Fraunhofer ITALIA

FRAUNHOFER ITALIA – INNOVATION ENGINEERING CENTER IEC

CIRCULAR ECONOMY

Fraunhofer Italy approach and applied research activities

Date: March 2021

Break page

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1 Fraunhofer Italia Research Scarl

Fraunhofer Italia Research Scarl - Innovation Engineering Center is the first independent foreign company in Italy of the Fraunhofer-Gesellschaft, the largest applied research organisation in Europe with a total of around 29,000 employees generating a total volume of research projects amounting to 2.8 billion euros. Fraunhofer is present in Germany with 75 research institutes and worldwide with offices in 19 countries. Fraunhofer Italy was founded in Bolzano in December 2009 as a non-profit research organisation and has a workforce of around 40 employees, operating since 2017 in the new headquarters at the Bolzano Technology Park (NOI Techpark). Fraunhofer Italy consists of three research departments (Automation and Mechatronics Engineering, Process Engineering in Construction, Robotics, and Intelligent Systems Engineering) and the application centre ARENA (Area for Research & innovative Applications). The activities carried out by Fraunhofer in Italy aim to support small and medium-sized enterprises in industrial automation projects in the manufacturing and construction sectors, as well as to develop management models capable of combining technologically advanced production processes, digitalisation, and sustainability.

Specific research focuses of the Bioeconomy and Sustainability thematic area are - without prejudice to the overall objective of sustainability - mainly the circular economy, the bioeconomy and sustainable digital transformation. As these issues are cross-sectoral in nature and influenced by a wide range of global factors, understanding, and addressing them requires an integrated multidimensional approach. This includes analytical and methodological tools to assess, monitor and develop business models and action plans for achieving industry-integrated sustainability goals.

2 Circular Economy: approach and competences

Our idea of a circular economy can be expressed through the following definition:

> The circular economy is an economic system designed to be restorative and regenerative, with the aim of maintaining the increased utility and value of products, components, and materials over time, with the goal of decoupling global economic development from the consumption of finite resources. The circular economy is essentially based on three major pillars: designing to avoid waste and pollution, maintaining products and materials, and regenerating natural systems.[1]

Thanks to these fundamental principles, a circular economic system can be considered an economic model that promotes sustainable development.

Sustainability, in this context, is understood according to the most classical definition: sustaining, preserving the level of something. Sustainability issues refer to how actions affect the economy, the environment and society. Social issues refer to how actions affect society, environmental issues refer to how actions affect the environment and economic issues refer to how actions affect the economy. Actions follow decisions, so sustainability is an objective of decision-making.

A desirable development model, which could be favourable for the future on Earth, is to apply the principles of the circular economy to take actions that follow choices aimed at sustainability.

One of the tasks of the circular economy is to minimise the consumption of natural resources and the emission of pollutants. This means acting on the inputs and outputs of processes: working on the functionality of products and services to design them, produce them, use them, and manage their end-of-life in a circular and sustainable way. Great possibilities are offered by the connection between the circular economy and the **bioeconomy**; the latter deals, in fact, with sustainable primary production and reuse of organic material not intended for food use in production cycles.

[1] E. M. Foundation, "Towards a circular economy: business rationale for an accelerated transition," Accessed October, vol. 25. p. 2016, 2015.

D. W. Pearce and R. K. Turner, Economics of natural resources and the environment. Baltimore: Johns Hopkins University Press, 1990.

Meadows, Donella H. The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind. New York: Universe Books, 1972.

Bringing man back to being the protagonist of his own choices and actions also means making the most of the cognitive and technological capabilities currently available: man is part of the natural balance and the so-called anthropic systems are integrated with the Earth ecosystem. In this vision, **digital transformation** can be designed and used in a sustainable way, at the service of the circular economy, to simulate the behaviour of production systems, predict impacts, support decisions, monitor and track. It should not be seen as a goal, but as a means to an end: to create a sustainable and competitive economy that benefits from a more efficient use of resources. In fact, among the various objectives of digitisation is the improvement of processes, services, and information flows, as well as the optimisation of technological, energy and operational resources that generates sustainability on all fronts. With the support of digitalisation, we can aim for a sharing of resources and skills that will help companies and regions to progress.

This is the general view we have of the issue, which is transformed into applied research projects and tools for companies and institutions. By its very nature, the circular economy must deal with complex systems, so we tackle it mainly by adopting approaches with the following characteristics:

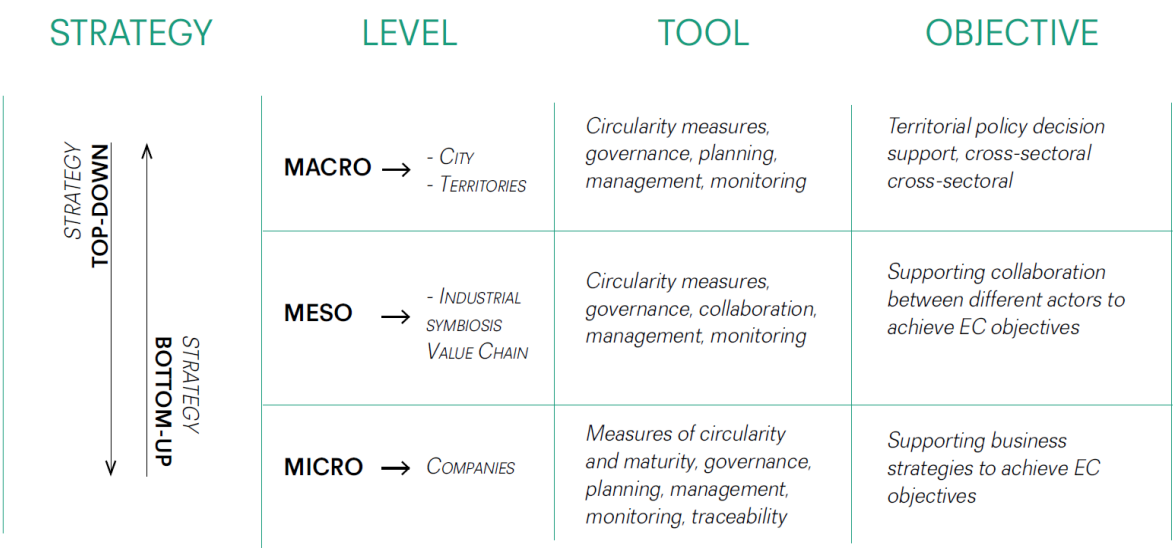
- *interdisciplinary*, starting from the expertise of the Bioeconomy and Sustainability team, and collaborating with all the other Fraunhofer Italia thematic areas, we create synergies and try to approach each activity with an eye to sustainability.
- *systemic and specific*, considering the best ways of tackling problems at different levels; accompanying individual companies towards circular solutions acting on specific production lines (micro), requires different skills, approaches and solutions compared to those required for interventions aimed at an industrial symbiosis or value chain context (meso) or even at managing a territory (macro).
- *linked to decision-making processes*, considering both the design phase of the interventions and the monitoring phase; in this context, the synergies created by an approach that simultaneously considers technology, basic sciences, culture, and governance are of great importance.
- *quantitative*, where possible, because it is necessary to know the starting point, to set measurable objectives to be achieved and to be able to monitor and track the transition towards these objectives.

- *collaborative*, to create synergies by sharing skills and experience; in this context we participate in research projects, organize, and attend seminars, conferences, and workshops, publish in popular and scientific journals, and participate in local, national, and international working groups.
- In concrete terms, we carry out *applied research* projects, directly commissioned by companies or by participating as a scientific partner in research consortia in the framework of European calls for proposals on the topics of innovation, bioeconomy, circular economy, business models for digital transformation and sustainability of individual companies or territories.

3 Themes and reference projects

When initiating a transition to a circular economy, all scales of action must be considered, as change must be implemented at all levels: macro, meso and micro. A mixed approach applying a bottom-up and top-down strategy is often considered the perfect combination to create a resilient, virtuous, and circular economy. Our activities in the circular economy address different issues of both the specific levels and the interconnection between the different levels based on the typical concept of complex systems, whereby each level of aggregation is characterised by collective and emergent properties.

The following diagram provides a summary of the scope of our activities (or tools offered). It is followed by a short description of the levels and a selection of activities and projects.



Micro Level

Definition: The micro level includes individual companies willing to start a transition to a circular economy.

Tools: Circularity and maturity measures are defined, and a system of governance, planning, management and monitoring and traceability of resources is outlined.

Objective: The Fraunhofer Italy team acts by supporting companies in defining technological innovations and business strategies with the aim of achieving circular economy objectives.

Meso Level

Definition: The meso level may include two to more actors working together in industrial symbiosis and/or value chains for a more circular economy.

Tools Circularity measures involving different actors in a value chain are defined, through a management and monitoring system that helps collaboration, also at technological level.

Objectives: The Fraunhofer Italy team acts by supporting collaboration between companies to achieve circular economy objectives with a view to shared management and governance between different companies.

Macro Level

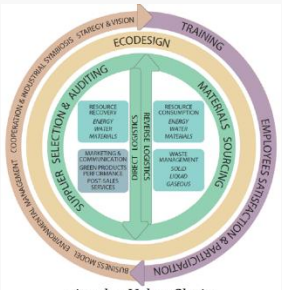
Definition: The macro level includes cities and territories, hence all those actors and bodies in charge of territorial governance, regulations, and laws.

Tools: Territorial circularity measures are defined, a sustainable governance structure is outlined, and a planning, management and monitoring system is established to support the established circular objectives.

Objective: The Fraunhofer Italy team acts by supporting decisions on territorial policies, coordination between different cross-sectoral actors in a perspective of sustainable and participatory governance between public administrations, financiers, entrepreneurs, civil society, and research centres.

Maturity and circularity check for companies

Tools for assessing the level of business maturity and circularity



circular Value Chain

Description

To progress and fulfil their potential in a circular perspective, companies need to know: 1) where they are, 2) where they want to be (objectives) and 3) how best to get there. Each of the above steps needs to be given a quantitative assessment, so that actions can be planned and implemented with as little risk and transparency as possible.
The Maturity and circularity check for companies was created with the question of how it could help companies to establish their starting and finishing points, so that they could then start to reflect on the paths to take.
The aim of the assessment tool is to provide a snapshot of the level of maturity and "circularity" of companies. It is not limited to giving an overall summary value but provides information that can be directly used in company decision-making processes. In fact, it is based on a framework that reflects the reality of most SMEs and companies in general, making it possible to identify the areas with the greatest room for improvement to increase performance in a circular perspective.
The assessment is relative, i.e., it allows companies to be positioned against an optimum or to compare their performance over time.
In addition, the assessment is adapted to the company's reality, as performance is assessed against the theoretical maximum achievable by the individual company.

Level

Micro

Duration

04.2019-12.2020

Partner

Fraunhofer Italia, Unibz

Financing

Internal project

AlpLinkBioEco

Linking BioBased Industry Value Chains Across the Alpine Region

Description

The project aims at mapping supply chains in the bio-economy sector and contributing to their development in Alpine regions. A web app has been developed with a database of actors that could potentially intervene in circular bio-based supply chains and artificial intelligence algorithms that connect economic agents producing biomass waste in different sectors, who want to make it available to create new potential value chains. A focus of the project concerns biomass from agriculture and forestry, raw material, and intermediate processing, as well as further processing and uses, for the development of new value chains in different sectors such as agriculture/forestry, pharmaceutical, chemical and food.

The project has led to the development of a strategic roadmap that will provide a common agenda for transnational dialogue on the bioeconomy through a master plan. This will allow the development of common policies and actions to promote the re-use of biomass and foster virtuous bio-economy chains in Alpine regions.

Level

Meso

Duration

10/2019-04/2021

Partner

CH (lead), IT, AT, DE, FR, SI

https://www.alpine-space.eu/projects/alplinkbioeco/en/about/partners/project-partners

Financing

Interreg Alpine Space 2014-2020

Performance and impact assessments

Performance evaluation on technological and sustainable aspects of business processes and value chains in waste utilisation

Description

The valorisation of production waste offers companies increasing opportunities for the development of new products, business models and for achieving a higher level of environmental and economic sustainability of production processes. In collaboration with the industrial partner, a feasibility study is carried out for the technical and economic analysis of the potential of exploiting production by-products and waste for the strategic development of new products.

Level

Micro, meso

Duration

6-12 months

Partner

Companies and organizations

Financing

Direct assignment

Sustainable production

Assessing the sustainability of decentralised and parametric approaches to production

Description

Within the SMART-Pro project, one of the lines of activity will be the definition of indicators and indices to measure the sustainability performance of decentralised and reconfigurable production systems. The indices will have the characteristic of being able to be used
- in the design phase, to estimate the performance of different configurations.
- in the optimisation phase, to support the algorithms that will manage the distributed system.
- in the monitoring phase of the implemented system.

The approach will be based on the concept of urban production, to allow the evaluation of design alternatives of production according to the logic of territorial distribution and mass customisation. All these technological and organisational alternatives have great potential for achieving circular objectives.

Level

Micro, meso, macro

Duration

11.2020-06.2022

Partner

Fraunhofer Italia

Financing

In the framework of the ERDF project 1135 SMART-Pro [CUP: B52F20001530009] - European Regional Development Fund of the Autonomous Province of Bolzano/Alto Adige - Investments for growth and employment. FESR 2014-2020

Circular territories

Assessment of the circularity of a territory through circularity indices and a management system for an autonomous and resilient territory

Description

Urban territories are becoming the privileged context for initiating the transition from the idea of circular economy to reality: new technologies, developed in the last decade, are making it possible to transform theories into practice, in a systematic and large-scale way. Territories cannot only aim at reducing their negative impacts on ecosystems but must become real places of transformation and innovation towards a circular, resilient, and virtuous territory.

This research analyses the opportunities and obstacles for a circular vision involving all the actors in the territory, demonstrating how awareness of the different needs of civil coexistence and business must lead to not only economic but also environmental and social benefits, revealing the essential role of all stakeholders and the importance of their involvement in the creation of shared value.

To undertake a vision of a circular territory, the research does not limit itself to certain materials or sectors but defines a circularity index that considers all systemic changes affecting the whole economy, analysing all the most influential sectors and actors that can support and drive circularity towards a more virtuous territory.

Level

Macro

Duration

1.2021-1.2022

Partner

Fraunhofer Italia

Financing

Internal project

4 Scientific publications on the subject (selection)

Vinante C., Sacco P., Orzes G. and Borgianni Y., 2021. Circular economy metrics: Literature review and company-level classification framework. Journal of Cleaner Production. Volume 288. 125090, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2020.125090. (https://www.sciencedirect.com/science/article/pii/S0959652620351349)