MEZeroE

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Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

Report on value chain and innovation workflows for nEES

July 2022

Work Package 3

Deliverable 3.1

Dissemination level
Public

The MEZeroE Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953157

Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

Deliverable No.	D3.1	dates
Related WP	WP3	
Deliverable Title	Report on value chain and innovation workflows for nEES	
Deliverable Dates	2022-07-31	
Deliverable Type	Report	
Dissemination level	Public	
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Approved by	Project Coordinator	2022-07-25
Status	Final	2022-07-25

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1 Executive summary

Technological innovation in the construction sector is considerably difficult to implement due to several factors such as the fragmentation and complexity of this sector. Many disciplines are involved at various stages, design and production are usually separated, there is a large number of players with a vast majority of small-medium enterprises (SME), and supply chains are long and variegated. As a result, gathering the different specialists together is difficult, and many potentially effective innovative solutions do not even reach the market.

H2020 MEZeroE project aims at tackling this complex issue by creating an EU distributed open innovation ecosystem for (i) developing nearly Zero Energy Building (nZEB) Enabler Envelope technology solutions; (ii) transferring knowledge; (iii) matching testing needs with existing facilities; (iv) providing monitoring in living labs; and;(v) standardizing cutting-edge solutions coming from SMEs and larger industries, to foster inclusive change in the building sector, being accessible via a single-entry point to all users.

MEZeroE ecosystem will be accessed via a single-entry point web-based multi-side virtual marketplace which will include 9 Pilot Measurement & Verification Lines (PM&VL), 3 Open Innovation Services (OIS), and resources for training, business model development, systematic intellectual property (IP) and knowledge management. MEzeroE will fast-track prototypes to the market as fully characterized products.

To better shape the modelling, testing and additional capabilities that will be offered by PM&VLs and OISs, one of the first step of MEZeroE development has been a comprehensive study of the current value chain of the nZEB Enabler Envelope Solution (nEES) Companies in order to map technical areas with high innovation potential and this prioritizing action according to their expected impact on the market.

The companies that participated in the study deals with several envelop aspects such as flexible structural connectors transferring loads and deformations, integration of photovoltaic in a brick-and-steel mesh to control sunlight for energy production and lighting, prefabricated multifunctional façades for integrating different services to achieve nZEB, insulating foam used to manufacture window frames, smart vapor control membranes and fastening systems for timber buildings, and advanced nanomaterial coatings for air purification and innovative glazing systems.

The current innovation workflows have been identified through a preliminary value chain analysis of the companies in which, through a questionnaire, the innovation potentials for the different technologies have been highlighted. Based on that, a series of MEZeroE services to reach the innovation goal for each technology has been defined, providing cash flow projections for the services themselves and drafting a path to be followed within the MEZeroE environment to perform the proposed innovation steps. In addition, industrial partners were asked to complete one more questionnaire specifically focused on the identification of the innovation potential areas within their Companies. The results showed a diffused lack of resources for technology development and testing activities, and this is likely to be due to time and cost issues. Furthermore, the strong need for support for market penetration emerged. Finally, most companies positively consider the possibility of outsourcing and collaborating with other institutions or companies in an open innovation perspective.

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The overall results of the study are (i) the evidence of the need for support to Companies in having effective quantitative methods and suitable technologies to achieve the innovation path, (ii) the presence of an overall interest in cooperation and open innovation approach to foster innovation, (iii) the need of funds, financial schemes and simplified processes for certification to support innovation actions within Companies.

Lastly, this study also highlighted how the proposed services are interconnected and may be optimally scheduled in order to perform a comprehensive innovation process. Depending on the value chain of each envelope product and company needs, the process may be followed partially or in full.

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2 Introduction

This document reports the results of the analyses performed within the Task 3.1 of the MEZeroE Project, namely “Value chain and innovation workflows for nZEB Enabler Envelope Solution (nEES)”.

One of the main objectives of the Work Package 3, that has to do with testing and modelling the nEES, is to acquire a thorough value chain knowledge for the current market situation and map technical areas with high innovation potential, prioritizing actions according to their expected impact on the market. Indeed, the definition of the current status related to innovative products and innovation potential needs as the first step to set the priority on which products have to be tested and how to test them within Pilot Measurement and Verification Lines.

Therefore, here the focus has been initially put on defining the building envelope products value chains, and, thanks to industrial partner feedbacks and business experience, they have been used to highlight bottle necks and rooms for improvement, as well as desired/perceived innovation areas.

Then, a further step has been done assessing, for most of the innovation workflows identified, a possible cashflow projections for the testing line use and technology transfer pricing.

3 Value chain and innovation workflows

In order to highlight possible bottle necks and rooms for improvement, as well as desired/perceived areas and products with high innovation potential, each Company has been asked to map its value chain and to fill in a questionnaire specifically dedicated to the identification of possible innovation areas.

In the following part of the document, the methodology and the results of this activity will be presented, although, due to confidentiality, references to specific Companies will be avoided.

3.1 Methodology

Value chain is one of the most valuable instruments in order to fully understand the nature of competitive advantage between Companies. In fact, this may be included in each of the activities performed, from design to production, from sale to customer care. The value chain helps in the disaggregation of the strategic activities, and it is useful to understand cost trends and possible differentiations within the Company activities. Of course, the value chain of a single Company is part of a wider system which is including also the value chains from different Companies involved in the production, supply and distribution chain, as well as those from clients. When we describe value chains, we are describing the relationships between all the economic actors who deliver a product or service with a specific value for their end user. This value comes from the benefit the final user gains from this product or service.

The typical value chain scheme, theorized by Michael Porter in the 1985 and reported below (Figure 1), is composed by 9 interconnected activity categories.

Figure 1 Value chain scheme by M. Porter

The activities, although they can be analysed separately, are interconnected between them, depending on the context and strategies of the Company itself.

Hence, the first step of the work performed in Task 3.1 has been related to let the Industrial partner to fill in this matrix, that has been proposed, unpacked, in form of an excel file.

Filling in the value chain of the Company should have highlighted the main innovation areas within the whole production process. Indeed, innovation may be related to the product itself, but also to the complete production chain, bringing from design to market uptake.

That is why a comprehensive value chain has been asked to industrial partners at the preliminary stages of the work package dealing with testing new products to bring the innovation forward.

The activities which can create a value are divided in two main areas:

- Primary activities – they deal with the practical realization of the product or service, its sale and assistance after being sold.

- Support activities – they support primary activities and provide to the entire Company inputs, human resources, technologies and other services.

In addition to the primary and support activities, there are also the infra-structural activities. These are not associated specifically with any of the primary activities but refer to the whole chain.

According to the value chain scheme in Figure 1, primary activities can be grouped in 5 categories as follow:

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- Inbound logistics: How are materials and resources gained from suppliers before the final product or service can be developed? Which are the activities connected to receive and store materials in the stock?

- Operation/Production: How are the materials and resources produced, resulting in a final product or service? Which are the activities related to transforming "raw" materials into final products? (Also considering machinery and the managing of the production line as well as its maintenance)

- Outbound Logistics: Once a product or service is finished, it needs to be distributed. How does the delivery process work? Which are the activities related to stocking final products as well as programming products delivery?

- Marketing & Sales: How is your product presented and sold to your ideal market? How are the activities connected to the analyses of purchase behaviour performed? Are they contributing to determining prices and sale channels?

- Service: How is your business providing support to the customer? (e.g., training for the product, warranties, guarantees?) Which are in general the activities dealing with during- and post- sell phases? (e.g., improving the perception of the purchased product, installation, managing maintenance and the customer satisfaction?)

On the other hand, support activities can be grouped in 4 categories:

- Human Resources Management: Which are typically your Company strategies in order to manage employees and hiring new staff in all the Company areas?

- Technology development: Technology can be used in various steps of the value chain to gain an advantage over competitors by increasing efficiency or decreasing production costs. How does your Company innovate? (Taking into account everything related to technologies, know-how and procedures to develop products e.g., preparing documents, moving products around the factory, production processes, developing new design etc.)

- Procurement/Supply: How resources and materials for your products are sourced? How high-quality suppliers are found? Which are the activities related with the acquisition of productive factors (e.g., raw material, machines, services, software etc.)?

- Firm infrastructure: Depending on the Company infrastructure, different activities can support the whole chain (e.g., general direction, administration, financial and legal issues, quality management); which are, in general, the management, financial and legal systems that the Company uses in order to make business decisions?

Furthermore, beside defining the value chain scheme, industrial partners have been asked to fill in another questionnaire related specifically to identify the innovation potential areas within their Companies. These questions have been a sort of follow-up of the questionnaire referring to barriers

identified in Task 2.1 and reported in the related D2.1 deliverable ("Needs/requirements and barriers breaking innovation of building envelope products").

Here below, the series of questions are reported:

In which of the **areas** identified in the value chain (*primary and/or support activities*) do you see more space for improvement?
Which are the **connections** between different value chain areas (*primary and/or support activities*) that should be further improved? Where could it be useful to have better communication/connection between different areas?
In which areas of the value chain do you identify a higher **innovation potential**?
If any, where do you identify bottle necks concerning the development of innovation processes and products in your Company?
In R&D area, where do you identify a higher space for improvement?
What give the input to innovation processes and innovative products in your Company?
How do you usually approach innovation processes and new ideas developed within the Company? How do these ideas become products?
Is your Company directly following innovative processes which are outsourced to other Companies?
How do you evaluate the support by University and Research Institutes in the Innovation process?
How do you evaluate the support of other external Companies in the innovation process (i.e., having in mind an OPEN INNOVATION approach, where could you contribute to or take the advantage from innovative processes or products by other Companies)?
Are you involved in any specific product or process innovation program that involves collaboration with other companies?
How does your company typically manage to find economic resources to carry out innovation processes and innovative products? (National fundings, European fundings, internal resources, etc.)
In case your company carries out collaborative innovation processes or collaborative innovative product development with other companies or universities, how is your company managing the product/process property rights?

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3.2 Results

In this chapter, the results from the value chain analysis and innovation potential analysis performed by the different Industrial Partners are reported.

Concerning the value chain, the available results are reported in form of tables, one per each Company that provided information. In the table, the main areas of the value chain scheme are mentioned. In the case of the questionnaire on innovation potential areas, per each question a summary of the available answers is reported. In order to keep all the feedbacks from Companies anonymized, Companies names are not mentioned, and they are just referred to as Company 1, 2, 3, etc.

Here below a brief description of the envelope product's sector covered by the Companies participating in the following study:

- Flexible structural connectors transferring loads and deformations.
- Integration of PV in a brick and steel mesh to control sunlight for energy production and lighting
- Prefabricated multifunctional façades for integrating different services to achieve nZEB.
- Insulating foam used to manufacture window frames.
- Smart vapor control membranes and fastening systems for timber buildings
- Advanced nanomaterial coatings for air purification and innovative glazing systems.

3.2.1 Results on value chain of MEZeroE Industrial partners

Below, the available results of the value chain description provided by industrial partners of the MEZeroE project are presented. Table 1 reported in ANNEX 1 summarize the Primary Activities and Table 2 in ANNEX 2 is related to the Support Activities.

3.2.2 Results on innovation potential for MEZeroE Industrial Companies

In **Errore. L'origine riferimento non è stata trovata.** reported in ANNEX 3, the available answers from the MEZeroE Industrial Partners focusing on the innovation potential of their Companies are reported. In particular, it has been asked to the partners to highlight possible space for improvement in general activities after having described their Company's value chain and, afterwards, identifying the specific internal processes and strategies to foster innovation and innovative products' production within the Company.

3.3 Summary questionnaire results

The results from previous questionnaires to Project's Industrial partners have been further analysed in order to define which specific services provided by the Project could satisfy the needs highlighted from their replies. The results of this analyses are collected in Table 4 and Table 5, provided in the separated annexes, attached to the present deliverable, respectively ANNEX 4 and ANNEX 5.

In particular, the answers to the questionnaire have been evaluated and summarized, and, using a matrix structure (ANNEX 4), all the needs have been assigned to one or more Project services, including OISs and PM&VLs. Indeed, needs for innovation potential could be both on testing and

prototyping level or more related to the use of the open innovation services for reaching a certification or being guided through market penetration.

After this matching process, an overview on how MEZeroE services could satisfy Industrial partners needs was available. Thus, assuming that the Industrial partners within the Project may be considered as representative of the Companies category related to their own specific market sector, it can be possible to extend the evaluation performed on innovation potential of those Companies on a wider scale.

In the table reported in ANNEX 5, an overview of the results of this analysis is shown, where “needed” means that a specific Project service has been identified as the most appropriate to satisfy a specific Company need.

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4 Cashflow projection for testing line use

After defining whether a MEZeroE service could satisfy a Company need in terms of innovation willingness, a cost for the use of the service has been assigned to these needs. The aim of this estimation was to answer to the question: *"How much would it cost to a Company to achieve its innovation targets (as those emerged by questionnaires reported in 3.3) by using MEZeroE offered services?"*

Hence, an estimation of the cost for each service (OISs and PM&VLs) has been defined, asking to services providers within the consortium. Hence, partners responsible of each services estimated the cost for offering the activities related to the use of the PM&VL or OIS they are involved in.

Table 1 summarizes the expenses that each envelope market sector's related Company should spend, accordingly to the needs identified through the questionnaires in previous section, to reach its innovation goals using the services developed within the MEZeroE Project. Of course, the numbers provided by in these first phases should be further refined and compared to the market expectations and trends, as well as with real Companies willingness to pay. Ranges in the table depends on the huge variety of services and activities that may be offered by each provider. Furthermore, it is quite variable the entity and number of activities connected to the use of a specific service or test.

Envelope Market Sector	Estimated costs to fully reach innovation goals through MEZeroE services
Advanced Material for Window Frame	between 135.500€ and 160.000€
Advanced Surface Coatings	between 176.200€ and 291.500€
Components for Hygrothermal management of building envelope	between 145.500€ and 200.500€
Facade Integrated PV Shading System	between 121.500€ and 163.500€
Flexible Structural Connectors	between 216.700€ and 401.700€

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Multifunctional Facade Component integrating HVAC system	between 150.000€ and 200.000€

Table 1 Estimated costs for reaching Innovation goals using services (PM&VLs and OIS) offered by MEZeroE

5 Conclusions

Starting from the description of the value chains of the project's industrial partners, their needs have been identified and associated to one or more services within MEZeroE which are the most appropriate to satisfy them. At the end of this process, a rough estimation of the cost that the company should spend in order to perform the innovation process, including technology transfer pricing and testing activities, hence using the services offered by MEZeroE (represented in the scheme in Figure 2), has been defined.

In the scheme in Figure 2, the MEZeroE service map where a company assessing the project would be integrated (at different and/or multiple level) is represented. The scheme shows how all the services are interconnected and scheduled in order to perform a comprehensive innovation process.

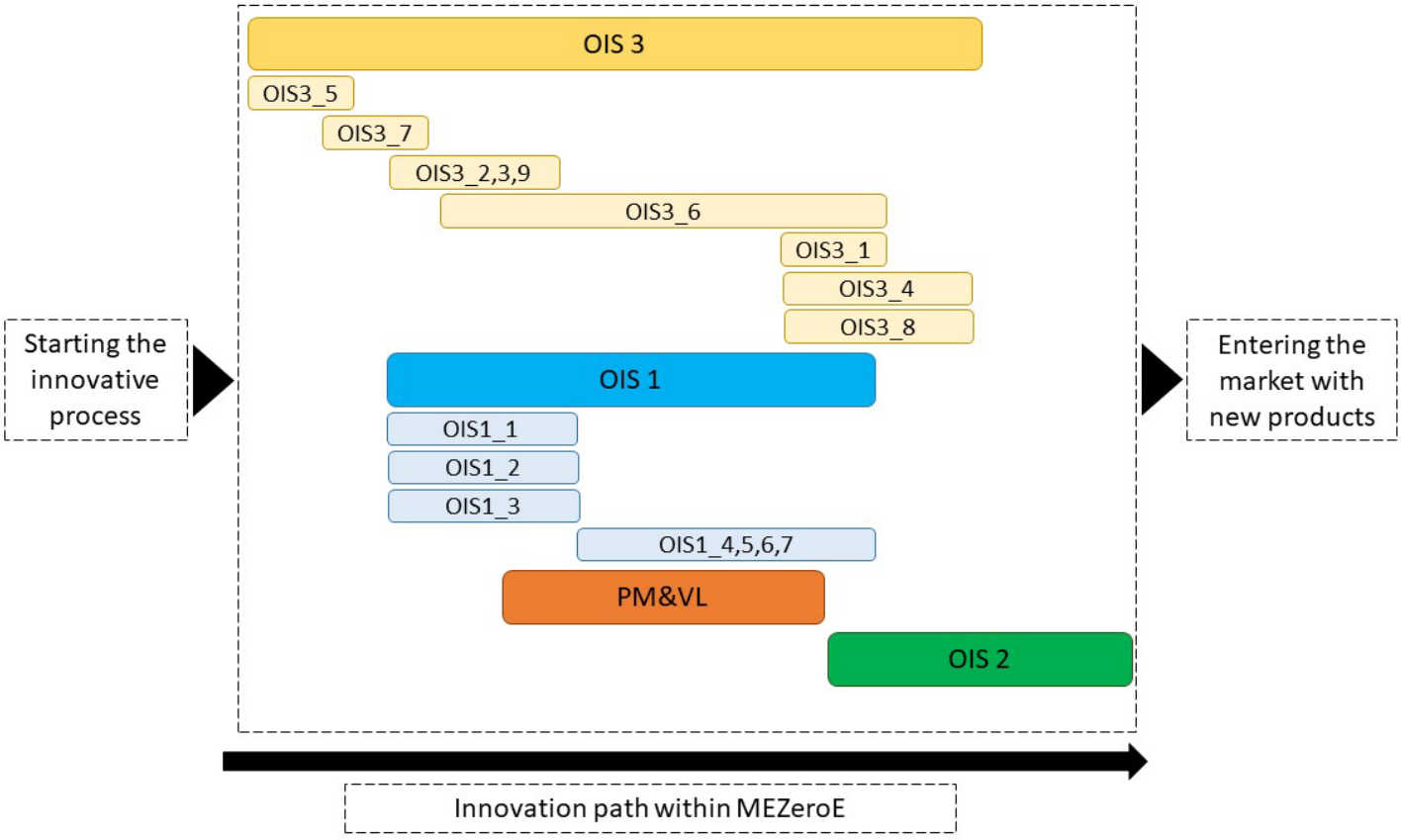

Figure 2 Innovation process within MEZeroE

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The whole innovation process of Figure 2 summarizes the MEZeroE offered services which should be integrated in the value chain of each generic envelope product Company, such as those represented by the industrial partners within the project, in order to foster innovation at product level.

Furthermore, considering the increasing need for industrialization and digitalization in the building sector to increase the market penetration potential of innovative solutions, the whole innovation process identified within the Task 3.1, as reported in this deliverable, could be usefully integrated within a wider scheme, such as the Value Stream Mapping[1]. Thus, for each envelope product, it would be defined as the most suitable industrial process coupled with a detailed digital information data flow, both integrating the processes identified in Figure 2, offered by MEZeroE innovation path. This approach, which is mapping the entire industrial process including both material and data flow, it provides a clear overview of how the MEZeroE services can integrate and enrich the path through innovation within a Company.

This approach, combined with the definition of a new digital strategy, such as the one offered by MEZeroE through the BIM dataset exploitation, under development into Task 3,2 as part of OIS 3 and also in collaboration with OIS1, to describe innovative products, will contribute bring to the market innovative products for the building sector, reaching the innovation goals as aimed by envelope product's Companies.

The work performed in Task 3.1 and described within this Deliverable has been needed in order to have an overview of the main innovation potential areas within nZEB Enabler Envelope Solution Companies, as well as for defining most critical bottle necks and space for improvements within Companies production processes. The work performed in this task created awareness on these aspects, demonstrating how the use of the Pilot Measurement and Verification Lines (T2.2 and T3.4), together with the use of the Open Innovation Services (T2.3 and T3.5) offered within the MEZeroE framework, can provide the proper means to reach innovation goals aimed by the Companies.

[1] "Value stream engineering-four paradigms for process design in industrial engineering" Schweizer, W. 2011 - 21st International Conference on Production Research

Annexes

ANNEX 1

Table 1: Value Chain Primary Activities

PRIMARY ACTIVITIES	Inbound Logistics	**Company 1** The Company give exclusive sublicense for distributing the patented technology of the main material used. Materials are ordered enough earlier because of long delivery time. Inbound materials are ordered in the amount and type directly needed for testing or products' manufacturing. Practically there is no storing of the material in the stock. The material is purchased by the company and are used for prefabrication of products in a manufacturing site or taken on site for application. Other possibility is purchasing of materials by company's client (only after designing and permission given by the company) and used for application on site under company's supervision. In case some material needs to be stocked, this can be done in the warehouse at room temperature. Control of expiration dates of the material is of great importance. Materials are delivered in hermetic canes. Some inbound materials are tested according to standards using the company's testing machine. **Company 2** Concerning the suppliers, the company considers two types: those who have an ISO or a Quality Management System (QMS), and those who do not have. The formers are preferred. The latter are asked about the control system of their product. Concerning the inbound materials, there are registers for the incoming material. The registers cover aspects as: Characteristics of the components, control method, acceptance criterion and frequency of the control. A reference numbers and types are assigned to the inbound package or material and finally they are stocked in-house. **Company 3** The Company has a dedicated department called acceptance office which manage the truck arrival, the unloading of the truck, materials registration, materials control, and the following storage placement or eventually shipment to other company. Within the department there are different sub-team which tackle the phase of the inbound goods depending on the type of materials. All the inbound materials have an identification code. Furthermore, the Company has wide indoor and outdoor space for the materials storage. The storage activities depend by different factor: the category of the materials, the machining they will need and the priority they have in the manufacturing process. Regarding the testing and checking phase, the Company has a dedicate team called quality control which regularly check and monitor the arrived materials. Visual control, dimension control, damaging control, etc. In some cases, the quality control team check the materials before they arrive to the Company. **Company 4** Materials for producing the product are ordered, their documentation is checked and then stored in the Company. **Company 6** The Company uses an application where inbound material/products stocked are controlled. This allows to know when it's necessary to order new materials or produce new products. Inbound materials are received, validated and then they are stored according to their properties (flammable, toxic, etc.) The purity of the specific inbound materials is checked by a dedicated quality control.
	Operation/ Production	**Company 1**

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		The material is prepared with specific geometry for prefabricated elements or directly prepared in-situ for application. If prefabrication is needed, forms are prepared according to requirements of clients and the final product are stocked. For the application on site, the product is applied after having delimitated the intervention area. The material requires in both scenarios up to 24 hours (maximum) to be ready for final use. Prefabricated elements are protected against dust and packed according to volume and transportation requirements. **Company 2** The company does not perform any manufacturing. The company basically buys the components and assembles them in its facilities. The assembly is carried out by workers following a technical plan and architectural design of the final element. The production process follows a control plan where all these topics are checked: inner material, acceptance criterion, rejected material, storage, assembly process, packaging and final product control. It must be noted that there are no activities related to transforming raw material into final products. The Company is managing just the assembly. **Company 3** The Company does not transform raw materials but assembles different technologies together in single components. The first phase of the production is managed by the cutting and machining department which uses computerized numerical control machines (CNC). The assembling phase is organized in production lines which is a set of sequential operations established in a factory where all the components are assembled. In this way all the operators improve their expertise in a specific action. **Company 4** At this phase products are currently made with a low productive technology, aiming to automate the whole process once obtained the required financial resources. **Company 6** The production phase is performed in chemical reactors in the Company factory, using pumps and shakers, among others. Specific restrictions and rules are kept in order to respect safety issues related to the use of large amount of chemicals. Then, the packaging phases are performed mechanically and manually depending on the type and volume of the package.
	Outbound Logistics	**Company 1** Products are manufactured only on demand and payment for ready products must be done in advance. In specific circumstances, the payment can be done also after finishing the work. The company does not stock final products for long time. Generally, client pick up products from the company's warehouse just after manufacturing. Usually, the transport is ordered by the client. **Company 2** The product is distributed by trucks and there is an order tracking of it. Once the product is delivered, the Company offers two possibilities: 1) sending workers on site to perform the installation of the product. 2) offering a course of formation to customers' workers to install the product themselves. **Company 3** The outbound logistics is managed by the shipment department of the Company. The distribution channel of the product depends on the receiving country since there are strong rules for shipment in terms of packaging, stillages, materials and dimensions. The departure office organizes the trucks, manage the packaging phase and the truck loading. The Company market segment is well defined in terms of locations, so the transportation company which the Company uses are often well known.

		Once the product is ready, the departure team starts the packaging phase in order to protect the product by rain, impacts and UV rays. Dealing with construction site project, the logistic plan has a crucial importance for optimizing time and cost. The outbound material is divided in prefabricated units and materials for the construction site. **Company 4** Currently the outbound logistic is managed through transport renting, while the installation is currently managed directly by the Company. **Company 6** Together with the Company factory and headquarter, technical-commercial agents and points of sale / distribution warehouses distributed throughout the world are available.
	Marketing & Sales	**Company 1** The company advertises products by its website, individual presentations for targeted clients and thanks to recommendations. All the aspects related to the product use are explained to clients during individual meetings and presentations or described on request. Moreover, the distribution of the product is in charge to a dedicated distribution company. **Company 2** The product is presented by means of the website of the company, internet pages, the physical catalogue of the product which may be sent to potential customers, specialized journals of architecture and awards given to buildings where the product appears. If necessary, the person in charge of the marketing department offers a meeting to the customers. At this moment there is not a standard procedure to connect the activities to the purchase behaviour. **Company 3** The Company has a communication and marketing department which aim is to advertise the company products, project and the company itself. The office is mostly active on the mass media channel as LinkedIn, You tube, Facebook, Instagram. A newsletter with the Company contacts and customers is also active, sharing the main achievements or commissioned projects. In addition, every year a brochure is produced, and the website is constantly renovated. Moreover, selling managers which physically meet the possible customers are employed. **Company 4** The product is promoted in showrooms/shops, strategic advertisement, and participation in specialised fairs. **Company 6** The Company is advertising products via web and social networks. The communication is handled by meetings, mail, phone calls. Before selling the products, the Company dedicated office calls to the costumers to understand the needs and possibly adapt the products to the costumers' necessities. In general, the product is highly flexible to the customers' needs and specific context. The Company presents points of sale and distribution warehouses distributed throughout the world.
	Service	**Company 1** The company offers service during application and training of companies interested in its products application. **Company 2** The Company directly offers the installation of the product but also it offers training courses to the workers of the customers to install the product themselves. Furthermore, a maintenance guide of the product (cleaning, etc.) is given to the customers. The product has a guarantee of some years, but an extra package of material is given to the customers with the delivery, to allow it to perform a repairment in case it is needed. **Company 3**

		At the end of each project the Company develops a maintenance and service documents listing the operations and instructions for the maintenance. Also, the product guarantee is available, but it depends on the projects, the customers and the country where the building is set. **Company 4** No service has been implemented yet, but the product will be given with 5-year guarantee. So far, only informal feedbacks form clients have been taken. **Company 6** After selling the product, dedicated service is provided to check the application site for eventual follow-up and to check the application performance. Furthermore, the Company organizes specific events where applicators can learn the product's properties and how to apply it. After selling the product, the Company keeps the contact with the costumers to know if they need any further support or information.

ANNEX 2

Table 2: Value Chain Support Activities

SUPPORT ACTIVITIES	Human Resources Management	**Company 1** Concerning the operation and production hiring and management, only people trained on the specific product field technology can work within the production phases of the company's products. The company cooperate with such people from time to time and will train new internal staff according to requirements. The company marketing & sales activity is provided directly by the owners of the company and the official distributor of its product. Therefore, the development in this aspect is strongly connected with distribution and marketing strategy of the distributor company. **Company 2** The Company does not have a Human Resources department. The hiring procedure of new staff in all the areas of the Company is promoted by job offers which are published on web portals. Another way is just asking to known and trusted persons of the sector. The professional development plan for the personal depends on the future growth of the company. **Company 3** The human resource department is active in recruiting new employees both exploiting work agencies and also Company channels such as website, LinkedIn and collaborations/presentations with Universities and Research Institutes. Normally the hiring process foresees two interviews with the Human Resources office, to evaluate the candidate skills and previous experience as well as letting him/her meet the responsible of the selected Company area. The professional development of the worker does not follow a standard procedure but usually courses have to be followed depending on the Company area each worker is working in. For the inbound department specific trainings are regarding materials and system management. For the production department specific trainings are also planned as well as for marketing department. Instead, concerning the service, a specific dedicated collaborator is not foreseen. **Company 4** Generally, hiring new collaborators occurs only when needed; concerning marketing and sales, an external service is used. **Company 6** Skilled personnel from a subsidiary Company are usually transferred to the Company itself, because the knowledge of the developed product's composition can facilitate the production process of this product. Furthermore, the same applies for marketing and sales related employees. Hence, personnel from the subsidiary Company are hired because the performance knowledge of the developed products can be useful to sale it.
	Technology Development	**Company 1** Concerning this aspect, at present stage no specific innovation is aimed in this field since the know-how about company's product is only shared with the partner company which is distributing input materials and distributing the company's product. Concerning the production and operations, new products are developed by the company owners according to requirements of clients or market needs. The background is provided by the company owners' scientific and technology knowledge, as well as own research results. There is no production line yet and all the products are prepared on demand.

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		So far, no need of organizing a specific outbound logistic system occurred. Company's product is unique on the market and competitors offering similar products have not been identified yet. Anyway, the company is continuously analysing the market and new products, via web-based analyses, scientific and industry publications, and advertisements. Concerning the use of technologies applied to offered services to the customer, since the company is based on personal contacts with potential clients, a system to manage the relations with customers is not needed at present stage. **Company 2** Concerning the technology development referring to inbound logistics, the Company does not have an automated line for assembly the product or to manage the stock. Referring to the production and operation activities, the development of a new production line is not foreseen at this moment. Indeed, the Company provides a product that consists of the assembly of different existing products. Concerning the outbound logistics, at the moment, products are tracked all the way, from factory to their destination. Perhaps a better informatic tool could be developed although at this moment is not already planned. A person is already in charge of the marketing activities, such as keeping contacts and relationship with customers, but no specific activities or market analysis have been planned so far, as well as no specific methodology to manage the relations with customers have been defined. **Company 3** The automation of the inbound and outbound logistics is a crucial topic which the Company has been investigating for several years. The automation should involve all the phases of the value chain. A limited technological innovation was the development of a QR code which could track the components. The automation of the production line is also a crucial topic for the Company and some automated activities are already conducted. No specific technology is applied to marketing activities, also because the Company operates on a well-defined market segment with limited numbers of competitors. Concerning the service, the tracking of components in order to facilitate the maintenance is available. In addition, sensor within the product could be integrated for the structural health monitoring. **Company 4** Main technology development referred to products is performed in collaboration with third party engineering Companies. In other areas of the Company, technology development is not needed at the moment. **Company 6** A subsidiary Company develops and continuously improve the technologies and the production techniques for the product. The partner Company instead focuses on customer needs and communicate to the subsidiary Company the adaptation to be applied to the products.
	Procurement/ Supply	**Company 1** Just one partner company provides high quality "raw" materials, suitable for company's products. Concerning the outbound logistics aspects, transport service or invoicing services are not needed by the company, considering the small amount of product managed. The company is not exploiting any service for marketing, media communication or public relations, as well as no external assistance service is used. **Company 2** Concerning the inbound logistics, the Company have a list of suppliers. They are ordered taking into account if they have an ISO, a QMS (quality management system) or none. Furthermore. there are registers related to all the components of the Company system. The registers are based on acceptance criterions. If

		the received product is correct, a register number is given, and the material is stored. On the other hand, if the material is rejected the supplier is contacted. The transport services are the same that were used by one of the Companies which formed the actual Company. The invoicing services are carried out by a specific employee of the Company. The marketing department is also composed by one person which is fully dedicated to it. There are no call centre services and external assistance services. At this moment an employee is in charge of these issues. **Company 3** The Company has a selection criteria document which lists the requirements for the suppliers' selection: - Firstly, the Company makes a site inspection to the supplier or receives samples of materials. - Then budget issues and quotes are managed. - Production capacity, in terms of quantity, time of procurement, certification is discussed. - Previous experiences between the Company and the supplier are also taken into account. - Sustainability is considered (in terms of certification or raw materials extraction and processes) The quality control department regularly check if the suppliers still have the above-mentioned requirements. The Company has a dedicated purchasing department which buy the required raw materials to the suppliers and the relative machining. The choose of transportation Company depends on the project contract. Also, the transportation Company needs to fulfil some requirements such as shipment timing, ability to reach the project county, price and truck dimension. There is not a dedicated call centre, but at the end of the project, the maintenance document with all the contact number is produced. Project managers numbers which were involved in the project are provided. **Company 4** Procurement and supply of resources in different areas is usually managed case by case. **Company 6** Qualified personnel buy the materials and look for alternative suppliers. The Company prepares technical, safety, and application data sheets to facilitate the use of its products by its customers. Furthermore, the Company also prepares videos to explain it.
	Firm Infrastructure	**Company 1** Company owners have proper skills in the management, financial and legal systems, used in making business decisions. Only a professional accounting firm is supporting the company. **Company 2** The company was born from the union of two national companies. Usually, legal and financial issues are managed by both "mother" companies. The day-today decisions are usually taken by the Director. **Company 3** The Company has recently adopted a platform which manages different phases and activities of the value chain. From the human research to the financial accounting, from the inventory to the production. The management programme is used as digital platform for joining the value chain processes. This digital system incorporates the key business functions of an organization. The Company is organized in a well-defined hierarchical structure which has a pyramidal structure in order to involve all the Company departments. Each organization meets several times during the years in order to take decision for the Company at financial, management and legal level based on the expertise of the senior executives.

		Company 4 A structured infrastructure of the Company is not implemented yet. **Company 6** In the Company, a decision group composed by general direction and market personnel who take decisions based on possible new opportunities is present.

ANNEX 3

Table 3: Summary result to questionnaire on value chain and innovation potential

Focus on the whole value chain in general	
In which of the areas identified in the value chain (primary and/or support activities) do you see more space for improvement?	**Company 1** The Company needs to improve in the following areas: recognizing the market potential while looking for new clients, effective developing of products thanks to prototyping activity and certification, application and prefabrication processes improvements thanks to automatization of the production processes, effectiveness in finding financial supports for products development. **Company 2** Mainly in support activities, since, due to the size of the Company, these activities are not very well defined. **Company 3** The Company is constantly trying to improve in all the aspects related to the value chain processes. It is stated that the logistic and storage of the components could be the department with more space for improvement since, without an extreme investment it could be automated. Automation would reduce human errors with consequent time and cost reduction. **Company 4** Space for improvement for the Company is in Manufacturing & Marketing areas. **Company 5** Space for improvement for the Company is mainly in technology development and Procurement supply. **Company 6** Main things to be improved are in the production lines optimization, and in the communication from technical area to the commercial area and vice versa about the development progresses.
Which are the connections between different value chain areas (primary and/or support activities) that should be further improved? Where could it be useful to have better communication/connection between different areas?	**Company 1** The Company cannot provide an answer. **Company 2** The connection between different areas is supposed to work well, given the size of the Company. Perhaps a better development of the departments related to support activities would be needed, eventually related to the growth of the Company. **Company 3** The connections between different value chain areas are crucial. All the areas should be aligned in real time regarding the entire process of the product. Within the Company there is space for improvement especially between the designing phase to the production one. **Company 4** N/A **Company 5** Connection between technology development related to operation production. Communication between R&D in the headquarter and the productions all over the world can be further improved. **Company 6** In the Company, the connections between the value chain areas are working properly.

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In which areas of the value chain do you identify a higher innovation potential?	**Company 1** The Company sees a higher innovation potential specifically in the support activities related to the *technology development* and in the primary activities related to the *operation and production* phases. **Company 2** The Company sees a big space for improvement in the connection with more suppliers. Especially in solar and sustainable energies sector. **Company 3** There are many fields that could be implemented through innovative solutions. Especially in the designing phase - there is a lack of connection between the designing. In addition, it would be useful to develop a database with the already used solution and materials. **Company 4** Manufacturing area. **Company 5** The Company identifies a higher innovation potential in the procurement and supply procedures. Technology development needs the right industrial partners to perform part of the research and having the right partners is crucial for industrial R&D. **Company 6** In the commercial area it would be helpful to know about new marketing methods, marketing channels, etc.
Focus on the innovation potential	
If any, where do you identify bottle necks concerning the development of innovation processes and products in your Company?	**Company 1** Lack of financial support for prototyping and difficulties in finding cooperating companies interested in developing new products with the Company's technologies. **Company 2** A bottle neck can be related to suppliers of a specific component to be added to the Company system. Therefore, a wide range of different suppliers must be found. **Company 3** Time is probably the most problematic issue, since usually there is not enough time to test innovative product. Therefore, innovation has a limited space. Furthermore, old habits behaviour may also slow down the innovative processes. Finally, the Company sees an issue related to the big initial investment in terms of costs. **Company 4** Main bottle neck for innovation initiatives is related to the lack of financial resources. **Company 5** Main bottle necks for innovation processes are related to the explanation of Company's needs to suppliers and partners on R&D. Sometimes the mutual interests or market views are not aligned and finding the right approach may be time consuming. **Company 6** Main barriers to innovative processes are related to the fact that, usually, new products are difficult to be pushed into the market (especially due to commercial issues and certification requirements).
In R&D area, where do you identify a higher space for improvement?	**Company 1** Testing prototypes to prove the Company's products advantages over other technologies present on market. **Company 2** In solar and sustainable energy field, in relation to PV components. **Company 3** N/A

	Company 4 A higher financial independence would enable considerable improvements in the R&D area. **Company 5** Space for improvements is in having the possibility to test products as the supplier does and translating customers' needs into parameters. **Company 6** The most improvement in the R&D area is to know which customers' needs is necessary to focus on and to satisfy them.
What gives the input to innovation processes and innovative products in your Company?	**Company 1** Cooperation with open-minded people, able to understand the product's potential, brain storming, recognizing of gaps in market related to customer needs. **Company 2** Usually, customers and research projects. **Company 3** The innovative processes often started with a need. With the Innovation department, the Company investigate eventual pitfall through questions or surveys in order to improve the process. **Company 4** Different internal and external feedbacks. **Company 5** The input to innovation could be a market need which has been considered as meaningful from the Company's management or a proposal from an industrial or research partner which is also a strategic choice to be aligned with the state of art in the specific sector. **Company 6** The Company is always aiming to satisfy the costumers needs.
How do you usually approach to innovation processes and new ideas developed within the Company? How do these ideas become products?	**Company 1** The Company is usually open for innovations, but only to ideas worthy for commercialization (i.e., potential client would like to pay for it) are developed into products. **Company 2** Ideas usually become products through the help of research projects. In fact, the Company was born from a research project and the union of two national companies. **Company 3** The Company firmly believe that innovation starts where there is a need which could involve all the value chain process. The Company has an innovation department which tests and develops new products especially within European projects. **Company 4** Market driven focus. **Company 5** The idea is assigned to a Project Leader who is responsible to bring the project to its realization, which means making the product available on the market. **Company 6** The Company is solidly supported by the innovative technologies developed at the partner Company. The research and development of new products is related to the interests that arise in the market and based on new technologies supported by the partner Company.
Is your Company directly following innovative processes which are outsourced to other Companies?	**Company 1** Yes **Company 2** No, the Company does not outsource the main innovative process. The Company can be helped by other Companies or Research Centres, but outsourcing is not the usual way. **Company 3** Not directly.

	Company 4 If required yes. **Company 5** Yes. **Company 6** No.
How do you evaluate the support by University and Research Institutes in the Innovation process?	**Company 1** The Company cooperate with Universities and Research Institutes in developing products. Company owners are scientists involved in research activities. **Company 2** Usually, University and Research Centre collaborates with the Company. Is the usual way. At this moment, some consultants from a university are working with the Company. **Company 3** Really important since the synergy between university and industrial partners allows to have a wider prospective. **Company 4** May provide highlights on upcoming technological trends. **Company 5** For certain projects, it is fundamental because a company cannot own all the technologies and know-how to do innovation by itself. **Company 6** Universities and Research Institutes are needed to characterize or certificate some Company's products.
How do you evaluate the support of other external Companies in the innovation process (i.e., having in mind an OPEN INNOVATION approach, where you could contribute to or take the advantage from innovative processes or products by other Companies)?	**Company 1** The Company had bad experiences with an external Company providing financial support. Anyway, the Company is interested in cooperation with other Institutions in developing and selling new products but with defined, clear and fair rules of cooperation. The Company is interested in having financial support, help in certification process and managing contacts with other Companies interested in collaboration. **Company 2** The support of other Companies is always evaluated positively, as long as the contribution brings improvements to the original Company's product. **Company 3** Strongly positive and useful. Innovation product could be developed by joining different knowledges and having an open innovation approach is a crucial feature for the Company. **Company 4** Open innovation approach requires to be provided by various external companies to diversify approaches. **Company 5** The support of external Companies is seen as beneficial if there are common interests in the innovative process. Innovation, in the Company's case, often arises from the mutual collaboration between the Company and our supplier. The idea without the production, design and selling capabilities remains an idea. Collaboration empowers both the Company and the supplier. **Company 6** The Company already carried out fruitful joint developments.
Are you involved in any specific product or process innovation program that involves collaboration with other companies?	**Company 1** At the moment, the Company is not involved in collaborative innovation process. **Company 2** H2020 programmes and national programmes. **Company 3** Beside for the European projects, which allow to develop innovative products with the collaboration of several European partners, the

	Company is also developing different projects with the collaboration of other companies. The projects mostly involve digitalization topics. **Company 4** The Company is already involved in product and manufacturing design involving different companies. **Company 5** The Company is involved in collaborations with suppliers and in some European projects. **Company 6** The Company is involved in some R&D projects.
How does your company typically manage to find economic resources to carry out innovation processes and innovative products? (National fundings, European fundings, internal resources, etc.)	**Company 1** The Company uses National and European fundings. **Company 2** Basically, through national and European fundings. Internal resources are usually not possible due to the size of the Company. **Company 3** The Company has a dedicate Innovation department which investigate new products and projects in order to develop new business model for the Company's future. In particular, most of the innovation projects are financed by European projects while some of them are financed through internal resources and in few cases, there is a collaboration between Companies in order to develop a proof of concept together. **Company 4** European and national fundings. **Company 5** Usually, the Company uses internal and suppliers' resources to perform innovation. For very big projects, fundings are used in support or as main source. **Company 6** The Company uses national fundings, European fundings as well as internal resources to carry out innovation processes and to develop innovative products.
If your company carries out collaborative innovation processes or collaborative innovative product development with other companies or universities, how is your company managing the product/process property rights?	**Company 1** The Company has full and exclusive license for the product from a Mother Company (as spin-off Company) and gives sublicense to other Companies. **Company 2** The Company was born through the union of two National companies. Legal and IP issues are managed by one of the two Companies office. **Company 3** The Company uses NDA singed contracts, and the intellectual property is defined at the beginning of the projects. **Company 4** Property rights are managed with a case-by-case procedure. **Company 5** Before starting the collaboration, the Company clarifies its interest in an NDA which must be signed. Each collaboration has its specific characteristics and depending on the intellectual property and the reciprocal contribution to the project, the NDA can be different. **Company 6** There are different options available: sharing the results, distribution agreements or exclusivities.

ANNEX 4

Innovation Potential Summary Table and MEZeroE services matching		MEzeroE service addressing the issue																
		OIS1_1	OIS1_2	OIS1_3	OIS1_4	OIS1_5	OIS1_6	OIS1_7	OIS2	OIS3_1	OIS3_2	OIS3_3	OIS3_4	OIS3_5	OIS3_6	OIS3_7	OIS3_8	OIS3_9
		Identification of the best methods for product characterization	Definition of a regulation framework guiding product design	Definition of lists of necessary tests for product certification	Establishment of a clear informative path to CE marking	Definition of a framework for the support of background data for verification of the test results to assess reliability of the experimental methods	Provision of ready-to-use approaches for the evaluation of economic rationale towards circular economy, environmental-social audits, LCA and LCC analysis	Definition of support methods for digitalization of the construction products	Monitoring LL	Expert mentorship in Accessing other markets	Expert mentorship in cross-sectoral innovation	Matchmaking Focused on Product Development	Matchmaking Focused on Product Commercialization	Innovation Service and tools: Idea radar	Innovation Service and tools: Innovation tracker	Innovation Service and tools: Innovation Compass	Market replication assessment	Open Innovation event management
Focus on the whole value chain in general																		
In which of the areas identified in the value chain (primary and/or support activities) do you see more space for improvement ?	**Flexible Structural Connectors**																	
	recognizing the market potential									x	x	x	x	x			x	x
	developing of products thanks to prototyping activity	x		x					x									
	certification	x	x	x	x	x												
	production process improvement (industrialization & automatization)														x			
	finding financial supports for products development												x					
	Facade Integrated PV Shading System																	
	Support activities, in general										x	x						
	Multifunctional Facade Component integrating HVAC system																	
	The logistic and storage of the components (automation)														x			
	Advanced Material for Window Frame																	
	Manufacturing & Marketing areas								x	x	x	x	x				x	x
	Components for Hygrothermal management of building envelope																	
	technology development and Procurement supply										x				x			
	Advanced Surface Coatings																	
	production lines optimization							x										
	communication from technical area to the commercial area							x							x			
	Focus on the innovation potential																	
If any, where do you identify bottle necks concerning the development of innovation processes and products in your Company?	**Flexible Structural Connectors**																	
	Lack of financial support for prototyping																	x
	Difficulties in finding cooperating companies										x							x
	Facade Integrated PV Shading System																	
	wide range of different suppliers must be found									x	x							x
	Multifunctional Facade Component integrating HVAC system																	
	time to test innovative products														x			
	old habits behaviour									x					x			
	big initial investment in terms of costs																	x
	Advanced Material for Window Frame																	
	lack of financial resources																	x
	Components for Hygrothermal management of building envelope																	
	mutual interests or market views are not aligned									x		x	x			x	x	
	Advanced Surface Coatings																	
	new products are difficult to be pushed into the market	x		x			x		x	x			x			x	x	
	certification requirement	x	x	x	x	x	x	x										
In R&D area, where do you identify a higher space for improvement ?	**Flexible Structural Connectors**																	
	Testing prototypes								x						x			
	Facade Integrated PV Shading System																	
	Technology development										x	x						
	Multifunctional Facade Component integrating HVAC system																	
	N/A																	
	Advanced Material for Window Frame																	
	financial independence											x						x
	Components for Hygrothermal management of building envelope																	
	possibility to test products								x									
	Advanced Surface Coatings																	
	define customers' needs to focus on								x				x				x	
What gives the input to innovation processes and innovative products in your Company?	**Flexible Structural Connectors**																	
	Cooperation with open-minded people									x	x	x	x					x
	Recognizing of gaps in market									x			x	x			x	
	Facade Integrated PV Shading System																	
	customers and research projects								x									x
	Multifunctional Facade Component integrating HVAC system																	
	Customer needs								x									
	Advanced Material for Window Frame																	
	internal and external feedbacks								x		x							
	Components for Hygrothermal management of building envelope																	
	market need									x							x	
	proposal from an industrial or research partner										x	x						x
	Advanced Surface Coatings																	
	costumers needs													x				
How do you usually approach to	**Flexible Structural Connectors**																	
	only to ideas worthy for commercialization are developed into products									x			x	x		x		
	Facade Integrated PV Shading System																	
	Ideas usually become products through the help of research projects										x							

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innovation processes and new ideas developed within the Company? How do these ideas become products?	**Multifunctional Facade Component integrating HVAC system**																	
	innovation starts where there is a need									x				x		x		
	test and develop new products especially within European projects														x			
	Advanced Material for Window Frame																	
	Market driven focus									x								
	Components for Hygrothermal management of building envelope																	
	Idea is assigned to a Project Leader making the product available on the market													x		x		
	Advanced Surface Coatings																	
	Market driven focus													x		x		
How do you evaluate the support of other external Companies in the innovation process (i.e., having in mind an OPEN INNOVATION approach, where you could contribute to or take the advantage from innovative processes or products by other Companies)?	**Flexible Structural Connectors**																	
	bad experiences with an external Company providing financial support																	
	interested in cooperation with other Institutions										x							x
	interested in having financial support																	
	help in certification process		x		x													
	support managing contacts with other Companies																	x
	Facade Integrated PV Shading System																	
	The support of other Companies is always evaluated positively																	
	Multifunctional Facade Component integrating HVAC system																	
	Strongly positive and useful																	
	having an open innovation approach is a crucial feature for the Company																	x
	Advanced Material for Window Frame																	
	Open innovation approach requires to be provided by various external companies to diversify approaches																	x
	Components for Hygrothermal management of building envelope																	
	The support of external Companies is seen as beneficial																	x
	Advanced Surface Coatings																	
	The Company already carried out fruitful joint developments.																	
		OIS1_1	OIS1_2	OIS1_3	OIS1_4	OIS1_5	OIS1_6	OIS1_7	OIS2	OIS3_1	OIS3_2	OIS3_3	OIS3_4	OIS3_5	OIS3_6	OIS3_7	OIS3_8	OIS3_9

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ANNEX 5

MEZeroE OIS and PM&VL needs for different construction segments			Advanced Material for Window Frame	Advanced Surface Coatings	Components for Hygrothermal management of building envelope	Facade Integrated PV Shading System	Flexible Structural Connectors	Multifunctional Facade Component integrating HVAC system
MEzeroE service addressing the issue	OIS1_1	Identification of the best methods for product characterization	-	needed	-	-	needed	-
	OIS1_2	Definition of a regulation framework guiding product design	-	needed	-	-	needed	-
	OIS1_3	Definition of lists of necessary tests for product certification	-	needed	-	-	needed	-
	OIS1_4	Establishment of a clear informative path to CE marking	-	needed	-	-	needed	-
	OIS1_5	Definition of a framework for the support of background data for verification of the test results to assess reliability of the experimental methods	-	needed	-	-	needed	-
	OIS1_6	Provision of ready-to-use approaches for the evaluation of economic rationale towards circular economy, environmental-social audits, LCA and LCC analysis	-	needed	-	-	-	-
	OIS1_7	Definition of support methods for digitalization of the construction products	-	needed	-	-	-	-
	OIS2	Monitoring LL	needed	needed	needed	needed	needed	needed
	OIS3_1	Expert mentorship in Accessing other markets	needed	needed	needed	needed	needed	needed
	OIS3_2	Expert mentorship in cross-sectoral innovation	needed	-	needed	needed	needed	-
	OIS3_3	Matchmaking Focused on Product Development	needed	-	needed	needed	needed	-
	OIS3_4	Matchmaking Focused on Product Commercialization	needed	needed	needed	-	needed	-
	OIS3_5	Innovation Service and tools: Idea radar	-	needed	needed	-	needed	needed
	OIS3_6	Innovation Service and tools: Innovation tracker	-	needed	needed	-	needed	needed
	OIS3_7	Innovation Service and tools: Innovation Compass	-	needed	needed	-	needed	needed
	OIS3_8	Market replication assessment	needed	needed	needed	-	needed	-
	OIS3_9	Open Innovation event management	needed	-	needed	needed	needed	needed
	PM&VL1	Advanced BIPV and hybrid PV/T systems characterisation facing Efficiency and Safety requirements				needed		
	PM&VL2	Building envelope/IEQ interaction facing Health requirements		needed	needed		needed	needed
	PM&VL3	Active energy component characterization facing Efficiency requirement				needed		
	PM&VL4	Visual and thermal performance analysis of dynamic glass systems facing Efficiency requirement		needed				
	PM&VL5	Building/user interaction characterization facing Efficiency requirement		needed				needed
	PM&VL6	Multi-layers dry nEES characterization facing Healthy and Safety requirement (	needed	needed	needed	needed	needed	

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	PM&VL7	Mechanical resistance and stability characterization of connections/joints between component materials and supporting structures facing Safety requirement	needed		needed	needed	needed	
	PM&VL8	Solar gain control in semi-transparent envelope component, facing Healthy requirement	needed	needed				
	PM&VL9	Wooden prefab components assessment line facing Safety requirement					needed	

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