



## ECOLE:

**ECO industrial park network for the Alpine Regions**  
**Leveraging smart and Circular Economy**

### Output O1.1

**A Systemic thinking community  
(STC) model for the integration of  
circular economy (CE) in industrial  
parks**

*Produced by*

*PP 7: TZE*

Document Details	
Project acronym	<b>ECOLE</b>
Project title	<b>ECO industrial park network for the Alpine Regions Leveraging smart and Circular Economy</b>
Project ID	<b>ASP0100091</b>
Action	
Output	<b>O1.1</b>
Due date	<b>04/2024</b>
Delivery date	
Dissemination	<b>PPs</b>
Partner in charge	<b>PP 7: TZE</b>
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### Short Description

Dissemination level		
<b>PU</b>	Public	
<b>PP</b>	Restricted to other programme participants	X
<b>RE</b>	Restricted to a group specified by the consortium	
<b>CO</b>	Confidential, only for members of the consortium	

Revision history			
Version	Date	Author	Organization
<b>V1.0</b>	29.02.2024	Nivethitha Ramamoorthy, Astrid Heindel	TZE
<b>V1.1</b>	30.07.2024	Nivethitha Ramamoorthy, Varad Limaye	TZE
<b>V.1.2</b>			
...			
<b>Final Document</b>			



The document has been prepared by the project partners of the Interreg Alpine Space project ECOLE. This project is co-funded by the European Union through the Interreg Alpine Space programme. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

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PP 9 – Grenoble-Alps Metropole (FR): GAM

PP10 – POLYMERIS (FR): POL

PP 11 – Lombardy Foundation for the Environment (IT): FLA

PP 12 – TUM International GmbH (DE): TUMint



## ABBREVIATIONS USED

AS	Alpine Space
ECOLE	ECO industrial park network for the Alpine Regions Leveraging smart and Circular Economy
STCM	Systemic Thinking Community model
EIP	Eco-industrial park
CE	Circular Economy
IP	Industrial Park
KPI	Key Performance Indicators
LP	Lead partner
PP	Project Partner
STC	Systemic Thinking Communities
EU	European Union

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## 1. Objectives and Summary

This document outlines the development of the Transnational Systemic Thinking Community model (STCM), which integrates circular and smart city approaches to empower industrial parks (IP) in addressing complex challenges. Drawing from circular economy (CE), smart city, and Eco-Industrial Parks (EIPs) development, the STCM incorporates validated outputs from previous projects and aligns with key policies in the Alpine region and Europe. With this objective in mind, the STCM aims to facilitate the integration of CE principles into EIPs across the Alpine region, with the ultimate aim of fostering a carbon-neutral and resource-conscious industrial sector.

This document summarizes the insights acquired during the implementation of the STCM across ten industrial parks in the Alpine Space (AS), obtained through collaborative working sessions involving park management, tenant companies, and various stakeholders from the community surrounding the parks. These stakeholders encompass representatives from public authorities, civil society, and industry, among others.

Initially, this document provides a concise overview of the fundamental principles of industrial symbiosis and circular economy within the context of industrial parks. Subsequently, it outlines key policies and political strategies that advocate and necessitate the transition toward sustainability within industrial parks.

## 2. EIPs And Systemic Thinking Communities

## 2.1 Industrial Symbiosis and Circular Economy

To minimize environmental footprints, enhance economic gains, and improve social well-being, IPs must revamp their infrastructure, taking into account resource consumption and waste generation. This overhaul necessitates embracing industrial symbiosis principles as prerequisites for the transition into eco-industrial parks. This approach ensures the exchange of materials, energy, water, and waste among tenant firms (Tseng et al., 2021). The development and operation of industrial symbiosis and EIPs have been extensively studied, with a focus on their economic, environmental, and institutional aspects. Industrial symbiosis facilitates the advancement of a circular economy by sharing underutilized assets among companies and repurposing residual outputs from one industry as feedstock for others (Krom et al., 2022).

The Circular Economy is a regenerative framework where the input of resources and the generation of waste, emissions, and energy leakage are minimized through the deliberate slowing, closing, and narrowing of material and energy loops. This objective is attained through strategies such as durable design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Geissdoerfer et al., 2017). This concept extends beyond mere waste reduction. It encompasses the notion that materials, components, and products should be designed and manufactured in a way that allows for their restoration, retention, and redistribution within the economy for as long as it remains environmentally, technically, socially, and economically viable (Iacovidou et al., 2020).

Eco-Industrial Parks (EIPs) can be defined as managed industrial areas that facilitate collaboration among industries and communities to achieve shared economic, social, and environmental benefits. EIPs promote resource efficiency, cleaner production, industrial symbiosis, climate change mitigation, pollution control, and social standards. They aim to optimize industrial



operations while minimizing negative impacts on the environment and local communities. EIPs integrate various disciplines and stakeholders to realize sustainable development goals and foster resilience in the face of challenges (World Bank, 2021).

Interest in Eco-Industrial Parks (EIPs) is growing as a strategy to advance the principles of Circular Economy (CE). These initiatives foster symbiotic relationships among industries within park environments, aiming to enhance waste reuse, recycling, and pollution reduction. EIPs are emerging globally, facilitating the sharing of materials and resources among industries to optimize both economic and environmental outcomes (Qdais & Kurbatova, 2022).

## 2.2 EU Initiatives for Circular Economy

The European Union primarily focuses on promoting industrial symbiosis as a key component of sustainable development and resource efficiency strategies. They aim to remove barriers, increase private sector participation, and improve data and reporting to facilitate the transition towards greener and more circular economies.

Key policies and initiatives include (Industrial Symbiosis Is at the Core of the EU Work With the Industrial Sector - EU4ENVIRONMENT, 2022):

**European Union Circular Economy Action Plan (2020):** This plan places industrial symbiosis at the core of resource efficiency strategies and the transition to a circular economy. It aims to facilitate and enable industrial symbiosis to transform consumption and production patterns for greater circularity in industry.

**EU4Environment Action:** Targeting Eastern Partnership (EaP) countries of the EU, this action promotes resource efficiency through various intervention levels essential for the application of industrial symbiosis. It includes activities focused on initiating symbiotic activities, such as providing information, common training, and facilitating cooperation among manufacturing enterprises.

**CORALIS Demonstration Project:** This EU-funded project operationalizes industrial symbiosis in selected member states. It aims to decarbonize resource and energy-intensive sector value chains through innovative technology-based approaches. The project focuses on technological, managerial, and economic factors and is implemented in industrial parks across multiple countries.

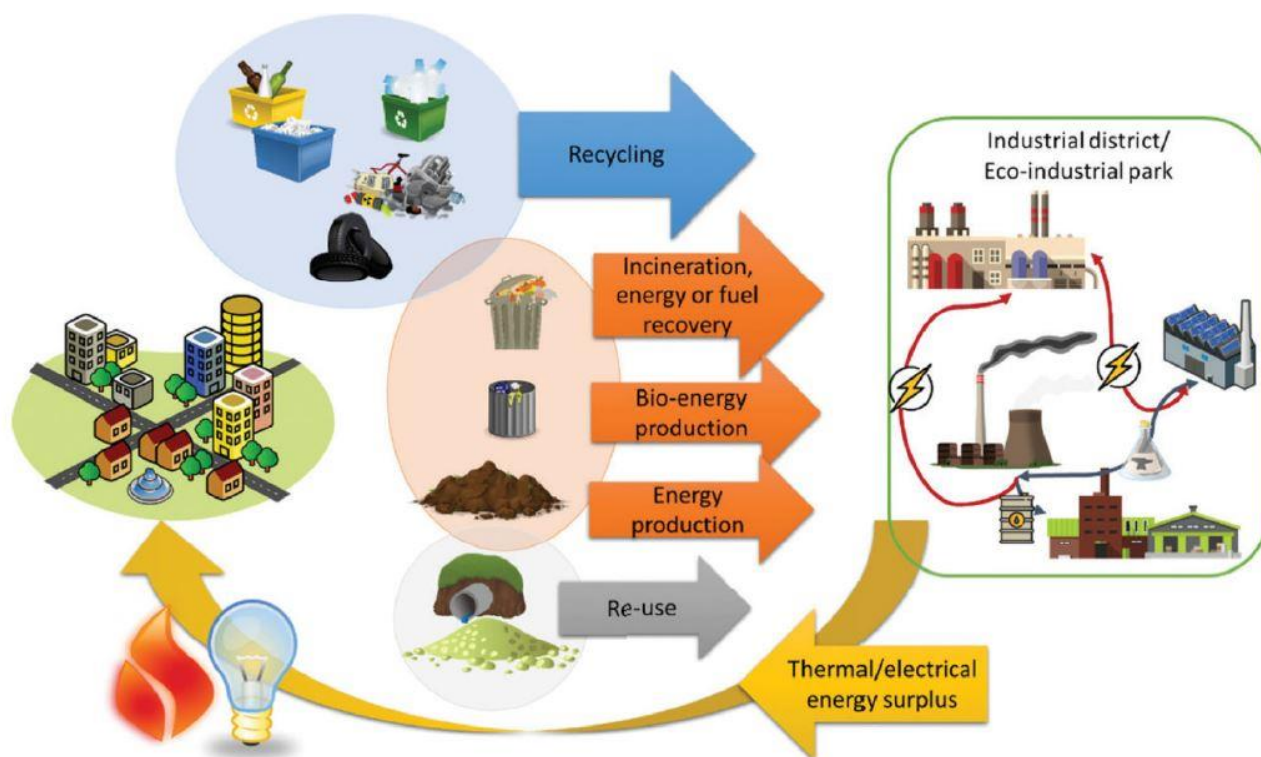
**RECP Clubs and Industrial Waste Mapping:** These activities aim to catalyze the efficient use of resources and IS principles through initiatives like joint coaching workshops, waste mapping activities, and evaluation of feasibility potential for industrial parks and economic zones. They provide tools for companies to improve resource efficiency and collaborate on industrial symbiosis.

## 2.3 Urban Industrial Symbiosis and Systemic Thinking Communities Model

Urban-industrial symbiosis, introduced in 2009 by Van Berkel et al., is a concept gaining traction globally, particularly as sustainability and circularity become focal points in policy and regulation. This symbiosis entails a network of collaboration between industrial and community actors to optimize resource utilization. Unlike traditional industrial symbiosis, which typically involves exchanges within industrial parks, urban-industrial symbiosis extends to utilizing urban solid waste as input sources for industries, broadening the scope of resource exchange (Ažman Momirski et al. 2021).

In such strategies, it is typically the responsibility of the government to foster collaborative relationships between companies and communities (Ažman Momirski et al., 2021). However, within the context of Eco-Industrial Parks (EIPs), our emphasis lies on the understanding that urban-industrial symbiosis primarily occurs between the industrial park and its adjacent community. This coordination is predominantly facilitated by a central authority within the EIP, which oversees the design and management of exchange mechanisms, working closely with municipal or governmental entities.

The management body within the industrial park supports tenant companies in fostering industrial collaborations and engages with the local community and surroundings (UNIDO 2017). Their involvement spans various functions, including integrating waste from cities or regions into industrial parks to enhance material recovery and resource usage.



**Fig 1: Urban Industrial Symbiosis**

Source: Butturi and Gamberini (2020)

At its fundamental level, Urban Industrial Symbiosis involves utilizing urban waste as a secondary material in industrial processes or as an energy resource in industrial waste treatment facilities. Conversely, waste heat generated from industrial processes can be distributed to urban areas through a district heating model (Butturi & Gamberini, 2020).

Collaborating with local governments and communities in Japanese eco-towns has proven to enhance opportunities and effectiveness in developing resource-sharing networks in a region (Van Berkel et al., 2009). Consequently, local governments were urged to offer financial support, such as matching funds, to incentivize their active involvement during the initial phase (Park et al., 2015).



Urban-industrial symbiosis initiatives exhibit considerable complexity due to involvement from diverse stakeholders with varying interests. Numerous studies have identified and classified critical symbiosis factors into two categories:

- (a) factors that facilitate and promote synergy implementation (enablers, drivers)  
(b) factors that impede or obstruct initiative realization (barriers, challenges).

**Enablers:**

Within an EIP, firms build strong social ties, fostering trust across the industrial network, crucial for enabling cooperative exchanges and circular solutions. In urban-industrial symbiosis, trust among stakeholders, particularly firms, is vital for four main reasons (Boons and Howard-Grenville 2009).

### Barriers:

Trust is crucial for EIP implementation, but competitive environments or stable histories can hinder it (Taddeo, 2016). Lack of transparency in communication, due to insufficient internal resources and capabilities, exacerbates this barrier (Zhu et al. 2015).

To facilitate the implementation of EIP and Urban Industrial Symbiosis effectively, it is imperative to establish a clear framework that aligns with the principles of the Systemic Community Thinking Model.

The transition from Industrial Parks to Eco-Industrial Parks necessitates a systematic approach. This is crucial because achieving the required outcomes for EIP performance relies on strong collaboration among companies both within and outside the park, as well as with neighbouring urban and rural communities. Effective collaboration demands a structured approach covering everything from initial design and planning to eventual implementation and operation. This comprehensive approach is often termed the Systemic Community Thinking Model.

Based on the combination of EIPs and this urban-industrial symbiosis approach, the ECOLE project developed the EIP systemic thinking community model

### 2.3.1 STCM Methodologies and Tools

The goal of STCM methodologies and tools is to understand stakeholders, assess their level of engagement, and plan engagement at different stages of the EIP project.

#### 2.3.1.1 Policy Cycle:

The policy cycle serves as a valuable guide for decision-makers, illustrating the iterative process involved in moving from an idea to the implementation of a policy or intervention. This process is interactive and cyclical, suggesting that it persists until the policy or intervention is refined, adjusted, adapted, or potentially discontinued.

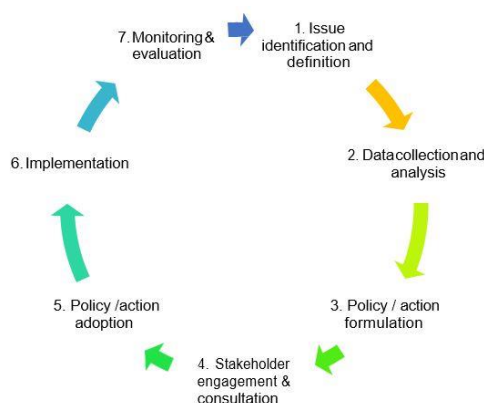


Fig 1: Policy Cycle

### Stage 1 – Issue Identification and Definition

The initial stage involves defining the problem and diagnosing gaps in performance and resources for the EIP project. This includes identifying the project's vision and objectives, such as reducing environmental degradation or enhancing industrial competitiveness, which can be initiated by a public entity, private investor, or public-private partnership. Consultation with stakeholders is crucial to ensure a clear problem/goal definition and effective interventions in subsequent stages.

### Stage 2 - Data Collection and Analysis

This phase serves as the foundation for decision-making, involving extensive gathering of quantitative and qualitative data across various levels, guided by the problem definition established in Stage 1. The analysis yields key performance indicators (KPIs) and identifies opportunities and challenges, including existing resources, waste streams, and potential synergies for industrial symbiosis within firms and communities.

### Stage 3 – Policy / Action Formulation

After assessing the evidence, various policy/action options will arise, with considerations for compliance with sectoral, regional, national, and international regulations. Additionally, specific policy/action instruments are deliberated in coordination with key stakeholders at this stage.

### Stage 4 – Stakeholder Engagement & Consultation

While stakeholder engagement should span the entire policy cycle, prioritizing certain stakeholders may occur at specific stages (stakeholder engagement). Once policy/action options are formulated, testing them with directly and indirectly impacted parties and topical experts is necessary for refinement and effectiveness. Broad stakeholder engagement also aids in reducing conflict, fostering trust, and aligning interests.

### Stage 5 – Policy / Action Adoption

The level of stakeholder engagement, and their contribution to defining needs, actions, and alignment, significantly influences the agreement and adoption of a specific policy or action.

### Stage 6 – Implementation

Implementing actions involves multiple stakeholders and can be time-consuming, particularly if consensus is widespread or compliance issues persist. Park managers or operators are instrumental in guiding implementation, defining roles, and monitoring progress.

## Stage 7 – Monitoring and Evaluation

In the final stage of the policy cycle, monitoring and evaluation are essential for assessing whether the action plan has achieved its objectives and determining necessary adjustments. This process aids decision-makers in anticipating issues and making necessary changes to reach goals for various KPIs. Park managers and operators lead this stage, collaborating closely with stakeholders to gain insights into progress, drivers, and barriers to achieving objectives.

### 2.3.1.2 Stakeholder Engagement:

Understanding and outlining relationships among entities in the EIP system is crucial for effective implementation across the policy cycle. Engaging stakeholders effectively requires understanding their roles, interests, and influence on project design and implementation. This assessment helps identify key focus areas and additional stakeholders to involve.

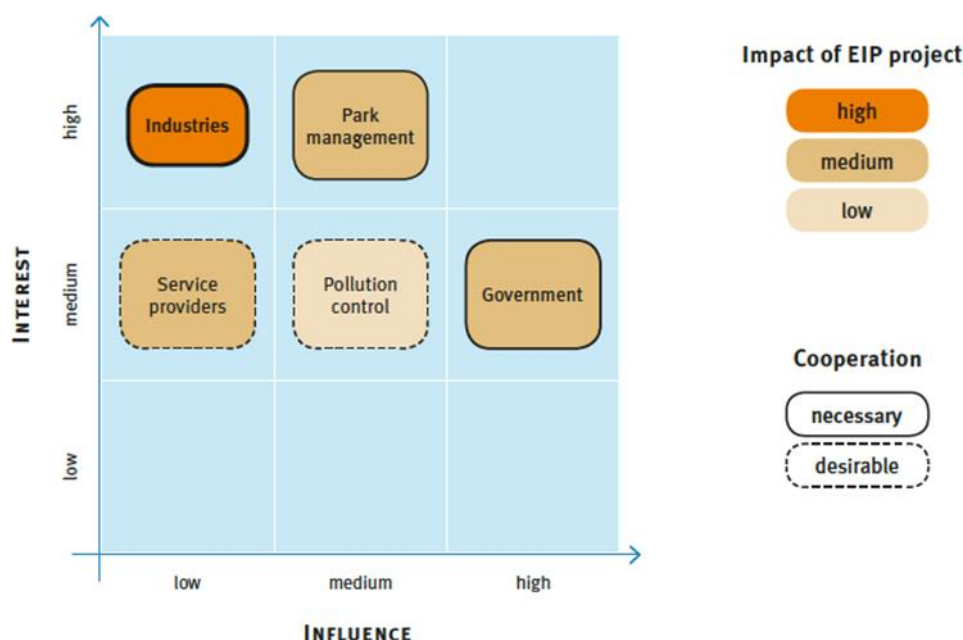
**Identify stakeholders:** Determine who is connected to or interested in the project.

**Analyze stakeholders:** Assess their level of interest and influence in the project.

**Map stakeholders:** Visualize the ecosystem to understand relationships.

**Prioritize stakeholders:** Develop a plan for engaging with them.

Based on identification and analysis, creating a stakeholder mapping by interest and influence is pivotal for effective stakeholder management. By employing a low-medium-high matrix to visualize the results, it becomes easier to prioritize engagement strategies and allocate resources efficiently, ensuring that the needs and concerns of stakeholders are appropriately addressed throughout the project lifecycle.



**Fig 2: Stakeholder Mapping Matrix**

Mapping stakeholders based on their interconnections is an essential aspect of stakeholder management. It's vital to comprehend how stakeholders collaborate and whether these

collaborations facilitate or impede engagement efforts. This mapping process, exemplified in Figure 3, illustrates the relationships among stakeholders and the nature of these connections, such as trust or financial ties. Stakeholders are positioned within circles based on their affiliations: whether they belong to the EIP, regional/local, national, or international levels.

**Fig 3: Inter-stakeholder dynamics map**

Once stakeholders, their interests, influence, and relationships are clearly understood, the next step is to prioritize them and create an action roadmap for engaging them towards the objectives. Utilizing a mapping approach, such as the interest/influence matrix, decision-makers can pinpoint the line of action necessary for respective stakeholder.



**Fig 4: Categorization of stakeholders based on level of interest and power**

### 2.3.1.3 Model Synthesis:

The Systemic Thinking Community Model (STCM) aims to harness synergies for urban/rural-industrial symbiosis in industrial parks, integrating circular economy solutions into products and services from park tenants and extending EIP benefits to surrounding communities and suppliers. This involves navigating complex stakeholder relationships and structuring interactions systematically for implementable solutions.

Model Synthesis consolidates the STCM, which relies on information gathered from methodologies and tool. Key questions for setting up a structured STCM process include:

- Who should be engaged?
- How should they be engaged?
- How often and for what purpose?
- What platforms could ensure systemic engagement (e.g., ICT networks, events platforms)?

Identifying stakeholders is the first step in model setup, facilitating effective EIP implementation throughout the policy cycle. Determining how to engage stakeholders depends on detailed stakeholder analysis and mapping. Engagement levels vary, from simple information sharing to deeper collaboration and empowerment actions. For example:

- Information: newsletters, seminars (online, in-person), policy briefs.
- Consultation: roundtables, focus groups, peer-exchange.
- Involvement: co-creation workshops, joint policy papers.
- Collaboration: joint projects, pilot initiatives, applied research.
- Empowerment: media features, awards, capacity building initiatives.

With the aid of these tools, the analyst can not only pinpoint stakeholders with a heightened interest in backing initiatives to integrate circularity in the industrial park but also gain insights into the interconnections and collaborations among stakeholders, explaining the nature of their relationships.

### 3. Learnings from ECOLE

### 3.1 Summary of the working session

The project partners in *Italy* conducted a meeting on “Energy materials and Circularity in which stakeholders from various sectors such as organizations involved in energy regulation, environmental governance, local government, port management, infrastructure development, public transportation, business advocacy, academic research, and commercial enterprises had taken part. During their sessions, the stakeholders presented the state of the art in their field and discussed how it could be implemented in the IP to enable STC. Their main aim is to establish a collaborative network to explore opportunities for resource optimization, where waste can be reused from other companies. **Zona Industriale Trieste** will develop an IT platform, where

enterprises will share energy demand and waste production to check the feasibility of renewable energy production and the implementation of industrial symbiosis practices.

The STC working session held in *Slovenia*, involving stakeholders from ministries to municipal waste management companies, emphasized the essential requirement of integrating sustainable and circular practices within industrial settings. This integration is crucial for ensuring environmental sustainability and striving towards climate neutrality goals. Throughout the sessions, stakeholders conceived innovative approaches, such as implementing photovoltaic systems, enhancing biogas plant efficiency, and employing effective waste management tactics. The involvement of local communities, specialized firms, governmental support, and clear delineation of roles among stakeholders was recognized as essential for the success of these initiatives. The collective knowledge and strategies generated from these sessions mark a substantial advancement towards cultivating a robust, sustainable economy aligned with environmental and circular economy principles. Key achievements for the **IP - EAP Zalog** included the identification of synergies between sustainability projects, innovative waste management solutions such as sludge processing and cooking oil recycling, and the formulation of sustainable business strategies.

The **Rudersdorf Business Park** and **CRAISS Industrial Park** in *Austria* recently held a collaborative session with stakeholders to explore the kinds of businesses that could thrive within their respective region. Factors such as proximity to transportation networks, access to renewable energy sources, and support for sustainable practices were considered. Moreover, they discussed strategies to market the industrial zone effectively, aligning with the region's economic, environmental, and social goals. One of the key visions of the Rudersdorf Business Park is to establish a proactive approach in engaging potential future residents and tenants. They aim to articulate the economic and technological advantages of adhering to the masterplan, particularly focusing on adopting technologies that enhance energy resilience and promote circularity within the entire business park. The municipality of Weiz and St. Ruprecht, is encapsulated in the slogan "*Together we are stronger.*" This cooperative effort between the two communities is seen as pivotal for the success of the industrial zone. Additionally, the stringent Editions requirements for industries before constructing their buildings serve as an effective means to minimize energy consumption. The main output of their discussion was that most of the stakeholders' lack on information which leads to sceptical thinking on investing in different technologies.

The industrial parks in *Germany* held separate meetings with their respective stakeholders, including park management and tenants. These sessions introduced stakeholders to the concept of circular economy. In particular, the **Cleantech Innovations Park** utilized the meeting to discuss future plans, ensuring stakeholders grasped the objectives and established a clear vision for the future. Meanwhile, **Siemens Technopark**, together with its tenants, engaged in both group and one-on-one meetings to explore the potential feasibility of implementing an eco-industrial park. Through these working sessions, park management and tenants were able to generate innovative ideas and hold discussions on their implementation.

In *France* the stakeholders from various sectors such as park management, SMEs, Chamber of commerce and industry etc., convened working sessions focused on understanding the main issues and needs for implementing a more circular model in the industrial park and improving park governance. During discussion, everyone's actions regarding the circular economy and knowledge on industries' needs to promote circular economy dissemination was understood. **Grenoble-Alps**



**Metropole** aimed to define what industries could share, such as waste, water, heat, and skills, to reduce costs and environmental impacts, facilitated by an online tool. Companies also shared their main issues and evaluated specific synergies detected during the meeting. Meanwhile, at the **Veyziat industrial park**, efforts were directed towards understanding challenges related to plastic waste management, waste collection services, mobility, and integration of tenant firms into the development of industrial park services. These sessions led to a better understanding of industrial park needs and identified previous initiatives regarding mapping and analysing opportunities in plastic waste management for further development of an action plan.

### 3.2 Lessons learnt

In crafting a systemic thinking community model for circular economy, it is imperative to learn from the example set by the municipalities of Weiz-St. Ruprecht. Their initiative cultivates a robust economic environment within and beyond their region, fostering collaborative governance, innovation, sustainability, and meaningful stakeholder engagement.

The local community's strong interest in the principles of circular economy and their application within the city's industrial parks serves as a catalyst for enhancing innovation and competitiveness while safeguarding the environment. During the sessions, it became evident that clear role allocation among stakeholders—comprising businesses, government bodies, and the community—is essential to instil a sense of shared responsibility and ensure successful project outcomes. Diverse viewpoints from stakeholders with expertise spanning business, technical, and political realms proved instrumental in comprehensively addressing the intricacies associated with technology implementation. However, effective problem-solving necessitates organizing multiple sessions to thoroughly identify issues and propose viable solutions. Furthermore, certain topics may require additional research by stakeholders to formulate informed responses, underscoring the importance of conducting several working sessions on the same subject. Moreover, on-site visits emerged as indispensable for identifying both obstacles and opportunities, facilitating enhanced planning, stakeholder engagement, visual confirmation of plans, and safety evaluations. Participants acknowledged the importance of adopting future-oriented approaches in regional development. The focus on future design and active support for future-oriented projects underscore the region's commitment to positioning itself as a leader in innovative and sustainable development practices.

## 4. Recommendations for Industrial Parks

The project partners working on the STCM recommend to have several strategies that ensures the successful involvement and engagement of all interested parties, including both public entities and private operators.

First, it is essential to tailor communication to each target group, highlighting specific benefits to engage politicians, energy experts, and investors effectively. Securing their support and approval for specific building plans is crucial for the project's progress.

Additionally, strengthening the park organization and showcasing initial results can attract more industries to join the project, thereby enhancing credibility and momentum.

Building trust among stakeholders is also vital; this involves identifying common and concrete challenges and planning bilateral discussions to share confidential data when necessary. By implementing these strategies, the project can foster collaboration, transparency, and support, ultimately leading to its overall success and sustainability.

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