FISSAC

FOSTERING INDUSTRIAL SYMBIOSIS FOR A SUSTAINABLE RESOURCE INTENSIVE INDUSTRY ACROSS THE EXTENDED CONSTRUCTION VALUE CHAIN

Final publications regarding living lab for FISSAC model

Date of document – February/2020 (M54)

D7.3: Final publications regarding living lab for FISSAC model
WP 7, T 7.1

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H2020-WASTE-2014-two-stage

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 642154.

Technical References

Project Acronym	FISSAC
Project Title	FOSTERING INDUSTRIAL SYMBIOSIS FOR A SUSTAINABLE RESOURCE INTENSIVE INDUSTRY ACROSS THE EXTENDED CONSTRUCTION VALUE CHAIN
Number	642154
Start date	01/09/2015
End date	29/02/2020

Deliverable No.	D7.3 Final Publications regarding living lab for FISSAC model
Dissemination level [1]	
Work Package	WP 7 – Industrial symbiosis replicability and social aspects
Task	T 7.1 Establishment of a Living Lab for replicating FISSAC model and development of transition process from linear to circular economy
Lead beneficiary	22 (RISE)
Contributing beneficiary(ies)	ACC, ACR, UNE, AKG, BEF, BGM, CBI, RINA-CSM, RINA-C, EKO, FAB, FEN, FER, GEO, GTS, TRI, HIF, KER, OVA, RINA-S, SYM, TCM, TEC, ECO
Due date of deliverable	28 February 2020
Actual submission date	6 March 2020

Document history

V	Date	Beneficiary	Author
01		RISE	Lena Heuts, Deliverable Draft Structure
02		ACCIONA	Blanca Juez, Contributions to Deliverable Structure
03		OVAM, Geonardo, FENIX TRINIUS, RINA Consulting, Símbiosy, HIFAB, TCMB, GTS and BGMC	Living Labs leaders contribution, Chapters 4 – 12.
03		RISE	Lena Heuts, Deliverable

[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

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0. Summary

The main objective of WP7 ”Industrial Symbiosis replicability and social issues” is to demonstrate the replicability of FISSAC model. An important tool for this is through the Living Labs (LLs), user-centric platforms. These involve different stakeholders in a real life context with the aim to facilitate user influence in an open and collaborative innovation process. Within the FISSAC Project, LLs aim to exploit knowledge about technological and non-technological factors that could impact Industrial Symbiosis. They help to co-develop with participants of LLs the FISSAC Model. This model is based on the circular economy, with a special focus on developed eco-innovative products. Nine LLs were set up in UK, Germany, Sweden, Czech Republic, Hungary, Turkey, Belgium, Spain and Italy.

The Living Labs all reflect the priorities of the stakeholders in the different countries. This means that different value chains and challenges, barriers and drivers related to this have been investigated. Each Living Lab had its own starting point, its own development and goals. For some this was to establish a network for knowledge sharing, whereas others strived to reach a more consolidated phase to obtain real “co-creation”. All Living Labs had their own challenges and were managed in line with them. This also sets the scene for replicability of the FISSAC model in the context of the various LL. This possibility has been tested and discussed in the various LLs.

During the project there has not been one over-all goal to align the Living Labs in the sense that they should all work in the same way. Comparisons between Labs have only been made in order to share experiences and knowledge on how to overcome barriers and to find inspiration through experiences made by the other Labs. All labs have worked to find the best way to increase cooperation within the value chains and industrial symbiosis, during the run of the project as well as going forward after FISSAC. This will create long term competitiveness and profitability for their stake-holders and a more sustainable construction sector. The European industry is facing a huge challenge in becoming part of a circular economy. Cooperation in the format of Living Labs can be one important tool in this.

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Abbreviations and acronyms

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1 WP 7 - Industrial Symbiosis replicability and social issues

The main objective of WP7 "Industrial Symbiosis replicability and social issues" is to demonstrate the replicability of FISSAC model. In this WP, Technical and non-technical aspects that could affect an Industrial Symbiosis are discussed and analysed. And, the necessary steps to change from linear to circular business models are defined for the most representatives EC countries and FISSAC related industries. To meet this purpose, several concepts and instruments are applied such as Living Labs (LLs), interviews and Technological Innovation System (TIS) analysis. The WP7 activities are divided in three main tasks, whose objectives are shown in the following figure.

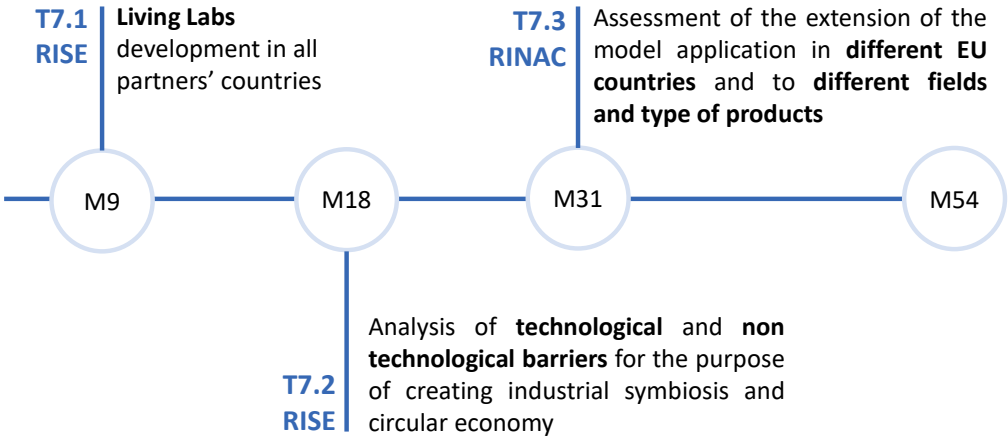

Figure 1: WP 7 Tasks and objectives

2 Task 7.1: Establishment of a Living Lab for replicating FISSAC model and development of transition process from linear to circular economy

A Living Lab (LL) is a user-centric platform that involves different stakeholders in a real life context with the aim to facilitate user influence in an open and collaborative innovation process. Within the FISSAC Project, LLs aim was to exploit knowledge about technological and non-technological factors that could impact Industrial Symbiosis (investigating different value chains, countries and stakeholders, etc.) and to co-develop with LLs participants the FISSAC Model, based on circular economy, with a special focus on developed eco-innovative products. LLs were set up in UK (BGM), Germany (IBT), Sweden (HIF), Czech Republic (FEN), Hungary (GEO), Turkey (TCM), Belgium (OVAM), Spain (SYM and ACC) and Italy (RINA consulting). According to the common strategy defined within the first reporting period, the Living Labs should reflect the priorities of stakeholders in the different countries; investigate relevant aspects of the FISSAC model; and bring valuable inputs to solve problems and explore pathways within the project and in some cases beyond.

3 Living Labs – The FISSAC Way

Within the FISSAC project, a broad definition of a Living Lab has been applied, leaving every partner free to design and manage a lab that suits their industrial and stakeholder context. This to increase chances that the FISSAC Living Lab should contribute to accelerating industrial symbiosis and a transition to a circular building and construction sector.

The organization of the Living Labs in Sweden started in advance, in order to generate some first insights about methodology and process relevant to the efforts to come in other regions. With this experience together with discussions during 4th General Assembly, held in Sheffield on March 2017, guidelines were developed to help the other LLs to a good start. The document called Living Labs Guidelines was prepared by RISE and shared with the partners. This guideline is reported below in a dedicated chapter.

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After these initial preparations each LL has been allowed to develop organically to have the best possible impact to accelerated industrial symbiosis in its respective context. Each LL is presented in separate chapters below.

The initial work with the Swedish LL and the following discussions resulted in a matrix with guiding topics to address, see

	FL/BE	CZ	DE	HU	IT
Issue 1: Starting point					
Existing initiatives	OVAM coordinates multiple platforms with the construction sector: implementation policy construction sector; Green Deal Circular Construction, Research Lab Urban Mining, Flemish Symbiosis Platform	Some IS promotion under ENVICRACK, but no active platform	International group established in a different R&D project, not focussing on industrial symbiosis but on identifying end-of-life routes, scenarios, technical, economic, legal and logistic constraints and incentives.	NISP - National Industrial Symbiosis Program. This was managed bw 2010-2012 by IFKA to promote good practices in the field of IS. The programme was funded by LIFE+ Environment.	In Italy there were different existing initiatives in Italy dealing with circular economy and industrial symbiosis, mainly at regional level (e.g. industrial associations) or sectoral level (e.g. cement and concrete sectors).
Existing agenda	1. Matchmaking platform; 2. Tracing and quality issues; 3. Regulation on non-stony fractions; 4; Cyclical construction action plan. Following are considered: stony fraction, sheet glass, isolation materials, gypsum board, cellular concrete, urban mining, circulair construction	Stakeholder knowledge and public awareness very limited.	Agenda relates to the identification, quantification and delaration of buidling-product-related end-of-life routes and scenarios. Ambition to define a generic approach based on three product groups with different levels of complexity, to be generalized and transferred to other product groups. Aim to implement findings in normative works in CEN and ISO.	Building on existing best practices, finding partnerships with stakeholders, feeding into relevant policy agendas.	Broad agenda touching on IS and resource efficiency, but not construction-specific IS as yet.
Issue 2: Stakeholder involvement					
Value-chain coverage	Constructors, crushing plant operators, building material producers, building federations, supporting industries, architecs	As wide as possible	indirect. Focus on manufacturers placing products on the market	Broad coverage especially important for post-FISSAC period	As wide as possible, from producers of waste from construction companies representatives
Non-business actors	Research institutes, other governmental agencies (environment, land and resources)	City authorities, universities, promotion to general public	R&D, governmental agencies, manufacturer associations, manufacturers, unfortunately difficult to involve deconstruction and recycling industry	Especially research	R&D and associations
Stable vs. Evolving	Core group established	Likely evolving	stable	Evolving strategic -> operational	Evolving
Issue 3: Lab structure					

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	FL/BE	CZ	DE	HU	IT
Open discussion	Cocreation	Different discussion fora for different stakeholders	open but guided. Key-note-presentations, clear defined targets for workshops (series of 3 workshops has been conducted in autumn 2017 and winter 2018), 4th open workshop (exceeding beyond the establisehd group) on international sustainable building conference SB19 Graz)	vital for challenging participants	Yes, especially for non-technical issues
Practical work	Set up experiments and tests	Likely, depending on topic	practical in terms of identifying routes and describing models and practical as involved manufacturers need to adress end-of-life apsects in their product to market information	Important depending on topic	No
Plenary vs. Groups	Both	Groups	both	Both depending on topic	Plenary
FISSAC vs. Post-FISSAC	Continuation as part of on-going transition to circular economy in the construction sector	Stakeholder are willing to contribute to the FISSAC platform after project ends, testing, using, feedback	parallel to FISSAC and scope , agenda, time, goals etc "not directly related", no compulsory link or inter-dependency	Both	Both
Issue 4 Subject focus					
Material-specific	stony fraction and non-stony fraction	Mainly cement and concrete, minor metal, plastics	Product specific	Demolished brick and concrete, WPC, glass concrete, construction waste	Yes (first two LLs focused on cement and concrete sectors)
Material-neutral	business models, monitoring, financial models	General colaboration	Yes	No	Yes (the last LL was about the evalutation of the potential of circular economy and IS)
Technical challenges	No	Local collection, processing and distribution of products. In the CDW recycling industry, very large mass flows are handled at relatively low prices, so any transport costs are very marked when handling them (proven that the maximum economically justifiable transport distances up to 20 to 30 km) - not traded across borders.	Yes	Yes	Limited (the production of cement and concrete with recycled materials is a mature and consolidated practice)

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	FL/BE	CZ	DE	HU	IT
Commercial challenges	Yes	Involvement of municipalities and public population in waste segregation. Support of the regional level. Price comparison between the traditional materials and eco-materials. Confidence in use of products from recycled materials.	Yes		Yes (costs of recycled materials can be high, especially due to the transport costs)
Intra/Inter-organisational	co-creating process involving stakeholders from building sector, government and research institute,	Trust between supply chain stakeholders.	Related to pre-normative and co-normative R&D aiming to identify end-of-life scenarios to be applied in environmental product declarations		No
Social/landscape issues	Assessing the potential of symbiosis and circular building taking onto account social aspects in particular affordable building	Generally low awarenes about recycling of waste materials. The existence of a number of smaller speculative landfills of construction and demolition waste. Existence of illegal waste management.	Not in focus	Not in focus	Yes (sometimes there is distrust regarding recycled materials)

Figure 2: Results status for each LL (Belgium – Italy) with respect to methodology and process at the end of the FISSAC project.

	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Issue 1: Starting point					
Existing initiatives	Known initatives focus on reuse of interior product, mainly office related and also development of digitalized documentation systems for building materials. The Swedish construction federation has recently launced a Roadmap for fossilfree competitiveness for construction and civil engineering sector. More than 100 actors (including municipalities, construction companies and other organisations) have signed the initiative.	There are no specific established working groups dealing with the circular economy/industrial symbiosis in the build environment. At Símbiosy, we normally work using a cross-sectorial and multistakeholder approach.	· Existing projects: INSIGHT project; Higher education and post graduate programs;	- There are initiatives of municipalities on recycling plastic, glass, paper and metal wastes. No specific initative on construction sector. - The Zero Waste Regulation, includes several industry wastes, and Alternative Raw Material Communique are in force in Turkey.	Some groups exist to discuss reuse and recylcling, for example those organised by the Green Building Association and the Institute of Demolition Engineers. However these do not encompass the whole supply chain and do not consider all materials in particular glass is absent from discussions

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Existing agenda	Log book; documentation to support material recycling in the future. Recycled content in concrete. Reusing av interior office products . Circular economy delegation within the Swedish Agency for Economic and Regional Growth; Working Group for Circular economy under The Nordic Council of Ministers; Roadmap for fossil free competitiveness (Swedish construction industries) Roadmap for increased uptake of industrial symbiosis in Sweden (Swedish Environment and Research Institute) Investmentfunds from Swedish govenmnet to work with innovation and circular economy (Vinnova)	Existing database at Símbiosy and knowledge transfer support from the Catalonia Institute of Construction Technology (ITeC)		The awareness of sectoral stakeholders, local waste suppliers and industrial partners determined very low. Therefore living lab studies are planned for the following years.	To desseminate case studies and raise awareness.
Issue 2: Stakeholder involvement					
Value-chain coverage	Stackholders from the entire construction value chain participated	We need to get the whole supply chain together to show the opportunities, identify the necessities and discuss how to work together. Consequently, the Símbiosy team paid special attention to the design of a multisectorial participant list of all Living Labs.	A multistakeholder group of expert (university-industry) has identified a number of common challenges and opportunities that would guaranty further research, exploration and discussion in the framework of FISSAC project and circular economy topic.	Focus on cement and concrete industries.	Focus on glass recycling across all stakeholders
Non-business actors	Local govenments, research institutes, universities	Representatives from R&D R&I, Associations, Architects, Designers, Governmental Entities...	university	Ministry of Environment and Urbanization, Ministry of Industry and Technology, Legal authorities and Universities.	Universities, Government and Non government recycling organisations
Stable vs. Evolving	Evolving There were some stakeholders that followed the process and participated in several workshops and others who connected to	Evolving	Evolving	Core group is stable but the rest is likely to evolve as the symbiosis vision is being disseminated.	Evolving

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
	particular workshops				
Issue 3: Lab structure					
Open discussion	Open, guided discussion with a set agenda and discussion topics	Encouraging an open debate is essential. Using a participative approach, attendees will have the opportunity to expose their points of view and discuss with the rest of stakeholders about the development of new business models that might transform the actual construction sector in a more circular one.	Facilited open discussion by a professional facilitator.	Open, guided discussion with predetermined subjects.	Open facilitated discussion on a selected topic
Practical work	Case study following a journy of gypsum plasterboards: site visits to construction and dempliting sites, as well as to a plaster board factory and a recycling plant	NO	Some examples of the innovative construction products were shown as well as the last case studies and real scale demonstrators carried out in the Project	Organizing technical seminars and trainings	Not anticipated
Plenary vs. Groups	Both All the workshops stared with some case or theoretical presentations, followed by groupdiscussions	The main structure of all Living Labs can be divided in three sections: an introductory part, which is followed by workshopping activities and/or presentations of concrete projects, followed by an open debate and a final conclusion part to summarise the main outcomes.	both	Both	Both

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
FISSAC vs. Post-FISSAC	Both As the living labs focused on mapping barriers and opportunities in order to acheive higher volume of circulatity in the construction value chain, ther was a lot of focus on practices and estabiliced systems also outside FISSAC and after FISSAC	The organisation of the Living Labs offered ideal networking opportunities. Not only for the team at Símbiosy, but also for the rest of participants, who made the most of the event and took the chance to broaden their professional/business network of contacts. The Living Labs have served as a great breeding ground to boost collaboration among some of the participants, who will surely envisage and launch future projects together.	both	Both	Continued engagement with stakeholders in the supply chain individually and at workshops.
Issue 4 Subject focus					
Material-specific	No/Yes 50/50 The goal of the Swedish LL was to engage a wide spectrum of stakeholders from the entire construction value chain. Gypsum plasterboards was in focus during three (#3-5) workshops in order to investigate the whole valuechain and the "journey" of a material from production to construction to waste management. .	NO	Construction sector, no specific products.	Cement and concrete	Glass
Material-neutral	Yes/No 50/50 explained in the previous answer	YES	General information about Circular Economy, Living Labs and principles of Systems Thinking	No	No

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Technical challenges	Yes However it was confirmed throughout the workshops that the barriers aren´t technical but rather about business models, logistics, storage, trasnportation ect	YES | Technical challenges were addressed during the first Living Lab Barcelona, "OPPORTUNITIES & CHALLENGES FOR THE BUILT ENVIRONMENT SECTOR", and during the third one, "DIGITAL TOOLS FOR SYNERGIES IDENTIFICATION". The objective of the latest was to learn more about some of the current digital tools available that allow to concentrate data and visualize materials flows within a territory and which can, therefore, serve as powerful tools to promote the creation of synergistic networks.	Skills and learning programs for the future professionals.	- Continuity of raw material supply, - Quality guarantees	Yes
Commercial challenges	Yes The question of current and new business models as well as cost of recycling and deconstruction and changing routines throughout the value chain was discussed. As well as price of rawmaterial that influences the recycling rates. Also matters of quality and insurance	YES | Commercial challenges were addressed during th first Living Lab Barcelona, "OPPORTUNITIES & CHALLENGES FOR THE BUILT ENVIRONMENT SECTOR": using a participative approach, attendees had the opportunity to expose their points of view and discuss with the rest of stakeholders about the barriers, challenges, opportunities, enablers and impacts of implementing IS initiatives.	YES	Standardisation is up to CEN committees, therefore it is not guaranteed.	Yes

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Intra/Inter-organisational	Yes. Trust and cooperation challenges between stakeholders as well challenges of carrying out changeprocesses within organisations	YES | The Símbiosy team paid special attention to the design of a multisectorial participant list for all Living Labs. The average number of participants was 15-25. A small-group approach was intentionally envisaged to favour the debate and the exchange of ideas among attendees. The participants represented different professional activities within the construction value chain: designers, architects, manufacturers, associations, universities, construction companies, consultancy companies, deconstruction and waste management companies, material providers, maintenance companies, etc.	YES	Co-manufacturing process with stakeholders.	Yes -- creating trust between supply chain partners key.
Social/landscape issues	Some social issues have been discussed. E.g general awareness and readyness to engage in change processes towards a more circular material flow; how using greener materials and possible changes in how we log/report the use of different materials while construction (in order to be able to demont) would affect the endprice of construction as well as how to change workprocesses and take it step by step instead of taking down constructions and building new ones from scrach	YES | Social aspects were specially addressed during the second Living Lab Barcelona, "CIRCULAR BUSINESS MODELS FOR THE BUILT ENVIRONMENT SECTOR & THE CONSUMERS ROLE": how would the way we build change if users decided on the design and use of the buildings and public spaces they inhabit? How would the professional relationships among the different actors within the construction value chain be transformed if consumers demanded renewable, healthy materials, bioclimatic buildings, modular constructions designed for deconstruction? The second LL served as a visualization spot of successful, local	YES	Negative public opinion on blended cement and alternative raw materials.	Yes

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
		and concrete projects that have launched alternative circular models within the resource management, the design, and the construction phase, in which the needs and expectations of the users have been taken into account			

Figure 3 Results status for each LL (Sweden – UK) with respect to methodology and process at the end of the FISSAC project.

. This table has been a "living document" during the project as a help for the LL. It has been up-dated regularly along the progress of the project. The status of each living lab is now easy to over-look and comparisons can be easily be made between the living labs.

The information under chapter 3 was previously reported e.g. in D7.1 First Publications regarding living lab for FISSAC model. But, the common approach and the guidelines is the starting point for and the logic behind the development of the LL and the conclusions on how to take the LL work further after the FISSAC project . It is therefore considered to be important for the understanding of the LL and their subsequent reporting.

	FL/BE	CZ	DE	HU	IT
Issue 1: Starting point					
Existing initiatives	OVAM coordinates multiple platforms with the construction sector: implementation policy construction sector; Green Deal Circular Construction, Research Lab Urban Mining, Flemish Symbiosis Platform	Some IS promotion under ENVICRACK, but no active platform	International group established in a different R&D project, not focussing on industrial symbiosis but on identifying end-of-life routes, scenarios, technical, economic, legal and logistic constraints and incentives.	NISP - National Industrial Symbiosis Program. This was managed bw 2010-2012 by IFKA to promote good practices in the field of IS. The programme was funded by LIFE+ Environment.	In Italy there were different existing initiatives in Italy dealing with circular economy and industrial symbiosis, mainly at regional level (e.g. industrial associations) or sectoral level (e.g. cement and concrete sectors).
Existing agenda	1. Matchmaking platform; 2. Tracing and quality issues; 3. Regulation on non-stony fractions; 4; Cyclical construction action plan. Following are considered: stony fraction, sheet glass, isolation materials, gypsum board, cellular concrete, urban mining, circulair construction	Stakeholder knowledge and public awareness very limited.	Agenda relates to the identification, quantification and delaration of buidling-product-related end-of-life routes and scenarios. Ambition to define a generic approach based on three product groups with different levels of complexity, to be generalized and transferred to other product groups. Aim to implement findings in normative works in CEN and ISO.	Building on existing best practices, finding partnerships with stakeholders, feeding into relevant policy agendas.	Broad agenda touching on IS and resource efficiency, but not construction-specific IS as yet.
Issue 2: Stakeholder involvement					

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	FL/BE	CZ	DE	HU	IT
Value-chain coverage	Constructors, crushing plant operators, building material producers, building federations, supporting industries, architecs	As wide as possible	indirect. Focus on manufacturers placing products on the market	Broad coverage especially important for post-FISSAC period	As wide as possible, from producers of waste from construction companies representatives
Non-business actors	Research institutes, other governmental agencies (environment, land and resources)	City authorities, universities, promotion to general public	R&D, governmental agencies, manufacturer associations, manufacturers, unfortunately difficult to involve deconstruction and recycling industry	Especially research	R&D and associations
Stable vs. Evolving	Core group established	Likely evolving	stable	Evolving strategic -> operational	Evolving
Issue 3: Lab structure					
Open discussion	Cocreation	Different discussion fora for different stakeholders	open but guided. Key-note-presentations, clear defined targets for workshops (series of 3 workshops has been conducted in autumn 2017 and winter 2018), 4th open workshop (exceeding beyond the establisehd group) on international sustainable building conference SB19 Graz)	vital for challenging participants	Yes, especially for non-technical issues
Practical work	Set up experiments and tests	Likely, depending on topic	practical in terms of identifying routes and describing models and practical as involved manufacturers need to adress end-of-life apsects in their product to market information	Important depending on topic	No
Plenary vs. Groups	Both	Groups	both	Both depending on topic	Plenary
FISSAC vs. Post-FISSAC	Continuation as part of on-going transition to circular economy in the construction sector	Stakeholder are willing to contribute to the FISSAC platform after project ends, testing, using, feedback	parallel to FISSAC and scope , agenda, time, goals etc "not directly related", no compulsory link or inter-dependency	Both	Both
Issue 4 Subject focus					
Material-specific	stony fraction and non-stony fraction	Mainly cement and concrete, minor metal, plastics	Product specific	Demolished brick and concrete, WPC, glass concrete, construction waste	Yes (first two LLs focused on cement and concrete sectors)
Material-neutral	business models, monitoring, financial models	General colaboration	Yes	No	Yes (the last LL was about the evalutation of the potential of circular economy and IS)
Technical challenges	No	Local collection, processing and distribution of products. In the	Yes	Yes	Limited (the production of cement and concrete with

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	FL/BE	CZ	DE	HU	IT
		CDW recycling industry, very large mass flows are handled at relatively low prices, so any transport costs are very marked when handling them (proven that the maximum economically justifiable transport distances up to 20 to 30 km) - not traded across borders.			recycled materials is a mature and consolidated practice)
Commercial challenges	Yes	Involvement of municipalities and public population in waste segregation. Support of the regional level. Price comparison between the traditional materials and eco-materials. Confidence in use of products from recycled materials.	Yes		Yes (costs of recycled materials can be high, especially due to the transport costs)
Intra/Inter-organisational	co-creating process involving stakeholders from building sector, government and research institute,	Trust between supply chain stakeholders.	Related to pre-normative and co-normative R&D aiming to identify end-of-life scenarios to be applied in environmental product declarations		No
Social/landscape issues	Assessing the potential of symbiosis and circular building taking onto account social aspects in particular affordable building	Generally low awarenes about recycling of waste materials. The existence of a number of smaller speculative landfills of construction and demolition waste. Existence of illegal waste management.	Not in focus	Not in focus	Yes (sometimes there is distrust regarding recycled materials)

Figure 2: Results status for each LL (Belgium – Italy) with respect to methodology and process at the end of the FISSAC project.

	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Issue 1: Starting point					
Existing initiatives	Known initatives focus on reuse of interior product, mainly office related and also development of digitalized documentation systems for building materials. The Swedish construction federation has recently launced a	There are no specific established working groups dealing with the circular economy/industrial symbiosis in the build environment. At Símbiosy, we normally work using a cross-sectorial and multistakeholder approach.	· Existing projects: INSIGHT project; Higher education and post graduate programs;	- There are initiatives of municipalities on recycling plastic, glass, paper and metal wastes. No specific initative on construction sector. - The Zero Waste Regulation, includes several industry wastes, and Alternative Raw Material	Some groups exist to discuss reuse and recylcling, for example those organised by the Green Building Association and the Institute of Demolition Engineers. However these do not encompass the whole supply chain and do not consider

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
	Roadmap for fossilfree competitiveness for construction and civil engineering sector. More than 100 actors (including municipalities, construction companies and other organisations) have signed the initiative.			Communique are in force in Turkey.	all materials in particular glass is absent from discussions
Existing agenda	Log book; documentation to support material recycling in the future. Recycled content in concrete. Reusing av interior office products . Circular economy delegation within the Swedish Agency for Economic and Regional Growth; Working Group for Circular economy under The Nordic Council of Ministers; Roadmap for fossil free competitiveness (Swedish construction industries) Roadmap for increased uptake of industrial symbiosis in Sweden (Swedish Environment and Research Institute) Investmentfunds from Swedish govenmnet to work with innovation and circular economy (Vinnova)	Existing database at Símbiosy and knowledge transfer support from the Catalonia Institute of Construction Technology (ITeC)		The awareness of sectoral stakeholders, local waste suppliers and industrial partners determined very low. Therefore living lab studies are planned for the following years.	To desseminate case studies and raise awareness.
Issue 2: Stakeholder involvement					
Value-chain coverage	Stackholders from the entire construction value chain participated	We need to get the whole supply chain together to show the opportunities, identify the necessities and discuss how to work together. Consequently, the Símbiosy team paid special attention to the design of a multisectorial participant list of all Living Labs.	A multistakeholder group of expert (university-industry) has identified a number of common challenges and opportunities that would guaranty further research, exploration and discussion in the framework of FISSAC project and circular economy topic.	Focus on cement and concrete industries.	Focus on glass recycling across all stakeholders

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Non-business actors	Local govenments, research institutes, universities	Representatives from R&D R&I, Associations, Architects, Designers, Governmental Entities...	university	Ministry of Environment and Urbanization, Ministry of Industry and Technology, Legal authorities and Universities.	Universities, Government and Non government recycling organisations
Stable vs. Evolving	Evolving There were some stakeholders that followed the process and participated in several workshops and others who connected to particular workshops	Evolving	Evolving	Core group is stable but the rest is likely to evolve as the symbiosis vision is being disseminated.	Evolving
Issue 3: Lab structure					
Open discussion	Open, guided discussion with a set agenda and discussion topics	Encouraging an open debate is essential. Using a participative approach, attendees will have the opportunity to expose their points of view and discuss with the rest of stakeholders about the development of new business models that might transform the actual construction sector in a more circular one.	Facilited open discussion by a professional facilitator.	Open, guided discussion with predetermined subjects.	Open facilitated discussion on a selected topic
Practical work	Case study following a journy of gypsum plasterboards: site visits to construction and dempliting sites, as well as to a plaster board factory and a recycling plant	NO	Some examples of the innovative construction products were shown as well as the last case studies and real scale demonstrators carried out in the Project	Organizing technical seminars and trainings	Not anticipated
Plenary vs. Groups	Both All the workshops stared with some case or theoretical presentations, followed by groupdiscussions	The main structure of all Living Labs can be divided in three sections: an introductory part, which is followed by workshopping activities and/or presentations of concrete projects, followed by an open debate and a final conclusion part to summarise the main outcomes.	both	Both	Both

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
FISSAC vs. Post-FISSAC	Both As the living labs focused on mapping barriers and opportunities in order to acheive higher volume of circulatity in the construction value chain, ther was a lot of focus on practices and estabiliced systems also outside FISSAC and after FISSAC	The organisation of the Living Labs offered ideal networking opportunities. Not only for the team at Símbiosy, but also for the rest of participants, who made the most of the event and took the chance to broaden their professional/business network of contacts. The Living Labs have served as a great breeding ground to boost collaboration among some of the participants, who will surely envisage and launch future projects together.	both	Both	Continued engagement with stakeholders in the supply chain individually and at workshops.
Issue 4 Subject focus					
Material-specific	No/Yes 50/50 The goal of the Swedish LL was to engage a wide spectrum of stakeholders from the entire construction value chain. Gypsum plasterboards was in focus during three (#3-5) workshops in order to investigate the whole valuechain and the "journey" of a material from production to construction to waste management. .	NO	Construction sector, no specific products.	Cement and concrete	Glass
Material-neutral	Yes/No 50/50 explained in the previous answer	YES	General information about Circular Economy, Living Labs and principles of Systems Thinking	No	No

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Technical challenges	Yes However it was confirmed throughout the workshops that the barriers aren´t technical but rather about business models, logistics, storage, trasnportation ect	YES | Technical challenges were addressed during the first Living Lab Barcelona, "OPPORTUNITIES & CHALLENGES FOR THE BUILT ENVIRONMENT SECTOR", and during the third one, "DIGITAL TOOLS FOR SYNERGIES IDENTIFICATION". The objective of the latest was to learn more about some of the current digital tools available that allow to concentrate data and visualize materials flows within a territory and which can, therefore, serve as powerful tools to promote the creation of synergistic networks.	Skills and learning programs for the future professionals.	- Continuity of raw material supply, - Quality guarantees	Yes
Commercial challenges	Yes The question of current and new business models as well as cost of recycling and deconstruction and changing routines throughout the value chain was discussed. As well as price of rawmaterial that influences the recycling rates. Also matters of quality and insurance	YES | Commercial challenges were addressed during th first Living Lab Barcelona, "OPPORTUNITIES & CHALLENGES FOR THE BUILT ENVIRONMENT SECTOR": using a participative approach, attendees had the opportunity to expose their points of view and discuss with the rest of stakeholders about the barriers, challenges, opportunities, enablers and impacts of implementing IS initiatives.	YES	Standardisation is up to CEN committees, therefore it is not guaranteed.	Yes

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
Intra/Inter-organisational	Yes. Trust and cooperation challenges between stakeholders as well challenges of carrying out changeprocesses within organisations	YES | The Símbiosy team paid special attention to the design of a multisectorial participant list for all Living Labs. The average number of participants was 15-25. A small-group approach was intentionally envisaged to favour the debate and the exchange of ideas among attendees. The participants represented different professional activities within the construction value chain: designers, architects, manufacturers, associations, universities, construction companies, consultancy companies, deconstruction and waste management companies, material providers, maintenance companies, etc.	YES	Co-manufacturing process with stakeholders.	Yes -- creating trust between supply chain partners key.
Social/landscape issues	Some social issues have been discussed. E.g general awareness and readyness to engage in change processes towards a more circular material flow; how using greener materials and possible changes in how we log/report the use of different materials while construction (in order to be able to demont) would affect the endprice of construction as well as how to change workprocesses and take it step by step instead of taking down constructions and building new ones from scrach	YES | Social aspects were specially addressed during the second Living Lab Barcelona, "CIRCULAR BUSINESS MODELS FOR THE BUILT ENVIRONMENT SECTOR & THE CONSUMERS ROLE": how would the way we build change if users decided on the design and use of the buildings and public spaces they inhabit? How would the professional relationships among the different actors within the construction value chain be transformed if consumers demanded renewable, healthy materials, bioclimatic buildings, modular constructions designed for deconstruction? The second LL served as a visualization spot of successful, local	YES	Negative public opinion on blended cement and alternative raw materials.	Yes

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	SE	SP (Barcelona)	SP II (Madrid)	TR	UK
		and concrete projects that have launched alternative circular models within the resource management, the design, and the construction phase, in which the needs and expectations of the users have been taken into account			

Figure 3 Results status for each LL (Sweden – UK) with respect to methodology and process at the end of the FISSAC project.

3.1 The common approach

As mentioned above a common approach and a starting point for the Living Labs organization and management was discussed and agreed early in the project.

The objectives of the Living Labs can be summarized as follows:

- To exploit knowledge about technological and non-technological factors that could affect an Industrial Symbiosis
    - Different Sectors
    - Different Countries
    - Different Stakeholders

- To co-develop the FISSAC Model, based on circular economy, with a special focus on developed eco-innovative products

To meet the objectives a common and shared strategy is needed to cover all the relevant aspects of the FISSAC Model, leaving partners free to organize their own labs. In particular, the definition of a common strategy ensures that the Living Labs depict and are representatives of different countries and investigate all the most relevant aspects of FISSAC model, bringing valuable inputs to solve problems and explore pathways within the project.
The elements zero of the Common approach is reported in Figure 4:

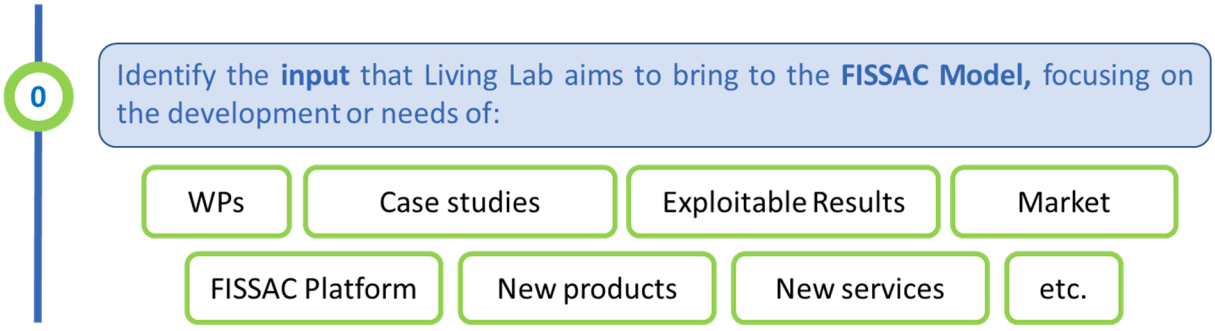

Figure 4: Element zero of the Common approach discussed during the 4th General Assembly

This common approach wants to stress the necessity to bring valuable inputs to the project, through the Living Labs. To facilitate the identification of the needs of the project, the Living Labs Guidelines reports an Appendix (List of topics of interest based on consultation with WP leaders) with a list of possible inputs that the Living Labs could bring to the project, divided per WP.

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3.2 Living Labs Guidelines

The "Living Labs Guidelines" document is meant to be read as a guidance, rather than an instruction, on how to set up and develop a Living Lab. It provides support, particularly related to:

- Alignment of the Living Labs so that shared knowledge is leveraged and the FISSAC project objectives are met
- The identification of key issues to consider in design and execution of a Living Lab, including potential challenges and trade-offs
- General guidelines for project management of the Living Labs

The section is structured as both a reference, collecting the knowledge and insights gathered so far in the project, and as a guide, with information that is particularly actionable highlighted and called out in text boxes throughout. For users looking to use this guide in practice, reviewing these boxes can be a pragmatic approach. The guidelines were developed and tested in an iterative process together with the Swedish Living Lab.

According to the statement above: "A Living Lab (LL) is a user-centric platform that is based on every day practices and experiences and research. It facilitates user influence in an open and collaborative innovation process engaging all pertinent stakeholders in real life context, aiming to create validated and sustainable value, and often operating in a territorial context."

It is important to note that the 'user' is not necessarily, or even most probably, the end-user of a sector's product or service. In the case of industrial symbiosis, the 'users' of the innovations are typically the firms working to establish symbiotic relationships.

It is also important to point out that 'collaborative innovation process' can be focused on both hard and soft technologies. To the extent that a lab is designed to 'test' a hypothesis, in the case of 'soft' technologies the collaborative process itself may represent the 'test'.

Living Labs are often categorized as for example: Utilizer-driven, Enabler-driven, Provider-driven, and User-driven. As part of a publicly funded project with a regional concept, the FISSAC Living Labs fit the Enabler driven model, characterized by:

- Strategy development through action
- Network forms around a region/project
- Information is collected and used together and knowledge is co-created in the network
- Guided strategy change into a preferred direction

The partners responsible for managing the nine national Living Labs have the freedom and responsibility to manage their own Living Labs in accordance with the conditions in which they must operate.

3.2.1 Living Labs as an input to the FISSAC project

The fundamental overarching objective of FISSAC Living Lab is defined in 'Element Zero' of the Common Approach[2]:

"[To generate] input to the FISSAC Model in the form of, for example, support to other Work Packages; case studies; exploitable results; market development; input to the FISSAC platform; development of new products or services; etc."

More specifically this objective can be achieved through 'Element 7' of the Common Approach, which specifies four additional objectives in the management of the Living Labs:

- ***Creating and maintaining trust***. This objective relates to the interaction with and between stakeholders in the Living Lab. While creating and maintaining trust is important to the success of the Living Lab activities, it is also

[2] Previously described as the 'Common Strategy' in presentation to GA March 2017.

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an outcome of value in and of itself, to the extent that positive interactions can be the foundation for relevant work outside the context of the project.

- ***Collecting data and specific information***. Data can be of various types and serve various purposes but capturing relevant qualitative and quantitative data is essential to transferring value from the Living Labs to the FISSAC project/model.
- ***Identifying and analyzing barriers and drivers***. This objective can be the most important from a stakeholders perspective, and will be important input into task 7.2.
- **Validating the work of the other WPs**. To the extent possible, working with issues raised in other Work Packages will create value for the FISSAC project. This must be considered in balance with the need to ensure stakeholder relevance. Figure 1 below illustrates the relationship between the Living Labs and WP5 and WP6 (a similar logic can be applied to WP3).

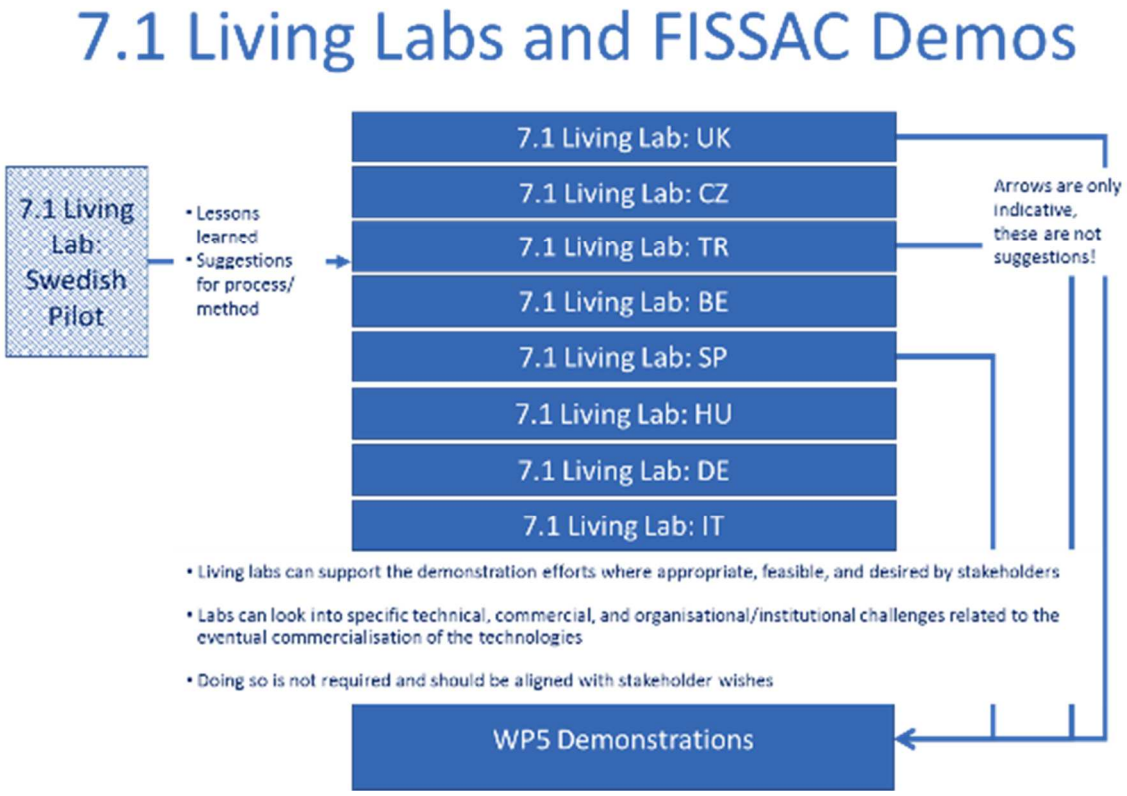

Figure 5: Relationships between Living Labs and WP5 (Demonstrations)

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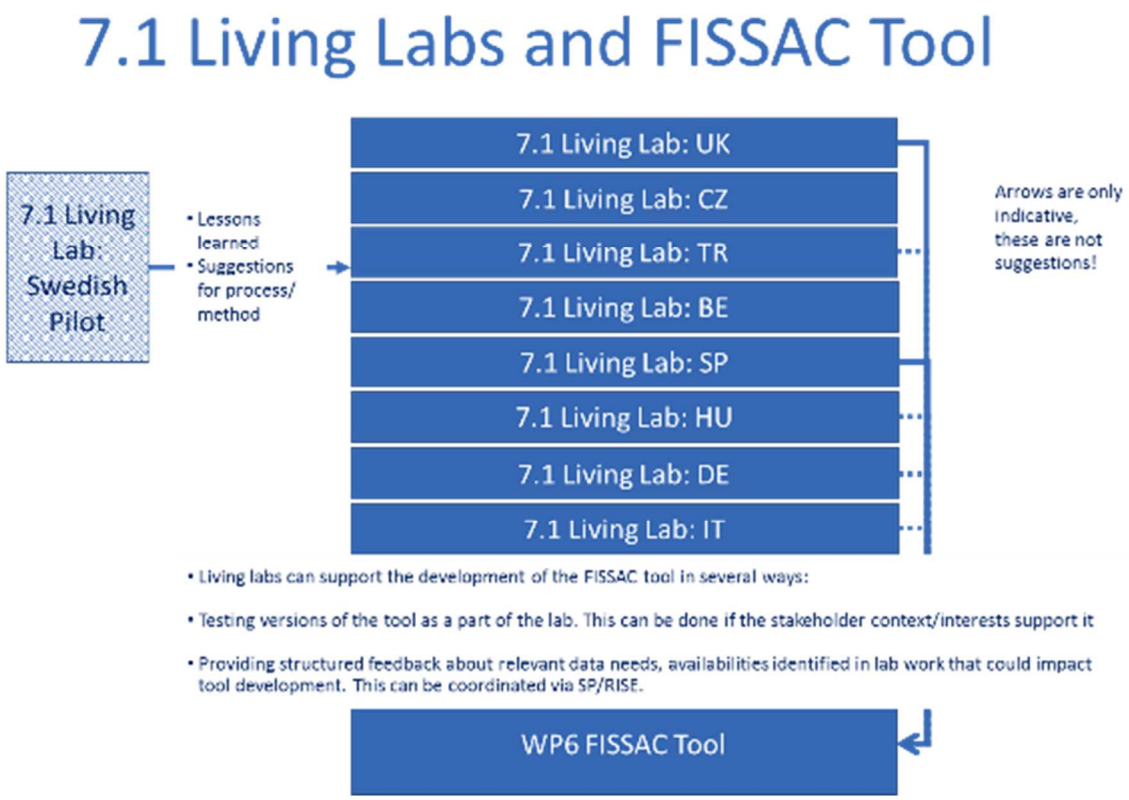

Figure 6: Relationships between Living Labs and WP6 (FISSAC Tool)

3.2.2 A stakeholder-centric approach

The starting point of the Common Approach is the FISSAC project and model. However, to a large extent, the success and impact of the Living Labs depends on successful engagement of stakeholders. Throughout the implementation of the Common Elements below, it will be crucial to balance the priorities of the project with the priorities of the stakeholders participating in the Living Lab. In general, however, stakeholder preferences should come first. In cases where stakeholders choose to raise new issues related to IS that are not dealt with elsewhere in the project, this is an

Recommendation: Stakeholder interests and needs should set the priorities of the Living Lab, especially in terms of topic selection.

opportunity to the project to gain new insights.

3.2.3 The FISSAC approach to Living Labs - Common elements of the approach

The following elements of the FISSAC Living Lab approach should be considered by all partners responsible for Living Labs. Specific decisions within these elements will vary in different national contexts.

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3.2.3.1 Stakeholders

Stakeholder identification

In order to ensure that the Living Lab is stakeholder-centric and relevant in a 'Real Life Context', a stakeholder identification effort should be the starting point for activities.

Recommendation: Begin the Living Lab with a Stakeholder identification process. To ensure flexibility, identify a broader selection of stakeholders than you initially plan to invite.

One useful approach is to begin by inventorying existing networks, projects, and industry groups who have a stated or potential interest in industrial symbiosis. These might include other research consortia investigating IS; construction and materials industry representatives and lobbying initiatives; and sustainability initiatives involving construction and materials industries. For initiatives that are highly relevant (i.e. both involving the construction sector and industrial symbiosis) collaboration in planning and executing the Living Lab should be considered. Interacting with existing networks may entail trade-offs, for example between surrendering control and gaining access to already engaged stakeholders. In the Swedish Living Lab, these trade-offs have been worthwhile, as there was little consensus about the topic for investigation and ideas from existing initiatives were treated as welcome suggestions.

Examples of relevant multi-actor groups or initiatives identified by the partners is for example:

- BAMB project (Swedish participant engaged)
- Re:Source Circular Economy platform Sweden (Participants consulted)
- Sveriges Byggindustrier (Branch organisation, leading role in Swedish lab)
- PLAN C/SUMMA/Agenda 2020 (Flanders Materials Programme)
- Liguria Circular (IS initiative in Italy)
- Zero Carbon Scotland

Trade-off: Working with existing platforms and initiatives may speed up your process and save resources, but will also entail giving those platforms extra influence over the Lab's management.

Relevant stake holders are listed in the reports from the various LL, chapters 4-12 below.

In identifying potential individual participants, one useful approach is to map stakeholders along one or more value chains. We recommend creating a stakeholder list that is relatively comprehensive and includes more actors than are likely to participate in the resulting Living Lab, as this will allow for some flexibility to respond to topic interests.

Inclusion of non-business stakeholders

In general those with experience of Living Labs and IS work have been positive towards the inclusion of non-business stakeholders. In many labs policy issues have come to the fore, and access to policy makers and/or civil society organisations can help to handle this. Additionally, while companies will inevitably have some issues regarding commercial sensitivity, giving active roles to non-business participants can help build trust among businesses.

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Recommendation: Include non-business stakeholders from the start. They can provide important perspectives on e.g. policy and also can advocate for action that is perceived as risky by commercial actors.

Evolution of participant group

Over the course of the Living Lab, there may be reason to consider revising the participant group. Many factors can affect this decision, but a typical trade-off may occur between maintaining a strategic perspective vs. bringing operational expertise to deal with specific issues. We recommend initiating the Living Lab with participants who have a 'strategic' perspective within their organization or initiative. This will aid in getting buy-in and in identifying truly relevant topics. However as the Living Lab evolves more specific operational knowledge may be required. A typical trade-off faced in the Living Labs involves securing the most appropriate participants vs. maintaining continuity in the group. Most organizations will struggle to justify the active participation of multiple representatives.

Trade-off: Living Labs will have to strike a balance between working with the same individuals throughout (continuity) and adding persons with needed expertise (specificity).

3.2.3.2 Topic selection

Selecting a topic for a multi-stakeholder Living Lab can be challenging. An important starting point is the FISSAC model and topics from the other Work Packages that may benefit from exploration/validation in a Living Lab context. There is the necessity that LLs bring valuable inputs to the project, investigating WP needs and issues. A list of suggested topics were compiled based on interviews with WP leaders in the FISSAC project.

Existing industry or civil society initiatives like those mentioned above may have already established agendas related to IS in the construction sector, or particular value chains. In the Swedish Lab, for example, multiple parties were already active around the issue of a 'log book' for materials, and the need to standardize across several existing/competing solutions. In the Flemish context, a four-part agenda was developed, which that Living Lab will build on:

1. Creating a matchmaking platform
2. Tracing and quality issues
3. Regulation on non-stony fractions
4. Cyclical construction action plan

Drawing on existing agendas entails a trade-off between leveraging existing engagement and tailoring the Lab activities to FISSAC.

We recommend identifying a small number of key stakeholders and discussing the both relevant FISSAC topics and existing external research/innovation/policy agendas in advance of the initial Living Lab. This can provide some insight

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Recommendation: Initiate discussion on topic selection (including important FISSAC topics) with a few key stakeholders in advance of launching the Living Lab, but do not pre-determine the topic.

into how to steer the initial discussions with the broader stakeholder group. However it is not necessarily recommended to launch a lab with a fully defined topic, as this may limit buy-in from participants.

Material focus. In general, choosing a single material around with the lab will be based will be advantageous. This helps with scoping the discussions, finding the right participants, and generating specific information/data. In the Swedish Living Lab there was significant interest in material-neutral topics, including the log book standard, and general mechanisms for value chain collaboration in advance of the construction phase. In the end, however, focusing the discussions and generating data required a material focus. In the Swedish lab this involved pursuing a 'material journey,' following a specific material (plaster) through the construction value chain, undertaking site visits, and documenting issues related to material circulation.

Recommendation: Orient at least some portion of the Living Lab around a single material, as this will allow for more specific data to be captured. A 'Material Journey' that follows the material through the value chain is one approach if the agenda is not clear among participants.

Technological and non-technological topics. Partners indicated varying views as to whether technical or non-technical topics will be prioritized. In the Swedish Living Lab both have been discussed to date; as noted above, the agenda in the Flemish/Belgian platform has been focused on non-technical issues primarily. In order to meet the overarching objective of analyzing barriers and drivers, it is particularly important to document non-technical issues even if a technical topic is the lab's core focus.

- ***Inter- and Intra-organizational issues***. The Living Lab method has been chosen, in part, to identify the ways in which different actors, both within and between organizations, need to change behaviours in order to make IS possible. It is important to capture these learnings, and the approach to data capture (see 5.3 below) will include documentation of these learnings.

- ***Social/landscape issues***. The social dimension of IS needs to be integrated in all FISSAC activities. The definition of social issues used by Work Package 1 includes inter- and intra-organisational issues, which are inherent in the Living Labs and are likely to be a key part of the findings as noted above. However social issues at the 'landscape' level – such as consumer awareness and acceptance, civil society advocacy, etc. – will not always be an obvious element of the topic definition. For this reason we recommend going through a 'checklist' of questions as the topic of the Living Lab is being defined. These questions will be followed up in the data capture and reporting process (see box below).

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Recommended questions regarding Social Issues at the Landscape level

1. Do the technical and non-technical innovations being 'tested' in the Living Lab raise issues that are likely to be of interest to consumers and citizens at large such as
    a. Safety concerns
    b. Health and toxicity concerns
    c. Changing environmental footprint
    d. Impact on local employment
    e. Impact on public services and infrastructure e.g. waste collection, energy infrastructure

2. Is there a case for proactively educating consumers and citizens at large about the innovations in question?
    a. If yes, what are some of the key messages?

3. Are there existing advocacy groups (business or non-business) who could be involved in consulting and communicating with consumers and citizens?
    a. If yes, have they been involved in the Living Labs?

3.2.3.3 The Lab structure

Each responsible partner will have to determine the structure of the Living Lab, in terms of meeting agendas and modalities. Some elements that should be considered include:

Open discussion. Allowing participants to meet and discuss industrial symbiosis with only a loosely-defined agenda can create risks in terms of delay and loss of focus. At the same time, participants should be given the chance to participate in the topic selection, and may require a more general discussion to become familiar with one another's perspectives and priorities. In the case of the Swedish Living Lab, most of the first meeting was given to a general discussion of industrial symbiosis, with the primary objective of securing the participants' engagement going forward.

Trade-off: Open discussion can be necessary to generate buy-in from participants, but can work against a focused Living Lab investigation.

Data gathering. Depending on the topic selection, sessions of the Living Lab may be explicitly structured to capture data. For example, if a Living Lab is looking at issues of Life Cycle Assessment, participants may need to bring (non-sensitive) data to the table for comparison and discussion of needs related to IS. If a Living Lab is working with the FISSAC tool, participants may be asked to assess functionalities in relation to their own data availability and needs, with both qualitative and quantitative data captured in the meetings. In the Swedish 'material journey,' participants document findings and insights via a journal that is submitted to the organizers.

Site visits. Understanding challenges, particularly technical ones, may be helped by site visits, which help actors from one part of the value chain better understand what their colleagues in the Living Lab are facing in their daily operations.

Workshops. For some innovations, understanding barriers and needs will be difficult without actually trying to solve the problem. Creative problem-solving or design-oriented exercises can bring participants closer to an understanding of what each party needs to contribute.

A good place to start is by defining the question or challenge that will be the focus of the living lab. Two methods to try are "Problem Definition" and/or "Framing your Design Question". Another valuable method to use is "Value Mapping". This is recommended for creating greater understanding and cohesion between the participant organisations of the Living Lab. All of these methods are described in Development, Impact and You (DIY) 08, Problem Definition. This report is bundled with this Guidance document in the distribution to partners.

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The Swedish Living Lab's focus on a material journey was inspired by service design methods like Customer journey Mapping [https://hbr.org/2010/11/using-customer-journey-maps-to] and the method "Experience Tour" is a good place to start when setting out on a new journey, be it in material, processes or customer experiences.

Throughout the Living Lab process, the "Partnership Map" can be very useful, to check the motivations of each partner and how they align with that of the Living Lab.

3.2.4 Different contexts, different living labs

It is worth emphasizing again that every Living Lab context is different: the Common Elements listed above should be treated as a menu of options that each partner should consider. In some cases, however, many of the choices will be clear due to the starting point for the Lab.

For countries where the construction sector is already exploring industrial symbiosis and may have an existing agenda for research and innovation in this area, it is likely that FISSAC partners will want to build on this agenda. Here the challenge may relate to generating specific findings that are highly relevant to the FISSAC model.

For countries where there is less existing engagement with IS from the construction sector, more time will likely be spent on open discussion of priorities and challenges, and finding ways to get stakeholders committed to participation in the Lab.

3.2.5 Project management, reporting and follow-up

The responsible FISSAC partners in each country have the freedom and responsibility to manage the Living Labs in the way they deem appropriate. What follows is a brief description of considerations for project management, along with a description of the reporting process within WP7.

3.2.5.1 Meetings

Multi-stakeholder, enabler-driven Living Labs are primarily composed of meetings. From the experience in the Swedish Living Lab, we note the following:

- Setting expectations – and getting commitment – regarding the frequency of meetings and the duration of the process is important. In the Swedish Living Lab bi-monthly meetings were agreed, with an expected duration of 1 year.

- There may be need for different 'levels' – all-stakeholder meetings to make big decisions and share findings, and 'working group' meetings tackling specific problems in specific constellations. The latter, if necessary, will have to emerge as a result of the former.

- Facilitation and presentation – Meetings may be facilitated by a FISSAC partner. Facilitation should focus on getting input from stakeholders rather than communicating to them. Neutrality regarding commercial issues is essential. While interaction should be prioritised over presentation, allowing stakeholders to act as 'hosts' for certain meetings and giving dedicated presentation time can increase buy-in. This role should rotate among the group.

3.2.5.3 Data capture and reporting

In general, the WP7 and task 7.1 leaders has kept internal project reporting from the Living Labs to a minimum. This to allow full focus on the LL work. The task 7.1 leader (RISE) has arranged for bilateral check-ins on an ad-hoc basis, and telcos with all LL responsible partners have- been held less frequently, on a quarterly or biannual basis.

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More detailed data capture is an essential responsibility of the Lab organizer, but the format for capturing qualitative and quantitative findings will depend to a large extent on the nature of the topics and the modalities used in the Lab. Some minimum expectations include:

- **Completed assessment checklists and summary findings**.
  - This is summarized and presented in the figure below.
- **Stakeholder and participant lists**: Partners should maintain a comprehensive list of relevant stakeholders, including those identified but not participating in the Lab, as well as information about which individuals attend which meetings. Where this has been applicable a list is included as appendix.

- **Meeting agendas and summary reports**: Partners should share agendas for Living Lab meetings as well as a brief summary report with both participants and WP7 and task leaders.

3.2.6 Topics of interest based on consultation with WP leaders

WP	TOPIC	NEEDS
WP1/WP2	IS opportunities identification	• To better define and study IS opportunities • To identify new IS opportunities • To collect technical e non-technical data to better characterize IS opportunities • To complete and validate the template containing technical and non-technical requirements and constraints
WP1/WP2	Social acceptance	• To establish a local network of stakeholder • To investigate social engagement and acceptance
WP3	ECO-DESIGN	• To make stakeholders aware of eco-design process • To investigate interest of stakeholders in the use/choice of eco-designed products
WP3	ETV certification	• To make stakeholders aware of ETV certifications • To identify interest of stakeholders in the use/choice of technologies with ETV certification
WP4	Logistic issues	• To investigate logistic issues related to waste transport
WP6	ICT Platforms	• To identify existing ICT platforms for IS opportunities identification and to ask for stakeholders feedback • To present FISSAC Platform and to ask for stakeholders feedback
WP6	FISSAC Platform opportunities: data gathering	• To collect relevant data (e.g. CAS Number, CER code, etc.) to better identify material flows within the FISSAC matrix • To collect relevant data for performing LCA and LCC of all the IS opportunities
WP6	FISSAC Model and Platform	• To investigate FISSAC Model and Platform userfriendliness • To collect suggestions for improving FISSAC Model and Platform
WP7	TIS analysis and Replicability assessment	• To collect information for evaluating the extension of the model application to different fields and types of producs • To identify non-technological barriers that may hamper the replicability of IS models and possible solutions to overcome them

Figure 7 List of interest based on consultation with WP leaders

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3.3 Living Labs – general overview

Several Living Labs has been developed within FISSAC Project. The main objective of Task 7.1 is to replicate FISSAC model through Living Lab development in different countries. Here a list of Living Labs that will be detailed on the subsequence sections:

- Belgium: ICT platform for industrial symbiosis. and exploration of possibilities of 'urban mining' for the construction and demolition sector
- Czech Republic: identifying barriers to Eco-innovation in building industry
- Germany: efficiency and the effective use of resources in an enlarged system view.
- Hungary: the role of construction and demolition materials in the circular economy
- Italy: Industrial symbiosis opportunities within cement and concrete sectors and replicability potential of Industrial Symbiosis and Circular Economy models in Italy
- Spain I (Barcelona): Role of the Circular Economy and the Industrial Symbiosis within the construction and demolition sector
- Spain II (Madrid): Role of the Circular Economy and the Industrial Symbiosis within the construction and demolition sector
- Sweden: Circular Economy and Industrial symbiosis (focused on gypsum/plasterboards – Material journey).
- Turkey: Raise awareness of stakeholders and related participant sectors about industrial symbiosis, focus on cement and concrete production by using secondary raw materials.
- UK: Increase sheet glass recycling in the UK. Possibly setting up pilot scale projects

These experiences have facilitated an open and collaborative innovation process engaging pertinent stakeholders in real life context, aiming to create validated and sustainable values and often operating in a territorial context involving 9 countries over Europe and Turkey with two LL in Spain, Barcelona and Madrid.

Figure 8 Development of Living Labs - countries

The ten living labs addressed different topics focused on the replication of an improved Industrial Symbiosis model in the construction scenario learning from different industrial sector. The high heterogeneity of the initiatives has allowed exploring technical and non-technical issues and social implications at regional scale.

The Figure 9 below gives a overview of Living Labs including their real-life context, purpose, main outputs and references.

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Belgium	
Organizers:	OVAM, the Public Waste Agency of Flanders region of Belgium. **Context**: The Living Labs within FISSAC build on the existing networks and ongoing platforms: The Flemish symbiosis platform, Consultation platform with the construction and demolition sector, Consultation platform with research and knowledge institutions (Research Lab Urban Mining), Green Deal Circular Construction (GDCC).
Purpose	Explore possibilities of 'urban mining' for the construction and demolition sector, provide input to FISSAC WP 6, share knowledge and good practices on Circular Economy between actors in the construction sector.
Activities	IS management tool: Two workshops organized on IS management tool/methodology, in 2017. Discussions on expectations on WP6 ICT platform. Experiences, added value, advantages etc of ICP platform. Urban mining: Two Workhops, in 2017. Discussing challenges related to urban mining: Demolition and treatment of materials, Policy and regulations, Business model and market, Eco-innovation, Cooperation along the value chain. GDCC: 4 inspiration days in 2019.
Barriers and Drivers	Business model, market secondary raw materials, knowledge CE and cooperation along the value chain
LL after FISSAC	Business model, market secondary raw materials, knowledge CE and cooperation along the value chain
Web	http://fissacproject.eu/en/category/ll-belgium-en/
Czeck Republic	
Organizers:	FENIX in collaboration with the Institute of Circular Economy INCIEN
Context	Circular economy, construction, demolition waste, industrial symbiosis, resource efficiency. The most prospective material is cement and concrete, in minor extent metal, plastics.
Purpose	The main aim of the Living Lab in Czech Republic is to identify barriers and drivers for the industrial symbiosis and to identify key stakeholders for the value chain and get their feedback.
Activities	Workshop June 21st 2017 (main stakeholders: SMEs, industry, Ministry of Environment, municipality representative, associations, media). Discussing and identifying Barriers and how to overcome them. A questionnaire regarding acceptance of FISSAC model was distributed. Second workshop was organized on September 20th 2018 as a one day event, with morning session introducing FISSAC project and main

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	outcomes, compared with other national initiatives and projects. Afternoon session was dedicated to workshop session with stakeholders (SMEs, industry representatives – construction companies, recyclers, Ministry of Environment, municipality representative, associations) when FISSAC platform was in detail introduced and stakeholders were asked for discussion about the possibilities to implement the platform in CR and what barriers eventually might arise. Main outcomes: Czech legislation is a barrier to introduction of the FISSAC IS Platform. If the platform is international, it might need arbitration court. One similar initiative already failed in CZ in nineties. Lack of awareness. Best practices and positive examples could motivate potential users.
Barriers and Drivers	Legislation, Lack of knowledge, cooperation and construction material recycling, increased use of eco-innovation on the market.
LL after FISSAC	To test FISSAC IS platform in practice with voluntary stakeholders identified during the workshops.
Web	http://fissacproject.eu/en/living-labs/czech-republic/
Germany	
Organizers:	Ingenieurbüro TRINIUS, in collaboration with UBA research project
Purpose	To establish a forum that groups the required competences to generate and feed background information and to serve as a reference panel for the establishment of a guidance document on the integration of end-of-life information in environmental declaration of construction products.
Activities	Background material, reports, goal definitions, ambitions of the R&D project and to related topics were sent to the LL members. The opinions, experience and perspective were valuable feedback to the project group and were utilized to develop the project content. By the means of a professional workshop moderation, it was ensured that workshops successfully performed their tasks. The interaction with the stakeholders was limited to exchanges in preparation and post-processing of the workshops. And to the discussion and interaction during the workshops themselves.
Barriers and Drivers	The key drivesr for the growing importance of end-of-life information related to building and construction products are - increasing awareness about the importance of full life cycle considerations in communication and decision making - the inclusion of end-of-life stages as obligatory EPD-elements in the revised version of EN 15804

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	- full life cycle consideration enables to overcome suboptimisation of production-related environmental concerns and enables all market actors to apply a more holistic perspective when communicating product performance aspects Meanwhile, the consideration of full life cycle and especially end-of-life life cycle stages is complicated by multiple barriers, including legal, administrative, economic, technical and logistical aspects. Moreover, these life cycle stages can only partly – if at all – be decisively influenced by product manufacturer. With the manufacturers being reliable for the content of product declarations, but not owning control of future processes, the conflict is obvious.
LL after FISSAC	Strictly, the LL and the workshop series are closed now. Meanwhile, the members are very likely to cross paths in other related contexts, due to their involvement in international R&D networks, standardization tasks, thematic fora. The content drawn from the workshops is collated and fed to key stakeholders. Ultimately their concerns and demands were the raison d'etre of the R&D project and the workshops. It was never the intention to set up a permanent orgnaisation
Web	
Hungary	
Organizers:	Geonardo Ltd.
context	Building on previous and existing projects and best practices in the construction and the demolition sector.
Purpose	To raise awareness of circular economy, industrial symbiosis in construction sector and how the FISSAC method could facilitate this. Identify drivers and barriers.
Activities	Two LL workshops were organized so far: in April 2018 and in June 2019. Both events had a good attendance and a constructive, open discussion on drivers and barriers.
Barriers and Drivers	Since the necessary regulatory, financial and market incentives are lacking, raising stakeholders' interest toward the subject is difficult
LL after FISSAC	One closing LL workshop is scheduled for February 2020 in Budapest to recap and to discuss next steps. We aim the closing event to serve as a catalyst to follow-up the subject (CE in the construction sector) in the framework of the Circular Point, which is the new circular economy business hub of Geonardo
Web	http://fissacproject.eu/en/category/ll-hungary-en/
Italy	
Organizers	RINA consulting

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Context	1stLL: IS in steel, construction aggregates, cement and concrete sectors in the north of Italy; 2ndLL: The recovery of materials in the cement and concrete sectors in a wider geographical context; 3rd: the replicability potential of Industrial Symbiosis and Circular Economy models in the Italian scenario;
Purpose	Promote Industrial symbiosis and the validation of the FISSAC model. **Scope:** Together with stakeholders reflect on industrial symbiosis opportunities, share experiences and knowledge, identify main driver/barriers for the replication of Industrial Symbiosis and Circular Economy models in Italy, identify solutions for overcoming non-technological barriers.
Activities	A Logo for the living lab was developed to ensure visual identity for the LL. Three different events have been organized: the first on November 10th 2017. "First Italian Living Lab: Fostering circular economy and industrial Symbiosis", in collaboration with Associazione Industriale Bresciana (AIB); the second on 11th December 2018, "The recovery of materials in the cement and concrete sectors ", in collaboration with the Italian Association of ready-mixed Concrete Manufacturers (ATECAP); the third on 4th October 2019, "Industrial Symbiosis and Circular Economy: which potential for the Italian scenario?", engaging different actors with a vision and investments in the circular economy and industrial symbiosis.
Barriers and Drivers (Main results)	Topics discussed were primarily non-technical barriers like economic i.e. low profitability, legislation e.g. lack of standards, distrust e.g. towards product quality. The excessive bureaucracy and an unclear authorization framework have been identified by all stakeholders as the main barriers for IS establishment. The technical point of view has been considered of secondary importance, especially in the cement and concrete sectors, where the use of waste in substitution of virgin raw material is a consolidated practice. During all the three LLs one of the main expectations and desiderata from stakeholders is the need of simplification of the authorization framework (e.g. the introduction of new end of waste criteria and the reduction of time for their development). Indeed different drivers already exist, which could promote the replicability potential of IS models: the willingness of customer to acquire "green products" and of the industries to reduce their waste, the potential benefits from the environmental point of view, etc., but further support from government is required to increase the replicability potential.
LL after FISSAC	
Web	http://fissacproject.eu/en/category/ll-italy-en/
Spain I Barcelona	

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Organizers:	SÍMBIOSY
Context	The construction industry is the **top global consumer of resources**. This implies that the design and development of **circular strategies** have already become a **necessity**.
Purpose	The objective of the Living Labs Barcelona will be to jointly **debate** about how companies of the construction and demolition sector can **optimize their resources** by means of **industrial symbiosis tools**. Using a participative approach, attendees will have the opportunity to expose their points of view and discuss with the rest of stakeholders about the development of new business models that might transform the actual construction industry in a more circular one. The concrete goals are thus to **create a space for reflecting on industrial symbiosis** in the construction and demolition sector, to **identify the tools needed** to make IS happen and to **gather feedback for the FISSAC platform**.
Activities	**Three Living Labs** have been organised. Living Lab I: "Industrial symbiosis - opportunities and necessities from the stakeholders' view" Living Lab II: "Alternative business models for the built environment sector & the consumers role" Living Lab III: "Digital tools for synergies identification"
Barriers and Drivers	The **identified barriers** for boosting the circular economy/industrial symbiosis in the built environment were in line with the ones related to other industrial sectors: **Regulatory and legislative issues**: current legal/regulatory frameworks that do not envisage the implementation of the industrial symbiosis initiatives, too heavy administrative burdens, excessively rigid environmental regulations, lack of certification schemes for waste streams as by-products for its use as raw materials (end of waste criteria), etc. **Financial, economic and market-related obstacles**: lack of actual demand and customers engagement, time and the costs related to all the activities necessary in order to identify, assess, negotiate, and implement industrial symbiosis initiatives, lack of suitable co-financing instruments and incentives, high capital investments and long return periods, etc. **Social, cultural and organisational aspects**: lack of trust and collaboration among stakeholders, lack of skills and know-how of the involved stakeholders, linear production and consumption patterns, short-term mindset, lack of open innovation spaces, lack of coordination and leadership, lack of capacity building and training, etc.

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	During the three Living Labs the different working groups put their ideas together and discussed about **possible enablers** that might tackle current barriers related to the actual implementation of circular projects. Some of the proposals were: **Do not punish for trying**: Give freedom to try new models. Collaborate on **pilot projects** with the rest of the stakeholders to visualise how the sector could change, to drive innovation and create knowledge and skills. Create an **ecoinnovation observatory** that allows interested stakeholders to know each other, promote collaboration and build trust among them. Consider assets as **material banks.** Create new ways to **track the materials** within assets, for example through materials passports. **Design for disassembly mindset:** Assets of the future should be retrofit-and upgrade-ready. **Drive a cultural change**: Inform customers and users about the environmental traceability of the products/materials/services they acquire so that they become more active and conscious about the spaces they inhabit. Prove that there are clear advantages: **Quantifying the impacts** of circular projects and case studies and **document value creation**. **Focus on the social dimension**, which is often overseen during the implementation of projects since the emphasis of the work is put mostly on more technical aspects. Reward and give **visibility to local best practices.** **Learn from successful initiatives** from other countries. **Provide training** in circular economy/industrial symbiosis across all grades and disciplines. **Facilitate public private partnerships** to develop scalable projects. **Create the demand for circular solutions**: Circular business models are solid enough only if there is market demand behind, and we all know that users create the demand. Thus, **well-informed consumers** can drive the transition to alternative and circular business models. Boost **policy and regulatory support** that can provide cities and industries with incentives and funding
LL after FISSAC	The organisation of the Living Labs offered ideal **networking opportunities**. Not only for the team at Símbiosy, but also for the rest of participants, who made the most of the event and took the chance to **broaden their professional/business network** of contacts. The Living Labs have served as a great **breeding ground to boost collaboration** among some of the participants, who will surely envisage and launch future projects together.
Web	http://fissacproject.eu/en/category/ll-spain-en/

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SPAIN II Madrid	
Organizers:	ACCIONA Construcción and Fundación Agustín de Betancourt
Purpose	The main objective of these Living Labs were to explore with the academic community the needs and challenges to face the future and train professionals specialized in circular economy and industrial symbiosis in construction. One of the challenges was to ensure that professionals who join the sector have the necessary skills to maintain and promote this type of symbiosis, which encourages the exchange of information and development of new value propositions. The education system faces the need to respond to these new professional needs, to ensure that the professionals of tomorrow are trained at the university to meet the challenges that organizations are already facing.
Activities	**Two Living Labs** have been organised. Living Lab I: The first lab was celebrated it at the kindergarten "El Alboroto", Alcobendas the last 10 May 2019. Living Lab II: The second Living Lab was organised at Higher Technical School of Civil Engineers in Madrid with the collaboration of the Craft Caminos organization and the Directorate of the School of Civil Engineers.
Barriers and Drivers	A concept map was prepared to serve as a tool for reflection and to initiate the dialogue and the exploration of alternatives among the Living Lab participants which included students and teachers of the Faculty of Civil Engineers, ex-students and current workers in sector companies. The purpose of the causal diagram was to make assumptions and models visible in the construction sector, identify which are the interdependence between the different agents involved in it and the main forces that facilitate or prevent change. The participants, in a playful way, worked in groups to analyze the factors that more influence have to boost the Circular Economy in the Construction sector. At the end of the session, each group presented a prototype of ideas or actions to carry out and that would help to meet the educational needs of the University to train specialists in circular economy in the construction of tomorrow.
LL after FISSAC	Hopefully, ACCIONA and FAB will continue working together with professionals and future professionals to reduce the use of virgin raw material consumption and developing new formulas to use as raw material with no damage on the infrastructure requirements (strength, durability, among others).

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Web	
SWEDEN	
Organizers:	HIFAB AB and RISE
Purpose	The Living Labb process in Sweden started with a broad approach to introduce FISSAC and industrial symbiosis to a wide range of actors in the Swedish construction value chain. During the second meeting collaboration with other similar initiatives and projects was established and the use of material logbooks was investigated. Living Lab meetings 3-5 focused on gypsum plasterboard and the journey of a material was looked closer at from the production to the use-phase in construction to the waste management. The sixth and last workshop was organised in cooperation with an active reconstruction/demolition site. The Swedish LL process and lessons learned was used to develop guidelines for the other LLs and how to apply TIS-analysis for developing Living Labs and industrial symbiosis.
Activities	Creating better understanding of the value chain and how to design a better framework for data needed to increase circularity of materials in the value chain. Activities: Six LL workshops were organized (2016 October – 2018 September). LL1: Introductory meeting. LL2 Topic: Material log book of the future. What information is needed to be a helpful tool for increasing circular material flow. LL 3-5: Following Gypsum as a case study. The Swedish LL was set up as a pilot case within the project. LL 6: Area of Hammaren – A practical example of a building as a material bank. The LL aimed at identifying drivers and barriers for recycling and re-using materials.
Barriers and Drivers	**Barriers**: Bussiness models, logistics, storgare and transportation issues, existing codes and regulations, quality guarantee and insurance questions, low price on raw materials; lack of big scale best practice examples; lack of trust and cooperation **Possoble drivers:** Public procurement, new requirement and regulations, economic value embedded in secondary materials.
LL after FISSAC	Sharing the knowledge of the FISSAC IS Platform with our network, when and where relevant
Web	http://fissacproject.eu/en/category/ll-sweden-en/
TURKEY	
Organizers:	TCMB
Context	Cement and Concrete industry. Production of eco-cement from waste like steel, glass, ceramics etc

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Purpose	To raise awareness of stakeholders and related participant sectors about industrial symbiosis and best practices applications, focus on cement and concrete production by using secondary raw materials.
Activities	Stake holders have been identified during 5 living lab studies at different platforms; 03 September 2018,Workshop with Quality and R&D Managers of Turkish Cement and Construction Sector, 02 November 2018, Certification Body Managers, Quality and R&D Managers of Turkish Cement and Construction Sectors, 26 February 2019, The Waste Management Summit 29 March 2019, Workshop with Certification Body Managers, Quality and R&D Managers of Turkish Cement Sector26 April 2019, Annual Meeting with Quality and R&D Managers of Turkish Cement and Construction Sectors
Barriers and Drivers	The LL concept is not well-known. It might be difficult to convince people of the potential finding profitable business opportunities through the LL process
LL after FISSAC	**Planned work**: 1) Questionnaire for both technical and non-technical topics.2) Preparing leaflet about LL. 3) Organizing a pre-workshop with our technical committee consisting quality managers of Turkish Cement Sector. 4) Evaluating the results of questionnaire. 5)Finally organizing LL meeting with our FISSAC partner Ekodenge for testing FISSAC software platform with participants.
Web	http://fissacproject.eu/en/living-labs/turkey/
UK	
Organizers:	British glass and Glass Technology Services (GTS). Working with Green Building Council UK (GBUK), Environmental Technologies and Resource Efficiency Service (ENTRESS)
Context	Architectural glass
Scope	Find solutions to barriers such as economically viable business case, rolling out infrastructure, educating supply chain.
Purpose	To identify how to increase collection of architectural glass and recycling to closed loop and high value secondary uses. Engagement of entire stakeholder chain from Architects and specifiers to glass manufacturers and recyclers
Activities	British Glass and GTS spoke to over 40 stakeholders individually and visited sites as part of the initial and ongoing research for FISSAC. Living Lab Workshops and presentations were organized in conjunction with:

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	• ZeroWaste Scotland. Barriers and Opportunities to creating an architectural glass recycling scheme in Scotland, Glass and Construction supply chain • Ferver, European Glass Recycling Association. Presentation of FISSAC and results of Initial Living Lab work. Discussion of Barriers and Opportunities with European glass recycling companies. • Green Building Council UK (webinar). Overview of the benefits of recovering glass from refurbishment projects, case studies from successful projects, Architects and construction project professionals. • Glass and Glazing Federation. Round table discussion at FIT show 2019 discussing issues around increasing flat glass recycling to remelt. • International Conference Construction Circular Economy 2019. Presentations of the FISSAC model and an overview of architectural glass recycling as part of a larger construction circular economy event, circular economy and sustainability professionals. • ENTRESS Deconstruction and Modern Building Materials Workshop. Overview of current glass recycling practice in demolition projects. Workshop on increasing recovery and quality of materials from buildings and inparticular future demolition/deconstruction projects. Demolition engineers and contractors, project managers.
Barriers and Drivers	Low value of recovered materials, lack of awareness/ education, time and space constraints, lack of regulation and/or enforcement of regulations, increasing use of glues and composites in building materials making separation difficult.
LL after FISSAC	Future work is planned to increase awareness of the potential to recycle glass to high value end uses from the construction sector. Case study video of Burrell recovery project being produced and launch event anticipated. Seeking funding to continue stakeholder living lab type events to maintain the momentum generated by the FISSAC project.
Web	http://fissacproject.eu/en/living-labs/uk/

Figure 9 General overview of FISSAC LL experience

3.4 List of Appendices

Appendix 1 Partner survey about methodology and process

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4 Belgium

4.1 THE SECTOR AND THE LIVING LAB

In 2016 the Flemish government accepted the transversal policy paper 'Vision 2050, a long term strategy for Flanders'. The transition to circular economy is considered a key priority to realise this policy. Given their experience in the past, OVAM (Public Waste Agency of Flanders) and Circular Flanders[3] are considered key players to realise this transition. The OVAM and Circular Flanders have taken the lead during the past years in multi-stakeholders initiatives to stimulate Circular Economy and Industrial symbiosis. The OVAM considers industrial symbiosis as an integral part of the transition to a circular economy.
Given its impact on the total use of materials and the environment the construction sector has been an important partner in the development of the waste and materials policy and implementation plans.
The Living Labs within FISSAC build on the existing networks and ongoing consultations with the construction sector:

- Implementation policy construction sector
- Green Deal Circular Construction and 'call for innovative projects'
- Research Lab Urban mining and 'Compass Group'
- Flemish symbiosis platform

The OVAM and Circular Flanders act as initiator and facilitator for these platforms.
While OVAM is a governmental agency only operating in the Flemish region, the Living Labs are open to participants in all three regions of Belgium. Many stakeholders in the building sector are active in the different regions of the country and abroad. There has been an open dialogue with similar initiatives in Brussels and the Walloon region. However, several aspects of the development of the methodology and the tools for FISSAC were exclusively discussed and dealt with in the living labs in Flanders.

4.2 THE LIVING LAB TODAY

4.2.1 PURPOSE AND GOAL

The purpose of the Living Lab is manifold:

- To give input to WP6, concerning the expectation and relevant features of the Industrial Symbiosis management software tool.
- To explore possibilities of 'urban mining' for the construction and demolition sector, with special emphasis on non-technical aspects (enablers) such as: legal, business model, employment, challenges related to the construction site in an urban environment.
- To share knowledge and good practices on Circular Economy between actors in the construction sector.

4.2.2 SCOPE

The starting point for the Living Lab on the Industrial Symbiosis Management Software tool is the experience with the Flemish Symbiosis platform. This was combined with the questionnaire for the Industrial Symbiosis Management Software tool, developed by WP6. The Flemish symbiosis platform is not limited to the construction sector and as such an interesting sounding board to verify whether different modalities are required depending on the sector.
The Living Lab 'Urban Mining' focuses on the potential for optimal reuse and recycling of parts of buildings, building elements, components and building materials in an urban environment. During the first Living Lab session the participants mapped the challenges and questions they encounter while (re)valorizing resources/waste from construction and demolition. In this first phase the Research Lab Urban Mining focuses on data collection on building and demolition sites as extra input for the research.

[3] Circular Flanders is the hub and the inspiration for the Flemish circular economy. It is a partnership of governments, companies, civil society and the knowledge community that will take action together. Its operational team, which is responsible for the day-to-day operation, is embedded in OVAM.

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Both Living Lab sessions on industrial symbiosis and urban mining are closely linked to the Green Deal Circular Construction. In February 2019 OVAM and Circular Flanders initiated the Green Deal Circular Construction, engaging over 300 companies in the construction sector. The Green Deal is a cooperation between OVAM, Circular Flanders and the VCB, the Flemish confederation for the construction sector. It is a learning network, set up to experiment and to share knowledge. It runs over a period of 4 years. For the first year of the Green Deal the main objective was to share knowledge about circular business practises such as industrial symbiosis. During several inspiration days and workshops industrial symbiosis and the FISSAC-model were presented and discussed. Feedback from these meetings is also used as input for the Living Lab on Urban Mining.

4.2.3 IDENTIFYING STAKEHOLDERS

Both Living Lab sessions on the Industrial Symbiosis Management Software Tool and on Urban Mining, gathered stakeholders from different sectors. The intended diversity of the participants, closely monitored throughout the plenary session and the debates in smaller working groups, was considered a real added value. It offered the opportunity to consider different aspect and viewpoints and lead the way for an cross-sectorial and interdisciplinary debate.
The invitation for the Living Labs were addressed to stakeholders already taking part in the different OVAM multi-stakeholders platforms, enlarged to people showing a specific interest in FISSAC.
The Living Labs on the software tool mainly involved participants already having experience with industrial symbiosis, or at least being favorable to the idea. We opted not to limit the invitation to stakeholder from the building and construction sector, given the potential interest of the tool for a broad range of sectors/companies. However, special efforts were made to involve waste traders in the debate.
The invitation for the Living Lab on Urban Mining was more generally distributed but focused on the construction and demolition sector. It attracted a more diverse audience, in line with the many challenges related to the concept of 'urban mining'.

IS Management software tool	Urban mining
Production: different sectors (retail, construction, production)	Construction and demolition federations
Technology / solution providers	Material producers / contractors
Waste traders	Government
Research institutes	Research institutes
Public Waste Agency	Consultancy and others

Figure 10 Representation different sectors during Living Lab

The Green Deal Circular Construction offered a new opportunity to present the FISSAC project to a larger public. It brings together construction companies, producers of building materials, local and regional governments, private building companies, property developers and researchers. Apart from the technical aspects on industrial symbiosis, the Green Deal focuses on enabling conditions to further circular economy in the construction sector: legal and financial issues, business models, cooperation along the value chain...

STAKEHOLDER INTERACTIONS AND ACTIVITIES
For the Living Lab session on the Industrial Symbiosis Management software tool two identic small scale sessions were organized. The focus was on past experiences with industrial symbiosis and an exchange of views on expectations and possible use of the software tool.
The first Living Lab session on Urban Mining started with a plenary session on Circular Economy and Urban Mining, defining both concepts for the following work sessions in interdisciplinary, but smaller groups. All groups addressed the following issues: selective demolition, value chain of materials, business models and vision for the future, building design, urban planning. The session ended with feedback from the different sub-groups.
The aim of the session was:

- To get insight on the questions and challenges encountered while (re)valorising waste/resources form construction and demolition
- Identify research questions to take up in follow-up labs and eventually in trial projects
- Explore the willingness to engage and contribute to the follow-up process

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The second Living Lab session worked on the outcome of the first meeting using a challenge tree method. The aim was to identify clear objectives and priorities for the follow-up process. Some of the issues raised were further taken up by the Research Lab Urban Mining.
In 2019 four inspiration days were organized in the framework of the Green Deal Circular Construction, focusing on different phases and challenges in the building process: demolition and urban mining 26/03), design (23/05), cooperation during the construction process (3/10), financial tools, business models, public procurement (5/12). During a plenary morning session the participants were introduced to theoretical models and good practises. During several break-up sessions in the afternoon in-depth discussion on specific topics were organized. These sessions gather a more specialized public and build on input from previous meeting such as the Living Lab on Urban Mining and Industrial Symbiosis.
For the Green Deal on Circular Construction a Knowledge Sharing Platform was created for the participants: gdcb.eloomi.com

4.2.4 IDENTIFYING BARRIERS AND DRIVERS

Some of the Living Lab sessions focused on drivers and barriers related to the use of the software tool to enhance industrial symbiosis. However, it very soon became clear that the tool and the concept of industrial symbiosis does not stand alone and needs to be seen as an integrated part of measures needed to make the transition towards circular economy. Within the broader discussion of the Living Lab several challenges were identified related to enabling conditions, changing business models, the need for new or adapted regulations and many logistics aspects. Several of these challenges will be taken up in the ongoing debate of the Green Deal Circular Construction and the Research Lab Urban Mining.
Barriers and drivers related to the use of the industrial symbiosis management software tool
Industrial symbiosis aims at giving a higher value to waste from one company by using it as raw material for another, and thus contributing to a circular economy. The software tool should be seen and used as a tool to enhance the valorization of waste and not as a mere instrument to search for alternative/cheaper waste treatment solutions, without added value from an environmental or social perspective.
As to avoid misuse of the platform it is considered essential to have a clear set of rules concerning the use of the platform and a clear engagement of the participating companies.
In the long run it will be essential to guarantee the financial viability of the software tool. Since the success of the platform very much depends on the number of participating companies and the amount of available data, it is essential for companies to have free access to (at least parts of) the platform, to discover its potential and its added value. This should be possible even without registration. In a later phase, a system of (paying) membership to the platform could be envisaged.
The software tool is a matchmaking tool, facilitating companies to connect. The subsequent process leading to the symbiosis, is an exchange between individual companies. In order to evaluate the success of the software tool as a platform for industrial symbiosis, feedback is needed on the actual outcome of the initial contacts. This should be envisaged at the initial design of the software tool.
The software tool should be more than just a platform connecting companies. It should be connected to a network offering advice or research on innovative opportunities, looking at ways to overcome practical barriers related to symbiosis, stimulating and supporting less obvious symbiosis initiatives. This 'help-function' could encourage potential participants to join the platform, even when a fee is envisaged.
The debate on industrial symbiosis and circular economy is still a very academic debate. In order to stimulate industrial symbiosis it is essential for the platform to be easy accessible and user-friendly.

<u>Business model</u>
Is there a market for secondary raw materials from construction and demolition sites: why or why not? How can we guarantee quality standards concerning security, safety… ? Where in the value chain are the cost and the benefits: can we develop a viable business model for all stakeholders involved?
How can we stimulate a market for secondary raw materials: do we need to review the existing regulations, the financing policies?

<u>Cooperation along the value chain</u>
While the concept of industrial symbiosis seems attractive at first sight, many practical problems remain to convert it to a business context. A platform is a useful tool to connect supply and demand, but will this be sufficient to realise symbiosis? Do we need brokers to accompany the process? How do we stimulate trust for recycled materials? How do we guarantee the quality of recycled content? How do we stimulate reuse for more generic materials? A model based on circular economy will need knowledge sharing and transparency between different stakeholder of the value chain: how can we improve this cooperation?

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4.2.5 OTHER RESULTS

The results within the framework of the FISSAC project are very much intertwined with on-going projects in Flanders to further Circular Economy in the demolition and construction sector:
The Research Lab Urban Mining: a research project over 4 years, aimed at policy development and the formulation of practical recommendations to accelerate the transition towards a circular economy in the building sector.
Compass group: multi-stakeholder platform, reflecting on long term vision for the transition towards circular economy in the construction sector in Flanders.
The Green Deal Circular Construction: a project over 4 years in which over 300 companies engage themselves to incorporate some circular economy aspects in their daily business practice.
The call 'innovative circular economy projects': giving financial support to innovative initiatives to further the transition to circular economy, many of which are related to the demolition and construction sector.

4.3 CONCLUSIONS

From the start OVAM opted to integrate the Living Lab of the FISSAC project in its existing networks and projects with stakeholders from the construction sector. This was done during the multi-stakeholder consultations for the development of the bi-yearly implementation plan for the construction sector, during the on-going consultations within the Flemish industrial symbiosis network. More recently the workshops during the Green Deal on Circular Construction offered an ideal platform to introduce and test the FISSAC methodology for the Living Lab. Given the context (limited geographical spread), it was important not to duplicate the work of existing consultation platforms with the sector. It also offered the opportunity to involve a larger and more diverse group of stakeholders in the debate. The FISSAC methodology provides the necessary flexibility to take this local context into account.
During the sessions of the Living Lab it was considered important to integrate the debate on industrial symbiosis within the larger context of the transition towards a circular economy. For many actors in the construction sector both circular economy and industrial symbiosis are both still comparatively new concepts. Taken against a backdrop of resource efficiency and the need to increase the use of secondary raw materials the industrial symbiosis, with the application of a suitable work method and tool, can be seen as an integral element in the way forward towards circularity. The closing of the value chains and the increase in the re-use or recycling of materials requires a methodic approach such as FISSAC provides.
The methodology and the tool were both tested. Technical aspects were not touched upon in the living labs. The emphasis was put on the conditions and settings that would encourage or dissuade the stakeholders to use the FISSAC model. It was felt that the use of the tool could only be interesting in the longer run when sufficient effort was made to keep all the information up to date. Matching supply and demand for secondary raw materials among the partners in the model require a lot of effort and willingness. The methodology is based on an open dialogue that ensures a free and unimpeded flow of information. This flux needs to take into account the requirements and in particular the privacy and data protection. This in turn asks for networking and the building of trust among the symbiosis partners. This process and the finalizing of the potential match can only be the result of countless effort and follow-up.
The development of a business model for the implementation of the FISSAC methodology and tool should not only focus on covering the costs. It should take into account the willingness to pay for the support and guidance which will bring the potential partners together in an industrial symbiosis for one or more material streams. The success and effectiveness of the tool and method developed in the FISSAC project are both largely linked to the amount and reliability of the data entered into the system. This needs a lot of effort and investment.

4.4 THE LIVING LAB AFTER FISSAC

In the Living Lab and the workshops set in the framework of the Green Deal Circular Construction, we managed to gather sufficient information on the replicability of the FISSAC model. This was also discussed in the Living Lab session on expectations and relevant features of an ICT platform for Industrial symbiosis. However, it was not possible to draw definite conclusions on the viability and continuance. This applies both to the FISSAC model and the application. More work is needed on the development of the business model. It will be important to draw more data from cases where the model and methodology have been applied. Only then the added value of the methodology and the FISSAC application will become apparent to the stakeholders in the construction sector and beyond.

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We expect to collect more data from Flanders during the experiments and trials on building and demolition sites as part of the on-going studies related to the transition towards the circular economy in construction. This should also be undertaken in the other countries. The collection and validation of useful and applicable data are an important factor in the viability of the FISSAC model and tools. It will depend on the quality and scope of the data whether a critical mass of users will spring up, both on the demand and offer side.
Further research and trials are required to incorporate the industrial symbiosis in construction and other sectors in line with the transition towards a circular economy. It is not enough to develop a methodology that offers opportunities to close value chains of materials. The use on secondary raw materials in a circular framework should take into account the effects on the environment in further cycles of use and end-of-life. The model should allow the incorporation of data on the basis of a life cycle analysis. In adition information on the technical suitability should be completed by data and insights on their potential for recovery. In this vein the emphasis should shift from the material properties to the possibilities for their use in dynamic building solutions.

5 Czech Republic

5.1 THE SECTOR AND THE LIVING LAB

INCIEN organizes several interesting workshops during the year concerning the topic of circular economy, construction demolition waste, industrial symbiosis, resource efficiency, and other. FENIX participated to few of them with FISSAC project and IS model introduction (e.g. ECO-INNOVATION FORUM on 30th November, Krtiny (about 150 participants, https://incien.org/event/incien-ekoinovacni-forum-udrzitelne-technologie-pro-budoucnost/) – two days event with the main topic "Waste as a resource" gathering togethering all stakeholders from the Circular economy and waste management in CR, various startups around the Europe connected to cross-border cooperation related to innovations circular economy and industrial symbiosis). The first common workshop called "Eco-innovation in building sector" on 21st June 2017 in Prague was a suitable event to firstly introduce FISSAC project and organize a brief Living Lab workshop with all participants (the group of experts in building, as well as construction and demolition waste). Generally, the building sector in the Czech Republic is extremely conservative and any new approach even if innovative is hardly accepted by stakeholders in the whole value chain. Second event was called "For someone waste, for the others material" was organized on September 20th 2018 in Prague as a one day event, with morning session introducing FISSAC project and main outcomes, compared with other national initiatives and projects which were presented as well by invited organizations. Afternoon session was dedicated to workshop called "Secondary material platform as a basis of circular economy application both in Czech and European framework" with key stakeholders (SMEs, industry representatives – construction companies, recyclers, Ministry of Environment, municipality representative, associations) when FISSAC platform was in detail introduced and stakeholders were asked for discussion about the possibilities to implement the platform in CR and what barriers eventually might arise.

5.2 THE LIVING LAB TODAY

Two Living Lab workshops were organized in the Czech Republic. The first workshop aimed at mapping and surveying relevant stakeholders' needs and wishes. A group of different stakeholders (20 participants) – representatives of SMEs, construction company, Ministry of Environment, municipality, associations, and media – actively participated during the workshop. The workshop did not touch topics only regarding the industrial symbiosis but also legislation and finances, science and research, education and sharing of best practices, and marketing and use of eco-innovation in the market. During the workshop, the project FISSAC, and in particular, IS platform was introduced by Fenix. A questionnaire regarding acceptance of FISSAC model was distributed to the workshop participants afterwards.
The second workshop invited the same stakeholders who participated the first workshop and extended the audience with other participants (different industry representatives). About 70 people participated this event. The morning session was dedicated to introducing FISSAC project, compared with other national initiatives and projects which were presented as well by invited organizations. Afternoon session was dedicated to workshop with key stakeholders (SMEs, industry representatives – construction companies mainly, other industry representatives, recyclers, Ministry of Environment, municipality representative, associations, etc.) when FISSAC platform was in detail introduced and stakeholders were asked to discuss possibilities of FISSAC IS platform adoption in CR and what barriers eventually might arise and how to overcome them.
The outcomes of the workshops were relevant for the purposes of the Living Lab.

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Start-up of the LL
The main goal of the first workshop was to identify barriers to Eco-innovation in building industry. Stakeholders have been working in three separate groups proposing specific steps to overcome these barriers. These steps are interlinked by a vision, which has been created based on a question: "If everything works perfectly, what would it be like in 5 years' time?". At the end, there was a space for networking and creating connections for possible future cooperation among the participants. Barriers were divided into 3 specific categories. Similarly, also the participants formed 3 groups and discussed the topic of positive VISION OF ECO-INNOVATION IN THE BUILDING INDUSTRY BY 2022. Specific steps of an ACTION PLAN to fulfil the vision has been identified as well.
Prior to second workshop organization, a brief questionnaire was prepared online (https://www.survio.com/survey/d/N0H5Q1V1Q1U1O8N4A) in order to gather inputs from stakeholders (questions such as: what is the nature of your business, what sort of materials are you working with, were you offered to participate in the past in a similar project regarding the industrial symbiosis, would you deem IS relevant for your business, would you be willing to take part in such initiative, etc.). The questionnaire was shared through INCIEN channels and also on their website as a short press release (https://incien.org/cirkularni-novinky-ze-stavebnictvi-pokracovani-kulatych-stolu-projekt-fissac-i-moznost-zapojeni/).
The main objective of the second workshop was to engage more closely with the stakeholders and identify possibilities of implementation of the FISSAC IS platform in Czech Republic building on the outputs from the first workshop. The workshop initiated with a short introduction of statistics and current situation of the waste management in the Czech Republic by innovation designer from Direct People. A presentation of the IS platform, developed under the FISSAC project, continued. FENIX TNT gave a presentation summarizing the main idea of "industrial symbiosis" with an example of eco-parks, the goals of the platform, target audience, functions of the platform, as well as the advantages of the platform. The process of trading was practically shown and explained. After the platform presentation, a representative from the construction company SKANSKA, shared his view on the use of secondary material in construction activities. He presented a construction project which took advantage of the secondary material use and generally welcomed the idea of industrial symbiosis in the Czech Republic. He also expressed intentions to join the platform once it is available. The last section of the Living Lab was devoted to discussions with relevant stakeholders. The discussion revolved around three main questions:

1. What would motivate stakeholders to use the platform?
2. What they see as a barrier to use the platform?
3. What materials are the most suitable for such platform in the Czech Republic?

Main outcomes from the second workshop: Czech legislation is a barrier to introduction of the FISSAC IS Platform. If the platform is international, it might need arbitration court. One similar initiative already failed in CZ in nineties. Lack of awareness. Best practices and positive examples could motivate potential users.

5.2.1 PURPOSE AND GOAL

The main aim of the Living Lab in Czech Republic is to identify barriers and drivers for the industrial symbiosis, key stakeholders for the value chain, on which material/s to focus, get feedback on the FISSAC model and possibility/willingness to test it by stakeholders.

5.2.2 SCOPE

After various discussions with the key stakeholders and analysis of the Czech market of reuse and recycling of materials, circular economy and industrial symbiosis, the most suitable material was chosen cement and concrete, in minor extent metal and plastics. The conservative construction sector proved to be a huge barrier as none of the participants of the first workshop proved interest in showed the FISSAC IS platform testing. However, the second workshop was more successful as the FISSAC IS platform and generally FISSAC project was accepted by the stakeholders very positively.

5.2.3 IDENTIFYING STAKEHOLDERS

A group of different stakeholders were identified for the first living Lab workshop thanks to INCIEN contacts – representatives of SMEs, construction companies, Ministry of Environment, municipality, associations, and media. The second workshop had much more participants and the forces of both organizers were combined (FENIX and INCIEN supported by the Business Innovation Centre in Brno), so at the end about 70 participants were presented and listen to

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the FISSAC project introduction during the morning session. About 30 participants (SMEs, industry representatives – construction companies, recyclers, Ministry of Environment, municipality representative, associations) participate the discussion during the afternoon session.

5.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

During the both workshops stakeholders were actively participating. FENIX is in regular contact with INCIEN sharing the news and progress about the FISSAC project and communicating the updates to the stakeholders.

5.2.5 IDENTIFYING BARRIERS AND DRIVERS

The main barriers and how to overcome them were identified within the first Living Lab workshop. Barriers were divided into 3 specific categories. Similarly, also the participants formed 3 groups and discussed the topic of positive VISION OF ECO-INNOVATION IN THE BUILDING INDUSTRY BY 2022. Specific steps of an ACTION PLAN to fulfil the vision has been identified as well.

The vision for the year 2022	Action plan
1) Regulations and statements delivering the standards about construction products and waste management 2) Building designers know well the new norms, and have knowledge about secondary raw materials 3) The environmental aspects (such as the requirements on recycled materials and construction waste handling) are considerate while using EU funds 4) Investors do require recycled materials and proper handling (separation and recycling) of the construction waste 5) Good awareness about the possibilities to recycle construction material 6) Access to information about announced tenders (so that companies that were not approached by the contractor are informed as well) 7) Model for environmental standards and requirements that could be used for public tenders. 8) Recycled products are part of the documentation: PRODCOM, TP170 (technical regulations) 9) Voluntary protocol for building demolition works in practice	1) Common action plan between the Ministry of Environment and Ministry of Industry and Trade. 2) Being well informed about responsible management of resources and secondary raw material is part of the curriculum for designers, The Ministry of Industry and Trade (MIT) and Czech Technical University create together a catalogue of recycled material products. MIT also prepares an action plan for requalification, which are incorporated to the National Educational Concept by the Ministry of Education. 3) Preparation of assessment standards (to support use of secondary raw material within construction) 4) Increased awareness about the quality of secondary raw materials, demand stimulation, increased knowledge of investors. 5, 6, 7) Sharing awareness also on conference that are not particularly focused on construction industry and waste (Regionservis, Information for mayors about environmental topics from the regional councillors, Connection with activities and trends of Smart Cities, Local Agenda 21, Regional Development Agencies, The National Health City Network, etc.)

Figure 11: Czech Republic Living Lab Barriers and Drivers - Legislation

The vision for the year 2022	Action plan
1) There is a platform to connect science, research and the private companies (it is functional and up dated) 2) Use of best practices from abroad. Use of well-known technologies. 3) Change of evaluation criteria and involvement of environmental aspects 4) Legislation and methodology support for the use of recycled materials (these information are available for designers) 5) Environmental standards are part of the public tenders criteria	- Ethical code applied within the science, research and private companies – research results are kept by the scientists themselves, but are available for the public as well; Financial motivation for researchers; working system of tax deduction (even without controlling by the Tax Office) - Quality control over the quantity - Awareness about the possibilities of cooperation (also for the Czech projects) - Decrease of the administrative burden (to support the research part not the administrative work). - Lifelong educational courses (for example for ČKAIT group). - Efficient use of financial resources for marketing and product promotion.

Figure 12: Czech Republic Living Lab Drivers and Barriers - Science and research, education/sharing of knowledge and best practices

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The vision for the year 2022	Action plan
1) Involvement of municipalities and public population in waste segregation 2) Support of the regional level 3) Certification of innovative materials 4) Price comparison between the traditional materials and eco-materials 5) Confidence in use of products from recycled materials	1) Motivating the municipalities and public population 2) Creating information software, platform (supporting the industry symbioses) 3) Cooperation with the scientific platform from the beginning of innovation. Transformation of waste into resources. 4) Local collection, processing and distribution of products. 5) Sharing of information.

Figure 13: Czech Republic Living Lab Drivers and Barriers - Cooperation and construction material recycling/marketing and use of eco-innovation on the market

The following points summarize the outcomes of the discussions during the second workshop:

- The stakeholders were interested to know weather the platform use will be for free or weather they are expected to pay. It was mentioned that the owners of the platform did not make a final decision on weather or not the users will pay some fee yet; however, that the operation of the platform requires employment of several experts and that some fee might be foreseen – exact amount was not specified.
- The main barrier to successful introduction of the industrial symbiosis platform is the Czech legislation. The law states that waste cannot be sold or donated, only if it is treated and becomes secondary product. All non-treated by-products are considered waste, which can be used by a company that produced it, however, it cannot be used by another party. In order to fully exploit IS platform in Czech Republic, a change in legislation must be done. Such change will take a lot of time and efforts. Similar initiatives (commodity market) failed in past due to the legislation barrier.
- The change in legislation could happen faster, if actors would align and together lobby for the change.
- International platform should take into consideration that each country has specific regulations, which might differ from one country to another. Stakeholders prefer regional cooperation (also due to language barrier and different laws). If the platform is international, it would require inclusion of arbitration court (judge) in case there is an international dispute (e.g. quality of material is low, one party does not pay, etc.).
- There is already a platform used for trading of the recycled concrete: www.betonserver.cz
- The lack of awareness about the benefits of using recycled materials is another barrier. Appropriate communication and promotion campaigns should be created and performed.
- What would motivate stakeholders to join might be inclusion of best practices and real-life cases of how the industrial symbiosis helped companies in the platform.
- Czech construction companies generally do not use recycled materials; the change could occur if the public procurement (but also private projects) would state that the requirements are to use recycled materials.
- The prospect idea to add “label or brand” to the material traded within the platform was welcomed by the audience.

5.3 CONCLUSIONS

After the analysis and discussions with the stakeholders, the adoption of FISSAC IS platform will not be easy in Czech Republic due to many current barriers (legislation, awareness, best practises, motivation, etc.), however not completely unrealistic as many stakeholders are interested in Platform testing once it is available.

5.4 THE LIVING LAB AFTER FISSAC

The plan for the next step is to test FISSAC IS platform in practice with voluntary stakeholders identified during the workshops with which FENIX is keeping close contact and communicate the main achievements of the FISSAC platform so far.

5.5 LIST OF APPENDICES

Appendix 2 LL Czech Republic. Photos from Living Labs workshops

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6 Germany

6.1 THE SECTOR AND THE LIVING LAB

The FISSAC Living Lab Germany is directly linked to a research project coordinated by the German FISSAC partner Ingenieurbüro TRINIUS. The living lab follows the approach of a thematic network that aims to resolve methodological, technical, logistic and practical obstacles when construction product manufacturers need or want to include “end-of-life” information in their product performance communication.
A key concern of the research project is to involve actors representing international best practice, both as product manufacturers, as sustainability consultants, as governmental body or as independent third part. The goal is to identify approaches that enable product manufacturer to identify reasonable scenarios and valid information to include in their product declarations.
Part of the background for the living lab is the upcoming revised version of the EN 15804 – the European standard defining the methodology and further rules for the establishment of environmental product declarations for construction products. With this revision, the declaration of post-usage life cycle stages becomes obligatory, while it was optional earlier.
Product manufacturers face a multitude of challenges. The living lab and the workshops aim to address these and aim to identify routes and approaches to overcome these. The R&D project, carried out for the german federal environmental agency (UBA) results in a guidance document making the findings and approaches available beyond the group of involved stakeholders

6.2 THE LIVING LAB TODAY

For the living lab – as an element of the UBA research project – a set of 3 international workshops has been set up. Each workshop focused on an important group obstacles and challenges. Based on preparatory background documents, guided discussions fed input into the next round of workshops and ultimately into the guidance document resulting from the R&D project.
A 4th international presentation and discussion workshop was held in conjunction with the international sustainable building conference SB19 in Graz, Austria. On that conference, the R&D project had been allotted a thematic stream in the main academic conference body, with scientific presentations not necessarily related to the project or lab participants, but to the topic “end of life declarations”. Furthermore, a thematic special workshop has been conducted within the framework program of the conference.
Currently, the R&D project is in its closing, the guidance document is currently in final editing.
With the end of the project, the workshop series (and the living lab) come to an end. Meanwhile, the information generated are being fed to the next generation of stakeholders, namely:
- international standardization working groups in CEN and ISO
- German Green Building Council (DGNB) where the material will be applied in the further development of building assessment criteria and product performance requirements
- IBU (Institut Bauen und Umwelt), one of the larger established EPD program operators in Germany and centrally embedded in the international ECO-platform

6.2.1 PURPOSE AND GOAL

The purpose and goal of the living lab was the establish a forum that groups the required competences to generate and feed background information and to serve as a reference panel for the establishment of a guidance document on the integration of end-of-life information in environmental declaration of construction products.
The purpose and goal of the guideline is to:
support the construction products industry in taking into account the entire life cycle of construction products in an EPD, thereby implementing current standardization requirements. In particular, it should enable the declaration of verifiable, quantitative information on environmentally relevant circumstances at the end of life of the product that may be relevant for recovery processes;
promote the specification and implementation of standard EN 15804: guidance is provided for interpretation, planning, and implementation.

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6.2.2 SCOPE

The scope for the living lab was to generate information to be fed into the R&D project, and to serve as a reference panel for that project.

The scope of the R&D project was in turn to identify barriers and to develop approaches to overcome barriers related the establishing full life cycle considerations in environmental declarations of construction products.

6.2.3 IDENTIFYING STAKEHOLDERS

The R&D project defined to include three product groups of different kind of complexity into the workshops. Consequently, products and materials, from manufacturing into end-of-life processes were intended to be addressed. Stakeholders were identified aiming at a European representation. As most project participants were German, and the initiator of the project was German, the panel needed to be international.
Panel – or LL members – were individually identified and invited representatives to allow the project to address:
- three product groups – windows, ETICS (external thermal insulation composite systems), concrete, with manufacturers and business associations as representatives
- information providers, meaning professionals from LCA and sustainability consultancies
- information users, meaning representatives from Green Building Councils and EPD program operators
- standardization bodies.

In many cases it was possible to identify persons who could represent multiple roles, so that the groups could be kept small enough to enable fruitful and intensive discussions

6.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

Background material, reports, goal definitions, ambitions of the R&D project and to related topics were sent to the LL members. The opinions, experience and perspective were valuable feedback to the project group and were utilized to develop the project content. By the means of a professional workshop moderation, it was ensured that workshops successfully performed their tasks.
The interaction with the stakeholders was limited to exchanges in preparation and post-processing of the workshops. And to the discussion and interaction during the workshops themselves.

6.2.5 IDENTIFYING BARRIERS AND DRIVERS

The key drivesr for the growing importance of end-of-life information related to building and construction products are
- increasing awareness about the importance of full life cycle considerations in communication and decision making
- the inclusion of end-of-life stages as obligatory EPD-elements in the revised version of EN 15804
- full life cycle consideration enables to overcome suboptimisation of production-related environmental concerns and enables all market actors to apply a more holistic perspective when communicating product performance aspects

Meanwhile, the consideration of full life cycle and especially enc-of-life life cycle stages is complicated by multiple barriers, including legal, administrative, economic, technical and logistical aspects. Moreover, these life cycle stages can only partly – if at all – be decisively influenced by product manufacturer. With the manufacturers being reliable for the content of product declarations, but not owning control of future processes, the conflict is obvious.

Establishing routines, discussed and agreed upon by involved stakeholders, was identified as a route to tranparantly consider barriers and drivers. Even where detailed scenarios and assumptions may still have a decisive influence on declared information, the transparency of such scenarios and assumptions, including identified options for adaptation of scenario-based information enables a better and fair consideration and communication of information.

6.3 CONCLUSIONS

The living lab – or series of thematic workshops – approach was identified as a promising and powerful way to establish a reference panel for the tasks related to the R&D project. It is considered far superior to a direct individual involvement, as all members engaged in open and direct discussion – even of sensitive information. For that it was necessary to agree

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on confidentiality and to establish other rules of "successful communication". Involving a professional moderation has proven to be a key to succeeding.
Obviously the success of a workshop series of a living lab depends on the members and their interests in participating. In our case, an "all in" spirit was rapidly established, all involved parties agreed to the comment goal and all were aware that they would not find a reasonable solution on their own. These cross-benefits for participants can be considered a key to success – also readable from the number of participants staying interested from the first workshop through to the last event.
Relating to the purpose to generate input to the UBA R&D project, the workshop series in the living lab format was very successful. Open

6.4 THE LIVING LAB AFTER FISSAC

Strictly, the LL and the workshop series are closed now. Meanwhile, the members are very likely to cross paths in other related contexts, due to their involvement in international R&D networks, standardization tasks, thematic fora.
The content drawn from the workshops is collated and fed to key stakeholders. Ultimately their concerns and demands were the raison d'etre of the R&D project and the workshops. It was never the intention to set up a permanent orgnaisation

7 Hungary

7.1 THE SECTOR AND THE LIVING LAB

In Hungary the construction sector has an important role in the economy and has been key a driving force behind the economic growth in the past couple of years. However, its ecological impact is still significant and its methods to increase secondary raw materials production and use, recycling and waste reduction is still lagging behind the EU average. For this purpose, Geonardo Ltd. has regarded the FISSAC project as an important tool to disseminate and exploit the best practices and the results of the project.
Geonardo Ltd. has been active in promoting resource efficiency and green economy in the past 20 years, therefore the FISSAC project fits well into our profile and commitment to circular economy. In spring 2019 we launched Circular Point, a circular economy service hub that aims to help companies and organizations in their transition efforts from linear to circular economy practices and thinking.
We have organized three Living Labs and these events served as a platform for stakeholders in the construction and demolition sector to understand the purpose and the benefits of the industrial symbiosis and to highlight the challenged and obstacles which hinder the wider applications.

7.2 THE LIVING LAB TODAY

7.2.1 PURPOSE AND GOAL

The purpose of the Living Labs was the following:

- Provide input for the WP6 and the preparation of the Industrial Symbiosis management software tool.
- Present the FISSAC-model and the importance of the industrial symbiosis in the construction sector.
- Raising awareness and disseminate knowledge about the various business opportunities in applying circular economy principles.
- Identifying those legal, regulatory, market and business issues which hinder or harden stakeholders to improve resource efficiency, increase recycling and reduce waste creation In the construction industry.

7.2.2 SCOPE

The aim of the first Living Lab was to present the FISSAC project and draw a general picture on the relevant situation in Hungary. The speakers came from academia, industry, professional organizations and the government. The participants had an open and constructive discussion on how they could use the FISSAC-model and what extent it could be useful and operational in Hungary.

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The second Living Lab focused on the progress of the project and made reference to an earlier industrial symbiosis project in Hungary (NISP) as well. In the discussion phase these specific challenges were raised:

- designers and architects are not aware of the latest methods and standards (training and dissemination is needed)
- financial incentives are needed to increase secondary raw material processing and low deposit fees should be substantially higher to discourage landfilling
- the state should encourage industry initiatives by favoring secondary raw material use and recycling in construction public procurements.

The last living Lab focused on the summary of the FISSAC project and how it can be implemented and integrated/adapted to local circumstances. We also discussed how Circular Point can provide assistance and professional support for the industry in making industrial symbiosis projects in Hungary by using the FISSAC-model.

7.2.3 IDENTIFYING STAKEHOLDERS

We tried to involve all relevant stakeholders who have are either active in the construction/demolition sector or have strong links or influence to it. Thus, we had representatives from construction companies, main contractors, property developers, building material producers/distributors, research institutes, professional organizations, ministry as well as architects and designers.

7.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

The Living Labs consisted of two parts. In the first we presented the FISSAC project and the actual status of the model and then speakers from different industry sectors and stakeholder group talked about their experiences and expectations on the potential of the circular economy in the Hungarian construction sector. In the second part of the event we opened the floor for discussion and recommendations along the line of given topics (i.e. regulatory and market framework, technical and design issues, business models and value chain collaboration, etc.). The summary of each Living Lab was sent out to all participants and we still keep them in the loop.

7.2.5 IDENTIFYING BARRIERS AND DRIVERS

The Living Labs have identified barriers and divers for the Software Tool and also for the local regulatory, market circumstances.

Software Tool:

- Crucial to have sufficient amount of companies to use to software, otherwise it will not attract further attention (promotion and marketing)
- Availability in Hungarian language as well
- Providing clear and easy-to-understandable description on the waste valorization
- Making successful industrial symbiosis needs more than just a software. Coaching and professional coordination is also crucial. How can we provide this?

Local circumstances:

I. Financial and regulatory barriers are needed to divert waste from disposal to secondary utilization (low landfill fees)
II. Low awareness and consciousness in the construction sector.
III. Problem with the enforcement with the existing legal requirements.
IV. Mindset shift if needed both with the architects and with the property developers to apply circular principles in the design and in the implementation phases.

7.2.6 OTHER RESULTS

The Ministry of Innovation and Technology is in the process of drafting a new waste management strategy and we have sent them the FISSAC project to consider industrial symbiosis and an important element of the strategy.

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7.3 CONCLUSIONS

The FISSAC project and the Living Labs contributed to the gradual and still early phase implementation of the circular economy transition in Hungary. With the growing interest towards resource efficiency and secondary raw material use, and the construction industry being one of the main responsible for natural resources use and waste creation, the FISSAC model can potentially be an interesting tool to help the transition towards a more circular industry. However, it is up the Government to boost this process, by implementing the necessary regulatory, financial and market conditions. Companies will obviously apply the legally (or semi-legally) available shortcuts to maximize profits on the expense of the environment and the natural resources.

7.4 THE LIVING LAB AFTER FISSAC

Our new initiative, Circular Point intends to follow-up the FISSAC project with the stakeholders we have engaged with during the Living Labs. We consider the construction industry as a key player in the transition to circular economy. The actual steps and actions will be decided later this year.

8 Italy

8.1 THE SECTOR AND THE LIVING LAB

Within the framework of the FISSAC project, RINA Consulting S.p.A. has organized the Living Labs for Italy. Different initiatives in Italy have been dealing with circular economy and industrial symbiosis, mainly at regional level (e.g. industrial associations) or sectoral level (e.g. cement and concrete sectors). The Living Labs have represented a valuable instrument to create synergies among these initiatives, gather different stakeholders and exchange experiences and opinion about industrial symbiosis opportunities.
Three different events have been organized:

- 1stLL: Industrial Symbiosis in steel, construction aggregates, cement and concrete sectors in the north of Italy;
- 2ndLL: The recovery of materials in the cement and concrete sectors in a wider geographical context;
- 3rd LL the replicability potential of Industrial Symbiosis and Circular Economy models in the Italian scenario

The **First Italian Living Lab**, organized in collaboration with Associazione Industriale Bresciana (AIB), was held on 10 November 2017, with the aim of presenting the project and addressing issues related to the industrial symbiosis, with focus on the steel, construction aggregates, and concrete sectors. A summary of the event is reported within appendix and the full details are available within the previous deliverable, D7.1 “First Publications regarding living lab for FISSAC model”; within this report, the other two LL are described, and the main results reported, to summarize the experience of the Italian Living Lab today and to depict its evolution during the project.
On 11th December 2018 the **Second Italian Living Lab** took place, organized by RINA in collaboration with ATECAP, the Italian Technical Economic Association for Ready-Mixed Concrete. In line with the first Living Lab organized with the AIB (Industrial Association of Brescia), the second Living Lab has represented an opportunity for discussion among different stakeholders involved in various ways in the recovery of material in cement and concrete sectors. The main aim of the Living Lab was to highlight the critical issues and opportunities related to circular economy models within these sectors. Different representatives from the cement and concrete industry, recycled aggregate producers and construction companies were involved in the event. The brochure of the event is shown in**¡Error! No se encuentra el origen de la referencia.**.
The **third Italian Living Lab** related to the FISSAC project took place on 4th October 2019 in Rozzano (Milan) hosted and organized by Rina Consulting. The ambition of this last event was to enlarge more the scope of the investigation and to collect positive experiences and success stories.

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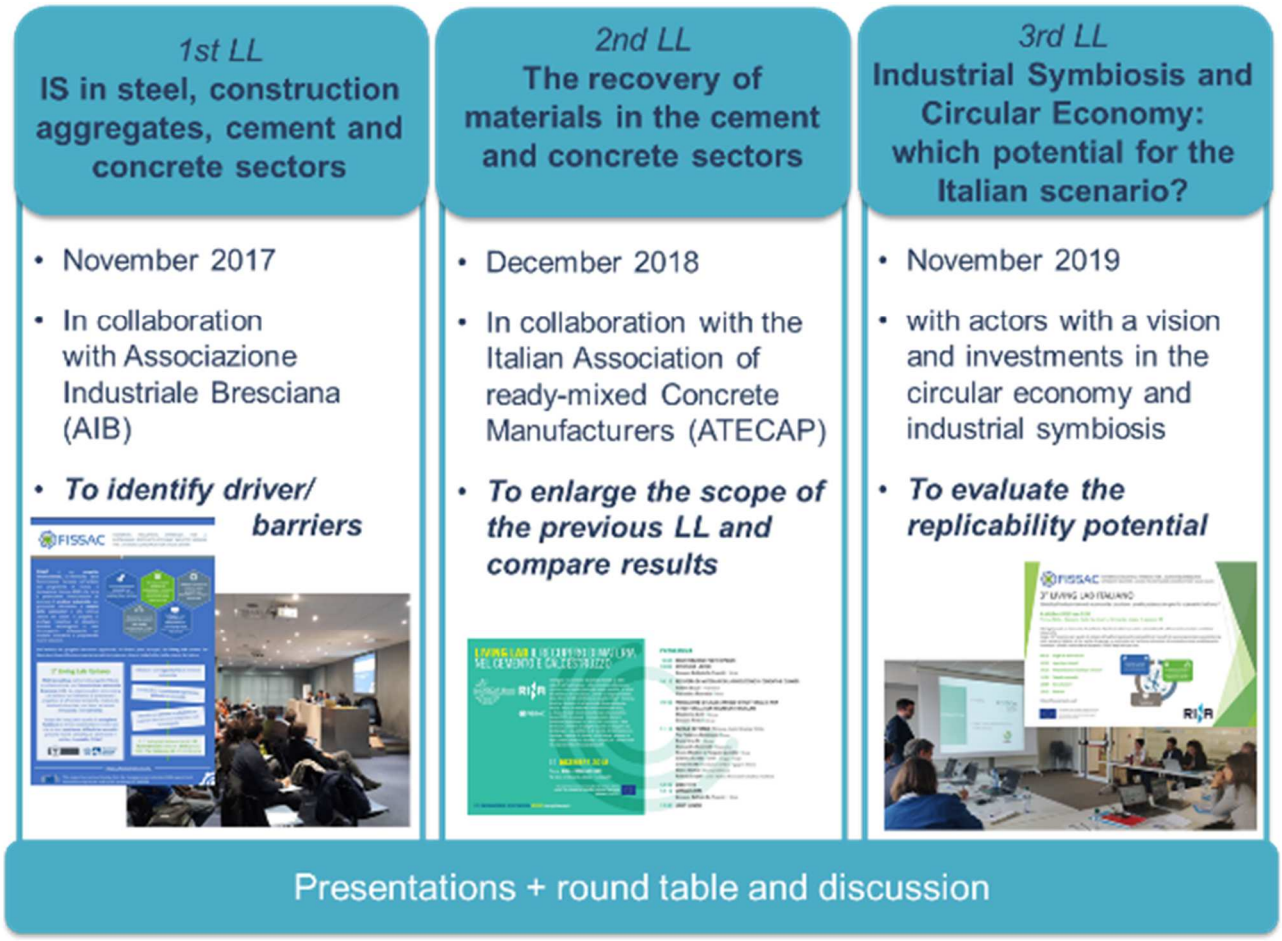

Figure 14 Summary of Italian LLs

8.2 THE LIVING LAB TODAY

8.2.1 PURPOSE AND GOAL

The main purpose of all the Living Labs was to analyze the Italian scenario and to investigate which are the main opportunities for stakeholders interested in establishing industrial symbiosis models.
The first two events were mainly aimed at identifying driver and barriers for industrial symbiosis: the first one was quite specific (focused on industrial symbiosis opportunities among steel, cement and concrete sectors). To validate the results of the first event and to make a comparison, the scope was enlarged for the second Living Lab, widening the audience (a national association rather than a regional one) and considering in general the recovery of materials in the cement and concrete sectors.
On the contrary, the third one wasn't material specific, but focused more in general on circular economy and industrial symbiosis models. The main aims of the third Living Lab were to:

- meet actors with a vision and investments in the circular economy and industrial symbiosis;
- evaluate the replicability potential of circular economy models and platforms in the Italian scenario;
- fill-in the Matrix (for Italy) focused on the replicability of FISSAC model in different countries.

8.2.2 SCOPE

All the Living Labs have been organized according to a similar structure: a first part dedicated to the FISSAC project presentation; a session dedicated to the presentations of the stakeholders and their vision about industrial symbiosis; a final round table and discussion, to draw some conclusions.

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8.2.3 STAKEHOLDER IDENTIFICATION, INTERACTIONS AND ACTIVITIES

8.2.3.1 *First Living Lab*

The First Italian Living Lab was organized in collaboration with Associazione Industriale Bresciana (AIB - http://www.aib.bs.it/), gathering different exponents of Brescia Industrial reality, mainly related to the steel, cement, and concrete sectors, together with builders, university representatives and other professionals linked to these realities, to investigate opportunities, drivers and barriers for industrial symbiosis, with particular reference to the reuse of steel slag from EAF.

8.2.3.2 *Second Living Lab*

The second Italian Living Labs was organized in collaboration with ATECAP, the Italian Technical Economic Association for Ready-Mixed Concrete (http://www.atecap.it/), which extended the invitation to all its associates.
Different perspectives were presented:
Cement and concrete producers: These producers have been active for long time in improving the efficiency of the processes and in using secondary raw materials, being aware that the cement, as concrete in all its applications, represents the second materials most used in the world after water, and actions taken in these sectors could have a very high impact in the challenge of reducing emissions. Indeed the cement and concrete sectors have been trying for a long time to reduce the quarry extraction and the consumption of natural materials, through the replacement of natural raw materials with secondary ones: in particular, the natural aggregates could be substituted with two types of aggregates: industrial a (e.g. form steel industry) and recycled (from demolition). Since a significant amount of research has been done in this sector, the major technological barriers have been overcome and are not considered major obstacles nowadays. What is considered a limiting factor is the unclear legislative framework, since the requirements for the use of waste are not clear and could generate uncertainty.
Steel slag recovery plant: The steel slag represents an industrial aggregate, which is quite different from the recycled one: its characteristics are very stable and can guarantee reliability in the performance (also thanks to the research made in this sector) and its content in concrete can be up to 90%. Since the steel slag is treated by the recovery plant, once it leaves the plant it is a product, CE marked. Consequently, the fact that it derives from a waste is negligible: the recovery plant manager must guarantee the characteristics of the product, reported on the label.
Construction companies: The customers want to be part of the virtuous mechanism aimed at reducing environmental impacts and natural resources consumption, but they are limited by legislation issues. The Italian legislation incentives the use of recycled materials through the Green Public Procurement and the CAM (*minimum environmental criteria*), which define specific criteria for the concrete, like for example the minimum amount of recycled content. At the same time, however, the willingness to promote recycled materials is not always supported by a clear authorization framework and this led to a distrust from customers and final users. Another aspect to be considered is that public tenders are mainly based on economic criteria, and if no incentive is applied, recycled materials can be more expensive than the virgin ones and for this reason, less competitive.
National associations: ATECAP, in collaboration with ANPAR (*National association of recycled aggregates manufacturers*), to overcome the distrust of public opinion, has prepared a document ("*Quaderno*"), containing information for the concrete producers who wants to use recycled materials. In addition, the two associations have developed a control protocol which can be adopted by the recycled aggregates producers to provide to their customers more restrictive guarantees, to assure the quality of the recycled materials. The associations are very active in participating to several national symposiums, to share knowledge about the use of recycled aggregates. Information is considered very important, since fake news and poor reliability of scientific communication can represent a real problem for the transition from a linear to circular economy.
Professional orders (of engineers): professional orders are focused on maintaining competencies. A possible answer to the difficulties generated by the legislative issue could be to improve the management system with new technical norms and standards. The sharing of best practices could represent a valid instrument to overcome distrust and to communicate clearly the compliance of the products, also from the legal point of view. In this sense, the professional orders could play an important role, having the possibility to share this kind of information through the mandatory refresher courses for professionals.

8.2.3.3 *Third Living Lab*

Since several barriers have been identified during the first two Living Lab, one of the aims of the third one was to focus on successful initiatives, gathering stakeholders with vision and investment on circular economy and industrial symbiosis, to detect the main opportunities. Different virtuous examples were presented during the Living Lab, to provide a first overview of the Italian scenario.

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The first presentation was made by **Silvia Sbaffoni**, researcher representing ENEA, *National Agency for New Technologies, Energy and Sustainable Economic Development*, a public body aimed at research, technological innovation and the provision of advanced services to enterprises, public administration and citizens in the sectors of energy, environment and sustainable economic development (https://www.enea.it/it). After a brief introduction of ENEA, among the most relevant projects, Silvia Sbaffoni presented the Italian Circular Economy Stakeholder Platform (**ICESP -** https://www.icesp.it/), a platform which is specular with the European platform ECESP (European Circular Economy Stakeholder Platform). The main aim of ICESP is to promote circular economy in Italy by means of specific actions, representing an instrument able to promote and facilitate the intersectoral interactions between different companies and to promote the dialogue and the synergies between Italian actors involved in Industrial Symbiosis initiatives.
Silvia Sbaffoni presented also "SUN", an industrial Symbiosis Italian network which includes Universities, Research Bodies, private companies and local Bodies. The aim of SUN is to promote contacts and exchange, share experience and issues regarding the Industrial Symbiosis and identify solutions to the main technical and regulatory issues that hinders the implementation of the industrial symbiosis.
Lastly, she presented the ENEA platform for industrial symbiosis (SYMBIOSIS) explaining that the platform is a complex georeferenced instrument, based on a structure able to identify solutions for industrial symbiosis, able to facilitate the sharing of resources.
The second presentation was done by **Luca Campadello,** Project & Researches Manager of Ecodom, main Italian Consortium for the WEEE management (http://www.ecodom-consorzio.it/it/home). Ecodom promoted a contest to map and to make an Atlas (covering 18 categories) concerning companies involved in the Circular Economy; they have mapped more than 300 companies starting from questionnaires submitted to these companies. At the beginning, they included a lot of quantitative indicators within the questionnaires, but then decided to use qualitative indicators, registering the difficulties of industries to provide the requested information. The main aims of the contest were to create a database to organize the existing initiatives, to put them in contact and to promote awareness related to CE among citizens. Each company can present itself and its CE experience through different expressive means, like photography, video, radio, comics, etc., and every year the most virtuous and creative one is awarded. Up to now on the Atlas it is possible to retrieve more than 200 descriptions.
The third presentation was carried out by **Roberto Vannucci**, responsible of Multisectoral Research and Innovation at CentroCot (*Centro Tessile Cotoniero e Abbigliamento S.p.A.* - https://www.centrocot.it/). He provided some information about CentroCot and the most innovative projects where CentroCot was/is involved, for example Life M3P (https://www.lifem3p.eu). M3P is a project aimed at creating a new Industrial Symbiosis model based on an on-line platform, able to promote the exchange of industrial waste among the companies of manufacturing districts.
Considering that generally industrial waste are not immediately reused and inserted in other industrial processes and that companies does not have direct access to the technologies and information of other industrial sectors, the developed platform has the objective to identify matches between companies which offer waste flows and companies which need these waste flows as inlet materials. According to Roberto Vannucci, the main role of IS platforms is to engage stakeholders and to create networks, but then these instruments need to be supported by specific technical competences to be made available to companies.
The fourth presentation was done by **Marco Battaglia** CEO & Co-founder of Sfridoo (https://www.sfridoo.com/). Sfridoo is an online platform launched in 2017 as Marketplace, B2B classified, allowing industries to share resources. The idea at the base of the platform is that the burden of one company can become a resource for another, according to the principles of the Circular Economy. However the launch of the platform wasn't as successful as expected, since the knowledge and awareness of industries related to their scraps resulted very low. After this first experience they decided to change a little bit their business model and to start offering training to companies, with focus on circular economy and industrial symbiosis topics. Now Sfridoo provides support to the companies that want to enter in the circular economy network offering advisory, operational and facility management services and in general specific service packages, creating projects tailored to the companies. Marco Battaglia emphasized that an important service offered by Sfridoo is the enhancement of the production wastes; in particular, Sfridoo is able to identify advantageous and innovative alternatives allowing the achievement of significant savings. For example, Sfridoo recognizes an economic and environmental value to the electronic devices no longer useful for a company, before they become waste. Sfridoo also introduced the "Company plastic-free certification", a protocol that follows the guidelines of the Ministry of Environment. Another important aspect on which they are working is the blockchain protocol for waste and secondary raw materials, conceived as an instrument able to ensure their traceability and to guarantee the certainty of reuse of materials (one of the elements to be proved to define that a material can be considered a by-product and not a waste).
The fifth presentation was done by **Laura Severino** of Rina Services who explained that Certification can help the enhancement of Circular Economy and Industrial Symbiosis because it provides guarantees on the products (and resources) characteristics and provides to the consumer reliable information about the environmental impacts of the products. Moreover, different certifications can be used to support the Green Public Procurement, since they can be used as means of proof for different criteria (e.g. the content of recycled materials). She pointed out that, currently, the

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only existing Rule on the Circular Economy is the BS 8001 of June 2017 issued by the British Standards Institution (BSI), but the Committee ISO ISO/TC 323 is working on Rules concerning the Circular Economy. She presented different example of Certification schemes, which have the aim to guarantee the renewability and the sustainability, like for example the Certification of the sustainability of biofuels and bio-liquids that certificates the traceability and sustainability of residues (waste and by products) derived from biomass and of biofuels and bio-liquids obtained from residues. She also focused on the European program EU ETV - Environmental Technology Verification, which states the environmental performances of technologies, products and processes in order to increase the credibility of these technologies on the market and to allow consumers and buyers to buy and identify the eco-technologies more suitable for their needs. Another example present was the international EPD system, which certifies all the possible environmental impacts connected to a product and provides information on the environmental performances of that product/service. She also focused on the "End of Waste" Certification and Certification of secondary solid fuels (UNI 15358) which certifies the suitability for the recovery and reuse of glass, copper and metal scraps and solid fuels, and the ReMadeinItaly scheme that certifies the quantity of recycled material in a product.

8.2.4 IDENTIFYING BARRIERS AND DRIVERS

8.2.4.1 *First Living Lab*

The main barrier identified by the participants in the Living Lab is the unclear regulatory framework. Other problems encountered are linked to the distrust of public opinion and customers, as well as low high costs e.g. related to the transports. The participants showed interest in extending the comparison to other regions, to assess if and how these difficulties have been faced in other contexts. The technological feasibility related to the reuse of the EAF slag, although presenting some difficulties, is not considered critical by the participants, since there is now a good number of practices tested.

8.2.4.2 *Second Living Lab – Main driver and barriers - Summary of the results*

The second Living Lab organized as part of the FISSAC project represented a valid opportunity for discussion between the various stakeholders involved in various way along the cement and concrete supply chains.
The opportunities related to material recovery were presented as well as the benefits that this could bring, from the environmental point of view. At the same time, the difficulties faced by producers and users have been discusses, since they sometimes hinder the establishment of the industrial symbiosis processes. Similarly to what was found during the first Italian Living Lab, the participants highlighted an excessive bureaucracy and an unclear authorization framework, which is also subject to different local interpretations.
The consequent mistrust, even by the clients, therefore represents an obstacle for the recovery of material, despite it is now widely validated from the technical point of view; it is worth also noticing that the cement and concrete sectors have been active for years in researching solutions aimed at reducing their environmental impact.
Since the regulatory framework for waste is simpler, the industries are consequently inclined to consider their outputs as waste, rather than secondary raw materials or end of waste. The participants therefore hope for a clearer regulatory framework that can provide homogeneous indications and promote material recovery.
Another aspect that has been discuss is the economic one: the low profitability can play a role, since high distances involve high costs, and this could become a limiting factor, if incentives are not foreseen (financial or fiscal).
During the events it was suggested that the platform that is being developed within the FISSAC project could support companies in the recovery of materials not only facilitating them in the search for opportunities, but also guiding them in the interpretation of the regulatory path. For a profitable development of the FISSAC platform and its effective implementation, synergies with the various realities already active and operating in these sectors can represent a strength point, as well as the promotion of virtuous initiatives such as the "*Quaderno"* created by ATECAP-ANPAR, and their protocol of controls.

8.2.4.3 *Third Living Lab – Evaluation of the replicability potential*

The third Italian Living Lab has represented the occasion to investigate the Italian context and to evaluate together with the participants which is the replicability potential for circular economy and industrial symbiosis models in Italy.
To guide the discussion, the ***Qualitative criteria for assessing replicability potential in different EU countries***, defined within the D7.2, "Report on Industrial Segmentation, criteria and correlation to the FISSAC first application", have been used. First, the criteria have been introduced to the participants, and a debate about each criterion has followed. At the end of the discussion, each participant has assigned a score to each criterion, according to its own point of view. The full details are reported in Annexes.

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According to the participants, several industries are involved in the development of solutions aimed at improving their circularity, also driven by an increasing demand for environmentally friendly products.
Industries look for synergies especially in a local context (and not on large scale). The exchange of experience is considered a strong enabler, and industrial association could play a relevant role in creating networks and clusters of enterprises.
However enterprises face two main obstacles: the legislative and the economic one.
The **legislative framework** is considered not clear enough and misunderstandings in the definition of waste and secondary raw materials could arise, leading also to legal disputes. End-of-waste criteria should represent an instrument to simplify, since they specify when certain waste ceases to be waste and obtains a status of a product (or a secondary raw material), but they are very few and the development of new end of waste criteria is very slow. In general, the lack of specific rules for certain waste, like for example plastic, represent a barrier for its recovery.
With reference to the **economic point of view**, investments to change usual processes and procedures could be very high, and if landfill fees are low, industries are not incentive enough to invest time and money, especially if the dimension of the enterprise is small.
Another limit to the formation of a virtuous network is the **difficulty in the exchange of confidential information**, that industries are not willing to share: an example is the list of sub-products launched by the Chamber of Commerce, which failed for this reason. All the participants agreed on the **necessity to increase education and training** on these topics for industries, to facilitate their role in promoting these models. Similarly, the importance of the dialogue among relevant stakeholders has been considered as fundamental element to establish industrial symbiosis: lack of communication or interaction among key partners could really hinder this process.

8.3 CONCLUSIONS

In Italy three different Living Labs have been organized, with the aim of putting in contact different stakeholders and collecting their feedback regarding driver and barriers of industrial symbiosis. The first two events were material-specific, dealing with the recovery of materials in the cement and concrete sectors. Since in these sectors the technical feasibility is not considered an obstacle, but it is considered an already mature and consolidated process, the main difficulties have been identified in the legislative framework. According to several stakeholders, the difficulty in law interpretation and the missing of end-of-waste criteria are elements that really obstacle the establishment of industrial symbiosis, despite the willingness of reducing the environmental impacts and the consumption of natural resources (and the technical feasibility to do that). For the last event, stakeholders with a vision and investments in the circular economy and industrial symbiosis have been invited, to focus more on opportunities rather than on threats: they underlined the same difficulties, but at the same time they reported an increasing number of industries which are involved in the development of solutions aimed at improving their circularity, as well as an increasing interest for more sustainable products from customers.

8.4 THE LIVING LAB AFTER FISSAC

Different stakeholders have been engaged during the FISSAC project, thanks to the Living Labs. They discovered the FISSAC project and showed their interest in remaining updated about the project activities: some of them were particularly interested in the FISSAC platform and would like to join it after the official launch; others were mainly interested in a comparison with the other countries involved within the project: other experiences and best practices could be a strong enabler for industrial symbiosis establishment also in Italy. For these reasons, to give continuity to the experience of the Italian Living Lab, the stakeholders who took part at the events will be updated on the main project findings and conclusions.

8.5 List of Appendices

Appendix 3 LL Italy. Brochure of the First FISSAC Italian Living Lab
Appendix 4 LL Italy. Brochure of the Second FISSAC Italian Living Lab
Appendix 5 LL Italy. Brochure of the Third FISSAC Italian Living Lab
Appendix 6 LL Italy. Some images from Italian Living Lab
Appendix 7 LL Italy. Tweet from second Living Lab
Appendix 8 LL Italy. Summary of the First Italian Living Labs
Appendix 9 LL Italy - Third Living Lab. Evaluation of the replicability potential

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9 Spain Barcelona

Símbiosy is a consultancy company that acts as a **facilitator in industrial symbiosis projects**, providing territorial entities with the **tools and the methodology** to implement **circular economy strategies** and **identify synergies among key stakeholders** within a network (companies, public authorities, research institutions, etc.). The overall **goal is to improve the resource efficiency and the competitiveness of the industry sector.**

As a result of **years of experience facilitating industrial symbiosis projects**, the team at Símbiosy has developed a **methodology** to launch and promote circular, collaborative projects, which serves as a **facilitation/implementation guide** addressed to any coordinating entity of industrial symbiosis projects.

Facilitating and managing industrial symbiosis projects involves analysing the **industrial ecosystem**, identifying **potential network synergies**, **engaging and building capacity of key stakeholders**, **facilitating collaboration** among them, and creating a common **action plan**, which is always followed by a **monitoring** process for each of the industrial symbiosis projects. This ensures a proper comparison and quantification of the network performance.

9.1 THE SECTOR AND THE LIVING LABS

The built environment sector is a **major consumer of natural resources**: the engineering and construction industry consumes worldwide more than 3bn tonnes of raw materials annually[4]. This implies that the **design and development of circular strategies** have already become a necessity.
Changes are beginning to be visible: some manufacturers are already designing products that are made out of secondary raw materials, which can be also reused or repurposed. On the other hand, new business models based on the return, rent, or sharing of products, spaces, and services are starting to come up.
However, there are no clear strategies of how individual companies will need to change across the industry yet. In order to make circular economy happen, different scales such as assets, buildings, infrastructures, cities and regions must be integrated into an interconnected whole. Without **cross-sector collaboration and communication among the stakeholders** of the construction and demolition supply chain, the implementation of the tools that the circular economy can provide, such as the industrial symbiosis, will never succeed.

9.2 The Living Lab today

9.2.1 PURPOSE AND GOALS

The **overall goal of the Living Labs** is fundamentally to approach complex challenges that exist in an evolving real-life context through the **collaboration**, **co-creation**, and **exchange of ideas** among stakeholders.
The global **objectives of the Living Labs Barcelona** are:

- To **create** a proper **environment to reflect openly** about the role of the Circular Economy and the Industrial Symbiosis within the construction and demolition sector (barriers, issues, challenges, enablers, opportunities, etc.)
- To **apply a whole value chain approach**
- To **identify the tools** needed to make Industrial Symbiosis happen
- To **gather feedback** for the development of the **FISSAC Platform**
- To provide **continuity to the Living Lab experience**. The aim is that the network created throughout the organization of the different Living Labs shall continue working together as a working group once the FISSAC project has finished.

[4] https://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_report_020516.pdf

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9.2.2 SCOPE

Símbiosy has organised **three Living Labs throughout the course of the project**. Each of them had a different scope:
First Living Lab Barcelona | **OPPORTUNITIES & CHALLENGES FOR THE BUILT ENVIRONMENT SECTOR:** the scope was to jointly debate about how companies of the construction and demolition sector can optimize their resources by means of industrial symbiosis tools.
Using a participative approach, attendees had the opportunity to expose their points of view and discuss with the rest of stakeholders about the barriers, challenges, opportunities, enablers and impacts of implementing IS initiatives.
Second Living Lab Barcelona | **CIRCULAR BUSINESS MODELS FOR THE BUILT ENVIRONMENT SECTOR & THE CONSUMERS ROLE:** how would the way we build change if **users decided on the design and use of the buildings and public spaces they inhabit**? How would the professional relationships among the different actors within the construction value chain be transformed if consumers demanded **renewable**, **healthy materials**, **bioclimatic buildings**, **modular constructions** designed for deconstruction…?
The second LL served as a visualization spot of successful, local and concrete projects that have launched alternative circular models within the resource management, the design, and the construction phase, in which the **needs and expectations of the users have been taken into account** (like the APROP project of the Barcelona City Council or the ones being implemented by the cooperative of architects LACOL).
Third Living Lab Barcelona | **DIGITAL TOOLS FOR SYNERGIES IDENTIFICATION:** the objective of this third multidisciplinary workshop was to learn about some of the **current digital tools** which allow to **concentrate data and visualize materials flows** available in a territory and that can therefore serve as powerful tools to promote the creation of **synergistic networks** within the construction sector.
After the presentation of several tools (MatMap, Escrapalia, RecursResidu, and the Fissac Platform) the workshop concluded with an open debate: What would the different potential users expect from an ideal platform?, which features should it include?, what kind of data should it show?, who should manage such a platform?

9.2.3 IDENTIFYING STAKEHOLDERS

We need to **get the whole supply chain together** to show the opportunities, identify the necessities and discuss how to work together. Consequently, the Símbiosy team paid special attention to the design of a multi-sectorial participant list of all Living Labs. The average number of participants was 15-25. A small-group approach was intentionally envisaged to favour the debate and the exchange of ideas among attendees. The participants represented different professional activities within the construction value chain: designers, architects, manufacturers, associations, universities, construction companies, consultancy companies, deconstruction & waste management companies, material providers, maintenance companies, etc.
In order to **get key local stakeholders involved** in the Living Labs experience and have access to their professional network, the first one was co-organised together with the ITeC (the Catalonia Institute of Construction Technology), while the second Living Lab was co-coordinated with Societat Orgànica (a professional cooperative that works in the field of sustainable building). The third and last Living Lab was organised as a free side event at the construction fair BBConstrumat 2019.

9.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

The main structure of all Living Labs can be divided in three sections: an **introductory part**, which is followed by **workshopping activities** and/or **presentations of concrete projects** and/or **an open debate and/or**, and a final **conclusion part** to summarise the main outcomes. The average length was **3 hours**.
For the workshopping activities of the first Living Lab, and in order to discuss about the impacts (positive and negative ones), necessities and opportunities of both the current and the possible “more circular” scenario within the construction sector, the Símbiosy team prepared two **templates** that served as a debate basis to encourage interaction among the different working groups (see pictures and templates at the Appendix). The second and the third Living Labs didn’t include any workshopping activities, but a **series of presentations** related to local and circular initiatives followed by an **open debate**.

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9.2.5 IDENTIFYING BARRIERS AND DRIVERS

The identified barriers for boosting the circular economy/industrial symbiosis in the build environment were in line with those related to other industrial sectors:

- **Regulatory and legislative issues**: current legal/regulatory frameworks that do not envisage the implementation of the industrial symbiosis initiatives, too heavy administrative burdens, excessively rigid environmental regulations, lack of certification schemes for waste streams as by-products for its use as raw materials (end of waste criteria), etc.
- **Financial, economic and market-related obstacles**: lack of actual demand and customers engagement, time and the costs related to all the activities necessary in order to identify, assess, negotiate, and implement industrial symbiosis initiatives, lack of suitable co-financing instruments and incentives, high capital investments and long return periods, etc.
- **Social, cultural, organisational aspects**: lack of trust and collaboration among stakeholders, lack of skills and know-how of the involved stakeholders, linear production and consumption patterns, short-term mindset, lack of open innovation spaces, lack of coordination and leadership, lack of capacity building and training, etc.

During the three Living Labs the different working groups put their ideas together and discussed about **possible enablers** that might tackle current barriers related to the actual implementation of circular projects. Some of the proposals were:

- **Do not punish for trying**: Give freedom to try new models. Collaborate on **pilot projects** with the rest of the stakeholders to visualise how the sector could change, to drive innovation and create knowledge and skills.
- Create an **ecoinnovation observatory** that allows interested stakeholders to know each other, promote collaboration and build trust among them.
- Consider assets as **material banks:** Create new ways to **track the materials** within assets, for example through materials passports.
- **Design for disassembly mindset:** Assets of the future should be retrofit-and upgrade-ready.
- **Drive a cultural change**: Inform customers and users about the environmental traceability of the products/materials/services they acquire so that they become more active and conscious about the spaces they inhabit.
- Prove that there are clear advantages: **Quantifying the positive impacts** of circular projects and case studies and **document value creation**. **Focus on the social dimension**, which is often overseen during the implementation of projects since the emphasis of the work is put mostly on more technical aspects.
- Reward and give **visibility to local best practices.**
- **Learn from successful initiatives** from other countries.
- **Provide training** in circular economy/industrial symbiosis across all grades and disciplines.
- **Facilitate public private partnerships** to develop scalable projects.
  Create the demand for circular solutions: Circular business models are solid enough only if there is market demand behind, and we all know that users create the demand. Thus, **well-informed consumers** can drive the transition to alternative and circular business models.
- **Boost policy and regulatory support that can provide cities and industries with incentives and funding**

9.2.6 OTHER RESULTS AND CONCLUSIONS

Spending time defining the **suitable participant list** is fundamental for the success of the Living Labs. It is not only crucial to choose the appropriate companies/organisations/institutions, but to invite the right representatives: people who are already working on circular strategies (or that at least are willing to do so!), creative, open minded, proactive, and collaborative people. These are the perfect participants to make the most of a Living Lab.

9.2.7 THE LIVING LAB AFTER FISSAC

The organisation of the Living Labs offered ideal **networking opportunities**. Not only for the team at Símbiosy, but also for the rest of participants, who made the most of the event and took the chance to **broaden their professional/business network** of contacts.
The Living Labs have served as a great **breeding ground to boost collaboration** among some of the participants, who will surely envisage and launch future projects together.

9.2.8 LIST OF APPENDICES

Appendix 10 LL Spain Barcelona | First Living Lab Barcelona Templates for the workshopping ac
Appendix 12 Second LL Spain Barcelona | Pictures from the second Living Lab Barcelona
Appendix 13 Third Living Lab Barcelona, Pictures from the third Living Lab Barcelona

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10 Spain Madrid

LIVING LAB SPAIN (Madrid) was organized by ACCIONA and Fundación Agustín de Betancourt.
Acciona is a leader in providing sustainable solutions for infrastructure and renewable energy projects across the world. Its offer covers the whole value chain, from design and construction to operation and maintenance. With a presence in more than 40 countries, the Group develops its business activities based on the desire to contribute to economic and social development in the communities in which it operates. Acciona executes its sustainability strategy through a Sustainability Master Plan, a road map containing all the initiatives of the Company in this field. The aim of Acciona is to lead the transition towards a low-carbon economy, bringing quality criteria and innovation processes to all projects in order to optimize the efficient use of resources and respect the environment, with the ambition and determination to become a carbon-neutral company from 2016 onwards.

This commitment has been ratified by the inclusion of Acciona in the world's top sustainability indexes, such as the FTSE4Good, MSCI Global Climate Index, CDP Climate A List 2017, CDP Water A List 2017, among others.

Fundación Agustín de Betancourt (FAB) is a Spanish Private Cultural Foundation established in 1977 with the aim of promoting and developing basic and applied research related to Civil Engineering as part of the Higher Technical School of Civil Engineering of the Polytechnic University of Madrid. Currently, the Foundation represents a technological hotspot highly acknowledged in the educational sector, especially in building and civil engineering faculties as well as in architecture. To achieve its objectives, the Foundation finances and manages research projects and organizes a large number of training courses and workshops oriented to promote these research topics among students, postgraduates preparing their PhD and also university professors. The Foundation research activities are divided into several investigation groups, one of the most important is the materials group, working towards the topic of management and design of durable civil infrastructures. This team and their network of collaborators bring together a comprehensive range of expertise covering all aspect of design, use and performance of the concrete civil infrastructure. Its staff consists of university full and associated professors, researches and fellows.

As result of years of collaboration, the ACCIONA and FAB teams lead innovation projects thought knowledge exchange. A multistakeholder group of expert has identified a number of common challenges and opportunities that would guaranty further research, exploration and discussion in the framework of FISSAC project and circular economy topic.

There is a significant increase in circular economy studies that investigate the topic from the construction value chain perspective. However, this body of knowledge is not currently present internally in the universities. ACCIONA and FAB, actively working together to address this gap, has proven that the collaborative approach between university and industry enables to adapt rapidly to new circumstances and to develop new knowledge, competences and innovations.

10.1 THE SECTOR AND THE LIVING LABS

The built environment sector is a **major consumer of natural resources**: the engineering and construction industry consumes worldwide more than 3bn tonnes of raw materials annually[5]. This implies that the **design and development of circular strategies** have already become a necessity.

Changes are beginning to be visible: some manufacturers are already designing products that are made out of secondary raw materials, which can be also reused or repurposed. On the other hand, new business models based on the return, rent, or sharing of products, spaces, and services are starting to come up.
However, there are no clear strategies of how individual companies will need to change across the industry yet. In order to make circular economy happen, different scales such as assets, buildings, infrastructures, cities and regions must be integrated into an interconnected whole. Without **cross-sector collaboration and communication among the stakeholders** of the construction and demolition supply chain, the implementation of the tools that the circular economy can provide, such as the industrial symbiosis, will never succeed.
Construction sector has always been very conservative and is reluctant to think about Circular Economy concept when designing materials for new infrastructures, due to the lack of knowledge related to the durability that could be achieved. Professionals has used always the same working formulas from university to site.

[5] https://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_report_020516.pdf

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The main objective of this Living Lab was to explore with the academic community the needs and challenges to face the future and train professionals specialized in circular economy and industrial symbiosis in construction.

10.2 PURPOSE AND GOALS

ACCIONA and FAB organised a series of "Living Labs" focused on educational issues at different levels, as part of the FISSAC project (Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain).

The global objectives of the Living Labs Madrid are:

- to co-create and to share the IS knowledge among the participant in search of different alternatives, solutions and ideas to face the challenge of impulse the Circular Economy on construction sector at University.
- to develop attitudes and values of respect for the environment; introduce the concept of reusing and recycling waste; promote collaborative working, creativity and tangible forms of expression; and develop creativeness, manual dexterity and experimenting at schools and kidergartens.

10.3 SCOPE

ACCIONA and FAB have organised **two Living Labs throughout the course of the project**. Each of them had a common approach focused on education issues:

First Living Lab Madrid
The main objectives of this workshop was to develop attitudes and values of respect for the environment; introduce the concept of reusing and recycling waste; to promote collaborative working, creativity and tangible forms of expression; and to develop creativeness, manual dexterity and experimenting.

This workshop, based on the three underlying pillars of sustainability –environmental, economic and social– was part of a campaign to encourage waste reduction, reuse and recycling, primarily focused on the recovery and transformation of waste into new materials. The pupils also created a mural during the workshop that has been exhibited at the end of the day.

This first experience took place in Madrid, 10 May. Main objectives of the information session on Circular Economy were addressing minimization, re-utilization and recycling focused on the recovery and transformation of waste into new materials and aiming to contribute to Sustainable Development Goals (SDG4 – Quality Education, SDG11 – Sustainable Cities and Communities, SDG12 – Responsible consumption and productions, SDG13 – Climate Action) to build sustainable and resilient societies.

Second Living Lab Madrid
The LL dynamic was focused on **Co-Creation and knowledge sharing** among the participant in search of different alternatives, solutions and ideas to face the challenge of impulse the Circular Economy on construction sector.
A **concept map** was prepared to make assumptions and models visible in the construction sector, identify which are the interdependence between the different agents involved in it and what are the main forces that facilitate or prevent change.
At the end of the session, participants presented a **prototype of ideas or actions** to carry out and that would help to meet the **educational needs** of the University to train specialists in circular economy in the construction of tomorrow.

10.4 IDENTIFYING STAKEHOLDERS

Living Lab Madrid experiences was focused on education issues, the first lab was celebrated it at the kindergarten "El Alboroto", Alcobendas the last 10 May 2019. The second Living Lab was organised at Higher Technical School of Civil Engineers in Madrid with the collaboration of the Craft Caminos organization and the Directorate of the School of Civil Engineers.

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10.5 STAKEHOLDER INTERACTIONS AND ACTIVITIES

The main objectives of these Living Lab were to explore with the academic community the needs and challenges to face the future and train professionals specialized in circular economy and industrial symbiosis in construction.
One of the challenges was to ensure that professionals who join the sector have the necessary skills to maintain and promote this type of symbiosis, which encourages the exchange of information and development of new value propositions. The education system faces the need to respond to these new professional needs, to ensure that the professionals of tomorrow are trained at the university to meet the challenges that organizations are already facing.

10.6 IDENTIFYING BARRIERS AND DRIVERS

First, ACCIONA and Fundación Agustín de Betancourt presented FISSAC project. The conceptual framework, Circular Economy, Industrial Symbiosis and Living Lab concepts were explained. Some examples of the innovative construction products were shown as well as the last case studies and real scale demonstrators carried out in the Project. Then, the facilitator briefly described the principles of Systems Thinking, as a fundamental tool to have a holistic approach to the challenge to address. This process was complemented with group dynamics, which allowed the concept to be internalized and it created a climate of participation and co-creation.

A concept map was prepared to serve as a tool for reflection and to initiate the dialogue and the exploration of alternatives among the Living Lab participants which included students and teachers of the Faculty of Civil Engineers, ex-students and current workers in sector companies.

The purpose of the causal diagram was to make assumptions and models visible in the construction sector, identify which are the interdependence between the different agents involved in it and the main forces that facilitate or prevent change.

The participants, in a playful way, worked in groups to analyze the factors that more influence have to boost the Circular Economy in the Construction sector. At the end of the session, each group presented a prototype of ideas or actions to carry out and that would help to meet the educational needs of the University to train specialists in circular economy in the construction of tomorrow.

10.7 OTHER RESULTS AND CONCLUSIONS

The group validated with their comments the description of how the process worked and incorporated some elements that, at the discretion of the different working groups, they also influenced the development of the circular economy in construction sector. Some of these elements are:
Some of these elements are:

- New construction and extraction technologies
- Lack of social awareness on the subject
- The availability of secondary materials
- The lack of knowledge and resistance of the construction sector to implement it
- The pressure of short-term results

10.8 THE LIVING LAB AFTER FISSAC

Hopefully, ACCIONA and FAB will continue working together with professionals and future professionals to reduce the use of virgin raw material consumption and developing new formulas to use as raw material with no damage on the infrastructure requirements (strength, durability, among others).

10.9 LIST OF APPENDICES

Appendix 14 First Living Lab Madrid, Conceptual map (Spanish version)
Appendix 15 First Living Lab Madrid, Pictures from the first Living Lab Madrid
Appendix 16 Second Living Lab Madrid, General Information - second Living Lab Madrid
Appendix 17 Second Living Lab Madrid, Pictures from the second Living Lab Madrid

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11 Sweden

11.1 THE SECTOR AND THE LIVING LAB

The two responsible organizations for carrying out the Swedish Living lab process were a research institute (RISE) and a consultancy of project managers & circular economy experts (Hifab). As neither of the project partners works with any material in particular, the living lab process was opened up to a wide range of actors from the entire construction value chain and the stakeholders from the industry themselves got to direct the course and scope of the Living Lab workshops.

11.2 THE LIVING LAB TODAY

As the Swedish Living Lab started 6 months before all other WP 7 partner countries, the workshops concluded by the end of 2018. The Swedish living lab process and lessons learned was used to develop guidelines for the other living lab partners and instructions on how to apply TIS-analysis for developing living lab workshops and industrial symbiosis were shared.
The living lab discussions contributed to a few still ongoing spillover processes. For an example a pilot study by the city of Gothenburg on how public procurement can be used as a tool to increase industrial symbioses and circular material flow in construction industry.

11.2.1 PURPOSE AND GOAL

The goal of the Swedish living lab process was to offer a platform for a wide range of stakeholders in order to create better knowledge and understanding between the stakeholders on their role in achieving a circular material flow as well as to design a better framework for needed data to increase circularity of materials in the construction value chain.

11.2.2 SCOPE

Living lab workshop #1: Introductory meeting.
The first, introductory meeting, aimed to generate interest to be part of the living lab events during the following two years and build a foundation to a network working with circular material flow. The first part of the day focused on raising knowledge about industrial symbiosis and FISSACs ambitions and the participants were given a chance to get to know each other, share their experience and understand each other's perspective for fostering potential future collaboration. The actors present expressed the need for more awareness-raising activities and more knowledge of good examples of material flow in the industry. There was also a consensus around the lack of relevant business models, policy instruments and standards.
Living lab workshop #2 Topic: Material log book of the future. What information is needed to be a helpful tool for increasing circular material flow?
A general interest of standardizing information about material content and characteristics was expressed. The former was followed by a discussion on the question of independent evaluation and the type of organization needed for carrying out the evaluation of the (recycled) materials on quality, characters, content etc. One of the proposed ideas was to create or enjoin an existing public actor to take on the task of guaranteeing the independent evaluation.
One wider idea proposed by a Living Lab participant was to begin every building project and logbook by putting together a "program of the building" that will become a shared knowledge by all the actors involved in realizing a construction project.
A recycling entrepreneur shares that gypsum/plaster boards as a widely used building material/element has a high recycling potential, however today the recycling rate of plasterboards is unnecessarily low. The group agreed that it would be interesting if a material could be followed throughout its life cycle to better understand the barriers and opportunities for reuse of secondary raw materials.
Living Lab meetings #3-5: Material journey case study on gypsum.
Gypsum plasterboards were followed and investigated from extraction of raw material to production (Gyproc) to building, to waste management. In the discussions of how to raise the amount of secondary raw materials on the production of new plasterboards, both the flow of spill material as well as the possibility of recycling plaster boards from demolition sites were analysed.
More detailed description on the case study is to be found here.

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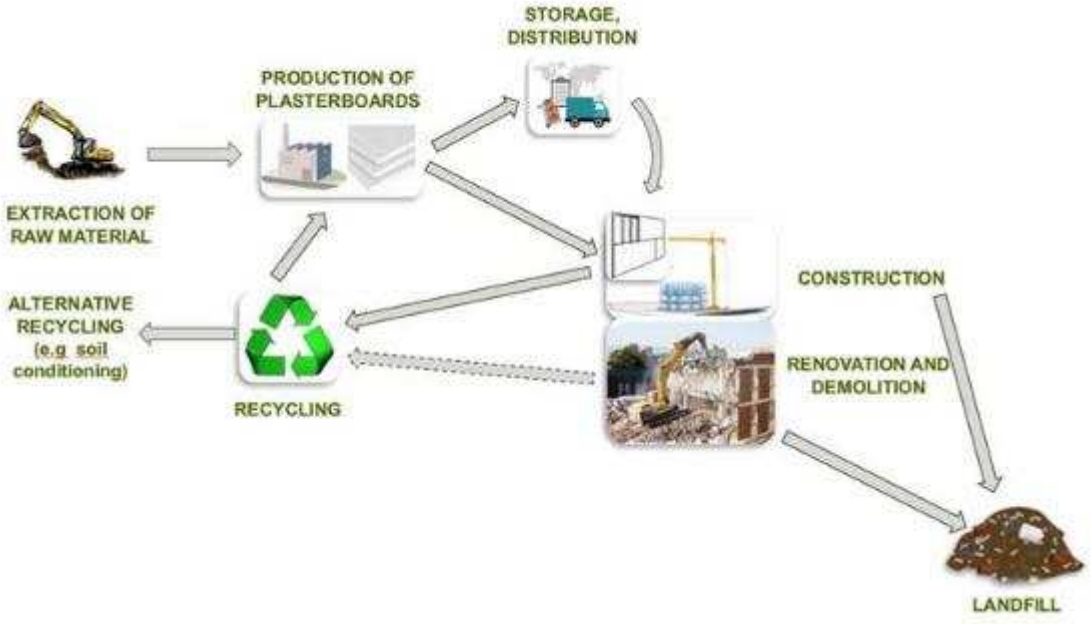

Figure 15 Material journey: Gypsum plaster boards

Living Lab workshop #6: Area of Hammaren – A practical example of a building as a material bank.
The 6th workshop was organized together with the real estate owner Stena Fastigheter and focused on a real-life development site. The main question in focus was to investigate what of the existing materials and building modules at the site could be repurposed, reused or recycled, so that the existing building could be seen as a "material bank" instead of "a demolishing site" .

11.2.3 IDENTIFYING STAKEHOLDERS

The goal of the Swedish Living lab was to gather stakeholders throughout the entire construction value chain. From architects to (international) construction companies to developers and real estate owners, material producers to demolishing contractors as well as public organizations and research institutes. The living lab workshops engaged 30 private companies; 11 public organizations and 6 research institutes.

11.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

The workshops offered the stakeholders a possibility to present their ongoing operations and projects within industrial symbiosis and circular economy as well as time for discussions on opportunities and barriers.
For example, contributed FISSAC Living Lab workshops to bringing two private actors – a recycling company and a plaster board producer - closer together with a goal to develop a logistics system for getting more plasterboard spill from construction sites back to the production site in order to be recycled for the production of new plaster boards.
FISSAC Living Lab in Sweden collaborated also with Win Win Gothenburg sustainability award 2018.

11.2.5 IDENTIFYING BARRIERS AND DRIVERS

Logistics, transport, storage
Throughout the discussions it surfaced again and again that the problem today isn't technology or a lack of knowhow on how to use more secondary raw material in the production of new building materials/modules, but rather the question of logistics, transportation and storage – getting for example the spill material from the construction site back to the production site, Both storage and transportation would create new costs as well as logistical problems that in case of gypsum plaster boards as an example possibly exceed the cost of the raw material. Which brings us to the next

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barrier – if the raw material is cheap, the material producers lack the initiative to use more secondary raw material in the production. Highly priced materials (metals) circulate in high volume.

Business models need to be changed

The living lab workshops made it clear that there are actors working all over the construction value change that recognize the need of moving towards circular economy. However, the new system requires also new business models. The process of change is slow and changing business models within big existing structures is extremely challenging and requires constant work on every management level. The new economy also requires collaboration, trust and transparency – a culture that doesn't yet describe that many actors in the construction value chain today.

Overwhelming amount of codes and regulations

Many of the stakeholder's state that the construction sector today, in Sweden, is already overwhelmed with codes, regulations and requirements that need to be met. New regulations on building materials that can be used or reporting on them through some kind of a logging system would overwhelm the process even more as well as make construction more expensive (construction costs per m^2 in Sweden today are the highest in Europe already).

Guaranteeing the quality of recycled materials

Guaranteeing the quality of construction materials where secondary raw materials have been used has its own procedures in place. However, if we widen the scope and include the reuse and repurposing of existing building elements from deconstruction sites, the question of quality and insurance come to play. Today there is now third-party organization that could help to solve the issues raised by insurance companies on guaranteeing the quality of reused elements.

Lack of best practice examples that could drive the change

Most of the known inspiring examples of industrial symbioses have little to do with the construction industry and the best practices within the construction industry are often examples of smaller scale initiatives. In order to inspire change within big established stakeholders we need to be able to translate the existing examples into today's dominating business culture.

Requirements and regulations

Requirements and regulations however are also the drivers of change. If it would be required from the sector to change their processes, what they purchase or to what extent new materials can be used in new construction, the stakeholders would follow. That means that the public bodies, municipalities and states embody an enormous potential to drive the change towards a more circular model in the construction value chain

Public procurement as a tool

A very simple tool that can drive a positive change already tomorrow is adjusting the requirements in the public procurement procedures. Municipalities in Sweden are very powerful and important clients to a vast variety of construction branch stakeholders. Adjusting the terms of public procurement would therefore open up a significant market for the use of secondary raw materials as well as recycled and repurposed materials.

The unused potential of the economic value embedded in materials

According to a study by Material Economics, the monetary value lost in the current material management system where only a fraction of the materials used in construction are recycled, is around 4 billion euros per year in Sweden. A vast majority of materials are instead burned and recycled to heating, deposited or not collected and managed at all. The loss of material value occurs also through downcycling of materials as well as contamination. As stated before, the challenge isn´t to find technology for higher volume of use of secondary (raw)materials, but the incentives to change the management processes.

11.2.6 OTHER RESULTS

The Living Lab workshops led to a pilot project carried out by the city of Gothenburg on how to use public procurement as a tool to increase circular material use in construction industry.

The workshops contributed to bringing two private actors, a recycling company and a plaster board producer (Suez and Gyproc) closer together with a goal to develop a logistics system for getting more plasterboard spill from construction sites back to the production site in order to be recycled for the production of new plaster boards.

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11.3 CONCLUSIONS

Swedish living lab workshops succeeded as a discussion and knowledge exchange platform. The stakeholders appreciated the forum and claimed that the reality is that it is very difficult to meet stakeholders throughout the value chain in an inquisitive and open environment where challenges can be analyzed, and solutions discussed together as sales meetings or fair arrangements where they otherwise could meet provide a very different surrounding. As FISSAC project aims for innovation in a very conservative branch, a lot of awareness raising and bridging work needs to be done in parallel with the technical innovations of developing greener materials. And we do believe that the Swedish living lab workshops succeeded in providing a platform for better understanding the changes needed for moving towards a more circular construction sector. However it shall be added the positive effects of the interactions during the workshops are difficult if not possible to measure.

11.4 THE LIVING LAB AFTER FISSAC

Our hope is to connect the Swedish Living Lab network to the FISSAC platform, so that the latter could be a tool used by all the stakeholders that had been part of the FISSAC living lab workshops.

11.5 LIST OF APPENDICES

Appendix 2_ List of Stakeholders
Appendix 6_Photos from activities

12 Turkey

In FISSAC project, Turkish Cement Manufacturers' Association (TCMA) is responsible for the production of CSA and blended cement as eco-cement. TCMA is the common voice of the Turkish cement sector. It represents a total of 67 enterprises, as 50 of them being integrated facilities and 17 cement mills, with the aim of better quality products and more efficient services and looking for solutions to potential problems.
TCMA provides common solutions to its members for their research and development activities, analysis, quality control, training services and makes common initiatives for legal and administrative regulations.

Turkish Cement Industry is the largest cement producer amongst Europe and 5th largest in the world. Around 100 million tons of cement, with an increasing trend, produced in Turkey in 2019.

12.1 THE SECTOR AND THE LIVING LAB

Cement sector is responsible for 5-8% global anthropogenic CO_2 emission. This ratio slightly decreases by reducing CO_2 emissions with increasing awareness and increasing tendency to use alternative raw materials and fuels in cement production.
Currently, alternative raw materials are already being used in the raw meals to be burned in the rotary kilns to produce clinker which is cement semi-product. Besides burning process, up to 65% various alternative raw materials can be used as additive in conformity with EN standards. In addition, in concrete industry, artificial aggregates can be replaced with natural aggregates in the concrete mortar, ready-mix concrete and dry-mix concrete production.

In FISSAC project, waste material utilization for eco-cements has been considered as both secondary raw material and mineral additive to cement. Electric Arc Furnace Slag (EAF), Ladle Furnace Slag (LF), Glass Waste, Ceramic Waste and Aluminium oxide-based materials were targeted as secondary raw material for Calcium Sulpho-Aluminate Cement (CSA) production. On the other hand, Glass Waste and Ceramic Waste are also considered to be used as mineral additive for the blended eco-cement, and in order to broaden the scope of the study, Aluminium oxide-based materials and Ladle Furnace Slag (LF) were added to the secondary raw materials usage trials in blended cement mix designs.

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In the scope of Turkish LL, informative meetings and seminars, that is about industrial symbiosis, difficulties of eco-cement production with zero waste approach and technological processes aiming end-users were organized to Turkish Cement Industry stakeholders, local authorities, decision makers and Ministries.

12.2 THE LIVING LAB TODAY

For the Turkish living lab a set of 5 national technical and non-technical meetings have been set up at different platforms; Each meetings focused on an important group obstacles and challenges.

First Workshop was held with Quality and R&D Managers of Turkish Cement and Construction Sectors on 03 September 2018,

Second meeting was held with Certification Body Managers, Quality and R&D Managers of Turkish Cement and Construction Sector on 02 November 2018,

The Waste Management Summit was held on 26 February 2019. The Ministry of Environment and Urban Planning and local administrative participated in the meeting. TCMA Environment Manager had a presentation about FISSAC Project and utilization of waste materials. Some bureaucratic issues and barriers/permission of waste transportation were discussed with authority.

Third meeting with Quality and R&D Managers of Cement Sector was held on 29 March 2019. FISSAC Project's outputs and contribution of TCMA were presented to participants. The meeting resulted significantly increase on awareness and gaining different points of view on:

-increasing waste diversity in Eco-cement production.
-utilization of different percentage of wastes.

Workshop was held with Certification Body Managers, Quality and R&D Managers of Turkish Cement Sector and annual meeting was held with Quality and R&D Managers of Turkish Cement and Construction Sectors on 26 April 2019. Ekodenge which is another partner of FISSAC Project participated to the meeting and had a presentation about demonstration of the software platform about industrial symbiosis and FISSAC model. The software platform helps transportation of wastes to factory from short distances.

12.2.1 SCOPE

In scope of Turkish LL, eco-cement production, CO_2 emission reduction, zero waste approach, industrial symbiosis waste stocking and management, waste homogenisation, ministry permissions, increasing awareness, increasing performance and quality subjects studied with production and quality managers in the industry.

To raise awareness of stakeholders and related participant sectors about industrial symbiosis and best practices applications, mainly focus on cement and concrete production by using secondary raw materials.

12.2.2 IDENTIFYING STAKEHOLDERS

The connection network is identified with our members as being the roof organization of Turkish Cement Industry. Those are:

Certification body managers, Quality and R&D managers of Turkish Cement and Construction Sectors Ceramic, Glass, Iron&Steel Manufacturers, Cement Manufacturers and Ready Mix Concrete producers are the stakeholders of Living Lab in Turkey. Also policy makers can be added in the stakeholders in order to widen the participant circle.

12.2.3 STAKEHOLDER INTERACTIONS AND ACTIVITIES

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At the Turkish Living Labs, after presenting the FISSAC project and the actual status of the model, presentations were made about the circular economic potential in the cement industry by the speakers from different industries and stakeholder groups. Afterwards, opinions about the whole value chain collected with questionnaire discussed in an open question-answer session. The results of the survey containing technical and non-technical questions were evaluated together and the results were announced to the participants.

12.2.4 IDENTIFYING BARRIERS AND DRIVERS

The Living Labs have identified the challenges and the results are presented as below;

A need to reduce negative public opinion about blended cement ,
A massive common agree on importance of waste management ,
Common agree on a separate waste stockpile in facility,
Barriers of waste transportation and bureaucratic issues,
Barriers of constructing of road regarding local administrative.

12.2.5 OTHER RESULTS

One of the results is the importance of providing the wastes used in clinker and cement production continuously and in the desired quality, without disrupting the production process.

12.3 CONCLUSIONS

The FISSAC project and the Living Labs contributed to the gradual and still early phase implementation on transportation and waste storage, governmental permits of waste supply to facility, waste management. At the same time, a significant increase was observed on awareness of circular economy and eco-cement production among cement stakeholders and successful organizations were organized with the interest of members.

12.4 THE LIVING LAB AFTER FISSAC

As stated in the results, the communication networks created within the scope of the project will be protected and the outputs of the project will be presented in large-scale technical seminars. Overall results (public) will be presented to industry representatives, decision makers and governmental authorities at the general meetings, technical seminars and leaflet and publications.

The FISSAC Platform developed within the scope of the FISSAC project will be explained at these meetings and its use will be made widespread after the completion of the project, making it easier for waste producers and waste users to find each other. Thus, continuity between the sectors will be provided in waste procurement.

12.5 List of Appendices

Appendix 18 LL Sweden. List of reports to download
Appendix 19 LL Sweden. List of stake holders of the Swedish LL
Appendix 20 LL Sweden. Photos from LL

13 UK

British Glass and Glass Technology Services (GTS) lead the FISSAC work on glass. GTS is a leading provider of innovation, analysis, mechanical and performance testing, due diligence support and quality assessment of glass. British Glass is a trade association that helps UK glass manufacturing and recycling industries have the influence, knowledge and skills to be world leading and globally competitive.

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13.1 The sector and the Living Lab

10 million tonnes of flat glass are manufactured in Europe each year for use in windows, architectural facades, internal partitions and vehicle windscreens. Approximately 80% of flat glass produced is used in the building industry.[6]

Figure 16: An overview of the glass supply chain showing closed loop recycling in the green ring, high value secondary uses in the blue ring, and downcycling to aggregate in the red ring.

13.2 The Living Lab today

Europe generates 1.5 million tonnes of waste sheet glass each year from building refurbishment and demolition projects[7]. Whilst some of this glass is currently recycled back to glass manufacture or other higher end secondary uses, it is believed that most of this is crushed into aggregate or sent to landfill. There is no consistent collection of data on the recycling of glass from building and construction so estimates of recycling amounts are difficult.

In the UK the most common recycling route for glass from construction is for it to be crushed up and used as backfill or as an aggregate substitute. In the UK in contrast to other European countries this is considered recycling even though this results in the material being lost from the closed loop recycling system forever. Current demolition or deconstruction and transport techniques often make the glass too contaminated for higher end secondary or closed loop reuse.
Post-consumer glass is a relatively low value material compared to metals and plastic and therefore is often not considered economic to recover and do is often overlooked in circular economy discussions in the construction industry

If sheet glass could be collected for recycling, it can be used to make a variety of new glass products, or to manufacture secondary materials such as eco cement and eco concrete. Glass back to glass is the best environmental option in terms of carbon dioxide savings but utilizing glass in any way is better than losing this valuable resource to landfill. For every

[6] Glass For Europe Website https://glassforeurope.com/the-sector/key-data/ Accessed 08/01/2020

[7] Report: Economic study on recycling of building glass in Europe, Deloitte, 2016

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1 tonne of recycled glass used 1.2 tonnes of raw materials are saved and 226Kg of CO2 emissions averted[8]. In order to realise the potential of glass in both closed loop and secondary raw materials it is essential to minimise contamination of the material.

Some sheet glass recycling operations already exist in Europe, in particular The Netherlands has developed a highly successful, nationwide system of sheet glass collection and recycling, paid for by a levy. In the UK, which we are using as a deep dive case study in FISSAC, there are already good recycling systems for 'pre-consumer' waste sheet glass (offcuts from glazing manufacturing), and some recycling of 'post-consumer' waste windows.

The UK Living Lab has engaged with a range of stakeholders involved with the use of glass in the construction sector. Engagement has been through events dedicated to glass and participation in events and workshops aimed at the wider construction and demolition sectors.

13.2.1 PURPOSE AND GOAL

The purpose of the living labs was to engage stakeholders to investigate the barriers and opportunities for increasing the recovery of glass from building projects, build partnerships and highlight potential for increasing the quantity and quality of glass collected for recycling.

13.2.2 SCOPE

The scope of the UK living labs was how to increase the quantity of post-consumer architectural glass recovered for recycling, increasing the quality of the glass recovered and developing economic business models for this recovery.

13.2.3 IDENTIFYING STAKEHOLDERS

Stakeholders for the initial living lab were identified through British Glass's contacts in the glass supply chain and through interactions with government agencies engaged in the recycling of construction waste in the UK.
Contacts made during the initial living lab led to interactions with other organizations working in the field of sustainability in the construction sector, this led to invitations to run joint workshops with these organisations and gave access to a wider range of stakeholders in the construction and demolition sector.
Initial contact with stakeholders was made by telephone and, where possible, followed up with face to face interviews based on a questionnaire which can be found in the appendix. These interviews were carried out on a confidential basis to allow free discussion of economic and commercial matters.
During the setting up of the living lab it was realised that partnering with organisers of events across the supply chain was the most effective way to engage with the widest variety of different organisations in order to gather constructive group feedback. As mentioned previously glass is rarely considered in detail as part of the sustainability discussion in the UK construction industry so by actively participating in workshops in forums interested in multiple materials this gave the opportunity to reach beyond the relatively small glass recycling community.

The stakeholder list has been included in the master list for FISSAC and the majority of participants were also included in the newsletter circulation.

13.2.4 STAKEHOLDER INTERACTIONS AND ACTIVITIES

13.2.4.1 *Living Lab, Glass Recycling Supply Chain.*

Zero Waste Scotland

[8] British Glass

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Barriers and Opportunities to creating an architectural glass recycling scheme in Scotland, Glass and Construction supply chain

Zero Waste Scotland, a government recycling organization in Scotland has worked extensively with British Glass and GTS in the past and is interested in developing a flat glass collection scheme in their country. They partnered with us to run the first living lab session in order to inform both the FISSAC project and their plans for flat glass recycling providing an additional incentive for attendance by stakeholders at the event.
British Glass and GTS spoke to over 30 stakeholders and visited 4 sites as part of our initial research for FISSAC. We built on our contacts to form a partnership with Zero Waste Scotland and Construction Scotland Innovation Centre. We organized a large, professionally facilitated workshop which brought together 40 key stakeholders to discuss the issue. We also invited the operators of the Dutch sheet glass recycling system to speak at the event.
The workshop coincided with the launch of a Circular Economy Investment Fund in Scotland which attendees could bid for to fund recycling activities. This was a good focus for action.

Article: https://www.britglass.org.uk/news-comment/pooling-ideas-close-flat-glass-recycling-loop

Feedback was collected from the different discussion groups which can be found summarized in the appendix.
During this initial workshop contact was made with members of FERVER the European Glass Recycling Association and this resulted in an invitation to present at their annual conference to a similar cross section of the supply chain from across Europe.

13.2.4.2 *European Glass Recycling Association. (Ferver)*

Presentation of FISSAC and results of Initial Living Lab work. Discussion of Barriers and Opportunities with European glass recycling companies.

FERVER is the European Federation of Glass Recyclers it is a Non-Profit Organization based in Brussels with a membership of over twenty private recycling companies from different European Countries. Its members are collectively responsible for the collection and recycling of approximately 70% of the total glass waste (flat and container) in the European Union.
GTS presented a summary of the first findings of the living lab to a meeting of glass recycling companies from across Europe held in Manchester in the UK. They provided feedback from a European perspective, identifying differences in recycling regulations and infrastructure in different countries and how recycling schemes adapted to the local situation and cultures in different regions.
Following on from this meeting British Glass and GTS were invited to participate in the Ferver and Go4Cirlcle seminar ”Towards recycling of building glass in Europe” attended by representatives of construction sector from across Europe. The event constituted of a number of presentations from experts in the field of construction glass recycling and circular economy. Following the presentations there was opportunity for discussions and feedback of ideas. During this event contacts were made that allowed interested parties to visit glass manufacturers and recycling sites.

13.2.4.3 *Keeping Glass Circular Webinar and Question and Answer*

UK Green Building Council (UKGBC).
Overview of the benefits of recovering glass from refurbishment projects, case studies from successful projects, Architects and construction project professionals.

The UKGBC is a Charity with over 400 member organisations representing the whole construction supply chain from architects through to construction contractors. Its aim is to unite the UK building industry using sustainability as a catalyst to positively transform the places people use every day.
The webinar presented an overview of closed loop glass recycling benefits, higher value end uses for post-consumer glass waste and the current situation in the UK. This was then followed by case studies of succesful glass recycling projects presented by ARUP and Verdantix, highlighting that it is possible to recover glass from projects using a method that allows good quality glass to be re-melted and reused.
The second half of the event provided an opportunity for listeners to ask questions of the presenters and talk about their experiences of trying to recycle glass from construction and demolitions projects.

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The event was attended by an audience of architects and project managers responsible for specifying and overseeing construction and refurbishments. They reported that there was often a will to recycle the glass to higher value uses but limited information, cost and time implications were barriers to being able to implement closed loop recycling across all materials.

13.2.4.4 *Round table discussion at FIT show 2019 (The UK glass window and door industry trade show)*

Glass and Glazing Federation. (GGF)

The Glass and Glazing Federation represents companies that manufacture, supply or install glass and glass related products in the UK and internationally.

British Glass/GTS & Pilkington UK joined a roundtable discussion organised by GGF. This event explored issues relating to the removal and recovery of glass from buildings from the perspective of the contractors who undertake the work and the quality requirements of the glass manufacturers to enable the glass to be recycled back to re-melt. Similar issues were reported to other areas of the supply chain with limited access to information, economics and time and space constraints making closed loop recycling difficult. It was clear from the event that there was a willingness to recycle from the companies spoken to and a desire for an increase in availability of high-quality cullet from the glass industry. All were keen to participate in a potential pilot and/or commercial collection scheme.

13.2.4.5 *International Conference Construction Circular Economy 2019.*

Presentations of the FISSAC model and an overview of architectural glass recycling as part of a larger construction circular economy event, circular economy and sustainability professionals.

GTS and British Glass in partnership with Arup delivered three presentations at this two-day event attended by Circular Economy Experts with an interest in the construction industry. Our presentations included a discussion of glass recovery and recycling, the FISSAC pilot projects and case studies on the successful recovery of glass from construction projects. Discussions after the presentations covered stakeholder experiences in recycling and recovery of glass and the difficulties that have been experienced with using recycled building products. There were also a number of discussions and concerns expressed at the difficulty of recycling new products containing secondary raw materials and composits when today's buildings are being deconstructed in the future.

13.2.4.6 *Deconstruction and Modern Building Materials Workshop.*

Environmental Technologies and Resource Efficiency Support Service (ENTRESS) with the Institute of Demolition Engineers

Workshop of demolition engineers and contractors, project managers and sustainability professionals looking at the future for deconstructing buildings.

Working across a variety of sectors in the British Midlands EnTRESS seeks to improve resource efficiency within SMEs. Its aim is to increase business competitiveness, improve productivity and identify new market opportunities for SMEs through the adoption of environmental technologies and the reduction of waste.

The Institute of Demolition Engineers represents Demolition Professionals across the UK sharing best practice in technology and knowledge across the sector.

The first half of this event involved a series of presentations from different groups working on the recovery of materials from demolition projects and the reuse of materials either directly or in secondary products. GTS and British Glass presented the FISSAC project and the case studies created and also gave an overview of the model.

The second part of the meeting was a workshop split into 3 groups where the future reuse of materials from todays construction projects was discussed. Key points raised were the traceability of materials and the increased use of composites and glues in construction which will make separation of materials for recycling in the future more difficult.

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13.2.5 IDENTIFYING BARRIERS AND DRIVERS

At all the events there was a focus on documenting the issues that are currently preventing glass recycling from happening at a significant level. There were common themes across all the stakeholder groups spoken with, these have been grouped into six categories that are illustrated in the diagram below.

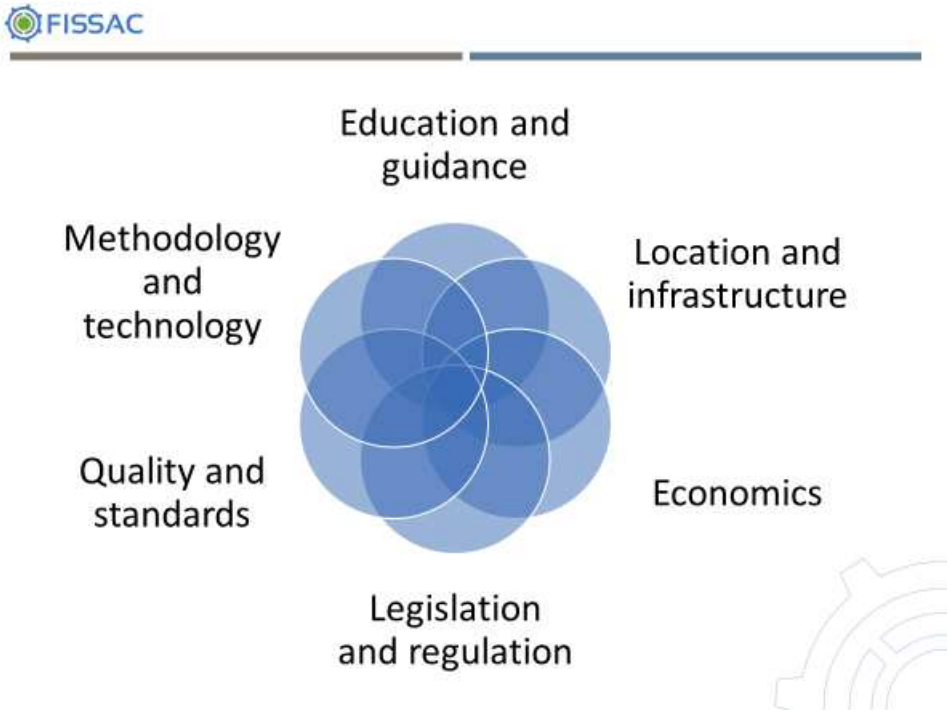

Figure 17 Pictorial representation of the main barriers identified to increased recovery of high-quality glass from construction and demolition projects.

Each of these areas has been summarised in the tables below based on the feedback from different areas of the stakeholder chain. In figure 3 we have mapped out the feedback from stakeholders to show the link between different areas of the supply chain. A larger version of this diagram can be found in the appendix

13.2.5.1 *Education and Guidance*

Supply Chain Area	Comments
Recyclers	• A "blueprint" for recycling is needed • Explaining the importance of closed loop recycling • Individual companies and managers have strong personal preferences. • If contractors are not engaged, it is difficult to recover good glass. • Site managers are important to influence • Increased education on the benefits of good recycling is important
Glass Manufacturers	• Many different people and contractors on a construction site; co-ordination and communication are challenging • Motivation i.e. persuading people to act on knowledge, is also a challenge
Construction and Demolition Sector	• Demolition contractors don't know where to recycle the glass. • General assumption is that it is not cost effective, and it is not normal practice. • 'If you ask a demolition contractor if they recycle glass, they will say they don't know where to do it or who will take it.'
Architects, Specifiers and Project Managers	• The client has a big influence in how things are done because they specify the results. • A client putting closed loop glass recycling as a condition in their contract would make things happen – especially in cases where it isn't commercially viable to recycle glass which is believed to be the majority of instances.

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Supply Chain Area	Comments
Other Interested Parties	• Lack of information is a big barrier to recycling more flat glass. • There is a perception that glass is 'difficult to recycle'. People are confused about contamination, and it is difficult to find places that accept glass. • More concrete information to help them with this. • We need to raise awareness. • Many people just do what they have always done; it is young people who change things.

13.2.5.2 *Technology and methodology*

Supply Chain Area	Comments
Recyclers	• Construction sites may not have the manpower to separate windows • At the end of the day, it is down to the people on site – if they are not engaged it is difficult to recover good glass. • Storage - Space on site is a big barrier. A project may only have space for 3 skips for all waste materials. • Some glaziers don't have any space at all for skips and have to store old windows in their vans. • H&S – Processing glass on their site may not make sense once you factor in H&S and cost of PPE. • Construction sites may not have the man power to separate windows • 1 person would have to break glass units all day to get a tonne of glass.
Glass Manufacturers	Operational obstacles and making it pay will be barriers. There are lots of different people and contractors on a construction site; co-ordination and communication
Construction and Demolition Sector	• In demolition projects, windows are removed manually with a crowbar. • If the project is on the ground floor, it may be possible to take it to a skip. • Even if it is 1 storey up, there will be a drop zone/shaft to drop heavy things, like windows, and this is where the glass gets smashed. • The process is rough but it doesn't matter because they are not reused and their value doesn't change. • Have to designate a dedicated area, separate the glass, transport the glass etc. It doesn't have enough value
Architects, Specifiers and Project Managers	• It is important to design recycling into projects early so a methodology can be included in the specification
Other Interested Parties	• Recommendations on material disposal are included in pre-demolition audits. • Glass is more difficult to deal with than other materials. • Time and space constraints often cited as reasons for not separating glass

13.2.5.3 *Quality Standards*

Supply Chain Area	Comments
Recyclers	• Glass must be treated like a high value product to maintain quality but it isn't worth that level of treatment' • Very high quality standards from flat glass manufacturers • Individual companies and managers have strong personal preferences on quality
Glass Manufacturers	• Quality is more important than volume
Construction and Demolition Sector	• Quality standards are difficult to achieve on most sites
Architects, Specifiers and Project Managers	• Quality standards relevant for different end uses are not always clear.
Other Interested Parties	-

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13.2.5.4 *Legislation and Regulation*

Supply Chain Area	Comments
Recyclers	• Need legislation banning from landfill • Regulations need to be enforced to work • Definitions: UK is the only country in EU which describes glass to aggregates as 'recycled'. • If there was an incentive to recycle • Landfill ban of glass • Putting clauses that glass must be recycled into the contract would be good
Glass Manufacturers	• Motivation i.e. persuading people to act on knowledge, is a challenge. Legislation would overcome this issue
Construction and Demolition Sector	• Legislation so that all contracts were obliged to recycle would level the playing field and prevent it becoming an easy to drop nice to have from contracts.
Architects, Specifiers and Project Managers	
Other Interested Parties	• Revising landfill tax to make landfilling of good glass less economically attractive would be helpfull

13.2.5.5 *Economics*

Supply Chain Area	Comments
Recyclers	• Got to treat it like gold, but it doesn't have the value of gold' • Putting clauses in contracts that glass must be recycled to level the playing field for companies doing the right thing • Transport cost is key • H&S – Processing glass on their site may not make sense for once you factor in H&S and cost of PPE. • Low value of glass compared to time required for processing – 1 person would have to break glass units all day to get a tonne of glass. • Space and time constraints impact costs of recycling
Glass Manufacturers	• Low price paid for recycled glass reduces motivation to collect it cleanly.
Construction and Demolition Sector	• It is not profitable to split panels on site but this is often a requirement from glass collectors • It all comes down to cost • We sell the metal. We want someone to take the glass off us for money.' • A client putting closed loop glass recycling as a condition in their contract would make things happen – especially in cases where it isn't commercially viable • Glass is a very small percentage of the crushed material and doesn't need to be there – there is just nothing better to do with it at the moment that is convenient and financially viable. • Demands for segregation to ensure free collection of glass are too onerous and costly. • Glass doesn't have enough value. • It is not economically viable to recycle glass unless there is a credit value for it or the client asks for it • Lack of value – If the demolition industry see a value for glass, they will take it out.
Architects, Specifiers and Project Managers	• Costs and values are not well understood • Costs assumptions greatly between projects depending on location
Other Interested Parties	• Solutions must be cost neutral, easy and quick. • Construction companies need to be efficient with costs and time. • Often hire one waste management contractor to do everything. • There needs to be a financial benefit, • Lack of market a barrier

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13.2.5.6 *Location and infrastructure*

Supply Chain Area	Comments
Recyclers	• Construction sites may not have the manpower to separate windows
Glass Manufacturers	• Glass manufacturers are located in areas away from large areas of waste glass generation
Construction and Demolition Sector	• If you ask a demolition contractor if they recycle glass, they will say they don't know where to do it or who will take it. • We don't recycle because we don't know where.
Architects, Specifiers and Project Managers	• Location is very influential on the feasibility of recycling projects
Other Interested Parties	• It is difficult to find recycling sites that accept waste glass

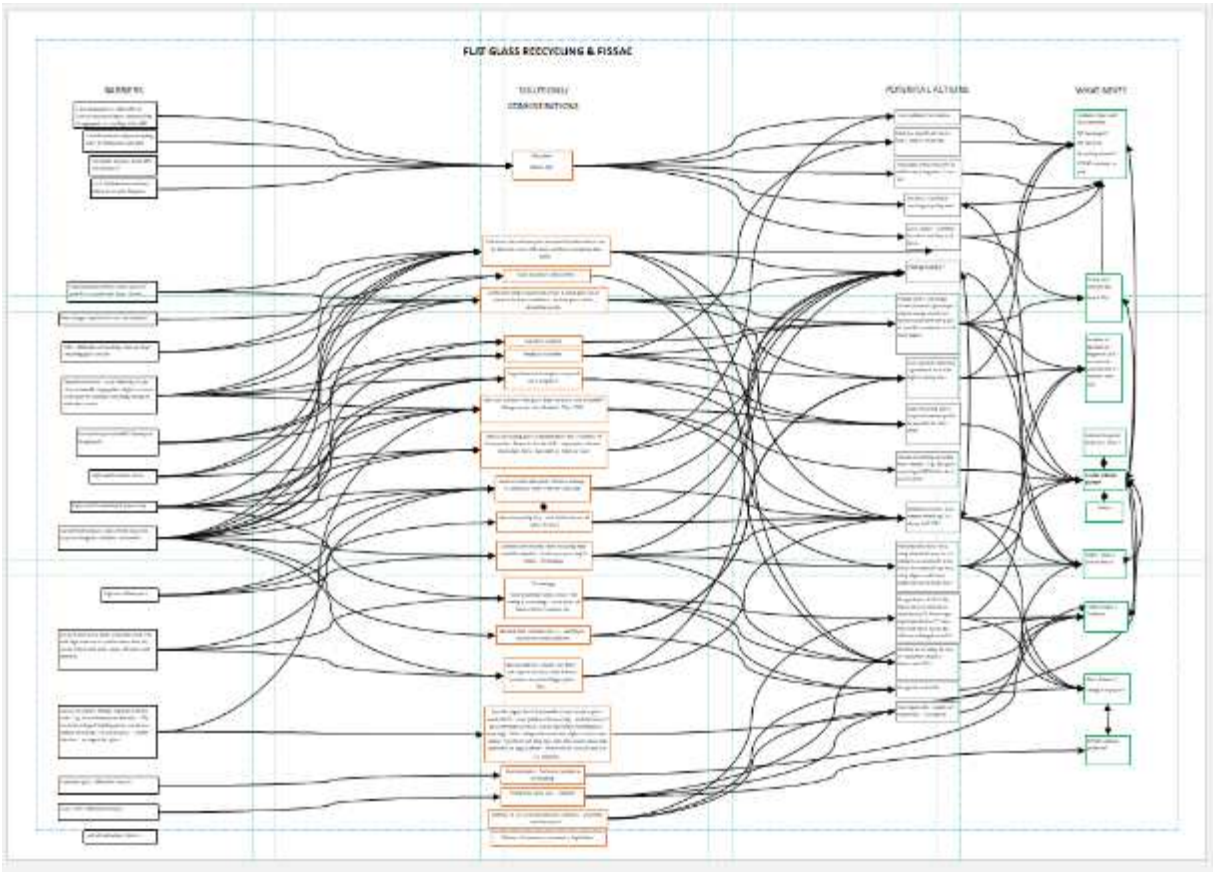

Figure 18 Map of considerations for increasing recycling of flat glass and potential solutions

13.3 OTHER RESULTS

Other key results from the interactions with stake holders included:

- Recovery and recycling of materials needs to be discussed at the specification stage of a project in order for recycling to be properly planned.
- Increased interaction between all members of the supply chain needs to increase in order to collaborate better.
- Most discussions and events on the circular economy in construction focus on steel, wood and cement products. There is a lack of awareness and research into options for other materials. This was specifically highlighted for glass and aluminium.
- Modern building techniques designed to improve the environmental credentials of building such as composite insulation and materials with high recycled content secondary materials built in will make recycling future

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buildings difficult. An example was provided of a 500 year old home where over 90% of materials could be reused compared to a 10 year old property where less than 50% was recyclable.
- Standardisation of fittings and sizes is key to being able to reuse materials in the future. For example the use of a standardised size of insulated glazing unit to allow it to be switch between building
- The ability to track construction products through their life cycle is increasingly important where secondary raw materials are used in new products.
- More real-world testing and pilots are needed to prove the benefits of high recycled content materials.

13.4 CONCLUSIONS

The main barriers to collecting glass from construction and demolition sites are economic. Recycled glass attracts a relatively low price compared to virgin glass and other construction materials but it is necessary to handle it carefully to ensure that the quality is sufficient for closed loop and high value secondary uses. However, schemes from other countries and case studies from the UK have proved that it is possible to economically recover high quality glass from buildings. Opportunities to increase flat glass recycling in the UK include increased education and information on the benefits and process of glass recycling, regulator or legislative incentives to recycle construction waste such as increased landfill tax for glass or change in definition of recycling targets. Collaboration between materials for example aluminium frame recycling and developing markets for glass fines that cannot be returned to a glass furnace are options to improve the economics of glass recycling. Centralised managed collection points for the collection of building glass could overcome storage and economic issues for smaller glass fitting companies.
Throughout the living lab process it has been reassuring to learn that there is a desire to increase the level of recycling of all construction materials and in particular glass. The networks and interactions created will hopefully continue in order to maintain the moment developed through the FISSAC living lab process.

13.5 THE LIVING LAB AFTER FISSAC

As mentioned in the conclusions, many useful contacts and networks have been created during the FISSAC project in particular between different areas of the supply chain and across materials. It is hoped that these can be continued in some form to maintain the momentum generated by the project and develop multi sector symbiosis and recycling projects.
Several initiatives have been begun during the five year project which have not reached completion. In particular the video case study of a glass recovery project in Glasgow. A large part of this work has been completed and it is planned to finalise the film in 2020 and hold a living lab type event to launch the final video. It is hoped that this might be timed to coincide with the COP50 meeting being held in the city.
Links with a number of leading architectural schools at British universities have been established as part of the project and materials were developed to deliver workshops on glass and the circular economy to civil engineers and architects. Unfortunately timetable issues and resource availability have delayed the delivery of these events but it is hoped that this will be possible after the project officially finishes.
The availability of guidance and information on glass recycling has been highlighted as a barrier to increased recycling rates. As part of the project materials have been developed in conjunction with stakeholders. A British Glass Flat Glass Website is being developed to contain this material and provide a resource for professionals working in the construction sector.

13.6 LIST OF APPENDICES

Appendix 21 LL UK. Scottish LL feed back summary
Appendix 22 LL UK. Wolverhampton Living Lab Feedback Summary
Appendix 23 LL UK. Barriers and Opportunities Map

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14 Living Labs analysis

The regional Living Labs can be discussed from three perspectives:

- The concept of Living Labs
- Living Labs for increased industrial symbiosis and circularity in the building sector
- Living Labs for replicability of the FISSAC model and the FISSAC platform

The concept of Living Labs

Early in the process it was stated that the various Living Labs must be developed based on unique opportunities and needs in the participating regions. The Living Lab is a user-centric platform which involves different stakeholders with the aim to facilitate user influence in an open and collaborative innovation process. The Living Labs must reflect the priorities of the stakeholders in the different countries. This means that different value chains are investigated, involving different stakeholders in the various countries. There are large regional differences when it comes to industry, stakeholders, policies etc influencing the drivers and barriers for developing industrial Symbiosis and Living Labs. In some regions there were already established Living Lab concepts at the start of project while other regions/sectors had no experience or even acceptance for this kind of acceptance

The development of the ten regional Living Labs must be analysed and understood with all this as a background. This complexity of course makes an analysis a very difficult task. So, an analysis must not be made with the perspective that the Labs all have the same goal or their progress relative to a common goal. They all have not only different backgrounds and starting point but also different goals. For some LLs the goal has been to establish a network. Others wanted to create a mature Living Lab aiming at working together in the spirit of "Co-creation" in an established consolidation phase. All the different phases have their own challenges and must be managed in line with this. A comparison must only be made in order to see what can be learnt from each other. It can help to reveal how the LLs can inspire each other to take one more step closer to increased industrial symbiosis.

This "educational" approach was elaborated in Spain where a second LL was started in Madrid. With inspiration from the Barcelona LL and with the aim of applying experiences from this Lab the aim was to test the concept in another context. Hopefully other countries will follow this example now that the FISSAC project ends.

Living Labs for increased industrial symbiosis and circularity in the building sector

Within the FISSAC Project the Living Labs should share and exploit knowledge about technological and non-technological factors that could impact Industrial Symbiosis. This is done by investigating different value chains, countries, stakeholders, etc.
In some of the regions there were already at the start of the project existing initiatives with the purpose of promoting industrial symbiosis and the development of a circular economy, at least within certain sectors.

Given the differences between the regions and between different sectors some features can be considered general as important barriers or drivers for increased industrial symbiosis. Even though based on the UK Living Lab and the glass sector the presentation of barriers in Figure 17 is in good agreement with discussions in other Living Labs, other sectors and other regions.

The barriers for industrial symbiosis can be sorted under some categories related to:

Legislation

The legislation framework is a barrier highlighted by most of the labs. The existing frame work is not adapted to Industrial symbiosis system and a circular economy. One major hurdle being the definition of waste. Differences in legislation between countries is also a hider hard to overcome. It is also emphasized that it takes a long time to change legislation. Not alone in every country but especially so if the whole of EU is to be considered to facilitate a market for recycled feed-stock.

Location, storage and transportation of the material Construction materials are often bulky hence driving costs for both storage and transportation. As the material to start with are of low value it might be hard to get out this higher cost from the customer. It is probably more do-able and realistic to have a more regional perspective.

Quality and standards

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With recycled materials it is difficult to guarantee quality levels of the recycled feed-stock. This might be a concern both when it comes to quality on final products but also from a legislation perspective on certain markets. However, with increased environmental concerns from the customers it might be possible to get a premium price for sustainable products on certain markets. But for this new standards are needed to facilitate eco-labelling.

Knowledge
Industrial symbiosis will require new knowledge in more or less all value chains that will handle the circular materials. This is not only knowledge regarding materials and production processes but also knowledge regarding recovery systems, environmental impact, customers need etc.

Economics
Going from linear to circular material systems there are many different parts driving costs. The economics of a circular system is a summary of all the barriers above. And, still there are few markets where it is possible to get a higher price to cover these increased costs.

The LL have discussed these barriers in their own context. The discussions on these topics are more elaborated under each LL section. Given the big differences between the LLs a general discussion and conclusion therefrom cannot be made.

Living Labs for replicability of the FISSAC model and the FISSAC platform
An important purpose of the LLs was to assist and co-develop the FISSAC Model and the FISSAC platform together with the other work packages. Discussions from the various Living Labs did contribute with valuable knowledge and were integrated in to the final version of the FISSAC models integrated Industrial Symbiosis Management Software tool.

The aim and the ambition of contributing to the FISSAC model has been included in different ways in the LLs. This is to a great extent due to the very different prerequisites for the various Labs. Most of them are still today not established enough to be able to really discuss concrete tools such as this, yet alone to use it, in the context of the Lab.

Having this is mind, some of the Labs have shown a clear interest in the FISSAC software platform whereas other Labs have concluded that this is not at all interesting for the time being. The interest might increase as the Living Labs get more established and as the content and business model related to the software platform is ready to be demonstrated.

A platform is a useful tool to connect supply and demand, but will this be sufficient to realise symbiosis? A model based on circular economy will need knowledge sharing and transparency between different stakeholders of the value chain. A Living Lab and its network could be a perfect arena for this and act as brokers for the process.

15 Discussion

As mentioned before an analysis and a discussion regarding the ability of the LL to address the three main purposes of the FISSAC LLs listed in the previous section is challenging due to the very large differences between Living labs and their conditions. There was not one common goal for all the Labs. Instead they are all on their unique journey to promote industrial symbiosis and increase the circularity in their respective region and business sector. A comparison between LLs should be made only to share experiences and knowledge on how to overcome barriers and to find inspiration through experiences made by the other Labs. All Labs must strive to find the best way to increase cooperation and industrial symbiosis. This will create long term competitiveness and profitability for their stake-holders and a more sustainable construction sector. The European industry is facing a huge challenge in becoming part of a circular economy. Cooperation in the format of Living Labs can be one important tool in this.

Even though general conclusions are hard to draw it can be stated that the networking and the new contacts built during the FISSAC project together with the increased knowledge on the Living Lab concept will be of great value also going forward for the participating project partners.

When it comes to the overarching goal of promoting industrial symbiosis. Some insights regarding barriers to overcome can be concluded from discussions in the various LLs.

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Legislation is a huge obstacle. There are big differences between regions and business sectors. To overcome this and reach a common legislation in all the EU countries can be assumed to take very long time. There are many, many different interests that must be aligned both between countries and between business sectors along value chains.

It can be assumed that a transition to a circular system initially will be costly. Storage and transportation of bulky materials will be costly. Given that much of the material used in the building sector is of low value these cost might be seen as unreasonably high.

Secondary raw materials traditionally have bad reputation as low quality. Here are several hurdles to overcome. There must be ways of giving guarantees on quality. New standards are needed to facilitate eco-labelling as a guarantee that the products meet quality demands. It is also necessary to increase knowledge on how to use these recycled feed-stocks for best performance. Value chains must be adjusted to use these new materials. Perceived "low quality" could instead be a competitive advantage. If the material is used in the right way good quality can be achieved in very resource efficient way. Altogether this will help drive market introduction and maybe also increase possibilities to get premium prices for "recycled" products as customers interest for more sustainable products increase

When it comes to the FISSAC model the Labs have worked with this topic in different ways. It can be concluded that it has been valuable for the FISSAC project to have the Living Labs as channels to reach out to the various stake holders in the different regions participating in the project. Knowledge transfer has been facilitated regardless if it is concrete discussions on software platform or maybe on more theoretical issues like Living Lab management or circular economy challenges. Knowledge transfer the opposite way has of course been equally important. It has been possible to share challenges and experiences from the stake holders with the FISSAC project.

16 Recommendations for Further Living Labs

What makes a Living Lab successful? In the long term an answer to that is: A Living Lab that help the participants to stay competitive will be successful. For industry stakeholders the Living Labs will be successful if it helps companies to improve their business. So, for the Living Labs the stake-holder analysis is very important. Not only do we need to know who the stakeholder is, we also need to understand their challenges and their business.

If industrial symbiosis in a value chain is to be developed it is of great importance that no "links" are missing. All relevant stake holders must be on board in the discussions. Sometimes the focus is on those already participating and the question on "who isn't here" is forgotten.

The stake-holder analysis must not only be made in the start-up phase, it must be updated as the Lab develops. The same is true when it comes to benchmarking with other initiatives, in the region or the sector. The concept of industrial symbiosis is developing fast as renewable feedstock is becoming more competitive. New possibilities might be just around the corner.

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17 Appendices

17.1 Living Labs -The FISSAC way

Appendix 1 Partner survey about methodology and process

Each regional living lab has a unique starting point. Important issues to consider include:

Existing IS initiatives in the construction sector
Are there existing collaborative initiatives/platforms for the IS in construction in your region? Do you participate/are you in contact with these?

Yes/No/Don't know (Choose one, delete others)

Comments:

Existing IS innovation agenda in sector
Is there an existing innovation agenda, in terms of prioritized materials, technologies, or markets, for IS in construction in your region?

Yes/No/Don't know (Choose one, delete others)

Comments:

Issue 2: Stakeholder involvement

Some of the most important choices in designing the Living Lab relate to stakeholder involvement. Important issues to consider include:

Value chain coverage
How broad will participation in your lab be, in terms of value chain/circle coverage? In terms of different materials and functions?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Role of non-business actors
Will you involve non-business actors (research, government, civil society) in the Lab?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Stable vs. Evolving Group
Do you expect to maintain the same group of stakeholders over the life of the lab, or to evolve (for example from strategy-level to operational-level representatives)

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Issue 3: Lab structure

Both the overall lab process and the individual meetings can be structured in a variety of ways. Important issues to consider include:

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Role of open discussion
Do you expect that the Lab meetings will have an element of open discussion, to explore issues with stakeholders and identify the specific tasks to be worked on?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Role of practice-oriented activities
Do you expect that the Lab meetings will involve other activities such as problem-solving, site visits, data gathering/capture, task-oriented discussions?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Plenary vs task forces/committees?
Do you expect the lab to maintain a format that involves all participants in the same discussions and tasks? Or do you expect to create smaller groups to deal with specific issues?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

FISSAC vs. Post-FISSAC work
Will the Lab seek to generate its results within the FISSAC project, or to create the conditions for stakeholders to manage their own labs outside of the project?

Have already discussed/Important, will consider/Don't know (Choose one, delete others)
Comments:

Issue 4: Subject focus

The subject matter or focus of the Lab will need to be determined, either in advance or as a part of the Lab process.

Which of the following do you expect to be a part of the Lab's focus? (Delete those that are not relevant)

- Material-specific analysis
- Material-neutral analysis
- Technical challenges
- Commercial challenges
- Intra- and inter-organizational issues
- Social/landscape issues
- Don't know/To be determined

Comments:

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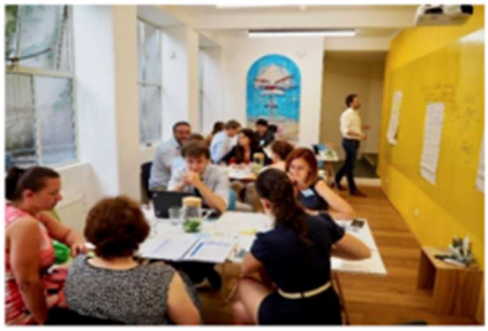
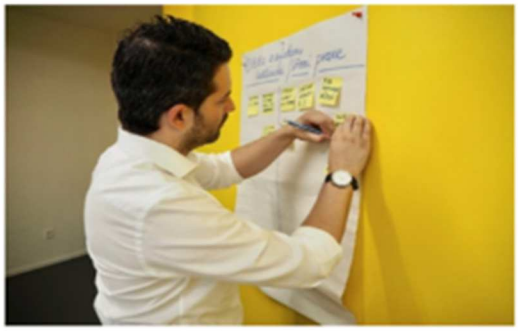
17.2 Czech Republic

Appendix 2 LL Czech Republic. Photos from Living Labs workshops

First LL workshop





Second LL work shop

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17.3 Italy

Appendix 3 LL Italy. Brochure of the First FISSAC Italian Living Lab

Appendix 4 LL Italy. Brochure of the Second FISSAC Italian Living Lab

PROGRAMMA

9.30 | **REGISTRAZIONE PARTECIPANTI**

10.00 | **APERTURA LAVORI**
Giovanni Battista De Franchi | RINA

10.15 | **RECUPERO DI MATERIA PER LA PRODUZIONE DI CEMENTO E CLINKER**
Antonio Buzzi | Federbeton
Pierandrea Fiorentini | Aitec

10.45 | **PRODUZIONE DI CALCESTRUZZO STRUTTURALE E NON STRUTTURALE CON AGGREGATI RICICLATI**
Margherita Galli | Atecap
Giovanni Plizzi | Atecap

11.15 | **TAVOLA ROTONDA** (Modera: Carlo Strazza RINA)
Pier Federico Baldinucci | Aitec
Bruno Cruciti | Atecap
Alessandra Ronchetti | Assobeton
Nicola Mondini e Pasquale Zanbito | Arpar
Gianluca Gamba | RINA - Gruppo Rendpi
Silvio Bosatti | Fondazione Ordine Ingegneri Milano
Marco Martini | Assimpredil Ance
Roberto Colzel | Centro Materia Rinnovabile (in attesa di conferma)

12.45 | **DIBATTITO**

13.15 | **CONCLUSIONI**
Giovanni Battista De Franchi | RINA

13.30 | **LIGHT LUNCH**

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Appendix 5 LL Italy. Brochure of the Third FISSAC Italian Living Lab

FISSAC

FOSTERING INDUSTRIAL SYMBIOSIS FOR A SUSTAINABLE RESOURCE INTENSIVE INDUSTRY ACROSS THE EXTENDED CONSTRUCTION VALUE CHAIN

3° LIVING LAB ITALIANO

Simbiosi industriale ed economia circolare: quale potenziale per lo scenario italiano?

4 ottobre 2019 ore 9.30

Presso RINA - Rozzano (MI), Via Gran S. Bernardo, strada 7, palazzo R1

Il living lab sarà un momento di confronto fra diversi attori con vision e investimenti sull'economia circolare e simbiosi industriale.
Scopo dell'incontro sarà quello di valutare il livello di potenziale replicabilità di modelli di economia circolare e piattaforme nello scenario italiano, al fine anche di operare un confronto con le diverse situazioni dei contesti europei parallelamente investigati a livello nazionale nel progetto FISSAC dagli altri partner.

09.30 *Caffè di benvenuto*
10.00 *Apertura lavori*
10.20 *Presentazione esempi virtuosi*
11.20 *Tavola rotonda*
13.00 *Conclusioni*
13.15 *Pranzo*

http://fissacproject.eu/it

RINA

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Appendix 6 LL Italy. Some images from Italian Living Lab

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Appendix 7 LL Italy. Tweet from second Living Lab

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Appendix 8 LL Italy. Summary of the First Italian Living Labs

The First Italian Living Lab was held in Brescia at the AIB headquarter on 10 November 2017, with the aim of presenting the project and addressing issues related to the industrial symbiosis, with focus on the steel, construction aggregates, and concrete sectors. In particular, the First Living Lab aimed to gather feedback from different exponents of Brescia Industrial reality, mainly related to the steel, cement, and concrete sectors, together with builders, university representatives and other professionals linked to these realities, to investigate opportunities for industrial symbiosis, with particular reference to the reuse of steel slag from EAF.

To start the debate, the results of the research on non-technological barriers, carried out by the project partners, were illustrated. The barriers were presented divided into four categories (economic, legislative, social and structural), and together with them some possible solutions were proposed to overcome them. The stakeholders were asked, starting from this preliminary list used as a starting point for the discussion, to provide feedback, based on their daily experience, in order to identify the main obstacles encountered in the Italian situation, and to identify together potentials mitigation actions.

What has emerged is that the participants of the event have long looked with interest to the theme of the circular economy, and study how to establish processes of industrial symbiosis in their realities. This need arises not only from the desire to make their processes more sustainable, but also from the awareness that the gravel of a quarry is a natural resource, which is expected for the future an increasingly limited availability of excavation due to environmental and protection aspects of land, and that the reception capacity of landfill sites will always be smaller. This leads companies to look for alternative solutions: steel mills are trying to reduce the amount of waste to be disposed of, and quarry workers and manufacturers of construction materials are looking for new alternatives to gravel, especially for less noble applications such as road foundations.

From this first comparison, however, it immediately became clear that, despite the desire to move to a circular economy, the industries of Brescia are often faced with bureaucratic-legislative difficulties, which make the re-use of steel slag a complex and not feasible option. This, according to the participants, is the main reason why a large part of the produced slag ends up in landfills.

In conclusion, the main barrier identified by the participants in the Living Lab is the unclear regulatory framework, subject to different interpretations, so that the process of industrial symbiosis is inhibited, due to bureaucratic-legislative difficulties. At the same time, the stakeholders also described other problems encountered rather frequently in this context: the distrust of public opinion and customers, the criticality of the economic aspect and the lack of a recognized market space. The technological aspect, although presenting some difficulties, is considered less critical by the participants in reference to the reuse of the EAF slag, since there is now a good number of practices tested for the industrial symbiosis with the production of concrete, mixed cement and asphalt.

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Appendix 9 LL Italy - Third Living Lab. Evaluation of the replicability potential

During the third Italian Living Lab, the replicability potential of circular economy and industrial symbiosis model in Italy has been investigated. The criteria ***Qualitative criteria for assessing replicability potential in different EU countries*** defined within the D7.2, "Report on Industrial Segmentation, criteria and correlation to the FISSAC first application" Nine different participants took part in the round table, expressing their own ideas about the different aspects introduced by the criteria. The feedback collected are representative of their point of views and are not unanimous since each participant is influenced by its own context and experiences; in any case these outcomes of the discussion are considered a good starting point to evaluate the replicability potential for circular economy and industrial symbiosis models in Italy, providing a first overview of the Italian context.
To allow each participant to freely express its own judgement, the tool Mentimeter has been used. Mentimeter (https://www.mentimeter.com/) is a tool aimed at creating interactive presentations: through this tool indeed it is possible to present polls, allowing the audience to response and give feedback through their smartphones or pc.
Each slide, containing a question or a criterion, is characterised by a code. The participants can enter that code in their smartphone or pc to visualize the question on their own devices, together with the possible alternatives; then they can express and submit a vote, that will be shown on the main screen and shared with the other participants.
In the figure below¡Error! No se encuentra el origen de la referencia.¡Error! No se encuentra el origen de la referencia.**,** an example of use of the Mentimeter tool is reported.

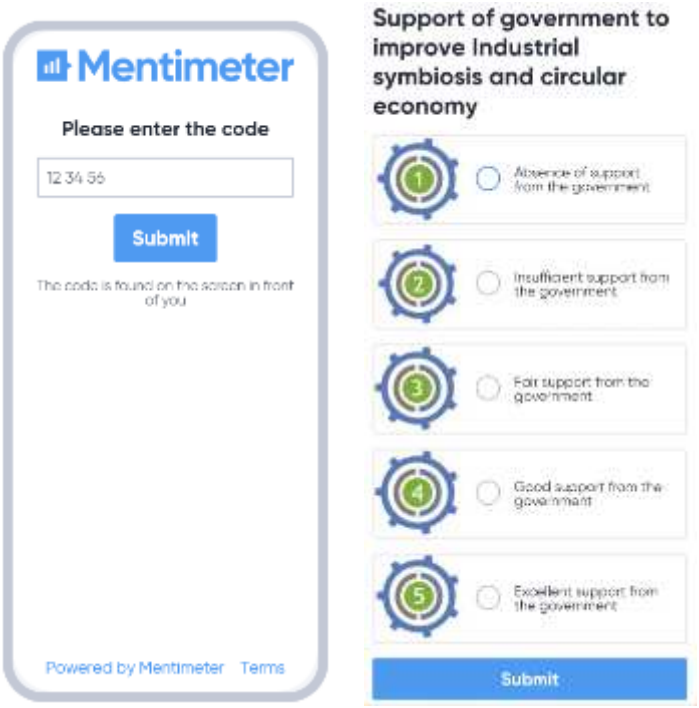

Figure 1. An example of use of the Mentimeter tool

The first criteria, ***Support of government to improve industrial symbiosis and circular economy***, is aimed at evaluating how much the opportunities and drivers promoted by governments may act as determinant facilitators for the implementation of industrial symbiosis strategies. Main instruments through which governments can support industrial symbiosis include, among others, legislative framework i.e. laws, rules, decrees, etc., fiscal incentives, reduction of paperwork burden.
The participants have expressed a negative judgment about the support from the government, mainly because of the difficulties related to the development of new end of waste criteria. End-of-waste criteria specify when certain waste ceases to be waste and obtains a status of a product (or a secondary raw material) and should be set for specific materials. These instruments should facilitate industries in the management of waste and secondary raw material, but the end of waste criteria already existing are very few and the development of new end of waste criteria is very slow (almost two year to finalize a single document). This issue raised also during the previous Italian Living Lab, during which the participants have complained about the long procedure necessary to finalize the end of waste criteria related to the recycled aggregate.

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According to the participants, in most cases the technical feasibility of waste utilization is assured, but the absence of end of waste criteria strongly limits the possibility to establish industrial symbiosis opportunities, since also the normal industrial practice is questioned. However, according to the latest news, the situation should change[9,10] and regions should soon receive more autonomy in issuing or approving authorizations for end of waste, reducing time and facilitating the authorization process.
Another issues that came out during the discussion is that industries are often scared by previous experiences regarding misunderstandings in the definition of waste and secondary raw materials, which led also to legal disputes, in which the industries feel they have few guarantees.
According to the participants, a better digitalization of the waste traceability could facilitate industries: up to now, the SISTRI (*Sistema di controllo della tracciabilità dei rifiuti*) system was not successfully implemented and it is not currently in operation, and the only instrument is the MUD (*Modello Unico di dichiarazione ambientale*).

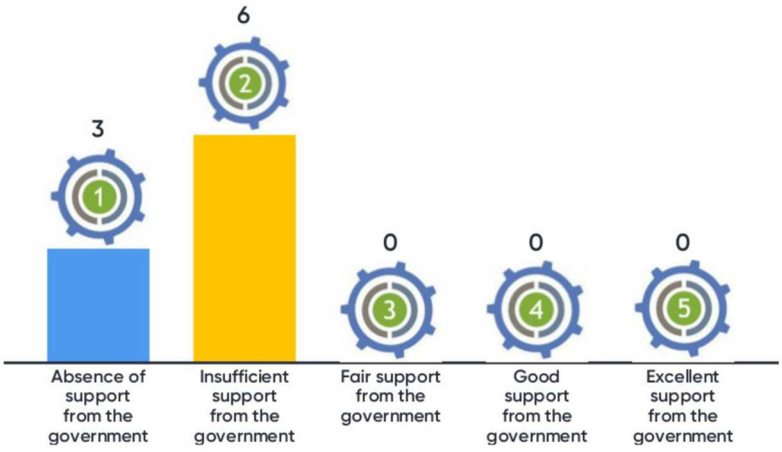

Figure 1. Support from the government to improve industrial symbiosis and circular economy

The second criterion regards the ***Role of enterprises in promoting industrial symbiosis and circular economy***; in countries where enterprises and industries are traditionally engaged and interested in the creation of synergies and linkages, the replicability potential for circular economy and industrial symbiosis models can be higher and more fruitful than under circumstances in which there is no interest for industrial symbiosis strategies. Furthermore, stakeholders can play a significant role in encouraging the development and implementation of actions of governments in the perspective of symbiosis and circular economy. During the discussion we found out that there are several industries which are involved in the development of solutions aimed at improving their circularity, however the main driver is the economic one: the industries start to look for alternative solutions when they face high costs, for example related to the landfill fees (e.g. higher than 150€/t), otherwise they are not incentivized to invest time and money in changing their usual process and procedures, specially if the dimension of the enterprise is small. In this sense, synergies among different entities should really make the difference, distributing among them efforts in research and development related to circular economy and industrial symbiosis models. The limit to this kind of synergies is that every situation needs to be evaluated case by case, considering the peculiarity of that industry and evaluating the most adequate solutions. Another limit to the formation of a virtuous network is the difficulty is the exchange of confidential information, that industries are not willing to share: an example is the list of sub-products launched by the Chamber of Commerce, which failed for this reason.
All the participants agreed on the necessity to increase education and training on these topics for industries, to facilitate their role in promoting these models.

[9] https://www.repubblica.it/ambiente/2019/10/03/news/uso_dei_rifiuti_c_e_l_accordo_per_dare_il_via_all_economia_circolare-237607845/

[10] https://www.ilfattoquotidiano.it/2019/10/04/end-of-waste-approvato-emendamento-che-sblocca-il-riciclo-dei-rifiuti-il-ministro-costa-dara-impulso-alleconomia-circolare/5495717/

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Figure 2. Role of enterprises in promoting industrial symbiosis and circular economy

With the third criteria, ***Clusterization of industries on territory***, the aim is to investigate how the location and level of aggregation of industrial areas on the territory can influence the way and the possibility of implementing industrial synergies. For example, if industries are highly clusterized within a country i.e. they are concentrated in industrial areas, easily accessible, exchanges between them can be implemented with limited effort. On the other hand, if industries are typically spread in different locations, which can also be isolated, interconnections may turn complex from a logistic and technical point of view.

The participants pointed out that the answer to this question depends also on the type of industries considered: in Italy there are several industrial areas where relevant clusters can be found, but considering the geography of the country, distances could also be quite long. Therefore it is not easy to assign a single score for this criterion.

In general, it was agreed that the proximity of similar industries can facilitate the adoption of circular economy and industrial symbiosis models, for example thanks to the possibility to share services and equipment which can be used in common. It was a shared opinion that synergies should be searched in a local context and not on large scale: the communication and the exchange of experience is fundamental in this sense, facilitating the possibility of identification of opportunities and their concretization. Industrial association can play a relevant role in creating networks and clusters of enterprises.

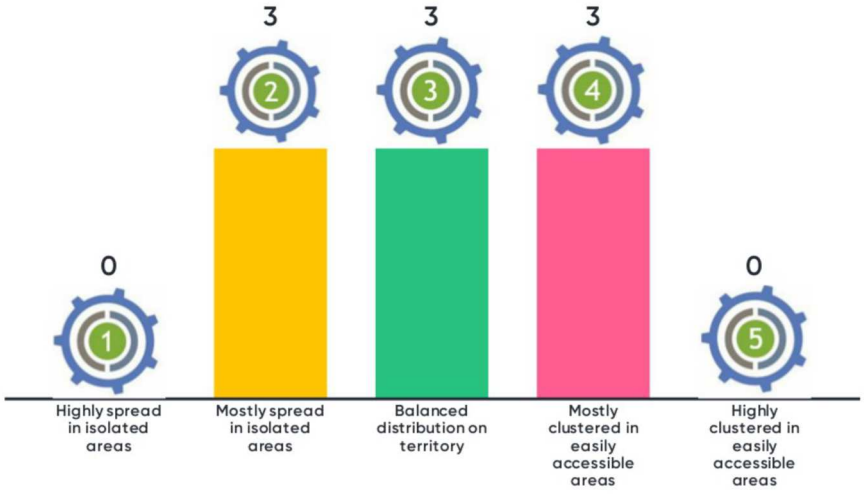

Figure 3. Clustering of industries on territory

The values of recovery and recycling rates for material commonly monitored within the European Union, for those waste flows for which recovery targets are in force, may work as a powerful indicator of the possibility of implementing circular economy and industrial symbiosis model. Indeed, to this rate aspects such as the availability of technological options for reprocessing waste and materials and economic feasibility are connected; the fourth criteria, ***Recovery and recycling rates***, can give an indication in this sense.

The answers to this criterion are as varied as the different waste considered by the participants: on one side, the main revealed problem of the electronic waste is their traceability (one proposed solution was to install GPS on the fridges, for example); on the other side, a key problem for textile waste is that they are difficult to separate in their components.

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In general, the main problem detected for all kind of waste is not their collection, recovery or recycling rate, rather than the grade of subsequent application: few are the waste used for high grade applications, even if the indicator aggregates all kind of applications, without distinguishing their grade. C&DW, for example, are often used for low grade application. Summarizing, although in general the rate of recovery and recycling rates for the different type of waste are quite high for Italy, and often over the EU target, the participants expressed their doubts about the level of application (high or low), which should be better monitored.

Figure 4. Recovery and recycling rates

With the fifth criteria, ***Awareness of industrial symbiosis and circular economy principles among citizens***, it is possible to measure the level of awareness about industrial symbiosis and circular economy principles among citizens. These aspects are considered influential because they can support the spreading of these practices also at very small scales (e.g. SMEs). Furthermore, high awareness may lead to a more conscious selection of environmentally friendly products by the consumers.

The answers to this question are very various since the participants focused on different aspects: not only on how much the citizens know about industrial symbiosis and circular economy, but also how much they are willing to change their habits to embrace more circular products or services. FISSAC project for example is aimed at developing new construction products incorporating recycled materials, but the willing of customers to acquire this kind of products is under question. It happens that customers refuse a certain product only because it includes recycled materials. To deal with this issue, information is considered even more important, because the mistrust related to the recycled materials is often linked to unjustified prejudices, which could be eradicated thanks initiatives aimed at showing the differences among virgin and secondary raw materials and increasing public awareness.

In general, it seems that recently trends are changing, and different brands are ever more proposing sustainable solutions, in respect of which the social acceptance is gradually increasing. An example is represented by the textile luxury sector, which is considering proposing new business models related to its products, e.g. the possibility to rent them, rather than only to buy. Changes are expected in the near future.

Figure 5. Awareness of industrial symbiosis and circular economy among citizens

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The sixth criterion is focused on the ***Skills on information technology*** of potential end-users: there are different web-based platforms aimed at facilitating at various levels circular economy and industrial symbiosis models, and the capabilities of interacting with technological equipment as well as high levels of confidence with ICT tools are considered as important enabling competences.
No major barriers have been identified by the participants, with reference to the ICT skills. However, it has been underlined the importance of digitalization of industries (industry 4.0), since it could really facilitate the use of platform or similar instruments. A problem identified, indeed, is that industries has low awareness of the amount and type of waste and by-products they produce and consequently the related data collection process is difficult. Sensors or digital twin concept could really fasten these operations, creating a direct link between the industry materials availabilities and the potential marketplace.

Figure 6. Skills on information technology

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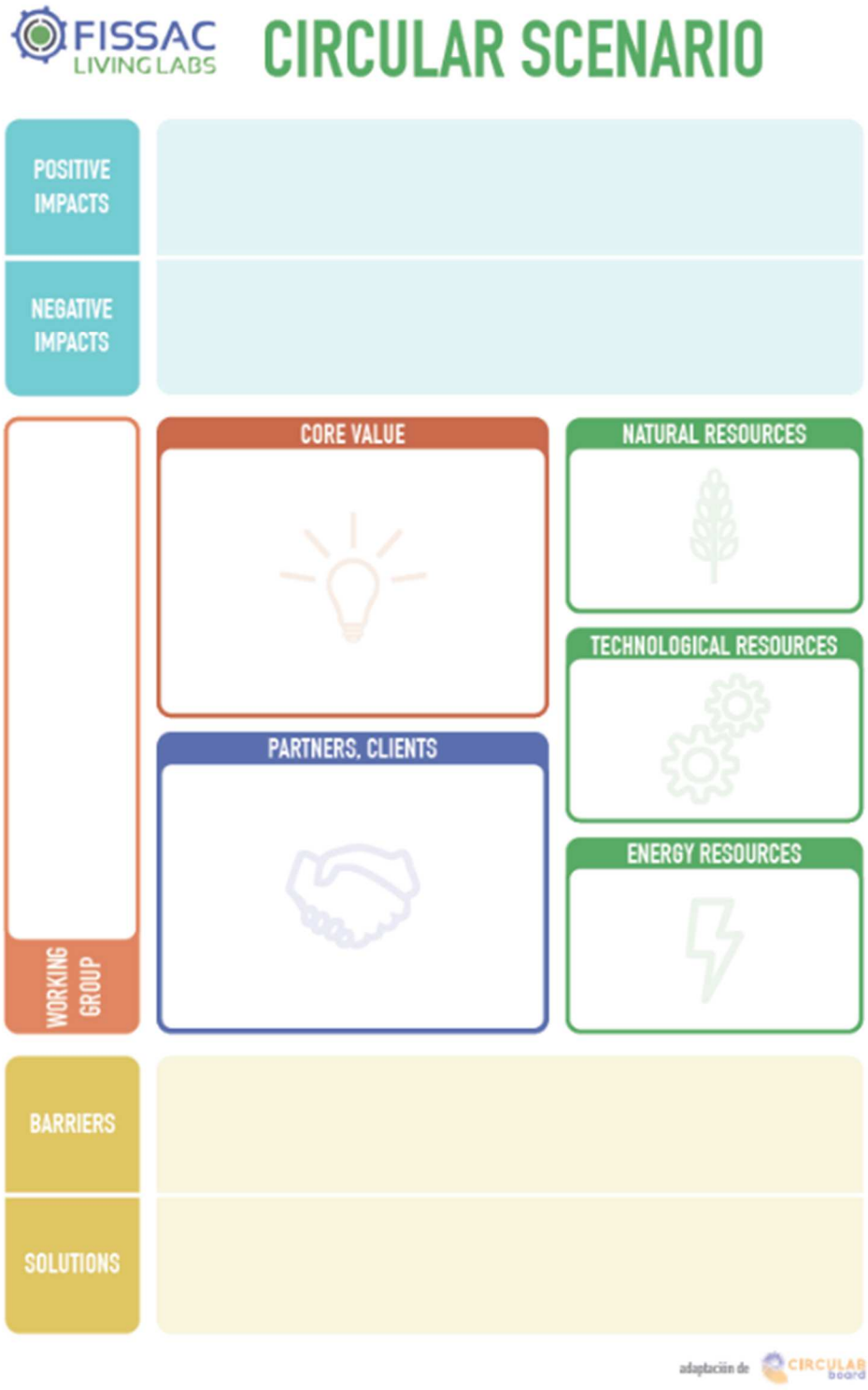
17.4 Spain Barcelona

Appendix 10 LL Spain Barcelona | First Living Lab Barcelona Templates for the workshopping ac



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Appendix 11 LL Spain Barcelona. Pictures from the first Living Lab Barcelona

Appendix 12 Second LL Spain Barcelona | Pictures from the second Living Lab Barcelona

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 64215

Appendix 13 Third Living Lab Barcelona, Pictures from the third Living Lab Barcelona

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 64215

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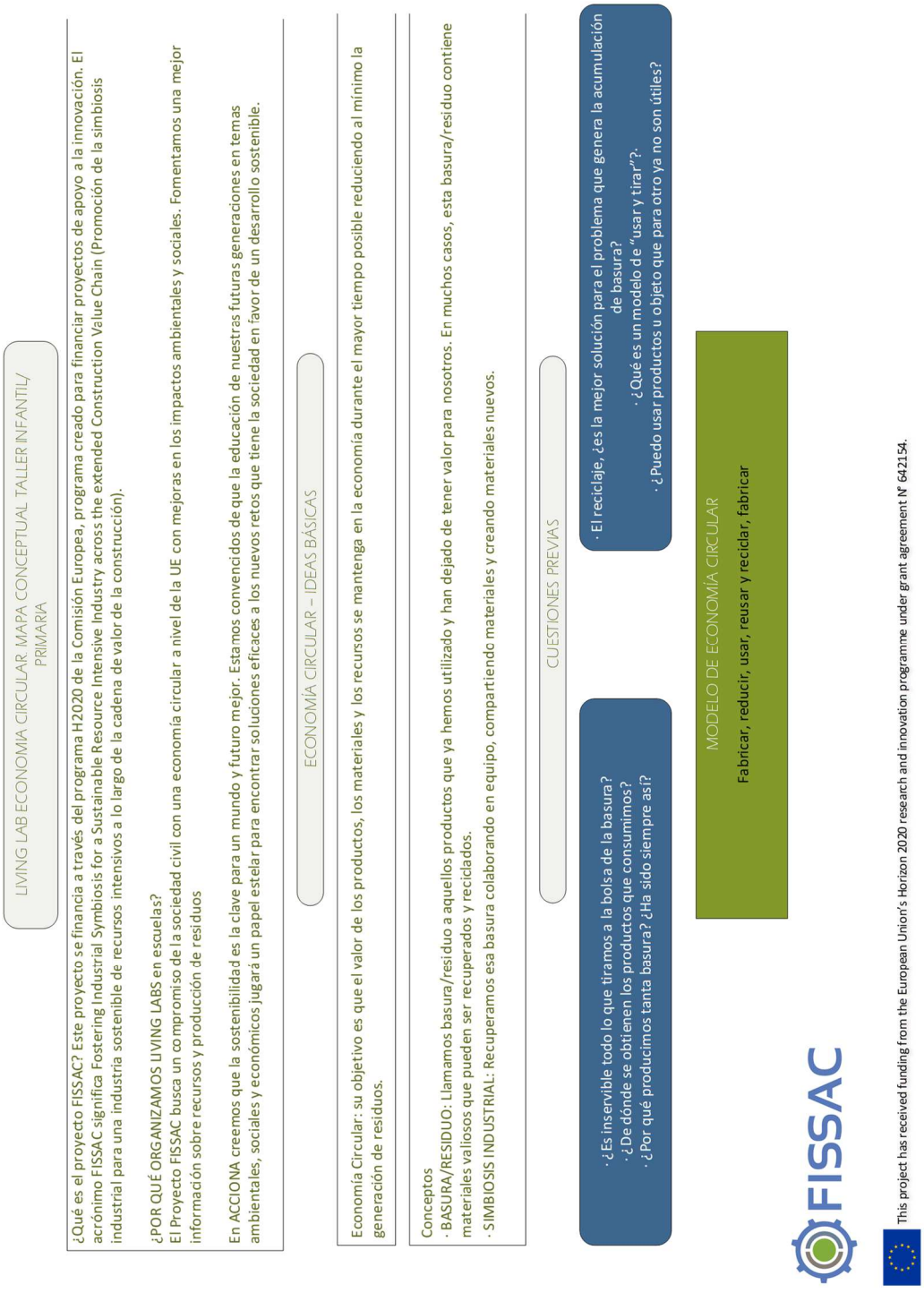
17.5 Spain Madrid

Appendix 14 First Living Lab Madrid, Conceptual map (Spanish version)



Appendix 15 First Living Lab Madrid, Pictures from the first Living Lab Madrid

Appendix 16 Second Living Lab Madrid, General Information - second Living Lab Madrid

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FISSAC

23 DE MAYO DE 2019

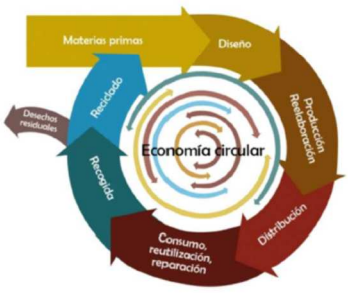
CAMPUS LIVING LAB - MADRID

HACIA LA ECONOMÍA CIRCULAR A TRAVÉS DE LA SIMBIOSIS INDUSTRIAL EN EL SECTOR DE LA CONSTRUCCIÓN

Organizan: Fundación Agustín de Betancourt · acciona Construcción

La economía circular

consiste en alcanzar un modelo económico y productivo en el que "el valor de los productos, los materiales y los recursos se mantenga en la economía durante el mayor tiempo posible, y en la que se reduzca al mínimo la generación de residuos".



La simbiosis industrial es una forma de intermediación para reunir a las empresas en colaboraciones innovadoras, encontrando maneras de usar los residuos de uno como materia prima para otro. Una cooperación local o más amplia en simbiosis industrial puede reducir la necesidad de materias primas vírgenes y el depósito de residuos, cerrando así el circuito del material, una característica fundamental de la economía circular y un motor para el crecimiento verde y soluciones eco-innovadoras. También puede reducir las emisiones y el uso de energía y crear nuevos flujos de ingresos. Para hacer que la simbiosis industrial sea una realidad comercial extendida, es necesario hacer más para gestionar el flujo de materiales de desecho de diferentes sectores e industrias, y aún queda mucho por entender sobre: Impactos ambientales y sociales, Compromiso de la sociedad civil con una economía circular, Información sobre recursos de residuos, Tecnologías de tratamiento de residuos y modelos de negocio, coordinación entre actores de la cadena de valor, ...

Como un **Living Lab**, la Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos de Madrid, a través de la Fundación Agustín de Betancourt y ACCIONA Construcción, será sede de una jornada de aprendizaje pionera en apoyo a la educación e intercambio de ideas basada en el marco de la economía circular. Los objetivos son:

Implicar a la comunidad educativa e investigadora y a otras partes interesadas, para que actúen como facilitadores, líderes y multiplicadores del cambio hacia una economía circular.

Explorar oportunidades de aprendizaje en la vida real para estudiantes y oportunidades para el impacto de la investigación para académicos y empresas.

Fomentar el compromiso de la sociedad civil con la economía circular a través de la educación y la coordinación de los distintos actores de la cadena de valor.

De un modelo lineal

Para garantizar un crecimiento sostenible en la UE tenemos que utilizar nuestros recursos de una manera más inteligente y sostenible. Es evidente que el modelo lineal de crecimiento económico en el que confiábamos en el pasado no se ajusta ya a las necesidades de las modernas sociedades actuales en un mundo globalizado. No podemos construir nuestro futuro sobre el modelo del «coge, fabrica y tira».

Hacia un modelo circular

En una economía circular, el valor de los productos y materiales se mantiene durante el mayor tiempo posible; los residuos y el uso de recursos se reducen al mínimo, y los recursos se conservan dentro de la economía cuando un producto ha llegado al final de su vida útil, con el fin de volverlos a utilizar repetidamente y seguir creando valor.

Living Lab

Opera en un contexto actual centrado en las necesidades reales de sus participantes. Es un ecosistema de innovación abierta y colaborativa orientada a los usuarios, en un entorno de vida real, donde los usuarios co-crean, experimentan y prueban nuevas ideas, a través de soluciones centradas en ellos, generando procesos continuos de innovación conduciendo a nuevas formas de productividad y competitividad.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 642154.

El **proyecto FISSAC** se financia a través del programa H2020 de la Comisión Europea, programa creado para financiar proyectos de apoyo a la innovación.

El acrónimo **FISSAC** significa *Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain* (Promoción de la simbiosis industrial para una industria sostenible de recursos intensivos a lo largo de la cadena de valor de la construcción). El proyecto se extiende desde septiembre de 2015 hasta febrero de 2020.

El proyecto FISSAC está coordinado por **Acciona Construcción**. El consorcio está compuesto por 27 socios de 9 países (8 Estados miembros de la UE y Turquía). La **Fundación Agustín de Betancourt** participa en el proyecto en la validación de nuevos materiales de construcción a través de los casos de estudio a escala real.

Involucra a agentes interesados en todos los niveles de la cadena de valor de la construcción y demolición para desarrollar una metodología y una plataforma software que facilite el intercambio de información, que fomente la creación de redes de simbiosis industrial y que replique esquemas piloto a nivel local y regional.

El modelo se basará en los tres pilares de la sostenibilidad: Medio ambiental (con un enfoque de ciclo de vida); Económico y Social (teniendo en cuenta a los interesados y el impacto en la sociedad).

El objetivo de la jornada es fomentar el intercambio de experiencias y conocimiento entre los asistentes para identificar oportunidades y necesidades, buscando soluciones conjuntas a retos relacionados con la implantación de proyectos de simbiosis industrial en su área de conocimiento.

FISSAC pretende demostrar la eficacia de los procesos, servicios y productos a diferentes niveles:

Procesos de fabricación

- **Demostración de procesos de reciclaje en circuito cerrado para transformar los residuos en materias primas secundarias** valiosas y aceptables.
- Demostración de los procesos de fabricación de los nuevos productos a escala industrial.

Validación de producto

- Demostración del eco-diseño de productos de construcción eco-innovadores (nuevos eco-cemento y hormigón verde, azulejos cerámicos innovadores y materiales compuestos de plástico, madera y caucho) en procesos preindustriales, bajo un enfoque de ciclo de vida.
- Demostración a escala real de la aplicación y del rendimiento técnico de los productos de construcción eco-innovadores en diferentes casos de estudio.

Modelo de simbiosis industrial

- Demostración de la plataforma software.
- Evaluación de la replicabilidad del modelo a través del concepto de Living-Lab.

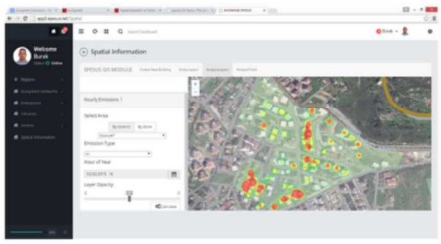
https://fissacproject.eu/es/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 642154.

FISSAC objetivos

Plataforma FISSAC

- Simulación, demostración y verificación de los casos de estudio con una perspectiva espacial.



Plataforma **georeferenciada** incluyendo:

- Datos sobre disponibilidad de residuos
- Características físicas y químicas
- Otros datos relevantes para ser compartidos

Facilitará el intercambio de recursos, los contactos entre los agentes de la industria de la cadena de valor de la construcción y fomentar la investigación y el desarrollo de flujos de residuos subdesarrollados.

- Mediante **Análisis de Ciclo de Vida** (ACV), permitirá el cálculo y la evaluación del impacto del ciclo de vida de las soluciones propuestas, así como el seguimiento y la verificación de los estudios piloto.

- **Cuantificación del beneficio económico** del flujo de materiales y de las soluciones propuestas de Simbiosis Industrial

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 642154.

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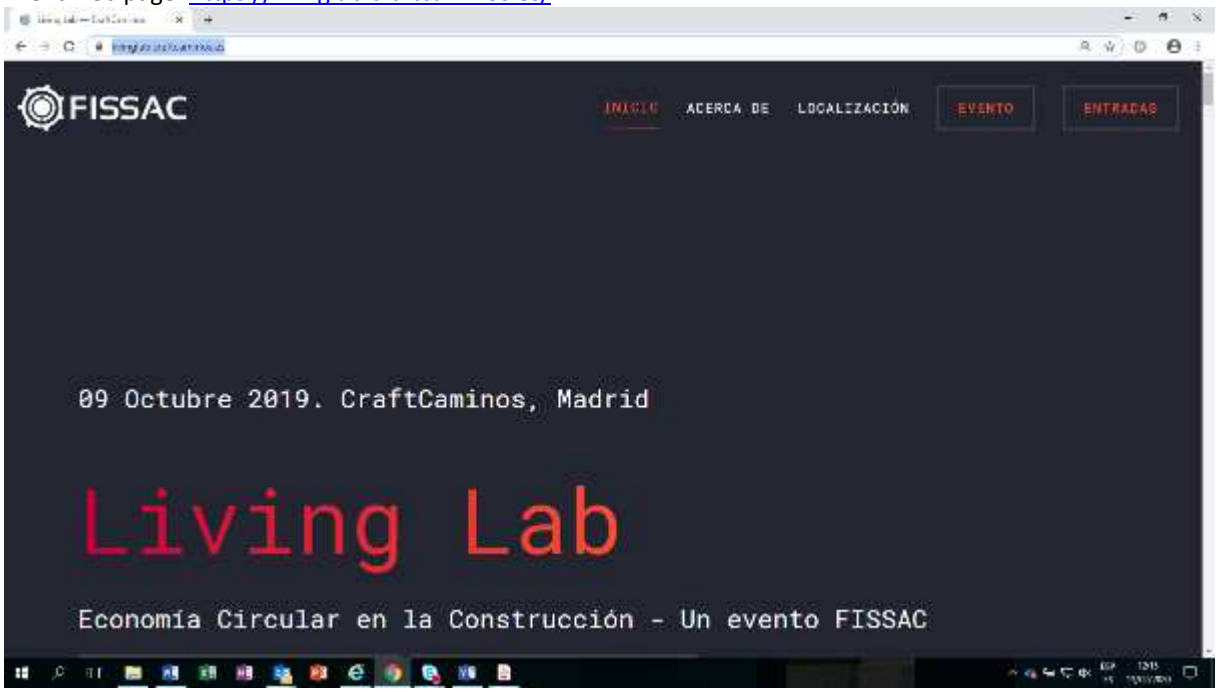
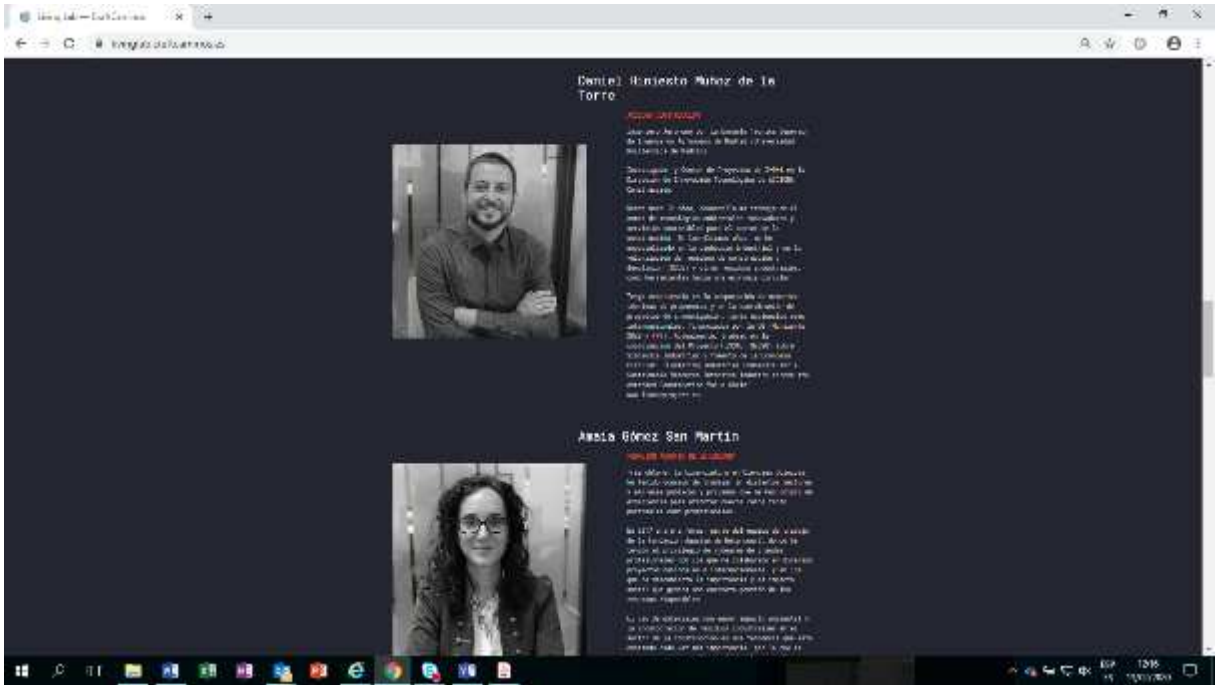
Event web page: https://livinglab.craftcaminos.es/





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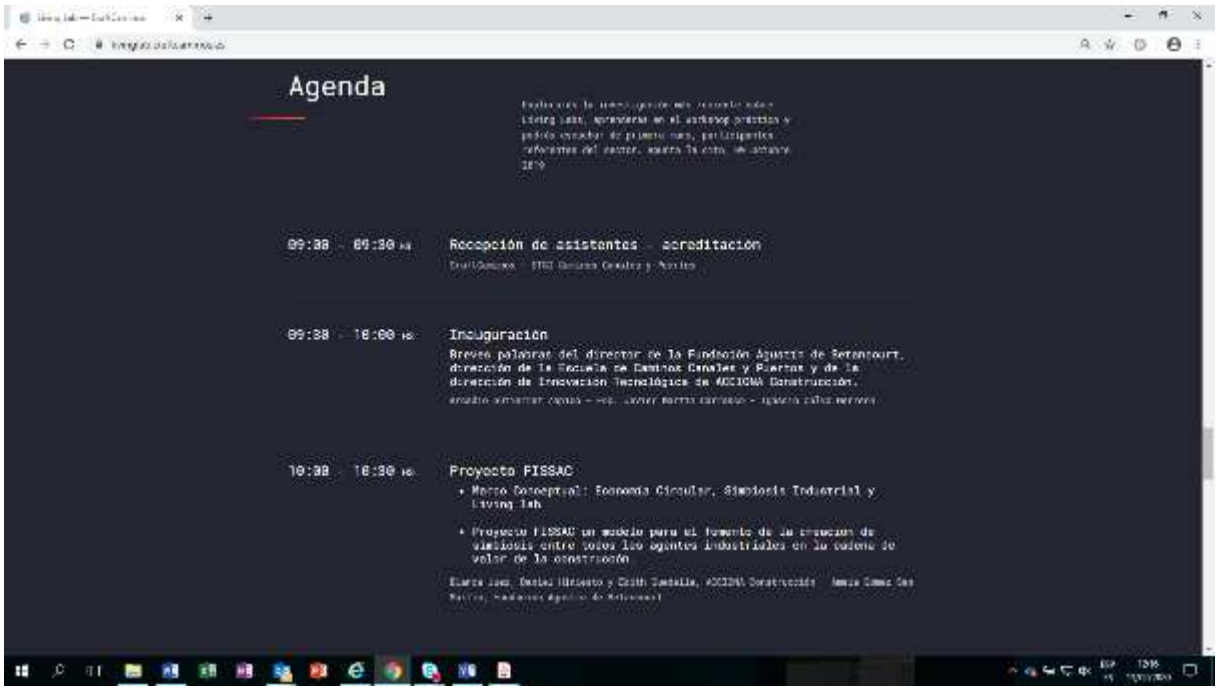

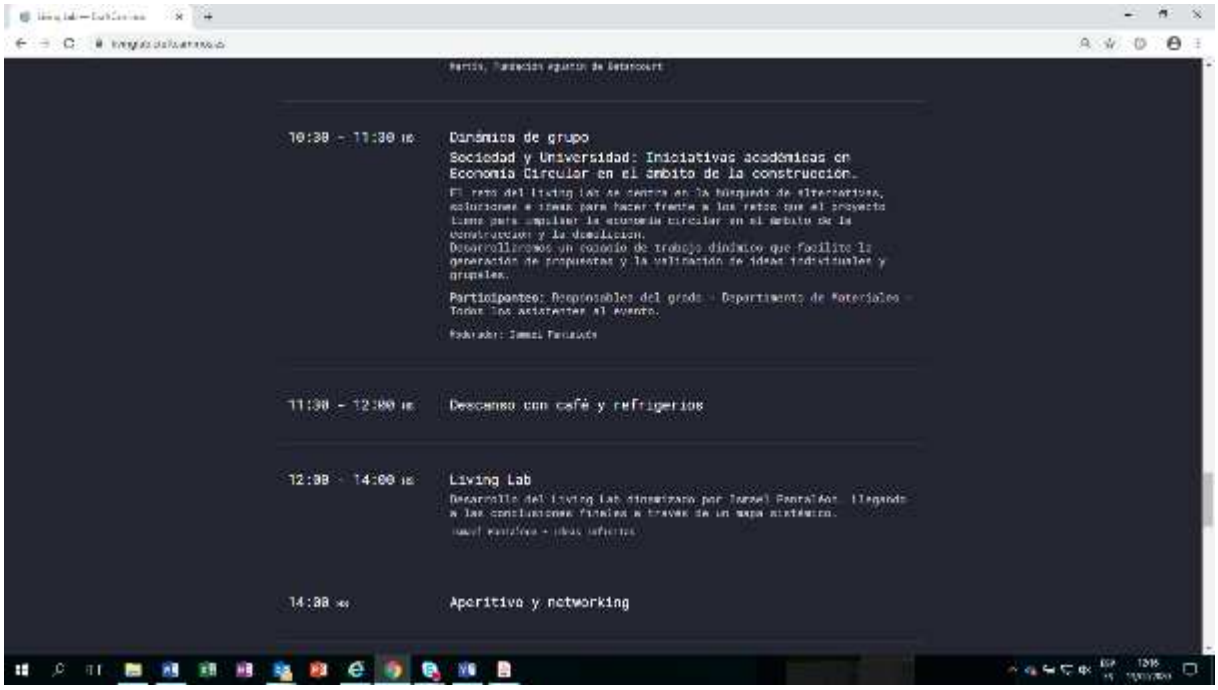

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https://www.eventbrite.com/e/entradas-living-lab-etsi-caminos-canales-y-puertos-66483912171#

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Appendix 17 Second Living Lab Madrid, Pictures from the second Living Lab Madrid

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17.6 Sweden

Appendix 18 LL Sweden. List of reports to download

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List of reports:	
To be downloaded from: http://fissacproject.eu/en/category/ll-sweden-en/	
Summary of Living Lab 1	
Summary of Living Lab 2	
Summary of Living Lab 3	
Summary of Living Lab 4	

Appendix 19 LL Sweden. List of stake holders of the Swedish LL

Company/organisation	**Role constuction in the value chain**
Akademiska Hus	Realestate developer, owner - sustainablity
Basta-online / IVL	Research
Bostadsbolaget	Real estate owner
Borås Energi och Miljö	energy, recycling
Brattöns Återbruk/CS Riv och håltagning	Recycling
BRG, Gothenburg Climate Partnership	business development, climate
BRG, Gothenburg Climate Partnership	business development, climate
Byggvarubedömningen	Material
Catena	Logistics, real estate owner
CBI/RISE	Research
Chalmersfastigheter	real estate owner, business development, sustainability
CIT / Constructivate	Consultancy, circular economy
Ekoarkitekt	Arcitecture
Fabege	Real estate developer
Finja	Business developer
Framtiden Byggutveckling	Real-estate development
Gyproc	Material producer, plasterboards
Göteborgs Stad, Konsument och Medborgarservice	public agency - circular economy
Higab	real-estate owner, sustainability
Garveriet, Floda	Real estate owner, cluster
Ikano Bostad	Real estate developer, owner - business development
Johanneberg Science Park / HSB Living Lab	Research, circular economy
Johanneberg Science Park / Riksbyggen	Research - architecture
Kubal	Material, aluminium
Kynningsrud	Material producer, concrete
LiU	Research - circular economy
Locum	realestate developer, owner
Lotus AB	Demolition contractor
Material Economics	Material, consultancy
Naturvårdsverket	Environment, sustainability
NCC	Construction company, circular economy
Passivhuscentrum	Architecture

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Ragnsells/KAM Segment Bygg	Recycling
Rekomo	Furniture, recycling
Renova	Recycling
RivAB	Demolition contractor
Saint-Gobain	Material producer - sustainability
RISE	Research
Stena Fastigheter	Real estate developer, owner - social sustainability
Stena Metall	recycling, material - business developer
Stena Recycling	recycling, material
Strängbetong	Material, concrete
SUEZ	Recycling
Sundahus	Material, certification
Svea	Real estate owner
Sveriges byggindustrier	trade association, construction
Thomas Betong	Material, concrete
Vasakronan	Real estate owner
Västfastigheter	Real estate owner
WIN WIN Gothenburg Sustainability Award	circular economy, sustainability
Älvstranden Utveckling	Real estate developer

Appendix 20 LL Sweden. Photos from LL

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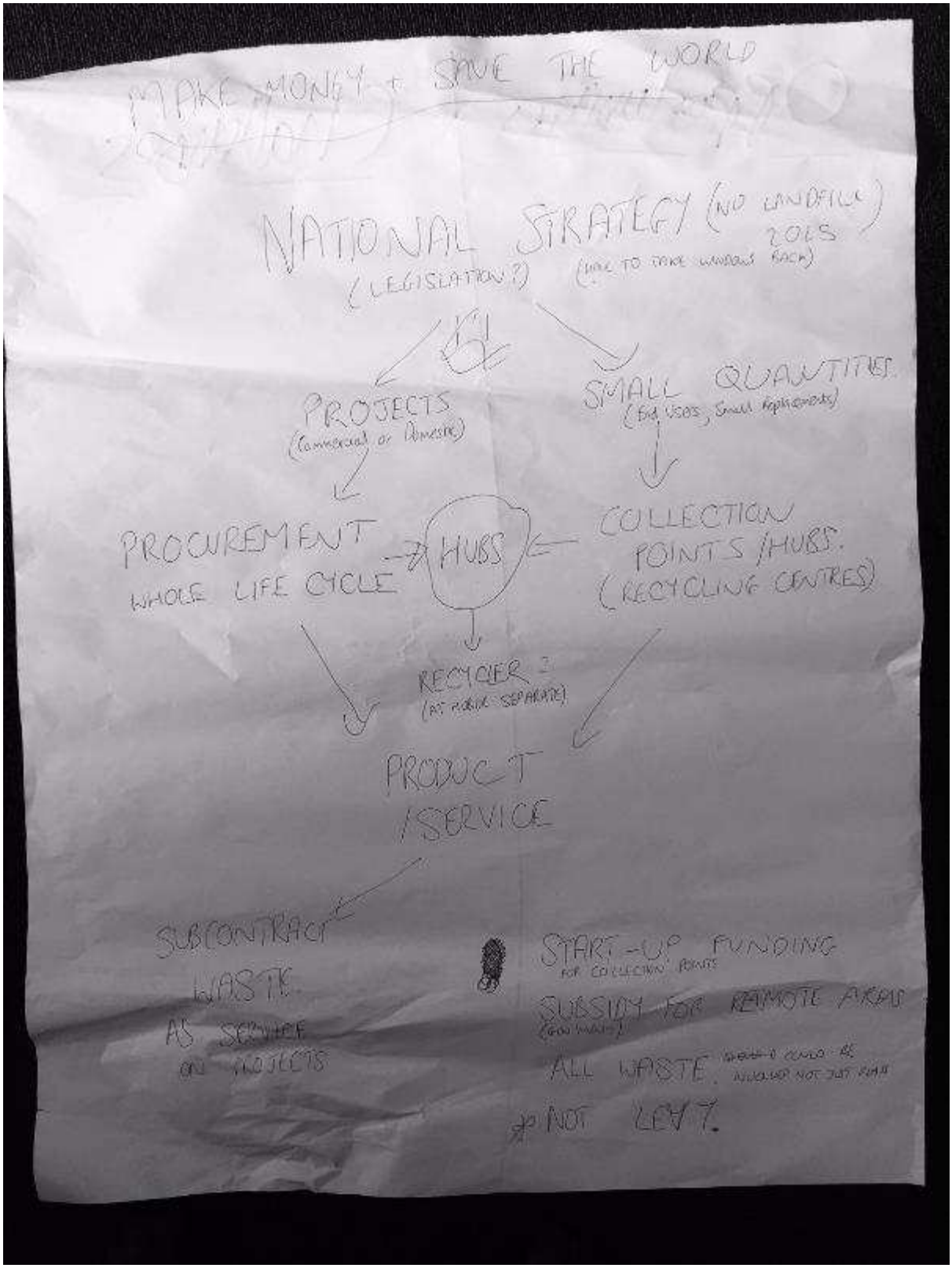
17.7 UK

Appendix 21 LL UK. Scottish LL feed back summary



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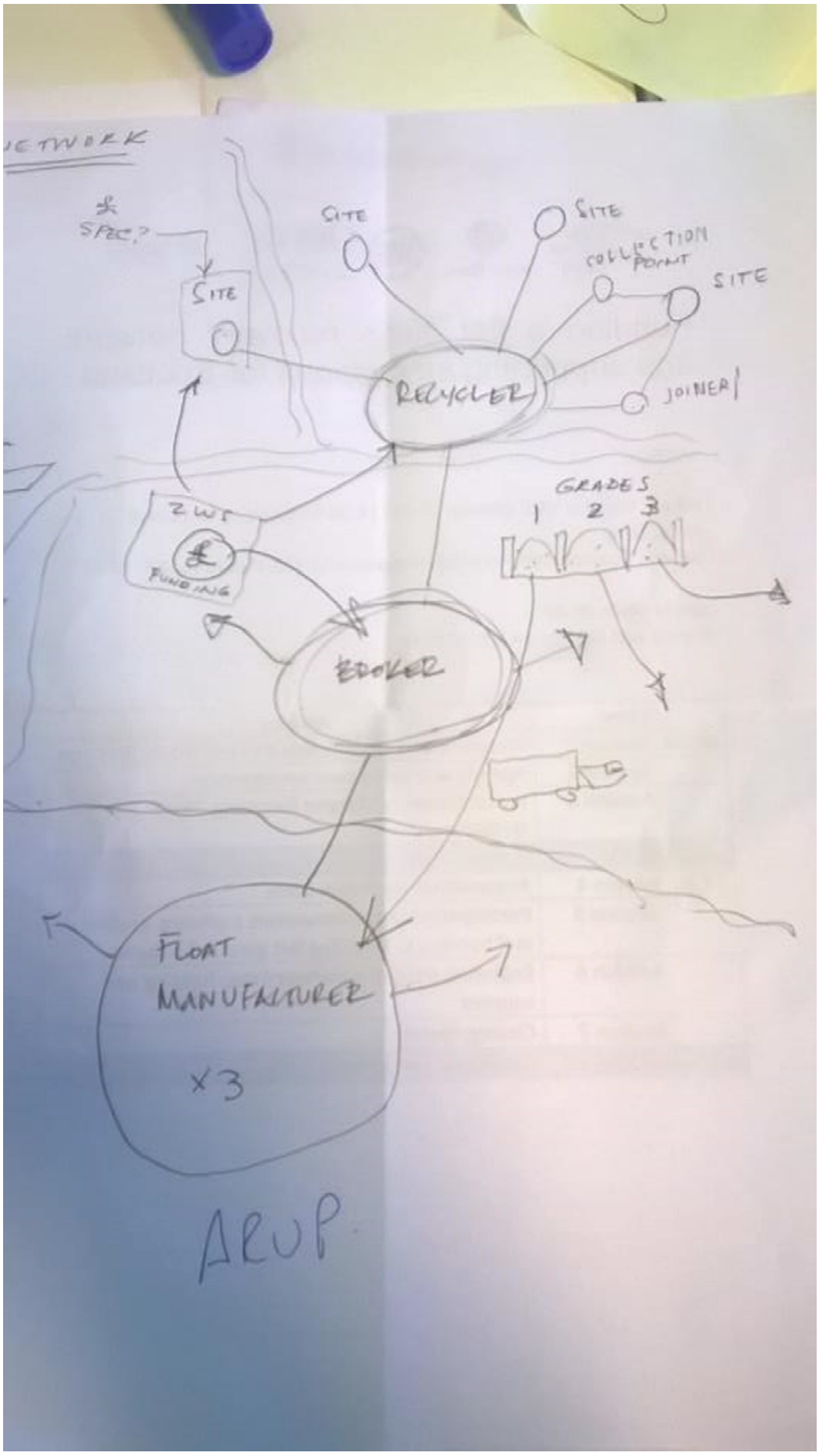

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Appendix 22 LL UK. Wolverhampton Living Lab Feedback Summary

Entress Demolition event Living Lab Wolverhampton November 13th 2019

Round Table discussion feedback

- End of life not considered during construction planning
- Specifications driven by cost not lifecycle
- Composites are a problem as difficult to recycle
- Insulation is difficult to recycle
- Landfill tax is structured wrong should be higher for recyclable materials
- There is a lack of early engagement in specifications with demolition engineers
- Products are being built that can't be recycled
- Crushing is considered recycling by the demolition for concrete and glass and brick.
- If there is value, then in would be separated.
- End of life is often not considered by specifier as it is not likely to be their problem. Building will be sold on to another party.
- Lobbying needed for higher landfill tax on recyclable materials
- Demolition industry is reactive not proactive
- Nuclear demolition model is interesting costs there ate 6-7 times standard demolitions
- Less glass needed and thicker walls to make environmental buildings
- Often easiest to send mixed skips to an MRF who separate as best they can and provide a report to tick the appropriate boxes and everyone is happy
- Manufacturers don't talk to demolition contractors
- New builds today being demolished after 20-30 years
- Standardization and a kit of parts would be better for new builds for future demolition or deconstruction and reuse.
- Only 30-40% of modern domestic houses are worth/ possible to recycle
- Off site prefabricated houses are likely to be a big problem to recycle/ deconstruct in the future.
- Steel work regulations have changed so reclaimed steelwork often can't be reused.
- Bespoke and fancy "grand designs" are often a big problem for deconstruction and recycling/reuse. Need to think more about the endo of life rather than headline eco-innovation at the build stage.
- Statements of residual risk at sign off often don't include recycling problems.
- OMM manuals generally not available by the time buildings are deconstructed
- Holland and Germany have standardized sizing that makes reuse easier.
- Less glue and more standardized mechanical fixings would make deconstruction better.
- Less composites
- Design for easy deconstruction and recycling
- More information and education for operators
- Easier identification of materials
- Technology for building and recycling changes overtime making planning difficult
- Lack of technology available to aid deconstruction
- Skills and knowledge shortage
- Demolition industry not involved at the design stage
- Time is generally a big constraint
- Lack of cradle to cradle legislation
- Fixed briefs give little opportunity for comments and changes by contractors
- Cynical waste is a problem i.e. Unused good building products skipped to make the site look tidy
- Mortar reclamation might be more important than brick in the future if sand becomes scarce
- Demolitions sector need involving in product design
- Bim, Bam and passports only apply to big projects
- Deconstruction will only happen if more economically viable than just tearing down.

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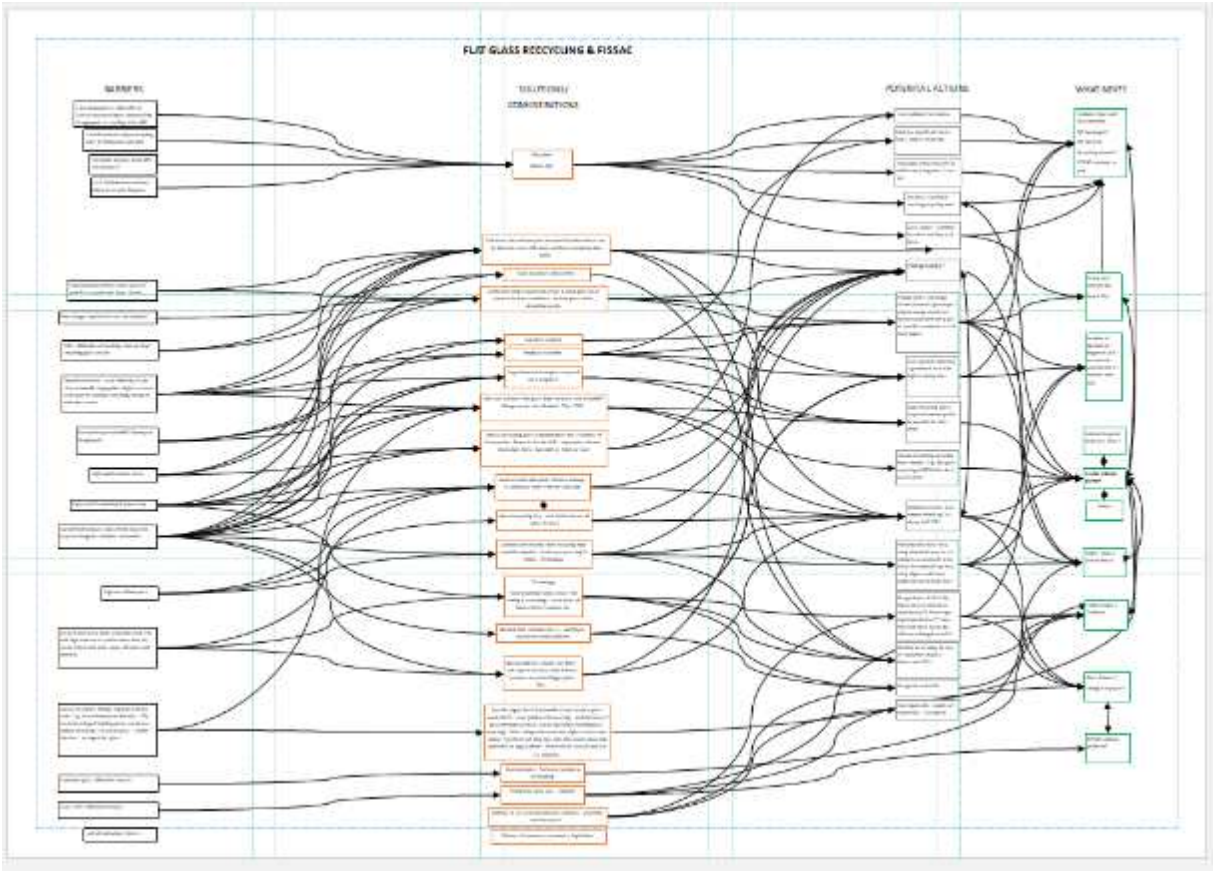
- Time is money
- Legislation is needed
- Demolition engineers need more of a voice
- New prefabs are not recyclable
- Materials can last forever it is construction methods that are the problem.
- Reusable modules that can be “zipped” up and down might be the answer.
- The current situation is not sustainable, 1 planet living/landfilling
- Government message about the wonders of prefab housing is all that is heard no articles on the problems this is creating for the future.
- Need an Attenborough effect for building techniques
- EPR, end of life construction directive etc. needed.
- Shared responsibility.

Appendix 23 LL UK. Barriers and Opportunities Map



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