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Input documentation for the organisation of the study visit to transfer experiences on transforming waste into by-products

Government Office for Development and European Cohesion Policy (SVRK)

Table of Contents

1 Introduction

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.

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.

This document is the first deliverable of SYMBI Activity A3.4, which includes the organisation of a study visit in Slovenia to transfer experience and best practices on waste recovery, separation and processing systems. The purpose of the study visit is to facilitate the transfer of experience, the enhancement of cohesion and the acquisition of operational and technical knowledge on how to steer policy implementation in different areas of waste management.

The input paper (to be shared beforehand) will be used as the primary source of knowledge for the exchange of experience process, prescribing the practices to be exchanged, addressing the main issues tackled by the project, and securing stakeholders' interest. In particular, the input study will:

- Present the legislative framework underlying waste management at the EU and national level.
- Highlight successful industrial symbiosis practices from across Europe (incl. Slovenia).
- Describe the financial mechanisms in place (at the EU level) for supporting industrial symbiosis projects and circular economy business models.
- Provide a list of similar projects, investigating potential synergies with SYMBI.
- Elaborate on a draft agenda with suggestions on topics and speakers.

The report is structured as follows: section 2 presents the legal barriers hindering industrial symbiosis deployment, including the framework underlying waste management; section 3 presents industrial symbiosis best practices; section 4 highlights the trends in setting up financial incentives to support symbiotic activities and encourage recycling and waste recovery; section 5 presents a list of similar projects under the Horizon 2020 and LIFE Programmes; finally, section 6 provides a draft agenda for the study visit, and suggests speakers to be invited by the hosting organisation.

2 Legislative framework for waste management and recovery

Sustainable waste management is considered as a key determinant for stimulating the emergence of secondary raw materials markets, which are kind of pre-requisition for industrial symbiosis. Sustainability in waste management does not include only using material resources efficiently to decrease waste generation but also handling/treating waste streams in such a way to promote materials reusability and recyclability. The EU makes explicit mention on the value to turn waste into resources, in order to foster the transition to a sustainable growth model (i.e. circular economy) that will gradually replace the resource intensive "take-make-use-dispose" economy. Evidence shows that only a small share (approximately 36%) is recycled and returns to the market as new products or secondary raw materials; the rest are landfilled or burned through incineration[1]. This means that the EU economy loses a significant amount of potential 'secondary raw materials' such as metals, wood, glass, paper, plastics present waste streams, considering that more than 600 million tonnes of waste (that remain unexploited) could be recycled or reused.

According to Eurostat (2011)[2], the European market for secondary materials is developing well and the intra EU-28 trade accounts for 80% of total transactions. Notwithstanding, the demand for secondary raw materials has considerably increased the recent years. This is mainly due to the introduction of new environmental regulations (or fiscal measures) for product development (e.g. eco-design, environmental labelling) that has prompted manufacturers to adopt economically-sound processes that minimise negative environmental impacts while conserving energy and natural resources (such as using secondary raw materials as input in the production). All the above highlight the need to establish an enabling policy framework that will facilitate the deployment of regional secondary raw materials markets (through sustainable waste management) towards industrial symbiosis.

The potential for creating new industrial symbiosis schemes is limited by a range of non-technical barriers such as environmental legislation, financial capacity, administrative burdens, skills and capacity and lack of information. Previous SYMBI activities demonstrate that among the most critical barriers to circular economy is the lack of effective legislation. For instance, uncertainty on definitions (e.g. waste, by-products, and recovery) or conflicting regulations (e.g. the REACH regulation[3], hygiene rules versus “best before” dates) hamper investments in capacity and technology development. This section presents the main legal barriers, hindering the valorisation of waste as input resources in industrial production processes, as well as the changes embedded in new waste regulations (under the Circular Economy Package) to address the identified shortcomings.

[1] http://ec.europa.eu/environment/waste/index.htm
[2] http://ec.europa.eu/eurostat/statistics-explained/index.php/Recycling_–_secondary_material_price_indicator
[3] REACH is an EU regulation, adopted in 2006 to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry.

2.1 Legal barriers

The main legal and regulatory obstacles, hindering the smooth development of industrial symbiosis revolve around the following issues: a) the lack of concrete definitions, b) the collection and pre-treatment of homogenous waste, c) the uptake of secondary raw materials, d) product requirements and sustainable design, and e) the absence of quality targets.

A. Lack of definitions

This barrier refers to the lack of definitions and the occurrence of gaps in the legislation concerning fundamental terms (e.g. waste, by-products, recycling, reuse and recovery), including also the lack of clarity for basic circular economy concepts such as producer responsibility, separate collection, and environmental labelling. The absence of concrete definitions act to hamper the development of an internal market for recyclables or secondary raw materials and discourage investments in industrial symbiosis, by creating an uncertainty over environmental regulations and product requirements.

Unclear and non-harmonised definitions for the different types of material (e.g. manure products) impede investments in R&D as well as in processing capacity across major industries. The problem is particularly evident in the following directives:

- Waste Framework Directive (articles for construction and demolition waste)[4]
- End-of-Life Vehicles Directive[5]
- Batteries Directive[6]
- Animal by-products Regulation[7]

For instance, practices in collecting, sorting and processing Construction and Demonstration Waste (CDW)[8] are not homogeneous in the EU. The national legislations differ significantly from country to country, prescribing diverse targets to be reached and comprising non-harmonised definitions that hinder sustainable waste management. The above make CDW management a country-specific issue, which essentially delays the emergence of secondary raw materials markets. The EU introduced the CDW management protocol (2016)[9] to address the definition gaps in national legislation and to establish a common set of technical, environmental and managerial principles applicable in the entire EU. Still, member states should make progress in terms of transposing the EU legislation into national laws.

[4] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098
[5] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32000L0053
[6] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006L0066-20131230&rid=1
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R1069
[8] http://ec.europa.eu/environment/waste/construction_demolition.htm
[9] http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8983

In addition, the EU should revise "end-of-waste" criteria and definitions in the regulation, to prevent exporting the generated waste outside the EU. According to Guardian (2013)[10], the top destination for waste is China, which in 2010 imported around 7.4m tonnes of discarded plastic, 28m tonnes of waste paper and 5.8m tonnes of steel scrap, while a big share of electrical waste ends up in developing countries such as Ghana, Nigeria, India and Pakistan. A reduction in waste exports can be realised by lessening the requirements for utilising products that have reached their end-of-life status. This is the case for plastics, where approximately 50% of the generated plastics waste in the EU is exported abroad, mainly to China. The current definitions for basic concepts related to plastic waste management (e.g. mixed-plastic, biodegradable, compostable, end-of-life status) make exports a favourable option for industries, whilst creating counter initiatives for recycling and waste recovery. For the palladium case, lacking definition for end-of-life vehicles has been seen as a major issue, allowing vehicles that have reached end-of-life status to be exported in international markets. A possible solution will be to formulate clearer definitions for the End of Life criteria to limit grey-area trade flows.

To sum up, all the above stress the need to harmonise circular economy definitions throughout all legislations, including addressing the diversity of definitions and descriptions in national regulations, so as to ensure a common understanding and accelerate the emergence of a single market for recovered materials.

Relevant legal barriers hindering the deployment of industrial symbiosis schemes comprise:

- The incomplete implementation or enforcement of EU legislation at national level. Member States fail to transpose efficiently the EU legislation into domestic laws, whilst showing low progress in reaching the defined waste management and collection targets. Lagging or incomplete national implementation is particularly evident in the context of the Waste Framework Directive[11] and the Exports and Shipment Regulation[12] (Technopolis Group, 2016).
- Conflicting regulations. This refers to the existence of regulations that represent contradicting values, for example with hygiene rules versus extending the product lifecycle, stringent material contamination limits versus the valorisation of secondary raw materials and the Restriction of Hazardous Substances Directive.

B. Lacking legislation for the collection and pre-treatment of homogenous waste streams

Waste collection is a significant stage of the waste management process in efforts to promote material reusability and resource efficiency. It refers to the process of gathering and transferring the waste or/and recyclables from the place of consumption and disposal to treatment facilities. Waste collection systems currently applied in the EU can be categorised according to a) the type of waste segregation model (e.g.

[10] https://www.theguardian.com/environment/2013/jun/14/waste-trade-china-recycling-rubbish
[11] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098
[12] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1013&from=en

single or multiple fractions, mixed waste) and b) the location of the collection system (e.g. surface containers, buried containers, door-to-door, pneumatic systems).

The EU has taken legislative action to regulate the collection and pre-treatment of homogenous waste streams (i.e. single fractions) such as batteries, electronic equipment and plastic packaging, seeking to minimise the resources (time and money) required for using recovered materials as input resources into other industrial (production) processes. The most feasible way to achieve this is to establish separate collection schemes, which means that a waste stream is kept separately by type and nature so as to facilitate a specific treatment.

Without specific legislation, multiple waste fractions may end up in the various collection systems as mixed waste; this requires additional treatment to separate the recyclable materials from non-recyclables before proceeding with waste recovery. The overall cost for sorting/recycling is much higher than the total revenues expected from using recycled materials (given their market price across the globe), making it difficult to build the business case for industrial symbiosis schemes.

Despite the progress made through a number of directives (e.g. Packaging and Packaging Waste Directive[13]) regulating the collection and pre-treatment of waste from certain products, there is still a lack of legislation to provide high quality collection and distribution systems for homogenous waste streams, ensuring thus the delivery of non-hazardous waste streams into appropriate treatment facilities. This is the case for plastics, whereas a large amount of post-consumer plastics waste ends up in energy recovery and landfilling instead of being recycled. In opposite, the recycling of copper (incl. the collection of scrap) is recognised as an established working model, supported by a well-functioning collection system that ensures the appropriate collection and pre-treatment of waste.

C. Legal implications hindering the uptake of secondary resources

This barrier refers to existing legislations that lead EU industries to focus primarily on virgin raw materials instead of the recycled ones. This is mainly due to law and legal inefficiency in integrating negative environmental externalities into products' market prices. The rationale is that the development of new products entails significant environmental costs and negative externalities (e.g. air quality, water pollution, resources scarcity, biodiversity loss, degradation of ecosystems) that are not taken into consideration by industries and consumers; as they are seeking to maximise their profitability and welfare respectively (i.e. utility function in economics).

These externalities result in market failures, which means that markets are not capable of allocating natural resources efficiently since the final price does not reflect the true costs and benefits of a product such as the impact on the environment. For example, the cost of using virgin raw materials in the production, which will eventually lead to resources scarcity, may not be reflected into product prices

[13] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0596

making this type of purchases more favourable. Evaluating the economic value of environmental costs will allow accounting for the negative impacts on the environment, whilst promoting more sustainable production and consumption patterns. Indicative solutions to correct such externalities comprise environmental regulations, quotas on natural resources extraction, taxes or charges for using primary raw materials, and removal of detrimental subsidies (see section 4.1 for more details on sustainable taxation and green tax reforms).

The absence of end-of-waste criteria or/and quality standards for some type of recyclables (e.g. manure derived products) creates legal uncertainties for industries that make it rationale to use primary raw materials, whilst hindering the creation of a single market for these materials. In addition, the standards of environmental and health protection in the EU are also comparatively high, undermining the efforts to promote the use of secondary raw materials. Recyclables' price volatility, which is particularly high - and in some cases five times greater – than price fluctuations for virgin materials that are close substitutes, is another barrier to the uptake of secondary raw materials (Eunomia, 2015). The rationale is that price volatility creates uncertainty and discourage investments towards industrial symbiosis, hampering also the emergence of regional secondary raw materials markets.

Finally, other countermeasures include a) the provision of market incentives for the production and distribution of one-off consumption goods as well as the disposal of used ones (demand-driven interventions) and b) the low implementation of green tenders through public procurement, which is considered as an enabler for circular economy (supply-driven measures).

D. Lack of concrete and enforceable product requirements

This barrier refers to the need of improving product design for reuse, repair and recycling. Theoretically, product design should follow sustainability principles to ensure that the final product will comply with environmental regulations and promote resource efficiency via effectively using natural resources, reducing waste and carbon emissions, whilst extending product lifespan and allowing for recycling.

Eco-design[14] is an approach to designing products, taking into consideration the environmental effects associated with products' development, distribution and consumption. In this context, companies employ the process of environmental lifecycle assessment (LCA) to benchmark their products' sustainability. LCA includes analysing and assessing products' environmental effects (e.g. carbon footprint, waste generation, use of natural resources) throughout their lifecycle from raw materials' extraction, production and distribution to the use, repair, maintenance, and disposal or recycling.

The consumption of natural resources can be significantly reduced by defining specific design requirements. All products should be designed to be either biodegradable or recyclable so that

[14] http://ec.europa.eu/growth/industry/sustainability/ecodesign_en

industries/companies can utilise individual components/parts as input resources in other production processes, setting the ground for industrial symbiosis and circular economy schemes.

The EU has acknowledged the need to promote better design, incorporating relevant aspects into legislation for several categories of products such as batteries, plastics and electronic equipment. Notwithstanding, concrete and enforceable product requirements to promote waste recovery and recyclability are still lacking. A typical example is the problematic enforcement of requirements of the WEEE Directive for the recyclability of electronic products, especially as concerns the disassembly of batteries. The WEEE Directive aims to contribute to sustainable production and consumption by promoting the re-use, recycling and other forms of recovery of this type of waste so as to reduce the disposal of waste and to contribute to the efficient use of resources and the retrieval of valuable secondary raw materials. To this end, the Directive dictates that manufacturers should design electronic appliances in such a way that waste batteries and accumulators can be readily removed.

Even though the Directive includes the separate collection as a pre-condition for ensuring specific treatment and recycling of WEEE waste, the problem lies in the lack of concreteness of these design requirements (i.e. battery disassembly). The description does not specify how electronic appliances should be manufactured so as to easily remove batteries without destroying the product, which is the case for a large share of these products (e.g. smart-phones, navigation systems, electronic toothbrushes). The incorporation of batteries into appliances that cannon be recharged or replaced results in the reduction of products' lifespan (i.e. eliminating its use phases), whilst increasing the generation of raw materials' waste. The Directive should be revised to specify design requirements for each product segment (such as smartphones or tablets) that will allow removing batteries without destroying the appliance or reducing its usage capacity, whilst improving batteries' recycling routes. This dimension seems to be neglected in almost all EU directives for waste materials such as plastic packaging, medicines and other electronic components.

E. Lack of qualitative targets/measures in the EU legislation

In most cases, waste legislation at the EU level focuses mostly on quantities by setting weight based collection or recycling targets, neglecting aspects related to the quality of recycled materials. These legislations do not prescribe targets for different qualities of materials to be recovered or recycled from a particular product segment, increasing the costs associated with the management of waste streams and making it difficult to measure the contribution of recycling to sustainable resource management.

The Waste Framework Directive defines quantitative targets regarding the share of waste prepared for reuse and recycling in the form of secondary raw materials. The WEEE Directive sets incremental targets in the form of minimum rates for separate collection, recovery and recycling. The proposal amending the Landfilling Directive introduced an ambitious target of restricting the share of municipal waste landfilled to 10% by 2030. Last, the updated Packaging Waste Directive sets targets for the share of various

packaging materials (such as wood or plastic packaging waste) prepared for reuse and recycling to be met by 2025 and 2030.

The EU legislation should be revised to complement the defined quantitative goals for recycling with qualitative targets, so as to establish a robust and comprehensive recycling strategy towards circular economy. The rationale is that waste streams may contain materials with different conceal density and utility, where only a small share can be used as input in the production. This means that a weigh based metric, for example, does not guarantee that the materials collected will have a high reusability/recyclability capacity. This requires not only the identification of the different uses of materials' components, but also the definition of quantitative targets based on their potential reusability/recyclability capacity and the anticipated valorisation (as input resources) in production processes. What is more, the EU legislation should prescribe all the procedures required to keep hazardous substances away from recycling routes, whilst determining the final destination for all the substances that cannot be recycled.

2.2 EU legislation on waste management (current state)

Waste management procedures in the European Union (EU) have improved considerably in the past decades; almost the one third of municipal waste is still landfilled and less than half is recycled or composted, with still large variations between Member-States (Bourguignon , 2016). The improvement of waste management would ameliorate considerably the environment, climate and human health, boost the economy and lead towards new business models, by fostering a sustainable pattern of growth based on waste recovery and materials' reuse.

The European Commission adopted in December 2015 an ambitious Circular Economy Package[15] aimed at nudging the EU towards a lean "circular economy". The Package explicitly highlights the need to unleash the potential of symbiotic synergies that will set the ground for a circular economy pathway. More particularly, the Package includes revised legislative proposals on waste management that seek to reduce waste to a minimum as well as to promote re-use, repair, refurnish and recycling of existing materials and products. In short, what is considered to be "waste" will be turned into a valuable resource. The management of resources in this more efficient manner, throughout their life cycle, is expected to not only to reduce pressure on the environment and enhance the security of supply of raw materials, but also bring significant economic growth and generate job opportunities. A better eco-design, waste prevention and reuse can bring net savings the EU business of up to €600 billion, while it is expected to reduce annual greenhouse gas emissions. Further to the four legislative proposals, the Package also includes a communication (Action Plan for the Circular Economy - Closing the Loop[16]) to complement the policy measures deriving from the legislative proposals with the introduction of the key actions. The proposed

[15] http://ec.europa.eu/environment/circular-economy/index_en.htm
[16] http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52015DC0614

actions will contribute to of the amelioration of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy.

The Circular Economy Package can prove to be a landmark in the creation of a more resource-efficient and competitive economy for Europe, paving the way for stronger EU engagement in order to enhance sustainable development goals. Recognising the opportunity to increase efficiency gains, can invite more innovation initiative within Europe. The relevant discussions have been focused on the end-of-life products, when the concept of resource efficiency includes everything from raw materials sourcing to end-of-life management. The debate should go beyond new recycling targets, landfill bans on recyclable waste or the lack of proper waste management infrastructures in the member-states, in order to address the entire product life-cycle. The Circular Economy package intends to increase recycling levels and tighten rules on incineration and landfill. However, the question is whether the new package will deliver and to what extent will benefit the European economy, if it will have an impact on the single market and how it can reconcile industrial environmental policy agendas. Most importantly, will all stakeholders be convinced about the benefits of resource efficiency and work together towards implementation discrepancies? In any case, progress towards a more circular economy and the effectiveness of action at the national and EU level will continue to be regularly monitored.

The Action Plan establishes a concrete and ambitious programme of action by introducing measures that cover the whole cycle of waste management, and also contribute to meeting the United Nations Sustainable Development Goals (SDG) adopted in 2015 and in particular Goal 12 on sustainable consumption and production. Key actions, both legislative and non-legislative, put forward in the action plan include: the reduction of food waste, the development of quality standards, measures in the eco-design working plan 2015-2017, a regulation on fertilizing products, a strategy on plastics, water re-use and waste water and a fitness check on eco-label.

More specifically, the key actions included in the action plan can be categorised as follows:

- **Actions to reduce food waste**, including a common measurement methodology, improved date marking and tools to meet the global Sustainable Development Goal to halve food waste by 2030;
- **The development of quality standards for secondary raw materials**, where they are needed – especially when plastics are concerned – and the proposal of improvements to the rules of the "end-of-waste";
- **Measures in the Eco-design working plan for 2015-2017**, in order to promote reparability, upgradability, durability and recyclability of products, in addition to their energy efficiency; as well as economic incentives for better product design through producer responsibility;
- **A new regulation on fertilising products**, which will encourage nutrient recycling while ensuring the protection of human health and the environment;
- **A strategy on plastics in the circular economy**, addressing issues of recyclability, biodegradability, the presence of hazardous substances in plastics and the Sustainable Development Goals target for significantly reducing marine litter;

- **Series of actions on water reuse**, including a legislative proposal on minimum requirements for the reuse of wastewater, e.g. for irrigation and groundwater recharge and
- **A fitness check of consumer legislation for the Eco-label**, followed by actions to enhance its effectiveness

When it comes to secondary raw material, the European Commission has pledged to undertake a series of actions for stimulating the emergence of relevant markets and supporting industrial symbiosis deployment. The rationale is that the use of secondary raw materials presents a number of advantages, such as increased security of supply, reduced material and energy use, reduced impacts on the climate and the environment, and reduced manufacturing costs. However, the envisioned valorisation faces a number of barriers that the EU is hoping to overcome with this action plan. In particular, the proposal targeting secondary raw materials is expected to a) develop quality standards for the use of secondary materials and in particular for plastics starting 2016, b) to analyse policy actions that address the interface between chemicals, products and waste legislation, including how to reduce the presence and improve tracking of chemicals and in products by 2017, c) to take measures to facilitate waste shipment across the EU, including electronic data exchange starting 2016 and further develop the EU raw materials information system. In the EC's resolution of July 2015 on resource efficiency, the European Parliament called on the Commission to "develop measures to incentivise and facilitate the development of markets for high-quality secondary raw materials and the development of business based on the reuse of secondary raw materials".

The proposal amending the Packaging Directive sets new clear targets to be met by 2025 and 2030 for the share of packaging waste prepared for reuse and recycling (65% and 75%, respectively) and more specific targets for various packaging materials (plastic, wood, ferrous metal, aluminium, glass, paper and cardboard). The proposal aligns definitions with other legislative acts, introduces an early warning system for monitoring progress towards the targets, clarifies methods used to calculate progress towards targets, simplifies and streamlines Member-States' obligations as regards reporting and improves the quality and reliability of statistics.

The following **legislative proposals on waste** have been adopted:

A. Proposed Directive on Waste (amending 2008/98/EC on waste[17])
B. Proposed Directive on Packaging Waste (amending Directive 94/62/EC on packaging and packaging waste[18])
C. Proposed Directive on Landfill (amending Directive 1999/31/EC on the landfill of waste[19])
D. Proposed Directive on electrical and electronic waste, on end-of-life vehicles, and batteries and accumulators and waste batteries and accumulators (amending Directives 2000/53/EC on end-of-

[17] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098
[18] http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:31994L0062
[19] http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A31999L0031

life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment).[20]

These proposals are expected to bring economic and environmental benefits but also generate costs. Bourguignon (2017) suggests that the four legislative proposals will a) create over 170.000 direct jobs in the EU by 2035, b) reduce greenhouse gases emissions, c) increase the competitiveness of the EU waste management, recycling and manufacturing sectors, d) reduce the dependency of the EU on raw material imports, and e) minimise the administrative burden. On the other hand, a cost of approximately €108 billion would most likely fall on public authorities, businesses and ultimately consumers. The Commission indicates, however, that the proposals will not have an impact on the EU budget.

A. Directive on Waste (Proposal 2015)

The proposal (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0595) amending the Directive 2008/98/EC on Waste, ultimately, facilitates the review of waste management targets set in the original directive by the provision of additional definitions regarding "waste", by the inclusion of procedural activities and operations regarding the preparation for re-use, as well as the final recycling process and backfilling process. Additionally to the definitions provided, it includes adopting actions for the definition of existing waste and ceased waste. Moreover, it introduces the mechanism of a "producer responsibility scheme" underlying the role of the Member-States and the definition of potential measures to be taken. Most importantly, the directive introduces measures for the prevention of waste and the subsequent procedures for the Member-States to monitor activity and suggestions on how to sort national systems for construction and demolition. The proposal empowers the role of the Member-States to ensure the procedures of waste management in several phases, such as recycling, composting, digestion and treatment activities, as well as prevention programmes. Without excluding the Commission's proportionality, the directive underlines the role of the Member-States for the overall management of waste. The directive is expected to facilitate industrial symbiosis through the facilitation of waste management procedures for EU companies and the simplification of the legal framework for by-products and the end-of-waste criteria. Last but not least, the directive provides a framework that enables the Member-States to develop a stronger role in the management of waste, which responds to the inadequate national implementation of the relevant EU legislation to date.

The proposal updates the targets defined in Directive 2008/98/EC to address member states' shortcomings and promote materials' recyclability, as follows.

- The share of non-hazardous construction and demolition waste prepared for reuse, recycling and back-filling to be increased to a minimum of 70% by weight until 2020.

[20] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0593

- The share of municipal waste prepared for reuse and recycling to be increased to a minimum of 60% by weight until 2025.

Ultimately, the achievement of the aforementioned waste management targets is expected to a) create more than 170.000 direct jobs by 2035, most of them impossible to delocalise outside the EU, b) reduce GHG emissions by more than 600 million of tons of greenhouse gas between 2015 and 2035, c) contribute to the competitiveness of the EU waste management and recycling sector and the EU manufacturing sector and d) enhance the EU economy of secondary raw materials that will eventually reduce dependency on raw materials imports.

B. Directive on Packaging Waste (Proposal 2015)

This Directive (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0596) sets measures and targets to prevent or reduce the impact of packaging and packaging waste on the environment, such as reducing the consumption of lightweight plastic carrier bags. The proposal amending the Packaging Directive sets specific targets for the share of packaging waste prepared for reuse and recycling to be met by 2025 and 2030, as well as for the different packaging materials.

- The share of all packaging waste prepared for reuse and recycling to be increased to 65% by 2025 and subsequently to 75% by 2030;
- The share of all plastic packaging waste prepared for reuse and recycling to be increased to 55% by 2025;
- The share of wood packaging waste prepared for reuse and recycling to be increased up to 60% by 2025 and 75% by 2030;
- The share of ferrous metal packaging waste prepared for reuse and recycling to be increased up to 75% by 2025 and 85% by 2030;
- The share of aluminum packaging waste prepared for reuse and recycling to be increased up to 75% by 2025 and subsequently 85% by 2030;
- The share of glass packaging waste prepared for reuse and recycling to be increased up to 75% by 2025 and 85% by 2030;
- The share of paper and cardboard packaging waste to be increased up to 75% by 2025 and 85% by 2030.

Additionally, the proposal aims to introduce new procedures regarding the shipping of packaging waste between the Member-States, as well as regarding the calculation of the targets attained on the measurement of waste weights; to establish minimum quality and operational requirements for the determination of recognised preparation for re-use operators and deposit-refund schemes, including specific rules on data collection, verification and reporting; to establish minimum quality and operational requirements for the determination of recognised preparation for re-use operators and deposit-refund schemes, including specific rules on data collection, verification and reporting, by the Member-States; to enhance the role of the Member-States in the reporting of the data to the Commission and clarify the

role of the Commission in the exercising their delegated power. The directive demonstrates contractual progress towards the role of the member-states in the process of waste management and adds on the effort to provide concrete definitions of waste in this context and it thus strengthens the industrial symbiosis market through the simplification of procedures.

C. Directive on Landfill (Proposal 2015)

The Landfill Directive (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0594) defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. The Directive aims to stimulate a progressive reduction of landfilling, which is necessary to prevent detrimental impacts on human health and the environment and to ensure that economically valuable waste materials are gradually and effectively recovered through proper waste management and in line with the waste hierarchy. The targets laid down in the Council Directive 1999/31/EC setting landfill restrictions should be amended to make them better reflect the Union's ambition to move to a circular economy and make progress in the implementation of the Raw Materials Initiative by reducing landfilling of waste destined for landfills for non-hazardous waste. To this end, the Directive is seeking to achieve the gradual limitation of the landfilling of municipal waste to 10% by 2030, through a number of article amendments that regard the definitions of waste, the targets and procedures followed by the Member-States to ensure the amount of the municipal waste landfilled by 2030, the extension of time given to 7 EU countries (Estonia, Greece, Croatia, Latvia, Malta, Romania and Slovakia) to reach the target of 10% reduction, new warning, reporting as well as new exercise of delegation procedures to be followed by the Member-States. In this directive, the different categories of waste that apply to landfills are defined, prompting the Member-States to drastically reduce landfilling. Furthermore, to address the incomplete implementation of enforcement, new procedures on warning, reporting and delegating duties are introduced for the Member-States to follow.

D. Directive on electrical and electronic waste, on end-of-life vehicles, and batteries and accumulators and waste batteries and accumulators (Proposal 2017)

The Directive (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0593) is part of a larger amendment addressing the management of different wastes, such as electrical and electronic waste, vehicles, batteries and accumulators, seeking to promote industrial symbiosis and circular economy. In view of the new waste management objectives, the protection and preservation of the environment and the human health, the EC amended the regulatory context of waste management procedures, including statistical data collection, reporting, compliance and national enforcement. Notably, the management of waste in the Union shall be achieved on a regional level and in accordance with the principles of subsidiarity, but with the indispensable support of the Member-States. More specifically, this directive amends a) the reporting period for the Member-States increasing 18 months within the reporting period, when the electronic data is collected, b) the reporting format by introducing

a standard format of reporting by the EC and c) the assessment of these reports by the EC on a certain list of criteria. Additionally, it highlights the responsibility and concrete obligations of the Member-States regarding the procedures of data and quality reporting, as well as the enforcement of the laws, regulations and administrative provisions in their national framework. By the provision of additional reporting procedures, the directive closes gaps in the legislation concerning the implementation of enforcement and the role of the Member-States to transfer the EU legislation into domestic laws and monitor their progress effectively. The earlier directive on WEEE (2012) has addressed the prior lack of precise product requirements by enhancing the rules around product design, and setting the framework regarding information & reporting of EEE producers and all relevant requirements. This is also expected to have a direct impact on product design for repair, re-use and recycling and set the ground for industrial symbiosis schemes.

Table 1: The legal barriers addressed by new waste regulations

Barriers / Directives	*A. Proposal on waste*	*B. Proposal on packaging*	*C. Proposal on landfill*	*D. Proposal on WEEE*
Lack of definitions and other legal barriers	X	X	X	X
Lacking legislation for the collection and pre-treatment of homogenous waste streams		X		
Legal implications hindering the uptake of secondary resources			X	X
Lack of concrete & enforceable product requirements				
Lack of qualitative targets/measures in the EU legislation	X			X

The proposal on Waste amends Article 3 to provide up-to-date definitions for “municipal waste”, “non-hazardous waste”, “bio-waste”, “construction and demolition waste”, “preparing for reuse”, final recycling process” and “backfilling”. In addition, the proposal makes explicit mention on the value to establish at the EU level harmonised conditions for substances or objects to be recognised as by-products and for waste that has undergone a recovery operation to be recognised as having ceased to be waste.

Finally, Article 11a prescribes rules on the calculation of the attainment of waste management targets based on qualitative characteristics such as “the weight of the municipal waste recycled shall be understood as the weight of the input waste entering the final recycling process”.

The proposal on Packaging, seeking to align definitions across the EU regulations, dictates that the definitions for “waste”, “municipal waste”, “hazardous waste”, “waste producer”, “waste holder”, “waste management”, “separate collection”, “recovery”, “recycling” and “disposal” laid down in Article 3 of the Directive 2008/98/EC shall also apply for the segment of packaging waste. What is more, the proposal introduces a concrete definition for “packaging waste” to address the identified gap in the previous directive. Furthermore, the proposal asks from member states to bring into force the laws, regulations, and administrative provisions prescribed in the directive to facilitate the collection and pre-treatment of homogenous waste. Indicatively, Article 6b states that “the weight of the packaging waste prepared for reuse shall be understood as the weight of packaging waste that has been recovered or collected by a recognised preparation for re-use operator and has undergone all necessary checking, cleaning and repairing operations to enable re-use without further sorting or pre-processing”.

Similar to the proposal on Packaging, the updated Directive on Landfill makes the necessary amendments to promote the alignment of definitions. The descriptions for basic “circular economy and waste management” concepts have been updated to be in line with the definitions laid down in the Directive on Waste. Furthermore, the setting of landfill reduction targets aims to further facilitate separate collection, sorting and recycling of waste, and to avoid locking potentially recyclable materials at the bottom of the waste hierarchy. The counter effect (i.e. the appropriate waste collection and treatment) will facilitate the valorisation of secondary resources, preventing the extraction of natural resources and stimulating the emergence of relevant markets.

Finally, the proposal amending the Directive on WEEE attempts to close the gaps related to incomplete implementation of the EU legislation at national level, by prescribing new reporting procedures and requirements to guarantee the successful implementation and monitoring of the adopted measures (Article 1). Previously, the Directive on WEEE called member-states to introduce concrete eco-design requirements that will facilitate WEEE products’ re-use, dismantling and recovery (incl. their components and materials).

2.3 Field experts to be invited by the hosting organisation

Field expert #1	**Joanna Drake**
Name	Joanna Drake
Organisation	European Commission
Education	Master in European Legal Studies
Position	Deputy Director-General, Directorate-General Environment
Profile and experience	Joanna Drake holds a Law degree from the University of Malta and a Master's degree in European Legal Studies from the College of Europe. Until 2005, she worked as a Head of the Legal and Regulatory Department of Vodafone Malta and between 2010 and 2015, she served as a Director for SME's and Entrepreneurship (DG GROW) and as a Principal Adviser, Chair of Task Force on The Collaborative Economy for New Business Models and SME's between 2015 and 2016. As of March 2016, she is the Deputy Director-General in charge of coordination of the resource-efficiency policies and instruments in DG Environment (ENV). During the EU Green Week, Ms. Drake chaired the TEDx session on sustainable employment, highlighting the existing variety of the green scene from agriculture and construction to manufacturing and waste management and showcasing the support of the European Commission to similar environmental projects.
Phone number	+32 22997859
Address	Avenue de Beaulieu 5, 1160 Auderghem, Belgium
Email:	Joanna.drake@ec.europa.eu
Website:	https://ec.europa.eu/info/departments/environment

Field expert #2	**Jean-Marc Boursier**
Name	Jean-Marc Boursier
Organisation	SUEZ
Education	Master in International Finance
Position	Vice-president
Profile and experience	Jean-Marc Boursier holds a Civil Engineering degree from Telecom Sud-Paris and a Master's degree in International Finance from the HEC Paris. He joined the SUEZ group in 1999 as financial controller for SITA France, then became Head of Financial Control and Mergers & Acquisitions for SITA in 2001 and finally Director of Planning and Control for Suez Environment in 2002. In 2004, he was appointed as Chief Financial Officer for Suez Environment. In April 2013, he was appointed as Deputy CEO, being in charge of Finance and Purchasing, whilst he had the supervision of SAFEGE, which is Suez Environment's engineering subsidiary. Since 2015, Mr. Bousier has been the Group Deputy CEO for the Recycling and Recovery segment in Europe. During the Circular Economy Summit, Mr. Bousier participated in a roundtable on the management of plastic in cities, where he highlighted the importance of recovering plastic in Europe and presented some of the best practices of SUEZ to recycle the plastic generated and give it new uses.
Phone number	+33(0)158812000
Address	Tour CB 21 16, place de l'Iris 92040 Paris La Défense Cedex France
Email:	jean-marc.boursier@suez-env.com
Website:	https://www.suez.com/en

Field expert #3	**Daniel Calleja Crespo**
Name	Daniel Calleja Crespo
Organisation	European Commission
Education	Master Degree in Law
Position	Director General For DG Environment
Profile and experience	Daniel Calleja Crespo holds a Law degree from the University of Comillas and subsequent Master's degrees from the Universities of Comillas, City of London Polytechnic and Complutense Madrid. In 1995 he was appointed Head of Cabinet of the Commissioner for Institutional Affairs, Audiovisual Policy and Relations with the E.P. and later became Head of Cabinet of the Vice-President of the European Commission in charge of Transport and Energy. Between 2004 and 2011, he served as a Director for Air Transport at the European Commission (TREN/MOVE) and subsequently as a Deputy Director - General of the DG Enterprise and Industry (ENTR) and SME Envoy. Between 2012 and 2015, he served as a Director-General at the DG Internal Market, Industry, Entrepreneurship and SMEs (GROW) and SME Envoy. As of September 2015, he is the Director - General for DG Environment (ENV). During the presentation of the EC country report on the environmental legislation, Mr. Daniel Calleja pointed that environmental protection is very important for the EU citizens and therefore a priority for the European Commission, however the correct implementation can be a challenge for most EU Member-States.
Phone number	+32 22961386/50920
Address	Avenue de Beaulieu 5, 1160 Auderghem, Belgium
Email:	daniel.calleja-crespo@ec.europa.eu
Website:	https://ec.europa.eu/info/departments/environment

3 Industrial Symbiosis (IS) good practices

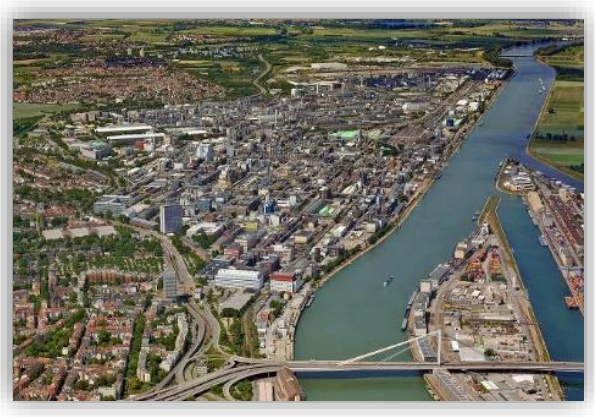
This section presents a series of industrial symbiosis good practices to be (potentially) presented in the two-day study visit, to be held in Slovenia. A good practice can be defined as a symbiotic initiative that a) addresses a common problem or issue experienced by different organisation and industries (i.e. waste management and recovery), b) makes an original contribution to a shared problem; c) has been proven successful by providing measurable impact in terms of economic and environmental performance and d) can be easily replicated into other organisational or regional settings.

The selection of additional good practices (included in this input documentation) has been based on the following criteria.

I. **Type of cooperative activity** amongst the actors (e.g. companies, research institutes, utilities) involved in the industrial ecosystem. To be thematically aligned with the study visit, the research had a primary focus on the identification of industrial symbiosis and synergetic schemes that facilitate the exchange of waste and by-product materials.
II. **Level of deployment**. The cases present integrated industrial symbiosis schemes, where companies are situated in close proximity to create economies of scale, by interlinking all the resources and actors involved in the manufacturing process.
III. **Geographic location**. Good practices were retrieved from two countries represented in the project consortium (i.e. Slovenia and Finland) and three European countries (i.e. Germany, Belgium and Iceland), which are advanced in the field of industrial ecology and have accumulated substantial experience over the years in the implementation of symbiotic synergies.
IV. **Results.** This criterion refers to the number, type and character of the results produced by the specific industrial symbiosis scheme. All cases presented below have earned considerable economic and environmental achievements in terms of cost reduction, increased productivity for the participating companies, enhanced employment, improved resource efficiency and social welfare.
V. **Transferability.** This refers to eco-industrial system's potential or proven record of being transferred to different geographical contexts and industries. All cases can be easily applied in other regions and production processed due to a) the needs addressed are common among industries, organisations and different regions/countries and b) the demonstrated achieved benefits outweigh investment costs by far.

The first two cases (i.e. BASF Verbund and Kaiserbaracke) have been retrieved from the pool of 48 good practices, collected for SYMBI A1.4. These cases are considered the most appropriate to be discussed during the two-day study visit, as they demonstrate high transferability potential and are particularly successful. The rest are the fruits of the secondary research carried out (for the needs of this report), in an effort to identify additional successful industrial symbiosis practices from Slovenia and other European countries.

3.1 BASF Verbund Industrial Symbiosis (Germany)



BASF Verbund, located in the heart of Europe's Rhine-Neckar metropolitan region, is an industrial symbiosis system initiated by BASF (a leading German company operating in the chemical industry), with the aim to create efficient value chains for industry through advanced synergies and symbiotic relationships. The "Verbund site Ludwigshafen" is the largest chemical cluster for supporting the manufacturing of complex and highly refined chemical products such as petrochemicals, detergents, body care products and fertilisers. The facility is home to several production plants, corporate units (e.g. company's headquarters), research centres, business support centres, and companies that are directly and indirectly associated with the chemical industry.

The BASF Industrial Symbiosis is a business-led programme, responding directly to the needs of the company and the chemical sector. The underlying idea was to create an integrated chemical site that will connect all the resources and actors involved in the manufacturing and delivery process (e.g. production plants, technical knowledge, energy and materials flows, public infrastructures, intermediaries and customers) in a smart way to improve resource efficiency, reduce ecological footprints, diminish production costs and increase companies' competitiveness and profitability.

From a circular economy perspective, the BASF Verbund is designed to foster the efficient consumption of energy resources and materials by promoting waste prevention, re-use, repair, remanufacture and recycling across all actors involved in the manufacturing process. For instance, the excess heat produced in one plant can be re-used as energy in another production facility, while industry by-products and residuals can be used as input resources in the production by other companies.

Industrial symbiosis in Verbund is realised through the following ways:

- Exchanging raw materials, energy and by-products through an extensive network of pipelines, roads and railway trucks that allows for the efficient and rapid delivery/exchange of input resources. The system seeks to diminish the consumption of natural resources and minimise carbon emissions thanks to chemical processes implemented with low energy inputs and high yields.
- Providing joint facilities to reduce production costs and stocks. The cluster provides a shared warehouse to centralise logistics, seeking to decrease the cost of shipping and transportation. To further optimise transportation, the BASF Verbund has integrated the entire system into a single 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).

- Knowledge and experience sharing through effective networking and collaboration among the employees and executives of participating entities, to guarantee easy access to available data, information and scientific knowledge. This dimension was mostly facilitated during the implementation of the "BASF 4.0" programme on fostering the digital transformation in the chemical sector. All employees get access to the necessary information via authorised accounts and QR codes.
- Fostering close cooperation with the research community to a) deliver R&D activities that will enable to optimise business and plant production processes by ensuring technological readiness and integrating technological improvements in the running and design of site's production plants and b) constantly conduct chemical analyses that will lead to the development of high-value products such as coatings and crop protection agents. This dimension includes also the delivery of training for current and future employees to help them keep up with the latest technological developments, contributing also to the diffusion of know-how across the BASF network.
- Working closely with intermediary bodies and customers so as to keep an eye on market developments and dynamics that will enable to identify emerging needs/gaps and better align technologies with markets. This also helps companies to gain practical insights into their products' effectiveness and usability by receiving direct feedback from end-users. An example of this cooperation is the development of a smart for vision concept car by Daimler and BASF.

Industrial symbiosis activities in Ludwigshafen have considerably increased participating companies' productivity and profitability (mostly through a decrease in logistics and transportation costs). Data shows that more than 8000 chemical related products (with a total volume of 8.5 million tonnes), made with secondary raw materials, are being produced in Ludwigshafen complex every year. The system has also significant environmental benefits, allowing for annual savings up to 1.5 million tons in oil consumption as well as a reduction in carbon emissions of 3.4 million tons per year. Finally, the industrial system contributes in jobs creation and regional employment, currently employing 35972 people from the surrounding cities.

The main success factors are the close proximity of companies combined with the same organisational culture to promote resource efficiency and sustainable growth. Another significant reason was the favourable geographical location and the accessibility to raw materials and energy resources. Companies have direct access to the Rhine River using transhipment facilities, direct rail with intermodal transport terminal, and motorway access. Private sector investments in a) developing new facilities or/and modernising existing ones, b) services and utilities to support the exchange of waste streams and energy, and c) the supply of raw materials when necessary have also contributed in the smooth operation of the industrial symbiosis system. Finally, the role of public authorities is also seen a key determinant for Verbund's success, as they supported the creation of public-private partnerships in the field of education, provided preferential loans for the construction of new facilities, and facilitated the development of the transportation system.

Contact details	
Name	Martin Brudermüller
Organisation	BASF
Position	Vice Chairman of the Board of Executive Directors and CTO of BASF, Ludwigshafen
Phone number	n/a
Email	martin.brudermuller@basf.com
Website	https://www.basf.com

Contact details	
Name	Michael Wadle
Organisation	BASF
Position	Executive for Chemicals in Central Europe
Phone number	+49 621 60-41685
Email	michael.wadle@basf.com
Website	https://www.basf.com

3.2 Kaiserbaracke Industrial Ecosystem (Belgium)

The Kaiserbaracke industrial ecosystem, located within the commune of Amel (Wallonia), emerged as a collective approach to improve economic and environmental performance through the use of by-products as substitutes for raw materials and conventional energy. It was between 2004 and 2005, when four companies operating in the wood and cogeneration sector decided to replace the previous energy supply (i.e. fossil fuels) with alternative, more sustainable sources. This need was driven by the fact that the industrial site (where companies were operating) was not connected to the natural gas network, the increasing price of fossil fuels, and companies' limited access to raw materials. To overcome these issues, the companies proceeded with the construction of a cogeneration plant; a system of biomass utilisation that burns wood residuals to supply the companies with heat and electricity.

Industrial symbiosis activities in Kaiserbaracke are carried out through a specific material flow network, which allows for utilising wood residuals as input for the production of energy. This process works as follows. Holz Niessen, a timber sorting company, engages with wood sorting and separation into different qualities. Half of this amount is sold (by Holz Nielsen) to the Belwood sawmill, where 50% of the wood is turned into finished and semi-finished products, with the remainder being bark, sawdust, and scrap wood. The sawdust is then partially transformed to pellet thanks to Delhez Bois Company, while the uncontaminated wood by-products feed the wood boiler operated by Renogen. Heat is used both to produce pellet in Delhez and wood plank in Belwood by drying sawdust. Finally, the surplus heat is sold to the public power utility for providing electricity and hot water to residential buildings.

Today, the Kaiserbaracke IS includes 7 companies, while since 2009 the plant has been expanded to include a second wood boiler and an emergency diesel boiler to produce more energy using agricultural waste and by-products, in an effort to secure energy supply in the site. The symbiosis has managed to address its main objectives and goals (such as the promotion of the use of sustainable bio-energy resources, and the reduction of CO_2 emissions), without significant problems during its application. Companies' close proximity, openness and commitment to collaborate for securing their energy supply (though alternative solutions based on waste recovery) are considered as the key success factors. The symbiosis has been founded on mutual trust and fruitful collaboration between the participating companies that have made the development of the symbiosis-system possible. Another success factor was the economic viability of IS investments (e.g. the construction of the cogeneration plant). Thanks to sound financial planning (in the design stage) and adequate funding by banks and internal capitals, the participating companies managed to reach their economic and environmental targets. Finally, the absence

of legal barriers, stemming from the simplicity of the legal frame to specify the market mechanisms for energy production and distribution should be also highlighted.

The industrial symbiosis has created significant economic benefits, including the reduction in production costs through the use of alternative (and more affordable) sources of energy stemming and the increase in productivity and profitability resulting from selling the surplus heat to the public electricity network. In environmental terms, the cogeneration unit a) makes it possible to substitute over 10 million litres of heating fuel at an annual basis, b) supplies enough electricity to power the equivalent of the annual consumption of 20,000 households, and c) contributes in the reduction of CO2 emissions, which are estimated to over 55,000 tonnes saved every year.

Contact details	
Name	Filip Lesaffer
Organisation	4EnergyInvest
Position	Chairman
Phone number	080 54 01 50080
Email	info@4energyinvest.com
Website	www.4energyinvest.com

3.3 ECONYL Regeneration System (Slovenia)

The ECONYL Regeneration System is an industrial process focused on the production of nylon yarn from regenerated waste materials. The System was created by the "Aquafil Group" (a global leader in the synthetic fibers industry) in 2011 and represents an innovative and sustainable way to manufacture products from waste in a closed cycle. The Regeneration System allows the transformation of nylon waste such as fishing nets and other discarded materials into high quality nylon for the production of apparel and other textile products. The regenerated nylon yarn is called "ECONYL" and has the same qualities as virgin nylon made using fossil raw material.

The industrial eco-system brings together production enterprises, waste management and collection companies, public institutions, consumers associations and research institutes from all over the world to form a global network of partners, engaged with the collection and pre-treatment of waste materials made from Polyamide 6 (e.g. carpet fluff, rigid textiles) to pave the way for waste recovery and regeneration. ECONYL's primary objectives include a) preserving natural resources (e.g. raw fossil materials) by shifting the focus towards renewable sources and reused materials, b) recovering Polyamide 6 waste streams that would otherwise end up in landfills or the nature, c) reducing manufacturing activities' ecological footprint, d) creating economic savings by diminishing production costs through materials reuse, and e) creating a positive attitude towards sustainable, ecological products, promoting recycling and sustainable consumption patterns.

ECONYL's circular economy approach comprises 6 stages:

I. **Waste collection**. The Nylon 6 waste is collected from all over the world to be sent for preparation to the ECONYL waste treatment centre, located in Ajdovščina, Slovenia. Waste collection is currently facilitated by three different projects/initiatives; a) the ECONYL Reclaiming Program, which works on expanding the collection network to new areas across the globe, b) the Healthy Seas Program, which includes the recovery of fishing nets by volunteer divers, and c) the Net-Works Programs, engaged with empower coastal communities to collect and sell discarded fishing nets.
II. **Waste preparation**. This process, taking place in the ECONYL waste treatment centre, involves cleaning the different types of waste material to get prepared for regeneration. The cleaned nylon waste is shredded, compacted, bagged and transported to the ECONYL regeneration plant in Ljubljana. All other than Nylon 6 materials are removed and transferred to other industries, where they can be used an input resources in production processes.

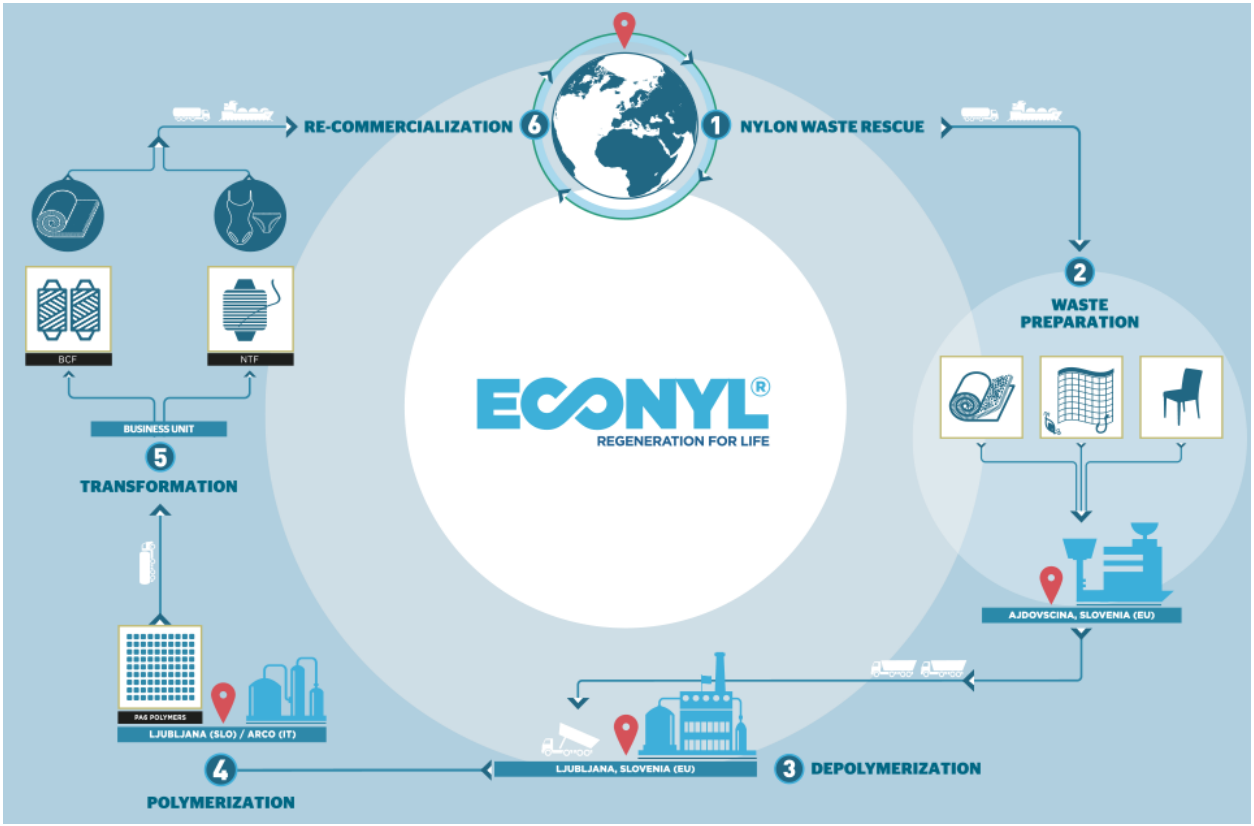
III. **Depolymerisation**. This process allows to remove all the useless properties from waste streams to keep a high ratio of nylon output (i.e. caprolactam) compared to the waste input. This is realised via a chemical recycling process that enables to regenerate raw materials that have the same chemical attributes as caprolactam from raw fossil material.

IV. **Polymerisation.** The next stage includes transforming the regenerated caprolactam into Nylon 6 polymers so that it can be used as input for the manufacturing of textile products.

V. **Transformation**. The Nylon 6 polymers produced from caprolactam are distributed to company's production facilities to be processed into carpet and textile yarns. The new products have a high degree of recyclability, allowing for regenerating over and over again without any loss in quality.

VI. **Commercialisation**: The main outcome of the aforementioned procedure is two different types of high quality yarn: a) carpet yarns to be used as input for manufacturing synthetic carpet floorings, and b) textile yarns that are used for garments such as sportswear, swimwear, and socks. All the products to be made from regenerated yarns should comply with the sustainability principles covering the entire production process (incl. product design and packaging). The production cycle closes with the collection and regeneration of post-consumer waste.

Figure 1: The "ECONYL" circular economy approach (Source: www.econyl.com)



The ECONYL Regeneration System is an excellent example of the industrial symbiosis paradigm for waste recovery and by-products reuse. This system has achieved several environmental/economic benefits for the fibre industry such as promoting the sustainable exploitation of natural resources through the development of regenerated raw materials, extending textile products' lifecycle and recyclability, reducing negative environmental impact, diminishing production cost and increasing companies' profitability. The main results are summarised as follows:

- Since its operation, 70,000 barrels of crude oil have been saved due to avoiding extraction of natural resources.
- Since its operation, 57,000 tons of CO2 emissions have been prevented/saved.
- 1,012,000 gigajoules have been saved due to a significant reduction in primary energy demand.
- 26,000 tons of pre- and post-consumer waste are being collected every year.
- 20,000 tons of regenerated caprolactam are being transformed into yarn every year.

Key factors that contributed to this success are the diversity of actors involved in the collection and pre-treatment process, the collaboration with new partners such as NGOs or companies from other industries to allow the utilisation of other than Nylon 6 waste in the production, the adequate funding (through mostly internal capitals) that allowed investments in R&D and infrastructures, and most importantly the high quality of regenerated materials that remain competitive with other fibres across the BCF (fibres for textile floorings) and NTF (fibres for the apparel and sport industries) sectors.

Contact details	
Name	Michele Prencipe
Organisation	Aquafil
Position	Director of Aquafil S.p.A.
Phone number	+386 1 5842200
Email	info.aquafilslo@aquafil.com
Website	http://www.aquafil.com/

3.4 CELCYCLE Programme (Slovenia)

The CELCYCLE Programme (http://celkrog.si) is not an established industrial eco-system but a national initiative to promote bio-economy in Slovenia by employing a circular economy approach for the exploitation of biomass resources. The Programme, funded by the European Regional Development Fund (ERDF), aims to explore the potential of biomass resources (in the form of wood biomass, agricultural by-products and green residuals) to be used as alternative source of energy or/and raw materials for the development of advanced materials and bio-based products.

The Programme will promote this circular economy approach by a) elaborating on new sustainable technologies for manufacturing new bio-based materials, b) promoting waste recovery and materials reuse, and c) creating integrated value chains to ensure materials' recyclability and reusability across all sectors and industries. The Programme brings together 21 partners from the dominant industries in Slovenia (e.g. forestry, textile, chemical, textile, wood processing, automotive, advanced manufacturing, construction, engineering and energy) to establish cross-sectoral synergies that will facilitate the utilisation of biomass resources. Programme's particular objectives include:

a) Developing a database on the availability, characteristics and usability of the various types of biomass
b) Designing advanced procedures for biomass fractionation
c) Conceptualising effective methods for nanocellulose production from various types of biomass
d) Elaborating on treatment technologies for improving fibres and materials' functional properties
e) Promoting the production of fibre webs and bio composites
f) Delivering sustainable treatment methodologies for solid waste and materials recovery
g) Exploiting the potential for energy recovery from waste streams

The Programme comprises 5 thematic sessions to promote bio-economy, two of which are strictly associated with industrial symbiosis and circular economy. More precisely, the 4th session includes the design of waste treatment methodologies to promote the biological and mechanical processing of solid waste. The aim is to extract secondary raw materials from biomass resources that can be used as input for manufacturing products that will deliver added value to the market. To this end, the consortium aims to develop innovative technologies that will facilitate the processing of waste streams that have been generated through biomass fractionation. For instance, these technologies can be applied for the treatment of mushrooms and other fungi by-products or residuals, allowing to extract their enzymes for improving industrial processes, especially in paper recycling. The Programme will design and implement a validated process with parameters for enzyme production and their valorisation in the production. To further promote waste recovery and material reuse, the programme will explore the possibility to valorise the waste generated from biological decomposition and consortium partners' production activities in the

construction sector. This will be realised via the establishment of a dedicated network for the collection and pre-treatment of waste streams, which are appropriate for use in the construction sector.

The 5th session foresees the development of an innovative system for energy recovery from waste. The key objective is to develop a pilot low-power (waste to energy) system for energy extraction from high water content waste materials to be generated from wastewater plants, paper processing, and sewage dumps. The system will be designed to be functional/operational for other types of waste such as fibres and paper and will have the following components: a) a hydrodynamic cavitation pump for wastewater treatment, b) an advanced drying system and c) a combustion device. The system will also use a low power operating system for energy efficiency, to comply with environmental regulations and promote sustainability.

Finally, another dimension promoting the circular economy concept includes the establishment of cross-sectoral synergies to support the creation of integrated value chains for cascading the use of biomass, covering the whole cycle from production and consumption to waste recovery and reuse. This will contribute in creating a sustainability culture within industries, whilst paving the way for collaborative actions for the collection and pre-treatment of waste. According to the Programme, industries' engagement (incl. civil society's willingness to contribute) in the identification and collection of waste biomass resources constitute an absolute necessity for effective implementation of circular economy in the country.

Contact details	
Name	Maja Frelih
Organisation	Pulp and Paper Institute (Programme coordinator)
Position	Head of Laboratory
Phone number	+386 1 200 28 63
Email	maja.frelih@icp-lj.si
Website	http://icp-lj.si/

3.5 Kemi-Tornio Industrial Symbiosis (Finland)

Kemi–Tornio's ecosystem is an industrial symbiosis scheme of by-products exchange implemented at regional level. The Kemi-Tornio region is located in northern Finland and comprises the cities of Kemi and Tornio, as well as surrounding municipalities (e.g. Kiminmaa, Simo, and Tervola). The region is dominated by large-scale industrial operations (e.g. forestry industry and stainless steel plants), accounting for approximately 80% of Lapland's industrial production and 7–8% of the total export value of Finland's products.

The industrial ecosystem brings together forestry, mining and steel industry companies, industrial service enterprises and SMEs, research and educational organisations and intermediaries, to facilitate the exchange of by-products and residuals towards using natural resources sustainably and delivering eco-innovative and resource-efficient solutions (mostly through waste recovery).

Kemi-Tornio's industrial ecosystem has been established to create a favourable environment for companies in the processing industry to minimise their waste production and increasing resources efficiency. To this end, the ecosystem provides all the mechanisms and tools required to enable the participating companies to make use of each other's by-products, residuals and waste streams in their production activities (as input resources). This scheme also aims to enable the emergence of new business opportunities including the development of start-ups that will undertake the role to support the processing industry by developing novel industrial symbiosis products and back-office services.

The main symbiotic activities carried out in Kemi-Tornio's ecosystem include: a) the valorisation of solid waste generated by the "Metso" forestry industry plant, to be used as mulch in landscaping, and after screening as fuel, b) the utilisation of by-products and waste from the "StoraEnso Veitsiluoto" mill, where ashes from the bark-burning boiler can be used in earth construction, replacing soil in certain structures such as in earth filling, protective layers and road structures, and c) the valorisation of carbon monoxide surplus produced by the Outokumpu ferrochrome factory, to be used as renewable energy fuel covering the need for 17,000 m^3 of oil annually.

The mapping of industrial product flows and waste streams in the region was a key factor in the development of Kemi-Tornio's industrial ecosystem. Digipolis, a technology park in Kemi, has led a project (2014) on the documentation of industrial by-products side streams and potential applications. The project aimed to create a network of regional actors (to be involved in the exchange process) and encourage matchmaking, seeking to make the valorisation of industrial by-products more efficient. Documentation of relevant by-products and residues included recording their chemical and physical

properties, analysis of the utilisation grade of the by-products and studies on markets, technology and logistics related to the by-products. The project set up a databank with real-time information on actors, references and potential new applications, and provided annual estimations for the total volume of waste production that can be recycled and reused.

The role of regional authorities was also a key determinant for the success of Kemi–Tornio IS. Regional authorities adopted measures to create an enabling policy/regulatory environment to support industrial symbiosis activities. They made environmental protection and climate considerations a top priority in regional development plans, building upon the need to follow a more sustainable pattern for economic growth based on waste recovery principles, the recycling and re-use of materials and the sustainable use of natural resources. This was seen as a key way to increase regional competitiveness and extraversion, adding new value to Lapland's exports and taking full advantage of region's specialisation potential. The regional policy instruments, which have been instrumental in promoting green growth, resource efficiency and eco-innovation are the following:

- ERDF 2007–2013 Programme for Lapland – Thematic priorities promoting business development and innovation.
- Lapland's Arctic Specialisation Programme – Actions promoting the sustainable utilisation of natural resources.
- ERDF 2014–2020 – Key objective to strengthen Finland's climate change and energy ambitions through the development of a new regional plan for climate and energy.

The Kemi–Tornio IS has managed to create benefits for all 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. The main results are summarised as follows:

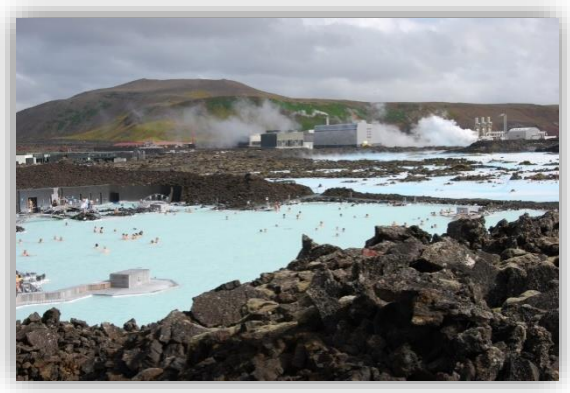
- The total volume of industrial symbiosis activities in the Kemi– Tornio Region has been estimated at €200 million annually.
- 1.3 million tons of annual by-products and residues are being exchanged annually.
- Reduced raw materials' consumption and waste disposal costs.
- New business opportunities have been opened up, stimulating the emergence of new companies (i.e. start-ups) and enhancing employment.
- Examples of industrial symbiosis in the Kemi-Tornio region have been the basis of regional cluster work and further implementation of the region's Arctic specialisation program.
- The industrial ecosystem in the Kemi-Tornio region brought to the fore new regional industrial symbiosis opportunities such as the potential synergy between mining and tourism in northern Lapland and the connections between traditional forestry, rural energy production and reindeer herding.

The case of Kemi-Tornio industrial symbiosis presents a multitude of lessons learnt for the development of circular economy schemes. To begin with, achieving effective cooperation between partners requires

identifying and highlighting the emerging business opportunities for participating companies, as they will be arisen from the exchange of by-products, energy and secondary raw materials and the creation of economies of scale even if these companies are competing each other. In addition, the documentation of industrial by-products side streams and potential applications in the production (at an early stage) has been proven particularly critical for utilising more efficiently waste streams and by-products, to fully exploit industries' innovation and growth potential. In Kemi-Tornio, the mapping of by-product resources together with the positive mind-set in the region regarding circular economy contributed to accelerating investments in recycling and treatment technologies, paving also the way for future sharing economy activities. Finally, the regulatory/policy environment seems to play a significant role in triggering developments in the field. The absence of legal barriers (e.g. strict quality standards, taxation, detrimental subsidies) constitutes a key enabler to circular economy, as demonstrated in Kemi-Tornio region where "resource efficiency" is on the top of the political agenda, and relevant action plans have been designed to foster sustainable development and green growth.

Contact details	
Name	Kari Poikela
Organisation	Digipolis
Position	Project Manager of the Arctic Industry and Circular Economy Programme in Lapland
Phone number	+358 50 435 8283
Email	kari.poikela@digipolis.fi
Website	http://www.digipolis.fi

3.6 Reykjanes Geothermal Resource Park (Iceland)



The Reykjanes Geothermal Resource Park (GRP), located on the Reykjanes peninsula in South-western Iceland, is an industrial symbiosis system that focuses on the exchange of energy resources and by-products. Established in 1992, the Park (also known as "The Blue Lagoon Geothermal Spa") provides opportunities for resource collaboration, setting the ground for a circular economic model, characterised by minimal consumption of natural resources and waste generation.

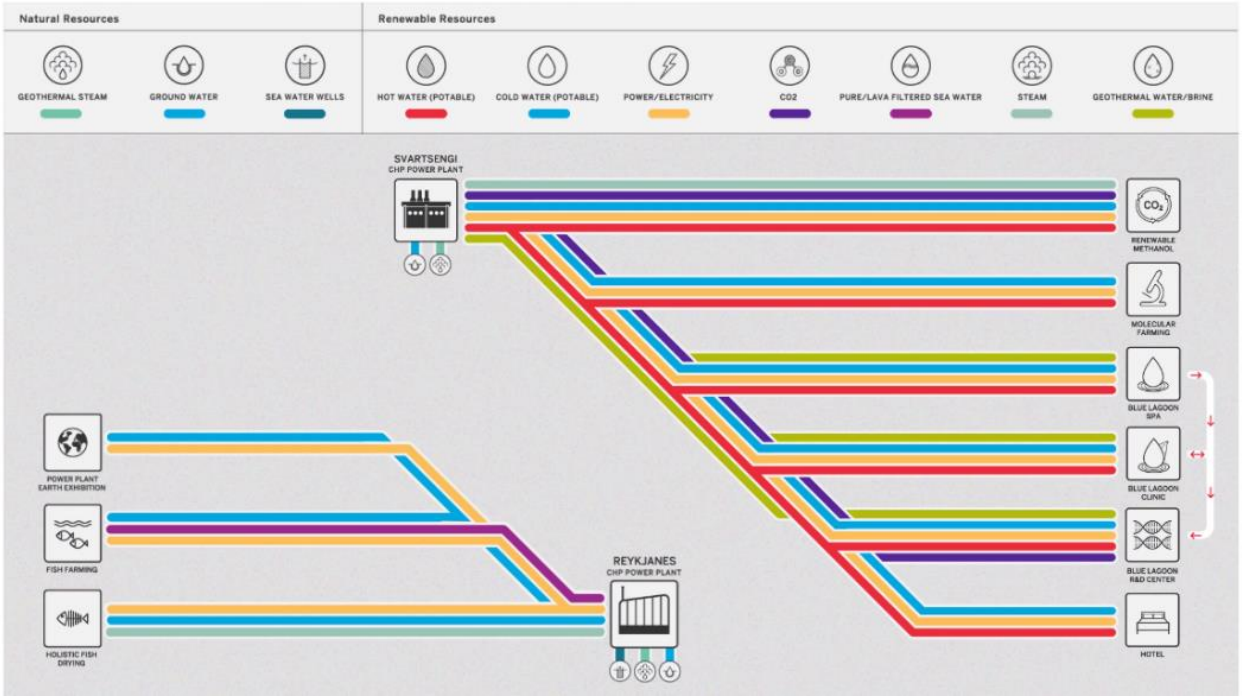
The Park, strictly connected with the geothermal Combined Heat and Power (CHP) plants, currently includes 11 companies and research institutes, which are located nearby the power plants, to form a community that is an excellent venue for scientific research, inventions and the development of new products.

The Resource Park provides a favourable environment with high technical expertise and social responsibility, to facilitate the utilisation of geothermal resources produced by the HS Orka (utility company) power plants (in Svartsengi and Reykjanes) in a diverse range of activities from hotel accommodation and algae farming to fish drying and dermatological research. The companies comprising the Geothermal Resource Park are presented below:

- Geothermal Combined Heat and Power plants.
- Blue Lagoon Health Spa with more than 750,000 visitors every year.
- Blue Lagoon Clinic, a modern dermatology unit that uses the healing properties of lagoon water to help ease psoriasis symptoms and other skin disorders.
- Blue Lagoon Research, an R&D centre focusing on researching potential applications and opportunities arisen from the exploitation of natural resources in the Blue Lagoon's ecosystem (e.g. development of cosmetics made from silica and algae).
- Haustak and Hateigur companies engaged with drying heads and bones in fresh air heated.
- Carbon Recycling Int., an innovative company that produces methanol as an alternative fuel for vehicles
- Northern Light Inn; a luxury "green" hotel that provides high-quality accommodation and spa services near the Blue Lagoon.
- ORF Genetics, a leading biotechnology company manufacturing growth factors for medical research and skin care products
- Sholt Sea Farm, a fish farming company employing innovative technologies throughout the farming process.

All the symbiotic activities in the park are being carried out, utilising the resource streams generated by the power plants and through the exchange of by-products and residuals among the participating companies. Some indicative examples include: a) a carbon recycling company (i.e. Carbon Recycling Int.), which turns CO2 from the power plant into methanol, b) a molecular farming company (i.e. ORF Genetics), which uses water and electricity from the power plant to produce proteins and growth factors from barley, and c) a data centre that is fully run on geothermal energy. Figure 2 illustrates the flow of resources from geothermal plants to the various activities and companies.

Figure 2: Flow of natural and renewable resources from geothermal plants to various companies (Source: www.resourcepark.is)



The Resource Park has earned considerable economic and environmental achievements towards sustainable development and social welfare. More precisely, the Resource Park has contributed in increasing regional competitiveness and productivity. The annual income of all the 11 companies participating in this industrial symbiosis scheme is more than ISK 21.5 billion, accounting for 1% of the national GDP. The added value has increased by more than 21% since 2008. The Resource Park's business growth has played a leading role in sustaining the regional economy during the years of crisis and supporting local employment by creating new jobs and stimulating the emergence of new companies (mostly SMEs providing support services for the park).

The Resource Park currently employs more than 500 people in all its companies, while it is expected than 600 new jobs will be created in the near future. What is more, the wages paid by Resource Park's companies are 30% higher than the average wage in Iceland. This growth rate is mainly attributed to the

valorisation of geothermal resources, favourable macro-economic conditions, aluminium production, tourism, and the accumulative experience in efficiently delivering business services. The Resource Park has also created environmental benefits, stemming from the sustainable use of natural resources and the valorisation of geothermal power. Environmental benefits include a reduction in the amount of waste landfilled, lower waste production, diminished carbon dioxide emissions and considerable improvements in areas such as soil degradation, air pollution and biodiversity loss.

The key success factors behind the development of the Geothermal Resource Park include the following: a) low energy prices and access to renewable energy, b) common public attitudes (civil society, companies, public authorities) towards promoting sustainability and environmental protection, c) the regional economy structure, which is highly dependent on geothermal energy and sustainable tourism and fishing, c) public authorities' strategic choice to promote the sustainable exploitation of natural resources by encouraging small-scale investments in this area, e) close proximity, active participation and commitment to further develop industrial ecology and promote sustainability by all the involved actors, and f) communication, openness for collaboration and understanding of each other's needs.

Contact details	
Name	Kristín Vala Matthíasdóttir
Organisation	HS Orka
Position	Vice-President of Resource Park
Phone number	+354 855-9353
Email	kvm@hsorka.si
Website	www.hsorka.is

4 Financial instruments for supporting industrial symbiosis

4.1 Trends in setting up financial incentives

Public authorities can provide a range of financial incentives to create a favourable environment for waste recovery, recycling and green investments, unleashing the potential for industrial symbiosis towards a circular economy pathway. Market incentives are a key driver behind the development of industrial symbiosis. In this regard, the presence of a dedicated fund for supporting industrial symbiosis projects through direct funding or legal, technical counselling, can help to stimulate symbiotic activities across companies. Public procurement can also play a crucial role in stimulating the demand for environmentally friendly products, providing also market incentives for suppliers to manufacture products using recovered materials or secondary raw materials. This sub-section presents the trends in setting up financial incentives and schemes to support industrial symbiosis development and create an environmental and sustainability culture within the society.

Fund for Industrial Symbiosis

This measure includes the establishment of a fund particularly focused on promoting industrial symbiosis initiatives. The fund can be part of a national or regional circular economy programme, or may have its own application capacity. The fund can support a wide range of activities capable to promote industrial symbiosis and circular economy, including a) supporting industrial symbiosis projects that are almost market-ready by facilitating products' commercialisation and stimulating the demand towards environmental friendly goods and services, b) promoting new green business ideas by directly financing investments in R&D activities, technology development and facilities design and construction (e.g. heating facilities to transform biomass resources or wood residuals into energy), c) stimulating the emergence of new innovative companies (i.e. start-ups) to develop and implement circular economy business models (e.g. manufacturing products using exclusively secondary raw materials), d) conducting studies on the financial viability and technical feasibility of potential symbiotic cooperation among companies, and e) identifying relevant companies/industries to create synergies, including the evaluation of companies' production residuals and matchmaking.

Financial support may be granted directly to regions or municipalities that face serious economic challenges such as declining low-productivity industries, high unemployment rates, and low competitiveness, in an effort to support industrial development and innovation adoption. A typical example is the Fund for Green Business Development in Denmark, which provides directly funding (in the form of grants) to selected businesses for adopting green business models and creating symbiotic synergies. Its main objective is to improve resource efficiency and regional competitiveness, by exploiting the potential for SMEs' growth within the circular economy model. The Fund has allocated more than 7 million euros in total to support industrial symbiosis and green growth projects.

Sustainable taxation

Taxation has been proven successful in addressing a wide range of environmental issues including waste disposal, water and air pollution, soil degradation and natural resources extraction. Their purpose is to address the market failure stemming from companies and customers' tendency to ignore negative environmental impacts. Environmental taxation allows internalisation the negative externalities into market prices, reflecting the damage caused to the environment throughout the whole cycle from production and consumption to waste recovery and reuse. In addition, environmental pricing through taxation gives customers and businesses the necessary flexibility to determine how best to diminish their ecological footprint and provides a strong incentive to innovate.

The European Environment Agency (EEA)[21] calls for a green tax reform that will shift focus from renewable resources and human labour[22] (as circular economy requires labour-intensive activities including recycling and waste treatment) towards unsustainable resource use, non-recycled products and waste generation. The rationale is that environmental taxation can yield several benefits such as to make unsustainable goods and services more expensive (increasing incomes and stimulating demand for green products), contribute in job creation, alleviate environmental pressures and spur innovation towards sustainable development.

New trends in environmental taxation involves a) imposing charges on the extraction of natural resources, seeking to increase the cost of using virgin materials for developing new products and to retain the demand for secondary raw materials despite market pressures, b) tax exemptions and reductions for biofuels and environmentally friendly technologies, c) preferential tax credit schemes for enterprises to strengthen R&D activity and foster innovation adoption, and d) introducing high landfill and incineration taxes to discourage waste generation and disposal, and encourage recycling.

To fully exploit the potential of environmental taxation, public authorities should complement taxes with additional incentives and fiscal measures (in the context of an environmental fiscal reform) to minimise the administrative costs associated with existing environmental taxes (e.g. collection, monitoring and reporting), tackle tax evasions, remove all environmentally harmful subsidies that prevent industrial symbiosis development (e.g. subsidies and exemptions granted for certain fossil fuel-intensive industries and transport), and sustain industries' competitiveness in international markets (European Commission, 2016).

Circular Procurement

Procurement can play a key role in the transition towards a circular economy. Circular procurement is a sub-category of green public procurement, focusing on promoting sustainable development and environmental protection through closed and safe material loops. Actually, there is not a standard

[21] https://www.eea.europa.eu/highlights/environmental-tax-reform-increasing-individual
[22] https://www.eea.europa.eu/media/audiovisuals/shifting-taxes-from-labour-to/view

description for circular procurement, even though several definitions have been suggested in the literature.

Philips (2016)[23] argues that circular procurement is all about making the right choices early on in the product creation process, so that materials and components are suitable, at end-of-life, for repair or refurbishment and re-use, thus helping to close the materials loop. MVO (2015)[24] states that in circular procurement the contractor ensures that the products are manufactured in accordance with the principles of the circular economy and will be further processed after use, i.e. are repairable and can be broken down into components and/or materials at the end of their life cycle, which can then be reused.

Public procurement can substantially increase the demand for sustainable products/services. The reason is that public authorities across the EU spend more than 2 trillion euros annually for purchasing goods, services and supplies; an amount which makes up around 14% of EU's GDP. Therefore, they can substantially contribute to industrial symbiosis development by procuring environmentally friendly products and energy resources; something that promotes products' reusability and recyclability, and encourages high value recycling. The integration of sustainability criteria into public tenders can essentially increase the demand for circular economy products and services, whilst stimulating investments in R&D and technological innovation and creating economic savings for the public, as the costs of the product's entire life cycle are being considered.

The Nordic Council of Ministers (2017)[25] suggests four approaches to circular procurement, meant to shift the focus from the most economic advantageous tender (regardless products' quality) towards sustainable products, new business concepts and finally to the establishment of industrial symbiosis ecosystems.

A. **Procurement including GPP based "circular" criteria**. This includes integrating circular criteria into the tendering process for procuring improved products and services. Circular economy criteria may include recyclability, share of recycled materials, reuse, etc.
B. **Procurement of new "circular" products and materials**. Public procurement can provide conditions that stimulate innovative solutions and create new business and markets for new products. This means products that have been manufactured using secondary raw materials and are considerably better in terms of recyclability, recycled materials, disassembly, and long lifespan.
C. **Procurement of services and new business concepts**. The focus is on procuring services or business models that facilitate the transition to a circular economy pathway, not on the final products. Indicative examples include leasing furniture instead of buying it, car hiring, buying light instead of luminaries.

[23] https://www.philips.com/a-w/about/company/suppliers/supplier-sustainability/our-programs/circular-procurement.html
[24] https://mvonederland.nl/circular-procurement-guide
[25] https://norden.diva-portal.org/smash/get/diva2:1092366/FULLTEXT01.pdf

D. **Procurement promoting circular ecosystems**. This approach seeks to stimulate the deployment of symbiotic synergies towards circular economy. This may include eco-industrial sites where companies exchange energy resources, waste and by-products to form a closed production loop.

Circular procurement can provide opportunities to a) alleviate pressures on the environment (e.g. resource scarcity, climate change, soil degradation, biodiversity loss), b) enhance security of supply of raw materials, reducing imports' dependency, and c) strengthen social welfare by increasing competitiveness, productivity, growth and jobs. Finally, public authorities (through circular procurement) can provide to the EU dominant industries (e.g. construction, transport, advanced manufacturing, energy, food and catering services) a strong market incentive for developing environmentally friendly products made from recovered materials and by-products, paving thus the way for symbiotic activities (supply-driven measures).

Pricing schemes for waste disposal

Public authorities across the EU are seeking to change their approach to waste collection and disposal, prompted by the increasing transportation and disposal costs, as well as the emergence to reach the EU recycling and waste collection targets. In this context, pricing schemes are considered an effective way not only to diminish waste generation but also to promote waste separation and increase recycling rates. The main benefit is a substantial increase in natural resources' savings (incl. energy and raw materials), which will result from the sustainable management of waste and the improved recycling rates that allow for material reuse and recovery. Furthermore, the reduction in the pace of waste disposal implies a subsequent reduction in the amount of trash that goes to landfills, which is responsible for several environmental problems such as soil erosion, air and groundwater pollution.

The most common pricing programme for waste disposal is the so-called "pay-as-you-throw" (PAYT), which is a usage-pricing model for disposing municipal solid waste (i.e. garbage). Under this scheme, residents are charged for the collection of municipal solid waste—ordinary household trash—based on the amount they throw away. There are three main types of pay-as-you-throw collection systems:

- **Full unit pricing**: Residents pay for all the amount of waste they want to dispose in advance by purchasing a custom bag (prepaid bag system), tag (prepaid tag system) or a container (single can system).
- **Partial unit pricing**: Public authorities decide on a maximum number of bags or waste containers, which are covered by taxes. Should the user exceed the permitted amount of waste, additional bags or containers can be purchased. A flat fee ('first-tier') is applied to create revenue stability, and then the 'second-tier' fee is based on the additional amount of waste thrown away.
- **Variable rate pricing**: Residents can choose to rent bins or containers of varying sizes with the price corresponding to the amount of waste generated.

Other financial incentives

This section presents a number of policy interventions that can indirectly facilitate the development of industrial symbiosis schemes, mostly through promoting recycling and environmental consumption patterns. To begin with, symbiotic synergies require labour-intensive activities (e.g. resource documentation and matchmaking, waste collection and treatment that make human resources a primary determinant for industrial symbiosis' success. Reducing the fiscal pressure on labour can spur sustainable growth, stimulating the development of industrial symbiosis schemes. This can be realised by setting up a preferential social security scheme with lower security contributions for industrial ecosystems' workforce or/and by providing workers with tax credits and allowances. In addition, it is important to keep in mind that customers' purchasing decisions affect industrial symbiosis development by determining the demand for environmentally friendly products (e.g. remanufactured products or products made from recycled materials and waste recovery). To increase the demand for industrial symbiosis products, public authorities can provide discount vouchers for environmental purchases and reward consumers that demonstrate their commitment to sustainable consumption with coupons, bonus points and tax credits. This may include the setting of consumption taxes based on the environmental performance of products. Finally, other fiscal measures that can be put in place to promote recycling and other waste disposal methods include a) setting lower fees per ton of waste to discourage landfilling and b) making investments in local infrastructures to support separate waste collection and pre-treatment.

4.2 EU financial mechanisms

The European Commission (EC) makes explicit mention on the value to promote circular economy and industrial symbiosis towards sustainable development. To this end, the EU has established an investment framework to provide funding opportunities for industrial symbiosis, especially as regards waste management, recycling, secondary raw materials, resource and energy efficiency, technology development, and product design. The EU's circular economy strategy is mostly facilitated by the following financial instruments:

- Horizon 2020
- LIFE Programme
- Cohesion Policy
- COSME
- European Investment Bank
- Green Bond Market

Horizon 2020

Horizon 2020 (https://ec.europa.eu/programmes/horizon2020/) is the biggest EU Research and Innovation Framework Programme to secure Europe's global competitiveness. The Programme, with

nearly €80 billion of funding available for the period 2014-2020, supports the 'Europe 2020' growth strategy, by supporting technology development, research and innovation and industrial leadership, whilst effectively tackling societal challenges. Programme's main pillars are:

- Excellent Science (24.3€ billion),
- Industrial Leadership (16.4€ billion),
- Societal Challenges (28.7€ billion),
- European Institute of Innovation and Technology (EIT) (2.4€ billion),
- Euratom (1.6 € billion)
- Other (3.1€ billion)

Circular economy is at the heart of the programme. The third pillar (Axis 5) calls for projects that will demonstrate the economic and environmental feasibility of the circular economy approach and will contribute to the enhancement of European industrial competitiveness, through the deployment of new business models, symbiotic synergies and environmental technologies. The programme has a total budget of €341 million to promote the transition to a circular economy, by funding projects and initiatives on circular economy business models, raw materials and recycling, environmental technologies, climate solutions and resource efficiency, and industrial synergies for the exchange of energy and waste resources.

The call "Industry 2020 in the Circular Economy", under the Societal Challenge 5 "Climate action, environment, resource efficient and raw materials", aims to boost economic growth and give a strong impetus to the re-industrialisation of the EU, by promoting a sustainable development path based on resources and materials reusability. The programme also supports systemic innovation that aims at responding to a societal challenge by obtaining a systems-wide transformation through affecting the system's economic, social and environmental dimensions. This implies a transdisciplinary perspective that integrates technology, business models and economic organisation, finance, governance and regulation as well as skills and social innovation.

The actions supported under this call contribute to the achievement of the goals outlined in the Communications "Towards a circular economy: A zero waste programme for Europe" and "European Industrial Renaissance", being also in line with the Commission's new Roadmap for a Circular Economy Strategy. An indicative (industrial symbiosis) example under Horizon 2020 is the RESYNTEX project. This project created an innovative textile recycling plant to allow the transformation of textile waste into secondary raw materials, to be used as input in relevant companies' production processes.

LIFE Programme

LIFE (http://ec.europa.eu/environment/life/) is the EU's funding instrument for the environment and climate action, contributing to the implementation, updating and development of EU environmental and climate policy and legislation. The programme, managed by the European Commission (DG Environment

and DG Climate Action), works towards preserving natural capital, fostering green growth and promoting sustainable development. Furthermore, LIFE is one of the main funding sources for demonstration projects that facilitate the implementation of the EU Circular Economy Package.

Since it was initially launched (in 1992), LIFE has co-financed more than 4000 projects supporting environmental, nature conservation and climate action initiatives across the EU. For the 2014-2020 funding period, the LIFE programme is expected to allocate more than €3.4 billion for promoting environmental protection, climate action and sustainable development, seeking to facilitate the achievement of the EU's key environmental targets, as described in the Europe 2020 Strategy, the 7th Union Environmental Action Programme and other EU environmental and climate strategies.

LIFE plays an important role in supporting the transition from a linear economic model (i.e. "take-make-use-dispose" approach) towards circular economy. The programme has co-financed more than 100 circular economy related projects, allocating approximately €270 million for initiatives designed to promote industrial symbiosis, waste recovery, as well as the uptake of secondary raw materials. Since 2014, the programme has prioritised the transition to a circular economy through actions particularly focused on spanning the value chain, promoting industrial symbiosis and stimulating the use of secondary resources into the production. This objective is being mainly achieved by a) designing environmental footprint methodologies, b) fostering green public procurement and c) linking regulatory, financial or reputational incentives to environmental performance.

Indicative (project) examples include the REBIRTH project, which targets art increasing the recycling rate of construction and demolition waste (CDW) in the construction sector; the PRISCA project that established creating waste reuse centres to increase the recovery and reuse of bulky waste; and the LIFECIP project, which aimed to integrate eco-design and LCA (Life Cycle Assessment) approaches to reduce environmental impacts in three industrial sectors.

In general, LIFE has managed to raise public awareness on circular economy's benefits and to establish new processes for preventing waste, contributing to 'closing the loop' upstream in areas such as product design, new production processes, consumer awareness and new value chains. In addition, the LIFE programme has not only helped to implement the EU environmental legislation, but it has contributed to the design of new regulations as well (e.g. CIRCWASTE-FINLAND). The rationale is that LIFE projects provide a number of good practices and pilot applications that can be easily transferred in other geographical contexts and economic sectors throughout the EU.

Finally, the current programming period provides opportunities for financing projects on improving or extending best practices developed by earlier LIFE projects in the circular economy field. This includes promoting resource efficient industrial processes, increasing recycling rates and fostering symbiotic activities / synergies between companies. Finally, LIFE aims to contribute to the development of waste mining and the recovery of critical raw materials, whilst fostering the diffusion of innovation among

traditional industries, encouraging public-private partnerships (PPPs) for the valorisation of secondary raw materials, and promoting the reusability, durability and upgradability of products.

Cohesion Policy

The Cohesion Policy, comprising the European Regional Development Fund (ERDF), the Cohesion Fund (CF) and the European Social Fund (ESF), is the EU's main investment policy providing more than €350 billion to support job creation, business competitiveness, economic growth, sustainable development, and improve citizens' quality of life. The Cohesion Policy contributes significantly to the circular economy agenda, allocating more than €150 billion to support investments in the field of industrial symbiosis, recycling, waste management, resource and energy efficiency, bio-economy, and innovative technologies.

More specifically, cohesion policy investments focus amongst other issues on recycling, improving waste management, resource and energy efficiency, strengthening the bio-economy and the creation of green jobs. Only for waste management (that includes waste prevention, reuse and recycling), the cohesion policy offers €5.5 billion or an additional €5.9 million tonnes/year of additional waste capacity in Europe. Furthermore, the policy aims to invest invests €2.3 billion in environmentally-friendly production processes and resources and supports projects which will turn waste into a resource, an essential part of moving towards a circular economy. Apart from helping EU member states and regions to reach their recycling targets, the EU cohesion policy makes an important role in enabling companies to be more sustainable, innovative and competitive. This goes beyond investment and provides tools such as smart specialization platforms for innovation as well as the fi-compass platforms for financial instruments. The following (indicative) projects have been financed by the cohesion policy, to improve recycling rates and promote sustainable waste management.

- Closing the waste cycle (Ljubljana, Slovenia): The project helped Slovenia reach its recycling targets and the citizens of Ljubljana have better, more sustainable waste management, by creating a waste management centre to facilitate the separate collection and recycling, and reduce the amount of waste sent to landfills.
- Closing the Circle, an Enhanced Landfill Mining project in Flanders (Belgium): This project demonstrates how innovative transformation technologies can capitalise on old landfills, to retrieve valuable materials and energy that can be used in the production.

COSME

COSME (http://ec.europa.eu/growth/smes/cosme_en) is the EU programme for the Competitiveness of Enterprises and SMEs, running for the period 2014-2020, with a total budget of €2.3 billion. The programme aims to improve SMEs' competitiveness and productivity by a) facilitating access to finance in different phases of their lifecycle (creation, expansion or business transfer), b) supporting internationalisation and access to markets, c) creating a favourable environment for competitiveness and d) encouraging an entrepreneurship culture.

The COSME programme is managed by the Executive Agency for Small and Medium sized Enterprises (EASME). EASME has been set up by the European Commission to administer a number of EU programmes, with the aim to provide high-quality support to beneficiaries for turning EU policy into action. Its mission is to contribute to the development of a more competitive and resource-efficient European economy based on knowledge and innovation. The programmes supported by EASME and tasked to promote industrial symbiosis and circular economy among SMEs are mainly Horizon 2020, LIFE and COSME. The remaining (e.g. Intelligent Energy, Eco-innovation Initiative, EU programme for SMEs' competiveness) provide business support services for SMEs, targeting to foster the diffusion of innovation, raise SMEs' competitiveness and productivity and promote energy efficiency.

COSME provides financial and technical support to European SMEs (recognised as the back bone of Europe's economy) to benefit from the EU's single market opportunities whilst boosting their extraversion. COSME also funds the Enterprise for Europe Network (EEN) that assists SMEs to find business and technology partners, as well as a series of web tools, specifically designed to support business development (e.g. the so-called "Your Europe Business Portal").

In relation to circular economy, COSME strives to create a favourable environment for synergies between companies. This is realised through actions focused on reducing unnecessary administrative and regulatory burdens and supporting the emergence of competitive industries with market potential by introducing circular economy business models and integrated value chains to ensure materials' recyclability and reusability.

European Investment Bank (EIB)

The European Investment Bank (http://www.eib.org/projects/initiatives/circular-economy/index) is a major partner for circular economy investments in the EU. During the last five years, EIB has co-financed projects worth EUR 2.4 billion, to promote sustainable growth, regional competitiveness and employment, by facilitating the transition to a circular economy pathway. The Bank provides funding for circular economy project/initiatives under the following priorities:

1. Climate action and environment – which aim to reduce resource consumption and waste generation which results in lower greenhouse gas emissions.
2. Innovation and skills – projects which may be innovative in products, production processes and business models.
3. Small and medium-sized businesses (SMEs) – since they play a key role in the transition to a circular economy because they are an important source of innovation and represent over 99% of businesses in the EU.

On the whole, the projects (to be funded) should have a particular focus on substituting virgin resources with secondary materials, reducing waste generation in production and consumption by closing material loops, extending the use and life of assets and products and recovering value from waste, by-products

and wastewater. Circular economy projects are financed by a range of loans and financial instruments including:

- **EFSI** is a financial instrument that has been launched jointly by the EIB Group – the European Investment Bank and the European Investment Fund – and the European Commission to overcome the current investment gap in the EU. It is one of the three pillars of the Investment Plan for Europe that finance strategic investments in key areas such as infrastructure, research and innovation, education, renewable energy and circular economy. EFSI, brings together public and private entities (through PPPs), to help spread information about the new market opportunities (incl. industrial symbiosis schemes) and create synergies that will enable to realise innovative projects that face several difficulties such as lack of funding, technical capacity and technological readiness.
- **INNOVFIN** is a joint initiative launched by the European Investment Bank Group (EIB and EIF) and the European Commission under Horizon 2020. It consists of a series of integrated and complementary financing tools and advisory services offered by the EIB Group to support investments in R&D across industries. The initiative's main objective is to facilitate and accelerate access to finance for innovative businesses and other European entities, providing a wide range of loans and guarantees either directly or via a financial intermediary (such as banks).

Green Bond Market

Green bonds are recognised as a substantial financial instrument to raise capital market finance for environmentally friendly and more sustainable investments (e.g. industrial symbiosis schemes, circular economy business models, green technologies). A green bond is differentiated from regular bonds in that the former is exclusively issued to finance or re-finance projects, assets or business activities, particularly focused on promoting environmental protection and sustainable development. Green bonds provide an opportunity to mobilise capital for green investments, helping investors to make informed and explicit decisions, whilst ensuring the necessary liquidity for the successful implementation of relevant interventions.

The green bond market emerged in 2007 with the first few issuances by Multilateral Development Banks. Since then, the market has expanded significantly. More and more investors (incl. banks, corporations, and public authorities) are joining the bond market, providing large amounts of capital for green and sustainable investments. In November 2016, more than USD 74 billion of green bonds were issued globally, which implies a 77.8% increase compared to 2015 (41.8 billion).

The rationale is that the green bond market provides greater flexibility and more options to exit the investment for project equity and longer-term project finance debt, which is provided by banks and financial institutions, and entails harsh constraints such as difficulty in deleveraging and strict regulations.

The bond market is regulated by the Green Bond Principles (GBP). These are voluntary process guidelines that recommend transparency and disclosure and promote integrity in the market by clarifying the

approach for issuing of a green bond. Their role is to provide issuers with guidance on the key components involved in launching a credible green bond, enabling to examine the technical feasibility of the envisioned investments and evaluate the associated impact on the environment. These principles have been broadly accepted by the EU market, utilised by national governments (e.g. France, Germany, and Italy) as an eligibility framework for deciding and prioritising investments to address key environmental challenges (e.g. biodiversity loss, natural resources extraction, air pollution).

The eligible categories of "green" projects under this framework revolve around the following areas: a) renewable energy and energy efficiency, b) pollution prevention and control, c) sustainable management of natural resources, d) biodiversity conservation, e) clean transportation, f) water management, g) climate change adaptation, h) green buildings, and i) circular economy adapted products, processes and technologies.

Symbiotic synergies fall mainly into the last category. This category favours investments/projects focused on promoting the transition to a circular economy pathway through the manufacturing of sustainable and environmental friendly products made from waste residuals and by-products. The uptake of secondary raw materials is also supported under the axis promoting the sustainable management of natural resources, with the aim to prevent natural resources depletion, while the exchange of energy resources contributes to securing energy supply and fostering energy efficiency. Today, green bonds mainly finance projects in renewable energy (45.8% of the issuance globally in 2015), energy efficiency (19.6%), low carbon transport (13.4%), sustainable water (9.3%), and waste & pollution (5.6%).

Finally, the climate bonds are a similar (to green bonds) initiative, seeking to mobilise investments for climate change solutions. These might be greenhouse gas emission reduction projects ranging from clean energy to energy efficiency, or climate change adaptation projects. Climate bonds are a relatively new asset class and can be considered as a sub-category of green bonds.

4.3 Field experts to be invited by the hosting organisation

Field expert #1	**Draško Veselinovič**
Name	Draško Veselinovič
Organisation	Slovenian Business & Research Association
Education	PhD in Financial Economics
Position	President of the Management Board
Profile and experience	Draško Veselinovič is President of the Management Board of the Slovenian Business & Research Association (SBRA) in Brussels since 2015 and Associate Professor of Financial Economics. During his career, he has held numerous senior management and top leadership positions in a variety of financial institutions and international banking. Between 2010 and 2012 Draško Veselinovič led Slovenia's and the region's largest international private retail financial conglomerate KD Group. In 2009, he became the CEO of Slovenia's largest bank Nova Ljubljanska Banka. Draško Veselinovič has also led the Deželna banka Slovenije and helped establish the Ljubljana Stock Exchange, of which he was president for 15 years. In parallel to his professional career, he has been active in academia, as a lecturer in numerous national faculties and institutions, professor and director of Gea College in the Faculty of Entrepreneurship, based in Ljubljana. Draško Veselinovič has published more than 500 books and articles in national and international journals and participated in the "2nd International Circular Change Conference 2017" in Slovenia, in the panel discussion "Circular Innovation as an Investment Opportunity".
Phone number	+32 2 645 1914
Address	Av. Lloyd George 7, 1000 Brussels, Belgium
Email:	drasko.veselinovic@sbra.be
Website:	www.sbra.be

Field expert #2	**Davor Inđić**
Name	Davor Inđić
Organisation	European Bank for Reconstruction and Development
Education	Master in International Finance and Banking
Position	Associate Director
Profile and experience	Davor Inđić holds a Masters in International Finance and Banking from the California State University and a Bachelor Degree in Economics from the University of Zagreb. Davor Inđić is an Associate Director and Senior Banker in the Municipal and Environmental Infrastructure Department of the European Bank for Reconstruction and Development (EBRD). Since 2005, he has been responsible for managing and financing high profile infrastructure projects (incl. industrial symbiosis projects) in Central Europe and Western Balkan region. In the past, Mr. Indic worked for Merrill Lynch (USA), Philip Morris International and the United Nations. Davor Inđić has participated as external speaker in several circular economy events such as the"2nd International Circular Change Conference 2017 in Slovenia"; the "Zagreb Forum 2016" in the panel regarding "Strategies and Financing Instruments"; and the "Smart Cities 2015 Conference".
Phone number	+385 1 6000 310
Address	Zagreb Resident Office, Miramarska 23/111, 10000 Zagreb, Croatia
Email:	indicd@ebrd.com
Website:	http://www.ebrd.com/croatia.html

Field expert #3	**Ernesto Hartikainen**
Name	Ernesto Hartikainen
Organisation	SITRA
Education	Master in Management and International Business
Position	Circular Economy Specialist
Profile and experience	Ernesto Hartikainen holds a Masters in Management and International Business from Aalto University in Helsinki and in Chemical Forest Products Technology (engineering) from Helsinki University of Technology. Ernesto Hartikainen is a specialist in the Circular economy focus area, being responsible for the World Circular Economy Forum 2017 Programme and bringing circular economy concepts to Finnish forests. He has worked on EU circular economy matters and studied global megatrends. Previous, to his current position, Ernesto Hartikainen has also been an entrepreneur and consultant to global companies on new business opportunities in the forest and energy sectors. Ernesto Hartikainen is a highly competent engineer and economist, with the ability to speak eight languages.
Phone number	+358 50 346 1035
Address	Itämerenkatu 11-13, PO Box 160, 00181 Helsinki, Finland
Email:	ernesto.hartikainen@sitra.fi
Website:	www.sitra.fi

5 Industrial symbiosis projects within other financial mechanisms

5.1 BAMB

Title	Buildings as Material Banks (BAMB)
Programme	Horizon 2020
Duration	2015-2019
Budget	9,933,112€
Lead partner	Brussels Environment (Belgium)
Project summary	The BAMB project (www.bamb2020.eu) aims at the prevention of construction and demolition waste, the reduction of virgin resource consumption and the development towards a circular economy through industrial symbiosis, addressing the challenges mentioned in the Work Programme on Climate action, environment, resource efficiency and raw materials. The focus of the project is on building construction and process industries (from architects to raw material suppliers). The BAMB project implements the principles of the waste hierarchy: the prevention of waste, its reuse and recycling.
Objectives and main activities	BAMB's primary objective is to enable a systemic shift in the building sector by creating circular solutions. Particular objectives include to: a) foster the sustainable lifecycle management of materials, products and buildings, eliminating waste and reduce the use of virgin materials, b) reduce the costs by managing resources rather than managing waste, and c) preserve the buildings. Main activities include the a) design of advanced ICT tools and management models to enable the organization of circular value chains in building and process industries, b) research activities to bridge the existing knowledge gaps concerning waste collection and recovery, c) the elaboration on new business models for circular value chains, d) the inclusion of strategic partners along the value chains in an industrial board, and e) communication activities to change consumers' behaviour.
Potential synergies with SYMBI	- Invitation to showcase the circular economy concept for the construction industry during the study visits - Integration of BAMB's main outputs in SYMBI partners' regional policy strategies and plans focused on the construction sector - Regular exchange of information and experience through Skype meetings and emails
Contact person	Caroline Henrotay (Project Manager) Brussels Environment chenrotay@leefmilieu.brussels

5.2 CABRISS

Title	Implementation of a CirculAr economy Based on Recycled, reused and recovered Indium, Silicon and Silver materials for photovoltaic and other applications (CABRISS)
Programme	Horizon 2020
Duration	2015-2018
Budget	9,281,682€
Lead partner	French Alternative Energies And Atomic Energy Commission (France)
Project summary	The CABRISS project (www.spire2030.eu/cabriss) aims to develop a circular economy pattern mainly for the photovoltaic, but also for electronic and glass industry. The project will comprise: (i) recycling technologies to recover In, Ag and Si for the sustainable PV technology and other applications; (ii) a solar cell processing roadmap, which will use Si waste for the high throughput, cost-effective manufacturing of hybrid Si based solar cells and will demonstrate the possibility for the re-usability and recyclability at the end of life of key PV materials.
Objectives and main activities	Project's main objectives include: a) developing industrial symbiosis by providing raw materials such as glass or silver pastes as feedstock for other industries, b) collecting up to 90% of the PV waste throughout Europe, c) retrieving up to 90% of the high value raw materials from the PV cells and panels, d) manufacturing PV cells and panels from the recycled raw materials achieving lower cost (25% less), and e) involving the EU citizens and industry into such a sustainable and financially viable new economy. Main activities include: a) PV waste collection and dismantling, b) purification of silicon recovered in PV wastes, c) fabrication of silicon wafers, and solar cells using recycled materials, d) transformation of recycled materials into usable products, e) materials qualifications, f) materials' lifecycle assessment and business models, and g) dissemination activities.
Potential synergies with SYMBI	- Showcase the circular economy pattern for photovoltaic in the SYMBI workshop on secondary raw materials. - Joint communication activities (e.g. a joint exhibition booth in the Circular Economy European Summit) - Regular exchange of information and experience through Skype meetings and emails
Contact person	David Pelletier (Project Manager) French Alternative Energies And Atomic Energy Commission david.pelletier@cea.fr

5.3 CIRC-PACK

Title	Towards circular economy in the plastic packaging value chain (CIRC-PACK)
Programme	Horizon 2020
Duration	2017-2020
Budget	9,252,466€
Lead partner	Research Centre For Energy Resources And Consumption (Spain)
Project summary	CIRC-PACK project aims at more sustainable, efficient, competitive, less fossil fuel dependence, integrated and interconnected plastic packaging value chain. To this end, three case studies will work in developing, testing and validating better system-wide economic and environmental outcomes by i) decoupling the chain from fossil feedstocks, (ii) reducing the negative environmental impact of plastic packaging; and (iii) creating an effective after-use plastics economy. All in all, the work will be supported by non-technological analysis and advanced methodological analysis (including circular economy and industrial symbiosis principles) which will trigger a broadly deployment of the tested solutions.
Objectives and main activities	- Validating 100% new biodegradable and cost-competitive materials, from renewable resources, non-competitive with agricultural crops - Validating new packaging solutions that will enable the end-of-life separation of materials. - Triggering the utilization of recycled material as raw material and create closed-loop recycling flows and multi-sectorial cascade recycling process - Addressing the barriers to facilitate a broader transition to the circular economy through development of roadmaps concerning regional and national integration strategies of plastic waste management - Developing a life-cycle methodology to assess the performance of CIRC-PACK value chain in terms of circularity improvement. - Developing new sustainable business models to enable a circular use of plastic materials
Potential synergies with SYMBI	- Invitation to participate in the SYMBI workshop on secondary raw materials markets, as well as the study visit to share practices on waste to energy systems - Dissemination of SYMBI's newsletters/outputs during CIRC-PACK project events - Access to CIRC-PACK's databases and knowledge repository to get practical information for introducing IS business models for the packaging industry
Contact person	Beril Şenyurt Ekodenge beril.senyurt@ekodenge.com

5.4 PAPERCHAIN

Title	New market niches for the Pulp and Paper Industry waste based on circular economy approaches (PAPERCHAIN)
Programme	Horizon 2020
Duration	2017-2021
Budget	9,217,196€
Lead partner	Acciona Construction SA (Spain)
Project summary	The overall objective of PAPERCHAIN (https://paperchain.eu/) is to deploy five novel circular economy models centred in the valorisation of the waste streams generated by the PPI as secondary raw material for a number of resource intensive sectors: construction sector, mining sector and chemical industry. PAPERCHAIN aims to unlock the potential of a resource efficient model based on industrial symbiosis which will demonstrate the potential of the major non-hazardous waste streams generated by the PPI as valuable secondary raw material.
Objectives and main activities	Project's main objectives are to: a) design the baseline for the circular economy models surrounding the Paper and Pulp Industry and the selected sectors, b) implement the valorisation processes at industrial scale, c) demonstrate the circular models at real scale in four EU countries, d) validate the sustainability of the circular economy models, e) carry out the certification processes, training and guidelines for the recycled solutions, and f) develop a market strategy, exploitation routes and ensure replication. A systemic approach will be followed for each of the major sectors targeted, integrating the whole value chain from the waste production through their final application. In each sector, all the major stakeholders will be present in the circular model including waste production, waste treatment and recovery, product manufacturing, end-users of the products and civil society. Five Different Circular Economy Models are proposed within the Construction sector, the Chemical sector and the Mining sector.
Potential synergies with SYMBI	- Regular meetings and coordination between projects, given the lead partners from both projects come from Spain - Integrate the main lessons learnt from PAPERCHAIN into SYMBI partners' regional action plans focused on the construction, chemical and mining sectors. - Showcase the deployed circular economy business models in SYMBI study visits
Contact person	n/a

5.5 FISSAC

Title	Fostering Industrial Symbiosis for a Sustainable resource intensive industry Across the extended Construction value chain (FISSAC)
Programme	Horizon 2020
Duration	2015-2020
Budget	11,523,404€
Lead partner	Acciona Construction SA (Spain)
Project summary	The FISSAC project involves stakeholders at all levels of the construction and demolition value chain to develop a methodology and software platform, to facilitate information exchange that can support industrial symbiosis networks and replicate pilot schemes at local and regional levels. The model will be based on three sustainability pillars: a) environmental (with a life-cycle approach), b) economic, and c) social (taking into consideration stakeholder engagement and impact on society). The project's ambition is that the model to-be-created can be replicated in other regions and other value chain scenarios.
Objectives and main activities	FISSAC's overall objective is to develop and demonstrate a new paradigm built on an innovative industrial symbiosis model towards a zero waste approach in the resource intensive industries of the construction value chain, tackling harmonized technological and non-technological requirements, leading to material closed-loop processes and moving to a circular economy. A methodology and a software platform will be developed in order to implement the innovative industrial symbiosis model in a feasible scenario of industrial symbiosis synergies between industries (steel, aluminium, natural stone, chemical and demolition and construction sectors) and stakeholders in the extended construction value chain. It will guide how to overcome technical barriers and non-technical barriers, as well as standardization concerns to implement and replicate industrial symbiosis in a local/regional dimension. The ambition of the model will be to be replicated in other regions and other value chains symbiosis scenarios. The model will be applied based on the three sustainability pillars.
Potential synergies with SYMBI	- Invitation to showcase the FISSAC platform during the SYMBI regional conference - Access to FISSAC's knowledge repository - Participation in FISSAC events - Co-develop a network of stakeholders from the construction industry
Contact person	Angeliki Koulouri Acciona Construction SA info@fissacproject.eu

5.6 REBIRTH

Title	Promotion of the recycling of industrial waste and building rubble for the construction industry (REBIRTH)
Programme	LIFE
Duration	2012-2014
Budget	981,528€
Lead partner	Slovenian National Building And Civil Engineering Institute (Slovenia)
Project summary	Waste and its value as a resource are an issue which has been recently addressed intensively in the EU. This is reflected both in the environmental strategies for future years and in the goals set in the waste directive 2008/98/EC for waste material streams, including construction and demolition wastes, subsequently referred to as C&D waste. This is recognised the most voluminous waste stream in most EU countries, representing on average roughly between 25-30 % of the total quantity of waste produced annually. This waste has a high potential to be transformed into excellent raw materials for construction and has already been identified as waste which could greatly benefit from the introduction of End-of-Waste criteria. Similarly certain inert industrial waste streams, currently being landfilled, display properties which make them promising raw materials for construction purposes.
Objectives and main activities	The general objective of the project is to contribute to the increased and better recycling of industrial waste and construction/demolition waste in the construction sector. Project's main activities included a) the implementation of a preliminary study on CDW to identify the current problem status and establish a common communication platform, b) the organisation of an international conference to inform target groups about the waste to resource problem, existing best practices, technical possibilities as well as the role of research and life cycle assessment, and c) the organisation of workshops and practical shows on waste management, green public procurement and the role of Life Cycle Assessment (LCA) in business-to-business environmental declarations
Potential synergies with SYMBI	- Integrate the main lessons learnt into SYMBI partners' regional action plans focused on the construction sector - Invitation to participate in SYMBI activities (e.g. workshop on secondary raw materials, regional conference) - Elaborate on a follow-up project on industrial waste management
Contact person	Alenka Mauko Pranjić Slovenian National Building and Civil Engineering Institute alenka.mauko@zag.si

5.7 LOWASTE

Title	Local Waste Market for Second Life Products (LOWASTE)
Programme	LIFE
Duration	2011-2014
Budget	1,109,000€
Lead partner	Municipality of Ferrara (Italy)
Project summary	The LOWASTE project (www.lowaste.it) demonstrated that through a public-private partnership model involving a community of local and social enterprises it is possible to find innovative governance solutions for decreasing local waste and developing closed loops for second life products at local level.
Objectives and main activities	The LOWASTE project aimed to reduce urban waste and preserve natural resources by developing a local market for recycled materials. Project beneficiaries worked toward this goal by enhancing existing green public procurement schemes, by promoting waste prevention and encouraging the use of recovered materials, and by raising awareness of how waste can be reduced through reuse or the purchase of recycled products. LOWASTE project has experimented a circular economy model in Ferrara, focusing on waste materials' prevention, reuse and recycling of waste materials. Pilot studies formed the basis for the emergence of a genuine local green circular economy district, which consisted of waste operators, small reuse and recycling platforms, artisans and SMEs engaged in the development of materials and manufacturing. Overall, the project implemented/developed: a) four pilot applications (chirurgical textile, aggregates from demolition, street furniture and play equipment, oils and food scraps), b) two feasibility studies (centre for preparation for reuse, plastic PET), c) three new recovery facilities authorized during the pilot, and d) a follow-up project (Waste Fab Lab).
Potential synergies with SYMBI	- Integrate the main lessons learnt from pilot application into SYMBI partners' regional action plans and strategies (where relevant) - Invitation to participate in the SYMBI workshop on secondary raw materials markets - Arrange a study visit in LOWASTE recovery facilities in Italy - Joint communication activities to raise public awareness on recycling and sustainable waste management
Contact person	Lara Sitti Municipality of Ferrara i.sitti@comune.fe.it

5.8 PAVETHEWAYSTE

Title	Demonstrating Resource Efficiency Through Innovative, Integrated Waste Recycling Schemes for Remote Areas (PAVETHEWAYSTE)
Programme	LIFE
Duration	2015-2018
Budget	1,758,267€
Lead partner	Municipality Of Naxos And Small Cyclades Islands (Greece)
Project summary	The PAVETHEWAYSTE project (http://pavethewayste.eu) aims to facilitate the implementation of the Waste Framework Directive in remote areas, by enabling local and regional authorities to improve their municipal waste recycling performance and thus pave the way to high resource efficiency. This will be achieved through the development and application of an economically viable solid waste management plan, based on the demonstration of an innovative system for the fine separation of municipal solid waste (MSW) at source.
Objectives and main activities	The projects' objective are to a) contribute to the maximum recovery of resources, producing more than five streams of pure materials using source separation of MSW from households in remote areas, b) make waste recycling an economically attractive option in remote areas where transport costs are predominant, c) promote waste separation and treatment at source, avoiding waste collection, transportation and treatment in centralised facilities, and d) eradicate MSW landfilling with the establishment of an integrated and replicable, innovative system for the sustainable MSW management in remote areas. Main activities include: a) assessing market potential for recyclable waste, b) setting an integrated solid waste management strategy for remote areas, c) designing innovative systems for waste separation and treatment, and pilot-testing in selected areas, d) assessing project results based on Life Cycle Analysis, and e) evaluating end-products' marketability.
Potential synergies with SYMBI	- Regular exchange of information/publications between the municipality of Kozani and the municipality of Naxos - Participation in the PAVETHEYWASTE workshop on integrated waste management strategies to be held in Ancient Olympia, Greece - Joint marketing campaigns through social media
Contact person	Dimitrios Tsoukleris Municipality Of Naxos And Small Cyclades Islands dtsoukleris@gmail.com

5.9 LIFE In-BRIEF

Title	Integrated business model for turning Bio-waste and sewage sludge into renewable energy and agri-urban Fertilizers (LIFE In-BRIEF)
Programme	LIFE
Duration	2015-2018
Budget	1,396,758€
Lead partner	Metal-Processing Technology Institute (Spain)
Project summary	The LIFE In-BRIEF project (www.lifeinbrief.eu) aims to develop and implement a new business model for the resource-efficient management of certain biodegradable waste, increasing its use for bioenergy and in bio-products. This will be done through an integrated management model for processing different bio-waste generated by agri-food enterprises, and sewage sludge from urban waste water treatment, transforming it into renewable energy and high quality fertilisers.
Objectives and main activities	Projects' main objectives include: a) designing a new management model of bio-waste and sewage sludge, b) demonstrating and validating the transformation process for turning bio-waste into valuable resources, c) developing an organic liquid fertiliser made from bio-waste, d) reducing the operating costs of a biogas industrial plant by recovering thermal energy surplus, e) mitigating soil and water polluting, and f) promoting the use of biogas plants for bio-waste management. The project comprises the following activities: - The elaboration on a new demonstration model of bio-waste management - The construction of a pilot plant for bio-waste management - The agronomic validation of fertilizers in urban and agricultural environment - Evaluating project's environmental and socio-economic impact - Assessing the replicability and transfer of this new business model
Potential synergies with SYMBI	- Invitation to participate in the SYMBI study visit to share practices on waste to energy systems (to be held in Finland) - Synergies through social media (e.g. joint marketing campaigns to promote circular economy and industrial symbiosis concepts) - Co-create a network of stakeholders (incl. policy makers) from the agricultural and food industry to promote sustainable bio-waste management
Contact person	Manuel Sánchez Metal-Processing Technology Institute msanchez@aimme.es

5.10 CREWSOD

Title	Waste Collection Rewarding System On Demand (CREWSOD)
Programme	LIFE
Duration	2011-2015
Budget	2,389,386€
Lead partner	Consorzio Sociale AM (Italy)
Project summary	The CREWSOD project (LIFE10 ENV/IT/000314) addressed two levels of the EU waste hierarchy: prevention and recycling. It worked with the public to minimise the amount of waste produced by offering tailored waste collection services - Service on Demand (SOD) and Self-Service on Demand (SSOD). These flexible tariff systems enabled households to pay only for the weight and volume of waste they generate, which proved an effective incentive to reduce waste. The project actions were implemented in seven Italian municipalities, where they increased amounts of separated waste suitable for recycling, and reduced waste disposal by landfill or incineration
Objectives and main activities	The CREWSOD project's main objectives focused on the introduction of a new public participation approach to minimise the amount of waste that people produce, where those that produce less waste will pay less for their waste collection services. The aim was to apply this innovative approach across the entire territory of the Municipality of Mosciano Sant'Angelo, in Italy's Teramo province. The project developed 7 prototypes of communal computerized containers for separate waste collection, whilst introducing flexible tariffs systems (rewarding households and businesses that make the most effort to separate their wastes and reduce waste disposal). The innovative containers' design (i.e. personal key card access systems) allowed the automated weighing of separated wasted as well as the traceability of users. The project also purchased new vehicles, bins and bags to facilitate the operation of waste processing stations.
Potential synergies with SYMBI	- Integrate CRESWOD's pricing schemes into SYMBI partners' regional action plans to discourage waste disposal and encourage recycling - Carry out a pilot application of the CREWSOD approach in a selected SYMBI area/region (e.g. KOZANI or EXTREMADURA, which have low recycling rates) - Invitation to participate in the SYMBI workshop on IS demonstration projects
Contact person	Angela De Laurtis Consorzio Sociale AM info@amconsorzio.it

5.11 Project managers to be invited by the hosting organisation

Project #1	**BAMB**
Name	Caroline Henrotay
Organisation	Brussels Environment
Education	PhD In Architecture
Position	Project Manager
Profile and experience	Caroline Henrotay has a master in the engineering sciences: architecture and finished her PhD in September 2008 at the Vrije Universiteit Brussel in the field of sustainable and reversible design. Between 2008 and 2012 she has been working as a lecturer, researcher and project manager within the field of sustainable and affordable building design at different academic institutes (VUB, ULB, Moi University – Kenia) and as a Technical and Academic expert for NGOs (amongst which Shelter Research Unit (SRU) of the International Federation of the Red Cross). She has been working as project manager at Brussels Environment since 2010, being also involved in the development and support of technical expertise within the area of sustainable construction & refurbishment in the Region of Brussels Capital. Over the years she has gained significant experience in the field of environmental protection, sustainable waste management, and resource efficiency. She is currently the technical coordinator and project manager of the BAMB project.
Phone number	+32(0)27757575
Address	Avenue du Port 86C / 3000 1000 Brussels, Belgium
Email:	chenrotay@leefmilieu.brussels
Website:	http://www.environnement.brussels/

Project #2	**CIRC-PACK**
Name	Beril Büyüker Şenyurt
Organisation	EKODENGE
Education	Master in Environmental Engineering
Position	Project Manager
Profile and experience	Beril Büyüker Şenyurt, a senior expert in ECODENGE, is responsible for the technical and administrative management of the Circular Economy EU-funded project (H2020) CIRC-PACK, and also a senior researcher in the FISSAC project (H2020). Beril holds a Masters and a Bachelor Degree in Environmental Engineering from the Middle-East Technical University and has an extensive working experience as an Environmental Expert, responsible for developing, implementing and monitoring environmental strategies to promote sustainable development in the cement industry, in compliance with environmental legislation and in liaison with state authorities.
Phone number	+90 312 299 25 55
Address	Hacettepe Teknokent 1, Ar-Ge Binası, 18 06800, Beytepe, Ankara, Turkey
Email:	beril.senyurt@ekodenge.com
Website:	http://www.ekodenge.com

Project #3	**REBIRTH**
Name	Alenka Mauko Pranjić
Organisation	Slovenian National Building and Civil Engineering Institute
Education	PhD In Geology
Position	Research Consultant
Profile and experience	Alenka Mauko Pranjić holds a Ph.D. In Geology from the Faculty of Natural Science and Engineering in the University of Ljubljana. She currently works as Deputy Head of the Laboratory for Concrete, Stone and Recycled Materials in the Slovenian National Building and Civil Engineering Institute (ZAG) on Circular Economy projects, such as ReBirth; the latter aims to contribute to the increased and better recycling of industrial waste and construction/demolition waste in the construction sector.
Phone number	+90 312 299 25 55
Address	Hacettepe Teknokent 1, Ar-Ge Binası, 18 06800, Beytepe, Ankara, Turkey
Email:	beril.senyurt@ekodenge.com
Website:	http://www.ekodenge.com

6 Study visit programme in Slovenia

" Study visit to transfer experiences on turning waste into resources"

Ljubljana, Slovenia

(21-22 November 2017)

DAY 1: TUESDAY, 21 NOVEMBER 2017

Time	Description
08:30 – 09:00	*Arrivals and registration*
09:00 – 09:30	*Welcome speech*
	Thematic session 1: Regulatory barriers to industrial symbiosis and waste recovery
09:30 – 10:00	Presentation by *Joanna DRAKE, European Commission – DG Environment (1)*
10:00 – 10:30	Roundtable Discussion: "Ways to overcome the key legal barriers hindering IS deployment"
10:30 – 11:00	Wrap-up: "Presenting the main conclusions drawn from the discussion"
	Thematic session 2: IS good practices: Success stories from across Europe
11:00 – 11:30	Presenting the BASF Verbund Industrial Symbiosis (Germany) *Martin BRUDERMÜLLER, BASF (2)*
11:30 – 12:00	Presenting the KAISERBACKE Industrial Ecosystem (Belgium) *Filip LESAFFER, 4EnergyInvest (3)*
12:00 – 12:30	Roundtable Discussion: "What are the main lessons learnt from actual implementation?"
12:30 – 14:00	*Lunch break*
14:00 – 18:00	**Study visit in the ECONYL regeneration plant in Ljubljana**
19:30	*Networking dinner*

DAY 2: WEDNESDAY, 22 NOVEMBER 2017

Time	Description
	Thematic session 3: Implementing a roadmap with financial incentives to promote industrial symbiosis
09:00 – 09:30	Presentation by *Draško VESELINOVIČ, Slovenian Business & Research Association (4)*
09:30 – 10:00	Interactive Exercise: "Formulating an action plan with funding measures to promote Industrial Symbiosis"
10:00 – 10:30	Wrap-up: "Presenting the main conclusions drawn from the discussion"
	Thematic session 4: Presenting the BAMB project
10:30 – 11:00	Presentation by *Caroline HENROTAY, Brussels Environment (5)*
11:00 – 11:30	Roundtable Discussion: "Forging synergies with other EU circular economy projects"
11:30 – 12:00	Wrap-up: "Presenting the main conclusions drawn from the discussion"
12:00 – 16:00	**Study visit: Experiencing the Dinos-DROE-UniREC industrial symbiosis project**
16:00 – 16:30	*Evaluation*

(1) Joanna Drake is the Deputy Director-General of the Directorate-General Environment, with extensive experience in EU policy development and implementation for circular economy.

(2) Dr. Martin Brudermüller is the Vice Chairman of the Board of Executive Directors and CTO of BASF, Ludwigshafen.

(3) Mr. Filip Lesaffer is the Executive Director of 4EnergyInvest; a wood processing company participating in the Kaiserbacke industrial ecosystem.

(4) Draško Veselinovič is President of the Management Board of the Slovenian Business & Research Association

(5) Carolin Henrotay is an experienced project management, currently coordinating the BAMB project under HORIZON 2020

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