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ACTIVITY 2: "COVID-19 IMPACT, CHALLENGES AND NEW INDUSTRIAL SYMBIOSIS OPPORTUNITIES (JOINT STUDY)"

METHODOLOGY TO IDENTIFY INDUSTRIAL
SYMBIOSIS PRACTICES AND OPPORTUNITIES
FOR ECONOMIC RECOVERY AND RESILIENCE
TO FUTURE CRISES IN PARTNERSHIP
REGIONS



SYMBI - 5th Interreg Europe call

**A Methodology prepared by
Municipality of Kozani**

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Abstract

This methodology, designed by Municipality of Kozani, aims to guide SYMBI partners to implement Activity 2, titled “COVID-19 impact, challenges and new Industrial Symbiosis (hereinafter ‘IS’) opportunities”. The latter consists one of the additional activities approved under the 5th Interreg Europe call, issued after the COVID-19 outbreak to support EU communities to recover from the pandemic and its socio-economic consequences.

More specifically, this document – consisting of four main sections – provides partners with the required thematic background regarding new IS practices and opportunities for recovery and resilience as well as with data collection guidance on how to gather relevant information concerning IS practices implemented in their region. Its structure is presented below:

- ❖ The [first chapter](#) introduces the rationale of SYMBI project, presenting key information about the Interreg Europe programme, the project itself as well as Activity 2.
- ❖ The [second chapter](#) presents the background research conducted, to better understand how IS practices have been disrupted by COVID-19 as well as the ways the former can contribute in economic recovery and resilience.
- ❖ The [third chapter](#) describes the data collection tool, it provides guidelines for the data collection process, and elaborates on the assessment criteria for the collected practices.
- ❖ The [fourth chapter](#) provides a detailed description of the evaluation criteria, to be applied to the cases collected, and specifies how the evaluation model works.

The data collection tool – namely, the questionnaire to be completed by stakeholders – [is annexed](#) at the end of this document.

1 Introduction

1.1 Interreg Europe

“Interreg Europe helps regional and local governments across Europe to develop and deliver better policy¹” through exchange of experience and good practices. It focuses on certain areas of regional and local development, such as research and innovation, SME competitiveness, low carbon economy, as well as environment and resource efficiency. More specifically, Interreg Europe funds interregional cooperation projects among partners, based in one of the 27 EU Member States, Norway, Switzerland or the United Kingdom. These partners can be public and managing authorities as well as agencies, research institutes, thematic and non-profit organisations, given that the latter are engaged with their local policymakers.

With respect to the support services it provides, Interreg Europe promotes cooperation, collaboration and community engagement in the partnership regions, which share a common interest in one of the aforementioned focus areas of the programme. Partners share experience, ideas and know-how about how best to deal with the issue at hand through different types of project activities, such as peer reviews, thematic workshops, capacity building events, and learning activities. The aim is to improve the way they design and implement their public policies in the supported areas by aid understanding and new ideas, different perspectives and collective learning. Finally, community engagement and public dissemination of results is also at the heart of Interreg Europe, whose secondary beneficiaries are citizens and communities as a whole.

1.2 5th call of Interreg Europe

In the context of the COVID-19 pandemic and its consequences on global economy, Interreg Europe continued supporting local and regional communities in its operational areas. More specifically, it currently supports local and regional policymakers in their attempt to mitigate the COVID-19 socio-economic impact and plan a fast and successful recovery from the ensuing economic crisis. Interreg Europe funds actions relevant to its nature, such as exchange of good practices, organisation of thematic activities and provision of expert support. However, due to the nature of the virus and the consequent restrictions taken by several EU countries, the programme ensures that all of the aforementioned actions are conducted in an appropriate mode with respect to the protective measures. To this end, virtual events and communication activities are foreseen as alternative to the physical ones.

1.3 The SYMBI project (Additional activities under the 5th call)

The “Industrial Symbiosis for Regional Sustainable Growth and a Resource Efficient Circular Economy – SYMBI” project aims to “improve the implementation of regional development policies and programmes

¹ <https://www.interregeurope.eu/about-us/what-is-interreg-europe/>





related to the promotion and dissemination of Industrial Symbiosis and Circular Economy² in the partnership regions. More specifically, industrial symbiosis looks at interactions between the environment, the economy and industry, and promotes the sharing of materials to minimize waste, following the example of a natural ecosystem, where everything is reused. Involving territorial synergies to manage waste and share services, utilities, and by-product resources, IS is of the fundamental pillars of circular economy. To this end, SYMBI project promotes these particular synergies in order to support partnership regions to transit to a circular mode of economy.

During its original duration – April, 1st 2016 until March, 31st 2021 – SYMBI project supported partners to exchange relevant good practices and lessons learnt, improve relevant policy instruments and action plans as well as develop synergies. However, the COVID-19 pandemic induced disruptions to IS practices; securing by any means the production and the operation of the territorial supply chains has come with the expense of sustainability and circularity. For these reasons, SYMBI project extended its duration by providing support for additional activities under the 5th call of Interreg Europe. This project extension aims to support partners to anew exchange of experience and lessons learnt concerning their attempt to mitigate the COVID-19 impact on their regional and local economies as well as conduct online events and actions to improve policy planning. The duration of these additional activities lasts from October, 1st 2021 to September, 31st 2022 – in case further time is required, activities can be concluded until December, 31st 2022.





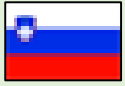
1.4 The SYMBI partnership

The SYMBI project brings together 9 partners from 7 countries. The synthesis of the partnership is the following:

Table 1: The SYMBI partnership

Country	Partner	Region
	Foundation FUNDECYT Scientific and Technological Park of Extremadura	Extremadura
	The Malopolska Region	Lesser Poland
	Chamber of Commerce of Molise	Molise
	Government Office for Development and European Cohesion Policy	Western Slovenia

² <https://www.interregeurope.eu/symbi/>

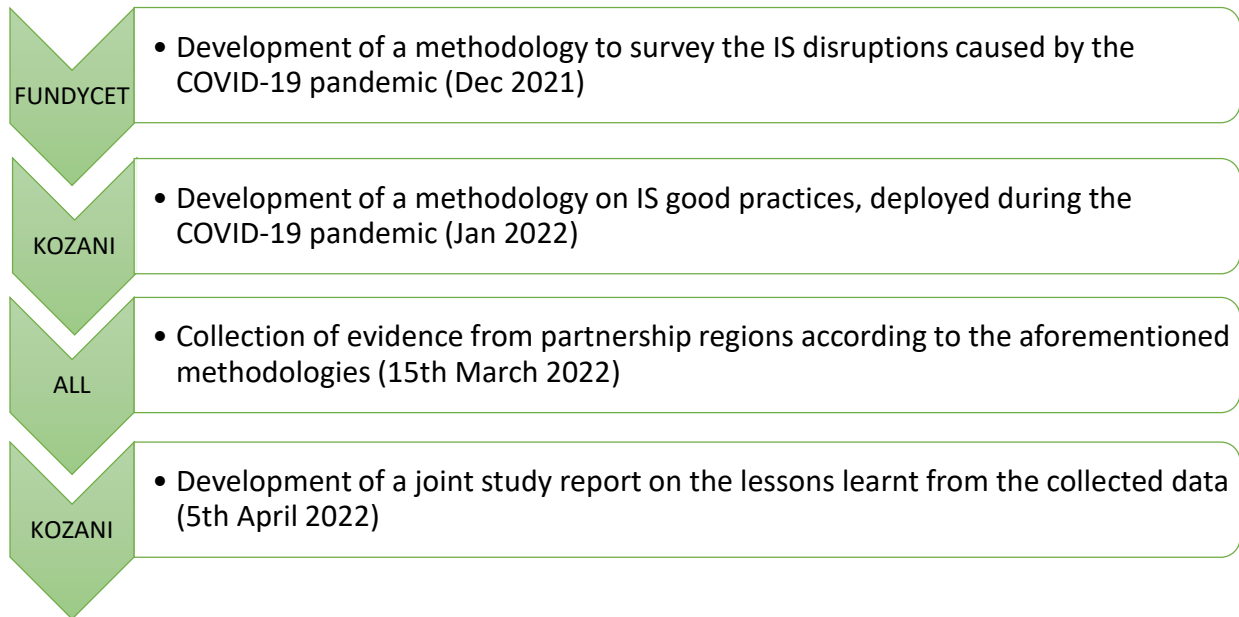
Country	Partner	Region
	Municipality of Kozani, Development and Planning Bureau	Western Macedonia
	Pannon Novum West-Transdanubian Regional Innovation Non-Profit Ltd	Western Transdanubia
	Regional Council of Häme	Southern Finland
	Häme University of Applied Sciences Ltd	Southern Finland
	Regional Development Agency of the Ljubljana Urban Region	Central Slovenia

1.5 **Activity 2**

Activity 2, titled “COVID-19 impact, challenges and new IS opportunities” will be completed with the delivery of a joint study, which will present the lessons learnt concerning (a) the identified good practices and emerging policy opportunities for IS in the partnership regions as well as (b) the COVID-19 impact on industrial, manufacturing, and waste management sectors. For the conduction of this study, relevant data is required. To this end, two methodologies will be developed by the Foundation (FUNDECYT) Scientific and Technological Park of Extramadura and the Municipality of Kozani. The current document, drafted by Municipality of Kozani, consists one of these two methodologies, addressing the second of the raised issues, namely the identification of good IS practices in the partnership regions.

The timeline of Activity 2 and partners’ main roles are presented below:

Table 2: Timeline of Activity 2



2 Thematic Background

2.1 Introduction

The outbreak of the pandemic has caused significant disruptions in the global economy and supply chains. Governments around the world have been forced to implement lengthy country-wide lockdowns or other restrictive measures in an attempt to curtail the spread of the virus. This has led to a significant drop in the demand for most goods, either as a direct result of the restrictive measures or due to the increased economic uncertainty and the deteriorating economic climate. Consequently, the impact of COVID-19 on the economies has been wide-ranging, encompassing most of the major economic sectors.

With regards to the EU, the pandemic has led its economy to plunge into severe recession. According to a relevant survey, the entire EU registered a 6.8% GDP contraction and the unemployment rate increased to 7.1%. At the same time, there has been an adverse impact on most supply chains, with international ones facing the greatest challenges due to the export bans and the limitations in international travel. For example, several countries imposed export bans or restrictions on medical supplies related to the fight against the pandemic. In a similar note, the agricultural sector, which is highly reliant on seasonal, often migrant labor, faced significant challenges due to the travel restrictions that required ad hoc measures from the governments in order to ensure the uninhibited continuation of agricultural activities.

Naturally, the disruptions to the fundamental economic activities are bound to have an adverse impact on synergetic and cooperative economic activities that encompass multiple supply chains. In that respect, circular economy are also expected to be negatively impacted by the pandemic.

2.2 Disruptions on IS practices, caused by COVID-19

Although the introduction of IS practices is expected to increase the resilience of the economy to external events (e.g., health crises, climate change, shocks in the supply / demand due to geopolitical developments), the latter will still have an impact on the economy nonetheless. In addition, the relative insignificance and immaturity – at least currently – of the circular economy compared to the conventional, linear economic model increases the vulnerability of IS practices and initiatives as they are embedded in an overwhelmingly linear economic structure, thereby sharing, necessarily, its vulnerabilities to external events. As a result, IS practices have also been impacted by the outbreak of the pandemic and the ensuing economic crisis. The current section focuses on disruptions on circular economy, in general, as the latter has been extensively explored with regards to the pandemic³. The main of them are presented below:

³ Particular focus on IS practices is attributed with respect to certain examples of cooperative practices that have been implemented during the pandemic.

2.2.1 Disruptions in social interactions among supply chain business partners

Studies have reported a more limited scope of social interactions among supply chain partners during the pandemic, which has not only caused information incompleteness but it has also reduced supplier engagement making it harder for the companies to develop a collaborative approach that builds synergies with other relevant actors. Although established cooperation initiatives that incorporate circular economy practices might not have been particularly impacted by this development, the restrictions in social interactions might have negatively impacted the development and realization of new industrial collaborations and cooperation initiatives.

2.2.2 Changes in public procurement priorities

Public procurement is expected to provide the necessary impetus for the transition to a circular, green economy. In the context of the pandemic, though, and the ensuing medical needs, there was a shift in policy priorities. The latter have primarily focused on procuring medical goods as quickly as possible to the detriment of green technologies and circular economy practices. Although necessary due to the severity of the health crisis, this shift had negatively impacted the adoption of circular economy practices by eliminating the available financial resources.

2.2.3 Regulatory changes

Beyond the changes in public procurement priorities, there were also COVID-induced changes in regulations that favored the current linear economic models and discouraged the adoption and implementation of circular economy practices. As an example, the compulsory use of single-use plastics in the hospitality industry has directly impaired the progress towards reusable items. Similar regulation changes due to safety protocols can have a considerable impact on the demand for circular products, discouraging further investment in the circular economy.

2.2.4 Changes in the private sector priorities

Along with the regulatory and procurement changes mentioned above, the willingness of businesses to adopt circular practices has waned during the pandemic, as lots of them have been adversely impacted by the economic crisis and are lacking the financial resources to invest in circular products / services. As an example, in a study among tourism experts, a number of them mentioned that the sustainability positions were the first to be cut due to the economic hurdles that the companies faced during the pandemic. In turn, this loss of valuable expertise is expected to significantly curtail the ability of these businesses to identify and implement circular economy concepts, thus, reducing the overall demand for circular products / services.

2.2.5 New types of waste

Finally, the outbreak of COVID-19 has given rise to types of waste that are new for most businesses (e.g., sanitizer gels, gloves, disposable masks), which lack the experience and the expertise to dispose them in

a sustainable way. In turn, this further reduces the circularity of the economy and poses new challenges to all the relevant actors. In a similar vein, certain types of waste are not suitable for recycling due to safety protocols. For example, the recycling of medical waste, which increased by 65% during the pandemic, is not allowed in Flanders. Instead, the waste is sent for decontamination or incineration.

2.3 Successful IS practices during COVID-19

Despite the disruptions in the circular supply chains and IS practices during the pandemic, COVID-19 has been also the cause for the realization of a number of successful bottom-up initiatives that employed circular economy concepts to mitigate the adverse impact of the crisis or provide urgently needed medical supplies, highlighting the advantages of circular supply chains in increasing the resilience of the economy and effecting a sustainable recovery.

For example, a study on breweries presented that the latter were able to utilize residue products to produce disinfection alcohol for medical applications. In another study, the case of a textile industry is presented, where individuals used textile leftovers to produce mouth masks that they subsequently supplied to hospitals and care facilities. Given the scarcity of medical supplies and the often exorbitant prices the governments had to pay to procure medical equipment and consumables, these examples underscore the importance of circular economy in providing alternative, more easily accessible supply sources in times of crisis.

In Denmark, the need for the urgent production of ethanol in Kalundborg, to be later used in the production of hand disinfectants, led to the creation of an IS synergy among the local actors. In particular, the wastewater generated by the production of ethanol, containing valuable organic material, is subsequently used in the production of biogas in the nearby biogas plant. The synergies created by the industrial cooperation have provided a number of benefits for the local actors and communities, showcasing the potential of IS. These benefits include, inter alia, reduced operational costs as waste is actually sold instead of requiring treatment and reduced CO₂ emissions.

At the same time, there are several cases, whereby the IS did not occur as a direct result of the COVID-19 outbreak but did take place during the pandemic, despite the adverse economic environment and the ongoing health crises. From this point of view, these initiatives provide lessons to be learned and implemented in the post-COVID era.

One example is provided by the North-C Methanol project, a large-scale demonstration project that will take place in North Sea Port, Belgium. The project comprises a 63MW electrolyser plant, which employs electricity produced by offshore wind turbines to separate water into hydrogen and oxygen. Oxygen will subsequently be used in the local steel industry, while the hydrogen will be combined with captured CO₂ from industrial sources in a catalytic methanol synthesis plant with a production capacity of 45,000 ton methanol per year. The project is currently in the realization phase, with the Joint Development

Agreement having been signed in 2020. A full-scale 300MW electrolyser plant has been scheduled for 2028, while a further expansion to a 600MW capacity has been planned for 2030.

2.4 Post-COVID economic recovery: Utilizing circular economy and IS to increase the resilience of the economy

The resilience of the European economy to external events came into question during the pandemic, which has made it conspicuous that there is a need to shield the EU economy from external events by increasing its resilience and ability to mitigate the impact of these events on the European value chains. This need is further amplified by climate change and the various geopolitical risks that increase the possibility of an environmental or geopolitical crisis. Consequently, the European societies are required to explore all avenues to increase the resilience of their economies in the coming years.

In general, several relevant studies agree that economic resilience to external shocks is related to the following attributes of the economy:

- The ability of the economy to avoid the shock.
- The ability of the economy to mitigate the impact of the shock.
- The ability of the economy to swiftly recover from the shock.

Adopting and implementing circular economy practices and facilitating the development of IS initiatives can prove highly beneficial in all of the three aforementioned cases by facilitating economic recovery and increasing the sustainability of European economy. In particular, the synergies developed through the establishment of IS schemes are expected to provide financial benefits to the participating businesses and the local communities, thus, contributing to a swifter and more effective recovery. At the same time, the reduced ecological footprint, intrinsic to circular economic models and practices, is expected to contribute to the longevity, economic and environmental, of the economic recovery.

From the IS practices that have been successfully implemented during the COVID-19 crisis (mentioned above), several important practices emerged as essential in mitigating the impact of external events, like the current COVID-19 pandemic. In that respect, it is important to orient the recovery efforts towards a direction that enhances their presence in the economy as well as the robustness of the synergies. To this end, the following factors should be considered:

2.4.1 Diversity in the supply chain

This refers to the necessity of having multiple supply sources to avoid bottlenecks and, consequently, increase the stability and sustainability of the system since the loss of an element can be replaced. This is particularly important in the case of circular economy due to the interdependence of the relevant actors. Relating this to the examples mentioned earlier regarding the successfully implemented IS practices, both the use of the brewery residues to produce disinfection alcohol and the production of ethanol in

Kalundborg, to be used for hand disinfectants, constitute alternative supply sources, which provide stability to the system in times of crisis.

2.4.2 Supply chain agility

This concept refers to the ability of an entity, a business or an integrated network of organisations, to quickly adapt to changes in the economic environment and adjust or shift its activities based on the economic environment. Ensuring that the entire supply chain has the necessary agility to adapt to changing situations and meet new challenges has obvious advantages in terms of sustainability and ability to alleviate the impact of unexpected external events.

2.4.3 Localization strategies and shorter supply chains

The implementation of circular economy practices increases the cooperation between the various economic actors by incorporating them in a single supply chain. When these practices have a localized character, as in the case of IS, they lead to shorter supply chains, thus reducing the overall exposure of the economy to risks and crises affecting third countries. A corollary to this is the reduced dependency on foreign sources for the supply of raw materials. The popularization of circular economy practices will increase the valorization of waste, providing alternative paths to obtain raw materials. This will curtail the dependence of EU on international supply sources and mitigate the impact of geopolitical risks and events on European value chains.

2.4.4 Increased cooperation between participating actors

Circular economy incorporates various economic actors into a value chain, developing synergies between them through a cooperative process that valorizes the waste produced in the previous stages of the value chain. Hence, circular economy, by definition, increases the cooperation between the various actors in the value chain. In turn, close cooperation between the primary actors of the value chain is expected to contribute to their ability to mitigate the impact of external events and disturbances in the world markets and, thus, increase the resilience of the economy.

Based on the above considerations, it becomes evident that i) there is a clear policy momentum towards “green”, climate-neutral solutions, and increasing the resilience of the economy ii) there is sufficient funding devoted to affecting an economic recovery from the pandemic-induced economic crisis and realizing changes of a fundamental nature to the EU economic model iii) introducing circular economy practices, such as IS, is essential in achieving those goals. Consequently, IS, along with other relevant practices within the context of a circular economy, should be viewed as an integral part of the post-COVID recovery.

3 Survey Design

3.1 Overview

As described in the introduction, the current survey aims to identify **good practices** that have helped or could help partnership regions to recover from the adverse economic consequences of COVID-19 and build resilience to future crises. To this end, it provides partners with the required tools to conduct case studies for their own regions by collecting relevant data.

To guarantee that all results are documented in a consistent and clearly structured manner, the methodology provides a common approach for collecting the required data. To this end, **a questionnaire** has been developed, addressed to:

- **Businesses and organisations that are involved in the implementation of IS practices in the partnership regions.** The questionnaire aims to identify IS practices that have been already implemented in the partnership regions, either during or due to the COVID-19 pandemic and the ensuing economic crisis.

The questionnaire can be found annexed at the end of this document. Specific information such as survey objective, target group and required data collection process is provided in the relevant subsections of the current chapter.

3.2 What is a best practice?

The goal of the Interreg Europe projects is to “jointly tackle common challenges and find shared solutions in fields such as health, environment, research, education, transport, sustainable energy and more⁴”. This is to be achieved through cross border cooperation and knowledge sharing between EU territorial authorities. Consequently, the identification and sharing of thematically-relevant successful examples (i.e., best practices) between the participating partners is integral to the realization of the overarching goals of the program.

In the context of this methodology report, it would be prudent to provide guidelines on what constitutes a successful example – here described as good / best practice depending on its effectiveness or impact – since conforming to a common set of selection criteria will simplify the post-survey analysis and significantly increase the quality of the conclusions drawn from the survey.

In general, practices (i.e., models, actions and initiatives, procedures, techniques or methodologies) that are proven to work well within certain geographic, administrative or organisational settings are defined as “good”, “best” or “effective”, based on their level of effectiveness, wider impact, transferability and replicability. A “best” practice also refers to the solutions, actions, processes, approaches or

⁴ <https://interreg.eu/about-interreg/>

methodologies that have proven to be successful in a specific context (e.g., country, region, city, enterprise, organisational department) and demonstrate strong evidence that there might be also efficient in similar settings and environments.

In order for a practice to be considered as “best” it should meet certain prerequisites. Therefore, a best practice could be defined as a practice that:

- ❖ Addresses a common problem or issue experienced by different organisations / contexts / regions / cities;
- ❖ Makes an original contribution or offers a significant improvement to a shared problem compared to existing practices;
- ❖ Is proven successful by providing measurable or demonstrable results or by going through internal or external validation and evaluation;
- ❖ Can be effective in more than one organisational or regional settings; and
- ❖ Can be replicated, at least to some extent.

In the context of the present methodology report, the following cases of successful IS should be examined by the participating partners:

- ❖ IS examples directly contributing to the fight against the COVID-19 pandemic
- ❖ IS examples taking place during the pandemic, even when not directly related to the fight against COVID-19.
- ❖ Older IS examples that the participating partners are still relevant as tools towards economic recovery and resilience.

Finally, it is important to note that the provided examples should take place (wholly or partly) within the country of the corresponding participating partner.

3.3 Survey objective and target group

The questionnaire aims to gather data on IS practices that have been implemented by businesses in the partnership regions. These practices might have been implemented **before or during the pandemic.** Moreover, they might have been deployed either as a response to the ensuing economic crisis or as a practice already involved in the business strategy, irrespective of the COVID-19 outbreak. To ensure that relevant information will be gathered, the questionnaire is expected to be completed by **businesses, organisations and / or institutions that are directly involved in circular economy.** To this end, **SYMBI partners are advised to disseminate the questionnaire to the aforementioned actors, operating in their regions.**

Relevant actors (i.e., businesses / organisations / research centres) are advised to assign a person who has the required knowledge and experience to complete the questionnaire (i.e., on IS development

projects and networks). This might be **employees** (e.g., board members and operational managers), owners and directors of businesses and / or organisations as well as **experts in relevant research centres that participate in the IS synergy**.

3.4 Data collection process

Based on their experience so far, the assigned person can fill out the questionnaire by providing information concerning the **relevance of IS practice, its implementation as well as its transferability**. Should respondents do not have all the required information, it is highly recommended that they consult **internal reports, business letters** as well as **financial sheets** (i.e., conduct an internal desk research). Respondents are also welcomed to include any further information / source regarding the implemented IS practice at the end of the questionnaire. These external sources are considered valuable for providing insights into the implementation process.

3.5 Examples of relevant cases to guide data collection

Example 1: The ULTIMATE project (<https://cordis.europa.eu/project/id/869318>)

The ULTIMATE project, initiated during the pandemic (June 2020) and expected to conclude in 2024, aims to operate as a catalyst for ‘Water Smart Industrial Symbiosis’ (WSIS). That is, it implements industrial symbiosis in the field of water/wastewater management in order to develop a resilient and dynamic socio-economic and business-oriented industrial ecosystem that addresses the needs of the sector that emerged during the pandemic. As a result, it will enable water providers to improve circular water/wastewater management in critical times and decrease water prices by making their industrial processes more efficient and eco-friendly.

26 actors from 11 countries are involved: 4 in Italy, 3 in Spain, UK, Greece, France and Israel, 2 in Germany, and Denmark and 1 in Belgium, Norway and Netherlands. Participants are leading water companies and water service providers, specialized SMEs, research institutes, all creating a water-industry collaboration network where a strong partnership between industrial complexes and symbiosis clusters is mobilized.

To this end, the collaboration networks involved aim to recover, refine and reuse wastewater (industrial and municipal) but also extract and exploit energy (combined water-energy management, treatment processes as energy producers, water-enabled heat transfer, storage and recovery) and materials (nutrient mining and reuse, extraction and reuse of high-added-value exploitable compounds) contained in industrial wastewater, to ensure their replicability through smart tools. So far there have been 25 publications indicating why water is key to unlocking circular economy between utilities and industries and the how symbiotic networks in the field of water and wastewater management can assist businesses in resilient planning.

Example 2: The INCUBIS project (<https://cordis.europa.eu/project/id/894800>)

Commencing at the beginning of the COVID-19 crisis, on May 2020, and expected to be completed in 2023, INCUBIS aims to assist in the decarbonization of the European industry by unlocking the market potential of Energy Symbiosis. That will be achieved by developing and deploying five Energy Symbiosis Incubators across Europe, complemented by a digital Cloud Incubator, thus enabling the utilization of waste energy from each separate Incubator. In doing so, INCUBIS will achieve total energy savings of 200GWh/year, trigger €6 Million of investments in sustainable energy, generate benefits of €4 Million, achieve GHG reduction of 55k tCO₂-eq/year, and convince 1450 business over 40 industrial parks to commit to energy cooperation. These energy savings, and benefits will be reflected as energy price decrease and financial aid to those whose job was suspended during the pandemic or those who completely lost their jobs. The project consortium consists of 8 partners including 5 SMEs that span 6 European countries (Spain, UK, Poland, Switzerland, Norway and Germany).

The project will achieve significant heat savings, accounting to 370.41 TWh gains per year for energy-intensive industries across Europe. On the other hand, it is estimated that at least 50-70% of EU households could be served more cheaply by thermal infrastructure through district heating networks. District heating currently provides only 8% of the heating demand in Europe. Therefore, the goal is to increase energy efficiency growth rates and to contribute significantly to the decarbonisation targets of the European Industry by using the large, under-utilized energy resources to substitute conventional heat sources in the European industrial and urban sector.

This development is expected to increase territorial resilience, in particular in EU regions in transition and increase their resilience in terms of energy dependency. So far, progress has been observed with the creation of an Alliance for Energy Cooperation in European Industries, setting up a common collaboration agreement that seeks to maximize their impact and improve the quality and the relevance of their outputs.

Example 3: the ICARUS project (<https://cordis.europa.eu/project/id/958365>)

The ICARUS project aims to demonstrate modular processing solutions at industrial scale to retrieve 95% of high-value raw materials from silicon ingot and wafer manufacturing, through eco-efficient processing, refining, and transformation of industrial silicon, graphite and silica waste streams in the context of industrial symbiotic scheme. Beginning during the pandemic, in June 2021, and expected to last approximately 4 years, the consortium comprises 16 partners from France, Norway, Germany, Cyprus, Spain, Italy, Sweden and Netherlands, with technological, environmental and other recognized actors among them.

Through industrial symbiosis, the partnership will provide refined raw materials for further industrial high-end applications. Material closed-loop systems will enable a circular economy for silicon ingot and wafer

manufacturers, potentially unlocking substantial volumes of raw materials: 9.600.000t of silicon, 1.165.300t of silica and 64.000t of graphite by 2050.

The end products to be created through this industrial symbiosis scheme are particularly relevant for addressing raw material gaps in key EU industrial sectors, especially regarding the silicon shortage (electronic chip production) and graphite (electric batteries production). Thus, the ICARUS project is a prime example of how territorial economies can both address supply chain gaps that emerged due to the COVID-19 crisis as well as enhance their competitiveness and create green jobs.

3.6 Additional guidelines for the collection of cases

- 1) **Project partners from the same country** will share the responsibility for data collection in own territory, **expected to identify cases that correspond to different IS approaches and synergetic schemes**. It is suggested that they should define different research areas to avoid duplication of work.
- 2) The cases on industrial innovation eco-systems and synergetic schemes of energy and by-product exchanges identified and collected by project partners should be sent to the **activity leader** (i.e., Municipality of Kozani) **for review and feedback**. In case of corrections or further comments, input will be asked from related partners.
- 3) Taking into account that industrial eco-systems have a unique structure, follow different patterns and address different needs, it is highly recommended that Municipality of Kozani – which is the partner responsible for the evaluation of cases and the development of the joint study – should ask project partners to contribute with peer review on the draft version of the report and recommendations for improvements, if needed.

3.7 Key performance indicators (KPIs)

Minimum targets for the collection of IS recovery and resilience practices have been set, by taking into account the timeline of Activity 2 as well as the dissemination capacities of partners. The aim of these targets is to track and monitor the data collection process and to make sure sufficient data will be gathered; the following table presents the KPIs set for each partner.

Table 3: Key Performance Indicators

Partner	Country	Minimum Target
Foundation FUNDECYT Scientific and Technological Park of Extremadura	Spain	2
The Malopolska Region	Poland	2
Chamber of Commerce of Molise	Italy	2

Government Office for Development and European Cohesion Policy	Slovenia	2
Municipality of Kozani, Development and Planning Bureau	Greece	2
Pannon Novum West-Transdanubian Regional Innovation Non-profit Ltd	Hungary	2
Regional Council of Häme	Finland	2
Häme University of Applied Sciences Ltd	Finland	2
Regional Development Agency of the Ljubljana Urban Region	Slovenia	2
Total	-	18

3.8 Action plan and roadmap for data collection

After project partners have received the methodology, to be delivered by Municipality of Kozani until January, 2022, feedback for it is expected **within two weeks**. Any comments will be incorporated into the final methodology report. The deadline for SYMBI partners to provide territorial data (by filling-in the questionnaire) is the **March, 15th 2022**. The activity leader (Municipality of Kozani) will review the collected evidence. All responses should be gathered and delivered in an integrated format. Finally, the data gathered will be analysed and used for drafting the **joint study** – the final deliverable of SYMBI Activity 2 – which is to be delivered by the activity leader until **March, 3rd 2022**.

Table 4: Action Plan of Activity 2

<p>Stage A: Development of Methodologies (FUNDECYT & KOZANI, 12/2021 - 01/2022)</p> <ul style="list-style-type: none"> •Development of methodologies to guide data collection.
<p>Stage B: Data collection (All partners, 03/2022)</p> <ul style="list-style-type: none"> •Filling in the questionnaire with relevant evidence and returning it to activity leader (Municipality of Kozani).
<p>Stage C: Data analysis & joint study (KOZANI, 04/2022)</p> <ul style="list-style-type: none"> •Validation and consolidation of data collected. •Data analysis and assessment of good practices. •Presentation of data analysis results as well as the identified good practices.

4 Evaluation Criteria for the practices collected

4.1 Questionnaire

The questionnaire will be evaluated accordingly. The required differentiations in the evaluation process are documented in the following table.

Table 5: Evaluation Criteria Breakdown

#	NAME	CRITERIA	POINTS	WF
A. Relevance & Effectiveness				
C.1	Relevance (cumulative sum)	Workforce shortage	1	
		Disruption in the supply chain	1	
		Materials' price inflation	1	
		Shortage in raw materials	1	
		Disruption in shipping operations.	1	
		Other	1	
C.2	Effectiveness	Major difficulties had been encountered and the symbiotic practice was not fully realised.	1	1
		Major difficulties had been encountered, which required great effort to be successfully tackled.	2	
		Major difficulties had been occasionally encountered, which were threatened in time without posing further disturbance.	3	
		The symbiotic practice faced minor difficulties and had an overall smooth implementation.	4	
		The implementation of the symbiotic practice had no problems or difficulties whatsoever, outperforming implementation expectations.	5	
B. Implementation				
C.4	Implementation cost	The implementation of the symbiotic practice had a positive impact on the economic activity of the participating business(es).	2	1
		The implementation of the symbiotic practice had no impact on the economic activity of the participating business(es).	1	

		The implementation of the symbiotic practice had a negative impact on the economic activity of the participating business(es).	0	
C.5	Enablers (cumulative sum)	Geographical proximity of the involved actors	1	1
		Multiple supply sources which can be easily replaced	1	
		Low economic risks	1	
		Adequate funding / support from public authorities	1	
		Adequate funding / support from private companies (e.g., banks)	1	
		Good cooperation among businesses	1	
		Previous experience in such synergetic practices	1	
		Legal and political support	1	
		Other	1	
C.3	Barriers (cumulative sum)	Lack of personnel	1	-1
		Lack of appropriate training of people involved	1	
		Lack of resources	1	
		Lack of communication / cooperation between participating businesses	1	
		Lack of appropriate external support (e.g., economic support by public authorities)	1	
		Lack of appropriate technology	1	
		Lack of strategic objectives / planning	1	
		Other	1	
C. Transferability				
C.6	Features of transferability (cumulative sum)	Demonstrated benefits outweigh investment costs	1	2
		Use of standardised technology solutions and processes	1	
		Low implementation risks	1	
		Small change in daily operations, low risk of organizational resistance	1	
		Needs addressed are common among industries, organisations and different regions / countries	1	
		Other	1	
C.8	Documentation of the implementation process (cumulative sum)	The symbiotic practice has documented in public documents and is easily accessible to the public.	1	2

		All the required information and data have been documented with descriptive details of the whole implementation process.	1	
		There are documented results, which can be consulted by any interested actor.	1	
C.7	Transferred to new settings	Yes	1	2
		No	0	
D. Robustness				
B.3	Geographical proximity	More than one countries involved.	1	1
		All are located within the same country.	1	
		All are located within the same region.	2	
		All are located within the same municipality / district.	2	
B.4	Type(s) of symbiotic relationship (cumulative sum)	Exchange of waste	1	1
		Exchange of energy	1	
		Exchange of secondary raw materials	1	
		Exchange of other type(s) of by-products	1	
		Joint use of services (e.g., transport)	1	
		Joint use of space	1	
		Joint use of utility infrastructure	1	
		Other	1	

Annex

Questionnaire

Questionnaire for identifying symbiotic practices between businesses as a response to the COVID-19 crisis in selected EU countries

Introduction

Thank you for taking the time out to fill this survey in these difficult and unprecedented times. We really appreciate it!

This survey is part of Interreg Europe project “SYMBI - Industrial Symbiosis for Regional Sustainable Growth and a Resource Efficient Circular Economy” (<https://www.interregeurope.eu/symbi/>), which has received additional funding to study the state of play of industrial symbiosis during the pandemic in selected EU countries.

Survey objective

This survey is an attempt to document symbiotic practices of circular economy nature, otherwise known as ‘industrial symbiosis’ that were carried out between businesses during and as a response to the pandemic.

In particular, this survey aims to identify cases that two or more businesses collaborated / formed a network to jointly (re)use, recover and/or redirect resources for reuse (e.g., waste, energy, by-products), sharing mutually profitable transactions.

Geographical coverage

The survey is being implemented in the following EU countries: Spain, Poland, Italy, Slovenia, Greece, Hungary, and Finland.

Respondents

This questionnaire is addressed to employees (e.g., managers) and owners of businesses as well as organisations and / or research institutions that have participated in some capacity in a symbiotic practice of circular economy nature during the pandemic.

Use of results

Data obtained from this survey will be analysed in a report and used to identify good practices that can showcase how industrial symbiosis can be a helpful tool in recovery and resilience planning of EU regions.

If you would have a question regarding the survey or would like to have access to the final report, please **contact the SYMBI partner, operating in your region:**

<https://www.interregeurope.eu/symbi/contacts/>

Confidentiality

The identity of the respondent will be anonymous. The name of the businesses involved will remain anonymous, if you declare so in the relevant section. Any data published or shared comply with EU’s ‘General Data Protection Regulation’ (GDPR).

Time estimated for completing the questionnaire: 15-20’

A. CONTACT INFORMATION

A.1 Contact information of the respondent

Name of respondent:		Click or tap here to enter text.
Name of business / organisation:		Click or tap here to enter text.
Contact email:		Click or tap here to enter text.
Location of business	Country:	Click or tap here to enter text.
	Region:	Click or tap here to enter text.
	City / Town:	Click or tap here to enter text.

A.2 Do you want information regarding the businesses / organisations involved to remain anonymous?

<input type="checkbox"/> Remain anonymous	<input type="checkbox"/> I am ok with these information being public
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B. CASE DESCRIPTION

B.1 Could you please identify the number, names, and economic sector(s) of the businesses / organisations that participate in the symbiotic practice?

Number of businesses / organisations:	Click here to enter text.
Names of businesses:	Click here to enter text.
Economic sectors involved:	Click here to enter text.

B.2 Could you please identify the type(s) of the participating businesses / organisations? (You can select more than one choice.)

<input type="checkbox"/> Large (industrial) enterprises
<input type="checkbox"/> Small and medium-sized enterprises

<input type="checkbox"/> Eco-industrial parks	
<input type="checkbox"/> Public authorities	<input type="checkbox"/> National
	<input type="checkbox"/> Regional
	<input type="checkbox"/> Local
<input type="checkbox"/> NGOs	
<input type="checkbox"/> Research centres / universities	
<input type="checkbox"/> Other: Click or tap here to enter text.	
B.3 What is the geographical proximity of the participating businesses / organisations?	
<input type="checkbox"/> More than one countries involved.	
<input type="checkbox"/> All are located within the same country.	
<input type="checkbox"/> All are located within the same region.	
<input type="checkbox"/> All are located within the same municipality / district.	
B.4 What is / are the main type(s) of symbiotic relationship between the participating businesses / organisations?	
<input type="checkbox"/> Exchange of waste Please, specify: Click or tap here to enter text.	
<input type="checkbox"/> Exchange of energy Please, specify: Click or tap here to enter text.	
<input type="checkbox"/> Exchange of secondary raw materials Please, specify: Click or tap here to enter text.	
<input type="checkbox"/> Exchange of other type(s) of by-products Please, specify: Click or tap here to enter text.	
<input type="checkbox"/> Joint use of services (e.g. transport) Please specify: Click or tap here to enter text.	
<input type="checkbox"/> Joint use of space Please specify: Click or tap here to enter text.	
<input type="checkbox"/> Joint use of utility infrastructure Please specify: Click or tap here to enter text.	
<input type="checkbox"/> Other: Click or tap here to enter text.	
B.5 Could you briefly describe the symbiotic relationship between businesses / organisations (i.e., the industrial ecosystem established)? (max. 5 lines)	
Click or tap here to enter text.	
B.6 Was the symbiotic practice firstly established during the pandemic?	
<input type="checkbox"/> Yes	<input type="checkbox"/> No
B.7 Was the symbiotic practice firstly established as a result of emergency needs that were caused by the COVID-19 crisis?	
<input type="checkbox"/> Yes	<input type="checkbox"/> No
B.8 Is the symbiotic practice still ongoing?	
<input type="checkbox"/> Yes	<input type="checkbox"/> No
B.9 If not, how long did it last?	
<input type="checkbox"/> 0-6 months	
<input type="checkbox"/> 7-12 months	
<input type="checkbox"/> 1-2 years	
<input type="checkbox"/> More than 2 years	

Other: Click or tap here to enter text.

C. CASE IMPLEMENTATION

C.1 To which of the following business disruptions, caused by the COVID-19 crisis, has the symbiotic practice responded?

Workforce shortage

Disruption in the supply chain

Materials' price inflation

Shortage in raw materials

Disruption in shipping operations

Other: Click or tap here to enter text.

C.2 To what extent difficulties were encountered during the implementation of the symbiotic practice?

Major difficulties had been encountered and the symbiotic practice was not fully realised.

Major difficulties had been encountered, which required great effort to be successfully tackled.

Major difficulties had been occasionally encountered, which were threatened in time without posing further disturbance.

The symbiotic practice faced minor difficulties and had an overall smooth implementation.

The implementation of the symbiotic practice had no problems or difficulties whatsoever, outperforming implementation expectations.

N / A

C.3 To what extent each of the following challenges has impeded the implementation of the symbiotic practice?

(Please reply on a scale of 1 to 5.)

1 – Not impeded at all

2 – Slightly impeded

3 – Moderately impeded

4 – Greatly impeded

5 – Critically impeded

N/A – Not Applicable / No answer

I. Lack of personnel

1 2 3 4 5 N / A

II. Lack of appropriate training of people involved

1 2 3 4 5 N / A

III. Lack of resources

1 2 3 4 5 N / A

IV. Lack of communication / cooperation between participating businesses

1 2 3 4 5 N / A

V. Lack of appropriate external support (e.g., economic support by public authorities)

1 2 3 4 5 N / A

VI. Lack of appropriate technology

1 2 3 4 5 N / A

VII. Lack of strategic objectives / planning

1 2 3 4 5 N / A

VIII. Other: Click or tap here to enter text.

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> N / A
C.4 Could you please indicate how the implemented symbiotic practice has impacted the business' economic activity? (Please explain your choice.)					
<input type="checkbox"/> Positive impact Briefly elaborate (1-2 lines): Click or tap here to enter text.		<input type="checkbox"/> No impact Briefly elaborate (1-2 lines): Click or tap here to enter text.		<input type="checkbox"/> Negative impact Briefly elaborate (1-2 lines): Click or tap here to enter text.	
C.5 Which of the following factors have facilitated the successful implementation of the symbiotic practice?					
<input type="checkbox"/> Geographical proximity of the involved actors					
<input type="checkbox"/> Multiple supply sources which can be easily replaced					
<input type="checkbox"/> Low economic risks					
<input type="checkbox"/> Adequate funding / support from public authorities					
<input type="checkbox"/> Adequate funding / support from private companies (e.g., banks)					
<input type="checkbox"/> Good cooperation among businesses					
<input type="checkbox"/> Previous experience in such synergetic practices					
<input type="checkbox"/> Legal and political support					
<input type="checkbox"/> Other: Click or tap here to enter text.					
C.6 What are the most significant features of the industrial eco-system that make it transferable?					
<input type="checkbox"/> Demonstrated benefits outweigh investment costs					
<input type="checkbox"/> Use of standardised technology solutions and processes					
<input type="checkbox"/> Low implementation risks					
<input type="checkbox"/> Small change in daily operations, low risk of organizational resistance					
<input type="checkbox"/> Needs addressed are common among industries, organisations and different regions / countries					
<input type="checkbox"/> Other: Click or tap here to enter text.					
C.7 To your knowledge, has / had the symbiotic practice been transferred to different regions and geographical contexts? (Please explain your choice.)					
<input type="checkbox"/> Yes		<input type="checkbox"/> No		<input type="checkbox"/> N / A	
If "yes", could you provide further details (e.g., location of synergy): Click or tap here to enter text.					
C.8 If another network of businesses wishes to implement this particular symbiotic practice, to what extent there is are adequate resources available? (You can select more than one choices.)					
<input type="checkbox"/> The symbiotic practice has documented in public documents and is easily accessible to the public.					
<input type="checkbox"/> All the required information and data have been documented with descriptive details of the whole implementation process.					
<input type="checkbox"/> There are documented results, which can be consulted by any interested actor.					
<input type="checkbox"/> N / A					
D. FURTHER INFORMATION					
D.1 Could you provide any further relevant information or data you consider important (e.g., URL, sources)?					
Click or tap here to enter text.					

References

C2CN – Cradle to Cradle Network: A capitalisation network that inspired actions for waste prevention and management (www.c2cn.eu)

Eco-Industrial Parks: A Strategy towards Industrial Ecology in Developing and Newly Industrialised Countries (<http://www.upv.es/contenidos/CAMUNISO/info/U0723427.pdf>)

Eco-Industrial Parks: A background report for the eco-industrial park project at Rantasalmi (http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf)

Eco-innovation in Industry: Enabling Green Growth (<http://www.oecd.org/sti/ind/eco-innovationinindustryenablinggreengrowth.htm>)

EU Commission - DG Environment (<http://ec.europa.eu/research/environment/index.cfm>)

European Partners for the Environment (www.epe.be)

FISSAC - Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain (<http://fissacproject.eu/>)

Industrial Symbiosis in Action (http://www.wrap.org.uk/sites/files/wrap/Industrial_Symbiosis.pdf)

OECD - Committee on Industry, Innovation and Entrepreneurship (<http://www.oecd.org/sti/ind/>)

PRERWASTE – Improve the effectiveness of waste prevention policies in EU territories (www.prewaste.eu)

ResCOM – Resource Conservative Manufacturing (www.rescoms.eu)

Smart Growth Network (www.smartgrowth.org)

Towards the Circular Economy: Accelerating the scale-up across global supply chain (http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf)

United Nations Environment Programme (www.unep.org)

World Business Council for Sustainable Development (<http://www.wbcsd.org/>)