantly aware of new trends that affect the product, especially new

technologies. It is crucial to identify exactly who is the end-user, and how the product or service will benefit his or her life. To be successful, it is critical to be able to articulate the benefit provided to the target market and in addition, the benefits must be better than the ones of the competition. Such benefits are then called “competitive advantage”. That message needs to be reinforced in every communication to the customers, including advertising, public relations, and sales aids.

3.3.2 SWOT analysis

SWOT analysis is a useful technique for understanding the strengths and weaknesses of the organization, project, or business venture, and for identifying both the opportunities and the threats to face. A SWOT analysis can be carried out for a company, product, place, industry, or person. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective. What makes SWOT particularly powerful is the fact that, with a little thought, it can help uncover opportunities that are well-placed to exploit. Moreover, by understanding the weaknesses of the business, the threats can be managed and eliminated in advance. In addition, by looking at the competitors using the SWOT framework, one can draft a strategy that helps to distinguish a company/product from the competitors, so that they can compete successfully in the market.

TABLE 1 SCHEME OF SWOT ANALYSIS

	Opportunities (external, positive)	Threats (external, negative)
Strengths (internal, positive)	Strength-Opportunity strategies Which of the company's strengths can be used to maximize the opportunities you identified?	Strength-Threats strategies How can you use the company's strengths to minimize the threats you identified?
Weaknesses (internal, negative)	Weakness-Opportunity strategies What action(s) can you take to minimize the company's weaknesses using the opportunities you identified?	Weakness-Threats strategies How can you minimize the company's weaknesses to avoid the threats you identified?

3.3.3 PEST analysis

A PEST analysis is a framework used to analyse and monitor the macro-environmental factors that may have a profound impact on an organisation’s performance. PEST is an acronym that stand for Political, Economic, Social and Technological factors.

3.4 Customer analysis

Customer analysis is a critical tool that helps to identify the target customer, understand needs of the target customer, and demonstrate how the new product meet the customer's needs.

3.5 Competitive analysis

Competitive analysis identifies competitors and evaluates their strategies to determine strengths and weaknesses.

4 Renovation market in Europe

4.1 Definition

Article 2 of the Energy Performance of Buildings Directive 2010/31/EU¹ defines major or deep renovation as renovation where the total cost relating to the envelope or its systems is higher than 25% of the value of the building, or more than 25% of the surface of the building envelope undergoes renovation. However, **Article 2 leaves each Member State to interpret and define differently major renovations.** According to the Global Buildings Performance Network², a general understanding of the term “ deep renovation” is that it is connected to heating, cooling, ventilation, and hot water and leads to a reduction of a significant amount of energy (approximately 75%) compared with the pre-renovation levels².

4.2 Current challenges for the European Building - Renovation market

Europe’s existing building stock is much older, on average, than that of Australia and even the USA. Despite construction traditions that date back many centuries, most of the existing buildings are affected by severe underperformance from an energy and comfort point of view.³

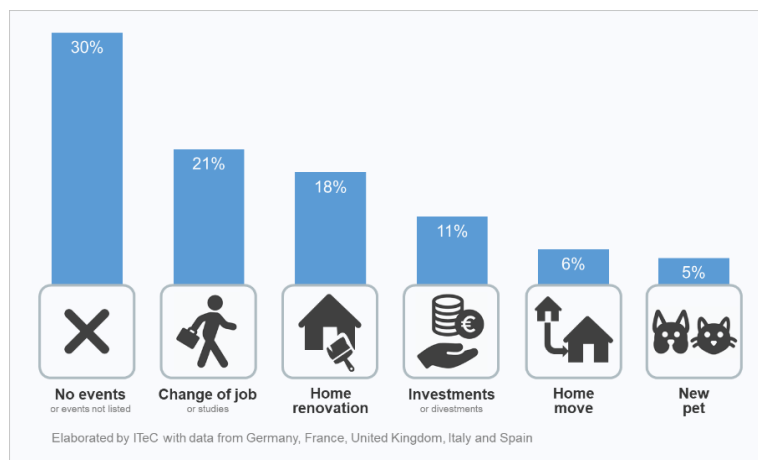
Therefore, The European Commission has proposed in the **Climate Target Plan 2030** to cut net greenhouse gas emissions in the EU by at least **55% by 2030** compared to 1990 (shown in Figure 2 and 3). Energy efficiency is an essential component for action, with the building sector as one of the areas where efforts must be ramped up. To achieve the 55% emission reduction target, by 2030 the EU should reduce buildings’ greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18%. It is therefore urgent for the EU to focus on how to make buildings more energy-efficient, less carbon-intensive over their full life cycle and more sustainable.¹ The COVID-19 crisis has also brought into sharper focus buildings and their importance for peoples’ lives. Throughout the pandemic, the home has been the focal point of daily life for millions of Europeans. A recent survey has proven that home renovation has been the second most frequent “life event” in the big-5 European countries such as France, Germany, Italy, Spain, and the UK, during the most critical months of the pandemic.

¹ https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

² <https://www.gbpn.org/more-and-deeper-renovation/definition-dr>

³ http://www.eurac.eu/it/research/technologies/renewableenergy/Documents/p_5700_Andaloro_Annalisa_Facade_rev1.pdf

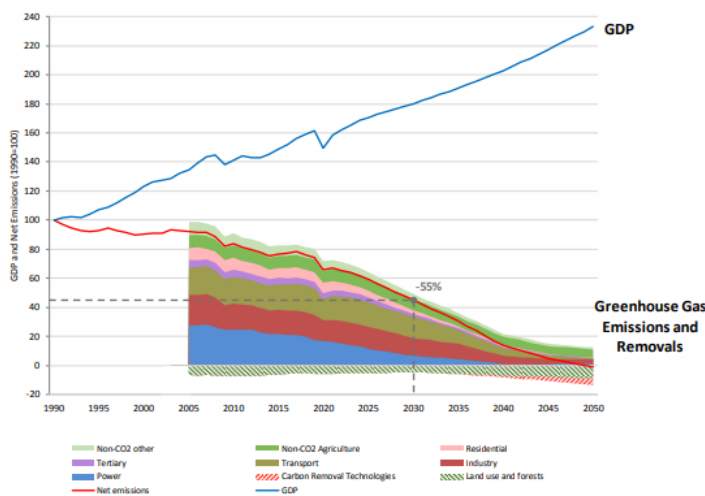
FIGURE 1 MAIN LIFE EVENTS BETWEEN MARCH 2020 AND MARCH 2021 TRIGGERED BY COVID



Source : <https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/survey-european-consumer-sentiment-during-the-coronavirus-crisis>

Obviously, most of the renovation reported in this survey cannot qualify as deep renovation, but nevertheless it points towards a positive trend: European families are now more aware of the performance of their homes and are more open to invest in improving it. As Europe seeks to overcome the COVID-19 crisis, renovation offers a unique opportunity to rethink, redesign and modernise buildings to make them fit for a greener, healthier, and digital society and sustain economic recovery.⁴

FIGURE 2 THE EU’S PATHWAY TO SUSTAINED ECONOMIC PROSPERITY AND CLIMATE NEUTRALITY, 1990-2050



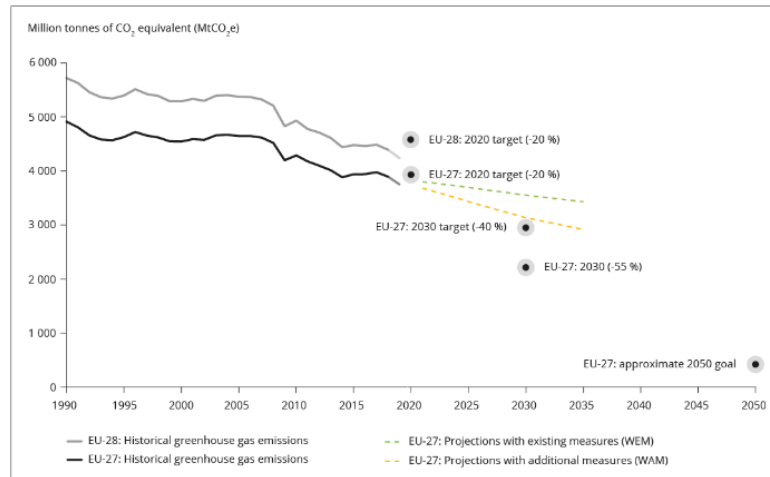
Source : <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0562&from=EN>

⁴ https://ec.europa.eu/energy/sites/ener/files/eu_renovation_wave_strategy.pdf



Figure 3 proves that so far; the EU has been succeeding in achieving set targets and decreasing greenhouse emissions.

FIGURE 3 GREENHOUSE GAS EMISSION TARGETS AND TRENDS IN THE EU



Source : <https://www.eea.europa.eu/data-and-maps/figures/greenhouse-gas-emission-targets-trends-1>

Currently, in the European Union, buildings are responsible for about **40%** of the total energy consumption, and for **36%** of its greenhouse gas emissions from energy. **Error! Bookmark not defined.** All buildings built before **1990** or **75%** of the building stock are inefficient (shown in Figures 4 and 5). **75%-90%** of the current buildings will stand in **2050**, while the construction rate is overall low.⁵

The fact that the European building stock is relatively old, with **40%** of the buildings being constructed before **1960** and **90%** before **1990**⁶, has a significant impact to the increased energy consumption. Amongst the different EU Member States, the energy demand differs considerably in relation to climatic conditions, the proportion for space heating or air cooling, as well as the characteristics of the buildings.⁷ Nordic countries with a colder climate demonstrate in general a higher energy demand.

Today, only **11%** of the EU existing building stock undergoes some level of renovation each year. However, very rarely, renovation works address energy performance of buildings. The weighted annual energy renovation rate is low at some **1%**. Across the EU, deep renovations that reduce energy consumption by at least **60%** are carried out only in **0.2%** of the building stock per year and in some regions, energy renovation rates are virtually absent. At this pace, cutting carbon emissions from the building sector to net-zero would require centuries.¹ If it were to increase to **3%**, energy demand in the current building stock could be reduced by **80%** by

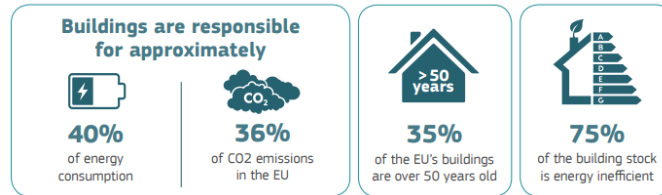
⁵ https://www.bpie.eu/wp-content/uploads/2017/12/State-of-the-building-stock-briefing_Dic6.pdf

⁶ Directorate -General for Internal Policies: Boosting building renovation: What potential and Value for Europe?

⁷ <https://www.odyssee-mure.eu/publications/policy-brief/buildings-energy-efficiency-trends.html>

2050 compared to 2005 levels. The potential revenues for the total construction sector are estimated to amount to around €1200-1400 billion/year⁸.

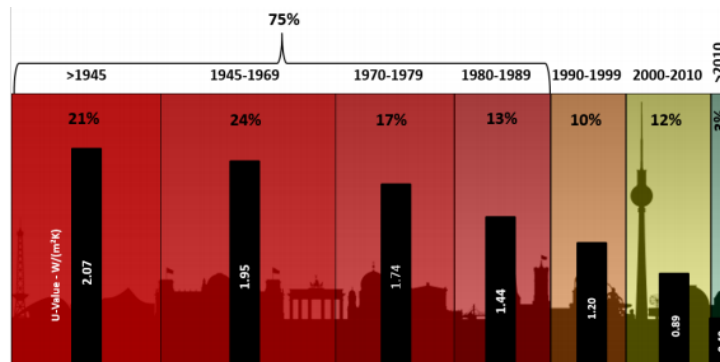
FIGURE 4 CURRENT SITUATION OF THE ENERGY PERFORMANCE OF BUILDINGS



Source : https://ec.europa.eu/energy/sites/default/files/documents/buildings_performance_factsheet.pdf

Figure 5 connects age of the building stock with its average U-value. It proves that building performance is constantly improving in the EU, but only after 2010 was an average building built to a standard that can be considered efficient (0,49 W/m²K) amounting to around 3% of the stock.

FIGURE 5 AGE OF EU BUILDING STOCK AND CORRESPONDING U-VALUE



Source: EU Building Stock Observatory, 2017⁵

Several EU countries have introduced a requirement of **Energy Performance Certificate (EPC)**⁹ making them compulsory for owners who wish to sell or rent out a dwelling. Such a certificate includes recommended potential energy efficient measures appropriate for the specific dwelling. The assumption behind this regulation is that better information about the energy performance of the building will trigger energy renovation. The quality of Energy Performance Certificate plays a vital role on its impact realisation¹⁰. Dwellings may vary from A to G, where A dwellings are environmentally friendliest and require least energy, whereas G dwellings consume most energy. Table 2 demonstrates the variation of EPC standards in some EU countries.

⁸ A Value-Based_Costenefit_Analysis_of_Prefabrication_Processes_in_the_Healthcare_Sector_A_Case_Study

⁹ https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-performance-certificates_en

¹⁰ <https://www.sciencedirect.com/science/article/pii/S0301421518307894>

TABLE 2 EPC STANDARDS FOR DIFFERENT EU COUNTRIES

EPC class	Corresponding primary energy (kWh/m ² /year)								Corresponding final energy			
	France	Austria	Sweden	Germany	Netherlands	Denmark	Portugal	Belgium	Czech Republic	Romania	Norway	UK
A	<50	<80	<50	<50	A++ / (EI: <= 0,5)	<20	<25	45	<43	<150	90,33	32
B	51-90	81-120	100	51-100	A+ / (EI: 0,51 < 0,7)	<30.0 + 1000 /A	26-50	95	43-82	150-259	125,67	33-65
C	91-150	121-160	150	101-150	A / (EI: 0,71 < 1,05)	<52.5 + 1650/A	51-75	150	83-120	259-389	161,67	66-100
D	151-230	161-280	200	151-250	B / (EI: 1,06 < 1,3)	<70.0 + 2200 /A	76-100	210	121-162	389-557	202,33	101-135
E	231-330	281-340	300	251-350	C / (EI: 1,31 < 1,6)	<110.0 + 3200 /A	101-150	275	163-205	557-785	243,67	163-170
F	331-450	341-400	400	351-400	D / (EI: 1,61 < 2)	<150.0 + 4200 /A	151-200	345	206-245	785-1150	303,33	171-200
G	>451	>400		>401	E / (EI: 2,01 < 2,4)	<190.0 + 5200 /A	201-250		>245	>1150	<303	>200

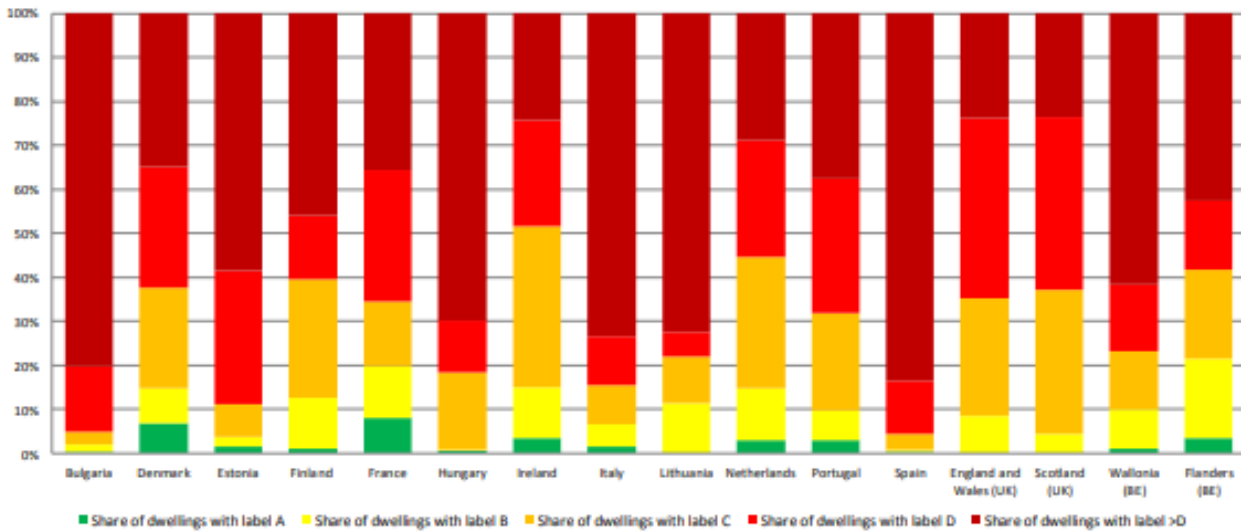
Source : <https://zebra-monitoring.enerdata.net/overall-building-activities/equivalent-major-renovation-rate.html#share-of-residential-buildings-with-epc-labels-a-or-b.html>

Goal of the EU to achieve a decarbonised building stock by 2050 requires that most buildings should be highly energy efficient and have an **Energy Performance Certificate (EPC) label A**.

In 2017, **Buildings Performance Institute Europe (BPIE)**, conducted a research, which was based on national EPC data of 16 European countries that covers 66% of the European total floor area. The research discovered that **less than 3%** of the building stock in those countries is A-label, which implies that **over 97%** of the building stock must be upgraded to achieve the 2050 decarbonisation vision. Detailed results are demonstrated in Figure 6. According to it, France and Denmark have the biggest share of highly efficient buildings, 7% and 8 % respectively.

Even though no comprehensive EPC data is publicly unavailable for Germany, designed energy performance data tells a similar story with just 2% of buildings being very efficient (compliant with 50 kWh/m²).

FIGURE 6 DISTRIBUTION OF THE BUILDING STOCK IN THE EU PER EPC CLASS



Source: https://www.bpie.eu/wp-content/uploads/2017/12/State-of-the-building-stock-briefing_Dic6.pdf

4.3 Trends of the prefabricated and off-site renovation market

Prefabricated and off-site renovation market represents an enormous opportunity in the construction value chain, for new sources of revenue as well as new prospects of growth.¹¹

Despite the obvious fact the trend for offsite construction is upward, the pace of its development is difficult to determine. The landscape will significantly change if some offsite company acquires a large traditional contractor, or some major building materials company opts for a switch to offsite. However, there are rough guidelines how offsite market would evolve.

Offsite will likely grow fastest in regions that emphasise new buildings rather than renovations and that have key market shapers such as a major developer or active government support. The UK and Japan fulfil both conditions and have fast-growing offsite ecosystems. On the contrary, Germany skews toward renovations, and the US lacks any major national offsite champion. As a result, growth of offsite in these markets is likely to be more subdued or localised.¹²

Normally, adoption is highest in construction segments that have the following factors:

- a high degree of complexity, with sophisticated components that would benefit from the time savings derived from offsite methods.

¹¹ <https://bpie.eu/wp-content/uploads/2016/02/Deep-dive-1-Prefab-systems.pdf>

¹² <https://www.bcg.com/en-cz/publications/2019/offsite-revolution-construction>

- a high degree of repetitiveness facilitating standardisation and economies of scale.
- strict requirements for quality, cost, or onsite logistics.

The factors are depicted in Table 3.

TABLE 3 FACTORS OF HIGH OFFSITE SOLUTIONS ADOPTION

Drivers	Complexity	Repetitiveness	Strict requirements
	<i>High number of components Sophisticated systems to install</i>	<i>Identical work repeated across projects/clients</i>	<i>Stringent standards Onsite logistical constraints</i>
Benefit of offsite	Shorter lead times	Economies of scale	High quality and consistency

Source : <https://www.bca.com/en-cz/publications/2019/offsite-revolution-construction>

There has not yet been a specific business model or company that emerged in the offsite construction as the winner. Current participants can be classified in two broad groups: **end-to-end providers and ecosystem coordinators**.


The group of end-to-end providers consists of asset-heavy, vertically integrated generalists, which participate all along the value chain. Companies of this type have design and engineering departments; they manufacture and preassemble most components in their own factories; and they actively manage the final onsite assembly. For them, having a seamless, integrated manufacturing system is crucial for producing top-quality results, and they are willing to invest capital to secure it. This model is currently the most common one.¹²

The group of ecosystem coordinators consists of asset-light overseers. Having developed an offsite-construction system, they then coordinate an ecosystem of specialised partners to deal with individual aspects of it. They may limit their own direct role to that of overall design and customer-relationship management, while relying on partners to make the various components to their specifications. They favour flexibility in manufacturing over sophisticated machinery. The ecosystem coordinator model is new, but many new entrants might be attracted to it because of its asset-light nature.¹²

Already soon, the offsite market will become disruptive in construction. Specifically, offsite construction will mean more productization, less onsite labour, different materials, and different tools. Such transformative developments will to some degree affect all companies along the value chain. Table 4 presents more details.

TABLE 4 PECULIARITIES OF CONVENTIONAL AND OFFSITE CONSTRUCTION

	Conventional construction	Offsite construction
Productization	Projects are tailor-made to individual specifications, with designs, processes, and partner constellations unique to each construction.	Projects use standardised (digital) platforms – from client engagement through to manufacturing and assembly – with a narrower set of options and providers.

	This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958218	18
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Less onsite labour	Workers from many different crafts and subcontractors work onsite for extended periods, creating significant complexity that needs to be managed.	Most work shifts to a factory; onsite teams are about 90% smaller and work about 95% fewer hours than on conventional construction.
Different materials	Concrete and bricks are the dominant materials owing to their low cost, despite concerns about their eco-friendliness and ease of use.	Construction favours materials that are easier to transport and have better eco-credentials such as cross-laminated timber, steel.
Different tools	Many different tools are used onsite by workers for extended periods with regular maintenance needs. For example, heavy equipment, installed tower cranes, power tools.	Fewer tools are used onsite (e.g., flexible cranes only) and for shorter durations. And offsite, different tools are used because processes and conditions are different in factories.

Source : <https://www.bcq.com/en-cz/publications/2019/offsite-revolution-construction>

Detailed analysis of the prefabrication market will be provided in the **deliverable D8.6 “Business cases and Plans”**, WP8 which will be submitted in **M42** of the project.

4.4 EU strategy in the Renovation market

To boost energy performance of buildings, the EU has established a legislative framework that includes **the Energy Performance of Buildings Directive 2010/31/EU**¹³ and **the Energy Efficiency Directive 2012/27/EU**.¹⁴ Both of these Directives get amended from time to time so new targets emerge. Together, the directives promote policies that will help: to achieve a highly energy efficient and decarbonised building stock by 2050, create a stable environment for investment decisions and enable consumers and businesses to make more informed choices to save energy and money.

Directive (EU) 2018/844 that amended two previously mentioned Directives claimed that each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80-95 % compared to 1990, in order to ensure a highly energy efficient and decarbonised national building stock and in order to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings.¹⁵

The amended **Energy Efficiency Directive** includes an ambitious target of reaching energy efficiency of at least 32,5% by 2030, following on from the existing 20% target by 2020.¹⁶

¹³ <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:en:PDF>

¹⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1399375464230&uri=CELEX:32012L0>

¹⁵ https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3A2018%3A156%3ATOC&uri=uriserv%3A0J.L_.2018.156.01.0075.01.ENG

¹⁶ https://ec.europa.eu/energy/sites/default/files/documents/energy_efficiency_factsheet.pdf

In September 2020, the European Commission set out strategic guidance for the implementation of the Recovery and Resilience Facility in its 2021 Annual Sustainable Growth Strategy (ASGS). The Facility is the key recovery instrument at the heart of Next Generation EU which will help the EU emerge stronger and more resilient from the current crisis. The Facility will provide an unprecedented **€672,5 billion** of loans and grants in frontloaded financial support for the crucial first years of the recovery.¹⁷

The Commission encouraged Member States to include in their investment and reforms plans in seven flagship areas: Power up, Renovate, Recharge and Refuel, Connect, Modernise, Scale-up, and Reskill & Upskill.⁴

The flagship area “Renovate” is defined in the Annual Growth Strategy 2021:

Improving the energy and resource efficiency of public and private buildings will substantially contribute to achieving the EU’s climate objectives, create many local jobs throughout the Member States and foster digital development through smart living and metering. By 2025, it will contribute to the doubling of the renovation rate and the fostering of deep renovation.¹⁸

This flagship area is strongly linked with the upcoming “Renovation wave”, published by the European Commission on 14 October 2020.

Renovation Wave for Europe is expected to trigger breaking down long-standing barriers to energy and resource-efficient renovation, supporting fresh investment over a sustained period starting from public and less efficient buildings, spurring digitalisation, and creating employment and growth opportunities across the renovation supply chain. The objective is to at least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations. Mobilising forces at all levels towards these goals will result in **35 million building units renovated by 2030**. The increased rate and depth of renovation will have to be maintained also post 2030 to reach EU-wide climate neutrality by 2050¹.

The strategy of Renovation Wave for Europe framework towards 2030 and 2050 is expected to involve the following key principles:

1. **Energy - efficiency first** - to make sure only necessary energy is produced.
2. **Affordability** - making energy-performing and sustainable buildings widely available.
3. **Decarbonisation and integration of renewables** - building renovation speeds up the integration of renewables and helps to decarbonise transport as well as heating and cooling.
4. **Lifecycle thinking and circularity** - resource efficiency and circularity.
5. **High health and environmental standards** - ensuring high air quality, good water management, disaster prevention and protection against climate-related hazards, removal of and protection against harmful substances, fire, and seismic safety.

¹⁷ https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1658

¹⁸ <https://clustercollaboration.eu/news/flagship-area-renovate>

6. **Tackling the twin challenges of the green and digital transitions together** - smart buildings combined with smart energy distribution systems will enable highly efficient and zero-emission buildings.
7. **Respect for aesthetics and architectural quality** - renovation must respect design, craftsmanship, heritage, and public space conservation principles¹.

The European Commission has defined several areas of intervention to accelerate renovation in the EU:

1. Strengthening information, legal certainty, and incentives.
2. Ensuring adequate and well-targeted funding.
3. Increasing the capacity to prepare and implement projects.
4. Promoting comprehensive and integrated renovation interventions for smart buildings, integration of renewable energy and enabling to measure actual energy consumption. Introduction of the new Smart Readiness Indicator.
5. Making the construction ecosystem fit to deliver sustainable renovation, based on circular solutions, use and reuse of sustainable materials, and the integration of nature-based solutions.
6. Using renovation as a lever to address energy poverty and access to healthy housing for all household.
7. Promoting the decarbonisation of heating and cooling, which is responsible for 80% of energy consumed in residential buildings.

A revision of the Energy Performance of Buildings Directive is a crucial part of the Renovation Wave strategy, since it focuses on the central aims while also contributing to the decarbonisation of buildings, in line with the enhanced climate ambition of the European Green Deal.

All afore-mentioned frameworks will make available an unprecedented volume of resources that will be used to kick-start renovation for recovery, resilience, and greater social inclusion¹.

The European Performance of Buildings Directive EPBD (EU) 2018/844 requires Member States to set up long-term renovation strategies – policy instruments outlining how European Member States aim to transform their existing national buildings into a decarbonised and energy-efficient building stock by 2050. Long-term renovation strategies can fulfil an essential role for local public authorities aiming to decarbonise the building stock, get access to funding and benefit from opportunities presented by **the Renovation Wave**. Renovation strategies serve as roadmaps with measurable milestones, indicators, and impact, supplemented by an overview of the national building stock, specific policies to stimulate renovation, innovative financing instruments and an overview of initiatives for smart technologies and skills in the construction sector.¹⁹

Another study by BPIE “Long-term renovation strategies as key instruments to guide local renovation – Lessons learned from good practices across Europe”, claims that long-term renovation strategies should address the five categories of good practice examples shown in Figure 7.

¹⁹ https://www.bpie.eu/wp-content/uploads/2021/03/OurBuildings-Long-term-renovation-strategies-report_final.pdf

FIGURE 7 CATEGORIES OF GOOD PRACTICE EXAMPLES



Source : https://www.bpie.eu/wp-content/uploads/2021/03/OurBuildings-Long-term-renovation-strategies-report_final.pdf

- **Innovative financing instruments**

Examples of innovative financial instruments – ranging from grants and subsidies to fiscal support that helps to overcome the challenge of high upfront investments – are highlighted, including large funds providing loans and innovative financing initiatives like the promotion of energy service company services. It is beneficial to implement financial instruments on the local level collaboration with regional banks and energy agencies.¹⁹

- **Data collection and storage**

EPC schemes could be very important tools to gather and store data about the building stock, including the worst-performing building segments. Despite their potential, most EPC schemes are not systematically used as databases for local planning purposes.¹⁹

- **Tailored approaches for specific stakeholders**

Tailored approaches focus on instruments or mechanisms targeting a specific segment of the building stock. In practice, tailored approaches for energy efficiency focus on building segments, e.g., single family buildings or multi-family buildings, but they can also be tailored to (e.g.) public buildings.

- **Holistic urban planning processes**

Policies aiming for integrative planning processes at the local level are only found in some of the Member States. Such comprehensive, long-term planning can include strategies to simultaneously tackle energy poverty, health, and environmental issues.

- **Public buildings**

The category includes examples of long-term public sector strategies for energy efficiency improvements and provides concrete examples of initiatives that focus on the renovation of public administrative buildings, schools, and healthcare facilities.

Annex 1 provides information on long-term renovation strategies per above-mentioned category in different Member States.

5 PEST and SWOT analysis of the renovation industry

5.1 PEST analysis

Table 5 demonstrates political, economic, social, and technical factors of the deep renovation industry.

TABLE 5 PEST ANALYSIS OF THE DEEP RENOVATION INDUSTRY

Political factors	Economic factors	Social factors	Technical factors
<ul style="list-style-type: none"> • Building regulations • Tax regulations • EU Directives 	<ul style="list-style-type: none"> • Financial support • Restricted access to loans for households • Economic gain for consumers 	<ul style="list-style-type: none"> • Cultural and social conventions • Homeowners' perception of deep renovation • Enthusiasm, income, and time 	<ul style="list-style-type: none"> • Technical knowledge and resource gaps • Emerging technical innovations

5.1.1 Political factors

- **Building regulations**

Each EU Member State has its Building regulations that comprise of requirements on energy management as well as upper threshold for energy use. Additionally, there are separate voluntary energy performance frameworks for existing buildings with different requirement for different classes of renovation. For example, EPC certificates discussed in section 4.2 “**Current challenges for the European Building – Renovation market**”.

Enerfund project demonstrates an application where it is possible to find out what energy levels residential and non-residential buildings in Europe belong to.²⁰ At first glance, it is obvious many buildings are still in lower levels of energy efficiency, which emphasizes the potential of deep renovation market.

Deliverable D1.2 as a part of WP 1, will be submitted in **M12** of the project and will provide detailed information on building regulations per Member State.

- **Tax regulations**

The existing housing tax policies in some EU Member States are more favourable for the new constructions to meet the increasing housing demand than on renovating the existing building stock²¹. Detailed analysis will be demonstrated in the following up deliverables.

- **EU Directives**

²⁰ <https://enerfund.eu/>

²¹ http://bygningsreglementet.dk/~media/Br/BREnglish/BR18_Executive_order_on_building_regulations_2018.pdf

The Energy Performance of Buildings Directive 2010/31/EU¹⁴ has been the main policy driver for reducing energy use for heating, cooling, ventilation, hot water, and lighting in buildings. The Directive requires the application of a methodological framework for calculating the energy performance of buildings. It has allowed Member States to set minimum energy performance requirements for both new and existing buildings and request the upgrade of existing buildings to meet the minimum energy performance levels upon “major renovations”. As part of this directive, Member States have also implemented certification systems which inform the potential buyer or tenant about the energy class of their building and provide recommendations for a cost optimal improvement of its energy performance.

Another crucial Directive, the **Energy Efficiency Directive in 2012 (2012/27/EU)** also includes several measures targeting energy efficiency improvements in buildings. These include establishing long-term strategies for the renovation of national building stocks as well as undertaking renovation of 3% of the total floor area of all central government-owned public buildings annually from 2014 onwards²².

The Renewable Energy Directive (2009/28/EC) established an overall policy for the production and promotion of energy from renewable sources in the EU. The **recast Renewable Energy Directive (2018/2001/EU)**²³ entered into force in 2018 as part of the Clean energy for all Europeans package. The recast Directive sets a renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023 and comprises measures for the different sectors to make it happen.

5.1.2 Economic factors

- **Financial support**

EU directives aim at increasing both the level and the rate of building renovation, and to promote the use of sustainable energy sources in heating and cooling through appropriate incentives. Generally, to overcome the high upfront cost barrier, companies involved in house renovation require significant investments that frequently can benefit from different types of public support in terms of grants and subsidies.

One of the latest financial funds is the **NextGenerationEU fund**, which has already been mentioned in section 4.3 EU strategy in the Renovation market. It is a European Union recovery package to support Member States hit by the COVID-19 pandemic. The fund is worth €750 billion: Recovery and Resilience facility - €672,5 billion; ReactEU - €47,5 billion; Horizon Europe - €5 billion; InvestEU - €5,6 billion; Rural Development - €7,5 billion; Just Transition Funds - €10 billion; RescEU - €1,9 billion.²⁴

²² <https://e3p.jrc.ec.europa.eu/articles/eu-policy-framework-energy-efficiency-existing-buildings#toc-1>

²³ https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC

²⁴ https://ec.europa.eu/info/strategy/recovery-plan-europe_en

- **Restricted access to loans for households**

Currently, access to loans for conducting deep renovation of households is restricted since the demand for such specific loan from house owners' side is low. Additionally, bankers perceive as a high risk to provide an additional loan to owners who already have an outstanding mortgage.

Undoubtedly, it should be a more sustainable means of financing as it provides liquidity and direct access to capital.²⁵ However, some of the European banks are already offering low-interest loans for energy renovation²⁶.

- **Economic gain for consumers**

Undoubtedly, the biggest gain of energy efficient solutions for consumers is substantial decrease of bills for energy such as heating and electricity. The payments decrease will eventually counterbalance deep renovation investments. Prefabricated and off-site preparation assume additional reduction in investment costs of more than 30% (see Table 3). Besides, once households are renovated according to sustainability criteria, the reduced energy demand would eliminate the necessity of investing in new grid capacity and building additional power plants, which will be eventually reflected in the electricity price and the grid tariffs paid by consumers. A more indirect gain occurs through health benefits because of improved indoor climate and thermal comfort.²⁷

5.1.3 Social factors

- **Cultural and social conventions**

A study has discovered that renovation decisions are impacted by the knowledge networks such as family members, friends or colleagues and advice from construction companies. It should be noted that sometimes construction companies have an interest of not promoting deep renovation.²⁶ In some old buildings, the scope of deep renovation can be limited by the desire and/or legal obligation to preserve the historical and cultural values.

- **Homeowners' perception of deep renovation**

The response towards deep renovation may differ depending upon what signals it will deliver to people's social surroundings. Thus, sometimes even an economically unattractive energy efficiency measure could still be attractive if it is perceived to strengthen the social status of the homeowner or if it affirms its commitment to ethical values such as respect for the environment. On the contrary, an economically feasible measure might not be obvious choice if it does not have any signalling effect.²⁸

²⁵ Financing building energy renovations: current experiences & ways forward. Science and policy report by the joint research centre, the European Commission (2014)

²⁶ <https://www.sciencedirect.com/science/article/pii/S1364032120309436?dgcid=author#bbib1>

²⁷ <https://www.sciencedirect.com/science/article/pii/S1364032120300745>

²⁸ <https://www.sciencedirect.com/science/article/pii/S0960148113002498>

- **Enthusiasm, income, and time**

There is a challenge to have simultaneously enthusiasm for making changes, enough income/savings, and appropriate time for carrying out deep renovation.²⁹ According to some research, young generations could be most interested to perform deep renovation, because this customer segment has time and enthusiasm to try new things and ability to take risk.²⁶ However, this segment may face financial constraints to invest more on renovation on the top of the existing home loan. Middle-aged group is likely to possess enthusiasm for change and stable income with savings but might have time constraint for renovation due to different priorities and occupation with family activities, specially related to children. Seniors may have time availability but are unlikely to have enough income/saving and interest for making major changes in the houses.²⁹ Anyway, seniors should not be totally excluded of the potential demand, since there is a rising interest in the concept of "aging in place". 81% of upcoming seniors plan to spend their retirement years at home, even if it means investing in it (e.g., adaptation to elder mobility, addition of "smart" home technologies and general comfort increase).³⁰

5.1.4 Technical factors

- **Technical knowledge and resource gaps**

Currently, the market for renovation is fragmented, and dominated by Small and Medium Enterprises (SMEs) that promote their own products and services. Varied knowledge and conflicting interests of these actors are perceived as hindrance for deep renovation.³¹ Very often, there is a shortage of skilled and competent workers, which could increase in the upcoming years as investments in the renovation market increase. Specific skills are required to enhance energy-efficiency in old buildings and sequencing and coordinating of various jobs within deep renovation process.³²

- **Emerging technical innovations**

Technological innovations need to address the existing hurdles of the renovation market. For example, the advantage of the prefabricated renovation solution is an ongoing transition.³² This can significantly reduce the onsite renovation time, offering less disturbance for dwellers and possibly offering cost-effective solutions.

5.2 SWOT analysis

Table 6 tabulates strengths, weaknesses, opportunities, and threats of the deep renovation market. Some of them have been taken from PEST analysis and others are described below.

²⁹ <https://www.mdpi.com/2075-5309/9/7/164>

³⁰ <https://digital-strategy.ec.europa.eu/en/library/silver-economy-study-how-stimulate-economy-hundreds-millions-euros-year>

³¹ <https://www.sciencedirect.com/science/article/pii/S0959652614010336>

³² <https://www.sciencedirect.com/science/article/pii/S1876610219311099>

TABLE 6 DEEP RENOVATION INDUSTRY SWOT ANALYSIS

<p>Strengths</p> <ul style="list-style-type: none"> • Promotion by the European Commission • Presence of long-term strategies in each Member State • Substantial financial support from the EU such as the Renovation Wave for Europe • Materials availability • Presence of reliable construction companies • Healthier benefits for people • Increases the real estate value of the property so there is a potential equity gain for homeowners 	<p>Weaknesses</p> <ul style="list-style-type: none"> • High investments • Renovation loan policies are frequently designed in accordance with superficial but not deep renovation • Limited interest for large construction companies • Shortage of small and medium companies' resources • No holistic knowledge about deep renovation • Disturbance of the surrounding environment • Lack of confidence from the homeowners' side • Lack of numerical proof of the economic gain (ROI) • Limited scope of deep renovation
<p>Opportunities</p> <ul style="list-style-type: none"> • The industry helps to solve environmental issues • Increase of energy prices • Availability of loans for house renovation on affordable terms • Tightening the rules by the EU regarding energy consumption • Introduction of financial incentives • Emerging technical innovations • Substantial financial support such as the Next Generation EU fund 	<p>Threats</p> <ul style="list-style-type: none"> • Scarcity of competent service providers • Quality of work is very dependent on the level of craftsmanship of the workers, so it is prone to inconsistencies • The theoretical energy savings calculated at design phase do not always correlate with actual results • Energy prices decrease • Homeowners feel dissatisfied with the role of "early adopters"

• **Strengths**

The largest advantage of the renovation market is its support by the European Commission through introduction of Directives and the latest the Renovation Wave for Europe that offer significant help to potential market participants by funding renovation projects, providing advisory services and communicating renovation advantages to European Union citizens. Besides, availability of high-quality building insulation materials backed by CE marking certification, availability of proven and reliable construction practices and presence of competent construction companies in the EU²⁶ – could be considered as strengths for the deep renovation market.

• **Weaknesses**

Deep renovation with higher energy performance requirements demands larger investments for materials and labour, therefore, not all owners will be willing or will be able to afford deep renovation. Because of that, the demand for the deep renovation may not surge. Many SMEs perceive this uncertainty as a major challenge, especially when there is no proper financing mechanism.

Another weakness is that very often house owners must cover the renovation cost from their savings, from home loan or from private loan.²⁶

Large construction companies are currently more motivated by conducting construction with larger business volume rather than in renovation of individual houses. Mostly, small, and medium scale construction companies are engaged in the renovation business. Such companies are competent in some specific jobs but might have limited competence in deep renovation. Besides, their resources are highly restricted as well. Renovation market is fragmented and dominated by a craftsman-based approach lacking holistic knowledge about deep renovation in SMEs and homeowners.³³

Inconvenience caused during the deep renovation such as disturbance of the surrounding environment, noise; lack of confidence of homeowners on the contractor are other weaknesses of the market. Some people argue that the renovation market is not able to attract homeowners regarding Return-on-Investment coefficient.²⁶

- **Opportunities**

It is vital to communicate advantages of the energy saving renovation to the society. So, citizens start being interested in houses renovation, the demand for renovation solutions will grow and the market will thrive. This could be reached through several opportunities.

Firstly, citizens should understand that deep renovation will contribute to solving environmental issues such as climate change and sustainability maintenance. This could be done through easy access to information, advising for systematic renovation and counselling on energy efficiency. Secondly, since deep renovation entails energy saving, energy prices increase could make the industry economically more attractive. Thirdly, availability of loans for house renovation on affordable terms could be another opportunity for the market. Additionally, tightening the rules by the EU regarding energy consumption and energy efficiency or introduction of some financial incentives for homeowners could substantially contribute to the renovation market awareness.²⁶

- **Threats**

Since large construction companies are more interested in constructing bigger business volume rather than penetrating the renovation market with individual contracts, there is a threat of scarcity of competent service providers in the renovation market. Besides, there might emerge risk of poor quality of the work during deep renovation due to lack of coordination among various craftsmen.

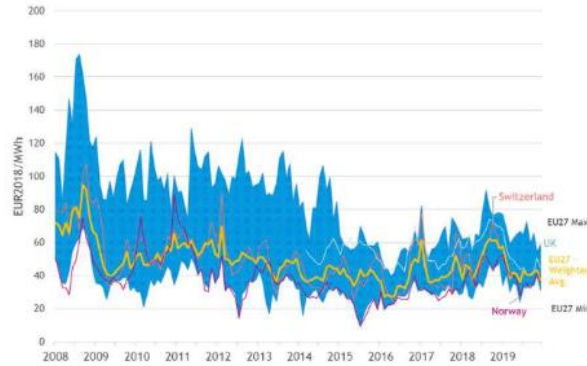
The theoretical energy savings calculated at design phase should correlate with actual results after the renovation has been executed, because it is crucial that all the market players gain confidence in the renovation strategy. This applies to homeowners (who probably have taken a financial decision based on an expectancy of energy savings that should materialise) and to the public sector that provides subsidies (who need proof of their money being put into good use).

Besides, if the energy prices go down, then the people might be less motivated for deep renovation. Figures 8 and 9 demonstrate dynamics of wholesale and household retail electricity prices in the EU over 2008 -

³³ <https://www.sciencedirect.com/science/article/pii/S0959652612006622>

2019 years. It is seen from graphs that wholesale electricity prices have been decreasing and household retail prices have remained relatively stable.

FIGURE 8 WHOLESALE ELECTRICITY PRICES IN EU27, IS, NO AND UK, 2008-2019, EUR2018/MWh



Source : https://op.europa.eu/en/publication-detail/-/publication/16e7f212-0dc5-11eb-bc07-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

FIGURE 9 HOUSEHOLD RETAIL ELECTRICITY PRICES IN EU27, CH, IS, NO AND UK, 2008-2019, EUR2018/MWh




Source : https://op.europa.eu/en/publication-detail/-/publication/16e7f212-0dc5-11eb-bc07-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

5.3 Strengths and weaknesses of the offsite prefabricated construction industry

In 2019, specialists of Boston Consulting Group prepared a research on the offsite market and identified the following strengths and weaknesses.¹²

5.1.1 Strengths

- Shorter building times and lower risk

	<p>This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958218</p>	<p>29</p>
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Offsite construction is less affected by the weather conditions, heavy burden of onsite project management. It is also less subject to legal and financial risks, which normally emerge due to complex collaborations with subcontractors. As a result, offsite construction reduces building-completion times by more than a third and improves punctuality, with best-in-class builders approaching 100% for on-time delivery.

- **Higher quality**

The defect rate can be substantially decreased because of controlled environments, standardisation, in-factory quality-checks. Currently, best-in-class producers have the defect-free rate on new buildings as of above 95%.

- **Lower costs**

The controlled weatherproof workplace environment raises the employee productivity and allows economies of scale, optimised logistics and lean manufacturing. The result could be saving up to 10% on overall construction costs.

- **Improved working environment**

In offsite construction, workers are protected from traditional risks such as harsh weather conditions, working at heights or underground. Additionally, their daily commute remains unchanged when construction sites change. Therefore, number of workplace accidents decreases, and the recruiting process facilitates as the jobs are now more desirable.

- **Reduced environmental impact**

Production efficiency and increased recycling contribute to reduction of construction waste and emissions.

5.1.2 Weaknesses

- **An image problem**


Europeans often associate offsite construction with the poor-quality, large-scale housing developments built in Europe during the 60s and 70s, a negative image that may be hard to reverse.

- **Inflexibility and uniform design**

Previously, offsite construction companies had a policy of standardisation to keep costs low. Such an approach conflicted with building-site constraints and with the individual owner’s preference for a certain degree of customisation.

- **Regulation and local building codes**

Traditional construction industry is widely subject to tight labour rules that regulate the whole constructing process such as the minimum workers number for a particular task or who can do what onsite etc. The offsite labour model implicates the operation of small teams of broadly trained workers. As a result, tight construction rules together with health and safety regulations, mortgage, or insurance requirements. Have

	<p>This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958218</p>	<p>30</p>
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hampered the offsite construction development. Besides, very often regulations are local, therefore easy scaling of solutions is not possible.

- **Risk aversion**

Historically, the construction sector is risk-averse, it is expensive when done right and ruinous when done wrong. On a supply side, it is a project-based cyclical business, that includes constant cost pressures and low margins, hence, an aversion to heavy capital expenditures and R&D.

Detailed technological SWOT analysis of prefabricated industry is demonstrated in the deliverable **D1.1 “Requirements: Context of application, building classification, used consideration – Definition of requirements and constraints, WP1** submitted in **M3**.

5.4 Deep renovation industry attractiveness

From the above analysis, we deduce that even though applied technologies are highly sophisticated, the market is fragmented and there could lack of human resources, the renovation Industry in Europe today could be considered as highly attractive. The main reason for it is that the European Commission has set up speeding up renovation aimed at creating energy-efficient buildings as its strategic goal and intends to throw significant resources tackling the challenge. This will lead to increase of participants in the market and emergence of new projects and businesses. As a result, if the PLURAL project wishes to stay afloat, it must comply with principles, trends, and standards, determined by the European Commission.

6 PLURAL project

6.1 Project definition

PLURAL aims to design, validate, and demonstrate a palette of versatile, adaptable, scalable, off-site prefabricated plug and play facades accounting for user needs (“Plug-and-Use” – PnU kits). The solution assesses three core systems, coupling heating-cooling, ventilation, heat harvesting systems with smart windows, 3D printing, low carbon footprint and nano-enabled coating materials to reduce the building total primary energy consumption to less than 60 kWh/m² per year and ensure on-site renewable energy generation to more than 50 kWh/m² reaching NZEB status for different European climates and different residential building typologies.

The project introduces a BIM based big data management platform and a Decision Support Tool (DST), which are coupled to enable the optimal component selection, and integration, best PnU kit design, speedy and low-cost manufacturing, and installation. Renewable energy and smart control systems are coupled with low environmental footprint prefabricated façade components to create the integrated all-in-one PnU kits for post war residential building deep renovation. The project creates best practice renovation examples for the residential sector based on innovation and competitiveness, with benefits for the citizens and the environment. It develops business cases and models for key stakeholders and improves the life cycle-based performance standards applied in the building sector.

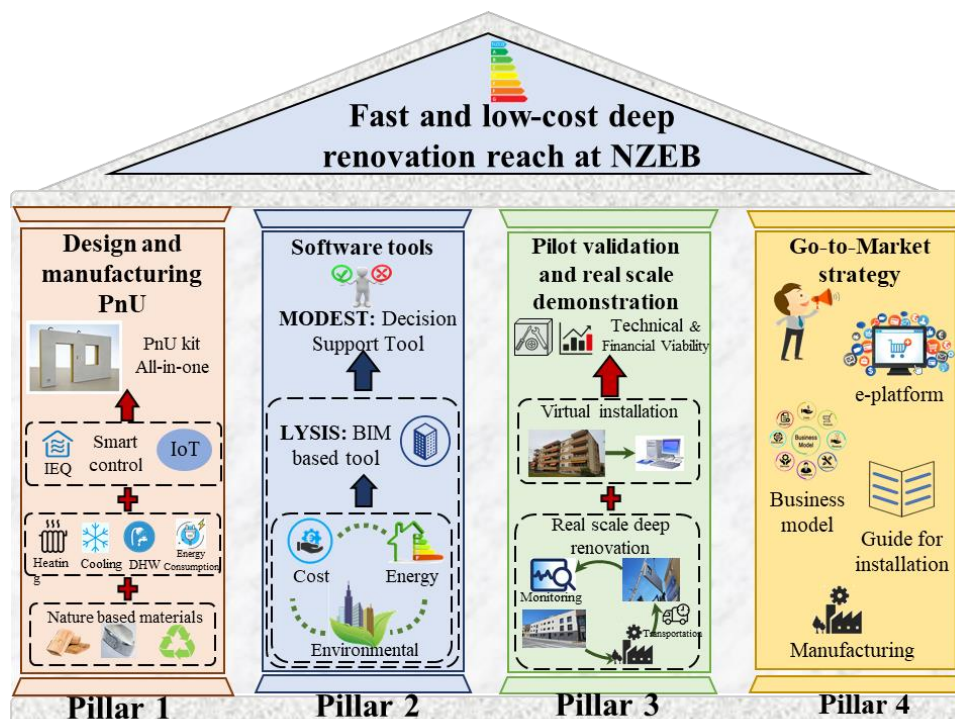
6.2 Main project objectives

The PLURAL aim will be realised via developments in four pillars, which are demonstrated in Figure 10. They are:

- Design and manufacturing of optimised PnU kits.
- Development and validation of IT tools.
- Pilot validation and real scale demonstration.
- Multi-stakeholder ‘Go-to-Market’ strategy.

Each pillar has several specific objectives.

FIGURE 10 DEMONSTRATION OF THE PLURAL PROJECT'S PILLARS



Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

6.3 Project demonstration sites

The PLURAL concept will be implemented in three different typology demonstrators: one retirement home and two residential dwelling blocks one built in 2008 and one in 1971. The buildings are selected to have high heating requirements (KASAVA demo site) but also moderate heating with variable cooling demands (TERRASSA and VVV demo sites), as indicated in Table 7. This combination of building typologies and climatic zones maximizes coverage of residential building deep renovation options. Emphasis is placed to meet the increasing cooling demands across Europe, due to the climate change and the increase of the global surface temperature. The three selected cities are representative and cover the energy needs of most European cities. Details on the demo sites are demonstrated in [Annex 2](#).

TABLE 7 HEATING AND COOLING DEGREE DAYS FOR THE CLIMATES OF DEMONSTRATION SITES

City	Heating Degree Days	Cooling Degree Days
Prague	High (HDD/year > 3000)	Low (CDD/year < 40)
Barcelona	Medium (1200<HDD/year <1500)	Medium (40 < CDD/year < 75)
Athens	Low (HDD/year < 1200)	High (CDD/year > 200)

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

The virtual demo sites are selected to address mainly Nordic country heating/cooling requirements, considering different economic factors. The Berlin and Väsby sites are already renovated, and the relevant data will be used to prove not only the energy performance of the virtually renovated buildings but also the time and cost savings resulting for the PLURAL concept and the PnU kits. Different building types are again selected for this purpose. Additionally, the data from the real demos will be used to validate the PnU kit performance in other climatic and user conditions. [Annex 3](#) shows data on virtual demo sites.

Deliverable D1.1 as a part of WP 1, provides more detailed information on climate zones, socio-economic indicators, and most common building archetypes in countries of demo sites.

6.4 PLURAL products

The PLURAL solution (the three core PnU's) will be sold to the renovation and real estate markets as a complete package of technological and design-assessment solutions, covering all aspects of sales requirements (customer tuned design, on-line energy-investment-environmental assessment, fast and reliable construction). The package will be offered in the market as an entity or as separate services and products by the key project IPR holders. Some PLURAL consortium partners will aim to ensure the implementation and market uptake of all the PLURAL exploitable results. Several of the exploitable results could and will be offered as individual solutions (e.g., ERs 5,6,7 and 8). Table 8 demonstrates the list of all project's exploitable results.

TABLE 8 EXPLOITABLE RESULTS OF THE PLURAL PROJECT

Exploitable results of the PLURAL project

Number	Exploitable results
1	Prefabricated Plug-and-Use facade modules for building renovation
2	Smart wall: External wall heating & cooling system
3	eWHC All-in-one external wall heating & cooling system
4	eAHC AHU with heating and cooling for integration
5	Energy harvesting windows
6	Smart control for the centralized HVAC, DHW and RES systems with energy storage
7	Nano-enabled coatings
8	3D printing for complex structural elements
9	LYSIS -Big data management platform
10	SEM based on MPC
11	Reduced energy behavioural models
12	IAQ IoT sensors
13	MODEST- Multi-objective decision support tool
14	"Best practice" certification handbook
15	"Best practice" industrialization handbook
16	"Best practice" renovation handbook

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

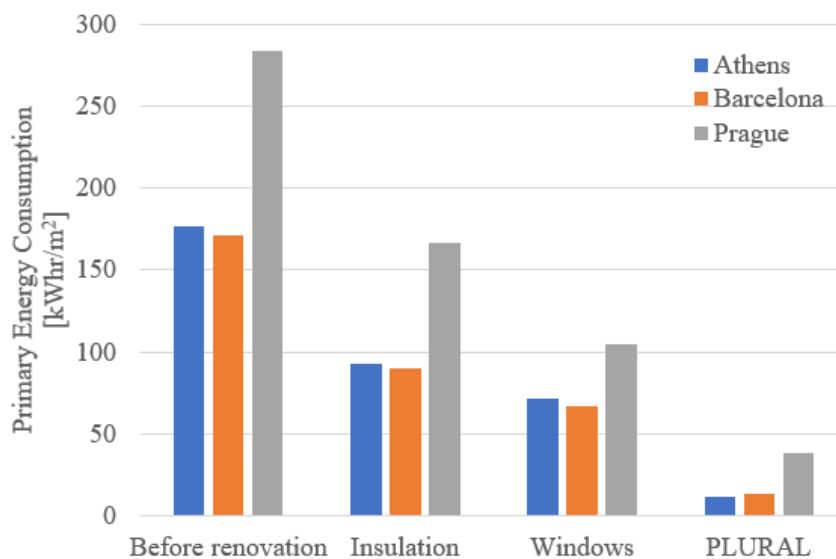
6.5 Value proposition/competitive advantage

The PLURAL solution has the following substantial advantages that differ it from other deep renovation projects.

6.5.1 Demonstrate retrofitting plug & build solutions and tools reaching nZEB standards suitable for mass production by industry for buildings under deep renovation

PLURAL will develop and demonstrate integrated solutions based on all-in-one, versatile, adaptable, scalable, off-site prefabricated envelop “Plug-and-Use” kits for fast-track, cost-effective and environmentally conscious deep renovation of various residential building typologies in all EU climatic zones, aiming at near zero energy consumption.³⁴ Figure 11 highlights potential decrease in primary energy consumption due to deep renovation offered by the PLURAL solutions in three different cities that form the core demonstration locations of the project.

FIGURE 11 PRIMARY ENERGY CONSUMPTION DUE TO DEEP RENOVATION



Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

6.5.2 Decrease of retrofitting time and costs by at least 50% compared to current renovation process for the same building type

Regarding time reduction, savings are anticipated in the design (-46%) and engineering (-44%) stages. Additional time savings in the procurement and logistics (-60%) and the fabrication and site preparation (-55%)

³⁴ Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

stages are anticipated due to the manufacturing logistics, which considers the LYSIS-MODEST outcomes. Further time savings are anticipated for on-site renovation (-40%) and clean up (-26%) due to the error minimisation of the prefabrication process and the optimised site management. The time savings due to prefabrication and use of the LYSIS-MODEST tools is expected to be more than 52%. The LYSIS platform will also be a shared knowledge resource for “total” information about the renovation project forming a liable basis for decisions during its life cycle.

As for cost reductions, PLURAL will develop case specific cost models, based on time planning and productivity to compute potential savings. Based on recent study³⁴, PLURAL estimated the cost savings according to the traditional percentage of costs due to the activities in both pre-construction and construction phase (together 100%), as well as for the enablers of construction, that can provide additional savings. The potential savings are expressed in relation to this original percentage. The biggest savings are for the materials (14%) and on-site labour cost (27%) compared to traditional approach. Detailed information is demonstrated in Table 9.

TABLE 9 COST SAVINGS PER RENOVATION TASK WITH PLURAL RENOVATION PROCESS

Cost savings per renovation task with PLURAL renovation process

Pre-construction phase	Planning		2%	-	
	Design	General	5%	-2%	No redesign necessary, savings with modular libraries
	Site Preliminaries	Building analysis	12%	-3%	
		Deconstruction			
Construction phase	Substructure		7%	-	
	Materials	General	29%	-10%	Economy of scale, cut out intermediaries, less waste (10%)
		Included transportation cost		-1%	Optimised logistics from providers down the supply chain
		Materials saved for interior works		-3%	Due to the HVAC integrated in the prefabricated panel in PLURAL solution
	On-site labour	General	40%	-25%	Up to 80% of the traditional labour activity can be moved offsite.
		For interior works saved		-2%	Due to the HVAC integrated in the prefabricated panel in PLURAL solution
	Off-site labour	General	0%	5%	Factory work can double the productivity
Building automation & energy	Initial investment to BEMS	0%	2%	Investment to increase the energy efficiency, saves in the use phase	

	management				
	Logistics	Materials to the construction site	5%	-	No increase due to 2D system
		Site equipment: scaffolding		-2%	No need for scaffolding
		Site equipment: crane		1%	Need for higher performance crane
Enables of construction	Redesign		10%	-8%	
	Financing	General	15%	-5%	Up to 50% shorter construction time, the ability to accelerate projects can lower costs
		Saved financing for renting apartment			-2%
	Factory cost	Setting up	0%	5%	Only simple assembly line needed
	Total		125%	-50%	

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

6.5.3 Minimal on-site disturbance

The PLURAL prefabrication offers minimal on-site disturbance due to the reduced construction time and interference to the day-to-day operation of the site and its occupants (noise, dust, pollution, congestion, and waste).

6.5.4 Improve Life Cycle Assessment (LCA) standards

The LCA approach in PLURAL project will focus on the manufacturing, installation, use phase and end of life of each demo site. The LCA activities of the project will assess the impact reduction of the materials and technologies, guiding the development process towards using sustainable processes and recyclable materials to minimise resource use and waste. The environmental impact of the materials life cycle is energy consumption in the manufacture of materials; CO2 emissions produced by manufacturing; the energy consumption of the commissioning of the materials, with the corresponding CO2 emissions; and the leftover materials and packaging generated during the commissioning of the materials themselves.³⁴

6.5.5 Target Key Performance Indicators

Overall, the PLURAL project provides an entire package of solutions for building renovation by targeting the achievement of key performance indicators, which are shown in Table 10.

TABLE 10 KEY PERFORMANCE INDICATORS AND PLURAL’S RESPONSES

Number	Key Performance Indicator	PLURAL’s response
1	Near zero energy consumption of buildings renovated with PnU kits.	Heat losses through the envelope will be minimized through improved insulation of the façade components, reaching U-Values of less than 0.23 2W/m ² K; Building primary energy consumption will be less than 60 kWh/m ² , achieved via the optimal design and operation of heating, cooling, ventilation, storage and harvesting components, and the increased share of renewable energy.
2	Cost-effective renovation	ca. 58% reduction in renovation costs will be achieved through offsite prefabrication, lean manufacturing and construction interactively supported by the BIM based platform and Decision Support Tool.
3	Fast-track renovation	PLURAL will achieve at least 50% reduction in the time required for deep renovation of e.g., multi-family blocks mainly by reducing the time to design/engineering, procurement, logistics, fabrication, and site preparation from avg. 5-7 months to 2-4 months. The BIM based platform and the DST will facilitate monitoring the production time of the PnU kits, which will be realized in parallel with the site preparation, allowing to complete the on-site renovation including installation within 3-4 months.
4	Environmentally-friendlier deep renovation	PLURAL aims at CO ₂ eq emissions 15% less than the current average 0.6 tCO ₂ eq/m ² and 70% material recyclability.
5	Flexibility – Adaptability	System combinations will allow easy adaptation of the PnU kits to be developed and validated as part of the project to various residential building typologies in all EU climatic zones.

Source: Grant Agreement number: 958218 – PLURAL – H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

Deliverable D1.4, WP1, which will be submitted in **M18** of the project, will provide detailed information on Key performance indicators, system components and performance targets.

6.5.6 Accelerate the renovation process by enabling access to better products

PLURAL will deliver to the market a range of high-quality new products at **TRL7-8** to accelerate the renovation process, these products are listed in Table 8 as exploitable results.

6.5.7 Close Integration of partners and projects

PLURAL is international multi-industry consortium that includes large number of SMEs (8 SMEs, 2 large industries) with participation of 5 universities and research centres, 3 public bodies providing the demo-buildings. The PLURAL project gains from each partner’s substantial knowledge, background, and experience; core technologies are provided by the key partners from each country of the demo site.

The entire PLURAL package is based on advanced materials, components, software tools and know how that have been developed in previous research projects and are close to the market. Integration of previous projects’ results will help to achieve economies of scale for the producers-designers-constructors, reducing the overall prefabrication, design, and renovation costs. The new business models and investment cost tools will bring forward and establish the cost savings for the end user and building occupants. Marketing costs will not be increased due to the use of the existing industrial channels. Overall, PLURAL has established solutions for costs of production, sales and marketing that ensure direct revenues and profit margins for the key stakeholders of the value chain.

6.5.8 Correlation to key principles of Renovation Wave for Europe framework

As Table 11 indicates, the PLURAL project addresses all key principles set up in the “Renovation Wave for Europe³⁵” framework, which is a substantial advantage and means that the project keeps up with the time and goes beyond fulfilling the near future requirements.

TABLE 11 PLURAL PROJECT VS RENOVATION WAVE FOR EUROPE KEY PRINCIPLES

Principle	Check
Energy - efficiency first	✓
Affordability	✓
Decarbonisation and integration of renewables	✓
Lifecycle thinking and circularity	✓
High health and environmental standards	✓
Tackling the twin challenges of the green and digital transitions together	✓
Respect for aesthetics and architectural quality	✓

³⁵ https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en#a-renovation-wave-for-europe

7 Market and business model analysis

7.1 Market identification

- **Geographical market identification: European Union**

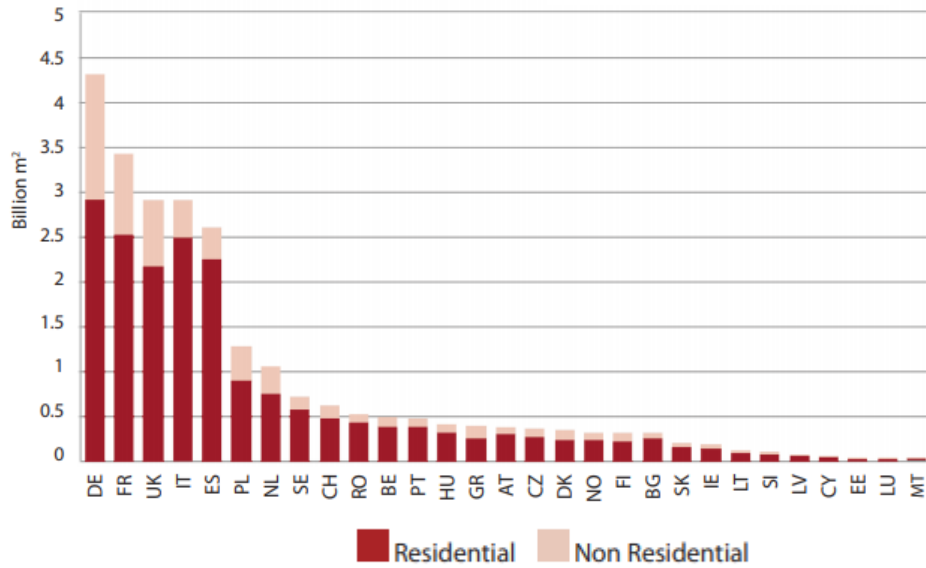
In terms of geographic relevance, in the ramp up phase, **all EU countries** will be the target for the PLURAL solution, since the three Plug-and-Use Kits developed in the project are targeting different climatic conditions and building typologies. Besides, all Member States, being tied to the EU's goal of decarbonising building stock by 2050, have initiated some form of renovation-tied energy efficiency policies.³⁴

In the **deliverable D1.1 "Requirements: Context of application, building classification, used consideration – Definition of requirements and constraints"**, **WP1**, which was submitted in **M3**, there has been carried out a brief market study that focused on two partner countries **Germany** and **Spain**. These countries represent two different European climatic zones and accommodating demo sites. The two countries were also investigated because they are characterised by a large building stock in comparison to other European countries, which is shown in Figure 12. According to the figure, Germany has the largest floor space distribution (residential and non-residential) across European countries, while Spain has the fifth largest floor space distribution (fourth largest for residential buildings only). It can be assumed that Germany and Spain offer a large-scale market potential, purely due to the size of the existing building stock. In addition, both countries have very strong construction industries, which will be able to adopt and promote the developed PLURAL solutions. Furthermore, it is expected that both countries offer a good potential of transferring the know-how into other markets.

Spread of PLURAL solutions will be also dependent on **partners' countries and their network of connections**.

This analysis is only a starting point and will be extended for other target countries as part of other tasks. The market study will be further elaborated in **WP8. D8.4 "Business models for PLURAL solutions"** and **D8.6 "Business cases and Plans"** that will be submitted in **M36** and **M42**, respectively.

FIGURE 12 FLOOR SPACE DISTRIBUTION PER COUNTRY



Source : https://bpie.eu/wp-content/uploads/2015/10/HR_EU_B_under_microscope_study.pdf

- **Market identification for Prefabricated Plug-and-Use facade modules for building renovation: residential and non-residential existing buildings**

According to the Renovation Wave for Europe, for the period 2020 – 2030, 35 million building units are expected to be renovated. On average, the Consortium anticipates **3%** of potential market penetration for the whole PLURAL package and from **1% to 6-7%** penetration for individual PLURAL solutions depending on technology, demand, and other factors.

Regarding the prefabricated market, given the advantages the project solution will provide to end-users, there is expected a **30%** penetration of the total addressable market once the business model is fully ramped up (estimated to be achieved by 2027). This percentage is an average across the EU, but it could be higher in markets with more advanced policies for renovation and energy efficiency, as well as with high ageing building stock. At the stage where the business model is fully ramped up and assuming no growth in the size of the turnover of the EU-wide renovation sector (lowest case scenario), the prefabrication solutions will be exploiting a market potential of EUR 430 billion annually.³⁴ This market potential is estimated at the current annual renovation rate which is 1,11% (vary between the countries from 0.08 to 2.4). Assuming the required EU 2050 goal of an annual renovation rate of 3% achieved by 2030 this gives an increased annual addressable market of EUR 1290 billion a year within 5 years of completion of the PLURAL project.

The PLURAL “LYSIS” design and decision-making platform will primarily target the real estate market aiming at a short-term (3 years) penetration. There is an urgent need for new real estate management systems

(e.g., the “LYSIS” platform) to improve performance, realize energy savings and reduce lifecycle costs of real estate renovations.

PLURAL creates an innovative concept, with no previously established market for the entire package of solutions. During the ramp up phase of the business model in the market (estimated to last 3-5 years after the completion of the PLURAL project), the target customers will be multi-family houses (government supported).

The focus for the overall PLURAL concept for systemic NZEB renovation is **the residential segment**, however, the **potential market for PLURAL in long-term** is diverse and exists across several customer segments: **single family houses, multi-family houses, hotels, offices, hospitals, educational buildings, retail buildings, government buildings and other miscellaneous non-residential buildings.**

7.2 Market barriers

Table 12 presents market barriers and the PLURAL’s response to them.

TABLE 12 MARKET BARRIERS

No	Market barrier	PLURAL’s response
1	The Information issues - can be either confusing information, i.e., different opinions expressed by different professionals, or incomplete information, lack of clear requirements, lack of inspiration or lack of knowledge about possibilities, potential benefits and added values of improving energy efficiency.	Prefabricated construction method combined with BIM decision making platform offers: Specific and clear definition of requirements; Examination of broad range of renovation solutions about possibilities; quantified benefits and added value of improving energy efficiency; insight into the energy performance; Determination of measures the decision maker can apply to reduce building-related energy consumption; Address a variety of design requirements; Optimization of the installation levels speed; Standardized methodology and BIM based know-how to renovation.
2	The Technical issues - are mainly related to lack of well proven systems, lack of complete solutions consisting of packages of technologies, lack of know-how to renovation and absence of standardized methodologies – guidelines to increase the renovation quality, absence of cost-effective combinations of energy efficiency measures demanding less effort and causing less disturbance to the occupants	Holistic, integral, modular, in system solutions; Standardized, certified, (energy, fire, sound, structurally) proven systems; Quality assurance in the overall process; Complete solutions encompassing a “tool-box” of most appropriate combinations; Solution of interface problems of technical building components; Integration of system functions; Guidelines to increase the renovation quality, cost effective combinations of energy efficiency measures demanding less effort and causing less disturbance to the occupants.

3	<p>The Ownership issues generally have to do with who must pay for the investment in energy renovations and who saves the money (not always the same person(s)).</p>	<p>The new financing models of PLURAL will target a) renovation investment including rewards or incentives for energy savings considering the different stakeholders' needs and cost saving priorities; b) the distribution of the life cycle costs of the renovated building involving homeowners/occupants; c) fast and broad market uptake of solutions.</p>
4	<p>The Economic issues can be as simple as too high investments needed, which often are also coupled with lack of incentives, uncertainty as to how much money can be saved from the energy renovation and thus, there are short term perspectives regarding the cost effectiveness of building renovation measures and lack of economic understanding or knowledge.</p>	<p>Financial solutions counter-balancing lack of incentives-energy index – regulations etc., cost effectiveness of PLURAL renovation measures; economic understanding of concept. Possibilities for individualization in the building sector due to modularization, in accordance with “Industrie 4.0” (serial architectural production and mass customization).</p>

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

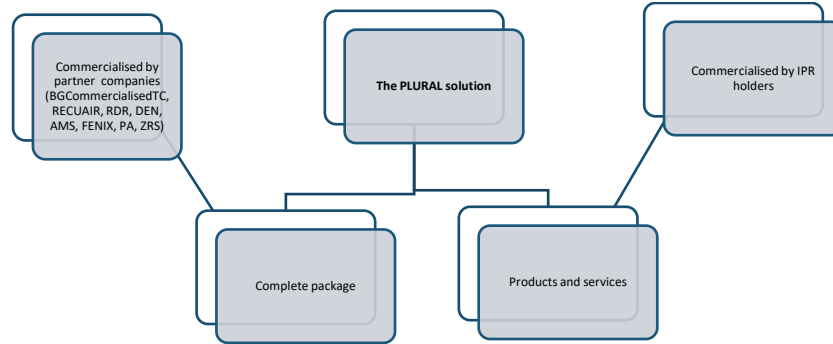
7.3 ‘Go-to-Market’ strategy

Prior to developing go-to-market strategy, in **M19** till **M42**, NTUA, IREC, ZRS led by ITeC will start identifying technical, regulatory, market and marketing requirements for PLURAL products as a part of **WP8, T8.1**. Marketing requirements will be expressed in deliverable **D8.1 in “Product requirement report”** created in **M32**. Awareness of marketing requirements will contribute to developing a viable go-to-market strategy.

Go-to-market strategy is a deliverable **D1.7 “Go-to-Market strategy”** within **WP1 and T1.8**. It will be developed in **M42** of the project and will assess the market potential and impact of the PLURAL’s results, firstly establishing and focusing on the partner’s exploitation network. A broader approach scaling to EU level will be then investigated, based on the partners’ exploitation network. Additionally, also in **M42**, within the same WP and **T8.4, there will be prepared deliverable D8.6 “Business cases and Plans”**. This deliverable will analyse the financial viability of the PLURAL technologies and establish the relevant business case.

Figure 13 demonstrates preliminary ways of selling project’s outputs.

FIGURE 13 THE PLURAL SOLUTION’S EXPECTED SALES STRATEGY



There are two main ways how the PLURAL project will go to the market (shown in Figure 13). The first one is that the PLURAL solution will be commercialised at the renovation and real estate market as a complete package of design and technological solutions, covering all aspects of sales requirements (customer tuned design, on-line energy-investment-environmental assessment, fast and reliable construction). Partners including companies (BGTC, RECUAIR, RDR, DEN), SMEs and consultants (AMS, FENIX, PA, ZRS) will offer the package in the market.

Another way is that IPR (Intellectual Property Rights) holders will offer in the market their products and services separately. All PLURAL consortium members can ensure the fast implementation and strong market uptake of all the PLURAL exploitable results (see Table 8). Detailed description of the PLURAL products’ commercialisation is planned to be determined in the upcoming deliverables within WP8 such a deliverables **D8.4 “Business models for PLURAL solutions”** and **D8.6 “Business cases and plans”**.

Because there will be developed separate assembly methodologies for real and virtual demo sites, there will be choice either to establish an entity that will sell all solutions or an entity per assembly methodology.

Partners will decide upon the project’s completion, whether they will commercialise PLURAL products directly or use licensing models.

7.4 Preliminary business model

This and the following section demonstrate preliminary business model and utilisation of project’s products. The precise Business model will be finalised within **WP8, T8.3, D8.4 in the form of report “Business models for PLURAL solutions”** in M36.

Business model demonstrates the way the project technology delivers its value in the form of marketable products. The business models are developed to address the cost-optimal aspects for representative building typologies and climate conditions across Europe, combining the effort of the industrial partners. The PLURAL preliminary business model CANVAS is demonstrated in Figure 14.

FIGURE 14 PRELIMINARY BUSINESS MODEL CANVAS


Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer Segments
Material and components Suppliers; Construction contractors; Marketing company; Transportation company;	Development, optimization and testing; Designing, manufacturing, and assembling; Certification/Standardization Marketing; Training Transportation/shipment	All-in-one, versatile, adaptable, scalable, off-site prefabricated envelop "Plug-and-Use" kits for fast-track, cost-effective and environmentally conscious deep renovation of various residential building typologies in all EU climatic zones	Direct assistance of the manufacturer; Provision of training and instructions;	Building owners; Municipalities; Construction companies; Developers; Building managers; Architects and Designers; Engineers; Assemblers and installers; Real estate
	Key Resources		Channels	
	Materials and components; Technology; Personnel; Facility and equipment; Initial investment;		<i>Communication:</i> advertisements, presentation at relevant fairs and conferences, campaign in relevant media; <i>Distribution:</i> direct/indirect	
Cost Structure		Revenue Streams		
<i>Fixed:</i> salaries, facility, equipment; <i>Variable:</i> the cost of materials and components, transportation, Marketing costs		Direct sales of the prefabricated envelop "Plug-and-Use" kits Maintenance inspections Licensing; Installations		

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

The PLURAL project has external suppliers for some building subcomponents, these suppliers are part of partners' network connections. A potential risk could be that once the project is completed, some partners will leave and there will emerge resource gaps. As a result, the project will have to either search for new suppliers or re-establish contact with existing ones, which would require extra time and effort. The detailed analysis of chosen materials will be provided in **deliverable D2.2 "Technologies and materials selected for the demo sites"**, which will be submitted in **M15**.

If Consortium members decide to sell licenses and produce PLURAL products themselves, at some point its customers could become competitors. Preliminary IPR intentions of partners are listed in deliverable **D10.1 "Knowledge Management and IP strategy"** submitted in **March 2021**. Additionally, IPR intentions for each exploitable result are mentioned in the following section.

Dissemination and communication activities throughout the project will significantly raise the brand awareness and contribute to the market uptake once the commercialisation stage starts. **D9.3 "Dissemination and Communication plan"** was submitted in **M6 within WP9, T9.1**. The plan defines the target audience, communication tools, and appropriate channels to promote the project and its results. Additionally, in **M4** there

	This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958218	45
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were designed project promo materials and in M3 there was created a project website in M3, D9.1 “Project website development” and D9.2 “Promo materials design” respectively.

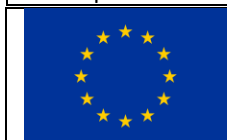
8 Competitors

Due to the growing interest to renovation and offsite construction market, there have recently emerged a lot of projects that propose a variety of solutions. Table 9 demonstrates some of them, which, after completion, could become PLURAL’s technological and market competitors either for the complete PLURAL solution or individual Exploitable results. These projects provide advanced technological systems that can integrate renewable energy sources (RES) and actively contribute to European decarbonisation objectives. Besides, deliverable D1.1 “Requirements: Context of application, building classification, used consideration – Definition of requirements and constraints” studies the following projects: E2REBUILD, 4RinEU, P2ENDURE, PLUG-N-HARVEST, RENOZEB, INNOWEE, HOUSEFUL, DRIVE 0, ABRACADABRA, PROGETONE, MORE-CONNECT.

TABLE 13 POTENTIAL PLURAL’S TECHNOLOGICAL AND MARKET COMPETITORS

Name	Project’s objective	Dates	Coordinator	Grant agreement	Website
A novel decentralised edge-enabled PREsCriptivE and ProacTive framework for increased energy efficiency and well-being in residential buildings	PRECEPT ambitiously aims to set the grounds for the deployment and operation of proactive residential buildings. The proposed framework introduces a “plug-n-play” Prescriptive and Proactive building energy management system (PP-BMS) installed locally at building level, at the Edge-Enable Proactiveness (EEP) device. The proposed PP-BMS is self-adapted, self-learned, -managed, -monitored, -healing and -optimized, requiring no (or minimum) installation costs and no maintenance. PP-BMS transform traditional reactive buildings to proactive ones, increasing their performance (both energy efficiency and occupants’ well-being), exploiting RES, storage, forecasts, and energy tariffs. PRECEPT also targets to the development of a real-time digital representation of the intelligent proactive residential buildings by employing 6D BIM technology.	01.10.2020 – 30.09.2023	WATT AND VOLT ANONIMI ETAIRIA EKMETALL EYSIS ENALLAKTI KON MORFON ENERGEIAS , Greece	958284	https://www.prec-ept-project.eu/

<p>ENvelope mesh aNd digitAl framework for building REnovation</p>	<p>ENSNARE's main objective is to boost the implementation of renovation packages through (1) the digitalisation of the entire process by means of a digital platform and (2) the development of an industrialised envelope mesh enabling fast assembly and interconnection of passive and multifunctional building components. The methodology and tools provided will facilitate the necessary market uptake of novel and highly efficient solutions for nZEB, accelerating the current retrofitting rate and supporting the transformation of the European building stock into a highly efficient and technologically advanced built environment.</p>	<p>01.01.2 021- 31.01.2 025</p>	<p>FUNDACIO N TECNALIA RESEARCH & INNOVATI ON, Spain</p>	<p>958445</p>	<p>https://www.ensnare.eu/</p>
<p>Lightweight switchable smart solutions for energy saving large windows and glass facades</p>	<p>Switch2save targets active management of radiation energy transfer through glass-based building envelopes by integrating transparent energy smart materials with switchable total energy transmission values (g-value). Such materials are electro-chromic (EC) or thermo-chromic (TC) systems. Intelligent switching of those allows significant reduction of both heating energy demand in winter and cooling energy demand in summer. Switch2save's unique and lightweight combined EC and TC smart insulating glass unit will be a breakthrough in performance (plus 20%); low-cost potential (minus 33% manufacturing cost) and increased design opportunities compared to state-of-the-art smart shading solutions.</p>	<p>01.10.2 019- 30.09.2 023</p>	<p>FRAUNHO FER GESELLSCH AFT ZUR FOERDERU NG DER ANGEWAN DTEN FORSCHUN G E.V., Germany</p>	<p>869929</p>	<p>https://switch2save.eu/</p>
<p>Highly advanced modular integration of insulation, energising and storage systems for non-residential buildings</p>	<p>POWERSKIN+ will develop and scale-up eco-innovative, cost-effective, and smart material solutions to renovate existing facade systems of both double skin and advanced integrated curtain walls. It will smart integrate unprecedented highly innovative insulations and renewable energy technologies, with breakthrough features based on nano-formulated VIP, PCM, flexible thin glass perovskite solar cells and multi-functional nano-enabled coatings. Comprehensive POWERSKIN+ portfolio comprising off-site prefabricated modular "ready-to-buy" and 'easy-to-install' glazing and opaque elements, sustainable eco-designed connecting framings and a dedicated large capacity electric building storage system will be processed up to the final commercialisable end products.</p>	<p>01.10.2 019 - 30.09.2 023</p>	<p>INSTITUTO PEDRO NUNES ASSOCIAC AO PARA A INOVACAO E DESENVOL VIMENTO EM CIENCIA E TECNOLOG IA, Portugal</p>	<p>869898</p>	<p>https://www.powerskinplus.eu/</p>
<p>INdustrialised durable building envelope</p>	<p>INFINITE aims at increasing the market penetration of industrialized all-in building envelope kits for the deep renovation, as competitive, reliable,</p>	<p>01.11.2 020 – 30.04.2</p>	<p>ACCADEMI A EUROPEA</p>	<p>958397</p>	<p>https://infinitebuildingren</p>



retrofitting by all-in-one interconnected technology solutions	stakeholders-accepted and life-cycle-based sustainable approach contributing to decarbonisation of the EU building stock. INFINITE will work to narrow the gap towards the full adoption of an industrialized renovation approach developing a set of multi-user and multi-disciplinary tools, and all-in-one industrialised envelope technologies, based on robust business, meeting the demand side requirements, by keeping the focus on final users and all the stakeholders in the value-chain.	025	DI BOLZANO, Italy		www.plural-renovation.eu/
Sustainable Plus Energy Neighbourhoods	Syn.ikia aims at achieving sustainable plus energy neighbourhoods with more than 100% energy savings, 90% renewable energy generation triggered, 100% GHG emission reduction, and 10% life cycle costs reduction, compared to nZEB levels. This will be achieved while ensuring high quality indoor environment and well-being. Our main strategy for achieving these goals is to deliver a blueprint for sustainable plus energy buildings and neighbourhoods, leading the way to plus energy districts and cities.	01.01.2 020- 30.06.2 024	NORGES TEKNISK- NATURVIT ENSKAPELI GE UNIVERSIT ET NTNU, Norway	841850	https://www.synikia.eu/
Mustbe0	9 housing providers in the UK, France, Germany, and the Netherlands have already committed to collaborating on the retrofit of at least 9 demonstrator buildings (415 apartments) using new technologies such as prefabricated facades, insulated rooftops with solar panels, smart heating, and ventilation and cooling installations. By the end of the project, the renovated apartments will be net zero energy (NZE). The project aims at a reduction of costs of 15% from the standard €1100/m ²	2019- 2022	Energiesprong Foundation, Netherlands	N/a	https://www.nweurope.eu/projects/project-search/mustbe0-multi-storey-building-e-0-refurbishment/
PLUG-N-play passive and active multi-modal energy HARVESTing systems, circular economy by design, with high replicability for Self-sufficient Districts Near-Zero Buildings	The main strategic goal of the PLUG-N-HARVEST proposal is to design, develop, demonstrate, and exploit a new modular, plug-n-play concept/product for ADBE - deployable to both residential and non-residential buildings - which can provide high (maximum possible) energy use reductions and high (maximum possible) energy harvesting from RES both at the single-building and the district scale while requiring medium-to-low installation costs and almost-zero operational costs. Moreover, by appropriately exploiting its	01.09.2 017- 30.11.2 021	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS, Greece	768735	https://www.plug-n-harvest.eu/

	attributes, the PLUG-N-HARVEST system will be designed and implemented considering circular economy principles, which will allow implementing new business models based on leasing and renting modes and, by this, leaving the door open to massive implementations.				
Robust and Reliable technology concepts and business models for triggering deep Renovation of Residential buildings in EU	The 4RinEU deep renovation strategy is based on 3 pillars: (i) technology (driven by robustness) to decrease net primary energy use (60 to 70% compared to pre-renovation), allowing a reduction of life cycle costs over 30 years (15% compared to a typical renovation) (ii) methodology (driven by usability) to support the design and implementation of the technologies improving the information flow and knowledge sharing among stakeholders to sustain participative design, ensuring to halve the current renovation time (iii) business models (driven by reliability) to enhance the level of confidence of deep renovation investors, increasing the EU building stock transformation rate up to 3% by 2020.	01.10.2 016- 30.06.2 021	ACCADEMI A EUROPEA DI BOLZANO, Italy	723829	https://4rineu.eu/
Innovative circular solutions and services for new business opportunities in the EU housing sector	HOUSEFUL project proposes an innovative paradigm shift towards a circular economy for the housing sector by demonstrating the feasibility of an integrated systemic service composed of 11 circular solutions. HOUSEFUL will introduce solutions to become more resource efficient throughout the lifecycle of a building, considering an integrated circular approach where energy, materials, waste, and water aspects are considered. This approach fosters new forms of co-creation, increasing the collaboration among stakeholders of the housing value chain to develop new circular solutions and services.	01.05.2 018- 31.10.2 022	ACONDICI ONAMIEN TO TARRASEN SE ASSOCIATI O, Spain	776708	https://houseful.eu/
Innovative prefabricated components including different waste construction materials reducing building energy and minimising environmental impacts	The main objective of InnoWEE is in fact the development of an optimized reuse of Construction and Demolition Waste (CDW) materials producing high add value prefabricated insulating and radiating panels to be used in energy efficient buildings.	01.10.2 016- 30.09.2 020	CONSIGLIO NAZIONAL E DELLE RICHERCH E, Italy	723916	https://innowee.eu/

9 Conclusion

Goals set up in the introduction of this Preliminary market assessment for the PLURAL project, prepared as a part of **WP8, T8.5, D8.7**, have been achieved: the renovation and prefabricated markets in Europe have been evaluated, target countries for the market uptake have been identified, business opportunities have been determined. Detailed analysis will be provided in the following deliverables.


To deepen further, the assessment starts with an explanation of basic marketing theoretical terms and frameworks, which was then used throughout the assessment. The next part describes the current situation in the renovation market in Europe and EU strategy regarding the market. Significant attention is paid to the latest framework, Renovation Wave for Europe, issued in October 2020. Then, there is provided PEST and SWOT analysis on the renovation industry and features of the offsite construction industry are described. The following section gives detailed information on the PLURAL project, including the project definition, its objectives, products, demo sites and competitive advantages. The next most significant part of the assessment is devoted to the market and business model analysis. The section provides information on market identification, market barriers, preliminary details of the 'Go-to-Market' strategy and business model in the form of CANVAS. Besides, it reveals details on the project's products potential commercialisation. The last part lists similar projects that could become PLURAL's competitors for the market uptake.

The market assessment will be regularly updated throughout the project. The document will be used as a basis for creating deliverables **D8.8 Initial Exploitation Plan and IPR manual in M18, D8.9 Final Exploitation Plan and IPR strategy in M48**.



• **Annex 1 Categorised long-term renovation strategies in Member States**

Category	Policy name	Country	Brief description
Innovative financing instruments	SEM POSIT'IF	France	The SEM (Société d'Economie Mixte) Energies Promote, Organise, Support, Imagine the energy Transition in Ile-de-France (POSIT IF) project was implemented between 2013–2016 in Ile-de-France in support of the 38% energy consumption reduction goal set by the region. Among the objectives was the attraction of private market investment through financing instruments like energy service contracts in addition to conventional public grant programmes. To achieve this a semi-public energy service company (ESCO) was established to renovate condominiums and public buildings, thereby attracting external expertise while giving local policymakers influence on the activities of the company.
	Réseau Canopée Logement Social	France	The Réseau Canopée Logement Social project was established in 2018 and will renovate 4,300 social housing units in France, as well as constructing 1,200 new ones. The platform will pool investment projects of the four relatively small housing agencies and will provide the necessary affordable long-term financing to allow rents to remain low after renovation.
	New Green Savings Programme	Czech Republic	The New Green Savings Programme provides residential building owners with subsidies for renovation activities like expert advice, fabric insulation, heating source and system replacement, solar thermal electricity generation, ventilation systems with heat recovery, heat recovery from wastewater, and green roofs. It is funded by the State Environmental Fund of the Czech Republic. Targeted building typologies are single-family buildings and apartment buildings in Prague, which are considered a high priority.
	Green bonds for municipalities	Sweden	In the Swedish LTRS, 'green bonds' are mentioned as relatively new and innovative financing tools that have received increasing attention. Stakeholders ranging from municipalities to building owners have shown interest in the bonds, which earmark capital for projects and activities with positive environmental impact.
	Green Home certification and green mortgage programme	Romania	The Romania Green Building Council has developed a green mortgage product rewarding energy efficiency and environmental responsibility in the building sector, in collaboration with a leading regional bank. The green mortgage includes a discounted mortgage pricing for the purchase of 'Green Home' certified residential buildings.
	On-bill and on-tax financing	EuroPACE and RenOnBill project	On-bill schemes involve the private sector, mostly utilities, in the energy efficiency market and create new business models for utilities or other financial or third-party institutions. There are various models of on-bill financing schemes that differ in the source of financing, the association with the property's meter or the property tax and underwriting methodologies. However, the main concept is that an utility or other investor with whom the building owner/tenant already has a relationship pays for the energy performance investments, and these are then repaid by the building owner/tenant via their monthly utility bill or regular taxes. If the loan is attached to the meter of the property, the final user pays an additional on-bill tariff and can transfer this debt to another user if the building/apartment is sold or there is a change in tenants. In most cases the on-bill programmes aim to ensure 'bill neutrality', which means that the energy savings offset the monthly additional loan or tariff added to the bill.
Public buildings	RenoWatt	Belgium	RenoWatt is a platform that functions as a one-stop-shop for public buildings in Wallonia. The pilot phase of the project between 2014–2017 proved its effectiveness in the province of Liège, winning the 'EU Best Energy Service Project 2017' prize. Building typologies covered




	This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958218	51
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			include public administration, schools, and healthcare. RenoWatt aims to reduce CO2 emissions with 40% compared to 1990 level, generate 32% renewable energy, and reduce energy consumption with 32%.
	Public Sector Energy Efficiency Strategy	Ireland	The Public Sector Energy Efficiency Strategy was published in 2017 and functions as a concrete renovation strategy for public buildings. The strategy contains a plan with concrete actions and objectives to achieve energy-efficiency goals for the public sector. The strategy aims to make public buildings more energy-efficient and sets energy efficiency targets for 2020 against the benchmark year 2009 (33% more efficient in 2020 and 50% in 2030). Besides improving energy efficiency, the goal is to ensure that structured energy management becomes an integrated part of sustainable resource management across the public sector.
	SPL OSER	France	SPL (Société Publique Locale) Oser is a publicly owned company that designs and implements deep energy renovation projects for public buildings like schools and administrative buildings. SPL Oser also gives energy performance guarantees and strives to create jobs.
	REHABITARE programme	Region of Castilla-León (Spain)	The central objective of the REHABITARE programme is to enlarge the public social housing stock and support population in rural areas. The programme provides grants for the renovation of publicly owned but abandoned properties. This reduces vacancy of buildings, combating depopulation and meeting housing demands of vulnerable societal groups, in particular young people.
Tailored approaches for specific stakeholders	PadovaFIT one-stop-shop targeting multi-apartment buildings	Italy, Bulgaria, Romania	PadovaFIT describes a one-stop-shop (OSS) business model targeting multiapartment buildings and public service facilities, implemented in close collaboration with local authorities. The OSS offers an integrated service to private and public homeowners. Standardised contracts and technical procedures to reduce costs and improve the quality of renovation measures were implemented by a consortium led by the municipality of Padova.
	JESSICA II multi-family building modernisation programme	Lithuania	The modernisation programme in Lithuania implements energy efficiency upgrades in multi-apartment buildings financed by a EUR 150 million revolving fund established through the EU's Structural and Investment Funds 2014–2020. The JESSICA II financing scheme is managed by the EIB and funds energy-efficiency projects in residential housing in Lithuania by preferential loans and leveraging private investment, building on the successful first phase of the scheme which ran until 2013. The scheme mostly addresses energy-poor homeowners' associations as most apartment buildings in Lithuania are privately owned, which means a majority vote is needed to initiate the renovation of a building – and homeowners have little incentive to invest.
	Better Energy Communities grant scheme	Ireland	The Better Energy Communities (BEC) scheme is one of the main grant schemes administered by the Sustainable Energy Authority of Ireland (SEAI), and aims at reducing the fossil fuel usage, energy costs and GHG emissions of the national building stock. The BEC scheme, which started in 2012, supports innovative community-oriented projects from various sectors, including residential housing upgrades and non-residential building works, and accepts applications from commercial and voluntary organizations, the public sector, and private homeowners, with a focus on vulnerable groups.
	Environmental Fund for Schools	Romania	The Romanian Environmental Fund for Schools aims to improve energy efficiency and foster intelligent energy management in public schools. The goals are both reduction of greenhouse gases and the modernisation of school buildings.
Data collection and storage	Woningpas	Flanders	Woningpas (Housing Pass) is a digital building passport for residential buildings in Flanders that was launched in late 2018. The Woningpas functions as a unique digital file linking multiple data sets about a

			particular building, to which building owners and their appointed representatives have access.
	EFEKT programme: Energy management systems for municipalities	Czech Republic	The grant for energy management systems in Czechia is part of the larger EFEKT programme and aims to reduce primary energy consumption through intelligent energy management in public authority buildings. This measure is mentioned as one of the strategies to improve data collection in public buildings.
	Passeport Efficacité Énergétique (P2E)	France	The Energy Efficiency Passport (P2E) in France is an experimental tool that provides an energy audit and tailored building renovation roadmap to individual residential buildings. The roadmap indicates the renovation phases, the level of performance that can be achieved, and an estimation of renovation costs. The objective is to foster the decarbonisation of the building stock.
	Klimatdeklaration	Sweden	The aim of Klimatdeklarations ('Climate Declarations') is to reduce the climate impact of newly constructed buildings. The upstream emissions in the lifetime of buildings are not sufficiently accounted for. The climate declaration will include all embodied emissions for the construction materials and the construction process of a new building.
	EPISCOPE	Northside Dublin Pilot	The goal of Ireland's EPISCOPE project is to track progress in energy renovation of the housing stock, in particular thermal insulation, and heat supply, in the context of energy savings and climate protection. EPC databases combined with other building information are visualised on an interactive website.
Holistic urban planning processes	District approach	The Netherlands	The Dutch government and nationwide transition partners agreed upon the 'district approach' (Wijkgerichte aanpak) in the national Climate Agreement in 2019. Within this planning approach to decarbonise the Dutch building stock, regional and local authorities play a prominent role.
	e5 scheme for municipalities	Austria	The e5 scheme for energy-efficient municipalities was initiated in Austria in 1998 by the federal states of Salzburg, Tirol, and Vorarlberg to support the long-term integrative planning of municipal climate protection and energy efficiency efforts. The scheme supports municipalities in implementing long-term measures and evaluates their effectiveness in a comprehensive and consistent approach. The e5 tools and support improve processes, identify potential for improvement and facilitate the participation of a range of stakeholders in energy policy decisions and activities.
	Regional and local long-term renovation strategies	Spain	Innovation in planning, management, and municipal renovation finance in the form of local renovation strategies. Essential elements in such strategies are the identification of spatial priority areas and subsequently timelines, financial support schemes and urban management tools to implement the strategies. Various concrete good-practice examples are provided from small, medium-sized, and large municipalities.

Source: https://www.bpie.eu/wp-content/uploads/2021/03/OurBuildings-Long-term-renovation-strategies-report_final.pdf

• **Annex 2 The three real demonstration buildings**

Real demo-cases	Prague, Czech Republic	Barcelona, Spain	Athens, Greece
Name	Kašava	Terrassa	VVV
Photo			
Location & Description	The “Kašava” multiple dwelling is situated in the North-East part of the Zlín region (ca. 17 km from Zlín). It is composed by 2 flats for the teachers of nearby nursery school and is permanently occupied. The façade is made by 45 cm full brick wall (no insulation). The building is classified as “F” in the energy consumption system used in the Czech legislation. The envelop will be renovated in PLURAL (ca. 400m ² façade including windows).	Situated in the southwest of the city of Terrassa (Barcelona), the building is composed by two residential blocks, and a commercial space (not included in pilot case). All of them are placed in a “U” form. with a common courtyard in the middle. PLURAL solutions will be implemented in one block (18 dwelling).	The building is protected by Municipality of Voula, Athens (VVV). It was renovated in the 1980s and now is operated as a free of charge shelter for homeless or low waged families (10 apartments). The building currently has 21 ³⁷ residents. The first floor will be retrofitted.
Climatic zone	Continental Warm-humid (12 C)	Mediterranean-mild summer	Mediterranean-hot summer
Typology	Multiple dwelling house	Block of residential dwellings	Block of residential dwellings
Construction, year	Full brick, 1962	2008	1971
Number of floors	3 (1 cellar floor and 2 living floors)	3	4
Surface area	150 m ²	1280 m ² (in PLURAL block)	669,8 m ²
Façade area	134 m ²	725 m ² (in PLURAL block)	299,4 m ²
Roof area	150 m ²	262,74 m ² (in PLURAL block)	133,81 m ²
Window area	30 m ² windows + 11 m ² doors and gate to the garage	137,21 m ² façade windows surface + 22,7 m ² roof windows surface	
Wall U-value	0,8 W/m ² K	1,60 W/m ² K	2,44 W/m ² K
Window U-value	1,4 W/m ² K	3,78 W/m ² K ³⁶	4,20 W/m ² K
Heating energy use	210 kWh/m ² y	87,4 kWh/m ² y	211,9 kWh/m ² y
Cooling energy use	0 kWh/m ² y	30,2 kWh/m ² y ³⁶	43,1 kWh/m ² y ³⁷
Lightning	11 kWh/m ² y	Unknown	Unknown
Hot water	N/A	Unknown	Unknown
Ambition of PLURAL (What will be renovated, expected time and cost)	Deep renovation towards nZEB with the eWHC concept. The all-in-one approach will be proven and demonstrated and compared to conventional renovation procedures. All facades of the building will be renovated using the PLURAL	The PLURAL solutions will be implemented in the East block facades. 590 m ² of façade will be renovated in 12 apartments. The AI frame eAHC kit will integrate: <ul style="list-style-type: none"> • Insulation 	2 ³⁷ apartments will be renovated with “Smart Walls” including: <ul style="list-style-type: none"> • Innovative windows, • Fan coil, • PV panels,

³⁶ Data was changed according to deliverable D1.6 that provided detailed analysis

³⁷ Data was changed according to partners’ input

savings)	<p>solution (eWHC)</p> <ul style="list-style-type: none"> Gas boiler heat source will be replaced by Heat Pump (DAI) facade panels with air handling and heating/cooling system/installation (SPF, RDR) Windows (RDR, BGTC) New control system, monitoring (CVUT, SPF) Integration of BIPV system and/or solar thermal for DHW (RDR). (Virtual) inclusion of fully prefab roof (budget not foreseen in PLURAL). 	<ul style="list-style-type: none"> PV panels Ventilation units Innovative windows Folding blinds <p>Aluminium profiles will also be used on the roof to support extra PV panel.</p>	<ul style="list-style-type: none"> Solar panels, Heat pumps, Control Toolbox, Multifunctional coatings.
Renovation budget secured by building owner	<p>Funds are secured via the region of Zlin and the Mayor of “Kašava” for the renovation of the two sister buildings. The municipality plans to reconstruct the bigger building with national funding (30% IROP-insulation, windows, doors, etc.) Available budget for renovation is ca.375,000 €.</p>	<p>AHC will finance 602,000 € to finish the whole complex and solve existing pathologies</p>	<p>VVV will finance 350,000€ by its own funds to complete the planned renovation.</p>

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage

• **Annex 3 The three virtual demonstration buildings**

Virtual demo cases	Bern, Switzerland	Berlin, Germany	Väsby, Sweden
Name	BERN	BERLIN	Dragonvägen, Upplands Väsby
Photo			
Description	Multi-family building from 1964 located in Switzerland with low insulation level. Massive construction with monolithic brick. Deep renovation by Swissrenova and SPF in a national pilot and demonstration project called "ProsumerSkin".	Energetic refurbishment of a detached house with separate apartment (1965 construction) with natural building materials. Brick masonry 36,5 cm, uninsulated, ext. plaster 1,5 cm, int. plaster 2,0 cm. External wall is ventilated timber façade or insulated and plastered with lime. Mechanical ventilation with heat recovery and PV for electricity generation.	A centre with a large selection of buildings with commercial and residential purpose (usual apartments & apartments for special groups e.g., seniors and youth)
Climatic zone Typology Construction, year Number of floors Surface area Façade area Roof area Window area Wall U-value Window U-value Heating energy use Cooling energy use Lightning Hot water	Continental Multi-apartment building 1964 4 1861 m ² 1075 m ² 393 m ² 128 m ² 0,78 - 1,3 W/m ² K 1,6 – 2,4 W/m ² K 128 kWh/m ² y 0 kWh/m ² y Unknown 11 kWh/m ² y	Northern Europe Single-family housing 1965 2 400 m ² 255 m ² 145 m ² 45 m ² 1,2 W/m ² K 3,0 W/m ² K Unknown Unknown Unknown Unknown	Nordic (Sweden) Multi-residential building 1960 8 6700 m ² 5167 m ² Roof is included above 859 m ² 0,45 W/m ² K 2,8 W/m ² K 125,8 W/m ² K 0 8,5 W/m ² K Unknown
Ambition of PLURAL (What will be renovated, expected time, and cost savings)	The SEM concept was already applied on this building but the all-in-one approach was not reached. Comparing with the PLURAL concept will give detailed cost and time saving data.	For both cases, the PLURAL concept will be virtually implemented at the pre-renovated building to compare the PLURAL deep renovation using PnU kits with conventional renovation in terms of energy performance, time, and cost savings. ZRS will provide information and data regarding the already realized renovation (envelop materials, windows, energy systems, energy performance certificates, time, and cost for realised renovation) to be compared with the PLURAL solutions in WP7.	

Source: Grant Agreement number: 958218 — PLURAL — H2020-NMBP-ST-IND-2018-2020 / H2020-NMBP-ST-IND-2020-singlestage