FISSAC

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

Identification of best practices and lessons learnt in Industrial Symbiosis

Executive summary

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D1.2 Identification of best practices and lessons learnt in Industrial Symbiosis
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This report summarises the key findings from overall sixty best practices of industrial symbiosis (IS) collected from FISSAC project partners. It reviews the state of the art of ongoing industrial symbiosis projects (public and/or private partnerships) and government initiatives in Europe and abroad, as well as the regulatory framework on waste management including technical specifications on the use of recycled materials as raw material for construction applications. Technical and non-technical barriers, risks and uncertainties which might hinder these developments but also drivers of new industrial symbiosis projects have been identified and analysed.

Finally, a review and analysis of various existing ICT tools and methodologies for industrial symbiosis are presented.

1. Analysis of 60 Industrial symbiosis practices

Industrial symbiosis is currently being implemented in many countries around the world, driven by public or private players. Europe has some EU support networks for industrial symbiosis and European Innovation Partnerships such as National Programmes (e.g. NISP (UK), Finnish Industrial SymbioSis System- FISS), regional initiatives (e.g. Sotenäs municipality (Sweden)) and local initiatives (e.g. Kalundborg (DK)).

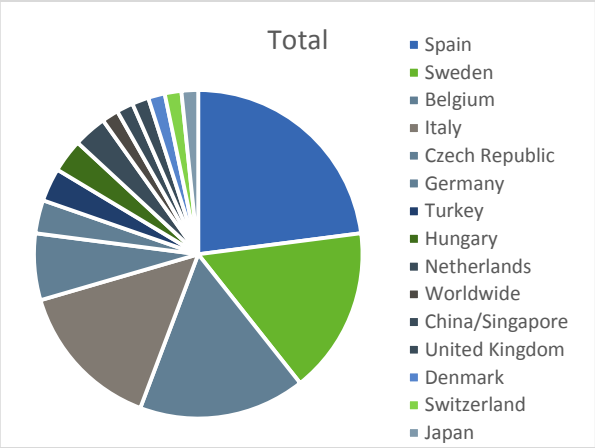
Industrial symbiosis in the context of circular economy

The European Union has recognized that IS has direct relevance not only to resource efficiency, but also to a broader policy agenda covering innovation, green growth and economic development. The European Circular Economy package (2015) contains measures to address the whole materials cycle from production to consumption through to waste management and the use of secondary raw materials, with the aim of contributing to closing the loop of product lifecycles through greater recycling and re-use.

Characteristics of the collected cases

The cases were sorted according to their function, the location, their types, the project initiators, their types of implementation.

The majority were identified in Spain (14 cases), followed by Sweden (10), Belgium (10) and Italy (9).



Split by country

Four different types of projects have been identified:

- 21 cases of industrial symbiosis (IS) based on (De)construction materials where the majority of materials exchange is of construction sectors. As we have found few examples of industrial symbiosis focus on the construction sector, we have also collected a sub-category of cases that are technology of reutilisation developed by one company.
- 14 cases of IS based on heat and power where the basis of the symbiosis is the energy even if, afterwards, others materials can also be exchanged.
- 13 cases of IS where two or more industrial facilities or companies in which the wastes or by-products of one become the raw materials for another. These cases are not especially based on (de)construction materials but can be source of inspiration for FISSAC project.
- 13 cases of regulations, plans, Research & Development programmes that are not exactly IS cases but that are interesting experiences of regulations, plans or R&D programs related to the sustainability of the construction sector.

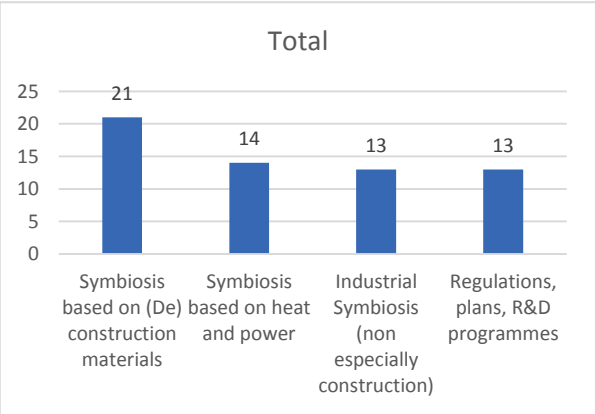


Figure 1 – Type of project

From the total cases,

- 29 cases are related to regulations, plans, R&D programs (13 cases) and technology developed by one **individual** company (16 cases)
- 32 cases are industrial symbiosis cases in which:
  - 23 cases are initiated by a **public authority** (72% of the 32 cases)
  - 9 cases are initiated by **private companies** (28% of the 32 cases)

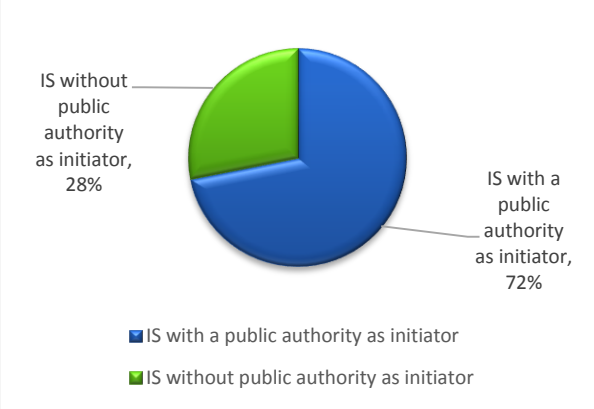


Figure 2 – IS with and without public authority as initiator

Multiple stakeholders benefit from the network in different ways: for businesses, it directly improves profitability environmental performance, and at an economy wide level, economic prosperity, reduced consumption of resources and carbon intensity, less material lost to landfills. The local and regional authorities benefit from an improved industrial waste management system, local job creation and local economic opportunities. The success of a IS programme is primarily due to the large and diverse network of participating companies as well as high-level stakeholder buy-in which provide public support and assistance recruiting new members and implementing useful common infrastructure if needed.

2. Barriers

The transformation of an industrial estate from a purely waste management facility to an IS focus requires close collaboration between industries in the area and the variety of synergy projects of different types (Golev and Corder 2012). The IS maturity grid has to reflect the barriers and drivers for synergy projects to mature and thrive, as well as stress the importance of evolutionary changes in eco-industrial development of a region.[1]

Seven types of barriers have been identified overall and could be classified as follows: three barriers related to the three pillars of sustainable development (environment, economic, social), two barriers related to "soft aptitudes" (information and collaboration) and two barriers related to "practical obstacles" (techniques and regulations).

a. Commitment to Sustainable Development

The social aspects of industrial symbiosis should be equally considered and not neglected: Organizational strategy, goals, and performance measures have to motivate managers to develop and change their mindset. The personnel should be encouraged to participate in the synergy projects, contributing to the company's goals.

b. Financial

Synergistic activities are expected to bring a positive economic outcome along with the environmental benefits. However, lack of access to long-term financing and uncertainty about the profitability of the partnership might hinder the project. High initial set up costs to create the infrastructure to enable recycling and symbiosis may prove a big barrier to the creation of schemes.

c. Community engagement

Community awareness (of the environmental and economic impacts and benefits that industries generate) can be a strong driver to initiate but also halt or delay the development of different projects. Well-established communication channels between the industries and local community, as well as the initiation of environmental education programs, and on site consultation help to ensure the legitimate status of new synergies.

d. Lack of information

Lack of detailed qualitative and quantitative data on waste streams and local industries' material/water/energy requirements might fail to provide the basis for developing regional resource synergies. The inexistent habit to share information and the knowledge sharing issue within and amongst companies and institutions is a detriment to progress.

e. Culture for cooperation

The cooperation and trust between key players, spirit of information sharing, and network development are important factors, without which no real synergy projects will be created. A neutral coordinating body (e.g., interindustry council) can play such a role.

[1] http://onlinelibrary.wiley.com/doi/10.1111/jiec.12159/pdf

As a new alternative concept, IS has to be introduced and therefore a moderator is essential to teach, create trust and make things happen. Often in a value chain, cooperation is constrained because of imbalances in the cost/benefit ratio for the different partners. An open exchange about gains and effort of all stakeholders and participants can open a process aimed at levelling out the differences.

f. Technical

Technical feasibility is an essential precondition for a potential synergy. The role of R&D is to early detect technical challenges, provide the technical solutions and work closely with the industry in pilot projects. This can be compensated by involving a consultancy or research organization. The difficulty to access the technology from an economic point of view constitutes a barrier: new business models based on circular economy are introduced and technical innovation is affecting the company as a whole not only the waste management facilities.

g. Regulatory

The inconsistencies in the environmental legislation and difficulties to obtain approvals for waste reuse projects from the regulatory authorities may also be an obstacle to potential synergies. At the same time, imposing compulsory legal requirements to recycle specific materials, introducing higher taxes for waste disposal, and so on, are the drivers for synergy projects. Rules on transportation of waste might hinder symbiosis particularly across borders.

Regulation in circular economy has to reinforce the working of the market by ensuring a level playing field and equitable participation where this cannot be achieved among the partners through self-regulation.

3. Drivers of Industrial Symbiosis

Lessons learned derived from the analysis of the cases are summarised in this figure.

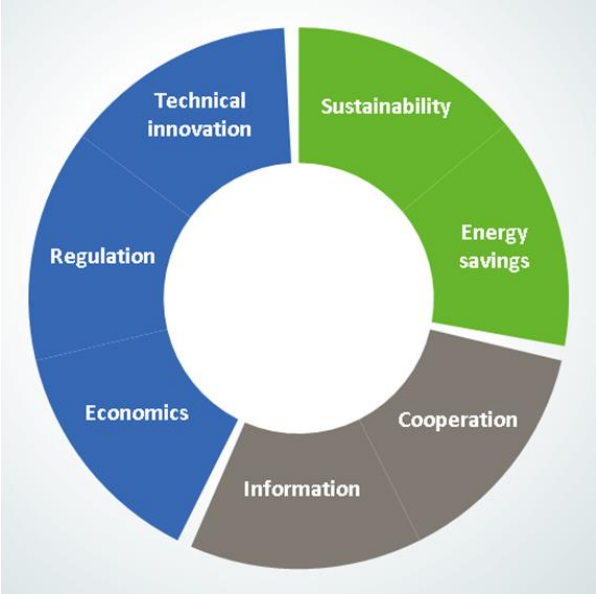


Figure 3 – The 7 drivers for industrial symbiosis

4. Review of ICT tools

The scope of an IS network is creating synergies between industries to valorise waste flows leading to environmental, social and financial benefits. Most important outcomes are the avoided burdens in terms of final disposal (landfilling), better use of resources, energy efficiency and moving forward towards a circular economy. IS networks should establish resource exchanges to facilitate recycling and reuse of industrial waste and establish sustainable value chains. They may bring many cross-sectorial members together, from segments of industry, generating a high number and variety of industrial waste streams with potential to be valorised. This necessitates high amount of information to be assessed during planning, design, implementation and monitoring of IS networks. Furthermore, communication of meaningful information to stakeholders, other IS networks and authorities also relies on handling of this high amount of information. In the FISSAC project, an entire process has to be implemented, based on an adaptive methodology, in order to put in place innovative industrial symbiosis model between industries (steel, aluminium, natural stone, chemical and demolition and construction sectors) and stakeholders in the extended construction value chain. To this end, ICT tools can support IS efforts immensely. The following table summarizes existing IS ICT tools based on fundamental functionalities. This discussion provides a basis for the vision and system requirements of the FISSAC IS platform to be developed under WP6.

Table 1 – Summary of the functionalities of existing industrial symbiosis ICT tools

		KBDSS	DIET	IME	DIME	MatchMaker	IEPT	WasteX	IEDP	RUES	IUWAWM	Presteo	SymbioGIS	CRISP*	SYMBIOSIS	eSymbiosis	C2C	USBCSD Market place	ZeroWIN	LoopLocal	MIPS	COMETHE	EPESUS
Opportunity Identification	New Process Discovery	✓								❍	✓				❍			❍		❍			✓
	Input-Output Matching	✓	✓	✓	✓	✓	✓	✓	✓	❍	✓	✓	✓	❍	❍	✓	✓				❍		✓
	Relationship Mimicking		✓			✓		✓	✓	❍	❍	✓	✓			✓			❍	❍		❍	
	Georeferencing & GIS						✓		✓		✓	✓	✓		✓								✓
Opportunity Assessment	SWOT analysis																						
	Cost Benefit Analysis		✓	✓	✓		✓			❍	✓		✓				✓					❍	
	LCA		✓												❍	✓					❍	❍	✓
	LCC																						✓
	Barrier Assessment													❍								❍	
	Network Strength Analysis																						
Barrier Removal	Technology Development										✓					✓	✓	❍					
	Regulatory Approval																					❍	
	Financing																✓	·					
	Public Approval																						
Commercialization & Adaptive Management	Stakeholder Analysis														❍		✓	❍				❍	
	Communication Management													❍	❍		✓	❍					
	Transfer of Knowledge													❍			✓	❍					
	Research & Collaboration													❍			✓	❍					
Documen -tation	Web Pages & Reviews	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	❍	✓
	Publications													✓	✓		✓	✓				✓	

* Compared to the other IS tools surveyed, CRISP resembles a project and contact management suite in contrast to a design tool and separates itself by clearly demonstrating its ability to facilitate coordinated collaboration between multiple

✓ Defines the ability which is mentioned in reviews, papers or the official web site with the function name

❍ Defines the ability which is mentioned in publications indirectly

5. Conclusions

This report serves as a first step of identifying current models of industrial symbiosis (IS), analysing them and gradually defining the requirements of a new model to facilitate information exchange to support development of current and future networks. It summarises the key findings from overall sixty best practices collected from FISSAC project partners. It reviews the state of the art of ongoing industrial symbiosis projects (public and/or private partnerships) and government initiatives in Europe and abroad.

The report also provides information on technical and non-technical barriers. Risks and uncertainties which might hinder these developments, but also drivers of new IS projects have been identified and analysed. The role of different players in setting up IS networks, particularly in public private partnerships, and the long-term vision for scaling up is discussed.

Finally, various existing ICT tools and methodologies for IS have been identified and extensively analysed as part of this task. The data collected will serve as input for the definition of requirements of the upcoming FISSAC software platform.

6. Annex

The table below displays a synopsis of the sixty identified cases to be then analysed.

Table 2 – Synopsis of Identified cases (Country/ Name of project/ Main advantages)

Country	Name	Main advantages
Belgium	**Irisphere** www.irisphere.be	• Project on a small scale in urban areas • Real support by consultants commissioned & supported by the public authority • Deep awareness by the businesses of opportunities for synergies.
Belgium	**Rotor** www.rotordb.org www.rotordeconstruction.be	• Make the work (of reuse, recycling and waste material) accessible to a wide audience • Instead of demolition, it proposes, when it is possible, to preserve the building volumes and make use as much as can be of what is already there.
Belgium	**Tertre** http://www.info-pme.be/news/video-tertre-hautrage-un-ecozoning-qui-marche-/	• Economic benefits linked to raw materials and energy prices • Business models changes with environmental constraints/opportunities • Attractive and dynamic image to all stakeholders
Belgium	**Cooperation agreement on gypsum, plaster, and plasterboard** http://www.ovam.be/gips-en-gipskartonplaten (in Dutch)	• This project encourages selective demolition • Setting targets • Platform for exchange and creative reflection • Trials and studies • Value chain cooperation of stakeholders
Belgium	**Cooperation agreement on sheet glass** http://www.ovam.be/vlakglas (in Dutch)	• This project encourages selective demolition • Platform for exchange and creative reflection • Trials and studies • Value chain cooperation of stakeholders
Belgium	**Cooperation agreement on cellular concrete** http://ovam.be/cellenbeton#acties (in Dutch)	• This project encourages selective demolition • Setting targets • Platform for exchange and creative reflection • Trials and studies • Value chain cooperation of stakeholders
Belgium	**Flanders' Materials Programme (VMP)** http://www.vlaamsmaterialenprogramma.be/flanders%E2%80%99-materials-programme	• Added value and/or economies create opportunities for exchange and cooperation • Governance of projects, leverage by external partners • Emphasis on cooperation • Extensive consultation looking at obstacles in all fields (legislation, practices, business and finances, …) • Applied research • Aimed at SMEs
Belgium	**Metallurgy Resource Regulation** http://ovam.be/grondstoffenregeling-metallurgie (in Dutch)	• This regulation encourages the recycling of materials from metallurgical production processes (included in the The Ministerial Decree), which are considered as raw materials instead of wastes
Belgium	**OVAM Materials Scan** www.materialenscan.be	• SMEs are aware of the costs of materials (average 40% of total costs) • SMEs are aware of the loss of material in their process (average 18%)
Belgium	**Unity Regulation for recycled aggregates** http://ovam.be/gerecycleerd egranulaten (in Dutch)	• This regulation encourages selective demolition • Setting the activities of crushing plants and of sorting lines in similar framework • Comprehensive management system to monitor the flow and quality of recycled aggregates • Quality control • Monitoring collection, transport, acceptance and production of debris to aggregates
China/Singapore	**Sino-Singapore Tianjin Eco-City** http://www.tianjineco-city.com/en/	• A sustainable city to work, live, play and learn in • With clear and measurable outcomes • Accessible from key cities and industrial districts in the region • Harmonies among people, environment and economy
Czech	**Act Clean project**	• Create high-quality and current database of innovative technologies

Republic	http://act-clean.eu/	• Eco-efficient production processes • Cleaner production and use of environmentally friendly technologies • Re-use of waste • Access to current information • Establishment of a help-line in innovative technologies
Czech Republic	**ALFA programme** https://www.tacr.cz/index.php/en/programmes/alfa-programme.html	• Support • Projects implementation • New opportunities for research projects • New knowledge applied in the form of innovation
Czech Republic	**EESS (VIZE 2024)/Platform for resource efficiency and sustainable consumption and production** http://www.empress.cz/	• Information sharing • Promotion • Education • Projects implementation
Czech Republic	**2014-2020 Operational Programme Environment – Priority axis 3: Waste management and material flows, environmental burden and risks** http://www.opzp.cz/about/	• Protect and ensure the quality of environment • Promote efficient use of resources • Elimination of the negative impacts of human activities on the environment and climate change mitigation
Denmark	**Kalundborg** www.symbiosis.dk/en	• An atmosphere of trust and mutual beneficial partnership existed in Kalundborg even in the absence of specific experience between firms • The presence of two or more firms that produce and consume a continuous stream containing useful by-products • Profitable material exchanges have been identified quite quickly • Flexible and self-sustaining system, no central management centre, room for new players to join and new by-products to be used as raw materials.
Germany	**Biotech Park Freiburg** http://www.biotechpark.de/index.php?lan=en&env=start	• Subsidies for the tenants • Contribution to the urban and regional business development • Support for the young and established biotechnology companies
Germany	**CEMEX Cluster West** http://www.cemex.com/AboutUs/Germany.aspx	• Established synergistic production system • Clinker substitution contributes significantly to the decrease of CO_2 emission
Hungary	**Duna-Dráva Cement KFT. (Heidelberg Cement Group)** http://www.duna-drava.hu/hu	• Lower production costs • Automated technology, with less human labour required • More stable product quality can be reached compared to the technology with natural plaster-stone • Waste is diverted from landfill – environmental benefits + cost reduction for the power plant
Hungary	**Mátra power plant industrial park (Mátrai Erőmű ZRt.)** http://www.mert.hu/hu/ipari-park	• Materials are diverted from landfill and sold for profit • The groundwater from the mining could be used • The power plant can share the services it has already paid for (protection, factory doctor etc.)
Italy	**Chenna Srl** http://www.chenna.it/	• Effective reduction of waste produced locally and resources saving • Increase of recovered materials • Decrease in the use of raw materials and other resources in industrial processes
Italy	**Greenwood Srl** http://www.greenwood-venice.com/en/index.html	• Effective reduction of wood use and wood saving • Increase of recovered materials • it does not release harmful pollutants into the environment • When the material comes to the end of its natural life, it can be 100% recycled in the same production process or can be used as fuel in waste-to-energy plants
Italy	**Lape Srl** http://www.lape.it/	• Use of production waste of LAPE or other companies' processes • Performances of the recycled insulation material comparable to those of the original product (thermal conductivity, 0.032 W/mK)
Italy	**LOWaste Project** http://www.lowaste.it/index.html	• Effective reduction of waste produced locally and resources saving • Increase of recovered materials • Reduction of CO2 emissions due to the lower amount of waste disposed of in landfills • Decrease in the use of raw materials and other resources in industrial processes • Can be promoted through public authorities in public construction thanks to the

		experience made in tender rules by Ferrara municipality
Italy	**MAPEI RE-CON ZERO Project** http://www.mapei.com/AE-EN/focus-on.asp?IDNews=2383	• Complete recovery of return concrete, avoiding the use of landfills • It does not produce waste neither solid nor liquid • It reduces the consumption of natural aggregates • It reduces road transport • It is easy to use and not based on hazardous substances • It determines lower cost of disposal • It reduces the cost of supply of natural aggregates
Italy	**Pandora Group** http://www.pandoraidea.com/#/11/1/1/	• Recycle material from both post-consumer and pre-consumer waste
Italy	**Plaxtech Srl** http://www.plaxtech.eu/en_US/index.html	• No use of virgin raw materials • No waste production • Reduce energy consumption • Eco-sustainable process • Eco-friendly products
Italy	**Santa Croce Tannery District** http://www.assoconciatori.com/index.php?option=com_content&view=article&id=54:fanghi-ecoespanso&catid=47:partners&Itemid=69	• Recycling of sludge, avoiding the use of landfills • It does not produce solid waste
Italy	**Siniat SpA** http://www.siniat.it/	• Recovery and recycling of gypsum waste • No use of virgin raw materials • No waste production
Japan	**Kawasaki Eco-Town** http://nett21.gec.jp/Ecotowns/data/et_b--kawasaki.html	• It became one of the leading area where recycling facilities are clustered • By-product exchange among business entities
Netherlands	**Glass plant uses water by-product** http://www.ardaghgroup.com/news-centre/win-for-ardagh-at-the-first-international-resource-recovery-awards	• Clear financial benefits to all actors. The water treatment plant avoids the cost of disposing their waste product, and the glass manufacturer can use this secondary raw material as an alternative • Financial viability: There is a significant cost benefit to using the secondary raw materials instead of primary raw materials. Because of the large potential benefits, the company were willing to spend the significant research effort necessary to overcome technical and other problems • Leadership: A passionate, determined and competent person drove the process and managed to solve a number of problems • Collaboration: The glass manufacturer worked with the water companies towards a common goal • Technical knowledge was available to solve a key problem - how to dry the pellets cost effectively. This was solved with the development of a purpose built truck which dries the pellets in transit using heat from the engine.
Netherlands	**Valkglas: flat glass collection** http://www.vlakglasrecycling.nl/index.php?page=home-en	• Benefits to stakeholders: Glass makers benefit from access to more recycled glass. Glass industry benefits from the greater flexibility of creating a voluntary scheme • Collaboration: In 2000, Dutch sheet glass manufacturers launched an initiative to set up a voluntary recycling scheme in order to meet their producer responsibility (EPR) • Supportive legislation: In the Netherlands, it was made compulsory for all producers and importers of double glazing to pay a waste disposal fee of €0.50 for every m2 of insulated glass. This funds the recycling scheme • Design: In the Netherlands, frames are put into the buildings first and glass units are added afterwards. It means that the glass and frames can be separated very easily and cheaply. This is a big factor in the financial viability of the scheme • Culture: Dutch people are environmentally conscious and are willing to recycle • Geography: The relatively small size of the country affects the cost of logistics • Communication: good communication is vital to maintaining quality of the collected material. This is done through newsletters, website, brochures, mailings, etc. • Training: Collection point managers are provided training about what can and cannot be put into the glass containers. Preventing contamination is vital to

		maintaining quality and hence, the viability of the scheme • Incentives: Containers are given to collection points for free. Any sheet glass that is too dirty to be recycled is removed as residual waste and the costs of this are reclaimed from the party responsible. When the quality is good a small collection fee is given to the collection point as a reward • Financial viability: Affordable rent is charged for renovation/demolition projects that wish to hire a glass recycling container.
Spain	**CLAMBER: "Castilla-la Mancha Bui-Economy Region"** clamber.castillalamancha.es	• Public administration participation • Rental of facilities • R & D projects • Participate as partners in projects with competitive funding • Training of personnel in biotechnology
Spain	**Mataró Water Company: "GREEN TUBE" district heating with waste and sewage treatment plants heat recovery (Catalonia)** http://www.messa.cat/es http://www.aiguesmataro.cat/ca/el-tub-verd	• The Green Tube uses excess energy from environmental infrastructures of Mataró thanks to the synergy between all the by-heat waste managers producers • The Green Tube provides services to customers for instant water heating and air conditioning at competitive prices • The Municipality uses the facilities for environmental training, public exhibitions, school programmes, raises environmental awareness
Spain	**Saica energy recovery plant** http://www.saica.com/en/Pages/Home.aspx	• Adequate technical performance • No complementary transformation/manipulation of PSA to be applied • Cost-effective and sustainable • Good industry cooperation
Spain	**Sagunto industrial area** http://discovery.ucl.ac.uk/762629/2/762629_Vol.II_Appendices.pdf	• Potential IS networks development through kernel analysis • Knowledge of how and why things does not work properly
Spain	**Cámaras: industrial by-products exchange system** http://www.camaras.org/bolsasubproductos/	• Recovery and reuse of materials and products for disposal • Lower costs of acquisition of raw materials and products and waste disposal • Finding new customers and diversification of suppliers • Guidance on new business opportunities • Reducing the volume of waste and by-products. • Improving the quality of the environment
Spain	**Best practices of sustainability of R&D (Castilla y León)** http://www.medioambiente.jcyl.es/web/jcyl/MedioAmbiente/es/Plantilla100/1284136625009	• Use of aluminium and RCDs waste as raw material in different application • Reduce energy consumption and CO2 emissions • Avoid to dump in the landfill.
Spain	**Cosentino recycled products (Almería)** http://www.cosentino.es/	• Cosentino Group identified a new market niche, and thanks to the Cradle to Cradle Certified recycled surface ECO by Cosentino, Cosentino Group has established itself as the leading provider of recycled surfaces in the world • An outstanding feature of our environmental strategy is the company's active policies for air control and dust and VOC reduction water management with the achievement of continuous reuse and "zero discharge" and the reuse of waste as raw material for recycling into new products • For Cosentino Group, the launch of the recycled surface ECO by Cosentino has been a success story, not only because of the benefits for society for launching a sustainable and Cradle-to-Cradle Certified Silver product, but also from a business point of view. Since the launch of ECO by Cosentino in April 2009, total worldwide sales have reached over 24 million Euro (about 32 million US dollars).
Spain	**Construction site methodology and innovative associated business model** www.construcia.com	• Synergies between providers-clients-actors can be pre-defined. Future development of symbiosis detected in advance • Inclusion of industrial symbiosis concepts in construction • Better knowledge and engagement of suppliers • New perspective through stakeholders dialogue
Spain	**Can Mata-Cerámiques Pierola: Energy recovery of biogás (Els Hostalets de Pierola, Barcelona)**	• The establishment of a cooperation framework between two private companies • Energy, environmental and economic savings • Use of renewable energy replacing fossil fuels.

	http://www.pieraecocerami ca.com/es/produccion- ecologica-con-biogas/	
Spain	**Manresa en simbiosi: industrial symbiosis implementation project in the Municipality of Manresa** http://www.simbiosy.com	• Municipalities seem to be good promoters of IS in the territory • Benefits for both, companies and Municipality, are high • Help companies to visualize how to maximize resource efficiency reducing costs • Promotion of the innovation and industrial competitiveness • Creation new companies and jobs • Social benefits • Promotion of circular economy and industrial symbiosis concepts • Strengthening Manresa's industrial network.
Spain	**Plaine du Var** http://www.inex- circular.com/fre/36/l- experience-de-la-plaine-du- var	• Use of the first results of the national plan Recybéton • Reduce transport distances and improve logistics • Improve exemplary of the sector • Revitalize local construction materials industry • Generate savings on purchases of resources and disposal costs
Spain	**IS in industrial corridor: information, training, implementation and promotion(Sabadell-Barberà)** http://www.bdv.cat/es/noti cies/simbiosis-industrial- fomento-de-la-economia- colaborativa-en-los- poligonos-de-barbera-del	• Municipalities are good promoters of IS in the territory • Benefits for both, companies and Municipality, are high • Third party 'energiser' always needed
Spain	**Bilbao Port (Basque Country)** www.bilbaoport.es	• The EAF steel slag concrete exhibited 15% higher density than design concrete due to the higher density of steel slag aggregates • The necessary volume of steel concrete for precast concrete blocks or docks is lower than the designed concrete due to its higher density • The EAF steel slag concrete precast blocks showed higher stability for docks reinforcement • The EAF steel slag concrete was more economic than design concrete • Reductions in 60% of natural aggregate being replaced by steel slag aggregates • Reductions in large amounts of energy and emissions needed for extraction, crushing, screening, cleaning and transporting the natural aggregate that is replaced by steel slag aggregates
Spain	**KUBIK (Basque Country)** http://www.tecnalia.com	• The incorporation of EAF steel slag aggregates (by weight) in structural concrete does not exhibit deleterious performance. It exhibits enhanced performance when comparing to concrete made with natural limestone aggregate • The mechanical behaviour of concrete containing EAF steel slag aggregate was higher than OPC, especially, without air entrainment on the dosage • The EAF steel slag concrete exhibited 10-15% higher density than OPC due to the higher density of steel slag aggregates • The steel concrete showed similar durability as OPC.
Sweden	**CBI, October 2015 (Stockholm)** http://celsa-steelservice.se/	• Eco-friendly and well-plannned smart business parks are needed. • Sweden has no shortage on aggregate and filling materials. • A financially winning concept is hard to find for other material replacements than cement. • Instead, logistics can be an advantage. • A smart business park with crushed glass and high quality crushed concrete waiting to be recycled just around the corner can make the difference • A fine example of this can be found for a reinforcement producer
Sweden	**Biorefinery cluster (Northern coast of Sweden)** http://www.processum.se/e n/	• Driven people (enthusiasts) in the member companies who believed in the project and initiated it and also a driven CEO of Processum • A triple helix organisation favour the development of the cluster • Good basis for applying for funding due to the breadth and number of involved actors • Pioneers of the biorefinery concept resulted in project attention, less competition, and a high profile. The project created credibility in the concept of biorefinery • Main part of fund on research and innovation to be competitive on the

		knowledge intensive sector of biorefineries • Available test-beds to facilitate scaling up technologies.
Sweden	**City of Malmö harbour area** www.malmo.se	• City of Malmö has as a coordinating function. The city has strong commitment to work with sustainable development, which is important in the start-up phase • The energy company Eon has previous experience of working with IS, in Norrköping. Eon is an important stakeholder in the Malmö symbiosis • Large energy, water, waste and material flows witch is a good base to build on • A willingness to cooperate between actors • The harbour area is expanding and when the city is looking for new actors to settle down, they are trying to find companies who fit into a symbiosis network.
Sweden	**Händelö Eco-Industrial Park (Norrköping)** https://www.liu.se/forskning/reportage/hallbara-norrkoping?l=sv	• A strong municipality and its environmentally motivated actions, e.g. the establishment of a district heating system, supporting the use of waste and biomass as fuels in the CHP plant and establishing markets for biogas and steam • Possibility to produce steam with low CO2 emissions, enabled the production of low-CO2 ethanol and created a symbiosis between producer and consumer • The high intensity farming activities in the region, enables synergies • Innovative and entrepreneurial mindset.
Sweden	**Industry Park of Sweden (Helsingborg)** **http://www.industrypark.se/**	• Industrial symbiosis has delivered savings • Trust and openness between the actors • Industrial symbiosis is integrated in the daily work and the culture, it is not a project.
Sweden	**Municipality of Ronneby** http://www.ronneby.se/sv/sidowebbplatser/cefur/	• Ability to facilitate networks between companies and academia • Local industry sees the potential economic benefits of working according to C2C-principles.
Sweden	**Sotenäs municipality** www.sotenas.se http://www.sotenas.se/nyheter/nyhetsarkivet/sotenaskompetenscentrumflyttartillsymbioscenterhagaberg.5.452a963f1506ac3fcd7bf0aa.html	• Public partner take lead • Long term work • A strong entrepreneurship in the region • Large potential to utilize waste and heat locally • Trust between actors
Sweden	**The chemical cluster in Stenungsund (and of Western Sweden)** http://kemiforetagenistenungsund.se/ http://www.businessregiongoteborg.com/huvudmeny/clusters/strongclusters/chemistryandmaterials.4.af7e50614cdb7ef12aafaea.html	• Already integrated cluster when forming the vision “Sustainable chemistry 2030” in 2010. The companies in the cluster have developed a trust and openness towards each other • Regional companies prioritise investment in research and development • The cluster is located in a region with a lot of knowledge and skilled labour • A triple helix organisation and good cooperation has created many synergy effect and cross-fertilization • A high level of enthusiasm among the key personnel in the cluster and organised networks involving representatives from the participating companies to find regional solutions and collaboration projects • A holistic approach on sustainability questions.
Sweden	**The Gävle collaboration** http://www.gavleenergi.se/sv/Fjarrvarme/Om-fjarrvarme http://www.bomhusenergi.se/om-bomhus-energi	• Already an established collaboration between the two main partners to develop further • Collaboration secured the actors energy demand and supply • A holistic approach was used for the energy collaborations • The project was based on openness, respect, commitments and trust between the companies involved.
Sweden	**Tomato farming at the Elleholm farm** http://elleholmstomater.se/index.html	• Cooperation between different companies gives a higher productivity • The driving force is economical.
Switzerland	**Geneva symbiosis project** http://www.cyclifier.org/project/geneva--symbiosis/	• The GIS tool create added value for technical analysis of IS opportunities and risk evaluation • Provides powerful tool for visualization and communication • Can be used as a guide to set up priorities and detect quick wins for an efficient and local use of resources
Turkey	**Industrial symbiosis project in İskenderun bay** http://www.endustriyelsimb	• A great potential for collaboration • Raw materials saving • Waste reduction

	iyoz.org/amac/, http://www.ttgv.org.tr/tr/endustriyel-simbiyoz, http://www.skdturkiye.org/haber/SKDveUyelerdenHaberler-195	• Improvement of working conditions and public health • Increase in stakeholder awareness on IS • Clear financial benefits to all actors. The water treatment plant avoids the cost of disposing their waste product, and the glass manufacturer can use this secondary raw material as an alternative • Financial viability: There is a significant cost benefit to using the secondary raw materials instead of primary raw materials. Because of the large potential benefits, the company were willing to spend the significant research effort necessary to overcome technical and other problems • Leadership: A passionate, determined and competent person drove the process and managed to solve a number of problems • Collaboration: The glass manufacturer worked with the water companies towards a common goal • Technical: Technical knowledge was available to solve a key problem - how to dry the pellets cost effectively. This was solved with the development of a purpose built truck which dries the pellets in transit using heat from the engine.
Turkey	**Industrial symbiosis project in OSTİM Industrial Zone**	• Due to the diverse type of products, there is a great potential for IS • Economic advantages for small regional producer companies (New business opportunities for SME's) • Reduction in raw material usage and waste • Improvement of working conditions and public health
United Kingdom	**Saint Gobain Glass' unique recycling scheme** http://uk.saint-gobain-glass.com/content/cullet http://uk.saint-gobain-glass.com/node/199	• Clear financial benefits to all actors. The glass processors avoid the cost of disposing their waste product and earn money by selling it (equivalent to raw material price). The glass manufacturer can use more recycled glass and hence, reduce emissions and energy • Leadership: A passionate, determined and competent person drove the process and managed to solve a number of problems • Technically proven – the science of using recycled glass to make new glass was already well understood and accepted by the glass making industry. This helped to make uptake faster • Technical– a suitable container to collect the glass pieces was required. It had to be easy to use, easy to move, fit onto trucks, and safe. The solution found was to use large double skin polypropylene bags which have excellent resistance to broken glass can hold 1 tonne of material • Communication: Training is provided to keep the waste glass pure, and to prevent contamination by other wastes. SGG provides clear explanations of how the system works and what the processors should and should not put in the bags. A brochure and CD are also used • Logistics – The scheme is financially viable because of back hauling. Trucks which deliver new glass sheets are also used to carry the waste glass back to the factory. This keeps transportation costs low • Incentives – Participant companies are paid for the glass pieces and hence, this is an incentive for managers to participate. Interest (and hence quality) is maintained by running a monthly competition to reward good performers • The equipment, training and support is provided for free.
Worldwide	**CALUMITE (steel by-product used as raw material in glass manufacturing)** http://calumiteint.com/	• Large advantages to using this new material (cost savings, better glass quality) instead of just staying with traditional, tried and tested materials. Without the additional benefits, people would not have undertaken the work and risks involved with using a new raw material • Leadership: A passionate, determined and competent person lead the process and kept it going through its many ups and downs • Trials: The leader worked in a glass factory and had the power and desire to trial the new material (without trials, it would never have become commercially acceptable) • Quality: A dedicated company was set up to process the by-product, deal with any changes in the primary process, and guarantee product quality. Without quality guarantees, glass companies would not have taken the risk of using this new material.