CHAMBER OF COMMERCE OF MOLISE

A1.3 Good practice guide and benchmarking guidelines on ecosystems of byproduct and energy exchanges

July 2017

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1 Introduction

This paper was prepared by the Chamber of Commerce of Molise within the context of SYMBI activity A1.3. It outlines the results of an analysis of the best cases of industrial symbiosis projects in SYMBI partnership regions and the European Union as a whole, and describes a benchmarking methodology that will be applied to evaluate both potential and concurrent industrial symbiosis projects. The analysis was based on data collected by the SYMBI partners from the entire EU.

After briefly presenting some key information about the SYMBI project and activity A1.3, the paper proceeds in presenting the key characteristics of best practices in industrial symbiosis based on the analysis of data for 48 successful industrial symbiosis projects all over Europe. Subsequently, the document proceeds in presenting cases of industrial symbiosis that can be characterised as significantly successful according to their compliance to the criteria of success developed in the methodology of activity A1.3. The document presents their score according to these criteria, their characteristics, and the lessons learned from the symbiosis projects in the countries where these cases are encountered.

Finally the document presents a benchmarking methodology based on a catalogue of conditions that can serve to check or estimate the success of an industrial symbiosis project.

The paper concludes with three annexes. Annex 1 presents the evaluation of all 48 cases according to the criteria developed in the methodology. Annex 2 presents the template used as an input paper by partners to gather information on cases of industrial symbiosis. Annex 3 presents all the 48 cases as they were described in the input papers.

2 Context of the SYMBI project

2.1 Background of the INTERREG Europe Programme

The INTERREG EUROPE programme[1] promotes the exchange of experience on thematic objectives among partners throughout the European Union (EU) on the identification and dissemination of good practices, to be transferred principally to operational programmes under the Investment for Growth and Jobs goal, but also, where relevant, to programmes under the European Territorial Cooperation (ETC) goal. This will be done via the support and facilitation of policy learning, sharing of knowledge, and transfer of good practices between regional and local authorities and other actors of regional relevance.

INTERREG EUROPE is one of the instruments for the implementation of the EU's cohesion policy. With this policy, the EU pursues harmonious development across the Union by strengthening its economic, social and territorial cohesion to stimulate growth in the EU regions and Member States. The policy aims to reduce existing disparities between EU regions in terms of their economic and social development and environmental sustainability, taking into account their specific territorial features and opportunities. For the 2014-2020 funding period, cohesion policy concentrates on supporting the goals of the Europe 2020 strategy, which targets to turn the EU into a smart, sustainable and inclusive economy delivering high levels of employment, productivity and social cohesion.

2.2 The "SYMBI" project

The "Industrial Symbiosis for Regional Sustainable Growth and a Resource Efficient Circular Economy – SYMBI" project aims to improve the provisions and support the implementation of policy instruments and measures for the diffusion of industrial symbiosis, to add value, reduce production costs, and relieve environmental pressures through increased resource efficiency and greenhouse gas emissions. The overall improvement is anticipated to positively contribute in regional sustainable development and job creation.

Circular economy is an emerging model that keeps resources in the economy as long as possible. Resources can be reused, creating further value while relieving environmental pressures. Resource efficiency, as outlined in the circular economy model, is primarily based

[1] www.interregeurope.eu

on: a) the "cradle to cradle" principle, focusing on eco-design and regenerative modes of consumption, and b) industrial symbiosis, which involves territorial synergies to manage waste and share services, utilities, and by-product resources. The territorial aspect of industrial symbiosis brings regions to the forefront of the transition towards circular economy.

Industrial symbiosis requires policy reforms measures at different levels. EU regions show very different levels of performance on each area relevant to industrial symbiosis, and advance at a different pace towards green growth models. There is thus a need to share and exchange practices, experiences, and knowledge within this fragmented context to: a) lift barriers by following successful examples, b) foster balanced territorial development and reduce disparities, and c) reverse the backwardness of least-favoured regions.

2.2.1 SYMBI activities

The SYMBI project brings together 9 partners from 7 countries to diffuse industrial symbiosis and align regional policies with the circular economy package of the European Commission (EC). To support the transition towards a resource efficient economy, the project includes a wide range of activities, focusing on promoting the interregional learning process and the exchange of experience among regional authorities. Project activities include:

- Evaluation and analysis of existing regional and national policies on industrial symbiosis and circular economy.
- Mapping the investment potential of participating regions in industrial symbiosis.
- Identification of good practices and benchmarking of eco-systems of by-product and energy exchanges.
- Prescribing green public procurement as an enabler of industrial symbiosis.
- Promoting public dialogue and consultation process to build consensus and ensure the successful implementation of regional action plans, through the support and participation of key regional stakeholders.
- Fostering interregional learning and capacity building through workshops, study visits, and policy learning events.
- Joint development of action plans to promote the improvement of the policy instruments addressed by the project.

- Increasing awareness, promoting and disseminating the project results and knowledge beyond the partnership.

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2.2.2 SYMBI expected results

SYMBI will improve 8 policy instruments, relevant to the abovementioned policy areas; 6 of the managing authorities participate in the consortium, so as to secure the impact of the project. SYMBI activities will:

- Incentivise regional waste transformation systems and cross-sectoral synergies
- Promote the use of secondary raw materials
- Prioritise green procurement
- Unlock investments by regional and local financial actors
- Explore, assess, expand, and enhance current practices in ecosystems of industrial innovation
- Build consensus between regional stakeholders

2.3 SYMBI Activity A1.3

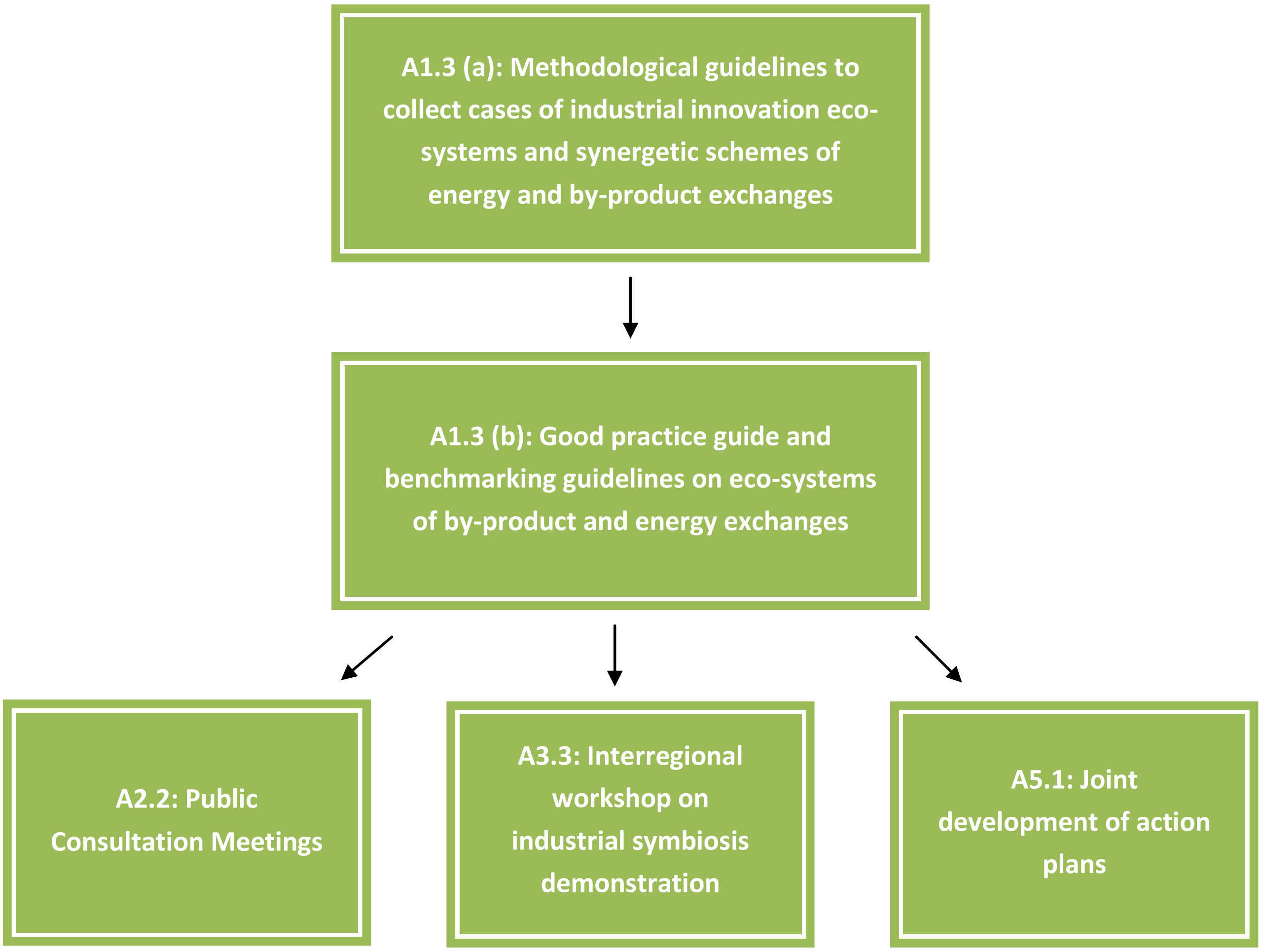
The SYMBI Activity A1.3 “Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges” includes the collection and assessment of cases eco-systems of industrial innovation and synergetic schemes of energy and by-product exchanges.

Based on a survey methodology, the project partners gathered, assessed and analysed good practices and benchmarking of ecosystems of by-product and energy exchanges. All partners conducted desk research at national level.

The analysis of the evidence collected results in this good practice guide and benchmarking guidelines on ecosystems of by-product & energy exchanges that will enable policy makers and stakeholders to identify which solutions work best in the field of industrial symbiosis, study how they work, and adopt the best practices that are most suitable for their own regions.

2.3.1 Connections with other SYMBI activities

The results of SYMBI Activity A1.3 will provide input and support the implementation of the forthcoming interregional workshop on industrial symbiosis demonstration projects (Activity A3.3), the public consultation meetings (Activity A2.2), and the partners' action plans (A5.1), where relevant.

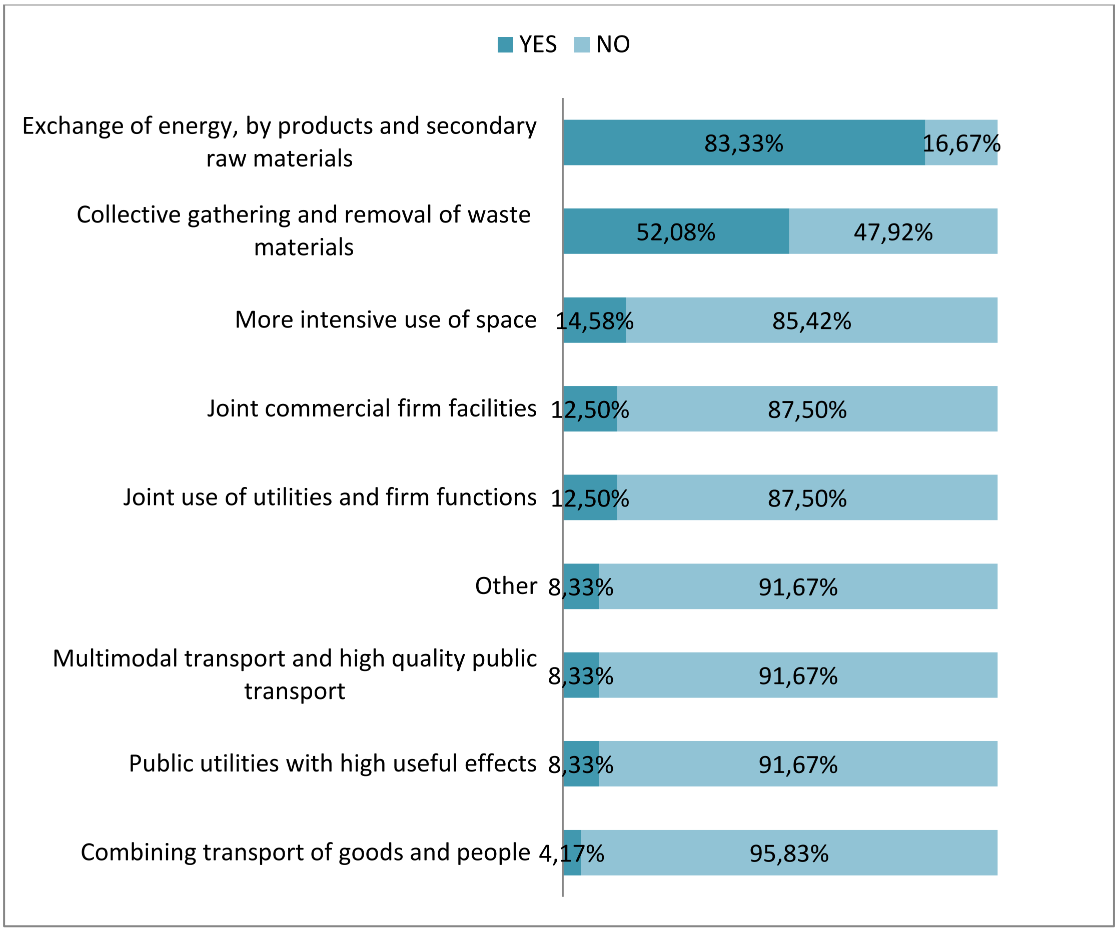


3 Overview of the findings

Data presented in this section derive from 48 cases of successful industrial symbiosis that SYMBI partners identified and described within the European Union, including 40 cases of energy and by-product exchanges. The 48 cases were described using the input paper supplied by the document "A1.3 Methodological guidelines to collect cases on industrial innovation ecosystems and synergetic schemes of energy and by-product exchanges", and can be found in Annex 1 of this document. It is important to point out that the input paper consists mostly of multiple response questions, and, as a result, the positive responses in each outcome of the questions should not be aggregated. More precisely the main types of cooperative activity in industrial symbioses across the EU are presented in the following table 1.

The survey shows that the exchange of energy, by-products and secondary raw materials accounts for 83% of successful cases of industrial symbiosis. Collective gathering and removal of waste materials accounts for 52.08%. Others types of activities described in Table 1, are considered less influent:

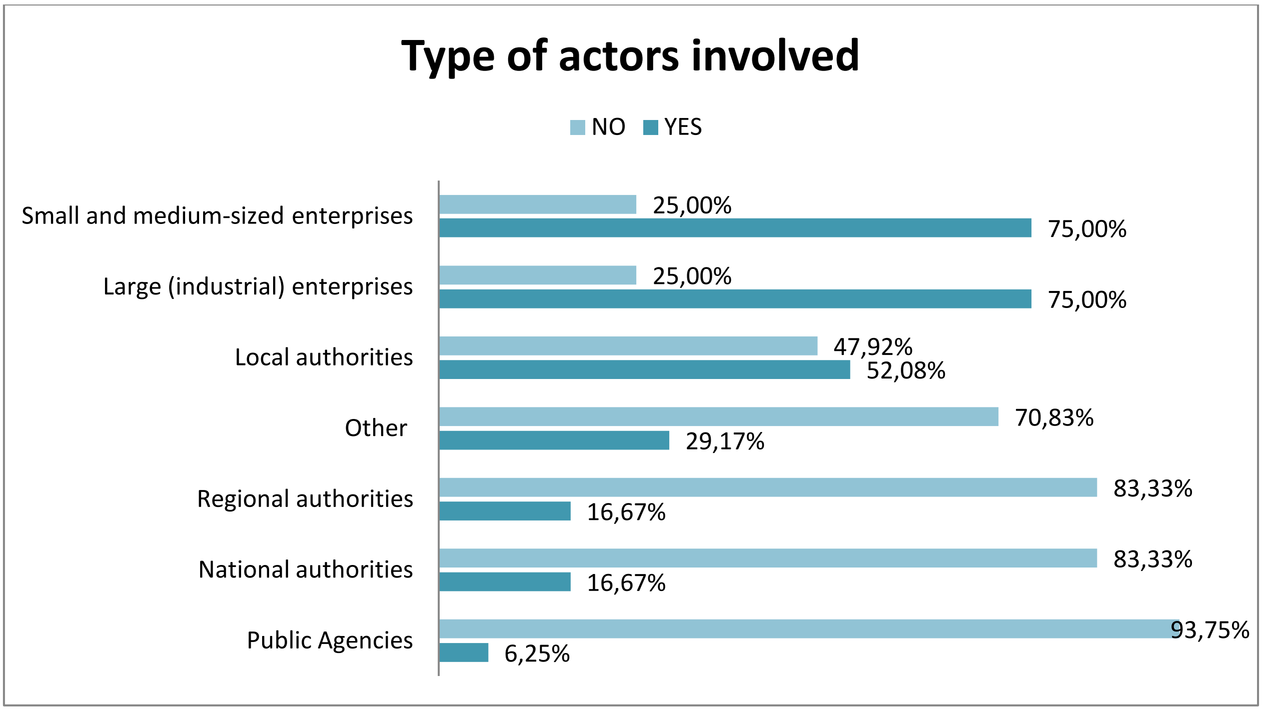
Table 1: Type of cooperative activity amongst firms in industrial eco-systems



That means that environmental aspects are considered crucial for the industrial symbiosis implementation and have a direct/strong impact on the environmental, economic and social sustainability, being firstly promoted by the EU Circular Economy Strategy.

Beyond the type of activity, to be successful, industrial symbioses in Europe usually have to involve a number of different actors. Nevertheless, there are three key types of actors that were mentioned in more than 50% of cases. These types are the large industrial enterprises, the SMEs of each sector and the local authorities. Results are summarised in the following table 2:

Table 2: Type of actors involved in successful industrial symbioses



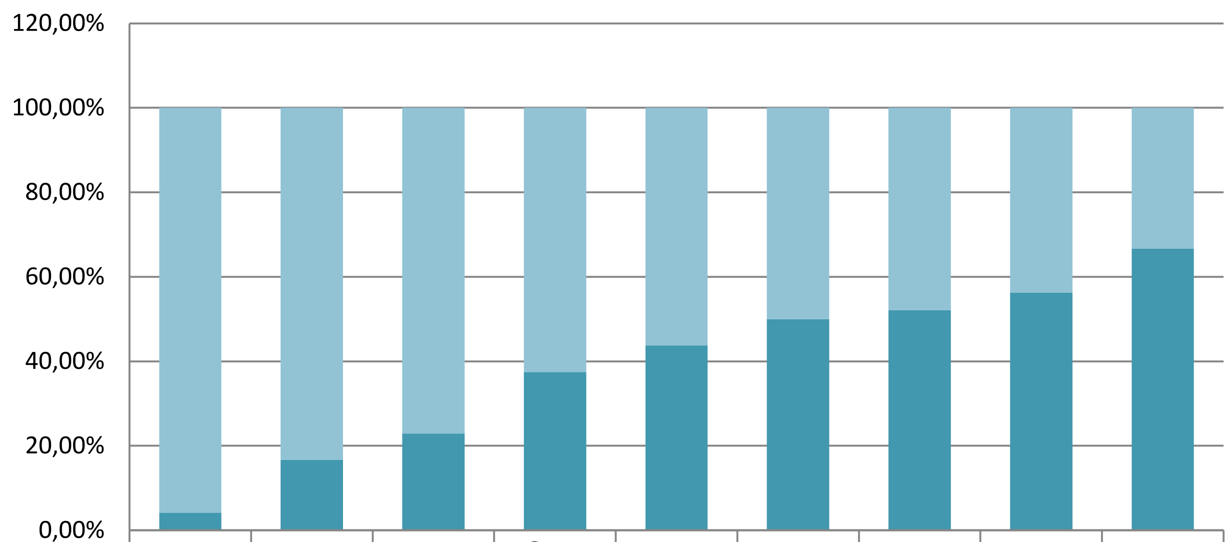
The effective and efficient relationship between key economic players/ producers of each sector and the local authorities of the area in which the industrial symbiosis projects have developed, could be considered an opportune precondition for successfully industrial symbiosis projects. Of course the key economic players can be large corporations, small SMEs, farmers.

Moving on to the rationale for developing industrial symbiosis, the analysis of data shows that (see Table 3) such projects emerge and are successful when they aim at reducing the environmental impact of the activities via: a) improving resource efficiency (67% of cases), b) promoting the use of sustainable bio-energy resources (56% of cases) and c) reducing CO_2 emissions (50% of cases). The second type of opportunities that industrial symbiosis can utilise for their success are cases where the symbiosis leads to the following economic benefits a) reductions in production costs (52% of cases), b) increases in profits and revenues (44% of cases), and openings of new markets for secondary raw materials (38% of cases).

Anyway, economic benefits are not the most important motivation for developing industrial symbiosis.

Industrial Symbiosis generates social benefits as well. More precisely SYMBI partners mentioned mainly two types of social benefits: a) overcoming the presumption that industrial symbioses are costly, and b) offering businesses the opportunity to cooperate and hence, to develop a cooperative culture which is essential in late knowing capitalist markets.

Table 3: Needs and objectives for the deployment of industrial symbiosis projects

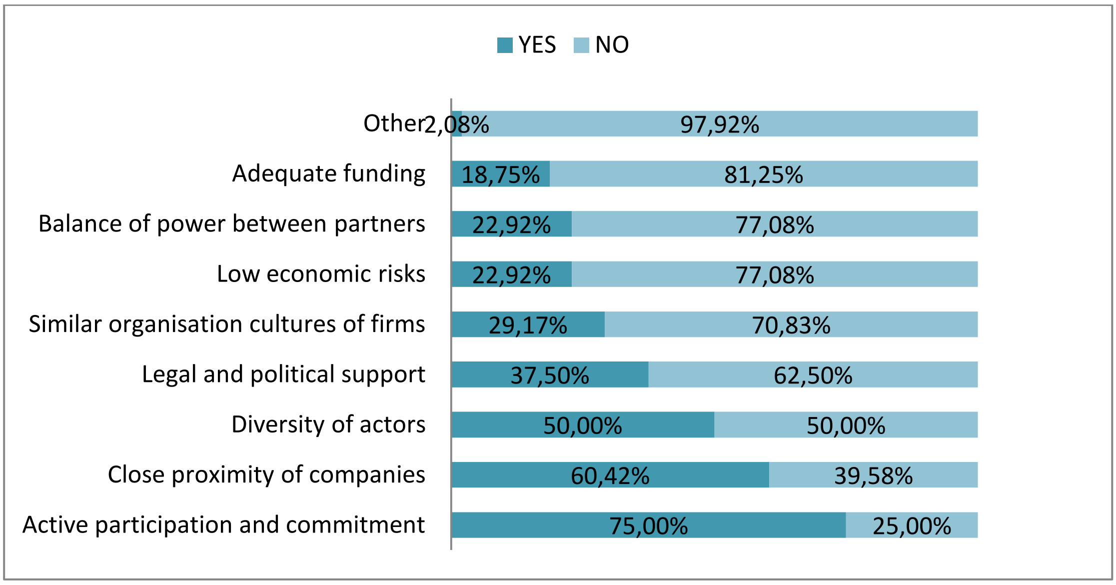


	Share risk	Access new markets	Other	Open new markets for secondary raw materials	Increase profitability, revenue	Reduce CO2 emissions	Reduce production costs	Promote the use of sustainable bio-energy resources	Improve resource efficiency
NO	95,83%	83,33%	77,08%	62,50%	56,25%	50,00%	47,92%	43,75%	33,33%
YES	4,17%	16,67%	22,92%	37,50%	43,75%	50,00%	52,08%	56,25%	66,67%

After locating the main incentives to engage in industrial symbioses, it is necessary to describe the success factors that determine the survival of such projects (see Table 4).

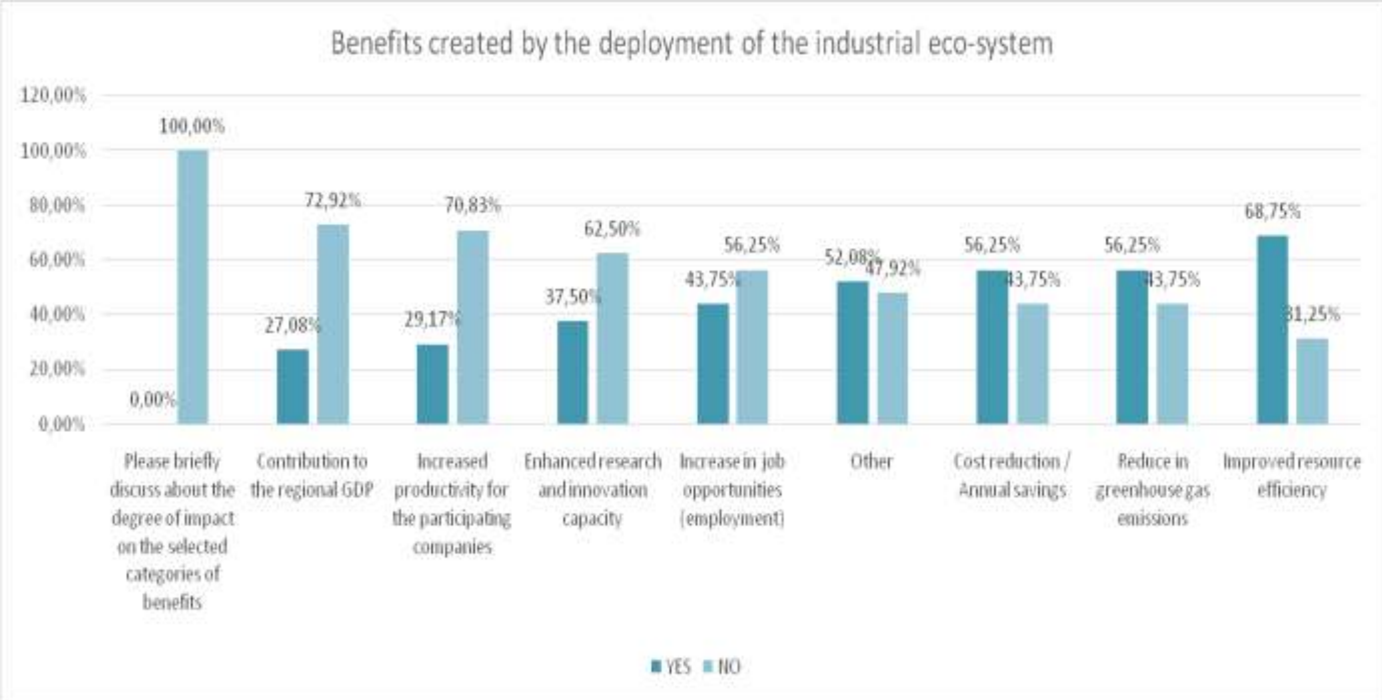
The most important success factors for the proliferation of industrial symbiosis projects revealed by the desk research of SYMBI partners are the active participation and commitment (75%) and the close proximity (60%) of the companies involved in the project, followed by the involvement of a diversity of actors in each project (50%). Interestingly, the existence of legal and political support (38%), the provision of adequate funding and the low economic risks associated with each industrial symbiosis case are not listed as often (38%, 15% and 23% respectively). It is possible to draw conclusions from these data that industrial symbiosis is possible even in sectors with high risks and low administrative and financial support, as long as a) there is active engagement of companies and organisations involved in the symbiosis and b) the businesses involved are closely situated. Furthermore, the diversity of actors involved in a project can further boost the chances of success, probably because a greater diversity of actors generates a greater spectrum of knowledge and material and energy exchanges that can take place in a project. The key success factors for industrial symbioses projects are summarised in the following table:

Table 4: Success factors for industrial symbiosis projects



Successful industrial symbioses have a significant positive impact on sustainability of the surrounding territory and the corresponding industrial or economic sectors. Industrial symbioses have been found by SYMBI partners to generate a number of environmental, economic and social benefits. The following figure provides an overview of the benefits generated by the industrial symbioses listed by SYMBI partners:

Table 5: Positive impacts of industrial symbioses



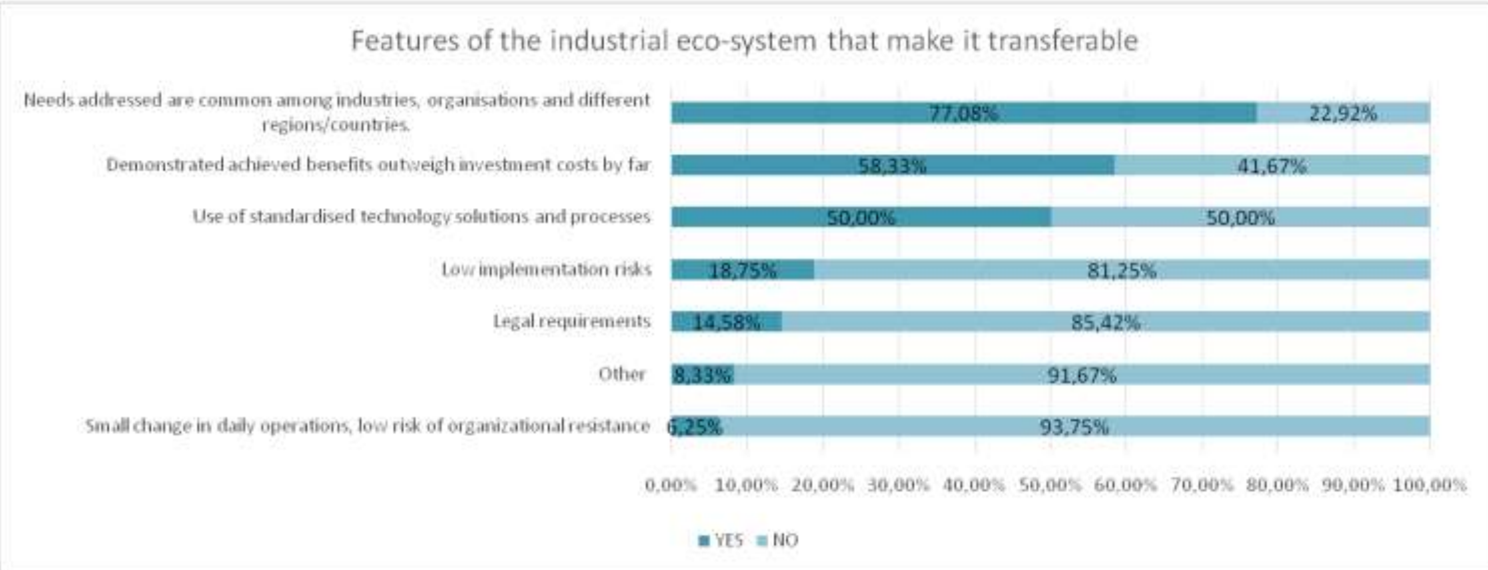
We can clearly see that most common benefits are related to sustainability and reduction of environmental impact, i.e. improving resource efficiency (69%) and reducing greenhouse gas emissions (56%), followed by economic and productivity benefits (cost reduction – 56%, increase in job opportunities – 44%). Particular attention should be paid to the fact that data reveal significant social benefits as the outcome of industrial symbiosis (under the label "other"- 52%), resulting in increased collaboration and networking among business and organisations and in the form of improved awareness of sustainability issues and image of businesses operating in the various regions. These social benefits are further linked to the enhancement of research and innovation capacity stimulated the industrial symbioses projects and mentioned in 38% of collected best cases.

These results lead to the conclusion that industrial symbioses, even if they are initially formed to increase the sustainability level of some areas, they generate a wide spectrum of benefits including significant economic benefits such as: creation of new jobs, increased competitiveness, increased added value for company, better branding of company.

Regional Authorities must be informed on this conclusion in order to consider the adoption of industrial symbiosis as a relevant contribution to the innovation growth and the networking capacities and European enterprises competitiveness. In the competitive global markets, the contribution to the innovation and networking capacity of fir ms caused by the industrial symbiosis process adoption, can be an important part of the necessary infrastructure to achieve a raise in the environmental and economic competitiveness of the EU

Finally, it is necessary to analyse the scalability and transferability of these benefits. Scalability is a key component of transferability of a production and consumption method. Development of alternative production and consumption models can be usually better transferred if it is applicable to a size that suits to different regions.
Desk research in 48 cases collected by SYMBI partners revealed that industrial symbiosis is transferable when the factors presented in the following table are valid:

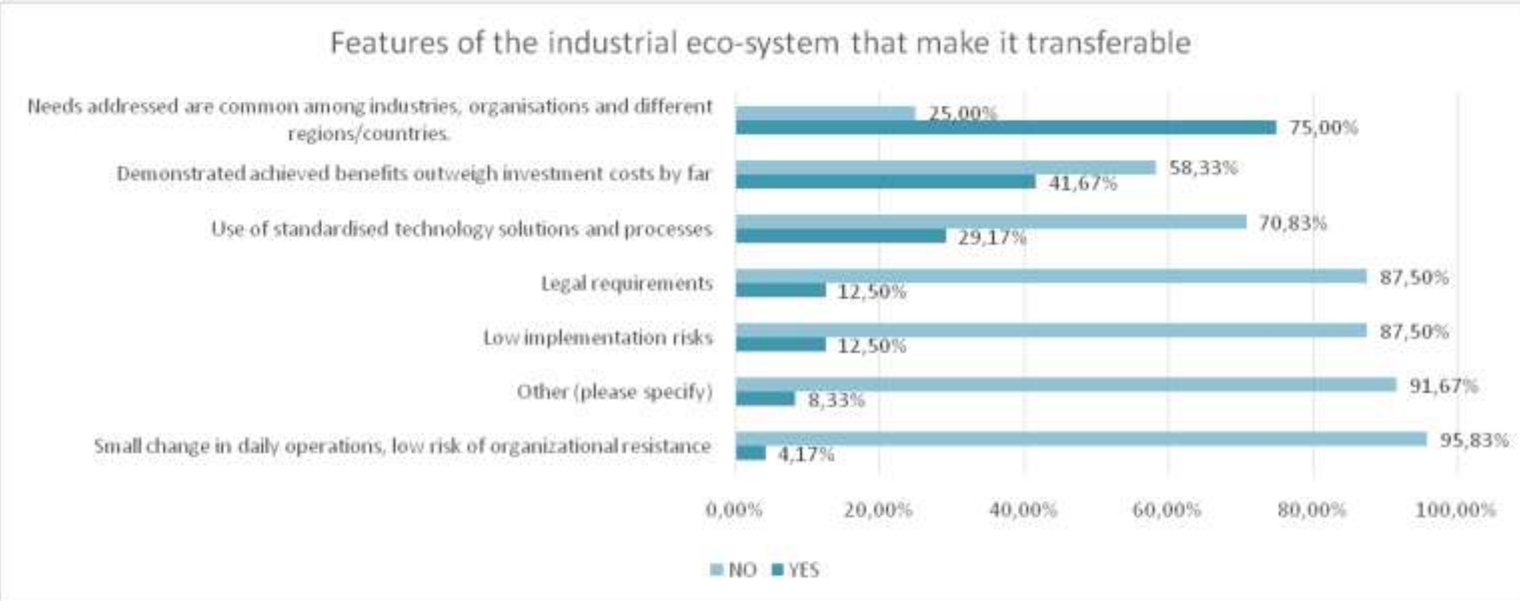
Table 6: Transferability factors for industrial symbiosis projects (48 cases)



Most important determining factor of transferability is the compatibility of needs addressed by the symbiosis among industries, organizations, regions and countries (77 % of cases). The next key factors for industrial symbiosis spill over effect are the existence of benefits that outweigh investment costs by far (58%) and the use of standardised technology solutions and processes (50%). Hence, it is possible to conclude that industrial symbiosis is transferred in the first place to address specific sustainability and resource efficiency needs, and secondly to achieve specific results (i.e. economic and environmental benefits). The transferability prospects are further strengthened if standardised technological solutions are applied.

However, the conclusions appear different if one considers only the 24 cases of industrial symbiosis described by SYMBI partners that have already been transferred. The three aforementioned factors are still the most important; however the effects o f demonstrated achieved benefits and of the use of standardised technologies are significantly reduced (42% and 29% respectively). On the contrary, the effect of compatible needs addressed is at the same level (75%). Hence, it is possible to reach the conclusion that addressing needs that appear in other organisations, industries, and regions is the key factor for t he scalability and transferability of industrial symbiosis practices. The conclusions about the transferability factors for the 24 already transferred industrial symbioses can be seen in the following table:

Table 7: Transferability factors for industrial symbiosis projects (24 already transferred cases)



Having finished the overview of the results of desk research, it is now time to proceed to the presentation of the specific best cases of industrial symbiosis that were found during the desk research.

4 Identification of best cases

4.1 Overview

Best cases of industrial symbiosis projects are those that comply the best in the criteria described in the following table:

Table 8: Criteria for the selection of successful industrial symbioses

CRITERIA	SCORE					THRES HOLD
	1	2	3	4	5	
Level of solution impact	The industrial innovation eco-system addresses a unique problem within the boundaries of a specific industry and geographical scope	The industrial innovation eco-system relates to more than one problem encountered within the boundaries of the specific industry/geographical scope.	The industrial innovation eco-system relates to a unique problem encountered by more than one industry or sector in the area.	The industrial innovation eco-system relates to more than one problem encountered by more than one industry and broader geographical scope	The industrial innovation eco-system addresses a widespread issue that is relevant to all industries and geographical contexts	**3**
Number / type of achieved objectives and produced results	The practice has not produced tangible results or measurable benefits for the community (e.g. increased use of secondary raw materials)	The practice has reached some objectives but not produced measureable results	The practice has reached most of the objectives but not produced measureable results	The practice has reached most of the objectives and produced measurable results	The practice has resulted in significant and measurable results for the community. All planned objectives were met and tangible results were produced	**3**
Extent of problems encountered in implementation	Significant problems were encountered during the deployment / operation of the industrial innovation eco-system	The industrial innovation eco-system had some problems that hindered its implementation	The industrial innovation eco-system had only occasional problems that have not hindered its implementation	Participating organisations faced minor difficulties during the deployment of the industrial innovation eco-system	The deployment / operation of the industrial innovation eco-system had no problems or difficulties whatsoever.	**3**
Scalability of practice	Practice has been	Practice has been only	Practice has been	Practice has been	Practice has been	**3**

CRITERIA	SCORE					THRESHOLD
	1	2	3	4	5	
	implemented with the involvement of a limited number of organisations/companies	implemented within a small area affecting a limited number of organisations/companies	implemented in considerable urban or rural area involving a limited number of companies	implemented in considerable urban or rural area involving a significant number of companies	implemented in the entire city/urban agglomeration involving most of the industries operating in the area	
Level of transferability	Practice has not shown any indications of transferability to different settings/activities	Practice has shown indications of possible replication in a limited number of industries / geographical contexts	Practice has demonstrated strong potential of being replicated in different settings	Practice has been transferred to other industries	Practice has been transferred to more than one industries and geographical contexts	**3**

All 48 cases were checked in order to evaluate the degree of meeting these criteria. Among 48 cases, 12 are considered to be more successful and to meet significantly better the 5 above mentioned criteria. The main reason why 12 and not 10 cases (as asked in the methodology) were chosen as representative of best practices depends on their qualitative characteristics representing various distinct types of industrial symbiosis.

The rationale for choosing the 12 cases had to do with their performance in terms of achieving a substantially high mark in each of the criteria outlined in table 8. As a result of this approach, all 12 cases satisfied to some extent the following criteria:

i. The type of activity included aspects of exchange of energy, by-products and secondary raw materials.
ii. Actors involved included large (industrial) enterprises and/or small and medium sized enterprises.
iii. Active participation and commitment of actors involved were included in the success factors of each of the cases.
iv. SYMBI partners evaluated the cases as successful or very successful examples of industrial symbiosis.
v. All selected cases were replicated or transferred in other areas and

settings.

vi. Commonality of needs addressed among industries, organisations and different regions/countries was one of the most important contributing factors to its transferability.

The scoring grid of the evaluation that led to the identification of these 12 cases can be seen in the table below:

Table 9: Best cases scoring grid

5 Country	6 Industrial symbiosis project	7 Level of solution impact 8	9 Number / type of achieved objectives and produced results	10 Extent of problems encountered in implementation	11 Scalability of practice	12 Level of transferability
13 Slovenia	14 Dinos DROE UniREC	15 4	16 4	17 4	18 4	19 4
20 Spain	21 Manresa en Simbiosi	22 5	23 5	24 4	25 5	26 4
27 Italy	28 Giuliani Environment Srl	29 5	30 5	31 4	32 4	33 4
34 Poland	35 Waste Management and Recycling	36 5	37 5	38 5	39 5	40 5

	Cluster (WMRC)					
	42 Industrial Ecology Club of Aube (IECA)	43 5	44 4	45 5	46 5	47 5
41 France	48 Arcelor Mittal	49 5	50 4	51 4	52 4	53 4
	54 Industrial zone of Lagny Sur Marne	55 5	56 4	57 5	58 4	59 4
60 Sweden	61 Stockholm SymbioCity	62 5	63 5	64 5	65 5	66 5

67 Belgium	**68 Kaiserbaracke**	**69 5**	**70 5**	**71 4**	**72 5**	**73 4**
74 Netherlands	**75 Industrial Symbiosis in Rotterdam**	**76 5**	**77 4**	**78 5**	**79 5**	**80 5**
81 Germany	**82 BASF**	**83 5**	**84 4**	**85 5**	**86 5**	**87 5**
88 Portugal	**89 Chamusca Industrial Symbiosis**	**90 5**	**91 5**	**92 5**	**93 5**	**94 5**

94.1 Brief descriptions

94.1.1 Dinos DROE UniREC - Slovenia

Dinos DROE UniREC is an industrial symbiosis system implemented at a national level and focuses on exchanging energy, by products and secondary raw materials, and the collective gathering and removal of waste materials.

More precisely, Dinos D.D. established in 2013 a subsidiary company, called UniRec, with the purpose to set up an industrial eco-system, called “Plastic bottle for plastic bottle”. This industrial eco-system involved 3 large companies, i.e. UniRec (Dinos), GastroPET and Fructal that formed a closed loop of materials.

The role of UniRec (Dinos) in the industrial symbiosis ecosystem is to collect and sort waste, which it then sells to GastroPET.

GastroPET is a production company, the primary activity of which is the production of PET preforms. GastroPET uses as resources for its production of plastic bottles secondary raw materials, coming from UniREC (Dinos). GastroPET then sells its produce to the Fructal beverage company.

Fructal fills the bottles with its beverages. Those plastic bottles that are considered waste (due to non-compliance with the technical standards) and those collected through dedicated waste-collecting programmes (including schools), are returned back to UniRec (Dinos), thereby closing the material loop.

Dinos DROE UniREC faced several problems, such as the limited support by local policy makers, the realisation of economically unsound or risky exchanges at the initialisation of the industrial symbiosis system, the lack of motivation and commitment among firms when the project was initialized and the lack of geographical and technological proximity of firms.

However, Dinos DROE UniREC managed to overcome these problems due to the sound coordination among partners. More precisely, Dinos DROE UniREC, due to the complementarities of partner firms’ functions is now an industrial symbiosis system with low economic risks, balance of power between partners who actively participate in resource exchanges, and sufficient support by the local authorities.

The efficient function of the industrial symbiosis system has resulted in reducing the greenhouse gas emissions from the functions of the participants in the industrial symbiosis system and, of course, in improving resource efficiency, since the amount of waste from the functions of the 3 large firms has been reduced significantly.

Other relevant info provided:

- National regulatory frame (absence of clear regulation and criteria between the by-products and waste)
- Absence of solid support among different similar companies

The companies, involved in the eco-system, were driven by the responsibility to protect the environment and to use the secondary raw materials instead of buying the primary resources. Though, there are certain economically risks (related to different quantities of collected waste, prices of materials and not stable source of financing), companies were ready to invest in the project due to long-term benefits. Geographical proximity of companies was an issue, but due to wide network of franchises of these companies (particularly Dinos) across Slovenia, they managed to reduce the transportation costs. But the eco-system could save on transport costs, if the companies were located closer to each other. Due to absence of national legislation on what can be considered by-product and waste, the companies surpassed this barrier by using the simpler way: collected plastics was sold as waste, since pre-qualification of the waste to secondary raw material would be more expensive and more difficult in terms of legislation.

Though the project (eco-system) is related to economic risks (not stable source of financing and returns), these are small compared to other processes. Therefore it is affordable for the companies to invest and financially support such system. In terms of “legal and political support”, there is a strong political support on local level (much better than on national level). Local communities (municipalities) are very much in favour of such eco-systems, therefore they are advocating inclusion of different stakeholders (schools, hospitals, public places etc.) in the system in order to maximize the effects and results. What plays an important role is active participation of all partners in eco-system as well as other relevant stakeholders. They are all strongly committed to continue implementing this project, since it is beneficial for the local communities, companies and most important, environment.

The eco-system does not have an impact on productivity of the firm, since it is carried out on a smaller scale. In terms of costs of production, it has a slight negative effect, since the companies still need to invest in it. But there a slight positive effect on quality of products and services (new knowledge, positive effect on brand and better cooperation among stakeholders). The eco-system (for the time being) does not any effect on regional GDP or employment, but it has a potential to have it in the near future. Due to this project, the companies needed to introduce new business models, affecting research and innovation (particularly in the domain of recycling and raw materials). But there are significant impact on greenhouse gas emissions, resource efficiency and energy efficiency. There is one more impact that have not been mentioned yet, i.e. health. By reducing the greenhouse gas emissions, the eco-system contributes to improving the health environment and thus acts pro-active.

These positive results of Dinos DROE UniREC led to a high potential for transferability of its model. In fact this industrial symbiosis concept has already been transferred in other areas of Slovenia. The eco-system served as a basis for setting up a new circular concept, called TetraPak. TetraPak system will aim at collecting TetraPak waste and putting it back in a circular loop for materials. The TetraPak eco-system will involve more industries, where waste of one will be the input raw material for another. The reason why Dinos DROE UniREC has demonstrated this high potential for transferability has to do with the fact that it uses standardised technology solutions and processes, addresses needs that are common among in Slovenia and demonstrates low implementation risks.

To conclude the analysis, the key lesson learned from the industrial symbiosis in Dinos DROE UniREC is that the key factors of success and transferability of industrial symbiosis are the following:

- Enhanced mutual trust between companies
- Better cooperation among companies and stakeholders
- Raising awareness about industrial symbiosis

Companies need to have the will to find opportunities to cooperate within the context of industrial symbiosis.

94.1.2 Manresa en Simbiosi - Spain

“Manresa en Simbiosi” is the first industrial symbiosis initiative of the Council of Manresa (Catalonia) with the participation of Simbiosy (http://www.simbiosy.com/) with the purpose of creating the basis for promoting synergies between companies / entities, thereby maximising the efficient use of available resources. The key characteristic of “Manresa en Simbiosi” is that it is an open industrial eco-system that aims to encourage exchanges of all types of by-products. The purpose is not to develop an industrial symbiosis ecosystem designed to include exchanges of only specific types of by-products. On the contrary, the purpose is to create the infrastructures and implement in Manresa an industrial ecosystem that allows firms to identify potential partners with which they can create synergies, exchange their by-products and maximise their efficiency. “Manresa en Simbiosi” helps companies in Manresa and Bages to learn to take advantage of synergies with other companies, reduce their costs and increase their competitiveness, thereby strengthening the industrial base of the area, promoting innovation and creating new companies and jobs. Other positive contributions of the formation of “Manresa en Simbiosi” are that it opens the way to future innovation and applied research projects for companies and territorial development, and that it raises awareness about the process of adaptation to a circular economy.

“Manresa en Simbiosi” has managed to help companies develop synergies by making available the following tools:

• The "INEX" Platform is a data management tool that allows identifying synergies and helps managing the networks of companies to implement them (www.inex-circular.com)

• Work sessions with other entrepreneurs to bring forth the synergies detected

• Advice to participating companies about how to increase the efficiency in the use of their resources

“Manresa en Simbiosi”, as can be seen in the description above, promotes many types of cooperative activity and includes many distinct types of actors. Cooperative activities promoted by “Manresa en Simbiosi” include the exchange of energy, by-products and secondary raw materials, the joint use of utilities and commercial firm facilities, the collective gathering of waste, the utilisation of public utilities and multi-modal transport. Actors involved in the industrial ecosystem include large enterprises and SMEs, regional and local authorities and public agencies. However, "Manresa en Simbiosi" has attempted to involve also the general public in its initiatives by raising its awareness to promote resource efficiency.

The open and multifaceted character of "Manresa en Simbiosi" means that it has the potential to benefit Manresa, Catalonia and, in general, Spain, by a multitude of ways. Increased resource efficiency and cooperation in many sectors can lead to increases in the local GDP and savings, more productivity and job opportunities, enhanced research and innovation capacity and reductions in greenhouse gas emissions.

Of course, "Manresa en Simbiosi", as all industrial ecosystems faced several problems during its development. Key problems included the lack of financial resources and expertise and the potential for economically unsound exchanges of by-products. However, factors such as the close proximity of companies involved in Manresa and Bages, the diversity of actors involved, the similarities in the organisation culture of the firms involved which participate in a balanced way, and their active participation and commitment helped address these problems. These are the reasons why the adaptable concept of "Manresa en Simbiosi" can be considered already from the first year of its implementation quite successful, and has already been replicated in other areas of Catalonia. Factors that make it easily replicable and transferrable include the use of standardized technology solutions and processes (e.g. INEX platform) and the fact that it addresses common needs encountered in the entirety of Spain.

Finally, a key lesson learned from "Manresa en Simbiosi" is that in our heavily networked economies, success is not determined by the amount of resources (in this case waste) available, but by the will of the people to change and get involved in circular economy processes.

94.1.3 Giuliani Environment Srl - Italy

Giuliani Environment Srl operates in Molise within the environmental sector. It was founded in 1998 through the transformation of the Francesco Giuliani company that operated since 1969 within the construction and environmental service sectors. Thanks to the continuous technological innovation, the exploitation of its know-how and the constant adaptation to the changing rules of the sector the company has become an important reference in the integrated waste cycle. Giuliani Environment Srl implements different activities, including the composting and treatment of the paper from the urban waste collection. This activity forms the basis for an industrial ecosystem.

Regarding the composting activity, the Giuliani Environment Srl through a specific technique accelerates, controls and improves the natural process of the organic substances. This process, which takes place under controlled conditions, allows Giuliani Environment Srl to obtain a biologically stable product, suitable for different applications: horticulture, industrial crops, fruit-growing, etc. In addition, the production of compost contributes to solving the problem of waste disposal, as the organic fraction represents about one third of the waste produced.

As regards the treatment of the paper, the Giuliani Environment Srl collects this waste, coming from urban separate waste collection, afterwards it selects and treats the paper waste according to the regulations. Subsequently, the paper is delivered to COMIECO consortium or directly to users, such as paper mills. Thanks to this process the paper becomes a secondary raw material ready for reuse.

Giuliani Environment Srl is a specialised industrial ecosystem focusing on the exchange of energy, by-products and secondary raw materials (i.e. urban waste paper), with the aim to improve resource efficiency and open new markets for secondary raw materials. It involves only specific types of actors in each of its functions, i.e. SMEs as receivers of waste and the national and local authorities as regulators and collectors of waste paper respectively. The problems that were encountered during the deployment of this industrial ecosystem were related to its specialised character. For example, the involvement of only specific types of firms and national/local public authorities led to imbalances in the power participants had over the characteristics of the industrial ecosystem. At the same time there was no consistent support to the ecosystem by local authorities which was expressed in a number of ways including the lack of sufficient funding for firms/local authorities that participated in the industrial ecosystem.

The aforementioned problems were address by instituting a process where all the companies participating in the industrial ecosystem met continuously and visited each other in order to learn about their organisational structures and their local contexts.

Furthermore, this process helped participant firms to internalise the legal requirements and market trends of the sector. Finally, Giuliani Environment Srl networking benefited from the formation of national packaging consortiums, as foreseen by national legislation.

In general, Giuliani Environment Srl has optimised its resource use (both human and technological) and to increase its productivity. The industrial symbiosis ecosystem has also contributed to improving the quality of the production process and to increase the company's turnover. These are the main reasons why "Giuliani Environment Srl" symbiosis can be considered both successful and transferable. Key reinforcing factors of its replicability include the use of standardised technology solutions and processes, and the common needs addressed among industries, organisations and different regions/countries.

94.1.4 Waste Management and Recycling Cluster (WMRC) - Poland

Waste Management and Recycling Cluster (WMRC) is not a industrial ecosystem that includes a limited number of firms, but rather an industrial ecosystem that aims to involve in exchange of by-products and waste as many companies as possible, even if some of them are competing with one another. WMRC has developed and aims to develop synergies in order to provide firms with access to specific resources (knowledge, new technology, trained personnel etc.) that will help them achieve better in the long run more their quantifiable, economic targets, compared to their achievements when remaining outside of the group. Increasingly, however, WMRC has followed the requirements of the market and, therefore, clusters are built based on functional criteria (how best to meet the market) and thus the cluster participants cooperate on the principles of complementarity and not competition, thereby creating a customer value chain.

In WMRC, most of SMEs focused on recycling waste of electric and electronic equipment (WEEE), until one of WMRC's members, the 3Re company noticed the development of circular economy in the EU and proposed to create an industrial symbiosis ecosystem to promote the reuse of materials by cluster members. 3Re proposed the formation of the industrial symbiosis as an instrument for the opening of new markets for secondary raw materials, the augmentation of the profitability and revenue of firms involved and the reduction of production costs. Indeed, to keep up with fast-changing trends in manufacturing of electronic devices such as mobile phones, smartphones, computers, tablets, touch screens, decoders, game consoles, monitors, printers and small domestic appliances, 3Re started to reuse and refresh these devices, instead of constantly buying them. The company offered to share a value and better price for the part of WEEE which can be reused. They introduced systems for testing, recovery and dismantling monitors, PCs, laptops, RAM, etc. Chosen devices i.e. disks are scanned for bad sectors and other damage, and after, it they satisfy the technical requirements, they are cleaned and prepared for reuse. Hence, all WEEE excess materials from companies are collected to provide them as raw materials for arts and crafts and/or making secondary products. Parts which are not suitable for reuse can be sent back to recycling companies.

Since its creation in 2011, WMRC has expanded and now includes about 70 different organizations, i.e. SMEs, and large companies, universities, NGOs, which have engaged in cooperation and exchange of resources. This successful course was not without problems. Those identified were the limited support WMRC enjoyed among local policy makers, the different organizational cultures among all those different firms that participate in WMRC, the lack of motivation and commitment that was observed among some firms, and, last but not least, the lack of geographical and technological proximity of various firms that participated in the industrial symbiosis. However, these problems were to some extent surpassed because WMRC encourages companies to adopt a collaborative approach in all aspects of their business and not in just some of their functions. This way WMRC managed to induce firms to complement the industrial symbiosis procedures with their competitive advantage, and used to its advantage the diversity of actors involved in the industrial ecosystem. Other success factors of WMRC included the low economic risks associated with WEEE and the active participation and commitment of firms therein.

These success factors have rendered WMRC the Key National Cluster in Poland in 2016, since it achieved a number of important targets such reducing greenhouse gas emissions, and improving resource and materials efficiency. These achievements combined with the low implementation risks of the WMRC key concept and the fact that it addresses needs that can be found in any region and/or company (all economies are in need of efficient reuse of WEEE), render WMRC a highly transferable industrial symbiosis. In fact, the 3Re is continuing to more attract companies for reuse, as they provide the highest quality standard. Also, it has been argued that, by encouraging the development of synergies beyond the neighborhood companies it is demonstrated that there is an underlying potential to establish an eco- industrial network within the whole region. Due to proper communication and proper agreement to share the profit among partners as well high technology development for reuse the industrial symbiosis can further develop. This idea can be promoted by national and EU policy as it is in line with circular economy assumptions.

94.1.5 Industrial symbiosis between Cristal Union and Appia Champagne - France

The Industrial Ecology Club of Aube (IECA) initiated the industrial symbiosis between Cristal Union Factory and Appia Champagne (ISCUAC). The aim of the project is to address long term issues pertaining to economic development and regional planning. More precisely, ISCUAC involves large (industrial) enterprises, SMEs and IECA to improve resource efficiency, open new markets for secondary raw materials, reduce CO_2 emissions, increase the profitability of the organisations involved and reduce the production costs.

ISCUAC is an industrial symbiosis project that focuses on the exchange of by-products and secondary raw materials. More precisely, the Cristal Union Sugar Factory located near Troyes processes daily 25000 t of sugar beets. The muddy water after washing sugar beets contains varied sediment granulation among other sand. As a result of muddy water treatment, sand is recovered. The sand is dirty and polluted; therefore, it cannot be used in agriculture industry, although it works well as a construction material. Since 1964 the sand has been stored on the fields within the radius of 30 km from the sugar factory, which results in high pollution and the development of landfills which cost Cristal Union from € 150000 to € 300000 per year. During the two months of beet campaign, 22000-24000 t of sugar beets were processed per day giving 15000 t of sugar and 1500000 hectolitres of ethyl alcohol, the by-product of this process was sand (300 t/day).

In 2004 a partnership between Cristal Union and Appia Champagne (subsidiary of Effiage, company specializing in engineering) was established pertaining to the disposal of sand. With the agreement concluded between these companies, the sugar factory does not have to pay for sand storage and Appia Champagne obtains construction material free of charge. Thanks to the joint venture, Appia Champagne is able to reduce sand extraction from quarries which leads to cost reduction. The enterprises have common transport of beets and sand by trucks so as to minimize the negative impact on environment (CO2 emissions) and reduce cost.

ISCUAC is a very successful project that was developed without significant problems and through the involvement of different actors and their active participation and commitment, managed to benefit the participating organisations in the following ways:

- Cost reduction: Cristal Union does not pay the cost of landfill, so the company saves € 150000 to € 300000 per year.
- Improved resource efficiency: due to the fact that enterprises provide common transport, it is possible to reduce the length of the journey by 100000 km, and thus save 40000 litters of oil.
- Social aspects: improving the environmental image of the companies involved.

ISCUAC has significant transferability potential since it uses standardised technology solutions and processes and addresses needs that are common among industries, organisations and different regions/countries. In general, the key lessons learned from the analysis of ISCUAC are the following:

- The fact that the companies represent different industries (Cristal Union enterprise engaged in food industry, and Appia Champagne company specialized in construction) is an important factor for industrial symbiosis.
- Effective implementation of industrial symbiosis has led to a significant reduction in costs.
- Openness and effective cooperation is a key aspect of the implementation of industrial symbiosis.

94.1.6 Dunkirk Industrial Symbiosis - France

Dunkirk Industrial Symbiosis (DIS) is an example of a successful application of industrial symbiosis in the urban environment. DIS is based on the recovery of heat from the exhaust gases from the ArcelorMittal steel manufacturing in Dunkirk (France), and involves large industrial enterprises and local authorities all combined in a district cluster in Dunkirk.

DIS was initiated when in 1985 ArcelorMittal implemented an initiative concerned with sustainable development of its industry by creating the district cluster in Dunkirk. The cluster is an example of cooperation between private and public entities, which has been successfully implemented for over 30 years. ArcelorMittal, along with the other industries in the cluster, provides heat as well as partially contributes to almost zero emissions of district heating of Dunkirk.

In ArcelorMittal heat recovery takes place during the first stage of the manufacturing process i.e. the sintering process of iron ores. The ore heated to 1,200°C is later cooled in industrial blowers. Once the temperature has reached 400°C, the hot air is directed to the heat exchanger where it heats water. The hot water is sucked in a pump and drives to district heating network of Dunkirk. With more than 40 km of pipes it is possible to provide heat for various locations. The total power of the system installed in the ArcelorMittal company is 120 MW (this is the equivalent of 2400 gas boilers). The system implemented by ArcelorMittal is about 15-20% cheaper than fossil fuel.

The heat recovered in ArcelorMittal allows for supplying 6000 housing units with heat. Beyond houses, from the heat benefits a number of private and public institutions such as hotels, swimming pools, colleges, and universities. Additionally, DIS is one of the focus topics of the EU-funded EPOS project (Enhanced energy and resource Efficiency and Performance in process industry Operations via onsite and cross-sectorial Symbiosis). A synopsis of the industrial symbiosis in Dunkirk can be seen in the following image:

DIS was developed to reduce CO_2 emissions and production/heating costs in the city of Dunkirk and has so far managed to achieve its targets without significant problems. Key success factors behind DIS have been the close proximity of ArchelorMittal and the city of Dunkirk, and the active participation of both the large industrial firm and the hotels, swimming pools, colleges etc. In fact, DIS managed to provide an alternative to fossil fuel that is significantly cheaper (15-20%). In addition, DIS managed to achieve a positive social impact: it increased the cooperation between ArcelorMittal and the city to promote the idea of sustainable development, thereby helping to develop a culture of cooperation in the local economy of Dunkirk. These results suggest that DIS is a very successful example of industrial symbiosis in an urban environment.

DIS is a type of industrial symbiosis that can be easily transferred to other settings because on the one hand, it addresses needs that are common among industries, organisations and different regions/countries, and on the other hand its demonstrated achieved benefits outweigh investment costs by far. Furthermore, its transferability potential increases by the fact that it has been implemented and constitutes an example of good practices for over 30 years. DIS has already been transferred in Sweden, where similar methods are used for heat recovery.

DIS provides a multitude of lessons learned with regards to developing industrial symbiosis in a cluster within an urban setting. Achieving effective cooperation between the partners in the cluster is crucial for its success, and it can be achieved only by demonstrating convincingly that environmentally friendly solutions, such as those proposed by ArcelorMittal, are cheaper than using fossil fuel. Hence, corporate social responsibility, i.e. the ability to demonstrate and promise convincingly that the exchanges through industrial symbioses are cheaper than the alternative, and then to follow up on this promise can be the most secure foundation for the success of industrial symbiosis structures

94.1.7 Industrial zone of Lagny Sur Marne - France

The industrial zone of Lagny Sur Marne (IZLSM) has developed an industrial symbiosis project that is managed by the local agglomeration authorities of Marne and Gondoire which provide regulation and the potential for dynamic development of the zone. Hence, it is an industrial symbiosis project that involves SMEs and local authorities. The industrial symbiosis project involves the exchange of energy, by products and secondary raw materials between the enterprise Yprema and Sietrem (Syndicat mIxte pour l'Enlèvement et le Traitement des REsidus Ménagers).

IZLSM was developed to promote the use of sustainable bio-energy resources, improve resource efficiency, and reduce CO_2 emissions and production costs. To achieve these targets IZLSM focused on the complementarity of the waste from the two firms. More precisely, Yprema is a company from the construction and public works sector. Yprema's activities focus on: using slag as a road construction material, and transporting wastewater to the association called Sietrem engaged in the collection, processing and recycling of municipal waste. The Sietrem enterprise also owns the Municipal Waste Incineration Plant (MWIP) in St-Thibault-des-Vignes. On the other hand, Sietrem provides treatment of municipal waste, produces slag as a result of the incineration of the municipal waste and uses wastewater (from Yprema enterprise) for the process of slag cooling.

Yprema built a barge made of recycled aluminium for transporting slag. This barge is 20 meters long and 4.5 meters wide, which allows the transport of 80 tonnes of slag per crossing. Currently, there are two crossings a day, giving a total of 160 tonnes of transported slag. The barge is towed by horses, which shows high environmental awareness. It also contributes to minimizing CO_2 emissions related to reducing road transport between two facilities.

Yprema has switched from road transport to pipelines directly connecting the two enterprises. Wastewater from treatment of slag (Yprema) is transported from a valorisation centre by means of pipelines to the MWIP in Saint-Thibault-des-Vignes to be used in the process of slag cooling. MWIP in St-Thibault-des-Vignes uses 16000 m^3/year of treated wastewater to cool incandescent slag. Thanks to industrial symbiosis (reuse of wastewater from slag treatment), water consumption has been reduced by half.

The symbiotic relationships developed within IZLSM were established without significant problems. This was due to the close proximity of companies, the participation of both businesses and local authorities, the similar organisation cultures of firms involved, and their active participation and commitment.

The latter was ensured by the success of IZLSM that brought about benefits such as the following:

- Reduce in greenhouse gas emission – annual emission savings of around 56 t of CO_2 as a result among others of reducing the number of truck journeys by 1350
- Increase in job opportunities (employment) – creation of 4 jobs in Yprema
- Improving the environmental image of the businesses.

Even though IZLSM is a very specific case of industrial symbiosis, it has a large transferability potential since it addresses needs (i.e. wastewater and slag reutilisation) that are common among industries, organisations and different regions/countries.

Finally, the lessons learned from the analysis of IZLSM are the following:

- Short distances between participating companies are advantageous.
- Complementarity of enterprises creates industrial symbiosis

A similar organizational culture is an important factor for the development of industrial symbiosis in Lagny sur Marne.

94.1.8 Stockholm SymbioCity - Sweden

SymbioCity is a Swedish government initiative run by Business Sweden and SKL International. Business Sweden oversees the SymbioCity trademark and promotes national exports on behalf of the Swedish government and industry. As part of Swedish international development co-operation, SKL International uses the SymbioCity Approach to support cities to plan and build sustainably e.g. by identifying inclusive and innovative solutions. Hence, SymbioCity aims to increase the awareness about some of the numerous opportunities available to local councils seeking to steer their cities towards sustainable development. There are many valid and different points of views and large- and small-scale solutions depending on differing conditions and cultures. Swedish expertise offers support and know-how to help you to create your plan towards a more sustainable city.

SymbioCity stands out among the best cases found in this research, because it is the unique example of applications designed to promote sustainable development that were deliberately developed to be exported and transfer know-how. Several of these applications have to do with circular economy and industrial symbiosis, such as:

- ***WASTE OFFER:*** SymbioCity provides best practices to achieve the transition towards sustainable waste management.
- ***SUSTAINABLE AIRPORTS OFFER:*** SymbioCity provides best practices to build or redevelop airports by applying a holistic model and a collaborative approach that unlocks synergies within and between systems: synergies that can deliver major benefits for safety and the environment – and cut costs.
- ***GRID SOLUTION OFFER:*** SymbioCity unlocks synergies in urban functions and boosts their efficiency and profitability, via the integration of next-generation ICT with the electrical power grid, thereby enabling the greater and improved utilisation of renewable energy sources. Smart grids also improve energy efficiency throughout the system, using intuitive user interfaces that involve and activate consumers.
- ***SYMBIOCITY BIOGAS OFFER:*** The SymbioCity Biogas offer proposes practical ways to save money and energy by producing fuel from sewage and waste.
- ***SYMBIOCITY HEATING AND COOLING:*** SymbioCity takes a holistic approach to

sustainable development. It is possible to find synergies in urban functions and unlock their efficiency and profitability. This is the key to Swedish design and manufacture of energy-efficient power supply and distribution systems.

As can be inferred from all the above, the application of SymbioCity know-how is more effective at a national level and needs to involve both SMEs, national & local public authorities. Where applied, SymbioCity managed to promote the use of sustainable bio-energy resources, improve resource efficiency, reduce CO_2 emissions and decrease the costs of production. The key for this success was the fact that SymbioCity involved diverse and committed actors, established the legal and political support of public authorities, and achieved a balance of power among most participants. The positive impact of SymbioCity consists of the following:

- **Contribution to the regional GDP**: SymbioCity has achieved 44% economic growth in the last 15 years that increased the GDP of Stockholm.
- **Cost reduction / Annual savings:** Thanks to its pioneering design, Hamnhuset, that was developed by SymbioCity, is 75 percent more energy-efficient than standard buildings while still offering the standards and comfort expected in newly constructed premises. In addition, the technology is cheap. Hamnhuset cost 2.5% more to build than a conventional building – an investment quickly repaid by lower running costs.
- **Improved resource efficiency:** SymbioCity has launched in Linköping a new system where biogas is used as fuel on the market. Its success inspired many other local authorities to press ahead with equivalent initiatives. In a short time, the produced bio-gas has conquered 7% of the local fuel market for vehicles. The majority of public transport buses are already converted to biogas. The project has cut volume of waste sent for incineration in Linkoping each year to 3,422 tonnes and boosted biogas production to 1,334,580 cubic meters - equivalent to 12.65 GWh of renewable vehicle fuel, mainly to be used for public transport.
- **Increase in job opportunities (employment):** SymbioCity has offices in 60 countries and works closely with trade associations, embassies, and chambers of commerce to promote Sweden internationally.
- **Reduce in green gas emissions:** SymbioCity has achieved significant cuts in CO_2 emissions in the last 15 years.

- **Social aspects:** SymbioCity increased the collaboration between 60 countries, and implemented successfully several international projects (SymbioCity Borås-Palu Cooperation, SymbioCity Probolinggo-Helsingborg Cooperation, Kenya SymbioCity Programme).

Finally, it is necessary to point out that SymbioCity was developed to be transferred to different regions and countries and addresses needs found all over the world. Hence, since 2010, SKL International and SymbioCity has supported cities in Africa, Asia and eastern Europe to enhance their capacity to plan, develop and manage urban areas in a more sustainable direction through the SymbioCity Approach. The projects have mainly been subsidised by The Swedish International Development Cooperation Agency (Sida) and have been carried out in cooperation with Swedish and local partners.

As a result SymbioCity provides highly important lessons for the transferability of know-how related to industrial symbiosis. More precisely:

- SymbioCity offers the knowledge, methods and experience and promotes methods that can be adapted to the needs and context of each region/country. SymbioCity has the experience of Swedish architects, planners, engineers and construction companies and institutions.
- SymbioCity is a dynamic concept that offers something for everyone. It can be apply from single blocks to entire urban areas, from regions to countries and from redevelopment schemes to greenfield initiatives.
- SymbioCity works regardless of stage of developed: it is dedicated a developed, developing or transitional economy.

SymbioCity can be used by public and private actors alike (by local government, utilities, private business and other stakeholders).

94.1.9 Kaiserbaracke - Belgium

The Kaiserbaracke industrial park is an example of an industrial symbiosis developed at a local scale. The main reasons for the implementation of the industrial symbiosis were limited access to traditional raw materials and substituting the use of fossil fuels due to their large costs. Kaiserbaracke participants managed to overcome these issues by developing a system of biomass utilisation. In 2004 an arrangement was initiated by three companies ie.

Belwood, Delhez et Renogen, and in 2005 the group was joined by the company Holz Niessen. The symbiosis initiated its operations in 2006, with a budget of approximately 40,000€.

Kaiserbaracke is a successful example of an industrial symbiosis that involves SMEs, local authorities and public agencies and where companies act only as business partners. At the Kaiserbaracke industrial park, wood is used as a raw material for energy production. The Holz Niessen company is a timber sorting centre. As a result of the wood sorting process at the Belwood sawmill, 50% of the wood is turned into finished and semi-finished products, with the remainder being bark, sawdust, and scrap wood. Production wastes are treated entirely on-site to produce heat (Renogen company), pellet (Delhez company), semi-finished wooden products. The Renogen company then contributes with its co-generation centre that allows for the production of heat and mechanical energy which is then converted into electricity. Heat is used both to produce pellet in Delhez and wood plank in Belwood by drying sawdust. Surplus heat is sold to the public electricity network. Ashes from the combustion of biomass are used in the construction industry for the production of clinker or ballast. The next stage of the project development was joined by Spi + , the economic development agency for the province of Liège, which is responsible for the development of the infrastructure of the industrial park. The area where the park is located belongs to Amblève municipality.

Kaiserbaracke is a successful application of the industrial symbiosis model that encountered no significant problems during its application. This was made possible by the close proximity of the companies involved and their active participation and commitment. The industrial symbiosis managed to achieve its objectives of exchanging energy and by-products, promoting the use of sustainable bio-energy resources and reducing the production costs of participants and resulted in increasing the productivity of the participating companies. A cogeneration unit produces the amount of electrical energy equal to the amount consumed by 26000 households during a whole year. Furthermore, Kaiserbaracke helped create 20 more jobs and reduced greenhouse gas emissions by 32 tons of CO_2 per year.

Kaserbaracke has already been transferred to other areas (the industrial park of Roch-en-Brille), mainly due to the fact that its demonstrated achieved benefits outweigh investment costs by far. This factor is even more strengthened when considering that the use of biomass for generating electricity and heat, and then management of ashes from combustion of the biomass in construction industry is a common technological solution. Furthermore, by dealing with cheaper sources of energy, Kaiserbaracke addresses needs that are common among industries, organisations and different regions/countries.

94.1.10 Industrial symbiosis (IS) in Rotterdam - Netherlands

Industrial symbiosis (IS) in Rotterdam began as the industrial ecosystem (INES) program in 1994 with the participation of 69 industrial companies. In 1994, several bilateral arrangements already existed, however the systematic holistic search for the possibilities of sharing resources across companies in the form of symbiotic linkages to use the language of industrial ecology and cooperation between industry and academic units were new in this region.

Currently, the port of Rotterdam is the largest sea port in Europe - hundreds of millions of tonnes of cargo are handled on an annual basis. 175,000 people are working in and for Rotterdam's port and whole industrial area. An extensive intermodal transportation network of rail, inland shipping, road, short sea and pipelines gives the port of Rotterdam the best possible connections to the rest of Europe[2].

In cooperation with local public authorities, power companies, industrial facilities and municipalities, the Port Authority has utilised the Deltaplan Energy Infrastructure to promote the construction of structures in the form of pipelines that allow the residual heat and steam from businesses in the port area to be put to better use. Residual heat and steam can be utilised by the industrial sector itself, but also by surrounding urban (e.g. as district heating) and horticultural areas (e.g. greenhouse farming). This system makes it possible to achieve considerable savings in power consumption and to reduce significantly the emissions of CO_2, NOx and particulate matter.

To describe the utilisation of residual heat and steam derived from the industrial ecosystem in Rotterdam by *specifically* the industrial sector, it is important to point out that industrial processes in the port release large quantities of heat, steam and CO_2, which is utilised by the chemical companies via an intelligent system of pipelines. It is an efficient way to contribute to a sustainable port and ensure a profitable and sustainable business climate. It is

[2] https://www.portofrotterdam.com/en/the-port/facts-figures-about-the-port

important to point out that Large-scale investments are required to create this infrastructure, as well as a joint effort by public and private parties.

Currently, the energy infrastructure includes the following routes[3]:

- Nieuwe Warmteweg – 26 km underground pipe network which transports heat from waste and energy company AVR to the Rotterdam city centre where it is used for district heating;
- Leiding over Noord – 16.8 km pipeline, energy supplier Eneco transports residual heat from waste and energy company AVR in Rozenburg via Vlaardingen and Schiedam to the district heating network of Rotterdam;
- Steam network – 2 km stem network brings available steam to companies which need steam. Network links up AVR with chemical company Emerland Kalama Chemical (EKC) in Botlek;
- CO_2 capture and use – pipeline network of OCAP, CO_2 is transported from Shell Pernis and Abengoa to the greenhouse areas of Westland, where it is used to enhance the growth and quality of crops.

Five units (the Port of Rotterdam Authority, Gasunie, the Province of Zuid-Holland, Eneco and Warmtebedrijf Rotterdam) signed a letter of intent regarding the realisation of a main infrastructure for distributing heat to a variety of users, including private households, horticultural firms for the heating of greenhouses and companies in the province of Zuid-Holland. The name of programme is Warmtealliantie Zuid-Holland (Zuid-Holland Heat Alliance)[4].

Industrial symbiosis in Rotterdam is a successful example of an industrial ecosystem that focuses in exchanges of energy and articulates a collaborative process between large industrial enterprises and local authorities that includes large scale investments. The symbiosis has managed to address its main objectives, such as the promotion of the use of sustainable bio-energy resources, and the reduction of CO_2 emissions, without significant problems. The use and re-use of heat in the port of Rotterdam has reduced the volume of fossil fuels used for heating. The most important benefit in view of regional sustainability

[3] https://www.portofrotterdam.com/en/cargo-industry/energy-industry/energy-infrastructure

[4] https://www.portofrotterdam.com/en/news-and-press-releases/zuid-holland-heat-alliance-setting-to-work-on-the-new-heat-network

ambitions is a substantial reduction in CO_2 emissions. The main reasons for this harmonious development were the close proximity of the institutions involved and the active participation and commitment of both local authorities and large enterprises that acknowledged the financial, environmental and social benefits from the symbiosis. The interaction of firms and local authorities within the industrial ecosystem has contributed to the development of a culture of collaboration between selected energy-related players in the region, that satisfies the needs of the society.

Industrial symbiosis in Rotterdam has a high potential for transferability and expansion since it has been followed from the very first moment the best practices developed by the Kalundborg symbiosis. Spaanse Polder (one of the project in Rotterdam) was a support case (next to Kalundborg) during the modelling of industrial symbiosis. Expansion is possible since the firms in the port area produce a large amount of industrial residual heat. There is a possibility that the projects outside this area can also be incorporated in the network, including sustainable sources of heat like geothermal wells. The residual heat generated in the port of Rotterdam can potentially fulfil the annual heat requirement of over 500,000 households. This is one of the most important environmental benefits for this region and it could play a major role in achieving the adopted climate targets. The use and re-use of heat in the port of Rotterdam could help reduce the volume of fossil fuels used for heating. This could bring a further benefit - substantial reduction in CO_2 emissions. According to the regional sustainability ambitions and the current public debate, the heat network in this area will not be relying on heat from coal-fired power plants. Beyond the expansion, the key factors that make transferable the Industrial ecosystem of Rotterdam is the use of standardised technological solutions and the common needs addressed among large enterprises and local authorities.

The main lessons that can be derived from Industrial Symbiosis in Rotterdam are related to the development of a collaborative culture and mutual trust building between industries and enterprises:

- Industrial symbioses should aim to address the needs of various different players within a society: the heat network in Rotterdam offers a reliable, affordable and sustainable heat supply to both private households and companies.

- Industrial symbiosis should not override the autonomy of the involved firms, by basing their individual industry agreements on commercially sound principles.
- Efforts should be made to reduce or eliminate the impact of legal barriers. The development of the symbiosis is voluntary but occurs in close cooperation with government authorities.
- Short physical distances between participating plants are advantageous for the development of industrial symbiosis

Efforts should be made for the development of a collaborative culture including mutual understanding of the management principles of the industrial ecosystem,cooperative commitment from participants and effective communication within the network

94.1.11 BASF Industrial Symbiosis (Verbund) - Germany

The industrial symbiosis initiated by the German company BASF (BASF IS hereafter), is an example of a successful industrial ecosystem developed around one company's functions. BASF is the world's leading chemical company with sites in more than 80 countries, including Europe, America, Africa and Asia, operating in five segments: Chemicals, Performance Products, Functional Materials & Solutions, Agricultural Solutions and Oil & Gas. The initiation of BASF IS took place after BASF developed the idea of Verbund and established it as one of its strengths. The Verbund idea is based on interlinking of production facilities, know-how & energy flows, customers and infrastructure in a smart way, to improve resource efficiency and reduce the production costs for all corporate participants. The Verbund idea is focused on four issues:

- Delivering more cost-effective, safer and environmentally friendly production processes, through the achievement of savings of energy by means of efficient processes and avoiding long transport routes (optimisation of transport),
- Developing more efficient technologies, through the establishment of a company unit for Engineering and Operational Excellence and strengthening BASF's global network to diffuse the innovation and to integrate know-how.
- Working closely with customers and receiving & analysing their impact, in order to interlink technologies with the appropriate markets.
- Integrating employees of participants in one company in order to share experience and knowledge and achieve good and effective networking, with the

aim to have easy access to the necessary information at any time using special tablets and QR codes (digital transformation under the banner “BASF 4.0”).

Currently, Verbund is a concept of industrial symbiosis that links both large corporations such as BASF itself and SMEs. To describe it more precisely, the largest BASF Verbund is located in Ludwigshafen, Germany. Ludwigshafen Verbund Site was established in 1865 and now it is one of the six Verbund sites in the world. Verbund allows for many different types of resource, waste and by-product exchange as long as each company uses the resources of other companies in an efficient way, taking into account economic issues, social responsibility and environmental protection. In addition, Verbund provides firms with the opportunity to utilise joint commercial firm facilities.

In Ludwigshafen, by-products of one company are used as raw materials in other plants. It is an example of efficient and resource-conserving value-adding chains, which preserve resources and energy, minimize emissions, and reduce logistics costs. So, the production plants, energy flow (the waste heat of one plant provides energy to others), infrastructure, expertise and customers are connected and integrated. This gives rise to efficient value-adding chains ranging from basic chemicals to highly sophisticated products. Furthermore, one facility’s by-products could serve as feedstock in other company. It provides savings in raw materials and energy, reduces greenhouse gas emissions, lowers logistics costs and makes use of industrial synergies.

Furthermore, in Ludwigshafen, cooperation with many science and industry units (600 excellent universities, research centres and companies - approximately 10000 employees in research and development) worldwide contributed to creation of an international and interdisciplinary Know-How Verbund. Expert knowledge is pooled into global research platforms. At the Ludwigshafen site, a part-time training programme for newcomers from other fields is offered, in order to qualify them for work in chemical industry.

Verbund was implemented without encountering significant problems. As a result, at this moment, the Ludwigshafen Verbund Site is the world’s largest integrated chemical complex under single management. It is a largest BASF Verbund site with the area of 10 km^2, 106 km of roads, 230 km of rail, 2850 km of pipelines and approximately 2000 buildings. Site traffic is equal to 2100 trucks daily and shipment 100000 containers p.a. By the integration of transport system in one network (98 trucks approx. 2100 daily - 30% of transportation volume, rail cars approx. 400 daily - 30% of transportation volume and barges approx. 20 daily - 40% of transportation volume), BASF IS has managed to reduce the logistics' costs for the participants in the industrial ecosystem. Moreover, at Ludwigshafen Verbund Site there are 110 production facilities with around 200 production plants, including 35972 employees. About 8000 products (based on raw materials) with a total volume of 8.5 million tonnes are currently produced in Ludwigshafen complex per year. The close proximity of companies combined with their similar organisational culture, based on the know-how exchange within Verbund, and their active participation and commitment, guaranteed the success of BASF IS in Ludwigshafen without any significant problems.

In fact BASF IS has managed to create benefits for BASF and other participants in the industrial ecosystem in the form of cost reduction, increased productivity for the participating companies, increased employment, improved resource efficiency and beneficial social aspects. These benefits are outlined below:

- *Cost reduction*: reduction of logistics costs by sharing the transport between following actors: trucks approximately 2100 daily - 30% of transportation volume, rail cars approx. 400 daily - 30% of transportation volume and barges approx. 20 daily - 40% of transportation volume
- *Increased productivity for the participating companies*: by sharing the know-how with companies through global research platforms; specific training sessions for employees in production and technical areas in order to increase of companies' productivity
- *Increase in employment*: in 2015 the "Start Integration" programme provided 50 placements in 2015. The programme is focused on refugees with a high probability of being granted the right to remain in Germany and aims to integrate them into the labour market in region. The programme is planned to be expanded to 300 placements.
- *Improved resource efficiency*: by-products of one company are used as resources by other companies in efficient way
- *Beneficial social aspects*: a) integration of one chemical industry in the region in order to keep sustainable cooperation, b) experience and knowledge exchange

between companies, c) training of refugees by the technical courses and language and intercultural training; d) establishment of the Work-Life Management employee centre (LuMit), which provides opportunities for an active life, such as a fitness and health centre and employee assistance, e) opportunities for achieving work-life balance – the LuKids childcare centre, which offers daycare for 250 children, f) elimination of systematic differences in pay rate between men and women.

The longevity of BASF IS (initialised in 1865) and all the beneficial impact it had in its participants, described above, signify that it is a highly successful industrial eco-system. Its success can be further verified by the fact that it has been transferred in multiple locations such as Antwerp (Belgium), Geismar, Louisiana and Freeport Texas (USA), Kuantan (Malaysia) and Nanjing (China). This high potential for transferability is due to the fact that it addresses common needs among industries, organisations and different regions/countries, and that it hjas proved that the achieved benefits will outweigh the investment costs by far.

To encapsulate all the above information, the main lessons learned from BASF IS, in terms of succeeding in developing industrial symbiosis, are the following:

- To achieve sustainable cooperation in one sector of the regional industry, it is necessary to integrate all chemistry-connected actors in the region.
-Training and development of skills and know-how are essential success factors for a strong company culture.
-High quality of communication brings benefits for companies and stakeholders.
-Regional divisions, corporate centres and research and functional units increase the adaptability of participants and support business development.
-The strategy of companies that participate should be compatible with sustainable development goals: ‘We create chemistry for a sustainable future’ contributes to a world that provides a viable future with enhanced quality of life for all people and is a strategy that creates a positive image for firms.
-It is necessary to adapt business functions optimally with customers' needs. Taking into account the needs of customers and satisfying them successfuly with innovative and sustainable solutions.

-Close partnerships with customers and research units are necessary, in order to develop new system solutions, customized products, functional materials, processes and technologies.

94.1.12 Chamusca Industrial Symbiosis - Portugal

Waste management legislation in Portugal requires that all waste should be treated by licensed waste management operators. Although there are no legal impediments that prevent a manufacturer to obtain a license to receive waste, the process can be bureaucratic and expensive, since it requires technological standards to assure the proper treatment for the waste. In this context, most of the waste recovered goes through Resource Recovery companies, since their main investment is in waste management and/or resource recovery. Taking advantage on a series of waste management regulations and waste recovery and treatment investments in their municipality, the local government in Chamusca reached for Industrial Ecology as a paradigm to develop Relvao Eco-Industrial Park (REIP hereafter), i.e. the first municipal eco-industrial park in the country. The concept for the formation of the eco-industrial park idea (Chamusca IS hereafter) is based on waste disposal, and is realised for many different types of waste (urban waste, non-urban waste, medical waste, plastic, battery). Chamusca IS connects producers, farmers and local entrepreneurs and aims to involve businesses and the local community as well.

What distinguishes Chamusca IS from other industrial symbioses, is that local public authorities understood that the current Portuguese waste management system, favoured recycling of materials through Resource Recovery companies. As a consequence, the larger waste treatment and recovery facilities at the park (e.g. two national centres for the recovery, treatment and disposal of hazardous wastes, a resource recovery and treatment centre for municipal waste and a treatment facility for nonurban wastes) aimed to attract recyclers of various natures (e.g. batteries, plastics, biomass), waste sorters (e.g. medical packaging) or disassemblers (e.g. end of life vehicles), and soon managed to achieve their target. Chamusca IS in collaboration with local government deployed several actions to promote the interactions and collaborations between Resource Recovery activities' managers themselves and with companies/institutions in the region surrounding the Relvao Eco Industrial Park. The result is that not only wastes are exchanged between manufacturers and some Resource Recovery companies in the Eco Industrial Park, but services and waste materials are exchanged, or are in the process of being exchanged, between the Resource Recovery companies themselves. Readers can see that this means that, for example, the main focus of car dismantlers is to strip the car of its various components, send the metal for fragmentation or recycling and sending other materials (e.g. plastics, batteries, oils) to other companies within the REIP. The battery processer receives the car batteries and is able to separate the various components, sending the acid to be regenerated at the CIRVER and plastic to the plastics recycler. In the case of the battery processer, in particular, it was able to develop a collaborative business strategy with a manufacturer of civil explosives, which will relocate to the vicinity of the REIP and use the lead recovered from the batteries in its production process, therefore creating a symbiotic relation.

Chamusca IS is an excellent example of adaptation of the industrial symbiosis paradigm to the regulatory idiosyncratic features of a region, that achieved the key objectives for its deployment, such as promoting the use of sustainable bio-energy resources, providing businesses (especially Resource Recovery businesses and other recyclers) with access to new markets, opening new markets for secondary raw materials, increasing the profitability for businesses in the region and reducing the costs of production. Key factors that contributed to this success are the diversity of actors involved that allowed for exchanges of various types of by-products, achieving a balance of power between partners (especially Resource Recovery companies) without favorising anyone, and generating a high level of commitment to participants. These success factors mean that at the moment, Chamusca IS is a highly transferable industrial symbiosis that continues to attract companies in a wide variety of activities – resource recovery and manufacturers alike. Also, projects are being deployed to encourage the development of synergies beyond the municipality, encompassing the Tagus Lezíria region, which surrounds it.

Not only waste are exchanged between manufacturers and some Resource Recovery companies in Chamusca IS, but services are exchanged, or are in the process of being exchanged, between the Resource Recovery companies themselves, based on the principles of Chamusca IS. Key characteristics of Chamusca is that makes it transferable are the utilization of standardised technology solutions and processes, the fact that the needs that it addresses apply to a wide range of areas, regions and countries, and the low risk of organisational resistance on behalf of participants since they all benefit from the functions of REIP. The key lessons learned from Chamusca IS are the following:

- Chamusca IS is a local symbiosis and to be successful, focuses primarily on the maximum use of materials.
- Most of recovered waste passes through Resrource Recovery, because they conduct waste management and recovery of raw materials in Portugal. This kind of waste disposal is easier in Portugal than obtaining a permit for waste collection. Hence, it is important for industrial symbioses to adapt to the regulatory systems of each country, by choosing the most cheap and fast course for resource exchange. The current Portuguese waste management scenario favoured recycling of materials through RR companies, so it is perfect situation for recyclers of various natures (e.g. batteries, plastics, biomass), waste sorters (e.g. medical packaging) or disassemblers (e.g. end of life vehicles).
- REIP in Chamusca is a industrial symbiosis that engages equally the local community and the business world.

94.1.13 Lessons learned

Lessons learned from the analysis of best cases has been summarised in the table below. The table presents lessons learned for both the issues of success and transferability of industrial symbiosis projects.

Country	Main lessons learned
Slovenia	• Industrial symbiosis projects have higher chances of success if there is: ○ enhanced mutual trust between companies ○ better cooperation among companies and stakeholders ○ greater awareness of the importance of such projects ○ the companies' will to cooperate in an industrial eco-system ○ ideas for new similar projects ○ spill-over effects are strengthened by attracting more stakeholders in the projects.
Spain	• The success of industrial symbioses is not determined by waste quantities, but by the will of people to change and get involved in circular economy projects.
Italy	• Belonging to an industrial symbiosis network of partners enable companies to develop mutual benefits and, at the same time, allows them to improve or strengthen their strategic positioning in the market.
Poland	• The reuse of waste within industrial symbioses is the preferred mode of recovery as reuse and repair of end-of-life products help reduce the increasingly growing waste amount. • By extending their life, product reuse within the context of industrial symbiosis enhances resource efficiency and saves energy, and thus reduces water and air pollution. • Industrial symbiosis can further develop if there are proper communications and agreements to share the profit among partners as well as rapid technological development for product reuse.

France

- Effective cooperation between the cooperating partners is crucial
- Effective collaboration between members of the cluster has a significant influence in reducing emissions within the context of industrial symbioses.
- Demonstrating that environmentally friendly solutions are cheaper than using fossil fuel is very important for the development of corporate social responsibility.
- Short distances between participating companies are advantageous;
- Complementarities of enterprises creates more chances for the formation of industrial symbioses
- A similar organizational culture is an important factor for the development of industrial symbioses.
- The representation of companies from different industries is an important factor for the success of industrial symbiosis.
- The effective implementation of industrial symbiosis has led to a significant reduction in costs
- Openness and effective cooperation is a key aspect of the implementation of industrial symbiosis.

Belgium

- Legal regulations are a very important factor influencing industrial symbiosis (for example, ash from the combustion of biomass can be used in construction industry, but it is not allowed in agriculture industry because of legal regulations in the region of Wallonia)
- Location is a very important factor for the successful development of industrial symbiosis
- Effective cooperation is one of the crucial factors on which the development of industrial symbiosis depends.
- Limited access to traditional raw materials can affect industrial symbioses

Sweden

- Methods of applying industrial symbiosis should be adaptable to the needs and context of the area.
- It is important to involve in an industrial symbiosis project personnel with the necessary skills and competences.
- Industrial symbiosis can be more successful if it is a dynamic concept that offers something for everyone.
- Industrial symbiosis should be designed in a way that allows for its application in developed, developing or transitional economies.
- Industrial symbiosis should involve public and private actors alike.

Netherlands

- Specific local social circumstances should not be underestimated, as they can serve to stimulate mutual trust building between industries and create an environment for cooperative action
- Industrial symbiosis should address the need of more than one organisation/actor (for example, heat networks offer a reliable, affordable and sustainable heat supply to both private households and companies)
- Firms involved in an industrial symbiosis project should be autonomous.
- All agreements in the context of an industrial symbiosis project should be based on commercially sound principles.
- The development of the symbiosis should be voluntary but should also occur in close cooperation with government authorities
- Short physical distances between participating plants are advantageous
- Mutual management understanding, cooperative commitment, and the establishment of effective communication between participants are required.

Germany

- It is important to establish sustainable cooperation in one sector of the regional industry (for example integrate all chemistry-connected actors in the region).
- The following are important success factors of an industrial symbiosis project:
    - training and the adequate development of skills
      existence strong company culture
      high quality of communication
    - employing regional divisions, corporate centres and research and functional units to support business development
      applying a company strategy that is compatible with sustainable development goals
    - creating a positive image of the firms
    - adaptation of business optimally with customers' needs - taking into account the needs of customers and contribution to their success with innovative and sustainable solutions
      close partnerships with customers and research units, in order to develop new system solutions, customized products, functional materials, processes and technologies.

Portugal

- Waste management and the recovery of raw materials is easier than obtaining a permit for waste collection.
- Eco-industrial park in Chamusca is an industrial symbiosis that benefits both communities and businesses.

95 Discussion: transferability

To a project like SYMBI, that is aiming to uncover the best practices for the advancement of industrial symbiosis in Europe, the development of an understanding of the factors that make aspects of industrial symbioses transferable to other areas, is perhaps its most significant contribution to the development of industrial symbiosis in Europe.

Fortunately, the analysis has led to the establishment of several conclusions that compose an initial description of the most important transferability factors for industrial symbiosis. It is important to point out that the results of all aspects of the analysis (statistical analysis of 48 cases, statistical analysis of 24 already transferred cases, and analysis of 12 important case studies) agree to a significant extent and are congruent with the conclusions of key literature.

According to the statistical analysis of 48 cases, the most important determining factors of transferability are the compatibility of needs addressed by the symbiosis among industries, organizations, regions and countries (77 % of cases), the existence of an economic incentive in the sense that benefits should outweigh investment costs (58%), and the use of standardised technology solutions and processes (50%).

Certainly, the statistical analysis of 24 cases has led to different results, in the sense that the effects of demonstrated achieved benefits and of the use of standardised technologies are significantly reduced (42% and 29% respectively). On the contrary, the effect of compatible needs addressed is at the same level (75%). However, this is a difference only in the frequency by which specific contributing to the transferability factors are mentioned. The three most important transferability factors remain the same. It is easy to reach the conclusion that the compatibility of needs addressed constitutes the most important factor for transferring industrial symbiosis.

This result is confirmed by the analysis of best cases. Addressing common needs found among industries and organisations was a key transferability factor for most selected cases. Examples include but are not limited to Manresa en Simbiosi, Giuliani Environment Srl, WMRC, Industrial Symbiosis in Rotterdam, Chamusca and Kaiserbaracke. However, it seems that the analysis of best cases agrees more with the statistical analysis of 48 cases. Equally, if not more ever-present was the fact that the benefits from the industrial symbiosis had to outweigh the costs of its development. The importance of the use of standardised technologies and transferable know-how has been mentioned in almost all selected cases, and the same is true for the need for an economic incentive. Furthermore, the existence of an economic incentive is always mentioned as a key factor for transferring industrial symbiosis but is not the most important factor for the success of an industrial symbiosis project as can be seen by the results of the statistical analysis.

Nevertheless, it is important to point out that several of these cases highlight different aspects of these contributing factors. In the case of Manresa en Simbiosi, what is highlighted is the importance of addressing needs pertaining to the regional economy. Manresa en Simbiosi was transferred exactly because it was especially adapted to the needs of the regional economy and took into account the specific characteristics and organisational culture of the firms involved. This allowed for a rapid transfer of this symbiosis to other regions of Catalonia.

Other successful cases of industrial symbiosis did not focus on adapting to the needs of the regional economy, but, on the contrary, focused on exchanges of types of waste and by-products that are present in every economy. The Polish cluster WMRC became transferable by having as its epicentre the exchange of WEEE which is ever-present in late modern economies. In addition, WMRC was easily transferable due to the existence of high quality standards for the processes of this type of industrial symbiosis and the constant search for synergies beyond the initial area of application

Beyond addressing common needs, the use of standardised procedures and technologies and high quality standards have been the key element for the successful transfer of industrial symbioses such as for example, DIS, Industrial Symbiosis in Rotterdam and Kaiserbaracke. DIS benefitted from the fact that its practices have been evolving for more than 30 years. Industrial symbiosis in Rotterdam took advantage of the best practices developed by the Kalundborg industrial symbiosis. The industrial symbiosis in Rotterdam further perfected these practices that can now be used to expand and transfer the industrial ecosystem. Finally, Kaiserbaracke industrial symbiosis has already been transferred to the industrial park of Roch-en-Brille, mainly due to the fact that the management of ashes from biomass combustion in the construction industry is a common technological solution, and that by dealing with cheaper sources of energy, Kaiserbaracke addresses needs that are common among industries, organisations and different regions/countries.

As a final comment on the importance of standardised solutions, the significance of the case of Stockholm SymbioCity could not be diminished. SymbioCity was designed specifically with the aim of transferring know-how for symbiotic relations. Hence, it points to the fact that transferring know-how for industrial symbiosis can be a successful economic activity in itself.

The results of the analysis indicate that transferability is an outcome of several factors of great importance. More precisely, the compatibility of the needs addressed across the various organisations and regions constitute the necessary condition for a successful transfer of an industrial symbiosis project. Aspects of the industrial symbiosis that pertain only to specific cases cannot be transferred. However, since addressing common needs is only a necessary condition for the development of industrial symbioses, the latter can be transferred successfully only if they satisfy the sufficient conditions: generating benefits that outweigh costs and using standardised solutions in the form of know-how.

This conclusion can be verified by the suggestions of key literature on industrial symbiosis. Chertow (2007) stresses the fact that conventional business interests in reducing expenses and/or in profit increases constitute key incentives for firms to join or initiate industrial symbioses. Moreover, according to Herees et al. (2004), Dutch EIP projects have been more successful than their US counterparts, because US projects were initiated by local and regional governments that saw the projects as a way to improve the local/regional economy with access to substantial government funds, whereas the more successful Dutch projects were mostly initiated by the companies themselves based on their own economic incentives.

Moreover, Chertow (2007) stressed the importance of addressing common needs by arguing that a ‘coordinative function’ is needed to play matchmaker for recycling opportunities, and provide assistance & coordination in their application. Match-making is necessary exactly because, without understanding and identifying the common and compatible needs of businesses and, in general, organisations, it is very difficult to initialise industrial symbioses.

The key policy conclusion that can be derived from these data suggests that, in order to transfer successfully best practices for industrial symbioses, policy makers should intervene in by identifying the common needs addressed by various successful industrial symbiosis projects and the standardised solutions that have been developed and used successfully in those projects. What this means is that policy makers should play an “enabling role” by providing political, coordinative, educational, and infrastructural support (Gibbs and Deutz, 2007), mostly as the informer of last resort. As Chertow (2007) pointed out, public authorities’s role consists in the following three parts:

1. Uncovering opportunities for cooperative activity that remain unnoticed
2. Assist symbiotic relationships that are taking shape, by informing about and providing successful standardised practices
3. Provide incentives to catalyse new symbiotic relationships by identifying the necessary economic benefits derived from their success

96 Benchmarking

96.1 Conditions of success

Having analysed the successful cases of industrial symbiosis and identified and presented the 12 most important successful cases, we can benchmark the characteristics of industrial symbiosis that can guarantee its success and transferability in Europe. Benchmarking in this case is meant to be the concretisation of criteria for the selection of industrial symbiosis with the aim of providing a catalogue of key conditions for the success of industrial symbiosis that encompasses all the aforementioned criteria. The catalogue is designed to be used a) ***before*** the implementation of an industrial symbiosis prospect in order to estimate its prospects of success, and b) ***after*** the initialisation of an industrial symbiosis project to check its progress.

The rationale for developing the catalogue of key conditions is based on encompassing all aspects of the criteria for success of industrial symbioses. As a result, each condition will cover specific aspects of the following criteria, which were developed in the methodology:

a) Level of solution impact
b) Number / type of achieved objectives and produced results
c) Extent of problems encountered in implementation
d) Scalability of practice
e) Level of transferability

The criterion of transferability is obviously the most important for the SYMBI project, since it provides insight on which policies should be implemented to promote and expand industrial symbiosis projects more efficiently across the partnership regions and countries. Hence, satisfying conditions related to transferability will be considered relatively more important compared to the rest of criteria.

The aspects covered that correspond to each of these criteria are presented in the following paragraphs. The *level of solution* impact can be evaluated by investigating the object of material and energy exchanges that take place in each industrial symbiosis project. The analysis of the data in the previous pages reveals that symbioses that include exchanges of energy by-products and secondary raw materials, and/or waste collection and exchange are usually more successful. The higher the compatibility of the materials and energy exchanges with the key agricultural and industrial sectors of an area, the higher the probability of success of an industrial symbiosis project and the better the prospects for achieving a high impact. Consequently, the conditions that should be included in the catalogue are the following:

1. Extent of exchanges of energy, by-products and secondary raw materials
2. Extent of waste collection and exchange
3. Compatibility of exchanges with key economic sectors of the area

The *number / type of achieved objectives and produced results*, can be evaluated by investigating the types and degree of positive impact that are generated (or are expected to be generated) by an industrial symbiosis project. Since our analysis has already identified the types of positive impact of industrial symbiosis project, the conditions that can be included in the catalogue are related to these types and to a pursued analogy between environmental, economic and social impacts. Hence, the conditions are the following:

1. Extent of (expected) improvements in the resource efficiency of the area
2. Extent of (expected) reductions in greenhouse gas emissions
3. Extent of (expected) reductions in production costs
4. Number of jobs (expected to be) generated by the industrial symbiosis project
5. Amount of extra income per job (expected to be) generated by the industrial symbiosis project.
6. Improved environmental awareness of the importance and feasibility of industrial symbioses
7. Extent of increases in network formation among organisations
8. Analogy in achieving environmental and economic benefits

The *extent of problems encountered in implementation*, can be evaluated by investigating the presence or lack thereof of key success factors in a proposed or concurrent industrial symbiosis project. Since the key success factors for industrial symbiosis have been identified as the active participation and commitment of organizations involved in an industrial symbiosis, the close proximity of companies and the participation of diverse organisations, the conditions that will be included in the catalogue are related to these three factors and are the following:

1. Expected or concurrent amount of financial resources that organisations participating in the project contribute to the project
2. Expected or concurrent number of personnel that is contributed to the project by organisations participating in the project
3. Distance between the organizations involved in exchanges that participate in the project.
4. Number of different types of organisations (i.e. large companies, SMEs, local authorities) that (will) participate in the project.

The *scalability of practice* can be evaluated by investigating several factors that affect the adaptation of an industrial symbiosis project in smaller or larger areas. These factors that were identified in the analysis of desk research data have to do with the flexibility of an industrial symbiosis project. Projects that are more flexible, i.e. can involve firms/organisations of many different types, regions and sectors can be easily scalable to the specific needs of a given region. Hence, the conditions for the scalability of a project are the following:

1. Extent of capability to realise the industrial symbiosis using different types of companies (large companies, SMEs)
2. Addressing resource efficiency needs of both small and large areas/organisations

Finally, the *level of transferability* can be investigated using a number of conditions that refer to the extent to which a specific industrial symbiosis concept has been applied to different regions, such as those below:

1. The type of industrial symbiosis has been replicated in more than one countries
2. The type of industrial symbiosis has been transferred in locales with different characteristics.
3. Addressing the need for resource efficiency and energy and by-product exchange.

96.2 Where to apply

The conditions described in the previous section are constructed so that the catalogue can be both concrete enough to benchmark any existing or proposed industrial symbiosis project and abstract enough to be adapted and further specified by specific regional authorities according to the needs of their territory. This level of abstraction allows for both drafting a specialised catalogue and for preserving the capability to compare benchmarking processes among different regions.

To be more precise, a territorial authority can further specialise the catalogue by updating it with information about the specific needs, organisations, sectors of the economy, and exchange materials that apply to its territory. For example, a regional authority in need of reductions in water consumption could redraft the condition "Extent of (expected) improvements in the resource efficiency of the area" in the form of "Extent of application of water reuse in the area".

96.3 How to apply

Each territorial (local, regional and national) authority can evaluate the proposed or existing industrial symbiosis projects by carefully checking or estimating if and how they meet the conditions included in the aforementioned catalogue. For all industrial symbiosis, territorial (local, regional and national) authorities will assign a value from 0 to 10 to describe how much they satisfy the conditions for success of industrial symbiosis projects. Values corresponding to conditions of transferability will be then multiplied by 2, to demonstrate the increased importance of transferability for the aims of the SYMBI project. The values will be added and then divided by the total number of conditions to develop an indicator of concurrent or expected success of an industrial symbiosis project. The mathematical formula for the indicator can be seen below:

$$I = 10\{[\sum_{(n=17,\, i=1)} v_i + 2\sum_{(x=3,\, i=1)} t_i]/m\}$$

Where:

I: expected or concurrent degree of success

n: total number of conditions related to all criteria except transferability

v: value attributed in each condition of those related to all criteria except transferability x: total number of conditions related to transferability

t: value attributed in each condition of those related to transferability

m: total number of conditions (20 in our case)

The highest value **I** can get is 115 and the lowest is 0. The higher the value of I, the higher the (potential or actual) success of the industrial symbiosis.

The following table can work both as a representation of the catalogue of conditions for success of industrial symbiosis as well as a template for the evaluation of such projects:

Table 10: Conditions for success of industrial symbiosis projects

#	Conditions for success of industrial symbiosis projects	Value (0-10)
	Non-transferability related conditions	
1	Extent of exchanges of energy, by-products and secondary raw materials	
2	Extent of waste collection and exchange	
3	Compatibility of exchanges with key economic sectors of the area	
4	Extent of (expected) improvements in the resource efficiency of the area	
5	Extent of (expected) reductions in greenhouse gas emissions	
6	Extent of (expected) reductions in production costs	
7	Number of jobs (expected to be) generated by the industrial symbiosis project	
8	Amount of extra income per job (expected to be) generated by the industrial symbiosis project.	
9	Improved environmental awareness of the importance and feasibility of industrial symbioses	

#	Conditions for success of industrial symbiosis projects	Value (0-10)
10	Extent of increases in network formation among organizations	
11	Analogy in achieving environmental and economic benefits	
12	Expected or concurrent amount of financial resources that organisations participating in the project contribute to the project	
13	Expected or concurrent number of personnel that is contributed to the project by organisations participating in the project	
14	Distance between the organizations involved in exchanges that participate in the project.	
15	Number of different types of organisations (i.e. large companies, SMEs, local authorities) that (will) participate in the project.	
16	Extent of capability to realise the industrial symbiosis using different types of companies (large companies, SMEs)	
17	Addressing resource efficiency needs of both small and large areas/organizations	
	Transferability related conditions	
1	The type of industrial symbiosis has been replicated in more than one countries	
2	The type of industrial symbiosis has been transferred in locales with different characteristics	
3	Addressing the need for resource efficiency and energy and by-product exchange	
TOTAL	**Sum of values of non-transferability related conditions:** **Sum of values of transferability related conditions:**	
	INDICATOR VALUE:	

97 References

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98 Annex 1

The following table presents the results of the evaluation of the 48 cases collected by partners:

Table 11: Evaluation results of 48 cases of industrial symbiosis

99 100 Industrial symbiosis project	101 Level of solution impact 102	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
		1. Slovenia			
107 Dinos DROE UniREC	108 4	109 4	110 4	111 4	112 4
113 Aquafil	114 2	115 3	116 3	117 4	118 3
119 Štore Steel	120 2	121 3	122 3	123 4	124 3
125 Tecos	126 1	127 2	128 3	129 4	130 4
		2. Spain			
131 Manresa en Simbiosi	132 5	133 5	134 4	135 5	136 4
137 PAMA	138 4	139 5	140 5	141 5	142 2
143 Nuestra Senora de los Remedios	144 2	145 3	146 4	147 4	148 3

99 100 Industrial symbiosis project	101 Level of solution impact 102	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
149 Castellon Ceramic tile	150 3	151 3	152 3	153 5	154 2
155 ChemMed	156 5	157 4	158 5	159 4	160 2
161 Sustratos de Extremadura	162 1	163 2	164 2	165 4	166 2
167 Sludge4Aggregates	168 3	169 3	170 5	171 4	172 1

3. Italy

173 Giuliani Env. Srl	174 5	175 5	176 4	177 4	178 4
179 SERIPLAST	180 5	181 4	182 4	183 2	184 3
185 TAPPO BAG	186 2	187 3	188 3	189 3	190 3
191 INLATTE	192 3	193 5	194 2	195 4	196 5

99 100 Industrial symbiosis project	101 Level of solution impact *102*	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
197 RICICLARTE	198 2	199 3	200 5	201 5	202 5
203 RUBBER RECYCLED	204 2	205 2	206 5	207 5	208 5
209 ERREPLAST	210 5	211 5	212 5	213 5	214 2
215 FIBERPACK	216 4	217 4	218 4	219 4	220 2
221 RECALL	222 1	223 3	224 5	225 4	226 2
		4. Poland			
227 WMRC	228 5	229 5	230 5	231 5	232 5
233 Bolesław	234 4	235 4	236 Unclear data	237 3	238 Unclear data
239 WEEE recycling	240 2	241 3	242 4	243 4	244 4

99 100 Industrial symbiosis project	101 Level of solution impact *102*	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
245 Vermicomposting	246 3	247 4	248 3	249 3	250 2

5. Finland

251 Envor Group Oy	252 5	253 5	254 4	255 4	256 2
257 FISS	258 1	259 5	260 4	261 4	262 5
263 HKScanFinland	264 3	265 4	266 5	267 3	268 2

6. Greece

269 Aluminium & Cement industrial symbiosis in Viotia	270 2	271 4	272 5	273 3	274 3

275 France

99 100 Industrial symbiosis project	101 Level of solution impact *102*	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
276 Industrial Ecology Club of Aube (IECA)	277 5	278 4	279 5	280 5	281 5
282 ArcelorMittal	283 5	284 4	285 4	286 4	287 4
288 Industrial zone of Lagny Sur Marne	289 5	290 4	291 5	292 4	293 4
294 AT France and Lincet 295	296 2	297 3	298 5	299 4	300 3
301 Bassens 302	303 4	304 2	305 4	306 5	307 4
308 Sweden					
309 Stockholm	310 5	311 5	312 5	313 5	314 5

99 100 Industrial symbiosis project	101 Level of solution impact *102*	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
SymbioCity					
315 Industrial Symbiosis in Helsingborg	316 5	317 4	318 4	319 5	320 2
321 Norrköping Industrial Symbiosis	322 4	323 4	324 4	325 4	326 2
327 Industrial Symbiosis in Enköping	328 4	329 4	330 4	331 4	332 2
333 Lidköping	334 4	335 4	336 4	337 3	338 2
339 Industry Park of Sweden	340 5	341 5	342 5	343 5	344 2
		345 Belgium			
346 Kaiserbaracke	347 5	348 5	349 4	350 5	351 4

99 100 Industrial symbiosis project	101 Level of solution impact *102*	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
352 Ghent	353 4	354 3	355 5	356 4	357 3
358 Netherlands					
359 Industrial Symbiosis in Rotterdam	360 5	361 4	362 5	363 5	364 5
365 Biopark Terneuzen	366 4	367 4	368 5	369 4	370 2
371 Germany					
372 BASF	373 5	374 4	375 5	376 5	377 5
378 WELTEC BIOPOWER	379 2	380 4	381 5	382 5	383 2
384 Chemical Industrial Park Knapsack	385 5	386 5	387 5	388 4	389 2

99 100 Industrial symbiosis project	101 Level of solution impact 102	103 Number / type of achieved objectives and produced results	104 Extent of problems encountered in implementation	105 Scalability of practice	106 Level of transferability
390 Portugal					
391 Chamusca Industrial Symbiosis	392 5	393 5	394 5	395 5	396 5
397 United Kingdom					
398 Diageo	399 2	400 2	401 5	402 4	403 4
404 Denmark					
405 EcoCity Aarhus	406 1	407 1	408 5	409 4	410 3

411 Annex 2

The following table constitutes the input paper form designed to be used by SYMBI partners in order to present successfull cases of industrial symbiosis projects.

<table>
<tr><td colspan="3">SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy</td></tr>
<tr><td colspan="3">Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Collection of good practices on ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Title:</td></tr>
<tr><td colspan="3">A. CASE IDENTITY</td></tr>
<tr><td rowspan="3">LOCATION</td><td>Country:</td><td></td></tr>
<tr><td>Region:</td><td></td></tr>
<tr><td>City/Town:
(if applicable)</td><td></td></tr>
<tr><td rowspan="2">ACTIVITIES / MAIN FOCUS</td><td>Geographical level of implementation</td><td>☐ National
☐ Regional
☐ Local</td></tr>
<tr><td>Type of cooperative activity amongst firms in the industrial eco- system</td><td>☐ Exchange of energy, by products and secondary raw materials
☐ Joint use of utilities and firm functions
☐ Collective gathering and removal of waste materials
☐ Combining transport of goods and people
☐ More intensive use of space
☐ Public utilities with high useful effects
☐ Joint commercial firm facilities
☐ Multimodal transport and high quality public transport</td></tr>
</table>

		☐ Other (please specify)
DURATION	Time of implementation	
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)	
Please briefly describe the industrial eco-system		
Image (if available)		
C. NEEDS, BARRIERS AND SUCCESS FACTORS		
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)	
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners	

	☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial	☐ Very successful ☐ Quite successful

eco-system deployed?	☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	
Further information (URL, sources)	

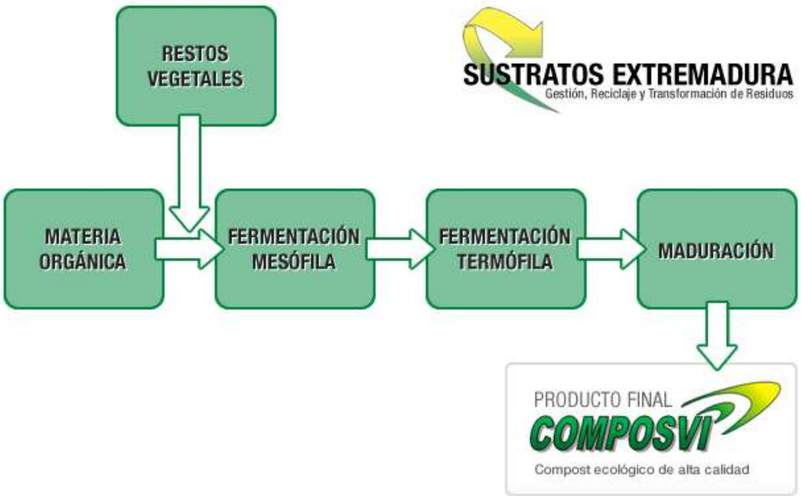
412 Annex 3

This annex presents the data of successful cases of industrial symbiosis as they were collected by the SYMBI partners, where the first 28 cases come from the partner’s countries and the rest come from the rest of EU countries:

1. Sustratos de Extremadura S.L. (ES)
2. Project LIFE Sludge4Aggregates (ES)
3. Manresa en Simbiosi (ES)
4. PAMA (Environmental Activities Park of Andalusia)(ES)
5. Nuestra Señora de Los Remedios Cooperative – Raising added value for olive oil production(ES)
6. Industrial symbiosis in the ceramic tile manufacturing in Castellón area(ES)
7. ZGH Bolesław - Industrial symbiosis – product from waste (PL)
8. An integrated approach to electronic waste (WEEE) recycling (PL)
9. Vermicomposting Industrial Symbiosis Network (PL)
10. Riciclarte (IT)
11. Rubber recycled from end-of-life tyres (IT)
12. RECALL - recycling of Complex AHP waste through a first time application of patented treatment process and demonstration of sustainable business model (IT)
13. TAPPO BACG–the original bottle caps bag (IT)
14. Integrated management system of municipal waste - development of dry and biodegradable parts (it)
15. ERREPLAST (IT)
16. Fiberpack project of lucart group (IT)
17. SERIPLAST - production of copolymer polypropylene regenerated from used batteries (IT)
18. INLATTE (IT)
19. Industrial Symbiosis of Aluminium Processing and Cement Industries (GR)
20. Aquafil (SL)
21. Dinos DROE unirec (SL)
22. Štore Steel (SL)
23. TECOS, Slovenian Tool and Die Development Centre (SL)

24. Waste management in West-Transdanubia (SL)
25. Envor Group Oy (FI)
26. Finnish Industrial Symbiosis System (FISS) (FI)
27. Hkscanfinland-lhjgroup-envorgroup (FI)
28. Kaiserbaracke– Industrial simbiosis (BE)
29. Diageo – global company with industrial symbiosis programme (UK)
30. Troyes (Cristal Union and Appia Champagne)– Industrial symbiosis (FR)
31. Biopark Terneuzen – Industrial symbiosis (NL)
32. Ecocity Aarhus – Industrial symbiosis (DK)
33. Oldenburger – Industrial symbiosis (DE)
34. Chemical Industrial Park Knapsack – Industrial symbiosis (DE)
35. BASF Verbund site Ludwigshafen – Industrial symbiosis (DE)
36. Ghent – Industrial symbiosis (BE)
37. Portugal Industrial Symbiosis (PT)
38. Rotterdam – Industrial symbiosis (NL)
39. AT France and Lincet – Industrial symbiosis (FR)
40. Arcelormittal (Dunkirk) – Industrial symbiosis (FR)
41. Lagny sur Marne– Industrial symbiosis (FR)
42. Bassens – Industrial symbiosis (FR)
43. Industrial Symbiosis in Helsingborg (SE)
44. Norrköping Industrial Symbiosis Network (SE)
45. Industrial Symbiosis in Enköping (SE)
46. Lidköping – Exploring the Industrial Symbiosis (SE)
47. Stockholm – symbiocity (SE)
48. Industry Park of Sweden (SE)

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Sustratos de Extremadura S.L.		
A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Extremadura
	City/Town: *(if applicable)*	Villafranca de los Barros
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ■ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by-products and secondary raw materials ☐ Joint use of utilities and firm functions ■ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	The company is working since 2009. The time of implementation, from the idea was designed by the promoters to the moment the company started to work, was around 2 years, since 2007 to 2009.
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ■ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ■ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The industrial ecosystem is compound by one main actor, Sustratos de Extremadura S.L., and around 6 other actors that supply the waste needed to produce the compost. The ecosystem is pretty simple, there are 6 secondary actors, 5 private companies and a local council, that produce sludge in the process of water treatment and another private company, the main actor, in charge of collecting the sludge from the secondary actors facilities and turn it into a high quality compost for its use in agriculture, gardening and other uses. The composting process used is through the technique of WINDROWS.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ■ Improve resource efficiency ☐ Access new markets ☐ Share risk ■ Open new markets for secondary raw materials

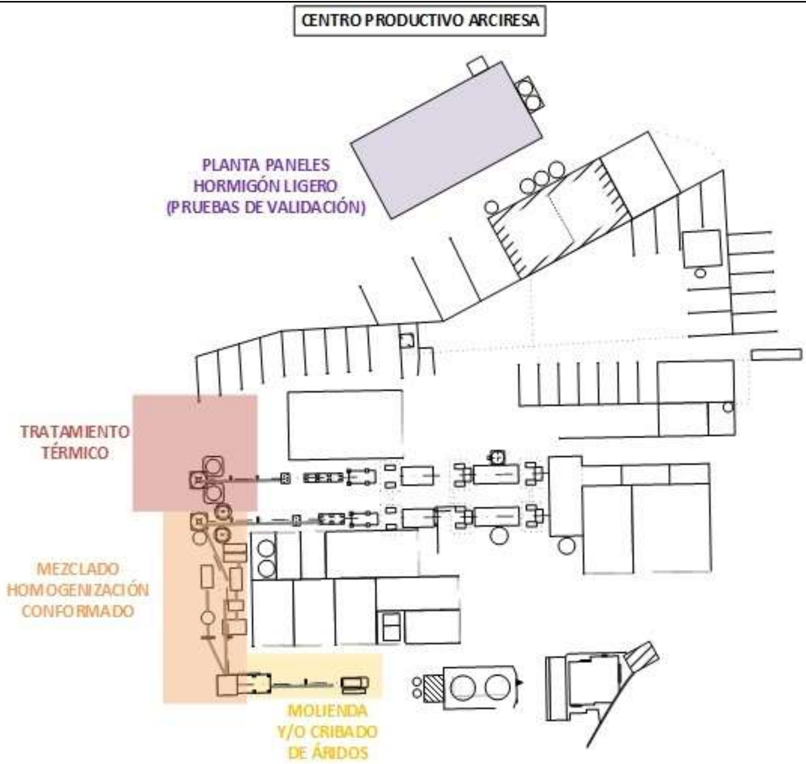
	☐ Reduce CO2 emissions ■ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	■ Regulation / limited support by local policy makers ■ Funding, lack of financial resources ■ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ■ Economically unsound or risky exchanges ■ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	■ Close proximity of companies ■ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ■ Active participation and commitment Please comment on the success factors: In order to make the business work, the promoters have changed the business model, because the regional legislation does not provide the necessary support for the development of this kind of business. However, the company is still working in the original idea because the promoters know that sooner or later it is going to be successful.
C. RESULTS & PROSPECTS	

What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ■ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ■ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ■ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* It increases productivity for the providers of waste because they do not have to pay attention to the management of it. There are many opportunities in research and development to improve the process and make the final product more attractive to potential clients. And it improves resource efficiency because you do not have to use new raw materials to produce the compost.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ■ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ■ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	■ Use of standardised technology solutions and processes ■ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by

	far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	The main problems encountered during the deployment of the business idea have been the lack of legislation support to boost this type of initiatives and the lack of culture related to environmental protection and benefits for the agriculture of the potential client, farmers. The main lesson learned by the promoters has been that without support from the legislators and without incentives for actors involved at the beginning of the process, the initiatives related to circular economy are very difficult to be implemented.
Further information (URL, sources)	http://www.sustratosextremadura.es/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Project LIFE Sludge4Aggregates		
A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Extremadura, Comunidad Valenciana, Castilla - La Mancha y Asturias.
	City/Town: *(if applicable)*	
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	■ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	■ Exchange of energy, by-products and secondary raw materials ☐ Joint use of utilities and firm functions ■ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	The project duration has been since 01/07/2013 to 30/11/2016
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ■ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ■ Local authorities ☐ Public Agencies ■ Other (please specify): Technological Centres and University
Please briefly describe the industrial eco-system	The LIFE Sludge4Aggregates project aimed to demonstrate the viability of the valorization of sludge from both WWTPs and the aggregate extraction process. It specifically hoped to develop a new artificial, lightweight aggregate from the sludge that can have industrial applications. The project applied a new technology based on the treatment of different mixtures of the mining and WWTP sludge wastes to obtain new and inert low density ceramic products. The final result of the project has been the design and development of a pilot plant for the production of these new artificial lightweight aggregates, including the definition of the necessary technological and environmental parameters for the process. This pilot plant (shown in the image of the next cell) is the centre piece of the industrial eco-system, which will be compound by several industries that generate mining and WWTP sludge wastes. So, we can say that the pilot plant is the central part of the symbiosis between water treatment and construction sectors. At a next stage it is expected to develop an industrial plant based on the results of the project to produce new products to be commercialized within sectors such as construction, infrastructure and horticulture.

Image (if available)	

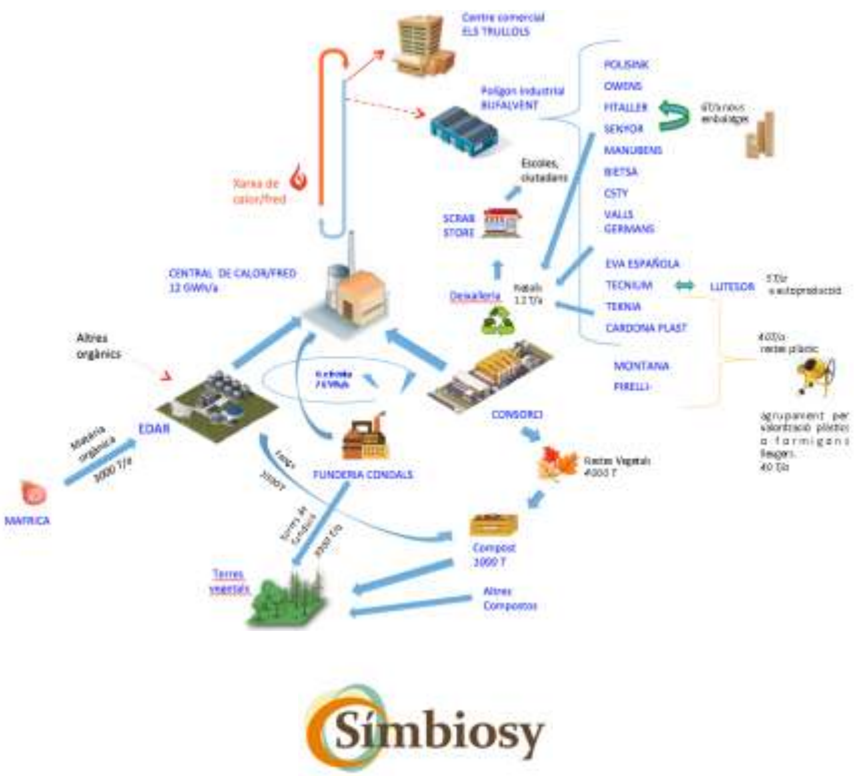
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ■ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ■ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges

	☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ■ No relevant problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ■ Adequate funding ■ Balance of power between partners ■ Similar organisation cultures of firms ☐ Legal and political support ■ Active participation and commitment Please comment on the success factors: The project was funded by the LIFE Program (European Commission), and it made its development possible. The consortium was well balance and that was a reason to be financed by the European Commission. All the partners in the consortium have Circular Economy and Industrial Symbiosis as strategic lines within their organizations. And the participation of all the partners was very active during the development of the whole project.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ■ Increase in job opportunities (employment) ■ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ■ Improved resource efficiency ☐ Other (please specify):

	Please briefly discuss about the degree of impact on the selected categories of benefits
How would you describe the industrial eco-system deployed?	☐ Very successful ■ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ■ No *Please briefly discuss about practice's potential for transferability / replicability* There are still some features of the material to be improved. Also, the main research and development have been carried out at laboratory level, and the results are not totally validated at pilot plant level. So there is still a long way to go until a product that can be commercialized will be ready. It is not the moment to transfer the good practice yet.
What are the most significant features of the industrial eco-system that make it transferable?	■ Use of standardised technology solutions and processes ■ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	The coordination is a very important factor to take into account in the development of European projects.

	At legislation level, national entities do not understand that these type of practices are prototypes for demonstration, the results cannot be implemented directly at the end of the project. The project partners must have to be close to private companies to ensure the exploitation of the results.
Further information (URL, sources)	http://www.lifesludge4aggregates.eu/index.php?lang=en

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Manresa en Simbiosi		
A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Catalonia
	City/Town: *(if applicable)*	Manresa
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ■ Local
	Type of cooperative activity amongst firms in the industrial eco- system	■ Exchange of energy, by-products and secondary raw materials ■ Joint use of utilities and firm functions ■ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ■ Public utilities with high useful effects ■ Joint commercial firm facilities ■ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	The implementation of the idea is still under development, and it was started in May 2015.

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	■ Large (industrial) enterprises ■ Small and medium-sized enterprises ☐ National authorities ■ Regional authorities ■ Local authorities ■ Public Agencies ■ Other (please specify): People
Please briefly describe the industrial eco-system	"Manresa en Simbiosi" is an initiative of the Council of Manresa (Catalonia) and the intermediation of Simbiosy (http://www.simbiosy.com/) with the purpose of implementing the first project of industrial symbiosis in Manresa (Catalonia) in order to maximize the efficient use of available resources, creating the basis for promoting synergies between companies / entities. The industrial eco-system is still under construction and it is going to be open for upcoming proposals, but there are several synergies already created between industries, as it can be seen in the image of the next cell.
Image (if available)	

C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	■ Promote the use of sustainable bio-energy resources ■ Improve resource efficiency ■ Access new markets ☐ Share risk ■ Open new markets for secondary raw materials ■ Reduce CO2 emissions ■ Increase profitability, revenue ■ Reduce production costs ■ Other (please specify): Strengthen the industrial base, industrial cohesion
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ■ Funding, lack of financial resources ■ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ■ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	■ Close proximity of companies ■ Diversity of actors ■ Low economic risks 2. Adequate funding ■ Balance of power between partners ■ Similar organisation cultures of firms ☐ Legal and political support

	■ Active participation and commitment Please comment on the success factors: In a process like this, with a high risk, it is very important the support from the local administration. The Industrial Symbiosis has to be developed at the local scope, so the support of the Council of Manresa (the forcing organization) is being essential to go forward.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	■ Contribution to the regional GDP ■ Cost reduction / Annual savings ■ Increased productivity for the participating companies ■ Increase in job opportunities (employment) ■ Enhanced research and innovation capacity ■ Reduce in greenhouse gas emissions ■ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* This is an open initiative, where all the stakeholders in the area are working in the identification of the best projects to be implemented. Because it is defined to impact in a wide area, the results will affect every category described above. It is an initiative with an integral point of view where they will discover new opportunities to turn Manresa in a reference in Industrial Symbiosis within the country.
How would you describe the industrial eco-system deployed?	☐ Very successful ■ Quite successful ☐ Somewhat successful ☐ A little successful

	☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	■ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability* It can be easily transfer to other regions following the same steps and with the commitment of local administration. Lessons learnt regarding potential synergies within industrial ecosystems are today being replicated to more IS projects in Catalonia.
What are the most significant features of the industrial eco-system that make it transferable?	■ Use of standardised technology solutions and processes ■ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	The wastes quantities do not determine the success of the Industrial Symbiosis, but the will of people to change and get involved in circular economy projects.
Further information (URL, sources)	https://manresa.cat/web/article/5977-projecte-simbiosi-industrial

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: PAMA (Environmental Activities Park of Andalusia)		
A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Andalucía
	City/Town: *(if applicable)*	Aznalcollar
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport **Other (please specify)**: Eco-innovation and ☐ environmental park with sharing facilities and logistics
DURATION	**Time of implementation**	Since 2007
B. CASE DESCRIPTION		

Type of actors involved **(choose all that apply)**	☐ **Large (industrial) enterprises** ☐ Small and medium-sized enterprises ☐ National authorities ☐ **Regional authorities** ☐ **Local authorities** ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The Environmental Activities Park of Andalusia (PAMA) is the first industrial park geared towards environmental activities in Spain. It is a good example of industrial conversion with a view to achieving sustainability and industrial symbiosis. Main objectives of PAMA are to: • Optimise waste management and use in Andalusia through re-use and recycling. For that aim, PAMA brings companies from the same sector together; • Improve local and regional socioeconomic and environmental conditions on the basis of environmental infrastructures and renewable energies. • To adapt land use from mining activities in order to make a better use of the existing facilities. Over 150 companies are located in three areas: - Large companies area - Mini-park area for ancillary enterprises - Commercial, sport and leisure area Some of the main companies at PAMA are: • GAMESA solar (photovoltaic energy installations) • INSELMA (industrial boiler making) • RECILEC (largest WEEE plant in Andalusia covering the full range of these appliances) which is associated with a waste reception centres network • LIRAS (recycling of ferric scraps and end-of-life vehicles) • EKIPASHOP (manufacturing and assembling of ecological furniture) • SANPROS (automotive and industrial batteries recycling plant), among some others
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ **Open new markets for secondary raw materials** ☐ Reduce CO2 emissions ☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ **Other (please specify)** The PAMA was created under the Economic Diversification Plan of the Regional Government to revive the Aznalcollar area after a holding dam burst at Los Frailes mine (Boliden-Aprisa) in 1998, releasing 4–5 million cubic metres of mine tailings and the subsequent mine closure. Most plots of the park are located on the land acquired by the Regional Administration for recovery and environmental activities. After the environmental restoration carried out in the Guadiamar river basin caused by the toxic waste spill and the closure of the mine, the Regional Government was committed to stimulate economic recovery of the area. A total investment cost of around EUR 73 million euro and the support of regional and local public institutions and administrations have made the Parque de Actividades Medioambientales de Andalucia (PAMA) an example of industrial recovery towards sustainability and circular economy in Spain. On the basis of a previous model of mining activities, a project for the future has to be undertaken, making it more diversified and thereby creating jobs and wealth to provide a required boost for the productive sector. With that aim, infrastructures have been reinforced, promoting economic diversification and treating distinctly sectors with comparative advantages.
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ **Lack of expertise / skills of existing employees within firms** ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered

	Other relevant info provided: Main difficulty has been to move from a certain economic model to another, that is, to change people's mind and to implement a project to attract large companies to invest in the area. Financial crisis has also been a constraining factor for this eco-system success, although at the moment nearly 100% of plots in the park are occupied.
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ **Adequate funding** ☐ Balance of power between partners ☐ **Similar organisation cultures of firms** ☐ **Legal and political support** ☐ Active participation and commitment Please comment on the success factors: PAMA has become a top-class business park, not only for the concentration of large companies but also for focusing on energy sectors, such renewable energies, and promoting the transition towards a circular economy in Andalusia. Therefore, PAMA is considered as an industrial conversion model which has made the move from an economic approach based on the mining activity towards an increasingly diversified project, in terms of employment and wealth creation and also environmental issues. It is also a pioneer initiative at a national level considering the area dedicated to environmental business activities, from recycling yards to photovoltaic energy installations. The strategic location has played an important role in terms of raw materials provision and by-products commercialisation. The PAMA is very close to Sevilla and Huelva harbours for national and regional matters and also close to the Algeciras international harbour.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ **Contribution to the regional GDP** ☐ **Cost reduction / Annual savings** ☐ **Increased productivity for the participating companies** ☐ **Increase in job opportunities (employment)** ☐ **Enhanced research and innovation capacity**

	☐ **Reduce in greenhouse gas emissions** ☐ **Improved resource efficiency** ☐ Other (please specify): The main benefit has been the environmental and economic revitalisation of the area, particularly after the toxic waste spill. Employment and wealth creation can be considered one of the major benefits of the project On the other side, for most companies, there were solid arguments to set-up or even relocate their premises to the PAMA, especially in terms of reducing production time, optimisation of production, cost reductions, better resource efficiency and increased productivity, among some others.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No (not yet) *Please briefly discuss about practice's potential for transferability / replicability* The idea of a business park focused on eco-innovation and environmental issues was pioneer in Andalusia which can be replicated to other EU regions
What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)

Main lessons learned	• Public support is a key element to success in a park such as PAMA, including financial support. • Expertise and good technical skills make it easier to implement an eco-innovation and environmental industrial park. • Strategic location in terms of transport links has to be taken into account when designing an eco-innovation park.
Further information (URL, sources)	http://www.eucc-pama.es/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Nuestra Señora de Los Remedios Cooperative – Raising added value for olive oil production

A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Andalucía
	City/Town: *(if applicable)*	Noguerones, Alcaudete (Jaen)
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ **Joint use of utilities and firm functions** ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ **Joint commercial firm facilities** ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	Since 2010
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ **Small and medium-sized enterprises** ☐ National authorities	

	☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The Cooperative Nuestra Senora de los Remedios has 837 members and it is devoted to continuous improvement of the olive oil production process. The cooperative uses an integrated production mill in the olive oil extraction process. The process results in a by-product, known as olive cake, which can pollute the soil and water systems if not managed correctly. The starting point was how to deal with this by-product. With the aim to protect both the environment and the community, the cooperative agreed to invest in the recycling of the by-product using composting techniques. The composting plant processes the olive cake together with the leaves cleaned from the olives, olive tree pruning residues and some liquid effluent from the mill. Therefore, organic by-products from the olive oil factory are recycled through the composting technique and these recycled by-products are given back to olive grove farms to be used as nutrients, thus making the production system more sustainable in the long run by reducing dependency on chemical fertilisers.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ **Reduce CO2 emissions** ☐ **Increase profitability, revenue** ☐ Reduce production costs ☐ **Other** (please specify): to support organic olive farming

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources **☐ Lack of expertise / skills of existing employees within firms** ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: The main bottleneck in the project implementation was the delay in obtaining the approval from the environmental authority of the region. The main reason was the strong pressure from large companies that produce olive pomace oil (low quality oil produced from olive cake, the by-product from the olive oil extraction process). The recycling of the olive cake to produce compost would compete with the olive pomace oil producing companies of the region, hence their objection to this project. This difficulty was overcome thanks to the persistence of the cooperative and the support they received from the regional government of Andalucia. Other difficulties encountered were related to the lack of experience and to external factors. More specifically, a lack of experience with this type of composting process. The first year an excessively large quantity of olive cake was piled up together with leaves and olive tree pruning residues which reduced the effectiveness of the composting process and part of the mixture got rotten. As a result the cooperative could not serve its clients with the compost quantities foreseen. The second year, after learning from this experience, the cooperative created smaller piles and turned them over frequently to reduce them in size and facilitate the fermentation process. As a consequence, the foreseen quantities were produced and eventually all products sold. On the other hand, external factors, in particular climate conditions, may always impact on the composting process since it takes place in the open air. For instance, scarce rainfalls result in limited water availability for irrigation, and excessive rainfalls do not allow turning over the mixture of olive cake, olive tree leaves and pruning residues.

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ **Balance of power between partners** ☐ **Similar organisation cultures of firms** ☐ **Legal and political support** ☐ **Active participation and commitment** Please comment on the success factors: • **Vision**. The overarching success factor was the vision and persistence of the cooperative leaders to add value to a product which offered no benefits otherwise, the by-product of olive oil production. • **Support from the cooperative members**. It is not very common for members of agricultural cooperatives in Andalucia to easily agree on innovative approaches to their farming processes. This can be considered innovative as it is not common to use olive cake for the production of compost. • **Institutional support** from the regional government of Andalucia. The composting plant was seen as an opportunity to recycle byproducts and re-use them for other purposes (compost) while bringing environmental benefits (increased organic matter in the soil, reduced soil erosion). • **Dissemination**. Experts from the regional government, the University of Jaen and representatives from organic farms provide expertise to raise awareness about the benefits of using olive cake to produce organic compost among the cooperative members.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ **Increased productivity for the participating companies** ☐ **Increase in job opportunities (employment)** ☐ Enhanced research and innovation capacity ☐ **Reduce in greenhouse gas emissions** ☐ **Improved resource efficiency**

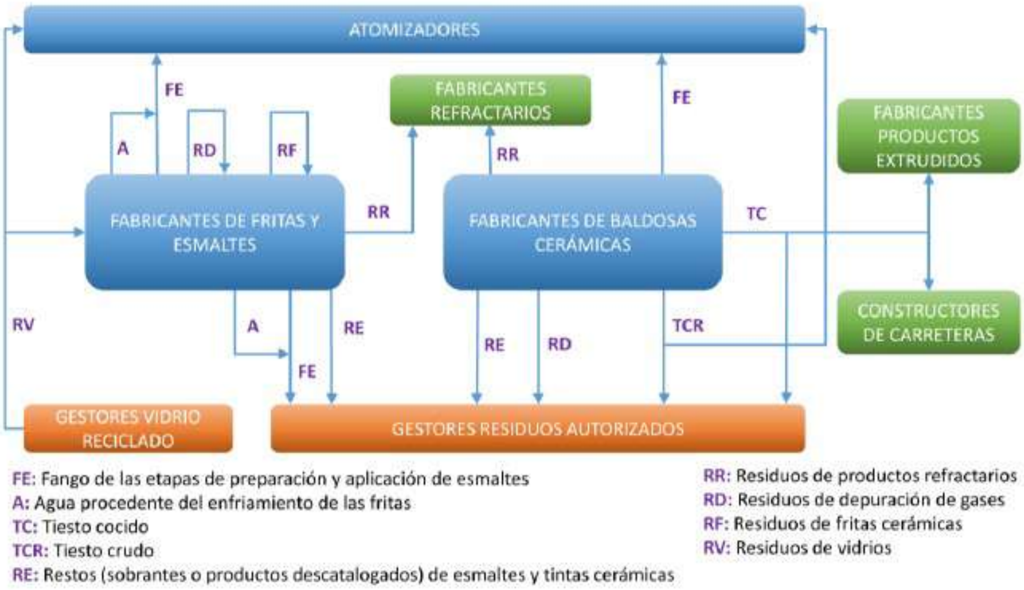
	☐ Other (please specify): The compost produced has a positive impact on the environment by reducing the use of chemical fertilisers, the greenhouse gas emissions and the soil carbon footprint, contributing to the growth of organic material and to the reduction of soil erosion problems which are frequent in this area of Andalusia. Therefore, main benefits can be summarised as it follows: • Improved soil quality by using organic compost and reduced dependency on chemical fertilisers; • Introduction of environmentally friendly fertilisation techniques to olive grove farmers which at the same time motivate them towards organic farming; • Environmental benefits from recycling the olive cake and not disposing of it; • Further environmental benefits from reduced pollution from nitrates in aquifers. • New jobs were created to manage this compost; • Increased awareness of the benefits of organic production and an increased tendency of farmers to convert to organic production methods.
How would you describe the industrial eco-system deployed?	**☐ Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes **☐ No (not yet)** *Please briefly discuss about practice's potential for transferability / replicability* The project has generated the interest of farmers from other Spanish regions, such as Castilla la Mancha, Cataluna and Extremadura, and also international interest. In Castilla la Mancha there are several olive oil mills that have set up composting plants using the olive cake. In Cataluna, there is a serious problem with disposing of olive cake as most of the orujo producing companies have closed down and farmers do not know how to dispose of it. As a consequence, five olive oil mills in Cataluna have developed draft proposals for the installation of composting plants and are searching for financial sources. In Extremadura, there is discussion about this type of composting

	plant that adds value to the olive cake, but financing sources are also sought. The experience has also appeared in the magazine of the Spanish Society for Organic Agriculture. At international level, there has been interest from Turkey, Morocco, Argentina and Chile. Turkey faces several environmental challenges in agriculture such as pollution risks of drainage basins. A consultant working on the development of a Turkish project to address these risks was very interested in Andalusian experience. And Morocco was developing an advisory service on composting processes but the initiative is still pending due to lack of funding. We can conclude that, despite the lack of a concrete transfer of the experience at international level, this interest shows the potential of the project to be replicated in other regions.
What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ **Low implementation risks** ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Good leadership within the group is essential for taking ambitious steps to introduce methods that are not common or very well known. • Institutional support is a key prerequisite as it can accelerate or delay the project implementation process. • A good understanding of the benefits of the approach/initiative facilitates the implementation of actions. • A thorough business plan, including detailed activities, costs, realistic timetable and resources allocated to each task is very important. • Good technical knowledge and practical experience benefits implementation as well as early advice and support from experts. • Continuous information provision to those involved

	contributes to increase their trust and awareness and consequently they became the main users of the compost produced.
Further information (URL, sources)	http://enrd.ec.europa.eu/enrdstatic/app_templates/enrd_assets/pdf/gateway/Project-life-cycle-ES_M123_MAL.pdf http://www.rndr.ro/en/publications/good-practices.html

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Industrial symbiosis in the ceramic tile manufacturing in Castellón area		
A. CASE IDENTITY		
LOCATION	**Country:**	Spain
	Region:	Valencia
	City/Town: *(if applicable)*	Castellón
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)	

Please briefly describe the industrial eco-system	Within the SHAREBOX-Developing a secure management platform for shared process resources project a number of tasks aiming at identifying synergies in the ceramic tile industry in Castellon area have been carried out. This project is funded within the Horizon 2020 programme. According to the results of this reseach work, the ceramic tile industry consists of the following tiers: the producers of tiles, the manufactures of frits and glazes, the raw material suppliers and machine producers. Ceramic tile production in Spain is concentrated in Castellon area (Valencia region), where over 200 companies can be found (126 producers of tiles, 24 manufacturers of frits and glazes, 42 machine producers and 8 raw material suppliers). One of the most significant and widespread industrial symbiosis examples in the ceramic sector is the re-use of sludge from the glazing process during ceramic support preparation. Currently almost all such waste produced is reused in ceramic support manufacturing, while avoiding significant environmental impacts, such us preventing waste water overflowing into water-courses. Symbiosis is organized on the basis of specific agreements between companies which lead to important cost savings. Spray-driers (spray dried ceramic powders producers for ceramic supports) receive ceramic glazing sludge from ceramic tile producers which are their clients, as well as cracked pieces of tiles. According to their nature some of these can only be treated as waste. Manufactures of frits and glazes, in some cases, come to agreements with spray-driers and send ceramic glazing sludge together with cold water where the frit is quenched. When there isn't such an agreement they are treated as waste. Another industrial symbiosis process is related to the use of recycled glass to produce frits, white clay and glazes, and sometimes also to produce ceramic supports. The emergence of glass recycling operators has made the implementation possible, overcoming the existing problems at a competitive price. The use of waste ceramic tiles as a raw material in the design of road pavement subgrade is also an example of industrial symbiosis. It can also be used by extruded products manufacturers, although due to the low number of them in the area it has rarely been the case. And finally, it has also been identified the use of waste of refractories by the refractories producers themselves due to the commercial link of these companies which makes industrial symbiosis easier. Further types of cooperation activities leading to industrial symbiosis in the ceramic tile industry has been identified as a result of different research works carried out among companies of this sector of activity. They will probably be implemented in the near future. These synergies are: • Mutualisation synergies, where companies share services, facilities and/or infraestructures. So, they are mainly related to logistics and services. • Substitution synergies to replace new input flow with the outgoing flow of waste or by-products from another company. They can be both from the ceramic tile industry to another activity sector or the other way round. For example, the valorisation of iron foundry sands and dust in ceramic tile. • New activities synergies. For example, setting-up new companies to provide services related to waste management in order to guarantee both the supply and the composition of by-products. Another example is finding alternative use for discontinued tiles. Finally, it should also be stressed that ceramic tile companies in this area are also working on other types of cooperation, such as sharing services (optical fiber, electricity, waste management and water treatment) to be tackled in a centralised way.

Image (if available)	 Figure 1. Location of ceramic tile companies in Castellon area  Figure 2. Industrial symbiosis examples identified in the ceramic tile industry in Castellon (Valencia region) Atomizadores = Spray-dryers Fabricantes de frita y esmaltes = frits and glazes manufacturers Fabricantes de baldosas ceramicas = tile producers Gestores de vidrio reciclado = recycled glass operators Gestores de residuos autorizados = authorised waste management operators Fabricantes de refractarios = refractories producers Fabricantes de productos extrudidos = extruded products manufacturers Constructores de carreteras = road constructors
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ **Improve resource efficiency** ☐ **Access new markets** ☐ Share risk ☐ **Open new markets for secondary raw materials** ☐ **Reduce CO2 emissions** ☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ **Other (please specify)**: the opportunity to increase business income (or reduce expenditures related to waste treatment) as well as to improve the corporate image and also to increase competitiveness. Government regulation has also played a key role.
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ **Funding, lack of financial resources** ☐ **Lack of expertise / skills of existing employees within firms** ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: Main difficulty has been the lack of funds to introduce new and modern equipment to innovate and improve competitiveness. The lack of expertise and awareness of managers and employees has also been a barrier for industrial symbiosis deployment.
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ **Balance of power between partners** ☐ **Similar organisation cultures of firms** ☐ **Legal and political support** ☐ **Active participation and commitment** Please comment on the success factors: Main drivers and success factors are: • Close relation between all key actors involved, from the producers of machines for ceramic tile making to the tile producers, and also business associations and local authorities

	• Collaboration and the synergistic possibilities offered by geographic proximity • The openness of business managers to explore new and high value added valorisation options • Partnerships both in terms of of sourcing materials for production, but also in terms of sales and waste management. • The increasing market potential for sustainable products • The increasing competition in the ceramic tile markets has worked as a general engine of creativity and innovation • Results from several EU-funded projects have promoted innovation and convince suppliers to undertake changes
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ **Increased productivity for the participating companies** ☐ **Increase in job opportunities (employment)** ☐ Enhanced research and innovation capacity ☐ **Reduce in greenhouse gas emissions** ☐ **Improved resource efficiency** ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* Main benefits initially searched by companies were the economic ones in the form of cost savings, more jobs, and competitiveness increase but clear benefits can also be identified for citizens as well as the environment and climate with lower GHG emissions, better more efficient handling of waste, lower use of virgin raw materials.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ **No (not yet)** *Please briefly discuss about practice's potential for transferability / replicability* Work is in progress to produce a tool to identify new synergies and manage the existing ones in a more flexible way using data mining and logic programming. The tool will be tested at the "La Mina"

	industrial park located in Nules (Castellon-Spain) and in other european chemical industrial parks such as CCB-Chemie Cluster Bayern and NEPIC-North East of England Process Industry Cluster.
What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ **Low implementation risks** ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Good leadership within the group is essential for taking ambitious steps to introduce methods that are not common or very well known. • Institutional support is a key prerequisite as it can accelerate or delay the project implementation process. • A good understanding of the benefits of the approach/initiative facilitates the implementation of actions. • A thorough business plan, including detailed activities, costs, realistic timetable and resources allocated to each task is very important. • Good technical knowledge and practical experience benefits implementation as well as early advice and support from experts. • Continuous information provision to those involved contributes to increase their trust and awareness and consequently they became the main users of the compost produced.
Further information (URL, sources)	http://www.conama11.vsf.es/conama10/download/files/conama2016/CT%202016/1998971831.pdf http://sharebox-project.eu/ http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4675&docType=pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: ZGH Bolesław - Industrial symbiosis – product from waste		
A. CASE IDENTITY		
LOCATION	**Country:**	Poland
	Region:	Małopolska

	City/Town: *(if applicable)*	Bolesław
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2014- Today

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	ZGH Bolesław S.A. is the largest company processing zinc in Poland and a producer of Special High Grade Zinc and its products. Company conducts zinc and lead ore mining in the Olkusz-Pomorzany mine. The excavated output is transported to the mechanical processing, where concentrates of zinc and lead are obtained in a flotation process. Zinc concentrates are directed to the smelters, where with pyro and hydrometallurgical process ZGH obtains metallic zinc and zinc alloys. During mining and processing operations, production and storage waste is produced. In the Olkusz-Pomorzany mine the content of zinc and lead in the ore is approx. 4%. After mechanical processing in Olkusz, the ore is converted into concentrates which are sent to the smelters, but almost 60% of total material are flotation tailings, (combination of water with crushed rock) that are later transported to the tailing ponds - a waste facility (tab.1).

Table 1. Waste generated in ZGH Boleslaw S.A. [thousand Mg/year]

The total mass of ZGH Boleslaw waste and methods of management	2015
The total mass of waste, including:	1 500,3
hazardous waste	54,0
non-hazardous waste	1 446,3
Total weight of waste by dealing methods, including:	1 500,3
recovery	1462,0
mining waste stored on-site disposal	38,3

In the metallurgical process, all generated waste is almost entirely used within the ZGH Boleslaw capital group.

ZGH Boleslaw S.A. started to look for technological solutions aimed at maintaining high standards of environmental protection, increasing technological efficiency and reducing production costs. The current activity of the company is focused on improving the efficiency of production processes, the development of technology in the waste processing with protection of the resource base (concentrates and scrap) in the context of the mine closure.
The primary objective pursued by ZGH Boleslaw S.A. waste management is to maximize the use of waste from its own production lines at all stages of production to recover zinc and associated metals within ZGH Boleslaw S.A. capital group. This approach maximizes amount of the main metal used by the company (zinc) and associated metals in the framework of its technical and technological potential.
Therefore, the company started industrial symbiosis with other companies, which were established by ZGH Bolesław and created the whole capital group. An example of efficient processing of own and foreign zinc wastes (sludge of zinc and metallurgical dust) is a zinc-lead concentrate (zinc oxide) produced in the re-rolling process in rotary kilns (Waelz process) in Boleslaw Recycling Sp. z o.o. (The company is part of the ZGH Boleslaw capital group). The concentrate is an additional input of raw materials for the zinc production in RLE (Roast-Leach-Electrowin) and ISP (Imperial Smelting Process) technologies in zinc smelter in Miasteczko Slaskie S.A. (the company is part of the ZGH Boleslaw capital group).
The slag produced in rotary technology kiln is used as a filling material in the opencast mining areas (own and others). At the production stage of zinc, metal waste is produced according to the RLE technology, which, depending on the chemical composition, is transported for further processing (recovery). Zinc sludges are subject to flotation enrichment with the purpose of producing collective concentrate of Zn-Pb-Ag. As a result, waste is transported to the final processing rotary kilns in Boleslaw Recycling Ltd, while waste like: dross zinc, cadmium and lead sulfate sludge are transported to smelters to recover zinc, lead and cadmium.

Moreover, ZGH Bolesław cooperates with NGOs. For example in May 2013, 50

	trees of TiliaCordata were planted in the area of the Company. It was carried out on the background of the cooperation agreement signed by ZGH "Bolesław" S.A. and AERIS FUTURO Foundation. Tree planting campaign was financed with funds provided by the Polish Energy TAURON within TAURON ECO product.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ **Regulation / limited support by local policy makers** ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding

	☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ **Enhanced research and innovation capacity** ☐ Reduce in greenhouse gas emissions ☐ **Improved resource efficiency** ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No *Please briefly discuss about practice's potential for transferability / replicability*

What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Focus on high standards of environmental protection, increase in technological efficiency and reduction of production costs • Creation of companies responsible for increasing environmental standards and promoting industrial symbiosis within a capital group • Effective implementation of industrial symbiosis has led to a reduction in costs; • Openness and effective cooperation is a key aspect of the implementation of industrial symbiosis.
Further information (URL, sources)	http://zghboleslaw.pl/en/

<table>
<tr><td colspan="3">SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy</td></tr>
<tr><td colspan="3">Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Collection of good practices on ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Title: An integrated approach to electronic waste (WEEE) recycling</td></tr>
<tr><td colspan="3">A. CASE IDENTITY</td></tr>
<tr><td rowspan="3">LOCATION</td><td>Country:</td><td>Poland</td></tr>
<tr><td>Region:</td><td>12 Regions</td></tr>
<tr><td>City/Town:
(if applicable)</td><td>Kielce as a main office of Cluster
Choszczno as a main office of 3.Re</td></tr>
<tr><td rowspan="2">ACTIVITIES / MAIN FOCUS</td><td>Geographical level of implementation</td><td>☐ National
☐ Regional
☐ Local</td></tr>
<tr><td>Type of cooperative activity amongst firms in the industrial eco- system</td><td>☐ Exchange of energy, by products and secondary raw materials
☐ Joint use of utilities and firm functions
☐ Collective gathering and removal of waste materials
☐ Combining transport of goods and people
☐ More intensive use of space
☐ Public utilities with high useful effects
☐ Joint commercial firm facilities
☐ Multimodal transport and high quality public transport
☐ Other (please specify)</td></tr>
<tr><td>DURATION</td><td>Time of implementation</td><td>The Cluster was created in 2011 – the effective cooperation with 3Re – in 2016.</td></tr>
<tr><td colspan="3">B. CASE DESCRIPTION</td></tr>
<tr><td>Type of actors involved (choose all that apply)</td><td colspan="2">☐ Large (industrial) enterprises
☐ Small and medium-sized enterprises
☐ National authorities</td></tr>
</table>

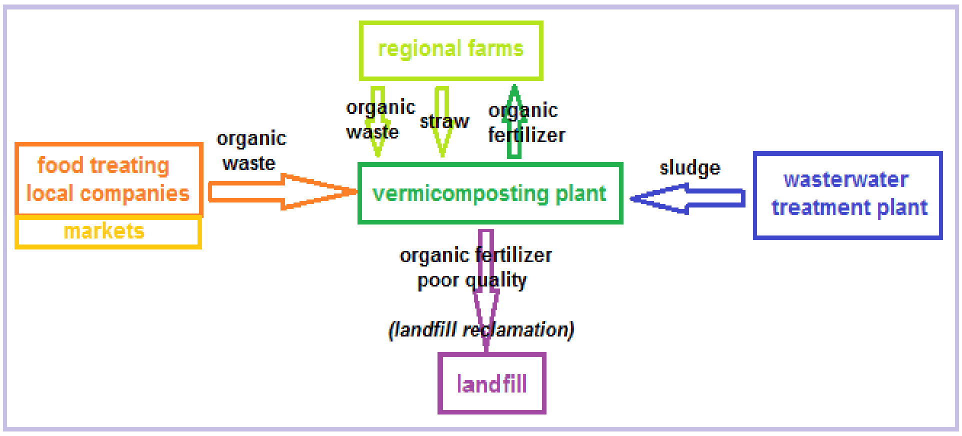
	☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Waste Management and Recycling Cluster (WMRC) is a platform and an area of cooperation of companies, often competing with one another, which through synergy and access to specific resources (knowledge, new technology, people, etc.) may in the long run achieve more for their own quantifiable, economic development than when remaining outside of the group. Increasingly, however, clusters are built based on functional criteria (how best to meet the market) and thus the cluster participants cooperate on the principles of complementarity, not competition, creating a customer value chain. WMRC was created in 2011. Now there are about 70 different organizations, i.e. SMEs, and large companies, universities, NGOs, which conduct effective cooperation. WMRC has become Key National Cluster in Poland in 2016. Most of SMEs' recycled waste of electric and electronic equipment (WEEE) , but with the development of circular economy, the 3Re company (WMRC member) proposed to create industrial symbiosis with cluster members for promotion reuse. By keeping up with fast-changing trends in manufacturing of electronic devices such as mobile phones, smartphones, computers, tablets, touch screens, decoders, game consoles, monitors, printers and small domestic appliances, company started to reuse and refresh these devices. The company offered to share a value and better price for the part of WEEE which can be reuse. They introduced system for testing, recovery and dismantling monitors, PCs, laptops, RAM, etc. Chosen devices i.e. disks are scanned for bad sectors and other damage, and after, it they are repair on the basis of technical condition, cleaned and prepared for reuse. The excess materials from companies is collected to provide them as raw materials for arts and crafts and/or making secondary products. The presented system encourages companies to adopt a collaborative approach in all aspects of their business so that resources can be recovered, reprocessed and reused elsewhere in the industrial network either by themselves or by other companies. This approach of industrial symbiosis based on competitive advantage by promoting the physical exchange of materials, energy and byproducts.

Image (if available)	WEEE Product
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ **Open new markets for secondary raw materials** ☐ Reduce CO2 emissions ☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ **Regulation / limited support by local policy makers** ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ **Different organisational culture within firms** ☐ Economically unsound or risky exchanges ☐ **Lack of motivation and commitment among firms** ☐ **Lack of geographical and technological proximity of firms** ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ **Legal and political support**

	☐ **Active participation and commitment** Please comment on the success factors: …………………………………
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ **Reduce in greenhouse gas emissions** ☐ **Improved resource efficiency** ☐ **Other (please specify):** **improved materials efficiency:** the main focus of WEEE reuse strategy is to divided them into various components and devices. Visually efficient device goes to the next process while worn are untwisted to obtain raw materials. Chosen devices i.e. disks are scanned for bad sectors and other damage, and after it they are repair on the basis of technical condition, cleaned and prepared for re-use. Part which are not suitable for reuse can be send back to recycling companies. *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ **Somewhat successful** ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other	☐ **Yes** ☐ No

areas and settings?	The idea is relatively new and it is one of the first company on the Polish market. Presently, the 3Re is continuing to more attract companies for reuse, as they provide the highest quality standard. Also, the idea are being deployed to encourage the development of synergies beyond the neighborhood companies to demonstrate that there is an underlying potential to establish an eco- industrial network within the region. Not only waste are exchanged but also services.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ **Low implementation risks** ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	3Re is a symbiosis focused primarily on maximum reuse of materials, where the WRMC is a network of WEEE companies, which can guarantee a constant flow of WEEE for reuse. Reuse of waste is the preferred mode of recovery as reuse and repair of end-of-life products help reduce the increasingly growing waste amount. By extending the product life reuse enhances resource efficiency and saves energy, and thus reduces water and air pollution. Due to proper communication and proper agreement to share the profit among partners as well high technology development for reuse the industrial symbiosis can further develop. Such idea can be promote by national and EU policy as it is in line with circular economy assumptions.
Further information (URL, sources)	http://www.3re.co/ http://www.rethinkrecycling.co

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Vermicomposting Industrial Symbiosis Network		
A. CASE IDENTITY		
LOCATION	**Country:**	Poland
	Region:	Podkarpackie Region
	City/Town: *(if applicable)*	Ostrów
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ **Joint use of utilities and firm functions** ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	Connections between the elements of the network are under construction, started in 2014 of the environmental decision.
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ **Regional authorities** ☐ **Local authorities** ☐ Public Agencies	

	☐ **Other (please specify): farmers, entrepreneurs**
Please briefly describe the industrial eco-system	The vermicompost technology combines many elements. Main collaboration occurs between farmers and KOMPOSAD company, implementing vermicomposting technology. Farmers produce biodegradable waste and straw. In exchange for biodegradable waste they can obtain money or organic fertilizer in their crops. The vermicompost technology implementing by KOMPOSAD company is also used by local entrepreneurs and local markets. Entrepreneurs and market managers may transfer biodegradable waste. They are obliged to selectively collect this waste and transfer it to organic recycling. An innovative element of this symbiosis is the combination of vermicompost installations with local wastewater treatment plants. By modifying the vermicompost process and optimizing it, it is possible to use sludge in the vermicompost process. This results in sewage treatment plants being able to fully recycle organic waste sludge. The finished compost can be used in different ways. Firstly, as already mentioned, it can be passed on to the farmers. It can be marketed as a full-grown organic fertilizer. If the fertilizer is of poor quality, it can be used as a reclamation layer on a municipal landfill. The vermicomposting process combines several elements of biodegradable waste management, it is a basic and necessary part of symbiosis.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ **Improve resource efficiency** ☐ **Access new markets** ☐ Share risk ☐ **Open new markets for secondary raw materials** ☐ Reduce CO2 emissions

	☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ **Regulation / limited support by local policy makers** ☐ **Funding, lack of financial resources** ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ **Diversity of actors** ☐ **Low economic risks** ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ **Active participation and commitment**
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ **Enhanced research and innovation capacity** ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ **Other (please specify):**

	- **Cost reduction / Annual savings** There are several aspects of cost reduction. First, the technology is quite cheap in construction, but requires enormous technological knowledge at each stage. If the facility is built in the vicinity of the sewage treatment plant, sewage sludge disposal costs may be reduced. - **Enhanced research and innovation capacity** The vermicompost process can be implemented for organic recycling of many waste groups. Depending on the type of waste, it is possible to optimize the waste mix to always receive organic fertilizer. In addition, it is possible to add different components to improve the process and product quality. It gives the opportunity to develop technology and research to adjust technology to a particular process. For the described process, the research is carried out by scientists from Cracow University of Technology. Implemented process of vermicomposting was described in the PhD thesis "Rationalization of the biodegradable waste vermicomposting process to obtain organic fertilizer". The PhD thesis was prepared by the PhD Student Weronika Wójcik, and the supervisor of thesis was Professor Agnieszka Generowicz, at the Cracow University of Technology. - **Other (please specify): Implementation of the organic recycling system** In Poland, there is still the unresolved problem of recycling organic waste. There are different methods of waste recycling, technology, but they usually involve a narrow waste group. The proposed vermicompost technology combines different groups of waste and significantly raises the level of recycling of waste (up to 60% in the region). Besides, as shown in the diagram, it is an element that connects several different entities and combines them in a non-waste synergy.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ **Do not know / Do not wish to answer (The system is in the process of being implemented)**
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ **No** The system has not been applied in other regions, but in some parts of southern Poland, an environmental procedure is already under way (e.g. Strzyżów). This procedure is a basic element. Moreover, at the stage of verification of local markets, many municipalities that have sewage treatment plants have shown interest in implementing the system

What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ **Low implementation risks** ☐ Small change in daily operations, low risk of organizational resistance ☐ **Legal requirements** ☐ Other (please specify)
Main lessons learned	- The process of vermicomposting is well known, but it requires a lot of knowledge, about waste disposal and earthworm living conditions. - The process can combine multiple elements - farmers, entrepreneurs, local sewage treatment plants. - The process of vermicomposting is an excellent example of recycling organic waste.
Further information (URL, sources)	- *The mass balance of selected organic waste in rural communities using vermicomposting process*, Acta Universitatis Nicolai Copernici Ekonomia, Vol 46, No 2 (2015), ISSN 2080-0339, Weronika Wójcik, Agnieszka Generowicz - *With the help of earthworms,* Przegląd Komunalny, 9/2014, p. 6-7, ISSN 1232-9126, Weronika Wójcik, Agnieszka Generowicz - *Vermicomposting – biodegradable waste and sewage sludge organic recycling - technologies and process products research,* Przemysł Chemiczny, DOI: 10.15199/62.2015.5.20, Agnieszka Generowicz, Małgorzata Kryłów, Weronika Wójcik - Environmental decision for the installation of vermicomposting biodegradable waste (2014)

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: RICICLARTE		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	18 regions of Italy
	City/Town: *(if applicable)*	n.d.

ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	1996- Today

B. CASE DESCRIPTION	
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco- system	Riciclarte is non-profit organization founded in 1996 which aim to be the meeting point of artists that make the recycling the basis of their art, preferring the use of recycled material for their own creations. It offers a virtual space, free of charge, to artists in which they can present their works and make themselves visible to anyone that organize initiatives, events or who simply want to spread this artistic culture.
Image (if available)	

C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: …………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: …………………………………

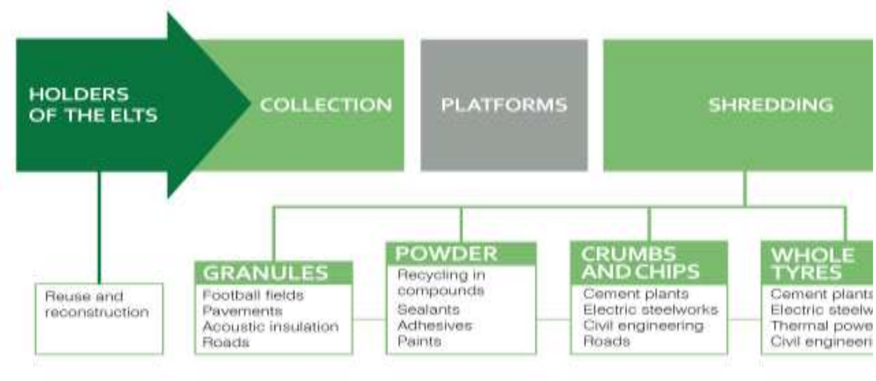
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - **Increase in job opportunities (employment):** thanks to this initiative each artist can increase the number of potential customers and therefore they can increase their sells hence this situation might create job opportunities. - **Enhanced research and innovation capacity**: every time an artist use a new recycled material for his/her creations he/she should study new techniques to apply them. - **Improved resource efficiency:**re-use of recycle material contribute to the resource efficiency.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** From the data retrieved from the network it seems that the number of artists that use recycle material have increases since the beginning of the initiative. Therefore, we can assume that the number of artist than use recycle material is increasing so that is a practice replicated.

What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	Using recycling materials is becoming a philosophy, a mental model that can be applied to daily life, even in the industrial production in the form of ReDesign

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: RUBBER RECYCLED FROM END-OF-LIFE TYRES		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	n/a
	City/Town: *(if applicable)*	n/a
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions

		☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	September 2011 - Today
B. CASE DESCRIPTION		
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)	
Please briefly describe the industrial eco-system	Ecopneus scpa is the non-profit company for the tracking, collection, processing and final destination of end-of-life tyres (ELT) created by the major tyre manufacturers operating in Italy (at the moment in Italy there are 62 companies associated to Ecopneus) under Art. 228 of Legislative Decree 152/2006, which obligates tyre manufacturers and importers to ensure the management of a quantity of ELTs equal in weight to that which is placed on the replacement market in the preceding calendar year. In order to recover the material, the ELTs are fed into special plants in which they are subjected to a granulation process, which reduces the ELT to increasingly small fragments, in several stages, culminating in the production of fine rubber powder with a grain size of less than a millimetre. The process ends with the separation of the granules from	

the powder according to their size and the separation of the metal and fabric residues normally contained in tyres. The latter are separated in the form of “fluff” which is deposited in a container and then sold to companies that handle this kind of waste. Immediately after the initial shredding phase, some items can already be recovered and reused, for example, in civil buildings. At the end of the entire process, gravity separators and zig-zag separators are used to separate the granules from the fine rubber powder, which is the finest product of the ELT shredding and granulation process.



The main applications of this second raw material are:

- Modified asphalts (it is used the powder for silent asphalt);
- Sports surfaces
- Insulating material
- Street furniture, flooring and minor constructions (es. speed humps, traffic markers)
- Building works (es. soundproofing barriers, anti-erosion barriers, slope stabilizers, coast barriers)
- Reuse in mixes (for the production of technical articles)
- Electric arc steelworks
- Mulching material
- Devulcanization (Regeneration)

The entire system is financed by an environmental contribution that every purchaser of tyres pays upon buying a new tyre (value proportionate to every different type of tyre, depending on the weight) and that is used exclusively to ensure the correct management of the end-of-life tyre that will be replaced by the new one purchased.

	List of the Ecopneus partner tyre production and import companies:A. R. Pneumatici;Apollo Vredestein;Asperti Angelo;Autogomma Perego;B. R. Pneumatici;Bellotto;Bersangomme;BIS;Bridgestone;Buymec;Camoplast Solideal Italia;Catania Gomme;Continental;Crespi Gomme;Devalle Gomme;Di Pasquale Diego;Driver Italia;Driver - Servizi Retail;Fiat;Fintyre;Gexpo;Goodyear Dunlop;Gottardi;Grassini Pneumatici;GRG Pneumatici;Harley-Davidson Italia;La Genovese Gomme;Laneve Pneumatici;Marangoni;Marangoni Tyre;Mazzon Leonardo;Mercedes-Benz;Michelin;Natale Illario;Nuova Pneus Vignola;Parise Gomme;Pirelli Tyre;Pneus Area;Pneus Sette;Pneusmarket;Pneusmarket Alpina;Pneusmarket ReD;Pneusmarket Romagna;Pneuspergine;Pneustore;Ponente Gomme;R.G.S. Pneumatici;Re-Ta Gomme;Ridolfi Idio & Figli;River;Rossi Lamberto;Spiezia Pneumatici;Top Ruote;Trelleborg Wheel Systems Italia;Tutto Gomme;Union Pneus Italia;Univergomma;Volkswagen Group;Zuin
Image (if available)	 ELT granules are used as an **infill material between the blades of grass or for the sub-layer underlying the playing surface**  
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

SYMBI Interreg Europe | Camera di Commercio Molise | European Union European Regional Development Fund

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ……………………………….
D. RESULTS & PROSPECTS	
What were the main benefits	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings

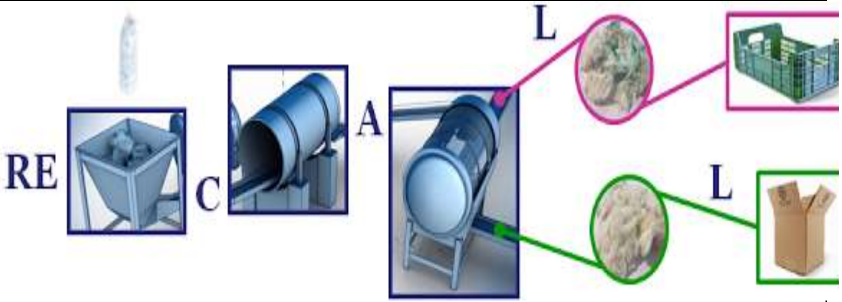
created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - **<u>Contribution to the regional GDP:</u>** reduction of raw material imports; - **<u>Increase in job opportunities:</u>**650 jobs confirmed for the collection and shredding; - **<u>Enhanced research and innovation capacity</u>**: Ecopneus is constantly looking for new applications and therefore for new technologies to treat the end-to-life tyres. - **<u>Reduce in green gas emissions:</u>**over 363,000 tons of CO avoid in 2015. - **<u>Improved resource efficiency:</u>** 1.7 million of m3 of water not consumed
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** There are 12 leading tyre manufacturers in Europe which, in about 90 plants, manufacture 355 million tyres a year, equivalent to 24% of those manufactured worldwide. Europe is one of the most active areas in the world for the recovery of ELTs. *http://www.ecopneus.it/en/il-sistema/in-europe.html*
What are the most significant features of the industrial eco-	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far

system that make it transferable?	☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	In this particular system the national regulations has played an important role that has lead to a system which final aim is to reuse ELTS: The law establishes the rules and makes the producers responsible for organizing the management of the ELTs. Non-profit consortia may be set up to manage the ELTs through cost-effective solutions. The producers are obliged to monitor the process and report to the national authorities.
Further information (URL, sources)	http://www.ecopneus.it/en/il-pneumatico-fuori-uso-pfu/recovery-of-the-material.html http://rapportosostenibilita2015.ecopneus.it/#highlights

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: RECALL - REcycling of Complex AHP waste through a first time appLication of patented treatment process and demonstration of sustainable business model		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Veneto
	City/Town: *(if applicable)*	
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions

		☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2015- Today
B. CASE DESCRIPTION		
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)	
Please briefly describe the industrial eco-system	This industrial eco-system begins with the project "RECALL - REcycling of Complex AHP waste through a first time appLication of patented treatment process and demonstration of sustainable business modeL" that starts in 2012 and end in 2015. RECALL is a co-funded project by the European Commission under the CIP Eco-Innovation - Pilot and Market Replication Projects Call 2011. The main objective of this project is to offer economic and eco-friendly waste management solution to the Absorbent Hygiene Products (AHP) consumers, municipalities, SME operators in the field of waste and recycling, AHP producers and last but not least to all citizens. Today, more than 6.000.000 tons/yr of AHP waste are still	

	incinerated or land filled in Europe. RECALL system (patented by Fater Italia) provides AHP separated collection and an autoclave treatment process where AHP will be sanitized, de-composed, and dried, leading to the recovery of its valuable components (mostly high-quality cellulose and specialty plastics). The recycled diapers become urban furniture and many other items of daily use such as cardboard for industrial packaging and fertilizers. The partners participated in the project were: CONTARINA SPA; FATER SPA; AMBIENTE ITALIA SRL (AI); COMUNE DI PONTE NELLE ALPI (PNA); EUROPEAN PLASTICS RECYCLERS (EuPR) from Belgium **FATER SpA:** Fater is an Italian company, a joint venture between Procter & Gamble and Angelini Group. It manufactures and distributes the brand products ACE Neoblanc and Comet in 39 countries in the Western European and Ceemea markets; in Italy it has been expanding the market of personal hygiene products since the late '60 and it now produces and sells brand products such as Pampers, LINES, LINES Specialist and Tampax. **CONTARINA SPA:** is responsible for the management of waste from the municipalities belonging to the Priula and Tv Tre Consortia, within the province of Treviso, in the Veneto region (Italy), through an integrated system involving waste from production to collection, treatment and recovery, generating a positive impact on the environment as well as on the lives of the citizens. **AMBIENTE ITALIA:** is one of the most important Italian companies of environmental consultancy, active since twenty years in Italy and Europe. Through a constant and recognized presence, Ambiente Italia produced innovative and original solutions for the Italian environmental and energetic policies, gradually assuming a recognized positioning in the areas of research, expert advice and planning for environmental sustainability. **EUROPEAN PLASTICS RECYCLERS**: Plastics Recyclers Europe was created in 1996 to represent plastics recyclers in Europe.

Image (if available)		
		
C. NEEDS, BARRIERS AND SUCCESS FACTORS		
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)- Transform a waste into a secondary raw material	
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms	

	☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ………………………………..
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): A new secondary raw material has been created. ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - <u>**Increase in job opportunities (employment):**</u>thanks to this project a new recycling system has been implemented, so that, new job opportunities will be created in order to run the whole recycled chain. - <u>**Enhanced research and innovation capacity**</u>: This innovative system has been patented .

	- **Improved resource efficiency:** re-use the bottle caps contribute to the resource efficiency. - **Other (New secondary raw material)**: thanks to this innovative technology, it is possible to recycled used diapers that can be used as a secondary raw material.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** From the data retrieved from the net, this system seems to be not replicated in other areas.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	-Research and development have been the success key in this initiative since thanks to the patented technology it has been obtained a secondary raw material.
Further information (URL, sources)	https://sites.google.com/a/fater.it/recall-en/home http://www.centroriciclo.eu www.ambienteitalia.it www.comune.pontenellealpi.bl www.plasticsrecyclers.eu http://www.contarina.it/chi-siamo/impianti/riciclo-prodotti-

	assorbenti

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title:TAPPO BACG–THE ORIGINAL BOTTLE CAPS BAG

A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Tuscany
	City/Town: *(if applicable)*	Pisa
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2012- Today

B. CASE DESCRIPTION	
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	In 2010 a group of persons founded an environmental charity called "Let's Eco Party". To support their activities, they carry on different projects where they used recycled waste material. In 2012, after a careful research and analysis looking for a waste material not yet used in fashion and highly polluting, they came up to the conclusion that the bottle caps waste was a big problem. So the idea was to create a bags brand, using this waste material. The new bag was called **Tappo Bag** (tappo, in italian, means bottle cap). They have partnered with bars and restaurants in Tuscany to repurpose unwanted bottle caps. Instead of having their bottle caps end up in landfills, they reuse them to make the bags. With their work, they would like to increase awareness and providing solutions to the problems bottle caps cause to wildlife and humans alike. A world wide problem. All bags are completely handcrafte and the fabric where the taps are stitched to are recycled vegan fabrics. There are lots of pubs and restaurants in the area of Pisa that provide the bottle caps but around n.10 pub/restaurants are the most active ones. The responsible of the project has chosen only providers in the area at km O in order to reduce pollution.

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………….

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ……………………………….
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): New market opportunities ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - **Increase in job opportunities (employment):** thanks to this initiative the association has proposed an innovative bag entirely made by hand and therefore new job opportunities have been created. Just bear in mind that it takes from 6 hours of work to 4 days to create just oneTappoBag - **Enhanced research and innovation capacity**: The idea of recycling bottle caps has arrived after an accurate research

	and a new production process has been implemented to be able to apply them on bags. - **Improved resource efficiency:**re-use the bottle caps contribute to the resource efficiency. - **Other (social aspects)**: the association has been able to introduce this innovative product in the market and the demand of consumers that would like to make green choices has been satisfied.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** From the data retrieved from the net, this system seems to be not replicated in other areas.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	-Environmental improvements and resource conservation. -Mutual management understanding & cooperative commitment. - Effective communication between participants is required.
Further information (URL, sources)	http://www.tappobag.com/ http://www.letsecoparty.com/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: **INTEGRATED MANAGEMENT SYSTEM OF MUNICIPAL WASTE - DEVELOPMENT OF DRY AND BIODEGRADABLE PARTS**		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Molise
	City/Town: *(if applicable)*	Montagano
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	1998 - Today
B. CASE DESCRIPTION		
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities	

	☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Giuliani Environment Srl operates in Molise within the environmental sector. It was founded in 1998 through the transformation of the Francesco Giuliani company that operated since 1969 within the construction and environmental service sectors . The Giuliani Environment Srl thanks to the continuous technological innovation, the exploitation of its know-how and the constant adaptation to the changing rules of the sector have enabled the company to become an important reference in the integrated waste cycle. The Giuliani Environment Srl implements different activities, we hereby highlight those within the eco-industrial system: the composting and treatment of the paper from the urban waste collection. Regarding the COMPOSTING activity, the Giuliani Environment Srl through a specific technique accelerates, controls and improves the natural process of the organic substances. This process, which takes place under controlled conditions, allows to obtain a biologically stable product, suitable for different applications: horticulture, industrial crops, fruit-growing, etc. In addition, the production of compost contributes to solving the problem of waste disposal, as the organic fraction represents about one third of the waste produced. As regards the treatment of the PAPER, the Giuliani Environment Srl collects this waste, coming from urban separate waste collection, afterwards it selects and treats the paper waste according to the regulations. Subsequently, the paper is delivered to COMIECO consortium or directly to users, such as the paper mills. Thanks to this process the paper becomes a secondary raw material ready for reuse.
Image (if available)	N/A

C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: Legal requirements imposed by the Sector ***Please briefly discuss about the degree of impact on the***

	selected categories of benefits All the companies participated in this industrial symbiosis have met continuously , they have visited each other in order to learn about their organizational structures and their local contexts. An important role has been imposed by the legal requirements of the sector and by the market trends. Moreover, the national packaging consortiums, foreseen by the national laws, have contributed to strengthen the networking.
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): ***Please briefly discuss about the degree of impact on the selected categories of benefits*** The activities described above have allowed the company to optimize the own resources (both human and technological) and to increase the productivity. They have also contribute to improve the quality of the process and to increase the company's turnover.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** Thanks to the national regulations the above mention symbiosis can be easily transferred, even more if the system foresees the

	recycling of domestic waste packaging.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	Belong to a network of partners enable you to develop mutual benefits and, at the same time, allows the company to improve or strengthen its strategic positioning in the market
Further information (URL, sources)	http://www.giulianienvironment.it/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title:ERREPLAST		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Campania
	City/Town: *(if applicable)*	Caserta
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2000- Today

B. CASE DESCRIPTION	
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Erreplast is one of the leading producers of recycled PET flakes. The development of recycling allows the entire community to actively contribute to the growth of a new conception of rejection. From waste it again be comes raw material and resource for new business and new opportunities, while minimizing environmental impact. The processing plant for the recovery of plastics has a capacity of 2,500 kg/h and is able to treat up to 18,000 tonnes per annum of containers in post-consumer PET. Completely built with Italian technology, the plant is now Erreplast advanced industrial application. A fully automated system produces high-quality PET flakes through a process of mechanical treatment of plastic containers from the collection . The production cycle includes the disintegration of the bales in a wet sieve cylinder with hot water washing and the subsequent selection of both manual and automatic for the separation of foreign elements and of other plastics (PVC, PE , other). The recycling of PET gives rise to a new product: the Redial. The range of RPET flakes produced from Errepast has numerous uses in the industrial field, satisfying the demand for the production of fiber-staple industries of furniture, car, clothing and that for products for the building. In addition, the latest innovative applications, allow you to make use of recycled PET in the production of three-layer containers, thermoformed blister, polyester rugs, industrial belts etc. The partners are: SRI – Società Recupero Imballagi: it is a company that select the packaging waste material from recycling. It treats the waste and then all the recycled material is sent to Erreplast that further treats the material. CO.RE.PLA: a consortium of companies to support them in the process of recycling the plastic in order to help the environment. Member of CO.RE.PLA are both manufacturers of plastic sand packaging processing companies. European PETCORE:is a non profit organization tha thas the purpose of facilitating a cost-effective recycling and favoring the production and marketing of recycled PET. E-GAZZETE.IT: The newspaper on the internet that deals with

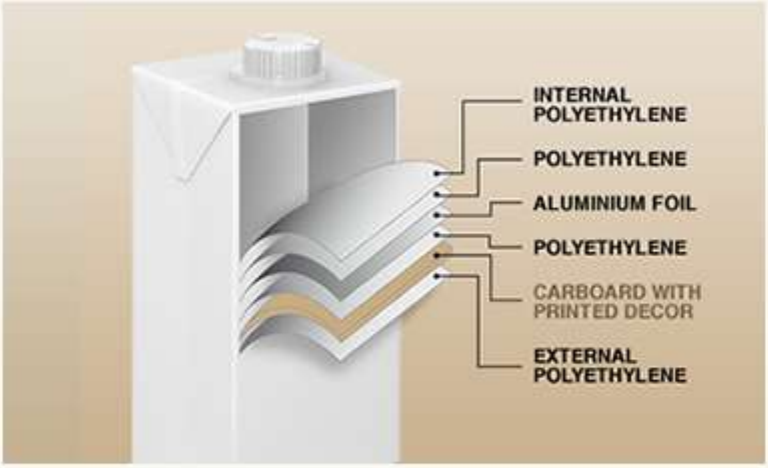
	ecology, energy and economy
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ……………………………….
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* - **Enhanced research and innovation capacity**: to treat the recycle PET the company has patented a specific process. - **Reduce in green gas emissions:** CO_2 emissions savings equivalent to 13,702.60 tons - **Improved resource efficiency:** the company Erreplast has patented a innovative plant to treat the plastic.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful

	☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability:*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Autonomy of the involved firms. The individual industry agreements are based on commercially sound principles. - Environmental improvements. - Mutual management understanding & cooperative commitment. - Effective communication between participants is required.
Further information (URL, sources)	http://www.erreplast.com/page.asp?g=103&a=32 http://www.srisrl.it/main.asp?g=87

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: FIBERPACK PROJECT OF LUCART GROUP		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Tuscany
	City/Town: *(if applicable)*	Lucca
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2011 - Today
B. CASE DESCRIPTION		
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies	

	☐ Other (please specify)
Please briefly describe the industrial eco-system	**Lucart's history** is that of **Italian excellence** which took a chance on ecology deciding to organise its very own production and logistics systems according to environmental criteria. At present, the result of such commitment is known as **Fiberpack®** and it continues along the path of ensuring that the relationship between companies and the environment grows ever more solid and positive. Fiberpack® is the material obtained from recycling cellulose fibres forming part of beverage cartons, all thanks to the innovative and exclusive technology developed by Lucart. Fiberpack® represents an environmental and technological feat, born from the partnership, the only one of its kind, between Lucart and Tetra Pak®. Fiberpack® marks the future of **ecological paper** and Lucart uses it as the **raw material** to produce its main brand products. In fact Lucart has succeeded in transforming the disposal of containers for beverages such as Tetra Pak® into a true circular business model, reusing all the components and avoiding the dispersion of landfill from the containers, with significant social and environmental benefits. Tetra Pak® beverage containers are composed of cellulose fibres, aluminium and polyethylene. Lucart produces tissue paper products for hygienic use with the cellulose fibres, while the parts of aluminium and polyethylene (plastic materials) are used by third parties to produce other objects, such as pallets, other products for the building industry and mooring poles used in the Venetian lagoon Fiberpack® is a flagship research concept, the result of **avant-garde technology** and extreme environment-friendly elements. The Fiberpack® production process begins with individual sense of responsibility, and it is only thanks to the collective that we can achieve a raw material which would otherwise be simply lost into the surrounding environment. Fiberpack® features, along with its logo, on all Lucart products made using the aforementioned, bearing witness to the exclusive and monitored use of cellulose fibres recovered from beverage cartons like Tetra Pak®. Tetra Pak is the world's leading food processing and packaging

	solutions company. This company is committed to running their business in an environmentally sound and sustainable way. They set goals for continuous improvement in their development, sourcing, manufacturing and transportation activities. As part of that commitment, they take a long-term and lifecycle view, continually improving environmental performance, communicating openly with their stakeholders and reporting regularly on their performance.
Image (if available)	 A beverage carton is, on average, made of **74% cellulose fibres**, **22% polyethylene** and **4% aluminium**
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment /	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms

operation of the industrial eco-system?	☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ……………………………….
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): Social aspects ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - <u>**Enhanced research and innovation capacity**</u>: A new material has been developed thanks to the Lucart's environmental

	commitment. The new material is obtained through an innovative production process that has required almost 10 million euro and a new partnership with Tetrapack. - **Reduce in green gas emissions:** over 52,000 tons of CO avoided between 2013 and 2015. - **Improved resource efficiency:** Almost 2 billion retrieved beverage cartons, approximately 900,000 trees saved, which would have been necessary for the production of the equivalent amount of virgin fibre paper. - **Other (social aspects)**: a) Increased collaboration between neighbour municipalities in the region, b) a more concerned society about environmental issues
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** The example provided by the Fyberpack project can be transferred to other areas where producers of MG paper for flexible packaging and/or tissue paper have their production premises.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Autonomy of the involved firms. The individual industry agreements are based on commercially sound principles.

	- Environmental improvements, resource conservation, and economic incentives go hand in hand. - Absence of legal barriers. The development of the symbiosis is voluntary but occurs in close cooperation with government authorities. New secondary raw materials have been made available thanks to the recycling laws and Lucart Group has seen an opportunity on this new scenario. In fact, they have implemente a new production process to reuse all the components of used beverage containers that otherwise would have been dispersed. - Mutual management understanding & cooperative commitment. - Effective communication between participants is required.
Further information (URL, sources)	http://www.lucartgroup.com/index.php?id=8 http://www.fiberpack.com/en/home/ http://www.tetrapak.com/uk h

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: SERIPLAST - PRODUCTION OF COPOLYMER POLYPROPYLENE REGENERATED FROM USED BATTERIES

A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Campania
	City/Town: *(if applicable)*	Caserta
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2011 - Today

B. CASE DESCRIPTION	
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities

	☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	SERI PLAST is an innovative and flexible company that deals with the production of thermoplastic compounds mainly based on polypropylene and polyethylene (recovered from industrial scraps and virgin raw materials) and the distribution of its products on Italian market and worldwide. Highly specialized in this field, in the early 2000s, SERI PLAST developed a polypropylene compound, now approved by the major worldwide battery manufacturers, specially designed for the production of boxes and lids for starter and traction batteries. The attention to details, the constant focus on the different phases of their process, as well as the innovative technology of production and raw materials management, have marked the growth of SERI PLAST making it one of the leading European producers of polypropylene used for battery boxes and lids. The long and strict cooperation with battery manufacturers and automotive sector customers (FIAT, BMW and VW) has pushed SERI PLAST to inaugurate, in 2011, a specific division dedicated to the production of polypropylene compounds for the automotive industry, and to expand its products range with different types of modified polypropylene compounds- Large production capacity, flexibility, competencies and know-how are the solid foundation on which SERI PLAST leans the relationship with its customers. SERI PLAST strategy is to provide "tailor made compounds" according to customer needs, is able to modify and create "ad hoc" plastic materials, in order to meet all kinds of needs whilst ensuring the best quality / price ratio.
Image (if available)	N/A
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing

	☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided: ………………………………..
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions

	☐ Improved resource efficiency ☐ Other (please specify): New market opportunities ***Please briefly discuss about the degree of impact on the selected categories of benefits*** - **Cost reduction / Annual savings:** costs and efficiency of the production processes have been improved thanks to the modern technologies developed with the sister company SERI PLANT - **Enhanced research and innovation capacity**: Industrial scraps have been transformed in a secondary raw material used for the production of compounds. This has been possible thanks to a modern technology developed with the sister company SERI PLANT (world leader in the treatment of exhausted batteries - **Improved resource efficiency:** re-use the polypropylene contribute to the resource efficiency. - **Other (social aspects)**: thanks to the investments in R&D, SERI PLAST has been able to compete in the global market offering product made of a recycle material.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** From the data retrieved from the net, this system seems to be not replicated in other areas.

What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Environmental improvements, resource conservation, and economic incentives go hand in hand. - Mutual management understanding & cooperative commitment. - Effective communication between participants is required.
Further information (URL, sources)	http://www.seriplastsrl.it/index.php/seriplast/recycling-divisionhttp://www.fiberpack.com/en/home/ http://seriplant.com/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: **INLATTE**		
A. CASE IDENTITY		
LOCATION	**Country:**	Italy
	Region:	Molise
	City/Town: *(if applicable)*	Campobasso
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firmfacilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2014 - Today
B. CASE DESCRIPTION		
Type of actors involved	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities	

	☐ Public Agencies ☐ Other (please specify) – University of Molise
Please briefly describe the industrial eco-system	Caseificio Molisano L. Barone is a dairy processing company that produces dairy products, especially mozzarella, using only high quality Italian raw materials. The production process of the company generates whey which has to be disposed through an authorized methodology, since it is a polluting material. The company in a partnership with another company (Az. Agr. Disenza Gianni) and with the local University (University of Molise) started to reuse the whey through an innovative process. The company obtained regional funds to put into practice this innovative process and, thanks to the positive results, since 2013 the company is financing itself all this activity. The process foresees different activities to reuse the whey, among which: Recovery and stabilization of the whey (the whey is provided by Casificio Barone and the University is in charge of the stabilization process of the whey) and used of the stabilized whey in the diet of dairy cows (activity implemented by Az. Agr. Disenza Gianni). The use of stable and nutritional whey in the diet of dairy cows (through the watering and silage) contributes to obtaining milk of higher nutritional values and, therefore, the cheeses that the company Caseificio Molisano Barone produces have higher nutritional proprieties.
Image (if available)	N/A
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Risk sharing ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue

	☐ Reduce production costs ☐ Other (please specify): Improve the wellbeing of the cows and reduce the use of medicines
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Other relevant info provided:
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify):

	Please briefly discuss about the degree of impact on the selected categories of benefits Thanks to the activity foreseen in this industrial eco-system, an innovative process to reuse the whey has been implemented where new methodologies have been applied thanks to the contribution of the local University and where the small companies involved have improve their processes and products.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** The process can be easily transferred.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	If you have got a valid idea and the partners you are working with are determined to implement the foreseen activities, any administrative barrier or any barrier of other kind can be easily overcome.
Further information (URL, sources)	http://www.barone.it/inlatte/Progetto.htm# http://www.barone.it/index.php/ita/news/curiosita/progetti-di-ricerca.html

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges

Title: Aquafil		
A. CASE IDENTITY		
NAME	**Company**	Aquafil
LOCATION	**Country:**	Slovenia
	Region:	Zahodna Slovenija (NUTS 2)
	City/Town:	Ljubljana
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	× National □ Regional □ Local
	Type of cooperative activity amongst firms in the industrial eco-system	× Exchange of energy, by products and secondary raw materials □ Joint use of utilities and firm functions □ Collective gathering and removal of waste materials □ Combining transport of goods and people □ More intensive use of space □ Public utilities with high useful effects □ Joint commercial firm facilities □ Multimodal transport and high quality public transport □ Other (please specify)
DURATION	**Time of implementation**	From December 2015

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	× Large (industrial) enterprises □ Small and medium-sized enterprises □ National authorities □ Regional authorities □ Local authorities □ Public Agencies □ Other (please specify)
Please provide a brief description of your organisation's profile and its involvement in eco-system	Since 50 years, Aquafil has been one of the leading players, both in Italy and globally, in the production of Polyamide 6: a landmark in terms of quality and product innovation. Additionally, the Group is a leader in the research of new production models for sustainable development. This commitment to research and development leads to the regular renewal of processes and products thanks to continuous investments of

SYMBI Interreg Europe | Camera di Commercio Molise | European Union European Regional Development Fund

	capital and knowledge. **Our mission and values:** - To **acknowledge the needs of everyone within the Aquafil Group** worldwide and those who help to achieve our goals: employees, contractors, suppliers and local communities in which the Group operates - To further **develop an international presence** by enhancing the potential in new and emerging countries - To **set new standards for the market** through research and innovation - To play a **leading role in new models for sustainable development** in order to secure the future of company growth and future generations
Please briefly describe the industrial eco-system	Aquapark Atlantis in Ljubljana's commercial city centre has agreed with Aquafil (Julon) to exchange the heat energy. Aquafil distributes its surplus of heat energy to Atlantis's swimming pools and thus fulfill 100 % of Atlantis needs. Since both companies are located next to each other, such agreement enables high reduction of greenhouse gas emissions and contributes to greener city. On top of its environmental sustainability, the project brings economic effects. The heat energy in form of hot water, using now by Atlantis, is produced within the process of producing the ECONYL. Part of this energy is used back in production cycle, while the surplus has until now represented unexploited energy potential. More can be found at: http://www.aquafil.com/localnews/vodno-mesto-atlantis-se-od-decembra-ogreva-s-toploto-podjetja-julon/
What is your position in the organisation / company?	□ Owner / director of company □ Board member □ Financial officer □ Technical officer □ Administrative manager □ Operations manager □ Other (please specify): Sustainability Compliance Manager
E-mail address	Tina.mavric@aquafil.com | lucija.aleksic@aquafil.com

Image (if available)						
C. NEEDS, BARRIERS AND SUCCESS FACTORS						
What were the main needs and objectives for the deployment of the industrial eco-system?	□ Promote the use of sustainable bio-energy resources □ Improve resource efficiency □ Access new markets □ Share risk □ Open new markets for secondary raw materials × Reduce CO2 emissions □ Increase profitability, revenue × Reduce production costs □ Other (please specify):					
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	□ Regulation / limited support by local policy makers	1	**2**	3	4	5
	□ Funding, lack of financial resources	**1**	2	3	4	5
	□ Lack of expertise / skills of existing employees within firms	**1**	2	3	4	5
	□ Imbalance of power between partners	**1**	2	3	4	5
	□ Different organisational culture within firms	**1**	2	3	4	5
	□ Economically unsound or risky exchanges	**1**	2	3	4	5
	□ Lack of motivation and commitment among firms	**1**	2	3	4	5
	□ Lack of geographical and technological proximity of firms	**1**	2	3	4	5
	□ No problems encountered					
	× Other relevant info provided: spatial planning (geographic proximity of companies play an important role)					

Please briefly discuss how and to what extent the participating organisations managed to overcome the barriers selected above:	- Spatial planning related issues have been solved by new investing in building infrastructure. - Structural dialogue is crucial. You have to communicate with your potential partners. What is more important in communication is that you perceive your counterpart as equal partner (you should not enter the conversation on the premise that your counterpart is your enemy).
To your knowledge, what are the enabler for eco-system? What are the enablers / success factors?	× Close proximity of companies □ Diversity of actors × Low economic risks □ Adequate funding □ Balance of power between partners □ Similar organisation cultures of firms × Legal and political support □ Active participation and commitment Please comment on the success factors: Cost efficiency
Please briefly discuss your experience related to the enabler / success factors selected (e. g. local policy measures, info about market growth and local environment, collaboration with key actors etc.)	- Close proximity of companies: if industries are located close to each other, this enables more synergies due to cost reduction (transport, infrastructure etc.). - Low economic risks: by entering the eco-symbiosis there are no major economic risks for industries / companies. You enter the eco-symbiosis because you already have certain product (by-product, waste) – you do not start producing something new because you wish to enter the eco-symbiosis. - Legal and political support: public sector can make a push by purchasing products coming from industries, involved in eco-symbiosis. This can be done by labelling (eco labels) or criteria.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	□ Contribution to the regional GDP × Cost reduction / Annual savings □ Increased productivity for the participating companies □ Increase in job opportunities (employment) □ Enhanced research and innovation capacity × Reduce in greenhouse gas emissions □ Improved resource efficiency □ Other (please specify):

What are the economic, social and environmental impacts derived from the deployment / operation of the industrial innovation eco-system?		*Strongly negative*	*Minor negative*	*Neither nor*	*Minor positive*	*Strongly positive*
	Productivity of the firm			×		
	Costs of production					×
	Product or service quality			×		
	Regional GDP			×		
	Employment			×		
	Research and innovation capacity			×		
	Greenhouse gas emissions					×
	Resource efficiency			×		
	Energy efficiency					×
Please briefly discuss the impacts selected above and/or other relevant socio-economic and environmental impacts (impacts on company and employees performance, previous situation compared to current, relevant statistics / performance indicators)	This industrial eco-symbiosis has a very positive effects on reduction of costs (particularly for Atlantis), greenhouse gas emissions and improved the energy efficiency (Aquafil in terms of its previously unexploited heat energy, Atlantis in terms of reducing its costs for electricity, since the heat is now assured from Aquafil).					

What are the main lessons learned from the deployment / operation of the industrial innovation eco-system (e.g. specific local social circumstances stimulated the mutual trust building between industries and created an environment for cooperative action)?	- Geographical proximity enabled cost reductions. - This industrial symbiosis has raised discussions among other industries to join it or to create eco-symbiosis in other areas.
How would you describe the industrial eco-system deployed?	× Very successful □ Quite successful □ Somewhat successful □ A little successful □ Not at all successful □ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	× Yes □ No
Please briefly discuss the industrial eco-system's potential for transferability / replicability.	Transferability is definitely possible, but few companies are aware that their by-products or waste can be secondary raw material for other industry. Therefore, Aquafil's system is possible to transfer, but companies should first know which products they can exchange.
What are the most significant features of the industrial eco-system that make it transferable?	□ Use of standardised technology solutions and processes □ Needs addressed are common among industries, organisations and different regions/countries. □ Demonstrated achieved benefits outweigh investment costs by far □ Low implementation risks □ Small change in daily operations, low risk of organizational resistance □ Legal requirements × Other: Economic benefits
Main lessons learned	- First steps in entering the industrial symbiosis may cause some additional investment costs, but on a long run, benefits are much higher. - There is a need for constant search of new synergies between

	industries. - Good practices (like the present one) have triggered discussions elsewhere about creating new industrial eco-systems. - Local support is very important. - Industrial symbiosis has higher potential to be implemented if it is created in industrial zones due to proximity of industries. Moreover, if industries with similar interests are located close to each other, it is easier to introduce eco-symbiosis. There might be a problem, if an industry is surrounded by companies to which completely different spatial laws are applied, since this cause additional administrative burdens and investments. Spatial planning thus plays a very important factor.
Further information (URL, sources)	- Aquafil: www.aquafil.com/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Dinos DROE UniREC		
A. CASE IDENTITY		
NAME	**Company**	Dinos d.d.
LOCATION	**Country:**	Slovenia
	Region:	Zahodna Slovenija (NUTS 2)
	City/Town:	Ljubljana
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	× National □ Regional □ Local
	Type of cooperative activity amongst firms in the industrial eco-system	× Exchange of energy, by products and secondary raw materials □ Joint use of utilities and firm functions × Collective gathering and removal of waste materials □ Combining transport of goods and people □ More intensive use of space □ Public utilities with high useful effects □ Joint commercial firm facilities □ Multimodal transport and high quality public transport □ Other (please specify)
DURATION	**Time of implementation**	From 2013
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	× Large (industrial) enterprises □ Small and medium-sized enterprises □ National authorities □ Regional authorities □ Local authorities □ Public Agencies □ Other (please specify)
Please provide a brief description of your organisation's profile and its involvement in eco-system	With over 60 years of tradition related to a sustainable development policy, modern technology of recycling waste and an extensive network of warehouses, Dinos d.d. provides integrated solutions for waste treatment. This makes a significant contribution to the preservation of natural resources. With Dinos's integrated services of collection, disposal and treatment of waste materials, the company takes care of the socially responsible treatment of the useful waste of your company. Let your behavior towards the environment become part of the policy of your company as you will contribute significantly to the protection of the environment and the preservation of natural resources. More information can be found at: http://www.dinos.si/?lang=en
Please briefly describe the industrial eco-system	Dinos d.d. established a subsidiary company, called UniRec, with the purpose to set up an industrial eco-system. The eco-system project, called "Plastic bottle for plastic bottle", was thus initiated by Dinos. This industrial eco-system involved 3 companies, i. e. UniRec (Dinos), GastroPET and Fructal. UniRec (Dinos) is a company which collects waste, sorts it and sell it to GastroPET. GastroPET is a production company, which primary activity is the production of PET preforms. Company's main resources are secondary raw materials (coming from Dinos). GastoPET thus produces plastic bottles, which are bought by Fructal beverage company. Fructal fills the bottle with the beverage. Those plastic bottles that are considered waste (due to non-compliance with the technical standards) and those collected through dedicated waste-collecting programmes (including schools), are returned back to UniRec (Dinos d.d.). This is how that material loop is closed.
What is your position in the organisation / company?	□ Owner / director of company □ Board member □ Financial officer × Technical officer × Administrative manager □ Operations manager

	☐ Other (please specify)					
E-mail address	Goran.ambroz@dinos.si | brigita.sarc@dinos.si					
Image (if available)						
C. NEEDS, BARRIERS AND SUCCESS FACTORS						
What were the main needs and objectives for the deployment of the industrial eco-system?	× Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs × Other (please specify): Raise awareness about the need to protect and save the environment					
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers	1	2	3	4	5
	☐ Funding, lack of financial resources	1	2	3	4	5
	☐ Lack of expertise / skills of existing employees within firms	1	2	3	4	5
	☐ Imbalance of power between partners	1	2	3	4	5
	☐ Different organisational culture within firms	1	2	3	4	5
	× Economically unsound or risky exchanges	1	2	3	4	5
	☐ Lack of motivation and commitment among firms	1	2	3	4	5
	× Lack of geographical and technological proximity of firms	1	2	3	4	5
	☐ No problems encountered					
	☐ Other relevant info provided:					

	- National regulatory frame (absence of clear regulation and criteria between the by-products and waste) - Absence of solid support among different similar companies
Please briefly discuss how and to what extent the participating organisations managed to overcome the barriers selected above:	The companies, involved in the eco-system, were driven by responsibility to protect the environment and to use the secondary raw materials instead of buying the primary resources. Though, there are certain economically risks (related to different quantities of collected waste, prices of materials and not stable source of financing), companies were ready to invest in the project due to long-term benefits. Geographical proximity of companies was an issue, but due to wide network of franchises of these companies (particularly Dinos) across Slovenia, they managed to reduce the transportation costs. But the eco-system could save on transport costs, if the companies were located closer to each other. Due to absence of national legislation on what can be considered by-product and waste, the companies surpassed this barrier by using the simpler way: collected plastics was sold as waste, since pre-qualification of the waste to secondary raw material would be more expensive and more difficult in terms of legislation.
To your knowledge, what are the enabler for eco-system? What are the enablers / success factors?	□ Close proximity of companies □ Diversity of actors × Low economic risks □ Adequate funding × Balance of power between partners □ Similar organisation cultures of firms × Legal and political support × Active participation and commitment Please comment on the success factors: ………………………………
Please briefly discuss your experience related to the enabler / success factors selected (e. g. local policy measures, info about market growth and local environment, collaboration with key actors etc.)	Though the project (eco-system) is related to economic risks (not stable source of financing and returns), these are small compared to other processes. Therefore it is affordable for the companies to invest and financially support such system. In terms of "legal and political support", there is a strong political support on local level (much better than on national level). Local communities (municipalities) are very much in favour of such eco-systems, therefore they are advocating inclusion of different stakeholders (schools, hospitals, public places etc.) in the system in order to maximize the effects and results. What plays an important role is active participation of all partners in eco-system as well as other relevant stakeholders. They are all strongly committed to continue implementing this project, since it is beneficial for the local communities, companies and most important, environment.
C. RESULTS & PROSPECTS	
What were the main benefits created by the	□ Contribution to the regional GDP □ Cost reduction / Annual savings

deployment/operation of the industrial eco-system? *(select all that apply)*	□ Increased productivity for the participating companies □ Increase in job opportunities (employment) □ Enhanced research and innovation capacity × Reduce in greenhouse gas emissions × Improved resource efficiency □ Other (please specify):

What are the economic, social and environmental impacts derived from the deployment / operation of the industrial innovation eco-system?

	Strongly negative	*Minor negative*	*Neither nor*	*Minor positive*	*Strongly positive*
Productivity of the firm			×		
Costs of production		×			
Product or service quality				×	
Regional GDP			×		
Employment			×		
Research and innovation capacity				×	
Greenhouse gas emissions					×
Resource efficiency					×
Energy efficiency					×

Please briefly discuss the impacts selected above and/or other relevant socio-economic and environmental impacts (impacts on company and employees performance, previous situation compared to current, relevant statistics / performance indicators)	The eco-system does not have an impact on productivity of the firm, since it is carried out on a smaller scale. In terms of costs of production, it has a slight negative effect, since the companies still need to invest in it. But there a slight positive effect on quality of products and services (new knowledge, positive effect on brand and better cooperation among stakeholders). The eco-system (for the time being) does not any effect on regional GDP or employment, but it has a potential to have it in the near future. Due to this project, the companies needed to introduce new business models, affecting research and innovation (particularly in the domain of recycling and raw materials). But there are significant impact on greenhouse gas emissions, resource efficiency and energy efficiency. There is one more impact that have not been mentioned yet, i. e. health. By reducing the greenhouse gas emissions, the eco-system contributes to improving the health environment and thus acts pro-active.

What are the main lessons learned from the deployment / operation of the industrial innovation eco-system (e.g. specific local social circumstances stimulated the mutual trust building between industries and created an environment for cooperative action)?	Main lessons learned can be summed up as following: - enhanced mutual trust between companies; - better cooperation among companies and stakeholders; - there is a need to continue with raising awareness about such projects; - if companies have will to cooperate in eco-system, they find the way; - generator of ideas for new similar projects; - such projects can attract new stakeholders in the system, enabling spill-over effects.
How would you describe the industrial eco-system deployed?	× Very successful □ Quite successful □ Somewhat successful □ A little successful □ Not at all successful □ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	× Yes □ No
Please briefly discuss the industrial eco-system's potential for transferability / replicability.	The eco-system served as a basis for setting up a new circular concept, called TetraPak, which will be launched in 2017. TetraPak system will aim at collecting TetraPak waste and will be put back in material circular loop. TetraPak eco-system will involve more industries, where waste of one will be the input raw material for another.
What are the most significant features of the industrial eco-system that make it transferable?	× Use of standardised technology solutions and processes × Needs addressed are common among industries, organisations and different regions/countries. □ Demonstrated achieved benefits outweigh investment costs by far × Low implementation risks □ Small change in daily operations, low risk of organizational resistance □ Legal requirements □ Other (please specify)
Main lessons learned	Main lessons learned can be summed up as following (<u>same as above</u>): - enhanced mutual trust between companies; - better cooperation among companies and stakeholders;

	- there is a need to continue with raising awareness about such projects; - if companies have will to cooperate in eco-system, they find the way; - generator of ideas for new similar projects; - such projects can attract new stakeholders in the system, enabling spill-over effects.
Further information (URL, sources)	Links (URLs) have already been inserted where necessary.

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Štore Steel		
A. CASE IDENTITY		
NAME	**Company**	Štore Steel
LOCATION	**Country:**	Slovenia
	Region:	Vzhodna Slovenija (NUTS 2)
	City/Town:	Štore
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	× National × Regional □ Local
	Type of cooperative activity amongst firms in the industrial eco-system	□ Exchange of energy, by products and secondary raw materials □ Joint use of utilities and firm functions × Collective gathering and removal of waste materials □ Combining transport of goods and people □ More intensive use of space □ Public utilities with high useful effects □ Joint commercial firm facilities □ Multimodal transport and high quality public transport □ Other (please specify)
DURATION	**Time of implementation**	2007
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	× Large (industrial) enterprises □ Small and medium-sized enterprises □ National authorities □ Regional authorities □ Local authorities □ Public Agencies □ Other (please specify)	
Please provide a brief description of your organisation's profile and its involvement in eco-system	The company was founded on 16 July 1997 under the name Slovenske železarne - Jeklo Štore, podjetje za proizvodnjo jekel d.o.o., and was inscribed in the Celje court register under item 1/06654/00. State owned Jeklo Štore has been sold to Inexa from Sweden and	

	Unior in 1999 and renamed to Inexa Štore. 220% share has been exchanged between Slovenske železarne and authorized company Železar Štore, d.d. for Slovenske železarne shares. In year 2003 has Unior d.d. bought share from Inexa and sold its previous share to partner companies Kovintrade d.d. and Dinos Celje d.o.o.. Company was renamed to Štore Steel. Štore Steel is successor of ironworks which started with company Berg- und Hüttenwerk Store in the year 1851. Conciliation between two owners in 1852, when F.B.Andrieu had to assign his property to P.Putzer, includes list of buildings and equipment which proves that a complete factory for industrial steel production had been built in 1851. There were: a steam machine, puddling mills, rolling stands and coal for providing of energy.
Please briefly describe the industrial eco-system	Štore Steel is involved in industrial eco-system with many companies, thus exchanging and trading with secondary raw materials. It is collecting different types of steel waste and by-products from many companies (e. g. car industry Revoz Novo Mesto, UNIOR Zreče). Their by-products are mainly recycled within the company, but certain by-products (e. g. black dross, scale, primary slags etc.) are further on sold to other companies (e. g. scale is used in Gorenje factory to produce washing machine weights; black dross is used in Ekomineral company to produce asphalt).
What is your position in the organisation / company?	◻ Owner / director of company ◻ Board member ◻ Financial officer ◻ Technical officer ◻ Administrative manager ◻ Operations manager ◻ Other (please specify): Technical director & Associate Director
E-mail address	Boris.kumer@store-steel.si | bojan.sencic@store-steel.si

Image (if available)	

C. NEEDS, BARRIERS AND SUCCESS FACTORS

What were the main needs and objectives for the deployment of the industrial eco-system?	□ Promote the use of sustainable bio-energy resources □ Improve resource efficiency □ Access new markets □ Share risk × Open new markets for secondary raw materials □ Reduce CO2 emissions □ Increase profitability, revenue □ Reduce production costs □ Other (please specify): Raise awareness about the need to protect and save the environment; raise the level of trust in local community that products are not harmful for the environment

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	□ Regulation / limited support by local policy makers	1	2	3	**4**	5
	□ Funding, lack of financial resources	1	**2**	3	4	5
	□ Lack of expertise / skills of existing employees within firms	1	**2**	3	4	5
	□ Imbalance of power between partners	1	**2**	3	4	5
	□ Different organisational culture within firms	**1**	2	3	4	5
	□ Economically unsound or risky exchanges	1	**2**	3	4	5
	□ Lack of motivation and commitment among firms	**1**	2	3	4	5
	□ Lack of geographical and technological proximity of firms	**1**	2	3	4	5

	☐ No problems encountered ☐ Other relevant info provided:
Please briefly discuss how and to what extent the participating organisations managed to overcome the barriers selected above:	- Regulation / limited support by local policy makers: investing in raising awareness and information campaigns in local communities that steel industry can be beneficial and not harmful for the environment.
To your knowledge, what are the enabler for eco-system? What are the enablers / success factors?	× Close proximity of companies ☐ Diversity of actors × Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………
Please briefly discuss your experience related to the enabler / success factors selected (e. g. local policy measures, info about market growth and local environment, collaboration with key actors etc.)	- Proximity of companies reduces the transport costs and costs related to investing in potential new infrastructure (in order to enable the industrial eco-system). - Introducing industrial eco-system represents small economic risks. - Use of secondary raw materials makes positive effects on environment. - Industrial eco-system enhances trust building between companies / partners.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	× Contribution to the regional GDP × Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions

<table>
<tr><td></td><td colspan="6">□ Improved resource efficiency
□ Other (please specify):</td></tr>
<tr><td rowspan="10">What are the economic, social and environmental impacts derived from the deployment / operation of the industrial innovation eco-system?</td><td></td><td>Strongly negative</td><td>Minor negative</td><td>Neither nor</td><td>Minor positive</td><td>Strongly positive</td></tr>
<tr><td>Productivity of the firm</td><td></td><td></td><td>×</td><td></td><td></td></tr>
<tr><td>Costs of production</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Product or service quality</td><td></td><td></td><td>×</td><td></td><td></td></tr>
<tr><td>Regional GDP</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Employment</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Research and innovation capacity</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Greenhouse gas emissions</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Resource efficiency</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Energy efficiency</td><td></td><td></td><td></td><td>×</td><td></td></tr>
<tr><td>Please briefly discuss the impacts selected above and/or other relevant socio-economic and environmental impacts (impacts on company and employees performance, previous situation compared to current, relevant statistics / performance indicators)</td><td colspan="6">Productivity of the firm: there is no significant impact on productivity of the firm.
Costs of production: since materials (secondary raw materials) can come from closer industries, this reduces the costs of production (less transportation costs etc.)
Product or service quality: no significant impact
Regional GDP: it has positive impact, since it encourages local companies / industries to change their business models and enter the eco-system
Employment: industrial eco-system contributes to new employment opportunities
Research and innovation capacity: due to new processes, new knowledge is needed and needs to be produced
Greenhouse gas emissions: recycling instead of producing contributes to lower the greenhouse gas emissions
Resource efficiency: circularity of materials contributes in better resource efficiency</td></tr>
</table>

	• Energy efficiency: less energy is needed to recycle secondary raw materials than producing the primary raw materials from ore
What are the main lessons learned from the deployment / operation of the industrial innovation eco-system (e.g. specific local social circumstances stimulated the mutual trust building between industries and created an environment for cooperative action)?	- Introduction of secondary raw materials market would be beneficial. - Companies should work on trust building in local communities by raising awareness and information campaigns. - Rigid legislation in the field of classifying waste and by-products makes interactions between companies very difficult.
How would you describe the industrial eco-system deployed?	× Very successful □ Quite successful □ Somewhat successful □ A little successful □ Not at all successful □ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	× Yes □ No
Please briefly discuss the industrial eco-system's potential for transferability / replicability.	- Industrial eco-system can be easily transferred to other sectors, since our model can serve as a role model for others. There are already technological solutions and processes present, meaning that no from-scratch R&I is needed.
What are the most	× Use of standardised technology solutions and processes

significant features of the industrial eco-system that make it transferable?	× Needs addressed are common among industries, organisations and different regions/countries. □ Demonstrated achieved benefits outweigh investment costs by far □ Low implementation risks □ Small change in daily operations, low risk of organizational resistance □ Legal requirements □ Other (please specify)
Main lessons learned	- Industrial eco-system is a solution for preserving primary resources. - Legislation at national level should be drafted in a way that it encourages industrial cooperation and exchange of secondary raw materials. - Environmental law should be strict, but flexible enough, meaning that when industry's circumstances change, new environmental permissions should be easily obtained. - For steel industry (which is considered large), the fragmentation of companies, buying by-products, is disadvantage (more administrative procedures). If there is economy of scale, industrial symbiosis is easier to manage. - We should be more open to transfer or adopt good practices (already existing) from abroad (e. g. from Germany, Austria).
Further information (URL, sources)	http://www.store-steel.si/PodjetjeE.asp Štore Steel Interni informativni časopis, 2-16. http://www.store-steel.si/Data/Novice/glasilo_2_16_slo.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Circular Economy, Industrial bio-economy, Closed Loop Production Cycles		
A. CASE IDENTITY		
NAME	**Company**	TECOS, Slovenian Tool and Die Development Centre
LOCATION	**Country:**	Slovenia
	Region:	Vzhodna Slovenija (NUTS SI-2), NUT SI-01, Savinjska Region
	City/Town:	Celje
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	× National × Regional × Local
	Type of cooperative activity amongst firms in the industrial eco-system	□ Exchange of energy, by products and secondary raw materials □ Joint use of utilities and firm functions □ Collective gathering and removal of waste materials □ Combining transport of goods and people □ More intensive use of space □ Public utilities with high useful effects □ Joint commercial firm facilities □ Multimodal transport and high quality public transport × Other: Introducing waste materials into the existing production lines, upgraded for manufacturing a novel end-products.
DURATION	**Time of implementation**	---
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	□ Large (industrial) enterprises × Small and medium-sized enterprises □ National authorities □ Regional authorities □ Local authorities □ Public Agencies □ Other (please specify)	
Please provide a brief description of your organisation's profile and its involvement in	**Slovenian Tool and Die Development Centre** was established in 1994 as a **non-profit organisation** to represent the collective interests of the Tool, Die & Mould-making (TDM) and Processing Industries with a comprehensive background	

eco-system	support of the global manufacturing ecosystem. TECOS was **founded by the Government of Slovenia – Ministry for Economy, Chamber of Commerce – GZS and Municipality of Celje** and thus has a direct access to the most relevant governmental policy makers in Slovenia. **TECOS** today **operates on three dimensional assets, as International Business Cluster, R&D Centre and VET Institution**, providing top level services not only for TDM industry but also to all other manufacturing/production companies in Slovenia. TECOS's R&D focus areas are advanced manufacturing (tools, processes, digital manufacturing), robotics, nanotechnologies, food packaging technologies and advancements for medical, home appliance, automotive and transportation industries (alternative material sources, optimized processes, hybrid technologies and innovative biomaterials). TECOS's highly skilled personnel and otherwise wide range of expertise services for industry are in many way related to bio-based products and eco-innovations (bioplastic and biocomposite processing development, feedstock logistics, energy-efficient processes, closed-loop recycling systems, business planning on sustainable and resource-efficient circular economies, Life cycle inventory, etc.). **TECOS operates as a competent institutional support of Slovenian Manufacturing Industries in the transfer of this knowledge & technical support services, providing the latest information and advancements on the bio-economy benefits and prosperous potentials for entering and conquering new global markets.** The Industrial Association of Slovenian toolmakers and Production Companies was initiated by the Slovenian TDM Industries with a goal of protecting the interests of toolmakers both on domestic and international market. TECOS's priority is to improve the members' competitiveness through the provision of valuable resources, and in so doing, cluster actively assist in the revitalisation of the TDM industry, which holds a great hope for the future as manufacturers commit to more efficient technology practice and green engineering, widely regarded as being near the top of recession-resistant industries. Industrial Association today constitutes close to 70 members, mainly small to medium enterprises, but also large industrial concerns, R&D institutes, regional development agencies and financial institutions.
Please briefly describe the industrial eco-system	TECOS is in industrial symbiosis with Interseroh company (located in Maribor). Interseroh is buying waste plastics from TECOS, since the plastics represents a secondary raw material.

What is your position in the organisation / company?	× Owner / director of company □ Board member □ Financial officer □ Technical officer □ Administrative manager □ Operations manager × Other: researcher
E-mail address	Ales.hancic@tecos.si | vesna.zepic@tecos.si
Image (if available)	*Of industrial symbiosis*
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	□ Promote the use of sustainable bio-energy resources × Improve resource efficiency □ Access new markets □ Share risk × Open new markets for secondary raw materials × Reduce CO2 emissions × Increase profitability, revenue × Reduce production costs □ Other (please specify): Raise awareness about the need to protect and save the environment

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	□ Regulation / limited support by local policy makers	1	2	3	**4**	5
	□ Funding, lack of financial resources	1	2	3	**4**	5
	□ Lack of expertise / skills of existing employees within firms	1	2	**3**	4	5
	□ Imbalance of power between partners	1	2	**3**	4	5
	□ Different organisational culture within firms	1	**2**	3	4	5
	□ Economically unsound or risky exchanges	1	**2**	3	4	5
	□ Lack of motivation and commitment among firms	**1**	2	3	4	5
	□ Lack of geographical and technological proximity of firms	**1**	2	3	4	5
	□ No problems encountered					
	□ Other relevant info provided:					

Please briefly discuss how and to what extent the participating organisations managed to overcome the barriers selected above:	With co-creating of Smart Specialisation Priorities, with raising the importance of ecological awareness and importance of green production methods (regulation drivers from EC).
To your knowledge, what are the enabler for eco-system? What are the enablers / success factors?	□ Close proximity of companies × Diversity of actors × Low economic risks × Adequate funding □ Balance of power between partners □ Similar organisation cultures of firms × Legal and political support □ Active participation and commitment Please comment on the success factors: ………………………………
Please briefly discuss your experience related to the enabler / success factors selected (e. g. local policy measures, info about market growth and local environment, collaboration with key actors etc.)	- Political support (on local and national level) is a strong enabler, since it can be seen as an incentive for introducing new models. - If the legislation at national was more in favour of industrial symbiosis, there would be more incentives for their creation. - There is a high interest among industries for eco-systems, since they bring many benefits for them (cost reduction, better cooperation etc.).
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	× Contribution to the regional GDP × Cost reduction / Annual savings × Increased productivity for the participating companies □ Increase in job opportunities (employment) × Enhanced research and innovation capacity × Reduce in greenhouse gas emissions □ Improved resource efficiency □ Other (please specify):

What are the economic, social and environmental impacts derived from the deployment / operation of the industrial innovation eco-system?		*Strongly negative*	*Minor negative*	*Neither nor*	*Minor positive*	*Strongly positive*
	Productivity of the firm					×
	Costs of production					×
	Product or service quality				×	
	Regional GDP			×		
	Employment			×		
	Research and innovation capacity					×
	Greenhouse gas emissions				×	
	Resource efficiency					×
	Energy efficiency				×	
Please briefly discuss the impacts selected above and/or other relevant socio-economic and environmental impacts (impacts on company and employees performance, previous situation compared to current, relevant statistics / performance indicators)	• **Costs of production:** strongly positive impact, since a closed loop cycles of the TDM production lines and the deployment of the circular waste streams along the entire value chains are the key factors of the resource efficiency and zero waste strategy. • **Product or service quality:** minor positive impact, since the quality regulations needs to be followed both in the current form of business - production systems as in modified forms by introducing the closed looped bio-economy model. However by introducing biodegradable products (biopolymers for example) with a green label pre-fix on the market, the company's innovation portfolio and high-tech image could be much improved. • **Regional GDP:** as the described eco-system is still on a relatively low degree of the industrial implementation, it is very hard to predict a rise of the regional GDP. • **Employment:** when introducing eco-business models it often comes to the re-arrangement of the currently employed staff on new tasks/responsibilities, and it is difficult to measure the increased share of the employment rate in that perspective. • Research and innovation capacity: strongly positive impact as by declaring the know-how in pursing of the global trends					

	movements they show a competitive advantages and the desire for penetrating on new markets (DIBBIOPACK project). • Greenhouse gas emissions: Positive impact since the described eco-system has plays an important role in reducing CO_2 emissions, although to a lesser extent in view of global movement, but still very effective. • Resource efficiency: very positive impact, since we are talking in the way of the circular economy - meaning that the waste streams or by-products are repeatedly introduced in new production cycles and new products (2 LIFE projects currently active). • Energy efficiency: active partner of the FP-7th ENER-Plast - From design to manufacturing: Instruments for reducing the energy consumption and carbon emissions of the polymer industry and its supply chain, with an overall objective to provide the European polymer and its supply chain industries with the information, resources and tools needed to reduce their carbon footprint and environmental impact. ENER-Plast went beyond the energy management, enabling organisations to consider both their operations and revenues in the context of climate change. The results were a great cost savings, clarity of responses to existing and pending legislation, operational improvements, corporate reputation and brand enhancement.
What are the main lessons learned from the deployment / operation of the industrial innovation eco-system (e.g. specific local social circumstances stimulated the mutual trust building between industries and created an environment for cooperative action)?	- There are not enough incentives on national level for encouraging the companies to introduce the industrial symbiosis. - The absence of the secondary raw material market represents a barrier in accelerating the industrial symbiosis. - Setting up the industrial eco-system enhances the trust building process between industries. - Workers and staff get better informed and aware of the industrial symbiosis concept.
How would you describe the industrial eco-system deployed?	□ Very successful □ Quite successful □ Somewhat successful × A little successful □ Not at all successful □ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of	× Yes

it) been replicated / transferred in other areas and settings?	□ No
Please briefly discuss the industrial eco-system's potential for transferability / replicability.	Industrial eco-system can be easily transferred and replicated if there were more incentives for introducing such (business) model at national level. Industries should intensify their cooperation in order to get information about which materials can be exchanged as secondary raw materials.
What are the most significant features of the industrial eco-system that make it transferable?	□ Use of standardised technology solutions and processes □ Needs addressed are common among industries, organisations and different regions/countries. × Achieved benefits / impact outweigh investment costs by far □ Demonstrated achieved benefits outweigh investment costs by far □ Low implementation risks Availability of external financing × Legal requirements □ Small change in daily operations, low risk of organizational resistance □ Other (please specify)
Main lessons learned	- Industrial eco-system can reduce the production costs at company level. - Absence of structural approach towards the industrial symbiosis makes its introduction and implementation more difficult. - Industries are keen on entering industrial eco-systems if they had more information, knowledge and particularly support. - There is absence of knowledge and information about industrial symbiosis concept, since workers, staff and management are in general too busy to discuss and learn new concepts. - Insufficient legal framework (at national level) makes industrial eco-system more difficult to be introduced.
Further information (URL, sources)	http://www.tecos.si

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Industrial Symbiosis of Aluminium Processing and Cement Industries		
A. CASE IDENTITY		
LOCATION	**Country:**	Greece
	Region:	Region of Central Greece
	City/Town:	Viotia
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2013
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities	

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Two industries with independent productive procedures participated in the EEMRU - Industrial Symbiosis project, run by the Technical University of Athens. "Aluminum of Viotia", which is a company that produces solid biochemical waste, and faces a gradually more intense problem of its disposal; and "AGET", which is a cement industry, obliged to purchase raw materials for cement production that have the same attributes of the waste, generated by "Aluminum of Viotia". The objective of the project was to connect the two industries, using the re-introduction of the biochemical waste of the first procedure in the productive process of the second one. Project activities included: - Definition of the suitability and the use of waste by the cement industry. - Development of a new type of fertilizer - Segregation of waste by means of sieve equipment for screening. - Production of cement with use of solid waste in industrial scale.
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other: Reduction of the disposal costs of the solid waste, Reduction of the required area for the landfill of the solid waste
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners

	☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* ***Cost reduction:*** *a) The cost of the waste disposal, which nowadays is 0.02 €/kg has been minimized, b) 10% reduction in the purchases of raw materials.* ***Improved resource efficiency****: 10% reduction of the waste volume*

How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- This model of Industrial symbiosis could be easily expanded to cover the entire production of solid biochemical waste, which accounts for 10% of the total solid waste produced in South Greece.
Further information (URL, sources)	http://environ.chemeng.ntua.gr/en/Default.aspx?t=189

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SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Waste management in West-Transdanubia		
A. CASE IDENTITY		
LOCATION	**Country:**	Hungary
	Region:	Wet-Transdanubian Region
	City/Town:	Zalaegerszeg
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ <u>Local</u>
	Type of cooperative activity amongst firms in the industrial eco-system	☐ <u>Exchange of energy, by products and secondary raw materials</u> ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2010
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ <u>Large (industrial) enterprises</u> ☐ <u>Small and medium-sized enterprises</u> ☐ National authorities ☐ Regional authorities ☐ <u>Local authorities</u>	

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The main element of the purpose of waste material recycling and circulate it into the local economy production is the biogas plant, which is located at the waste water treatment in Zalaegerszeg city, in the framework of Zalavíz Zrt. company, owned by the local municipality. The treatment plant is similar to a conventional activated sludge system with an anaerobic zone ahead of the aerobic basin but also includes an additional anoxic zone following the anaerobic zone. The wastewater treatment plant treats approximately 50.000 – 60.000 m3 of surplus activated sludge generated on site and sewage sludge imported from other local wastewater treatment plants from 30kms. The installation of an upgrading unit also allowed the diversification of end uses to include vehicle fuel and electricity powers as well. The upgrading plant and refuelling station occupy an area of approximately 500 m2.
Image (if available)	https://www.zalaviz.hu/index.php/rolunk/cegtortenet
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other: Reduction of the solid waste
What are the main difficulties encountered during the deployment / operation of the	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners

industrial eco-system?	☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* ***Reduce in greenhouse gas emissions:*** *by 1000-1500 m3/day biogas production* ***Improved resource efficiency****: 100% recycling of the waste*

How would you describe the industrial eco-system deployed?	☐ Very successful ☐ <u>Quite successful</u> ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ <u>Yes</u> ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ <u>Use of standardised technology solutions and processes</u> ☐ <u>Needs addressed are common among industries, organisations and different regions/countries.</u> ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ <u>Legal requirements</u> ☐ Other (please specify)
Main lessons learned	This model of waste management could be implemented in the middle type of the municipalities. Biogas upgrading and the production of biomethane nowadays are the one of the best interesting types of the renewable energy technologies. The average daily biogas production is 1000 – 1500 m3/day, which are used by three ways, as electricity power, heating and vehicle fuel. This technology contributes to the company transportation and the city public mass bus transportation as well, and the same time by decreasing the CO2 emission in the surroundings of the town.

Further information (URL, sources)	https://www.zalaviz.hu/index.php/rolunk/kornyezetvedelem

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SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Envor Group Oy		
A. CASE IDENTITY		
LOCATION	**Country:**	Finland
	Region:	Häme
	City/Town: *(if applicable)*	Forssa
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	Ongoing
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities	

	☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	**Envor Group Oy** Location: Forssa **Saint-Gobain Rakennustuotteet Oy** Location: Forssa and Hyvinkää **HK Scan Finland Oyj** Location: Forssa and Lahti **Cool-Finland Oy** Location: Forssa **Helsinki Region Environmental Services Authority (HSY)** Location: Helsinki metropolitan area Benefits of Symbiosis: Economical benefits New innovations Jobs created Material efficiency Energy efficiency Carbon footprint **Envor Group** acts as an environmental management partner for business and public sector actors. The recycling and recovery services provided by Envor Group cover the treatment of biodegradable waste, metals, plastics, paper and cardboard, and glass. Envor Group produces secondary raw materials, fertilisers and renewable energy, such as upgraded biogas for traffic fuel. The company also makes use of energy, construction and mixed waste. In 2013, Envor Group recovered and recycled roughly 100 million kg of waste flows and sidestreams of various kinds. Envor Biotech accepts biowaste, which is further processed into methane to be used as fuel at the Saint-Gobain Isover plant. The plant also utilises the sidestream ammonium sulphate as a raw material.

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify): The symbiosis create essential raw material for production (most probably Saint-Gobain would not be in Forssa without Envor's biogas production).
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers (Note: Actually, these two should be separated. Envor Group has not been having too much difficulties from local policy makers side, but national regulations have been problematic sometimes.) ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: When the industries involved are so tightly depending on each other, resilience should be taken seriously (For example: If Saint-Gobain – which is a big multinational company – decides one day to remove the production from Forssa to somewhere else, Envor is having a lot of biogas without a customer.) => The resilience plans are just

	now (January 2017) in preparation process.
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* (The four first ones are difficult to measure in details because the business is not restricted in the region. The last two ones are to be researched in the near future.)
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful

	☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability* This is quite a complicated (having several industries involved) symbiosis. There should be 'pieces' of it developed in the stage which allows transfer (after necessary modifications) to other regions.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify): Please, refer to the previous question.
Main lessons learned	Note: Answers from Envor Group
Further information (URL, sources)	http://www.industrialsymbiosis.fi/envor-group-oy

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Finnish Industrial Symbiosis System (FISS) (Note: this is not an industrial symbiosis but a tool to find and develope them)		
A. CASE IDENTITY		
LOCATION	**Country:**	Finland
	Region:	
	City/Town: *(if applicable)*	
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify) **In FISS the areal coordinators are arranging workshops where companies are delivering information about side products and wastes they would like to get rid off and materials they are looking for as raw material for production (note: in FISS, services are included)**

DURATION	**Time of implementation**	**2014 -**
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify) **Basically, all mentioned are involved. Anyhow, the 'FISS-tool' is specially meant for enterprises.**	
Please briefly describe the industrial eco-system	**Today (November 2016) there are totally 11 regions in Finland having a FISS-coordinator who is actively looking for materials/companies that could be involved in a new symbiosis.** **There are two ways the coordinators are operating:** **A) Visiting certain companies known having some side product or waste that could be utilized elsewhere. Through interviews the amount and properties of the material concerned are recorded for someone else to consider utilization.** **B) Arranging special workshops which are open to all enterprises interested in cooperation with others concerning more efficient utilization of materials (and/or services).** **In both cases, the resources found are added in the data base called SynergiE. This database is utilized by not only the companies participating in a certain workshop but by all companies listed in the very same database. At the moment, there are 599 enterprises and 4573 resources listed in the database.**	
Image (if available)		
C. NEEDS, BARRIERS AND SUCCESS FACTORS		

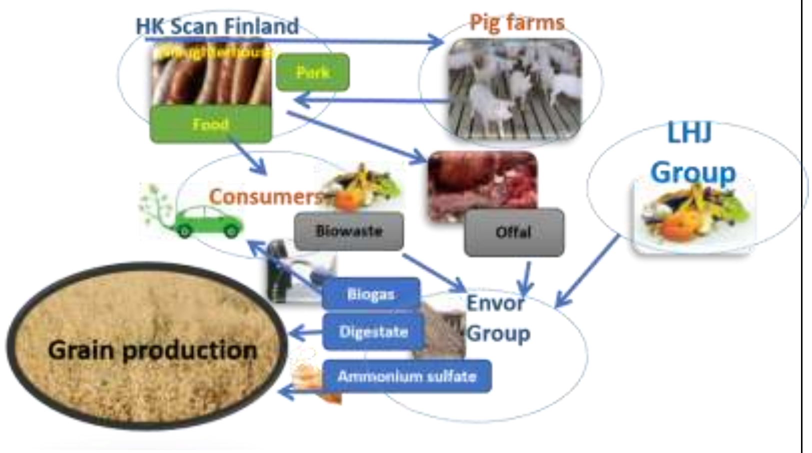
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify) **<u>All valid</u>**
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: **The computer program SynergiE is maybe not the most 'user friendly'. There should be some product development work done with that.**
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: **Lot of possibilities found! And, when enterprises are participating in the workshops the knowledge about symbiosis and circular economy is delivered efficiently.**

C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ **Somewhat successful (limited experience so far)** ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No **This system is in use in several regions in Finland and elsewhere as well.** *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs

	by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	
Further information (URL, sources)	**www.industrialsymbiosis.fi**

<table>
<tr><td colspan="3">SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy</td></tr>
<tr><td colspan="3">Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Collection of good practices on ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Title: HKScanFinland-LHJGroup-EnvorGroup</td></tr>
<tr><td colspan="3">A. CASE IDENTITY</td></tr>
<tr><td rowspan="3">LOCATION</td><td>Country:</td><td>Finland</td></tr>
<tr><td>Region:</td><td>Häme</td></tr>
<tr><td>City/Town:
(if applicable)</td><td>Forssa</td></tr>
<tr><td rowspan="2">ACTIVITIES / MAIN FOCUS</td><td>Geographical level of implementation</td><td>☐ <u>National</u>
☐ <u>Regional</u>
☐ Local</td></tr>
<tr><td>Type of cooperative activity amongst firms in the industrial eco-system</td><td>☐ <u>Exchange of energy, by products and secondary raw materials</u>
☐ Joint use of utilities and firm functions
☐ Collective gathering and removal of waste materials
☐ Combining transport of goods and people
☐ More intensive use of space
☐ Public utilities with high useful effects
☐ Joint commercial firm facilities
☐ Multimodal transport and high quality public transport
☐ Other (please specify)</td></tr>
<tr><td>DURATION</td><td>Time of implementation</td><td>Ongoing. Started 1997</td></tr>
</table>

<table>
<tr><td colspan="2">B. CASE DESCRIPTION</td></tr>
<tr><td>Type of actors involved (choose all that apply)</td><td>☐ <u>Large (industrial) enterprises</u>
☐ <u>Small and medium-sized enterprises</u>
☐ National authorities
☐ Regional authorities
☐ Local authorities
☐ Public Agencies</td></tr>
</table>

	☐ Other (please specify)
Please briefly describe the industrial eco-system	The majority of the pigs of the pig farms in the area end up in the Forssa meat processing factory of **HK Scan Corporation**, where they are processed into food products. Waste suitable for the bio processing of food production and municipal bio waste from the area with the radius of roughly 200 km and collected by **LHJ Group** are delivered further to **Envor Group**, which manufactures biogas from them. The digestate generated in connection with the process and the ammonium sulphate recovered from the process are partly provided as fertilizers to the fields nearby as part of the grain production from which this example chain starts. The produced biogas may be used to fuel cars at Envor's fuelling points. Envor is delivering plastics etc. non-organic waste recovered from the bio waste back to LHJ Group for processing.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs

	☐ Other (please specify): This way municipal waste can be utilized as a resource instead of dumping it in land fills.
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors * ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: * The companies working in different markets (different products) are not competitors.
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency

	☐ Other (please specify):
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No **
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify) ** Up to these days, this symbiosis is utilizing 'old technology'. When new ones (digitalization) are progressing, transferability might improve also.
Main lessons learned	Note: These answers are from LHJ.
Further information (URL, sources)	http://www.brightgreen.fi/circulareconomy

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Parc d'activités de Kaiserbaracke– Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	Belgium
	Region:	Wallonia
	City/Town: *(if applicable)*	Kaiserbaracke
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2004- Today

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ **Regional authorities** ☐ **Local authorities**

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The Kaiserbaracke industrial park is an example of a symbiotic system. The main reasons for the implementation of the industrial symbiosis were limited access to traditional raw materials and cost reduction (the system based on biomass is three times cheaper than the installations which use fossil flue). In 2004 an arrangement was initiated by three companies ie. Belwood, Delhez et Renogen, and in 2005 the company Holz Niessen joined. In 2006, the joint operations of the enterprises began. Companies act only as business partners. The total cost of the project amounted to € 40,000. The next stage of the project development was joined by Spi + ,the economic development agency for the province of Liège, which is responsible for the development of the infrastructure of the industrial park. The area where the park is located belongs to Amblève municipality. The Holz Niessen company is a timber sorting centre. As a result of the wood sorting process at the Belwood sawmill, 50% of the wood is turned into finished and semi-finished products, with the remainder being bark, sawdust, and scrap wood. Production waste are used in 100% on-site to produce heat (Renogen company), pellet (Delhez company), semi-finished wooden products. As a part of the Renogen company, the co-generation centre allows for the production of heat and mechanical energy which is then converted into electricity. At the Kaiserbaracke industrial park, wood is used as a raw material for energy production. Heat is used both to produce pellet in Delhez and wood plank in Belwood by drying sawdust. Surplus heat is sold to the public electricity network. Ashes from the combustion of biomass are used in the construction industry for the production of clinker or ballast. The Renogen company conducted research on turning the ashes from burned biomass to fertilizer, although the government of Wallonia has expressed its opposition. The implementation of the project helps to: reduce carbon emissions and oil consumption during the year; create new jobs.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ **Active participation and commitment** Please comment on the success factors: ……………………………….
C. RESULTS & PROSPECTS	

What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ **Increased productivity for the participating companies** ☐ **Increase in job opportunities (employment)** ☐ Enhanced research and innovation capacity ☐ **Reduce in greenhouse gas emissions** ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories of benefits* - Reduce in greenhouse gas emissions – 32 t of CO_2 per year - Increase in job opportunities (employment) – creation of 20 jobs; - Increased productivity for the participating companies - A cogeneration unit produces the amount of electrical energy equal to the amount consumed by 26000 households during a whole year.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No *Please briefly discuss about practice's potential for transferability / replicability* The use of biomass for generating electricity and heat, and then management of ashes from combustion of the biomass in construction industry is a common technological solution; a similar example of

	industrial symbiosis occurs at an industrial park called Roch-en-Brille.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Legal regulations are a very important factor influencing industrial symbiosis – ash from combustion of biomass can be used in construction industry, but it is not allowed in agriculture industry because of legal regulations in the region of Wallonia; • The location is very important for the development of industrial symbiosis; • Effective cooperation is one of the crucial factors on which the development of industrial symbiosis depends. • Limited access to traditional raw materials
Further information (URL, sources)	Bory A., Brévers F., Dopagne C., Droeven E. & van der Kaa C. 2010: Annexe 2: Eco-zoning – Note de synthèse du benchmarking «ecozoning ». Université de Liège, LEPUR, Région wallonne, Conférence Permanente du Développement Territorial. http://www.vallonia.it/documenti/2008_08-newwalloniaclusters.pdf http://eecca.recpnet.org/uploads/resource/688da464b6be6db1a8d16083a227a769.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Diageo – global company with industrial symbiosis programme

A. CASE IDENTITY		
LOCATION	**Country:**	United Kingdom
	Region:	Northern Ireland, Scotland
	City/Town: *(if applicable)*	Case Study 1 Maltwood – Fife Case Study 2 - Heriot-Watt University Edinburgh
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ **National** ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ **Joint commercial firm facilities** ☐ Multimodal transport and high quality public transport ☐ **Other (please specify)** new product from waste
DURATION	**Time of implementation**	2008 – Today
B. CASE DESCRIPTION		

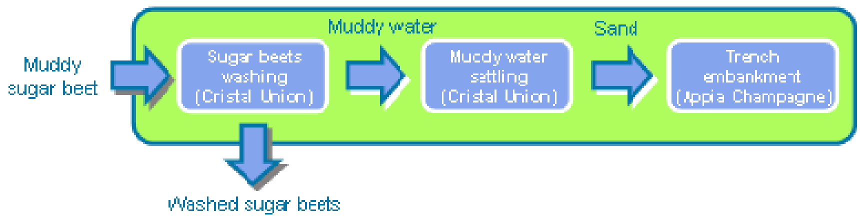
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ **National authorities** ☐ **Regional authorities** ☐ **Local authorities** ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Diageo is the world's leading premium drinks Trading in approximately 180 markets, the company employs over 20,000 people around the world. **Case study 1 - from waste to product** Maltwood is a start-up from Fife (Scotland), which uses the staves from old whisky barrels to produce firewood sold in hessian sacks. Another company, Diageo gets the aromatics for its gin in hessian sacks, which - categorized as waste – were landfilled. But NISP (National Industrial Security Programme) realized that Maltwood can reuse the hessian sacks from Diageo. However, the problem was that sacs were categorized as waste according to the environmental permit. Thanks to the help of Scottish Environmental Protection Agency it was possible to re-categorize the hessian sacks as a by-product. Additionally, NISP invited a social enterprise called Kibble to the project. The Kibble is responsible for improving education of teenagers. They help to chop the wood as well as prepare it for shipping. This industrial symbiosis helps Maltwood to save over £20,000 of packaging cost and reduces Diego's of landfilling cost. **Case study 2 - From whisky to salmon** Another example of industrial symbiosis is the cooperation between the Diego company and a spin-out Horizon project. The project was developed with financial support from Edinburgh's Heriot-Watt University by providing £600 m acquired in 2014 by Scottish Enterprise, which allowed for the commercialisation of the concept. Scotland produces about 2.34 m tonnes of pot ale each year. Cattle feed is sometimes produced using pot ale but the downside

	is a high-energy process. On the other hand, Horizon proposes new technology for using pot ale which is based on a more energy-efficient process. New technology initiated by Horizon allows the recovery of barley protein and it has been tested on an industrial scale by Diego company. The barley protein is perfect for feeding Atlantic salmon. With 150,000 tonnes of pot ale, it is possible to produce 2,000 tonnes of extract. By 2022, it is assumed that the recovery of protein-rich compounds could be 12,000 tonnes high. According to the research conduct in the project, protein extract is worth £1,500 per tonne. The potential annual value of protein in pot ale and spent wash in Scotland amounts to £272 m.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ **Open new markets for secondary raw materials** ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: …………………………………

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ **Diversity of actors** ☐ Low economic risks ☐ **Adequate funding** ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ **Legal and political support** ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ **Improved resource efficiency** ☐ Other (please specify): cost reduction / Annual savings: Case study 1- industrial symbiosis helps Maltwood to save over £20,000 of packaging cost and reduces Diego's of landfilling cost. Case study 2- Due to the research conducted in the project, protein extract is worth £1,500 per tonne Improved resource efficiency: Case study 2 - By 2020, Diego company plans to increase the recovery of high-protein 6-fold compared to previous results Other (please specify): Social aspects: Case study 1: Involvement in the project's social enterprise by Kibble attests to the high level of attention paid to CSR aspects; Case study 2: promotion of environmentally friendly solutions.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful

	☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Openness to cooperation in the local community; • Effective cooperation between academic institutions and public administration is one of the crucial factors on which the development of industrial symbiosis depends.
Further information (URL, sources)	http://www.orbuk.org.uk/article/the-national-industrial-symbiosis-programme-nisp https://www.environmentalistonline.com/article/whisky-salmon http://www.bbc.com/news/uk-scotland-scotland-business-30145724

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Troyes (Cristal Union and Appia Champagne)– Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	France
	Region:	Grand Est
	City/Town: *(if applicable)*	Troyes
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2004- Today
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies	

	☐ **Other (please specify):** The Industrial Ecology Club of Aube
Please briefly describe the industrial eco-system	The Industrial Ecology Club of Aube (IECA) initiated the industrial symbiosis between Cristal Union Factory and Appia Champagne enterprise. The aim of the project is to address long term issues pertaining to economic development and the regional planning. Cristal Union Sugar Factory located near Troyes processes daily 25,000 t of sugar beets. The muddy water after washing sugar beets contains varied sediment granulation among other sand. As a result of muddy water treatment, sand is recovered. The sand is dirty and polluted; therefore, it cannot be used in agriculture industry, although it works well as a construction material. Since 1964 the sand has been stored on the fields within the radius of 30 km from the sugar factory, which results in high pollution and the development of landfill which cost Cristal Union from € 150,000 to € 300,000 per year. During the two months of beet campaign, 22,000-24,000 t of sugar beets were processed per day giving 15,000 t of sugar and 1,500,000 hectoliters of ethyl alcohol, the by-product of this process was sand (300 t/day). In 2004 a partnership between Cristal Union and Appia Champagne (subsidiary of Effiage, company specializing in engineering) was established pertaining to the disposal of sand. With the agreement concluded between these companies, the sugar factory does not have to pay for sand storage and Appia Champagne obtains construction material free of charge. Thanks to the joint venture, Appia Champagne is able to reduce sand extraction from quarries which leads to cost reduction. The enterprises have common transport of beets and sand by trucks so as to minimize the negative impact on environment (CO2 emissions) and reduce cost.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ **Open new markets for secondary raw materials**

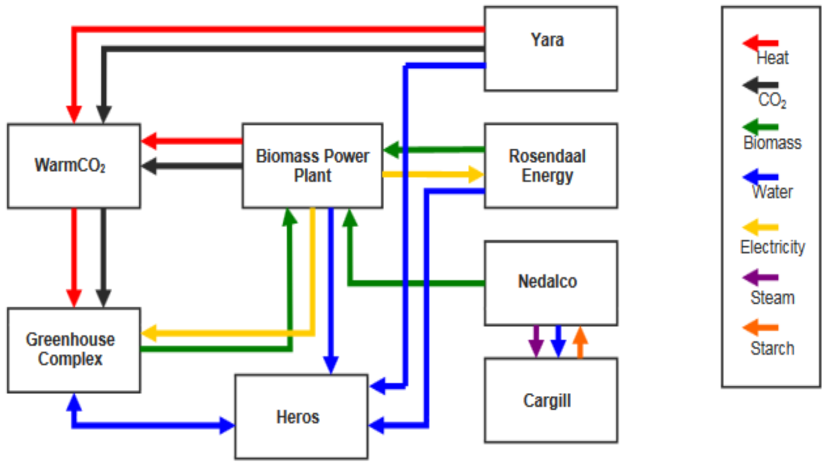
	☐ **Reduce CO2 emissions** ☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ **Active participation and commitment** Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions

	☐ **Improved resource efficiency** ☐ **Other (please specify):** - Cost reduction / Annual savings – Cristal Union doesn't pay the cost of landfill, so the company saves € 150,000 to € 300,000 per year; - Improved resource efficiency- due to the fact that enterprises provide common transport, it is possible to reduce the length of the journey by 100,000 km, and thus 40,000 liters of oil; - Other (social aspect): improving the environmental image of the company.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No *Please briefly discuss about practice's potential for transferability / replicability* The symbiosis between Cristal Union and Appia Champagne is difficult to transfer because of the specificity of the region and enterprises.
What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• The fact that the companies represent different industries (Cristal Union enterprise engaged in food industry, and Appia Champagne company specialized in construction) is an important factor for industrial symbiosis; • Effective implementation of industrial symbiosis has led to a significant reduction in costs; • Openness and effective cooperation is a key aspect of the implementation of industrial symbiosis.

Further information (URL, sources)	http://www.usinenouvelle.com/article/ecologie-industrielle-plus-simple-qu-il-n-y-parait.N26941 http://languedoc-roussillon.ademe.fr/sites/default/files/files/Domaines-intervention/Economie-circulaire/guide-ecosysteme-ecologie-industrielle-territoriale.pdf https://www.ceiaube.fr/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title:: Biopark Terneuzen – Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	Netherlands
	Region:	Zeelandic Flanders
	City/Town: *(if applicable)*	*Terneuzen*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2016 - Today
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ Regional authorities ☐ **Local authorities** ☐ Public Agencies	

	☐ Other (please specify)
Please briefly describe the industrial eco-system	Industrial symbiosis (IS) towards agro-industrial sustainability was created in the form of 'Smart Link' initiative in February 2007 in the Ghent-Terneuzen Canal Zone. Biopark Terneuzen (BT) is located on the Westerschelde - between Rotterdam and Antwerp. The area of Zeeland Seaports has an open connection to the North Sea and the Rijn-Schelde Canal. Biopark promotes and facilitates the exploitation of key synergies on the local level – it includes businesses located in the same geographic area (45 ha site). The companies involved in project exchange and use each other's by-products and waste streams as feedstock or energy for their own processes. BT was established not just for business benefits. One of the most important benefits in encouraging industrial development on a sustainable basis is a creation of new job opportunities including the prospect of long-term viability. The following Partners are included in Biopark now: Biopark Terneuzen, BER / Holland Innovation, Cargill, DELTA NV, Dow, DSD, Econcern / Evelop, Express Energy / Bio2E, Gemeente Terneuzen, Ghent Bio Economy Valley, Goes on Green, HZ University of Apllied Science, Heros Sluiskil, ICL-IP, Impuls Zeeland, Lijnco Green Energy / Schücking, Nedalco, Provincie Zeeland, ROC Westerschelde, Sagro, Valuepark Terneuzen, Wageningen UR, WarmCO2, Yara, Zeeland Seaports. Zeeland Seaports is the initiator and administrator of Biopark Terneuzen. Biopark Terneuzen's partners by converting waste streams into Smart Links are able to capitalise on residual values that would otherwise go unused. One of the examples is Yara Sluiskil, which is producing CO2 from ammonia production process and the low temperature heat in many of production processes. Yara Sluiskil is integrated in two Smart Links for the greenhouses in the BT. Yara deliveres these links to WarmCO2 which distributes the flows to the vegetable growers. In order to reach the global sustainable development goals, these bio-complementary cooperation between partners combine to help (www.bioparkterneuzen.com/en/benefits): • Conserve non-renewable resources; • Exploit the recoverable value of resources after first use; • Reduce the waste and pollution burden on the atmospheric and physical environment; • Contribute towards the sustainability of future industrial growth.

Image (if available)	 http://www.pressreleasefinder.com/prdocs/Biopark_Fact_Sheet.pdf
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ **Reduce CO2 emissions** ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: ………………………………

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ **Similar organisation cultures of firms** ☐ Legal and political support ☐ **Active participation and commitment** Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ **Cost reduction / Annual savings** ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ **Other (please specify): social aspects** *Please briefly discuss about the degree of impact on the selected categories of benefits* **Cost reduction / Annual savings:** a) Eliminate storage and disposal costs; b) Decrease in the amount of environmental taxes; c) Optimise production costs; **Other (social aspects)**: a) Increased collaboration between neighbour companies with similar awareness about environment in the region, b) openness to cooperation in local conditions, c) sharing the experience;
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful

	☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ **No** *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- openness to cooperation in the region; - large, well-skilled and well-educated workforce, which is continually increasing (many region's excellent technical schools and training centres) is one of the key success factors; - entrepreneurs aimed at reducing the cost of their production are interested in participating in industrial symbiosis; - willingness to participate in activities which are reaching sustainability ambitions;
Further information (URL, sources)	http://www.pressreleasefinder.com/prdocs/Biopark_Fact_Sheet.pdf http://www.bioparkterneuzen.com/en/biopark.htm

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: EcoCity Aarhus – Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	Denmark

	Region:	Jutland peninsula
	City/Town: *(if applicable)*	*Aarhus*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco-system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ **Multimodal transport and high quality public transport** ☐ Other (please specify)
DURATION	**Time of implementation**	2016 - Today

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ **National authorities** ☐ Regional authorities ☐ **Local authorities** ☐ Public Agencies ☐ **Other (please specify): Citizens**
Please briefly describe the industrial eco-system	Aarhus is a part of the Danish EcoCity project, which is vested in the Ministry of Climate and Energy assisted by the Danish Energy Agency, which deals with the project implementation. The City Council in 2007 presented an ambitious goal for the city that Aarhus will be CO2 neutral in 2030.This goal highlights the fact that Aarhus wants to be one of the top climate friendly cities in Denmark. The CO2 emission from Aarhus as a business organization in 2007 reached 110,000 tonnes. It was approx. 5% of the total emission from the city of Aarhus and an average of 4.7 tonnes pr. full time employee.

	Ambitious plans have now lead to a deliberate and productive course for tackling climate change in Aarhus. The project focuses on cooperation between national, regional and local authorities and citizens, business community, and all stakeholders to take action in the field of climate and energy issues. By the assumed actions - energy savings and CO2 reductions, the city will contribute to fulfilling the global and national energy and climate goals. The three efforts were indicated in the vision for climate change in city: holistic thinking, synergy between different players and long-term perspective. The following action were taken in Aarhus : • environmental action plans, • energy management systems, • wastewater plans, • green accounts, • environmental appraisal of construction projects. In Aarhus, four cornerstones for working with climate change are realised: • public solutions: an environmentally friendly heating supply (95% of all households are connected to the system); an efficient public transport system – e.g. "park and ride" facility in connection with both the northern high way and the light rail, the commuters will benefit from fast and efficient public transportation while avoiding parking problems and better conditions for cyclists - 250 kilometres of bicycle lanes in city; promotion of environmentally friendly vehicles, electric cars and electric bicycles in the streets; • public participation: all citizens in city - home owners, car owners, consumers, employees and rest citizens all contribute to the reduction of CO2 emission, eg. by purchasing low energy household electrical appliances and by carrying out energy renovation on private houses; • cooperation with the business centres, consultants, enterprises and educational units (providing campaigns in order to increase of citizens awareness of the climate challenges, including social media participation; boosting awareness of climate issues among local schools), climate adaptation: Protection against flooding and other consequences of climate change. Plan for the doubling of the forest area in Aarhus by 2030 - public and private forests (attractive subsidy schemes promoting private afforestation);
Image (if available)	

C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ **Reduce CO2 emissions** ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: …………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ **Legal and political support** ☐ **Active participation and commitment** Please comment on the success factors: …………………………………

C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ **Reduce in greenhouse gas emissions** ☐ **Improved resource efficiency** ☐ **Other (please specify): Social aspects** - **Reduce in green gas emissions:** energy from the incineration plant is now close to CO2 neutral; the heat system upgrades contribute to a yearly reduction in CO2 emission of 60,000 tonnes. - **Improved resource efficiency**: well-educated citizens of Aarhus are capable recyclers - 67 % of all waste is recycled; 31% of waste is utilized for incineration and heating supply; the six recycling centres in city count 1.2 mil. visits each year. - **Other (social aspects)**: a) 250 km of bicycle lanes making it appealing to go by bike and keep the fit. b) openness to cooperation in local conditions by governments, citizens and business, c) education campaigns for children make sure that future adults are equipped to continue the job of tackling climate change, d) integration in order a common goal - combat climate change;
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer

Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No The EcoCity Aarhus case has started in 2007, is a good example of how Danish Ministry inspires local authorities to make increased efforts in the field of climate and energy. The solutions could be transferred in other cities.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ **Legal requirements** ☐ Other (please specify)
Main lessons learned	- well educated local government with high awareness of the environmental impact is essential; - integration in the cooperation in the local community, in order to achieve common goal – make city to be CO2 neutral in 2030; - high citizens awareness of the climate challenges;
Further information (URL, sources)	https://stateofgreen.com/files/download/135 http://www.aarhus2017.dk/en/

<table>
<tr><td colspan="3">SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy</td></tr>
<tr><td colspan="3">Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Collection of good practices on ecosystems of by-product and energy exchanges</td></tr>
<tr><td colspan="3">Title: Oldenburger Münsterland: WELTEC BIOPOWER – Industrial symbiosis</td></tr>
<tr><td colspan="3">A. CASE IDENTITY</td></tr>
<tr><td rowspan="3">LOCATION</td><td>Country:</td><td>Germany</td></tr>
<tr><td>Region:</td><td>Lower Saxony (northwest Germany)</td></tr>
<tr><td>City/Town:
(if applicable)</td><td>23 towns and communities - counties Cloppenburg and Vechta</td></tr>
<tr><td rowspan="2">ACTIVITIES / MAIN FOCUS</td><td>Geographical level of implementation</td><td>☐ National
☐ Regional
☐ Local</td></tr>
<tr><td>Type of cooperative activity amongst firms in the industrial eco-system</td><td>☐ Exchange of energy, by products and secondary raw materials
☐ Joint use of utilities and firm functions
☐ Collective gathering and removal of waste materials
☐ Combining transport of goods and people
☐ More intensive use of space
☐ Public utilities with high useful effects
☐ Joint commercial firm facilities
☐ Multimodal transport and high quality public transport
☐ Other (please specify)</td></tr>
<tr><td>DURATION</td><td>Time of implementation</td><td></td></tr>
<tr><td colspan="3">B. CASE DESCRIPTION</td></tr>
<tr><td>Type of actors involved (choose all that apply)</td><td colspan="2">☐ Large (industrial) enterprises
☐ Small and medium-sized enterprises
☐ National authorities
☐ Regional authorities
☐ Local authorities
☐ Public Agencies</td></tr>
</table>

	☐ Other (please specify)
Please briefly describe the industrial eco-system	Industrial symbiosis (IS) in Oldenburger Münsterland (called also Südoldenburg) was created by the two rural districts of Cloppenburg and Vechta in 1995. The ides of the cooperation was to make use of common strengths in the competition among economic locations and also travel regions. The slogan of the network is "the region on the move". Currently, 23 towns and communities are involved in the cooperation. The main task of the network is to attract attention to products and services originating in this region, to create investment incentives, innovation development and to increase the population's identification and connection with their home region. The network is supported by the membership fees of the rural districts, sales proceeds and sponsoring revenues. Moreover, the network is promoted by special dedicated campaign (marketing programme), which is resolved upon by the board of directors and the meeting of members (sent out from the district councils and the local heritage union for Südoldenburg). Performance priorities of industry areas in region are the following sectors: • food industry (foodstuffs and luxury food) - agribusiness cluster - The livestock farming, the regional production of fruit and vegetables with an area farmed of 4,500 hectares are indicated as a very significant economical factor. The companies represent quality, safety and diversity at competitive prices (http://www.om23.de/cms/en/lines-of-industry/agriculture-and-food-industry); • agri-technology (mechanical engineering and plant construction) - in order to develop innovative solutions in agri-technology, the market-leading companies from the animal husbandry and agricultural machinery sectors work together in region. The success of the cooperation is the part of 'agricultural revolution' - automatisation of production processes and the development of electro-technical bases for controlled production systems (http://www.om23.de/cms/en/lines-of-industry/mechanical-engineering-and-plant-manufacturing), • plastics engineering - in the plastic technology, about 100 companies are involved in the Oldenburger Münsterland region. Currently, this is a centre of the German plastic industry. Renowned development partners of international car manufacturers and leading companies of the packaging industry in the areas of food, pharmaceuticals and cosmetics are located here (http://www.om23.de/cms/en/lines-of-industry/plastic-technology), • building trade - in Oldenburger Münsterland, the building trade offers grown competence in the production of building materials and in the building trade for quality-oriented commercial and domestic construction (http://www.om23.de/cms/en/lines-of-industry/building-trade).

	In the Oldenburger Münsterland network, an example by-product and energy exchanges is the activity of WELTEC BIOPOWER GmbH. WELTEC BIOPOWER is one of the world's leading firms in the field of stainless-steel biogas plant construction. The company is working in the area of planning, developing and building anaerobic digestion plants since 2001. Currently, the WELTEC BIOPOWER GmbH is the medium-sized company with approx. 80 employees at the headquarters in Vechta. The company has established more than 300 energy plants in 25 countries worldwide and the global distribution and service network spans six continents. The range of customers includes businesses from the agriculture, food, waste and wastewater industries. In 2013, the WELTEC BIOPOWER plant by Eco Sustainable Solutions Ltd., Piddlehinton (Dorset) was presented with the Organics Recycling Award 2013 by British Organics Recycling Group (REA). The company developed and built the plant distinguished itself against a renowned competitor's field with the best overall concept. The plant is supplied with 20,000 tons of leftovers annually and generates an electrical output of 498 kilowatts per hour. Leftovers from local restaurants and canteens as well as overdue packed food from supermarkets, as substrates, are transformed into biogas. Before this input material goes into the fermenter, it is unpacked on site, fractionated and sanitised. Also the use of energy is exemplary. The heat generated in the power production process is transported to a feed mill in the neighbourhood via an underground pipeline. Most of the power produced is also absorbed by the mill. Surplus electricity is fed directly into the electricity net. After the fermenting process, the fermented substrates are used as fertilizer by the local farmers. In particular this is an example of sustainable use of the whole plant output by local companies (http://www.om23.de/cms/en/component/content/article/107-issues-2013/1462-business-news-april-2013?q=recycling+network).

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ **Improve resource efficiency** ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered** Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ **Similar organisation cultures of firms** ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ **Increase in job opportunities (employment)** ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ **Improved resource efficiency** ☐ **Other (please specify):** - **Increase in job opportunities (employment):** firms (including WELTEC BIOPOWER) are regularly looking for new employees;

	firms invest in young people "young people for young ideas" - young population and an efficient educational system in private public partnership - **<u>Improved resource efficiency:</u>** by products of one company (leftovers from local restaurants and canteens as well as overdue packed food from supermarkets, as substrates), are transformed into resource for activity of other company (WELTEC BIOPOWER) – biogas production. Moreover, after the fermenting process, the fermented substrates are used as fertilizer by the local farmers. The whole idea is consistent with 'zero waste' strategy. The surplus electricity from biogas production is fed directly into the electricity net. - **<u>Other (social aspects)</u>**: a) Increased collaboration between firms in the region *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational

	resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	-one of the most important factor of successful cooperation is regional awareness, in Oldenburger Münsterland that has grown during 600 years of common history; -promotion of business development as a priority in Oldenburger Münsterland is indicated as a mail success factor; -solid budgets and innovative ways of safeguarding sovereign tasks and designing up-to-date local conditions are the characteristics of regional municipalities as committed partners; -the active people involved in business cooperation with their motivated staff created an innovation development; -the experiences and the know-how gained in the agricultural and plastic technology started to be put into practice also in other area of industry and could bring development in other sectors of industry;
Further information (URL, sources)	http://www.om23.de/cms/en/about-us/partner-companies http://www.om23.de/cms/images/stories/downloads/informationen/business_information.pdf http://www.om23.de/cms/en/component/content/article/107-issues-2013/1462-business-news-april-2013?q=recycling+network http://regis.inecos.de/olm/en/profile/UNT-35693

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Chemical Industrial Park Knapsack – Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	Germany
	Region:	North Rhine-Westphalia
	City/Town: *(if applicable)*	*Hürth*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies

	☐ Other (please specify)
Please briefly describe the industrial eco-system	The Chemical Industrial Park Knapsack is the head office of the service company - InfraServ Knapsack. InfraServ Knapsack was founded in 1998 in the course of the reorganization of the Hoechst AG company. Chemical Industrial Park Knapsack is located 10 km south west of Cologne in Germany. It has a total area of 180 hectares with unoccupied area of 33 hectares. The Industrial Park Knapsack is home to about 10 chemical firms and more than 20 service providers. The Materials Network supplies the production enterprises at the park with important materials and products. The companies on site use this efficient network on a partnership basis, thereby jointly achieving valuable industrial symbiosis. The Chemical Industrial Park Knapsack provides companies with a scale-up platform and access to know-how for production in the chemical industry and integration into existing value chains. Infrastructure available in the park includes: rail and road connections, container terminal on site, connection to chemical pipeline network (natural gas, ethylene, steam etc.), one-stop customer service, two wastewater treatment plants, steam power station. In the Knapsack Park, every partner concentrates on their core business - production, logistics or services. The location within the closed and protected-access chemical park with industry-friendly conditions creates an opportunity to concentrate fully on core business of companies. In this way, costs of energy, raw materials and logistics could be significantly reduced. The enterprises involved in the park profit from the infrastructure at their disposal and the opportunity to take advantage of the custom services offered by the site operator InfraServ GmbH & Co. Knapsack KG. Investors could achieve optimal economic conditions and individual solutions for their business models. Currently, almost 30% of all foreign investments are concentrated in North Rhine-Westphalia region (where Knapsack Park is located) due to the largest buying and selling market. So the symbiosis in Knapsack Park could be expanded. InfraServ Knapsack has an annual turnover of about 185 million EUR. There are 800 employees, fifty of whom are trainees. InfraServ experts support the firms on site with customized services where required. InfraServ offers about 10 international companies operating in the chemical industry (production of organic and inorganic chemicals, crop protection products, fine and special chemicals, plastics, developmental products, energy and media) sustainable conditions and opportunities to operate their production plants. Moreover, InfraServ offers a full range of services from just one source to customers outside the park as well, for example plant planning and construction, maintenance and certification of industrial plants. Services offered in Chemical Industrial Park Knapsack include: • Logistics, • Health, safety, and environmental management, • Energy supply (electricity, natural gas, steam, compressed air, industrial gases, water),

	• Waste management, • Industrial maintenance, • Analytical services, • Engineering & Contracting, • Information technology, • Personnel management. The following companies are involved on site: Abwasser-Gesellschaft Knapsack GmbH, Bayer CropScience AG, CABB GmbH, Clariant Produkte (Deutschland) GmbH, E-ON Energy from Waste Saarbrücken GmbH and other.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ **Reduce production costs** ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ **No problems encountered**

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ **Active participation and commitment**
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/ operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ **Increased productivity for the participating companies** ☐ Increase in job opportunities (employment) ☐ **Enhanced research and innovation capacity** ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ **Other (please specify):** - **Increased productivity for the participating companies:** the location within the closed and protected-access chemical park and the industry-friendly conditions creates an opportunity to concentrate fully on core business of companies. - **Enhanced research and innovation capacity:** the research and development activities are conducted by companies involved in the park; young people are trained for skilled jobs – it could bring further research ideas and innovations development in park. - **Other (social aspects)**: a) operation in well-known market leaders and specialists from the chemical industry - good environment for the development and cooperation; b) advantages of the cooperation in chemical industry, sharing the experience between the companies;
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful

	☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ **No** *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- regional cooperation of companies active in the same (chemical) industry brings significant savings; - particular emphasis on the engineering of individual plants is a factor providing effective collaboration - entrepreneurs can focus on their own production and benefit from the activities of other entities; - investment in personal development of young people - young people trained for skilled jobs can bring economic benefits in coming years; - focusing on the partnership and good working relationships ensure benefits for everyone involved in the Chemical Industrial Park Knapsack;
Further information (URL, sources)	http://www.chemietechnik.de/wp-content/uploads/migrated/docs/artikel/2852.pdf http://www.chemicalparks.com/parks/39/Seiten/default.aspx http://www.chemiepark-knapsack.de/invest/vacant-spaces/?L=1 http://www.dnhk.org/fileadmin/ahk_niederlande/Bilder/Evenementen/Infobrochure_BiomaterialsNetherlandsGermany_30June2016.pdf

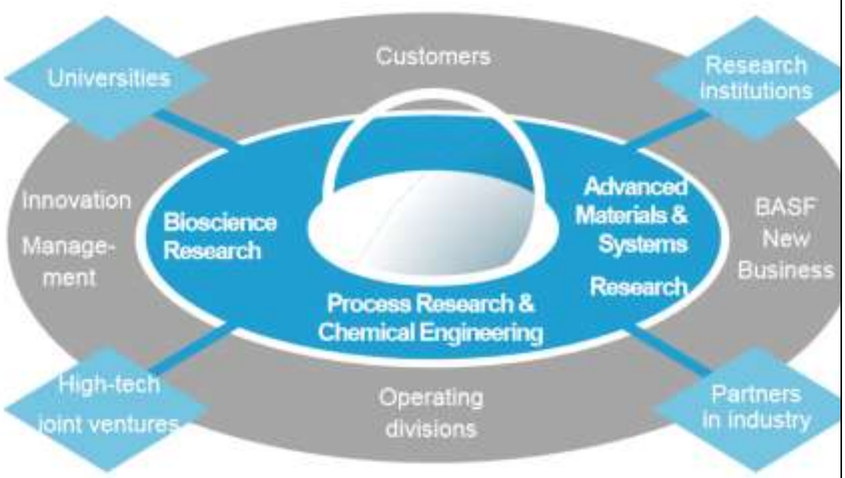
SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: BASF Verbund site Ludwigshafen – Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	Germany
	Region:	Rhineland-Palatinate
	City/Town: *(if applicable)*	*Ludwigshafen*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	1865 - Today
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	BASF is the world's leading chemical company, operating in five segments: Chemicals, Performance Products, Functional Materials & Solutions, Agricultural Solutions and Oil & Gas. BASF has sites in more than 80 countries, including Europe, America, Africa and Asia. In BASF, the idea of Verbund was developed and it is indicated as a company strength. The Verbund idea is based on interlinking of production facilities, energy flows and infrastructure in a smart way. Moreover, know-how and customers are also connected. Currently, the largest Verbund site in BASF Group is located in Ludwigshafen in Germany. Ludwigshafen Verbund Site was established in 1865 and now it is one of the six Verbund sites in the world. In this concept, one company uses resources of other companies in an efficient way, taking into account economic issues, social responsibility and environmental protection. By-products of one company are used as raw materials in other plants. It is an example of efficient and resource-conserving value-adding chains, which preserve resources and energy, minimize emissions, and reduce logistics costs. So, the production plants, energy flow (the waste heat of one plant provides energy to others), infrastructure, expertise and customers are connected and integrated. This gives rise to efficient value-adding chains ranging from basic chemicals to highly sophisticated products. Furthermore, one facility's by-products could serve as feedstock in other company. It provides a raw materials and energy savings, and avoids emissions, lowers logistics costs and makes use of industrial synergies. Currently, the Ludwigshafen Verbund Site is the world's largest integrated chemical complex under single management. It is a largest BASF Verbund site with the area of 10 km^2, 106 km of roads, 230 km of rail, 2,850 km of pipelines and approx. 2,000 buildings. Site traffic is equal to 2,100 trucks daily and shipment 100,000 containers p.a. By the integration of transport system in one network (98 trucks approx. 2,100 daily - 30% of transportation volume, rail cars approx. 400 daily - 30% of transportation volume and barges approx. 20 daily - 40% of transportation volume), the reduction of logistics costs is achieved. At Ludwigshafen Verbund Site there are 110 production facilities with around 200 production plants, including 35,972 employees. About 8000 products (based on raw materials) with a total volume of 8.5 million tonnes are currently produced in Ludwigshafen complex per year.

<table>
<tr><td></td><td>The Verbund idea is focused on four issues:

Production: more cost-effective, safer and environmentally friendly production processes; savings of energy by means of efficient processes; avoiding of long transport routes (optimisation of transport),
Technology: company unit for Engineering and Operational Excellence; strengthens BASF’s global network,
Customer: works closely with customers; interlinks markets and technologies,
Employee: integration in one company in order to achieve success; sharing experience and knowledge; good and effective networking among Verbund employees; easy access for information at any time using special tablets and QR codes (digital transformation under the banner “BASF 4.0”).

Global Know-How Verbund: Cooperation with many science and industry units (600 excellent universities, research centres and companies - approx. 10,000 employees in research and development) worldwide contributed to creation of an international and interdisciplinary Know-How Verbund. Expert knowledge is pooled into global research platforms. At the Ludwigshafen site, a part-time training programme for newcomers from other fields is offered, in order to qualify them for work in chemical industry.</td></tr>
<tr><td>Image (if available)</td><td>Global Know-How Verbund


https://www.events.trade.gov.uk/media.viewer/uploads/pdf/ekp_file_0__richard-carter_ifb-liverpool-day-4_1466509043.pdf</td></tr>
<tr><td colspan="2">C. NEEDS, BARRIERS AND SUCCESS FACTORS</td></tr>
<tr><td>What were the main needs and objectives for the deployment of the industrial eco-</td><td>☐ Promote the use of sustainable bio-energy resources
☐ Improve resource efficiency
☐ Access new markets
☐ Share risk</td></tr>
</table>

system?	☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ……………………………….
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity

system? *(select all that apply)*	☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): - **Cost reduction:** reduction of logistics costs by sharing the transport between following actors: trucks approx. 2,100 daily - 30% of transportation volume, rail cars approx. 400 daily - 30% of transportation volume and barges approx. 20 daily - 40% of transportation volume - **Increase in job opportunities (employment) -** in 2015 the "Start Integration" programme provided 50 placements in 2015. The programme is focused on refugees with a high probability of being granted the right to remain in Germany and aims to integrate them into the labour market in region. The programme is planned to be expanded to 300 placements. - **Increased productivity for the participating companies:** by sharing the know-how with companies through global research platforms; specific training sessions for employees in production and technical areas in order to increase of companies' productivity - **Improved resource efficiency**: by-products of one company are used as resources by other companies in efficient way - **Other (social aspects)**: a) integration of one chemical industry in the region in order to keep sustainable cooperation, b) experience and knowledge exchange between companies, c) training of refugees by the technical courses and language and intercultural training; d) Work-Life Management employee centre (LuMit), which provides opportunities for an active life - fitness and health centre, employee assistance; e) opportunities for achieving work-life balance – the LuKids childcare centre, which offers daycare for 250 children; f) no systematic differences in pay rate between men and women *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful

	☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No The Verbund concept was developed and optimized in Ludwigshafen and later applied to other sites around the world – Antwerp (Belgium), Geismar, Louisiana and Freeport Texas, Kuantan (Malaysia) and Nanjing (China). *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- sustainable cooperation in one sector of the regional industry– integration of all chemistry-connected actors in the region; -training and development of skills are essential success factors for a strong company culture; -high quality of communication work brings benefits for companies and stakeholders; -regional divisions, corporate centres and research and functional units support business development; -strategy of company compatible with sustainable development goals: 'We create chemistry for a sustainable future' contributes to a world that provides a viable future with enhanced quality of life for all people, strategy creates positive image of firm; -adaptation of business optimally with customers' needs - taking into account the needs of customers and contribution to their success with innovative and sustainable solutions; -close partnerships with customers and research units, in order to develop new system solutions, customized products, functional

	materials, processes and technologies.
Further information (URL, sources)	http://www.chemicalparks.com/parks/53/Seiten/default.aspx https://www.basf.com/en/company/about-us/strategy-and-organization/verbund/verbund-sites.html https://www.events.trade.gov.uk/media.viewer/uploads/pdf/ekp_file_0__richard-carter_ifb-liverpool-day-4_1466509043.pdf https://www.basf.com/documents/corp/en/about-us/publications/reports/2017/BASF_Report_2016.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Ghent – Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	Belgium
	Region:	Flemish Region
	City/Town: *(if applicable)*	*Ghent*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco-system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ Regional authorities ☐ **Local authorities** ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	Industrial symbiosis between two companies - Stora Enso's Langerbrugge Mill and Volvo Car Group started in 2016 at Ghent harbour in order to reduce carbon emissions at Volvo plant in Belgium by means of renewable energy, via a district heating connection. The partnership results in considerably lower energy consumption and CO2 emissions. It is an example of saving materials and energy, thanks to neighbours' by-products. Stora Enso Langerbrugge Mill in Ghent, Belgium, produces 550,000 tonnes of newsprint and magazine paper on an annual basis, based on 100% recovered paper. Langerbrugge Mill is located in Gent close to Volvo's manufacturing facility, Volvo Car Gent. Stora Enso installed an underground hot water pipeline during 2015 to transport hot water at a temperature of 125 degrees Celsius to the car production facility. It is used to heat Volvo's buildings and paint booths. Hot water delivery started in the autumn of 2016. The Stora Enso paper company provides the Ghent site of Volvo Cars with hot water via a four kilometre-long heat network. Waste heat from Stora Enso's bio co-generation plant replaces a great deal of the fossil-fuel derived heat that Volvo used, allowing the Ghent plant to cut its annual CO2 emissions by about 15,000 tonnes. It is an example of developing responsibility for the environment by Stora Enso – the company has a stated purpose to care about the people and the planet. The joint project with Volvo is an additional step on this journey. As a result of this initiative, Volvo Car Gent is able to substantially reduce its use of fossil fuels for heating purposes, decreasing its CO2 emissions by about 40%.The annual reductions correspond to the heating demand of 5,000 households
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: …………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ **Close proximity of companies** ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ **Similar organisation cultures of firms** ☐ Legal and political support ☐ **Active participation and commitment** Please comment on the success factors: …………………………………
C. RESULTS & PROSPECTS	

What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): - **Reduce in green gas emissions:** annual emission savings of around 15 000 tonnes of CO_2 per year for Volvo Car Group, and reduction of the plant's total CO_2 emissions by more than 40 percent. - **Other (social aspects)**: a) Increased collaboration between neighbour companies with similar awareness about environment in the region, b) openness to cooperation in local conditions, c) sharing the experience, d) integration in order a common goal - combat global warming;
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability*
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational

	resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- well educated management team with high awareness of the environmental impact is essential; - openness to cooperation in the local community is a success factor; - short distances between participating companies are advantageous;
Further information (URL, sources)	www.storaenso.com/newsandmedia/stora-enso-joins-forces-with-volvo-to-cut-co2-emissions www.storaenso.com/sustainability/stories/renewable-energy-in-the-pipeline

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
415 Title: Portugal Industrial Symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	Portugal
	Region:	Center of Portugal, region Alentejo
	City/Town: (if applicable)	Chamusca
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ **Local**
	Type of cooperative activity amongst firms in the industrial eco- system	☐ **Exchange of energy, by products and secondary raw materials** ☐ Joint use of utilities and firm functions ☐ **Collective gathering and removal of waste materials** ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	The researchers have been following the EIP's evolution since 2004 and tracking the economic activities being developed and the exchanges being established.
B. CASE DESCRIPTION		
Type of actors involved	☐ **Large (industrial) enterprises** ☐ **Small and medium-sized enterprises** ☐ National authorities ☐ **Regional authorities**	

	☐ **Local authorities** ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The waste management legislation in Portugal requires that licensed waste management operators treat all waste. Although there are no legal impediments that prevent a manufacturer to obtain a license to receive waste, the process can be bureaucratic and expensive, since it requires technological standards to assure the proper treatment for the waste. In this context, most of the waste recovered goes through Resource Recovery companies, since their main investment is in waste management and/or resource recovery. Taking advantage on a series of waste management regulations and waste recovery and treatment investments in their municipality, the local government in Chamusca reached for Industrial Ecology as a paradigm to develop the first eco industrial park in the country. The eco industrial park idea is based on waste disposal, and is realised for a lot of groups of waste (mainly urban waste, non-urban waste, medical waste, plastic, battery). It connect producers, farmers and local entrepreneur. In this context, industrial symbiosis was encouraged as an objective for the community and business alike; however, local government also understood that the current Portuguese waste management scenario favoured recycling of materials through RR companies. As a consequence, the larger waste treatment and recovery facilities at the park (e.g. two national centres for the recovery, treatment and disposal of hazardous wastes, a resource recovery and treatment centre for municipal waste and a treatment facility for nonurban wastes) soon began attracting recyclers of various natures (e.g. batteries, plastics, biomass), waste sorters (e.g. medical packaging) or disassemblers (e.g. end of life vehicles). It was in this setting that local government deployed several actions to promote the interaction between RR activities’ managers themselves and with companies/institutions in the region surrounding the Relvao Eco Industrial Park. The result is that not only wastes are exchanged between manufacturers and some RR companies in the Eco Industrial Park, but services and waste materials are exchanged, or are in the process of being exchanged, between the RR companies themselves.

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ **Promote the use of sustainable bio-energy resources** ☐ Improve resource efficiency ☐ **Access new markets** ☐ Risk sharing ☐ **Open new markets for secondary raw materials** ☐ Reduce CO_2 emissions ☐ **Increase profitability, revenue** ☐ **Reduce production costs** ☐ Other (please specify)

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ **Regulation / limited support by local policy makers** ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies (location) ☐ **Diversity of actors** ☐ Low economic risks ☐ Adequate funding ☐ **Balance of power between partners** ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ **Active participation and commitment** Other relevant info provided: ……………………………….
D. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the eco-industrial system? *(select all that apply)*	- Contribution to the regional GDP (economic benefits for the municipality) - Cost reduction / Annual savings - Increased productivity for the participating companies - Increase in job opportunities (employment) - Enhanced research and innovation capacity - Reduce in greenhouse gas emissions - Improved resource efficiency - **Other (please specify): Improved materials efficiency** *Please briefly discuss about the degree of impact on the selected categories of benefits*

	- **improved materials efficiency:** As is shown on a car example, the main focus of car dismantlers is to strip the car of its various components, send the metal for fragmentation or recycling and sending other materials (e.g. plastics, batteries, oils) to other companies within the REIP. The battery processer receives the car batteries and is able to separate the various components, sending the acid to be regenerated at the CIRVER and plastic to the plastics recycler. In the case of the battery processer, in particular, it was able to develop a collaborative business strategy with a manufacturer of civil explosives, which will relocate to the vicinity of the EIP and use the lead recovered from the batteries in its production process, therefore creating a symbiotic relation.
How would you describe the industrial eco-system deployed?	☐ **Very successful** ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ **Yes** ☐ No ***Please briefly discuss about practice's potential for transferability / replicability:*** Presently, the REIP is continuing to attract companies in a wide variety of activities – resource recovery and manufacturers alike. Also, projects are being deployed to encourage the development of synergies beyond the municipality, encompassing the Tagus Lezíria region, which surrounds it. Not only waste are exchanged between manufacturers and some RR companies in the EIP, but services are exchanged, or are in the process of being exchanged, between the RR companies themselves.
What are the most significant features of the industrial eco-	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.**

system that make it transferable?	☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ **Small change in daily operations, low risk of organizational resistance** ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- REIP in Chamusca is local symbiosis and is focused primarily on maximum use of materials. - The most of recovered waste passes RR, because the main idea of RR is waste managemen and or recover of raw materials. This kind of waste disposal is easier than obtain a permit for waste collection. - Current Portuguese waste management scenario favoured recycling of materials through RR companies, so it is perfect situation for recyclers of various natures (e.g. batteries, plastics, biomass), waste sorters (e.g. medical packaging) or disassemblers (e.g. end of life vehicles). - Eco industrial park in Chamusca is a industrial symbiosis for the community and business.
Further information (URL, sources)	- Costa, P. Ferrão, "A case study of industrial symbiosis development using a middle-out approach," Journal of Cleaner Production 18 (July 2010):984-992. - https://www.researchgate.net/profile/Ines_Costa/publication/236881105_Crossroads_between_resource_recovery_and_IS_networks_evidences_from_case_studies/links/00463519deaefbe217000000.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Port of Rotterdam – Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	Netherlands
	Region:	Zuid-Holland (South Holland)
	City/Town: *(if applicable)*	*Rotterdam*
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	1994 - Today

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies

	☐ Other (please specify)
Please briefly describe the industrial eco-system	Industrial symbiosis (IS) in Rotterdam began as the industrial ecosystem (INES) program in 1994 with the participation of 69 industrial companies. In 1994, several bilateral arrangements already existed, however the systematic holistic search for the possibilities of sharing resources across companies in the form of symbiotic linkages to use the language of industrial ecology and cooperation between industry and academic units were new in this region. Currently, the port of Rotterdam is the largest sea port in Europe - hundreds of millions of tonnes of cargo are handled on an annual basis. The 175,000 people working in and for Rotterdam's port and whole industrial area. An extensive intermodal transportation network of rail, inland shipping, road, short sea and pipelines gives the port of Rotterdam the best possible connections to the rest of Europe (https://www.portofrotterdam.com/en/the-port/facts-figures-about-the-port). In cooperation with the Province, power companies, industrial facilities and municipalities, the Port Authority uses the Deltaplan Energy Infrastructure to promote the construction of infrastructure which allows the residual heat and steam from businesses in the port area to be put to better use. It offers opportunities to the industrial sector itself, but also to the surrounding urban areas (e.g. as district heating) and to horticultural areas. The available infrastructure makes it possible to achieve considerable savings in power consumption. The system also provides a considerable reduction of emissions of CO_2 , NOx and particulate matter. Large-scale investments are required to create this infrastructure, as well as a joint effort by public and private parties. Industrial processes in the port release large quantities of heat, steam and CO_2. Heat is generated only for the needs of chemical companies, greenhouse farming and households in the region. These energy sources can be exchanged cleverly via pipelines. It is one way to contribute to a sustainable port and ensure a profitable and sustainable business climate. Currently, the energy infrastructure includes the following routes (https://www.portofrotterdam.com/en/cargo-industry/energy-industry/energy-infrastructure): • Nieuwe Warmteweg – 26 km underground pipe network which transports heat from waste and energy company AVR to the Rotterdam city centre where it is used for district heating; • Leiding over Noord – 16.8 km pipeline, energy supplier Eneco transports residual heat from waste and energy company AVR in Rozenburg via Vlaardingen and Schiedam to the district heating network of Rotterdam; • Steam network – 2 km stem network brings available steam to companies which need steam. Network links up AVR with chemical company Emerland Kalama Chemical (EKC) in Botlek; • CO_2 capture and use – pipeline network of OCAP, CO_2 is transported from Shell Pernis and Abengoa to the greenhouse areas of Westland, where it is used to enhance the growth and quality of crops. Five units (the Port of Rotterdam Authority, Gasunie, the Province of Zuid-

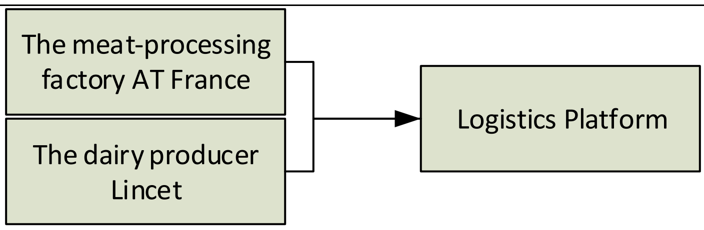
	Holland, Eneco and Warmtebedrijf Rotterdam) signed a letter of intent regarding the realisation of a main infrastructure for distributing heat to a variety of users, including private households, horticultural firms for the heating of greenhouses and companies in the province of Zuid-Holland. The name of programme is Warmtealliantie Zuid-Holland (Zuid-Holland Heat Alliance) (https://www.portofrotterdam.com/en/news-and-press-releases/zuid-holland-heat-alliance-setting-to-work-on-the-new-heat-network). The firms in the port area produce a large amount of industrial residual heat. There is a possibility that the projects outside this area can also be incorporated in the network, including sustainable sources of heat like geothermal wells. The residual heat generated in the port of Rotterdam can potentially fulfil the annual heat requirement of over 500,000 households. This is one of the most important environmental benefit for this region and it could play a major role in achieving the adopted climate targets. The use and re-use of heat in the port of Rotterdam could help reduce the volume of fossil fuels used for heating. This could bring a further benefit - substantial reduction in CO_2 emissions. According to the regional sustainability ambitions and the current public debate, the heat network in this area will not be relying on heat from coal-fired power plants.
Image (if available)	 https://www.portofrotterdam.com/en/news-and-press-releases/zuid-holland-heat-alliance-setting-to-work-on-the-new-heat-network
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk

deployment of the industrial eco-system?	☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: …………………………………
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: …………………………………
C. RESULTS & PROSPECTS	
What were the main benefits created by the deploymen	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity

t/operation of the industrial eco-system? *(select all that apply)*	☐ **Reduce in greenhouse gas emissions** ☐ Improved resource efficiency ☐ Other (please specify): Social Aspects *Please briefly discuss about the degree of impact on the selected categories of benefits* - **Reduce in green gas emissions:** The use and re-use of heat in the port of Rotterdam could help reduce the volume of fossil fuels used for heating. The most important benefit in view of regional sustainability ambitions is a substantial reduction in CO_2 emissions. - **Other (social aspects)**: a) Increased collaboration between selected energy-related players in the region, b) satisfying the needs of the society
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability* The Rotterdam case was inspired by Kalundborg symbiosis. Spaanse Polder (one of the project in Rotterdam) was a support case (next to Kalundborg) during the modelling of industrial symbiosis – description of potentials and barriers in Aalborg Denmark (www.symbiosis.dk/sites/default/files/P7%20Industrial%20Symbiosis%20Aalborg%20University%20Christoffer.pdf). Therefore, Rotterdam symbiosis could be opportunity to implement similar initiatives in other European areas.
What are the most significant features of the industrial	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks

eco-system that make it transferable?	☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Specific local social circumstances stimulated the mutual trust building between industries and created an environment for cooperative action; - Needs addressed to various units and society - heat network offers a reliable, affordable and sustainable heat supply to private households and companies; - Autonomy of the involved firms. The individual industry agreements are based on commercially sound principles; - Absence of legal barriers. The development of the symbiosis is voluntary but occurs in close cooperation with government authorities; - Short physical distances between participating plants are advantageous; - Mutual management understanding & cooperative commitment; - Effective communication between participants is required.
Further information (URL, sources)	Tomassini, A. (2016). The emergence of industrial symbiosis in the Rotterdam Harbor region; the role of social proximity and place attachment (Master's thesis), Utrecht University. https://www.google.pl/search?q=rotterdam+industrial+symbiosis&ie=utf-8&oe=utf-8&client=firefox-b&gfe_rd=cr&ei=z7WiWNHbFMuv8wft95nICg https://dspace.library.uu.nl/handle/1874/325658 https://books.google.pl/books?id=QAVFuUi-uXUC&pg=PA218&lpg=PA218&dq=rotterdam+industrial+symbiosis&source=bl&ots=29kQKc9q7Q&sig=CeKwtXkK7PWRg6170zG1LAnk_B0&hl=pl&sa=X&ved=0ahUKEwiD7c-VjI_SAhXGE5oKHQeaC_wQ6AEIVjAG#v=onepage&q=rotterdam%20industrial%20symbiosis&f=false https://www.portofrotterdam.com/en/cargo-industry/energy-industry/energy-infrastructure https://www.portofrotterdam.com/sites/default/files/Factsheet-Rotterdam-Energy-Port.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: AT France and Lincet – Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	France
	Region:	Grand Est
	City/Town: *(if applicable)*	Torvilliers
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	2009- Today
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities	

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The meat-processing factory AT France and the dairy producer Lincet had the same limitation in terms of process control, storage and transport of products. Therefore, in 2009, they created a logistics platform so called GJ Service Froid, which specializes in cooling food. AT France and Lincet are engaged in trade of local products. Both companies had the same IT systems for managing the cooling system , which were created by the same consulting firm. The reason for the creation of logistic platform in 2009 was need to store products in similar conditions at both AT France and Lincet which minimized energy demand on the cooling system and reduced transportation cost for the dairy producer Lincet by 20%. The total cost of the investment, which was associated with the development of GJ Service Froid platform amounted to 3.8 million euros. The temperature in the building is 3,5 degrees Celsius and the space is shared between the two companies. There is also an innovative platform designed for: storing (1800 pallets for the two companies), preparing of orders (15 000 boxes per day for 250 different directions, 45 T of finished products) managing computer data. Due to the platform development GJ Service Froid created 20 jobs. The platform is located 150 km from Paris, which had enormous influence on the success of industrial symbiosis. Torvilliers Logistic Park, where the platform is located, is ten minutes from the highway exit (A5 and A26). The Torvilliers Park offers innovative solutions for the development of agribusiness, for example: increasing the range of activity of industrial plants; sharing processes and services. Torvilliers zone is a part of Cometh project implemented by the National Agency for Research.
Image (if available)	

C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify) ☐ **logistics in product management** (Creation of a platform that will impact the effectiveness of the supply chain, reduce transport costs of products and will also feature a proper cooling system, were the key aspects for developing the symbiosis between the two companies)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms

	☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: …………………………………
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): - Cost reduction / Annual savings – reduced transportation cost for the dairy producer Lincet by 20%; - Increase in job opportunities (employment) – platform creates 20 jobs; - Other (social efects) – efficient cooperation between the managers of the enterprises; uniting for the purpose of increasing the success of both companies. *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer

Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability* The platform created by AT France and Lincet seeks to facilitate the logistics of product transportation. The location of GJ Service Froid enables increased, effective industrial symbiosis. This is a simple example to implement in another country, region, or city, which increases the effectiveness of product transport management.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Due to similar sizeproducts type and activity area of the organizations, industrial symbiosis was effectively implemented; - For two companies, the storing conditions were the same, which made the implementation of logistics solutions easier.
Further information (URL, sources)	http://languedoc-roussillon.ademe.fr/sites/default/files/files/Domaines-intervention/Economie-circulaire/guide-ecosysteme-ecologie-industrielle-territoriale.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy

Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges

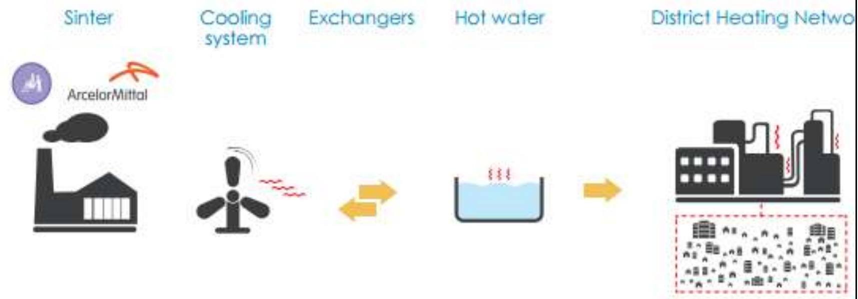
Collection of good practices on ecosystems of by-product and energy exchanges

Title: ArcelorMittal (Dunkirk) – Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	France
	Region:	Hauts-de-France Region
	City/Town: *(if applicable)*	Dunkirk
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies

	☐ Other (please specify) district cluster in Dunkirk
Please briefly describe the industrial eco-system	Industrial symbiosis is exemplified by the recovery of heat from the exhaust gases from the steel manufacturing by ArcelorMittal in Dunkirk (France). In 1985 ArcelorMittal implemented an initiative concerned with sustainable development of industry by creating the district cluster in Dunkirk. The cluster is an example of cooperation between private and public entities, which has been successfully implemented for over 30 years. ArcelorMittal, along with the other industries in the cluster, provides heat as well as partially contributes to almost zero emissions of district heating of Dunkirk. In ArcelorMittal heat recovery takes place during the first stage of the manufacturing process i.e. the sintering process of iron ores. The ore heated to 1,200 degrees C is later cooled in industrial blowers. Once the temperature has reached 400°C, the hot air is directed to the heat exchanger where it heats water. The hot water is sucked in a pump and drives to district heating network of Dunkirk. With more than 40 km of pipes it is possible to provide heat for various locations. The total power of the system installed in the ArcelorMittal company is 120 MW (this is the equivalent of 2400 gas boilers). The system implemented by ArcelorMittal is about 15-20% cheaper than fossil fuel. The heat recovered in ArcelorMittal allows for supplying 6 000 housing units with heat. Thanks to ArcelorMittal, public facilities such as: swimming pools, hotels, colleges, universities are kept warm. Additionally, the industrial symbiosis between ArcelorMittal and the district heating network of Dunkirk is one of interests the EU-funded EPOS project (Enhanced energy and resource Efficiency and Performance in process industry Operations via onsite and cross-sectorial Symbiosis).

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: …………………………………

Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): social aspects *Please briefly discuss about the degree of impact on the selected categories of benefits* - Cost reduction / Annual savings: The system implemented by ArcelorMittal is about 15-20% cheaper than fossil fuel. - Other (social aspects): Increasing cooperation between ArcelorMittal and the city to promote the idea of sustainable development; openness to cooperation in local conditions.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful

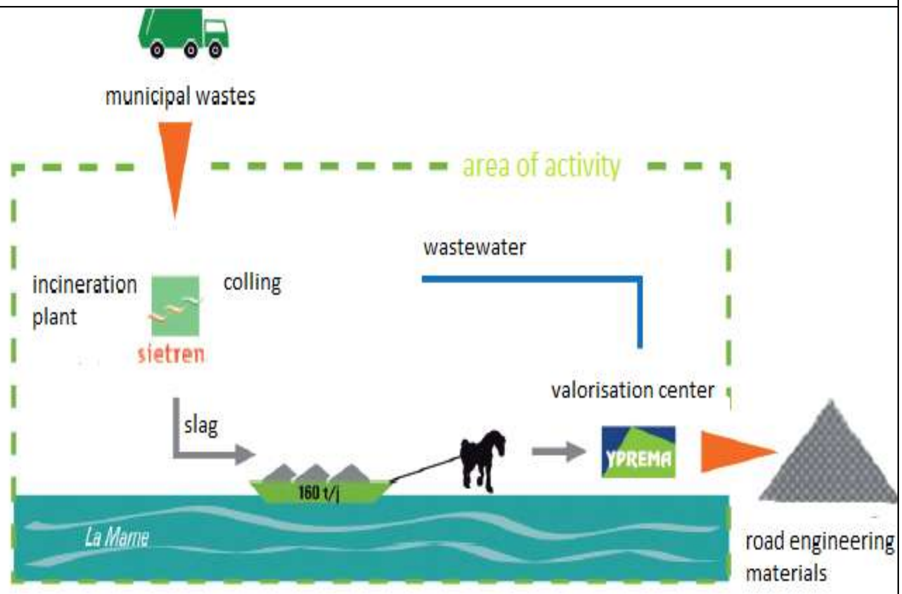
	☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No *Please briefly discuss about practice's potential for transferability / replicability* Heat recovery during steel manufacturing at ArcelorMittal is an example of good practices implemented for over 30 years. Similar methods are used for heat recovery in Sweden.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Effective collaboration between members of the cluster has a significant influence in reducing emissions; - Effective cooperation between the cooperating partners is crucial; - Demonstrating that environmentally friendly solutions proposed by ArcelorMittal are cheaper than using fossil fuel is very important for the development of corporate social responsibility.
Further information (URL, sources)	https://www.communaute-urbaine-dunkerque.fr/fileadmin/documents/Rev3/GAUCHE_03_OPTIMISATION.pdf http://rrien.univ-littoral.fr/wp-content/uploads/2015/06/doc46.pdf http://france3-regions.francetvinfo.fr/hauts-de-france/cop21-dunkerque-se-chauffe-grace-arcelormittal-861333.html https://fr.linkedin.com/pulse/lecologie-industrielle-dunkerque-facteur-fabienne-manceau https://www.spire2030.eu/sites/default/files/users/user222/epos%20insight%202.pdf

	https://www.spire2030.eu/sites/default/files/users/user222/epos%20insight%205.pdf http://blog.arcelormittal.com/2016/01/18/how-arcelormittal-is-helping-keep-dunkirk-warm-this-winter/

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Lagny sur Marne– Industrial symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	France
	Region:	Île-de-France
	City/Town: *(if applicable)*	Lagny sur Marne
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	1995- Today

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies

	☐ Other (please specify)
Please briefly describe the industrial eco-system	The industrial zone of Lagny Sur Marne is managed by the local agglomeration authorities of Marne and Gondoire which provide dynamical development of the zone. The COMETHE (Conception of Methodological and evaluation Tools for Industrial Ecology) project has had an influence on the development of this zone. The main aspect of the successful symbiosis between the enterprise Yprema and Sietrem (Syndicat mIxte pour l'Enlèvement et le Traitement des REsidus Ménagers) are the complementarity of their activities as well as close proximity to each other. Yprema is a company from the construction and public works sector. Yprema's activites focus on: using slag as a road construction material, and transporting wastewater to the association called Sietrem engaged in collection, processing and recycling of municipal waste. The Sietrem enterprise also owns the Municipal Waste Incineration Plant (MWIP) in St-Thibault-des-Vignes. On the other hand, Sietrem provides treatment of municipal waste, produces slag as a results of the incineration of the municipal waste and uses wastewater (from Yprema enterprise) for the process of slag cooling. Yprema built a barge made of recycled aluminium for transporting slag. This barge is 20 meters long and 4.5 meters wide, which allows the transport of 80 tonnes of slag per crossing. Currently, there are two crossings a day, giving a total of 160 tonnes of transported slag. The barge is towed by horses, which shows high environmental awareness. It also contributes to minimizing CO2 emissions related to reducing road transport between two facilities. Yprema has switched from road transport to pipelines directly connecting the two enterprises. Wastewater from treatment of slag (Yprema) is transported from valorization center by means of pipelines to the MWIP in Saint-Thibault-des-Vignes to be used in the process of slag cooling. MWIP in St-Thibault-des-Vignes uses 16,000 m3/year of treated

	wastewater to cool incandescent slag. Thanks to industrial symbiosis (reuse of wastewater from slag treatment), water consumption has been reduced by half. Through their cooperative efforts, Sietrem and Yprema reduce costs and provide environmental benefits, including reducing greenhouse gases emissions (56 t of CO_2 eq. per year) as well as creating more jobs at Yprema.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO_2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): *Please briefly discuss about the degree of impact on the selected categories*

	of benefits - Reduce in greenhouse gas emission – annual emission savings of around 56 t of CO_2 as a result among others of reducing the number of truck journeys by 1,350; - Increase in job opportunities (employment) – creation of 4 jobs in Yprema; - Other social aspects: improving the environmental image of the businesses.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No Because of a very specific nature of the symbiosis in Lagny sur Marne, it is difficult to find a similar example or recommend this solution to be replicated in another case.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	• Short distances between participating companies are advantageous; • Complementarity of enterprises creates industrial symbiosis; • A similar organizational culture is an important factor for the

	development of industrial symbiosis in Lagny sur Marne.
Further information (URL, sources)	Schalchli, Paul. *Mettre en oeuvre une démarche d'écologie industrielle sur un parc d'activités: environnement*. Société alpine de publication, 2009. http://webcache.googleusercontent.com/search?q=cache:sgQJvluS_wgJ:www.oree.org/_script/ntsp-document-file_download.php%3Fdocument_id%3D1900%26document_file_id%3D1908+&cd=1&hl=pl&ct=clnk&gl=pl http://www.yprema.fr/index.php?rub=qui_sommes_nous_ https://www.pagesjaunes.fr/pros/07440315 http://www.haropaports.com/sites/haropa/files/u21/2015_11_10_dossier_presse_cop_21ven.pdf http://www.sietrem.fr/ http://webcache.googleusercontent.com/search?q=cache:sgQJvluS_wgJ:www.oree.org/_script/ntsp-document-file_download.php%3Fdocument_id%3D1900%26document_file_id%3D1908+&cd=1&hl=pl&ct=clnk&gl=pl&client=opera

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Bassens – Industrial symbiosis

A. CASE IDENTITY		
LOCATION	**Country:**	France
	Region:	Aquitaine
	City/Town: *(if applicable)*	Bassens (near Bordeaux)
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies

	☐ Other (please specify)
Please briefly describe the industrial eco-system	The industrial-harbour zone was shaped between 1950 and 1970. Since then the Bordeaux-Bassens harbour has been very important for the French industry and has played a key role in the development of symbiosis. Case study - **Michelin and SIAP** The symbiosis concerns one of the largest tire manufacturers - Michelin and SIAP - waste incineration plant in the Bordeaux-Bassens harbour. The project initiated in 2008 is based on the flow of steam. SIAP processes 88,000 t of hazardous waste per year. The recovered heat is transferred in the form of water vapour to the Michelin company, which allows to reduce Michelin energy consumption by 10% per year, and CO_2 emissions by 15,000 t per year. The project was funded by DALKIA and the Mayor of Bassens. The investment cost €4 million and involved construction of 1500 meter long steam pipe. With industrial symbiosis, companies pursue the strategy of sustainable development as well as the idea of circular economy.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ……………………………….
C. RESULTS & PROSPECTS	

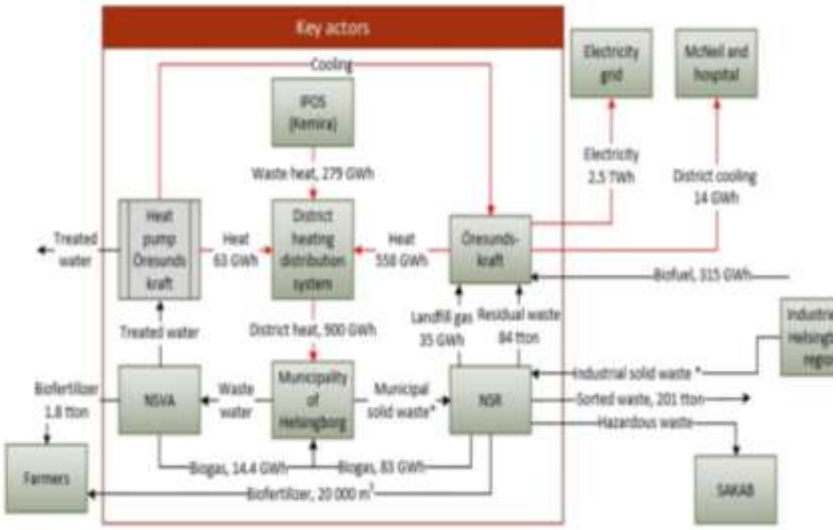
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): - **Reduction in greenhouse gas emission:** annual emission savings of around 15 000 tonnes of CO_2 per year for Michelin. - **Other (social aspects)**: The implementation of pro-environmental policies; closer cooperation between entrepreneurs from different sectors, which is an example of an interdisciplinary approach.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No Heat recovery in waste incineration plants, and transferring it to other facilities is a common form of industrial symbiosis used around the world.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements

	☐ Other (please specify)
Main lessons learned	• The location is very important for the development of industrial symbiosis • Effective cooperation between the units of the symbiosis is crucial; • Support from the government facilitates the implementation of industrial symbiosis.
Further information (URL, sources)	http://ewam.fr/test/synergies/synergie-de-substitution/ http://www.territoires-durables-paca.org/files/20131216_EcologieindustrielleOreDGIScomptitivitdurabledesentreprises.pdf Caroline GRAND, La démarche d'écologie industrielle sur le territoire de la Communauté urbaine de Bordeaux, Pôle Développement Durable et Rayonnement Métropolitain Direction du Développement Durable et de la Participation http://www.gironde.gouv.fr/content/download/24363/154271/file/PROC_Etude%20de%20Dangers_V5_PROTEGE.pdf http://www.uic.fr/Activites/Changement-climatique/Les-entreprises-de-la-chimie-et-l-Accord-de-Paris/Les-entreprises-de-la-chimie-Des-innovations-pour-le-climat/Produire-autrement

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Industrial Symbiosis in Helsingborg		
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	south of Sweden
	City/Town: *(if applicable)*	Helsingborg
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	The city is seen as the main actor in the development of synergies, has 130 000 inhabitants and 11 000 companies. Helsingborg is a city where sustainable development is an important issue while developing new areas in the city. For instance, in 2010 the city of Helsingborg signed an agreement with some of the large

		companies working in Helsingborg, to decrease the environmental impacts made by citizens and industries in Helsingborg. Furthermore, the municipality of Helsingborg is the owner of the main producer of energy and heat delivered to the city through a district heating system, as well as it owns the local waste treatment company.
B. CASE DESCRIPTION		
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify): farmers	
Please briefly describe the industrial eco-system	**WASTE SYNERGIES** Helsingborg is known to have a well-organized system for waste collection and sorting. This makes it easy to maintain a good quality of the waste which makes it an important output from the city. Both municipal and industrial solid waste from the region is delivered to NSR. Due to the waste sorting system NSR is able to process and send large amounts of sorted waste, such as paper, plastics and other recycled materials, to distributers in Europe. Residual waste is not possible to sort out to benefit reuse or recycling and is thereby sent to Öresundskraft (Filbornaverket). NSR also provide the plant with gas from landfills. The material that cannot be taken care of by NSR, such as hazardous waste, is sent to Sakab. **HEAT AND COOLING SYNERGIES** Västhamnsverket, another plant owned by Öresundskraft, produces district heat by burning biomass and natural gas. It also takes care of heat from sewage water, using a heat pump, and waste heat from	

	the industries in Helsingborg. For instance heat is recovered from Kemira Kemi AB, a chemistry industry in the IPOS area, which is the biggest supplier of waste heat. The Filbornaverket plant was recently built by Öresundskraft on the property of NSR as collaboration. In this plant, they incinerate residual waste and provide district heat to the city. The ashes from Filbornaverket and Västhamnsverket are sent to Öresundskraft´s plant Åkerslund which is located in Ängelholm, where it is burnt together with biomass to recover heat. The Åkerslund plant is outside the system boundaries, and thereby this plant is not evaluated further. Heat and electricity are then utilized in the city of Helsingborg by both industries and households. District cooling is distributed to the city and used by the hospital of Helsingborg and a ompany named McNeil AB. **BIOGAS AND BIOFERTILIZER SYNERGIES** Since Helsingborg has a well established harbour, tons of groceries pass through the city, to be stored a couple of days before it continues to the rest of Sweden. It is therefore easy to find stocks belonging to companies such as Unilever (producers of margarine, cream etc.) and ICA in Helsingborg. These industrial waste streams make them all big suppliers of biological waste, which is taken care of by NSR. By digesting this biological waste, NSR is able to produce biogas which is distributed to Helsingborg's industries and municipality through a system owned by Öresundskraft. For instance the biogas is utilized as fuel in the buses in the Helsingborg region. Biogas is also produced by NSVA. Sewage water, another big output from the municipality is sent to NSVA where it is processed in the cleaning treatment. The residual sludge then goes to a plant which includes two digesters where biogas can be produced. This biogas is also distributed by the system owned by Öresundskraft. As a by-product the bioreactors create biofertilizers. Due to its high content of nutrients, parts of the sludge from the bioreactors can be used as fertilizer and it is sent to farmers through pipelines. The

	agreement between the farmers and both NSR and NSVA provides that the farmers stores and distributes the biofertilizers on their lands. **OTHER RESOURCE EXCHANGES** There are also some smaller exchanges in the region which benefit the development of the municipality of Helsingborg. The EVAA project is a collaboration between the municipality of Helsingborg, Öresundskraft, NSVA and NSR. Its main purpose is to identify synergies between the involved actors that make it possible to increase the sustainability of the systems, while reducing environmental impact. The focus is on finding integrated system solutions within the areas energy, water, wastewater and waste. Another such synergy is between Move About and Öresundskraft, who have a car pool cooperation where electrical cars are loaded by solar energy. This synergy benefits more sustainable transportations in the region.
Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials

	☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions

	☐ Improved resource efficiency - Other (please specify): environmental benefits - **contribution to the regional GDP and cost reduction / annual savings:** It is often difficult to quantify economic benefits that derive solely from industrial symbiosis, partly because such data has a confidential nature, and partly because such calculations are complicated. Generally speaking, one could argue that achieving more regional synergies simultaneously improves the region's economy. Of course this differs from case to case, but replacing raw material and energy inputs with waste flows from other actors should be economically sound. In the case of Helsingborg, there is an established network of energy and material flows between the key actors NSR, Öresundskraft and the municipality of Helsingborg which is economically beneficial. To name an example, the heat exchange between Kemira Kemi AB and Öresundskraft allows decreased energy costs for the first part, and increased incomes for the latter. In 2012 Öresundskraft had the best annual profit ever, which of course depends on several factors but where industrial symbiosis is likely to be one of them. A large part of the synergies in the Helsingborg region concerns solid waste. Thus, a geographical proximity should have a relatively large influence on the total cost advantage. Furthermore, a focus on industrial symbiosis can help improve the environmental trademark of Helsingborg city, which in a longer perspective is likely to result in business benefits. - **reduce in greenhouse gas emissions and improved resource efficiency:** The different symbiotic relationships in Helsingborg has several environmental benefits. The main ones are a reduced need to produce heat and less demand for different types of fuel. This is due to the fact that excess heat from different industries in Helsingborg can be utilized mainly in the district heating system. Furthermore, natural gas can be

	replaced with biogas which is a by-product from for example wastewater treatment. Another benefit from the industrial symbioses in Helsingborg is a reduced number and distance of transportations by linking the different companies, which results in reduced emissions. Further, the different symbioses also lead to a smaller volume of waste placed in landfills, especially since much of the waste is recycled and a lot of the remaining waste is used for combustion. An additional benefit is that farmers in the area substitute some of the mineral fertilizers with a nutrient-rich sludge, which reduces the demand for finite phosphorus rock and fossil natural gas. Moreover, the choice made by the municipality and the companies to work together for environmental gain, brings awareness of environmental issues to the population of Helsingborg.
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No There is no information about the implementation of the system, in Sweden there are several similar systems, for example: Industry Park of Sweden, Industrial Symbiosis in Enköping, Industrial Symbiosis in Stenungsund. But there are several plans regarding future possible synergies in the area that are examined by the involved companies and administration. There are various possibilities for further developing the symbiotic network in Helsingborg, like expand the district heating system to Lund, Helsingör and to other industries in Helsingborg, produce district cooling to the hospital of Helsingborg and McNeil AB, create more

	linkages is to use the already existing tracks connecting Chiquita and Unilever to the ICA Storage, build a plant to produce liquefied biogas (LBG), reduce energy use by creating a higher awareness as well as energy efficient buildings and increased utilization of biogas fuelled transports and produce oil from hydrocarbon materials, such as used tires, plastic waste, oil sludge and waste oil.
What are the most significant features of the industrial eco-system that make it transferable?	☐ **Use of standardised technology solutions and processes** ☐ **Needs addressed are common among industries, organisations and different regions/countries.** ☐ **Demonstrated achieved benefits outweigh investment costs by far** ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- The city of Helsingborg is located in the south of Sweden, and has around 11 000 companies, and is home to one of the important harbours in Sweden. - Sustainable development has been and is an important consideration for the city's development. The city is home to an industrial symbiosis network involving various exchanges among a number of private and public actors. - A geographical proximity have a relatively large influence on the total cost advantage. Furthermore, a focus on industrial symbiosis can help improve the environmental trademark of Helsingborg city, which in a longer perspective is likely to result in business benefits. - The synergies between the involved actors is based on waste synergies, heat and cooling synergies and biogas and biofertilizer synergies, and it focus on finding integrated system solutions within the areas energy, water, wastewater and waste. Not popular and typical synergy is

	between Move About and Öresundskraft, who have a car pool cooperation where electrical cars are loaded by solar energy. This synergy benefits more sustainable transportations in the region. - For the moment, the city has a well-developed network of synergies, but it is possible to develop synergies in the following areas: expand the district heating system to Lund, Helsingör and to other industries in Helsingborg, produce district cooling to the hospital of Helsingborg and McNeil AB, create more linkages is to use the already existing tracks connecting Chiquita and Unilever to the ICA Storage, build a plant to produce liquefied biogas (LBG), reduce energy use by creating a higher awareness as well as energy efficient buildings and increased utilization of biogas fuelled transports and produce oil from hydrocarbon materials, such as used tires, plastic waste, oil sludge and waste oil.
Further information (URL, sources)	http://www.industriellekologi.se/symbiosis/helsingborg.html http://www.industriellekologi.se/documents/Helsingborg.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Norrköping Industrial Symbiosis Network		
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	Östergötland
	City/Town: *(if applicable)*	Norrköping
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	Norrkoping Industrial Symbiosis Network was formed in the 90s of the twentieth century. At that time, the plant was privatized, have been taken a number of upgrades and began utilization of biomass. Latest key elements, Svensk Biogas has started to operate in 2007. A publicly owned combined heat and power

		plant, Händelöverket, was established in an island just outside Norrköping in 1982. The plant was privatized in early 1990s and is today owned by E.ON Sweden. Numerous upgrades were made in this plant, most notably in early 1990s to utilize biomass, and later in 2002 and 2010, to utilize domestic and industrial waste as fuel - thereby replacing coal. Lantmännen Agroetanol was originally set up in 2001 as a pilot and quadrupled its production in 2009 following a major expansion. A biogas plant owned by Svensk Biogas was put into operation in Norrköping in 2007.

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify): farmers
Please briefly describe the industrial eco-system	Norrköping is also home to an industrial symbiosis network involving diverse range of symbiotically connected private and public sector actors. The industrial symbiosis network in Norrköping is a telling example of how synergistically integrated industrial, urban and agricultural activities can play a key role for improving regional sustainability. Key actors of this network are: wastewater treatment plant, gas upgrading, forestry, pulp and paper production, waste processing, various industries, port of Norrköping, chemicals plant, ethanol plant, power plant, regional farms, biogas pland and Norrköping

Municipality.

Some of the key actors of the network and their relevance for the symbiosis can be summarized as following:

415.1.1 MUNICIPALITY OF NORRKÖPING

The municipality of Norrköping was one of the first in Sweden to install and operate a district heating system. This system is now served by a combined heat and power (CHP) plant. The municipality has also been a key player for the modifications made to this CHP plant that enabled the utilisation of alternative fuel sources (see below). Today, the municipality provides the CHP plant with household waste (~ 25 000 t/y) as fuel, and the municipality is a key customer for the heat, electricity and cooling produced by this plant [1].

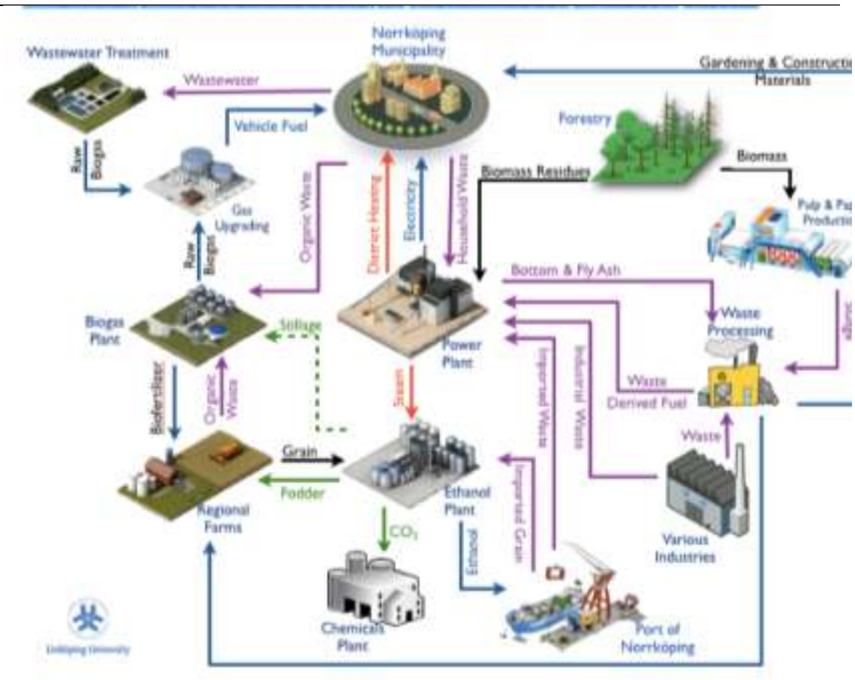
415.1.2 E.ON'S COMBINED HEAT AND POWER PLANT

A publicly owned combined heat and power plant, Händelöverket, was established in an island just outside Norrköping in 1982. The plant was privatised in early 1990s and is today owned by E.ON Sweden. Numerous upgrades were made in this plant, most notably in early 1990s to utilize biomass, and later in 2002 and 2010, to utilize domestic and industrial waste as fuel - thereby replacing coal. Today the plant is dominantly fueled with forestry residues from the region (~ 480 GWh/y) as well as domestic (~ 580 GWh/y) and industrial waste (~ 980 GWh/y) sourced from Norrköping, from other Swedish municipalities, and other European countries. Today, this plant provides district heating (~ 1130 GWh/y – used mainly in Norrköping but also in other municipalities in the region), electricity (~ 320 GWh/y), some district cooling, and industrial steam (~ 500 GWh/y) that meets the demand from neighboring Agroetanol [1].

415.1.3 AGROETANOL

Lantmännen Agroetanol is owned by the Swedish agricultural cooperative and produces grain-based bio-ethanol with high environmental performance. The plant was originally set up in 2001 as a pilot and quadrupled its production in 2009 following a major

	expansion. The grain used in the production (~ 550 000 t/y) is sourced from regional farmers and from export markets, and the steam required for the processes is provided by the nearby CHP plant. Majority of the stillage, a by-product rich in protein content, is turned into fodder (~ 190 000 t/y) and sold to animal farmers, while some fraction is used by the nearby biogas plant as substrate. Another organic by-product stream is bio-fertilizer, which is received by the local farmers (~ 8100 t/y). The plant also produces substantial amounts of biogenic carbondioxide (~ 170 000 t/y). This CO_2 stream will be used in a new plant, which is under development at the time of writing, for the production of industrial grade CO_2 [1]. 415.1.4 SVENSK BIOGAS A biogas plant owned by Svenk Biogas was put into operation in Norrköping in 2007. The raw biogas produced in this facility is upgraded to vehicle grade (~ 4.2 million Nm^3/y) and fuels biogas buses and cars in Norrköping. For some years the plant primarily used stillage from the nearby Agroetanol. However, since 2012, it is primarily using organic fraction of the household waste collected in Norrköping. The digestate (~48 000 t/y) from biogas production is used by the regional farmers as organic fertilizer [1]. 415.1.5 ECONOVA Econova is a company specialized in producing usable products from industrial and domestic waste streams – like a scavenger in natural ecosystems. The company receives a rather wide range of waste streams as input, and produces an equally wide range of products. Some examples of the waste streams processed by the company includes sludge and bark from paper industry, wood and combustible waste from industries, and bottom- and fly-ash from combustion facilities. Some of the products of the company, on the other hand, include waste derived fuels for energy plants, soil for gardening, materials for covering landfills, and plastic bags from recycled plastics

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered

	Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ……………………………….
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions - Improved resource efficience - Other (please specify): **Reduction of waste landfilling** - **contribution to the regional GDP (economic benefits for the municipality) and cost reduction / annual savings:** Using household waste as fuel in energy production has economic benefits for the CHP plant, as the plant receives a gate fee for the domestic waste brought to the plant for incineration (here it needs to be noted that capital and operational expenses of a plant designed to use waste-derived-fuels are higher than those running on fossil fuels). Ability to send waste to the CHP plant also offers economic benefits for the municipality of Norrköping

	and industrial waste generators, as compared to other alternatives for managing their waste. Having a sizeable and stable recipient for steam, which is a higher-value product, is also an important economic benefit for E.ON, particularly in times of low electricity prices. While also being able to sell steam, E.ON is able to produce and sell more electricity due to Agroetanol's stable demand throughout the year. For Agroetanol, sourcing steam from E.ON has significant economic and business value. Economically, the company is able to avoid a substantial investment and operational costs linked to having its own steam system. However, Agroetanal derives further business value from such transaction, as the steam sourced from E.ON has very low CO2 footprint, which significantly improves the environmental profile of the ethanol produced. Production of high-quality animal food from solid residues is another important business leverage for Agroetanol. Through this dynamic, the company overcomes a costly operational bottleneck related to waste disposal and at the same time creates additional income streams. The ability to transfer thin stillage–the management of which as a waste stream would be problematic–to Svensk Biogas for biogas production, on the other hand, is providing Agroetanol with an important safeguard. In a similar fashion, ability to utilize bio-sludge as fertilizer in regional agricultural activities reduces waste management costs for the ethanol and biogas plants. Farmers, that utilize the bio-sludge, on the other hand, are not only able to reduce their fertilizer but also to gain access to fertilizers suitable for organic agriculture [1]. - **reduction in greenhouse gas emissions:** Having a CHP plant that is primarily fueled by waste-derived fuels and biomass provides significant reductions in CO_2 emissions. This is partly because meeting the heat and steam demand of domestic and industrial users by the CHP is a much more efficient alternative as compared to these users operating their own boilers. Moreover,

	the CHP plant is able to use waste-derived fuels and biomass as fuel thereby replacing coal or other fossil fuels, which would be difficult to achieve in individual boilers. In addition, thanks to the stable steam demand throughout the year from Agroetanol, CHP plant is able to produce more electricity, which brings more environmental benefits [1]. - **improved resource efficiency (reductions in fossil-resource dependence):** Bio-ethanol and biogas reduce the dependence on fossil fuels, whereas the use of bio-fertilizers from ethanol and biogas production reduces the dependence on chemical fertilizers in agricultural activities [1]. **reduction of waste landfilling:** The amount of industrial and household waste that needs to be landfilled is significantly reduced by using such wastes as fuel in the CHP plant or as substrate for biogas production [1].
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No There is no information about the replication of the system. In Sweden there are several similar systems, for example: Industry Park of Sweden, Industrial Symbiosis in Enköping, Industrial Symbiosis in Helsingborg, Industrial Symbiosis in Stenungsund. But there are several plans regarding future possible synergies in the area that are examined by the involved companies. There are various possibilities for further developing the symbiotic network in Norrkoping, like utilization of sawmill by-products and production of green industrial CO_2.

What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- The strong position of the municipality and its environmentally motivated actions has been a key driver in Norrköping. Establishment of a district heating system, development of a CHP plant, and supporting the use of waste and biomass as fuels are among such actions. The municipality has also been a key actor for the development of a biogas market in transportation. The business development department of the municipality has been instrumental for Agroetanol's decision to locate their plant in Handelö, in order to take advantage of the available steam. This department is still trying to promote the development of further synergies around steam, through giving priority to new industries that have a steam demand in their development work. - The fact that there is high intensity of farming activities in the region also acts as a key enabler for some of the synergies. Local capacity of the farms to utilize the digestate produced as part of biogas production, for example, is a of vital importance. - In the case of Norrköping, innovative capabilities and entrepreneurial mindsets of local enterprises is also acting as a strong driver for the development of new synergies. In this regard, a local company called Econova is a good example. The company is continuously finding ways of

	turning various waste streams into inputs for productive uses.
Further information (URL, sources)	[1] http://www.industriellekologi.se/symbiosis/norrkoping.html [2] http://www.ep.liu.se/ecp/057/vol12/060/ecp57vol12_060.pdf

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges
Collection of good practices on ecosystems of by-product and energy exchanges
Title: Industrial Symbiosis in Enköping

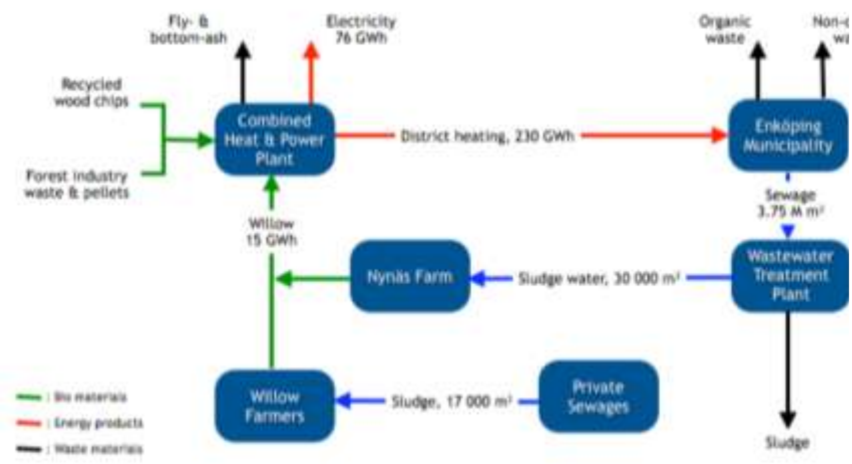
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	Center of Sweden
	City/Town: *(if applicable)*	Enköping
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	

B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities

	☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	The idea behind the collaboration took form in a conference room at the office of the local wastewater treatment facility. A local farmer, who owned land in connection with Enköping, had a vision of bringing his operation closer to the city. The wastewater treatment facility faced a 30 - 35 MSEK investment in denitrification equipment, due to problems with fulfilling the requirements of maximum nitrogen content in their treated water. When looking at an aerial photo hanging on the wall of the conference room, picturing the wastewater facility and its surroundings, the representatives of the three actors saw the potential in taking advantage of the geographical proximity. The photo showed that the CHP plant was located just north of the wastewater facility and the farmland south of it. If the farmer would start to grow some sort of primary wood energy source, the wastewater facility could spread its nitrogen rich sludge water over the fields to increase the growth capacity. The primary wood fuel would then be incinerated in the CHP plant to produce biomass based electricity and heat. By implementing this arrangement, the wastewater facility avoided the otherwise needed equipment investment. The farmer got the opportunity to grow a crop with low demand for attendance and have it fertilized ecologically free of charge. The farmer also received a steady income from selling it directly to the CHP plant. Furthermore, the CHP plant was able to further diversify its production mix and strengthen its relations to the surrounding area. **KEY ACTORS AND EXCHANGES** The symbiosis in Enköping primarily consists of three key actors. **ENA ENERGI** ENA Energi, that runs the local power plant in Enköping, is a company owned by the municipality. The power plant supplies electricity to the main grid as well as district heating to most of the residents and companies within the Enköping municipality. The main

	boiler of the plant has a capacity of 55 MW of heat and 24 MW of electricity, using mainly wood resources as fuel. The largest contribution comes from recycled wood chips (RT-flis) but forest industry wastes and pellets are often used as well. Some willow is also used as energy input, and during the colder season EO1 is used as a top load fuel. In 2010 the plant had an output of about 230 GWh of district heat and 76 GWh of electricity. Apart from the willow the other fuels are considered to be crossing the system boundary and are therefore not further discussed in this text. ENA Energi is involved in the symbiotic network within Enköping as the main contributor of heat to the district heating system and as end-user of the willow produced at the farms. They have also started to receive raw biogas, which they incinerate, from a nearby recently covered landfill site. The size of this flow is not established since it's just starting up. Currently, the ash from the boilers ends up in dumpsites in Västerås and Sala. It used to be mixed with the sludge and utilized as fertilizer by the willow farmers. **WASTEWATER TREATMENT PLANT** The Enköping municipality supplies the wastewater treatment plant (WWTP) with 3 750 000 m^3 (2012) of wastewater every year. After the water has been treated it is released to the Enköping River. The sludge water is separated from its solids and then put through anaerobic digestion, creating flammable methane gas. The gas was previously transported to the CHP plant but is currently flamed on site. The reason for this is unclear but ENA Energi claims it's due to technical difficulties in the WWTP. The remaining sludge water, which is rich of nutrition and is fluid enough to be distributed through hoses, is used to water the local willow fields. The remaining solid sludge used to be sold to other willow farmers in the region, but nowadays it is deposited nearby the WWTP without usage because of too high concentrations of zink. **THE WILLOW FARMERS** There are five different plantations that are a part of the industrial symbiosis network. The plantations receive sludge as fertilizer that

	would otherwise be handled by the WWTP. One plantation is a bit different from the others, Nynäs Gård, as water is sent directly from the WWTP whereas the other plantations receive sludge from private septic tanks and does not take the rout via the WWTP. The sludge is hygienized in ponds for one year and, when ready, used for fertilizing the willow fields. The fertilizing sludge makes the willow to grow faster which allows it to be harvested sooner. This makes it possible to harvest the willow every third year instead of every fourth. The sludge water used at Nynäs Gård has less concentration of solids than the sludge used on the others farms. **OTHER RELEVANT ACTORS** Other main actors include the city of Enköping and the local water park run by the municipality. The storm water that is collected in the city of Enköping used to be led through pipes and Krokängsdiket to Enköpingsån from which it was sent directly into Mälaren. This was done without any treatment of the water. Pollutions such as heavy metals, phosphorous and nitrogen were therefore transferred to Mälaren where it caused problems for the ecosystem as well as eutrofication. To decrease the negative effects on Mälaren the municipality of Enköping created a natural treatment system for storm water. The treatment system consists of a canal across a field with depths varying between 0.2- 1.5 meters. Different processes occur naturally in the different sections of the canal and the circulation time for one drop of water is between 5-10 days. The canal has created a beautiful area that is suitable for recreational purposes and has a diverse bird population. The symbiotic exchange between the municipality and the water park might not be an example of classic industrial symbiosis. It can be argued the local community benefits from this, since the park provides a recreational area as well as a diverse habitat for animals. Furthermore, the authors still find it a great example of an environmental initiative that ought to be highlighted.

<table>
<tr><td>Image (if available)</td><td>
</td></tr>
<tr><td colspan="2">C. NEEDS, BARRIERS AND SUCCESS FACTORS</td></tr>
<tr><td>What were the main needs and objectives for the deployment of the industrial eco-system?</td><td>☐ Promote the use of sustainable bio-energy resources
☐ Improve resource efficiency
☐ Access new markets
☐ Share risk
☐ Open new markets for secondary raw materials
☐ Reduce CO2 emissions
☐ Increase profitability, revenue
☐ Reduce production costs
☐ Other (please specify)</td></tr>
<tr><td>What are the main difficulties encountered during the deployment / operation of the industrial eco-system?</td><td>☐ Regulation / limited support by local policy makers
☐ Funding, lack of financial resources
☐ Lack of expertise / skills of existing employees within firms
☐ Imbalance of power between partners
☐ Different organisational culture within firms
☐ Economically unsound or risky exchanges
☐ Lack of motivation and commitment among firms
☐ Lack of geographical and technological proximity of firms
☐ No problems encountered

Other relevant info provided: One main challenge in the cooperation between the WWTP and the Nynäs Gård farm was the question of how to divide investment and operational costs.</td></tr>
</table>

	Through a high level of responsiveness from both parts, an agreement that was aligned with their capabilities and made that satisfied both parties. This agreement stated that the WWTP was to bear the chunk of the investment costs while the farmer would give up some of his land for the sludge water dams and to manage the operation of the irrigation system. They also signed a contract, spanning over 15 years, ensuring that the farmer was obliged to receive the sludge water and ENA Energi had to purchase the willow, thus removing many uncertainties for the actors regarding this matter. Another challenge that the actors had to face was the risk of generating bad press from discontent citizens in the process of spreading sludge water on farmlands. This was thwarted by being transparent towards the public, emphasizing the environmental benefits of the project and avoiding watering the area closest to the municipality with sludge water.
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: …………………………………
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions

	☐ Improved resource efficiency ☐ Other (please specify): - **cost reduction and improved resource efficiency:** The WWTP was in need to improve nitrogen removal, which required an investment of around 35 million SEK. By using the nutrient-rich effluents as irrigation water in willow plantations, the company was able to meet emission regulations only through an investment of around 15 million SEK (invested for the contruction of three natural ponds and the purchase of equipment for the spreading of effluents on land). Using sludge from private sewage systems as fertilizer provides further economic benefits, as their transport to the central WWTP is avoided. For the local farmers, growing willow is often as profitable as growing grains if not more. The largest cost of growing willow is to set the willow plant but in Sweden there are programs that offer financial aid for up to half of the investment cost. Another aspect improving the profitability of willow farming collective ownership of harvesting machinery by farmer organizations–representing another form of symbiosis–as well as the sale of the willow unharvested. In relation to ENA Energi, the size of the economic benefits depends on what assumptions that are made regarding which type of fuel the willow is replacing. However, assuming that the willow burnt in the CHP plant is offsetting pellets, ENA Energi reduces its cost for fuels by 2,5 MSEK/year. - **reduce in greenhouse gas emissions:** having a district heating system and a CHP plant fueled almost exclusively by biomass resources enables substantial reductions in CO_2 emissions - partly due to increased efficiency and partly due to the substitution of fossil fuels. Locally grown willow further contributes to lowering CO_2 emissions by reducing the transort of biomass fuel. - **environmental benefits:**

	recovery of phosphorus and nitrogen: Phosphorus is a precious resource with limited availabilty. Nonetheless, every year large amounts leak out into the water system and are lost for future utilization. This leakage also causes significant environmental impacts through eutrophication and associated eco-system damage. By using sewage water as fertilizer more than 1 ton of phosphorus is recovered back into the cultivated system every year, which not only reduces eutrophication potential but also reduces the amount artificial fertilizer needed. In a similar fashion, use of nutrient rich effluents and sludge from wastewater treatment operations reduces both the uncontrolled release of nitrogen into the environment and the need for sysnthetic fertilizers. Through the use of effluents in willow plantations, the WWTP has reduced the nitrogen discharges by 30 t/year–corresponding to a 25% reduction. **removal of Cadmium from soil** Cadmium is hazardous heavy metals and therefore its presence in the agricultural land is tightly regulated. The special kind of willow crops used at the plantations absorbs cadmium well and therefore purifies the soil. This can lead to the de-contaminated of the land used for willow plantations, in time potentially making the suitable for growing food crops. *Please briefly discuss about the degree of impact on the selected categories of benefits*
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ **Quite successful** ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer

Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ **No** There is no information about the implementation of the system, in Sweden there are several similar systems, for example: Industry Park of Sweden, Industrial Symbiosis in Helsingborg, Industrial Symbiosis in Stenungsund. But there are several plans regarding future possible synergies in the area that are examined by the involved companies and administration. There are various possibilities for further developing the symbiotic network in Enköping, like use of biogas from WWTP in the CHP, improved extraction of biogas from the landfill, utilization of fly ash, utilization of bottom ash, extraction of phosphorus, utilization of sediment in sludge pools.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- *In Enköping, ideas of a visionary farmer triggered symbiotic developments and evolved into a local Industrial Symbiosis network. This network enables replacing fossil fuels with biomass based resources in the production of various energy products, adds value to local waste materials, and generates additional income streams for local farmers and forest owners.* - Enköping is home to an industrial symbiosis network involving the city, municipally controlled services and local farmers and forest owners. - Municipally owned combined heat and power plant delivers district heating to the the city and sources most of its fuel from willow localy grown by the farmers and from forest residues and

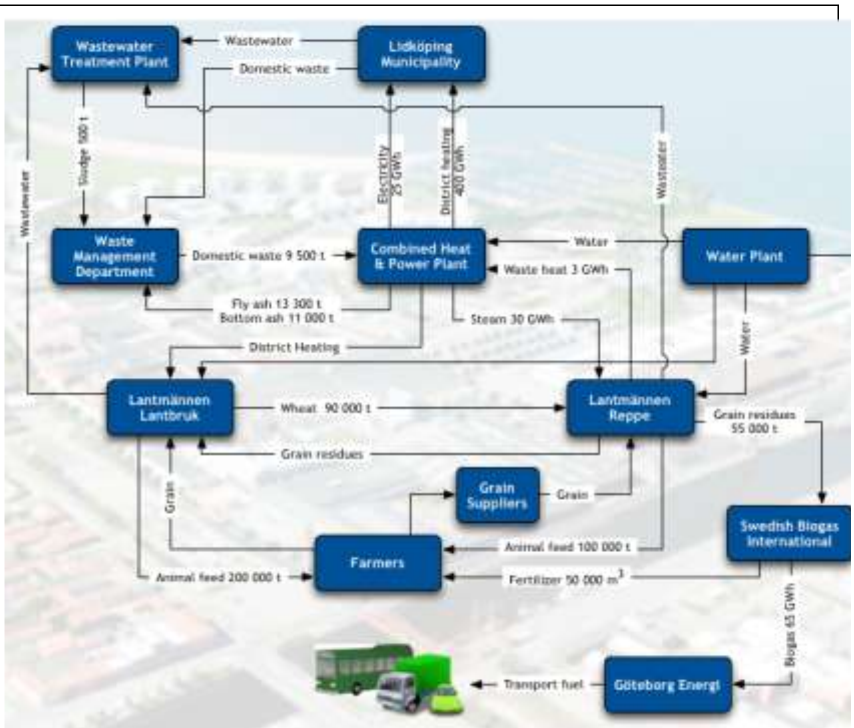
	wood chips sourced locally and from the region. The willow farmers, make use of effluents of the municipal wastewater treatment plant as well as sludge from private sewage systems to accelarate the growth of willow. - Even though the current system is beneficial for both the environment and for the actors economically, there is always room for improvement (use of biogas from WWTP in the CHP, improved extraction of biogas from the landfill, utilization of fly ash, utilization of bottom ash, extraction of phosphorus, utilization of sediment in sludge pools).
Further information (URL, sources)	http://www.industriellekologi.se/documents/Enkoping.pdf http://www.industriellekologi.se/symbiosis/enkoping.html

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Lidköping – Exploring the Industrial Symbiosis		
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	South of the country
	City/Town: *(if applicable)*	Lidköping
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	There is no single date of system implementation. The production (combined heat and power plant) started in the mid 1980's with the combustion of waste to produce heat.
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	There are couple of areas which appear to have supported the development of synergistic connections in and around Lidköping: 1. The department of waste management 2. Lantmännen Reppe 3. Swedish Biogas International 4. Combined heat and power plant ***THE DEPARTMENT OF WASTE MANAGEMENT*** The department of waste management is primarily responsible for the collection of domestic waste in Lidköping and for operating the waste disposal infrastructure that includes a landfill, a recycling centre and a manual sorting facility. The department also collects and manages sludge from wastewater treatment and a minor fraction of industrial waste. The department mixes the sewage sludge with wood chips and sells this to the CHP plant for incineration, together with some of the household waste. Both the bottom- and fly -ash from CHP plant is then returned to the department of waste management. While the bottom ash is used as construction material in the landfill, the fly ash is landfilled. The liquid effluents from waste management are sent to the wastewater treatment plant for treatment. ***LANTMÄNNEN REPPE*** Lantmännen Reppe can be classified as a basic bio-refinery. Using wheat as the main raw material, the company produces a wide range of products and is constantly seeking new applications and markets for them. Currently, the main outputs are glucose syrup, gluten, ethanol, wet and dry animal feed, and raw material for production of biogas.

	The company requires wheat with high levels of protein and starch, which is sourced from a number of suppliers. The steam needed for the production processes is supplied by the nearby CHP plant. The residual heat from the plant still maintains a high temperature and is sent back to the CHP and is subsequently used for district heating. The relatively high quantities of water required by the plant is sourced from the municipal water treatment plant and the effluents from production are sent to the municipally operated wastewater treatment plant. The operations of Lantmannen Reppe also produce various streams of organic residues, the presence of which were a major limitation for the company in earlier days. Today, these residues are sent to local plant as substrate for biogas production and to the local farmers as fodder. ***SWEDISH BIOGAS INTERNATIONAL*** The biogas plant in Lidköping was established in 2011 and is an outcome of cooperation between Swedish Biogas International (SBI), Göteborg Energi and the municipality. The plant, owned and operated by SBI, produces biogas and upgrades it to higher purity to be used as transport fuel, which is eco-labelled (Nordic Ecolabel). While a small fraction of the produced gas is compressed and sold as vehicle fuel in a nearby station (jointly owned by Göteborg Energi and DONG Energy), the major part is send over to one of the world's first biogas liquification plants (Lidköping Biogas – owned by Göteborg Energi and the municipality of Lidkö-ping). Here, the biogas is liquefied and afterwards distributed in the wider region to be used as fuel in heavy duty trucks. In order to meet the requirements of the eco-label, the plant only uses certain raw materials, primarily sourced from food industry in and around Lidköping. In addition to biogas, the site also produces considerable amounts of of nutrient-rich digestion residue, which is used as fertilizer by local farmers. Following video provides a good overview and further information about biogas production in Lidköping.

	COMBINED HEAT AND POWER PLANT The main objective of the CHP plant is to produce electricity and district heating for the city of Lidköping. To do so, the company incinerates the household waste collected by the department of waste management and receives some waste heat from Lantmännen Reppe. The company also produces some steam and electricity for Lantmännen Reppe and sends the fly ash and bottom ash to the waste management plant. The symbiosis between Lantmännen Reppe and the CHP plant is mainly favourable due to large use of steam. The exchange leads to reduction of emissions from the CHP plant since the company has invested in substantial treatment of the fumes. There are also economic benefits for the CHP plant. Reppe provides a secure base load for the CHP plant and Reppe, in return, doesn't need to invest in a combustion chamber. Though Reppes steam demand only represents 10 % of the total energy delivered by the CHP plant the value of the steam is higher than the value of district heating, which makes it important for the CHP plant. The CHP plant is the only producer of heat for the city, and therefore the focus is to maintain a steady and secure delivery of heat to Lidköping.

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms

	☐ No problems encountered Other relevant info provided: Nowadays Lantmännen Reppe has a very well established network of synergies, but before the synergies were established Reppe had a hard time producing at full capacity since the company could not find appropriate use for its by-products. In making the by-products in to valuable animal feed and biogas feedstock, Reppe has not only kept production going but can also generate income from their by-products.
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency Other (please specify): **Reduction of emissions of other air pollutants** **Reduction of waste landfilling** - **cost reduction / annual savings:** Domestic, institutional, industrial and commercial heat users realise economic gains as

	the district heating provided by the CHP plant is more competitively priced, as compared to heating produced using fuel oil in their own boilers. Using household waste as fuel in energy production has economic benefits for the CHP plant, as the plant receives a gate fee for the domestic waste incinerated. Thus, instead of paying for the fuel, which is the case for using fossil fuels, the company generates an income on the input side as well. At this stage, these benefits are not quantified. The exchange of steam and residual heat between the CHP plant and Lantmännen Reppe provides economic benefits for both parties. More specifically, Lantmännen Reppe avoids a substantial investment and operational costs linked to having its own boiler system. The CHP plant, in return, has a higher-value demand for an important by-product and has a more steady demand for the heat it produces. This makes additional electricity production feasible and reduces the need to store waste over summer months. Just like the steam and heat exchange with the CHP plant, Lantmännen Reppe realizes similar benefits by having its effluent treated by the municipal wastewater treatment plant. More importantly, by revalorizing its organic waste streams as fodder and as substrate for biogas production, the company overcames a significant production bottleneck, eliminates landfill tax and waste management costs associated with these streams, and turns these streams into sources of income. For the waste management department, incineration of waste offers a lower cost alternative as compared to landfilling. - **reduce in green gas emissions:** Meeting heat and steam demand of domestic and industrial users by the CHP eliminates the need to operate larger numbers of less efficient and more polluting boilers. Significant efficiency gains are also realized by producing electricity (~35 GWh/y) in a CHP compared to conventional thermal power generation. In addition to these

	efficiency gains, further CO_2 savings are enabled by using waste-derived-fuels, which have higher biogenic carbon content, instead of fossil fuels. According to the municipality, CO2 emissions linked to heating in Lidkoping have been reduced from 64 296 t/y in 1985 to to 4 700 t/y in 2006 – a reduction of 93%. There are additional benefits linked to the integration between the CHP plant, Lantmannen Reppe and the district heating system that enables cascading of energy and reduces overall energy demand. Further reductions of around 18 000 t/y of CO_2 equivalent are enabled by the production of biogas and its use as a transport fuel, thereby substituting fossil fuels like diesel but also gasoline. - **improved resource efficiency:** Reduction in the use of fossil resources by using waste as fuel, use of 30 000 m^3 of oil is avoided by the district heating system alone. Furthermore, with the increased use of biogas, 6 500 m3 less diesel is needed in the region. In addition, with the availability of organic fertilizers from Lantmannen Reppe and from biogas producton, regional demand for chemical fertilizers is reduced. - **reduction of emissions of other air pollutants:** Partly due to the higher efficiency and alternative fuel usage in CHP plant and partly due to advanced flue gas cleaning systems employed in this plant–that would not be feasible to adopt in individual heating or steam boilers–significant reductions in SO_x and NO_x emissions were realised. More specifically, between 1985 and 2006, SO_x emissions were reduced from 355 t/y to 55 t/y, and NO_x emissions were reduced from 146 t/y to 8 t/y. Further reductions on emissions of trace metals, HCl and particulate matter are also enabled. **reduction of waste landfilling:** Thanks to the exchanges taking place, the amount of household waste that needed to be landfilled has been reduced by 90 000 t/y, and is instead used for the production of electricity and district heating.
How would you describe the	☐ Very successful

industrial eco-system deployed?	☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No There is no information about the implementation of the system, in Sweden there are several similar systems, for example: Industry Park of Sweden, Industrial Symbiosis in Helsingborg, Industrial Symbiosis in Enköping, Industrial Symbiosis in Stenungsund. But there are several plans regarding future possible synergies in the area that are examined by the involved companies and administrations. There are also several possibilities that were discovered by the authors during the fieldwork and that could be of interest for further investigation.
What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- The department of waste management is involved in a number of synergistic connections in the region, and is a baseline element of system. - Industrial Symbiosis in Lidköping combines crucial elements of the city (region) economy: water treatment, sewage treatment, waste disposal, heat and power production, and the involvement of smaller businesses and agriculture. - The municipality of Lidköping is involved in a number of ways with the local actors, usually by the law of public procurement.

	The law has in many ways been a driver for reducing the environmental impact from companies involved with the municipality by affecting how they do business.
Further information (URL, sources)	http://www.industriellekologi.se/documents/Lidkoping.pdf http://www.industriellekologi.se/symbiosis/lidkoping.html

SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Stockholm – SymbioCity		
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	centre of the country
	City/Town: *(if applicable)*	Stockholm
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ Regional ☐ Local
	Type of cooperative activity amongst firms in the industrial eco- system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	SymbioCity as a trademark was launched in 2008 and is administered by the Swedish Trade Council. Since 2010, SKL International has used the SymbioCity Approach (SCA) as a concept and a platform to support sustainable urban development around the globe.
B. CASE DESCRIPTION		

Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other (please specify)
Please briefly describe the industrial eco-system	SymbioCity is a Swedish government initiative run by Business Sweden and SKL International. Business Sweden oversees the SymbioCity trademark and promotes national exports on behalf of the Swedish government and industry. As part of Swedish international development co-operation, SKL International uses the SymbioCity Approach to support cities in developing countries to plan and build sustainably e.g. by identifying inclusive and innovative solutions. SymbioCity Scenarios aim to increase awareness of some of the numerous opportunities available to local councils seeking to steer their cities towards sustainable development. In this area there are many valid and different points of views and large- and small-scale solutions depending on differing conditions and cultures. Swedish expertise offers support and knowledge to help you to create your plan towards a more sustainable city. SymbioCity is present at many areas: ***WASTE OFFER:*** Focus on environment and health is driving a transition to better waste management. ***URBAN TRANSPORT OFFER:*** The urban transport offer delivers mobility solutions, using multifaceted strategies to create maximum-efficiency networks for proactive cities. ***URBAN AGLICULTURE OFFER:*** The urban The Urban Agriculture offer proposes a new way to cultivate food by building vertical greenhouses that reduce transport costs and emissions. This approach integrates with the city and saves money and the environment. ***SUSTAINABLE AIRPORTS OFFER:*** A holistic and collaborative approach during building or redeveloping airports. Only then is possible to unlock synergies within and between systems: synergies that can deliver major benefits for safety and the environment – and cut costs. Interventions are often quite small and they make safety, climate, economy and social responsibility all go hand in hand. ***GRID SOLUTION OFFER:*** SymbioCity find synergies in urban functions and unlock their efficiency and profitability. They integrate next-generation ICT

	with the electrical power grid, enabling greater and improved utilization of renewable energy sources. Smart grids also improve energy efficiency throughout the system, using intuitive user interfaces that involve and activate consumers. ***ICT OFFER:*** ICT sews a fabric where new ideas can flourish and grow. It offers new ways to create jobs, growth and prosperity while driving sustainable development across the triple bottom line – social, economic and environmental. ***SYMBIOCITY BIOGAS OFFER:*** The SymbioCity Biogas offer proposes practical ways to save money and energy by producing fuel from sewage and wasteSYMBIOCITY ***HEATING AND COOLING:*** SymbioCity takes a holistic approach to sustainable development. It is possible to find synergies in urban functions and unlock their efficiency and profitability. This is the key to Swedish design and manufacture of energy-efficient power supply and distribution systems. ***SYMBIOCITY HOSPITAL SOLUTIONS:*** SymbioCity Hospital Solutions bring together the design and technologies for systems that substantially reduce energy consumption and make hospital services greener. Products and services include mainly heating and cooling, indoor climate control, automated waste and laundry collection. ***SYMBIOCITY CLEANWATER OFFER:*** SymbioCity CleanWater offer is a business-led initiative that offers integrated water and wastewater treatment solutions from Sweden. SymbioCity CleanWater can design, construct, service and maintain solutions tailor-made to needs.

Image (if available)	
C. NEEDS, BARRIERS AND SUCCESS FACTORS	
What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)
What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered

	Other relevant info provided: ……………………………….
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ……………………………….
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/ operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): Social aspects - **Contribution to the regional GDP**: 44 percent economic growth in the last 15 years - **Cost reduction / Annual savings:** Thanks to its pioneering design, Hamnhuset is 75 percent more energy-efficient than standard buildings while still offering the standards and comfort expected in newly constructed premises. The technology is not even expensive. Hamnhuset cost 2.5 percent more to build than a conventional building – an investment quickly repaid by lower running costs. - **Improved resource efficiency:** The Linköping system has launched a new biogas as fuel on the market and inspired many other Local Authorities to press ahead with equivalent initiatives of Their Own. In a

	short time, the produced bio-gas has conquered 7% of the local fuel market for vehicles. The majority of public transport buses are already converted to biogas. The project has cut volume of waste sent for incineration in Linkoping each year to 3,422 tonnes and boosted biogas production to 1,334,580 cubic meters - equivalent to 12.65 GWh of renewable vehicle fuel, Mainly to be used for public transport. - **Increase in job opportunities (employment):** offices in 60 countries and work closely with trade associations, embassies, and chambers of commerce to promote Sweden internationally. - **Reduce in green gas emissions:** cut CO_2 emissions by 9 percent in the last 15 years. **Other (social aspects):** increased collaboration between 60 countries, implementation of international projects (SymbioCity Borås-Palu Cooperation, SymbioCity Probolinggo-Helsingborg Cooperation, Kenya SymbioCity Programme).
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No Since 2010, SKL International has supported cities in Africa, Asia and eastern Europe to enhance their capacity to plan, develop and manage urban areas in a more sustainable direction through the SymbioCity Approach. The projects have mainly been subsidised by The Swedish International Development Cooperation Agency (Sida) and have been carried out in cooperation with Swedish and local partners.
What are the most significant features of the industrial eco-system	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks

that make it transferable?	☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- SymbioCity offers the knowledge, methods and experience. Methods are adaptable to needs and context. SzmbioCity has the experience of Swedish architects, planners, engineers and construction companies and institutions. - SymbioCity is a dynamic concept that offers something for everyone. It can be apply from single blocks to entire urban areas, from regions to countries and from redevelopment schemes to greenfield initiatives. - SymbioCity works regardless of stage of developed: it is dedicated a developed, developing or transitional economy. - SymbioCity can be used by public and private actors alike (by local government, utilities, private business and other stakeholders).
Further information (URL, sources)	http://www.symbiocity.org/PublicDownloads/SymbioCity%20Approach%20Building%20Blocks/SCA%20building%20blocks%202015.pdf http://www.symbiocity.se/en/approach/ http://www.symbiocity.org http://www.metrodcliving.com/urbantrekker/2008/03/symbiocity-sust.html

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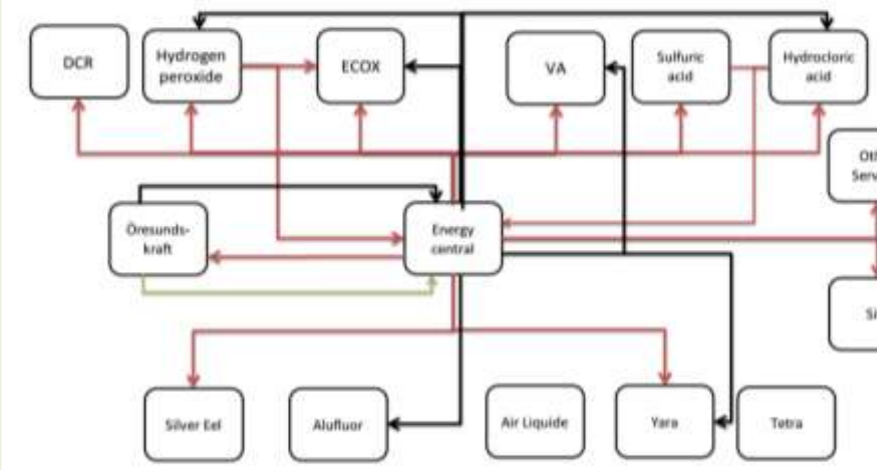
SYMBI - Industrial Symbiosis for Regional Sustainable Growth & a Resource Efficient Circular Economy		
Activity 1.3: Identification of good practices and benchmarking of ecosystems of by-product and energy exchanges		
Collection of good practices on ecosystems of by-product and energy exchanges		
Title: Industry Park of Sweden		
A. CASE IDENTITY		
LOCATION	**Country:**	Sweden
	Region:	south of the country
	City/Town: *(if applicable)*	Helsingborg
ACTIVITIES / MAIN FOCUS	**Geographical level of implementation**	☐ National ☐ **Regional** ☐ Local
	Type of cooperative activity amongst firms in the industrial eco-system	☐ Exchange of energy, by products and secondary raw materials ☐ Joint use of utilities and firm functions ☐ Collective gathering and removal of waste materials ☐ Combining transport of goods and people ☐ More intensive use of space ☐ Public utilities with high useful effects ☐ Joint commercial firm facilities ☐ Multimodal transport and high quality public transport ☐ Other (please specify)
DURATION	**Time of implementation**	There is no single date of system implementation. The site's chemical business was started in 1872, but Industrial Park was built progressively, throughout the twentieth century. The official name Industry Park of Sweden is functioning since 2007 year.

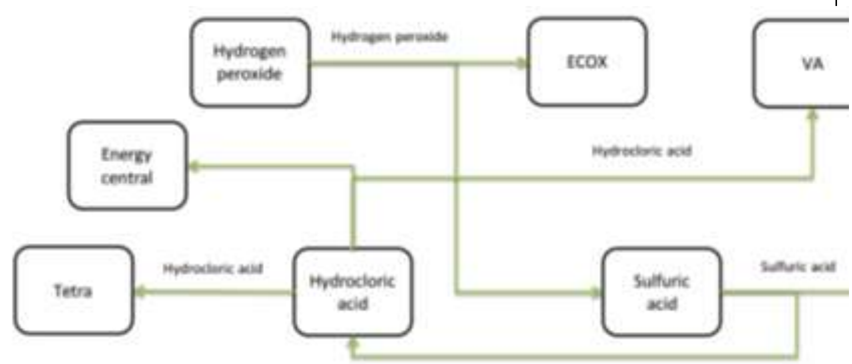
B. CASE DESCRIPTION	
Type of actors involved (choose all that apply)	☐ Large (industrial) enterprises ☐ Small and medium-sized enterprises ☐ National authorities ☐ Regional authorities ☐ Local authorities ☐ Public Agencies ☐ Other : Neighbours
Please briefly describe the industrial eco-system	Today the Industry Park of Sweden can offer various services to the companies established there. The objective is to use central coordination to achieve cost savings for the individual companies that would not have been attainable if they had been working on their own. IPOS is working to achieve synergies in logistics, site care and energy. The park has an extensive network for distribution of natural gas, steam, district heating, compressed air, electricity and water to the companies in the park. Almost all parts of the park can be reached by the distribution networks. All distribution is done through IPOS' energy center. Much of the excess heat in the park is sent to the energy center and converted into electricity, steam of various pressures and district heating. The sulphuric acid plant generates 90 %, or 600 GWh, of the excess heat sent to the energy center - the remaining 10 % is generated by the hydrogen peroxide and hydrochloric acid factories. The energy center supplies all the heating needed in the park and also about 35 % of Helsingborg's urban district heating. Electricity production is 50 GWh annually and is used internally in the park, accounting for a third of the park's electricity demand. The natural gas used in the park and the remaining electricity is purchased through IPOS. By joint purchasing of electricity economic benefits, such as lower grid costs, are achieved due to a lower total peak load for the industrial park, compared to the sum of peak demands if each company would purchase electricity individually. It is also more cost effective to purchase larger quantities of electricity and natural gas, compared to

	establishing individual contracts with the suppliers. The energy can be considered carbon neutral partly because no fuel is used to produce electricity and heat and also because most of the excess energy comes from sulfuric acid production, which is free from carbon emissions since, sulfur does not contain carbon. Even if the sulfur would contain carbon, all emissions could be allocated to the main product, sulfuric acid. Using electricity and heat generated from production processes at IPOS not only lower costs but also gives the advantage of using "green energy" which can be a marketing advantage. The energy center has a pump station and treatment plant that supplies the entire park with cooling water. IPOS also distributes feed water, deionized water and municipal freshwater. IPOS also manage all residual water flows in the park and is responsible for the sewer system. Compressed air is produced and distributed centrally removing the need for companies to have their own compressors. This results in a lower use of electricity since the most energy efficient compressors can be used. Costs are further reduced thanks to increased energy efficiency of the compressed air processes. This has been achieved because of a heightened awareness due to gauges that show when and how much compressed air each company uses. Joint distribution of compressed air also contributes to lower maintenance costs. In addition to the coordination of energy, compressed air, cooling-water etc. there are also material exchanges. These material exchanges primarily take place at Kemira’s production facilities, but also to somewhat minor extent between the other companies in the park.

Image (if available)



Energy flows at the Industry Park of Sweden. Red indicates heat and steam, green electricity and black natural gas. The electricity, entering the energy central, is then distributed to all individual companies.



Material flows at Industry Park of Sweden.

C. NEEDS, BARRIERS AND SUCCESS FACTORS

What were the main needs and objectives for the deployment of the industrial eco-system?	☐ Promote the use of sustainable bio-energy resources ☐ Improve resource efficiency ☐ Access new markets ☐ Share risk ☐ Open new markets for secondary raw materials ☐ Reduce CO2 emissions ☐ Increase profitability, revenue ☐ Reduce production costs ☐ Other (please specify)

What are the main difficulties encountered during the deployment / operation of the industrial eco-system?	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within firms ☐ Imbalance of power between partners ☐ Different organisational culture within firms ☐ Economically unsound or risky exchanges ☐ Lack of motivation and commitment among firms ☐ Lack of geographical and technological proximity of firms ☐ No problems encountered Other relevant info provided: ………………………………..
Why such industrial symbiosis approach has been effective? What are the success factors?	☐ Close proximity of companies ☐ Diversity of actors ☐ Low economic risks ☐ Adequate funding ☐ Balance of power between partners ☐ Similar organisation cultures of firms ☐ Legal and political support ☐ Active participation and commitment Please comment on the success factors: ………………………………..
C. RESULTS & PROSPECTS	
What were the main benefits created by the deployment/operation of the industrial eco-system? *(select all that apply)*	☐ Contribution to the regional GDP ☐ Cost reduction / Annual savings ☐ Increased productivity for the participating companies ☐ Increase in job opportunities (employment) ☐ Enhanced research and innovation capacity ☐ Reduce in greenhouse gas emissions ☐ Improved resource efficiency ☐ Other (please specify): - **contribution to the regional GDP:** 90 MSEK increased tax intact

	- **cost reduction / Annual savings:** 196 MSEK disposable income - **increase in job opportunities (employment):** IPOS employs 1400 employees. - **reduce in greenhouse gas emissions:** CO_2 reduction – 130 000 t/y - **energy recover:** 96% energy recover - **improved resource efficiency:** IPOS has an extensive network for distribution of natural gas, steam, district heating, compressed air, electricity and water to the companies in the park
How would you describe the industrial eco-system deployed?	☐ Very successful ☐ Quite successful ☐ Somewhat successful ☐ A little successful ☐ Not at all successful ☐ Do not know / Do not wish to answer
Has the industrial eco-system (or aspects of it) been replicated / transferred in other areas and settings?	☐ Yes ☐ No There is no information about the implementation of the system, in Sweden there are several similar systems, for example: Industry Park of Sweden, Industrial Symbiosis in Helsingborg, Industrial Symbiosis in Enköping, Industrial Symbiosis in Stenungsund. But there are several plans regarding future possible synergies in the area that are examined by the involved companies and administrations. There are also several possibilities that were discovered by the authors during the field work and that could be of interest for further investigation. The managing of the Industry Park of Sweden tend to the creation new synergies: to produce biogas, by digesting the manure, after which the sludge could be used as a soil enhancer, to build a farming facility for mussels in Öresund and to expand the steam distribution network and thereby make it possible for them to use steam in process.

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What are the most significant features of the industrial eco-system that make it transferable?	☐ Use of standardised technology solutions and processes ☐ Needs addressed are common among industries, organisations and different regions/countries. ☐ Demonstrated achieved benefits outweigh investment costs by far ☐ Low implementation risks ☐ Small change in daily operations, low risk of organizational resistance ☐ Legal requirements ☐ Other (please specify)
Main lessons learned	- Industry Park of Sweden focuses on the development of their activities, focusing on the needs of the region, and also cooperates with companies operating in the neighbourhood. - Industry Park of Sweden is based on coordination of energy distribution of natural gas, steam, district heating, compressed air, electricity and water to the companies in the park. These material exchanges primarily take place at Kemira's production facilities, but also to somewhat minor extent between the other companies in the park. - Industry Park of Sweden as a whole is viewed as an eco-industrial park where farreaching exchanges happens that are contributing to a better environment as well as increased resource efficiency. At the site there are several relations that might be evaluated as industrialsymbiosis, as well as some exchanges, which are more doubtful in being either symbiosis or internal synergies. No matter the naming, this would be an example on utilization of byproducts as well as efficient use of resources.
Further information (URL, sources)	http://www.industriellekologi.se/documents/IPOS.pdf http://www.sebroschyr.se/IndustryParkofSweden_uk/WebView/ http://www.industrypark.se