

FRAUNHOFER ITALIA – INNOVATION ENGINEERING CENTER IEC

BIOECONOMY

Approaches and applied research activities at
Fraunhofer Italia.

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1 Fraunhofer Italia Research Scarl

Fraunhofer Italia Research Scarl – Innovation Engineering Center is Italy's first foreign independent institute of the Fraunhofer-Gesellschaft, Europe's largest applied research organisation with 25.000 employees working on projects together worth 1.9 billion EUR. Fraunhofer is particularly active in Germany, where it boasts 74 research institutes, and has branches in 19 other countries. Fraunhofer Italia was founded in Bolzano-Bozen in December 2009 as a non-profit research organisation and has a staff composed of approximately 30 employees, all of whom are based at its new headquarters located inside the NOI Techpark since 2017. Fraunhofer Italia is made up of three research teams, namely *Automation and Mechatronics Engineering*, *Process Engineering in Construction* and *Business Model Engineering*, in addition to hosting the research centre ARENA (*Area for REsearch & iNnovative Applications*) (Figure 1).



Figure 1: Fraunhofer Italia Competence Team e ARENA

Through the various activities it carries out, Fraunhofer Italia dedicates itself to the support of small and medium enterprises (SMEs) in projects linked to industrial automation in the manufacturing and construction sectors, as well as to the development of business models capable of harmonising complex production processes, digitalisation and sustainability.

In the latter field of activities, the thematic area of “*Digital Transformation*” of the *Business Model Engineering Team* develops business models, tools, methods and action plans for industrial and institutional stakeholders, undertaking innovation and digital transformation for the sustainability of their business. The knowledge of productive value chains, business logics, technological and market trends enable Fraunhofer Italia to support partners on the management of complex production systems and decision-making processes, characterised by the interplay of advanced technologies and networks of heterogeneous agents.

Based on Fraunhofer's research and development experience with various industry partners, we acknowledge a growing need to consider notions of sustainability (economic, social and environmental) into the business models developed for the purpose of technology adoption and digital transformation.

2 Bioeconomy: approaches and competences

The activities and the research agenda of Fraunhofer Italia's "*Digital Transformation*" is aligned with the definition of Bioeconomy put forward in the Italian Strategy for the Bioeconomy (Strategia Italiana per la Bioeconomia): "The Bioeconomy consists in the sustainable production of biological and renewable resources and in the transformation of such resources and of waste products into high added value industrial products the likes of human foods, animal feed, bio-based products and bioenergy".

This understanding of the bioeconomy assumes that all social and economic activities are somehow connected with each other, and most importantly, that they are tightly connected with the environment where they take place. Based on this understanding, the fostering of the bioeconomy rests on two fundamental pillars: on the one hand, the production of goods must be made cleaner in order not to harm the equilibrium of the ecosystems on which it relies, while on the other hand, production systems and supply chains must be improved in such a way that they make the use of raw materials and energy more efficient.

From an applied research perspective, this leads to the following three conclusions:

1. Research and innovation activities conducted in a business context require the use of a systemic and integrated approach.
2. The bioeconomy's complex nature represents an opportunity for the sustainable management of economic activities at the supply chain level.
3. The potential of Industry 4.0 in general, and digitalisation in specific, to facilitate the achievement of environmental and social sustainability goals within enterprises, especially within SMEs, is considerable.

As a research institute, Fraunhofer Italia is involved in both fundamental and applied research, and collaborates with a wide range of organisations, be they private or public. As a result of the various competences it has acquired over the years, of the constant analysis of the socio-economic environment in which it evolves and of the large number of interactions with stakeholders, the organisation has recently taken the decision to reorganise its "*Digital transformation*" unit in such a way that its activities become more in line with the priorities put forward in the Italian Strategy for the Bioeconomy. More specifically:

- a) To move from "sectors" to "systems": A systemic approach to business activities must be adopted, considering both technological and economic aspects as well as business models which are both traditional and innovative. The integration of the latter aspects is achieved through the application of the concept of sustainability defined as a *Triple Bottom Line* encompassing three distinct dimensions (economic, social and environmental & governance).

- b) To move from “economy” to “sustainable economy”: Most of the current applied research aiming to design innovative solutions for organisations tries to consider the various aspects related to sustainability and to view technological innovation as a tool to enable organisations to improve their performance in terms of sustainability. Some research projects linked to the circular economy and to sustainability are focused on very specific aspects, such as business models, visions, political negotiations, and performance assessment.
- c) To move from “idea” to “reality”: one of the fundamental aspects of Fraunhofer Italia’s mission is to conduct applied research with the goal of generating tangible value in the least time possible. To achieve this purpose, Fraunhofer Italia dedicates considerable attention to every single phase of any given project, in such a way that mature innovations reach the market more easily.
- d) To promote the bioeconomy: Fraunhofer Italia has many channels through which it manages to share its vision and to inform the public about its activities. Scientific publications, academic theses and events held in partnership with stakeholders and network members are all examples of such channels. Moreover, the institute enjoys a privileged location inside the NOI Techpark, an important centre of cooperation on projects tied to the Alpine Arc that is based in Bolzano, one of Europe’s main communicating nodes between its northern and southern regions.

Nowadays, it is widely recognised that the use of a systematic vision constitutes one of the keys to the successful adoption of innovative technologies and processes within organisations. Indeed, specific competences linked to the field in which these innovative solutions are being adopted are also required. For this reason, Fraunhofer Italia’s “Digital Transformation” unit has developed a multidisciplinary expertise covering a wide range of competences, such as analysis, modelling and development of systems and processes, multi-dimensional and multi-actor evaluations, data science, ecology, roadmap design, strategies and visions, circular economy and sustainability.

As a matter of fact, competences such as the ones mentioned above, as well as those linked to the management of digital innovation within enterprises, prove to be particularly relevant in the bioeconomic field, more specifically in the following research fields:

- Technological assessment for sustainable production (e.g. agri-food and wood sector).
- Business information systems, smart agriculture, agri-food supply chains.
- Assessment methodologies (e.g. multi-criteria, multi-actor, LCA, circularity models).
- Multi-level analysis: process, enterprise, supply chain, territory.
- Digital solutions and bioeconomy for the optimisation of resource use at supply chain level.
- Transition towards circular business models, including in the context of product and service development.

- Methods for *innovation management* in the bioeconomic sphere with sustainable approaches.
- Techno-economic feasibility analysis for the reuse of production waste.

Concretely, Fraunhofer Italia carries out its applied research activities related to the bioeconomy as a scientific partner either under direct assignment of companies or within broader research consortiums, e.g. in the context of European research projects focusing on topics such as innovation, bioeconomy, circular economy, business models for digital transformation and tools to assess the level of digital maturity/readiness and circularity of companies (Chapter 3).

In addition to conducting research and development projects with companies as well as with other public/private institutions, the collaborators also contribute to the expansion of knowledge in the field of digital transformation, by publishing in scientific journals at international level (Chapter 4).

3 Reference projects

AlpLinkBioEco

Linking BioBased Industry Value Chains Across the Alpine Region



Description

The goal of this project is to identify new or already-existing supply chains in the bioeconomy of the alpine regions and to foster their development. To reach this objective, a database is being developed in which AI algorithms link together economic agents which produce waste biomass potentially available for the creation of new value chains. The project is particularly focused on the use of biomass coming from agriculture and forestry, from the processing of raw and intermediate materials, as well as from other processes and industrial uses, in order to create new supply chains in the agricultural/wood, pharmaceutical, chemical and food sector. The project also foresees the design of a strategic roadmap containing a common agenda for transnational dialogue on the topic of the bioeconomy. This common agenda should pave the way for the adoption of policies and the undertaking of common actions which can stimulate the creation of bioeconomic supply chains based on residual biomass in the alpine regions.

Duration

2019/10-2021/04

Partners

CH: Plastics Innovation Competence Center (*Lead Partner*);

IT: Fraunhofer Italia Research; Confindustria Lombardia, Hub Innovazione Trentino; Lombardy Green Chemistry Association; Centro Studi Alpino Pieve Tesino;

AT: Business Upper Austria,

DE: Chemie Cluster Bayern; Technologiezentrum Horb; BIOPRO BW;

FR: France clusters; Plastipolis;

SI: Slovenian Ministry of Education, Science and Sport;

Financing programme

Interreg Alpine Space

Brotweg

The making of bread in alpine areas: new mechanised solutions for the cereal sector in high-mountain areas



Description

The main goal of this project is to design and test new mechanised methods for the cultivation of cereals in mountain areas characterised by a very steep terrain (70%), as well as to assess their level of feasibility. The attractiveness of the cereal sector (cereals-flour-bread) in mountain areas with respect to other sectors such as cheese-making (hay-milk-cheese) stems from its lower requirements in terms of labour force, annual workload, investments as well as from its overall lower environmental footprint. This project foresees the development of prototypes of special machines operable on extremely steep terrain, as well as of new farm-scale facilities for the post-harvest handling and the storage of grains. In this context, Fraunhofer Italia is in charge of assessing the overall performance of the various solutions put forward and tested at every stage of the production chain: cultivation, drying, storage and bread making. The assessment is conducted using methodologies based on consolidated standards, such as the UNI ISO norms and other methodologies widely recognised in the scientific community. In the assessment, particular attention is given to the respect of the fragile balance between human activity and environmental preservation which has always characterised mountain agriculture. Thanks to this approach which ensures that technological innovation correlates with a higher level of overall sustainability in mountain agriculture, innovation can be seen as a tool to increase well-being from an economic, environmental and social perspective.

Duration

2018/06-2021/09

Partners

Libera Università di Bolzano (Lead Partner)
Fraunhofer Italia Research
Geier Srl
Neuero Italiana Farm System Sas
Maso Taser

Financing programme

European Regional Development Fund of the Autonomous Province of Bolzano/South Tyrol – Investments for growth and jobs. ERDF 2014-2020.

Feasibility study

Technical and economic analysis of the valorisation potential of processing waste

Description

For many enterprises, the valorisation of processing waste represents an opportunity to develop new products, new business models and to increase both the economic and the environmental sustainability of their business operations. In this context, Fraunhofer Italia conducts techno-economic feasibility analyses to help industry actors assess the potential of their business ideas for the valorisation of processing waste.

Duration

6-8 months (on average)

Partners

Enterprises operating in the agri-food and manufacturing sector.

Financing programme

Direct contracting

Circularity assessment

Instruments to assess the level of circularity of enterprises

Description

The project foresees the development of a system to assess the level of maturity and “circularity” of enterprises. This system is based on a framework which is representative of the reality of most SMEs and enterprises in general. The assessment is of relative nature, in that it allows enterprises either to compare their performance to that of an optimum or to follow its evolution over time. In addition, the system allows enterprises to identify the areas where the potential for improvement in terms of circularity is the greatest.

Objectives:

- Development of a framework capable of adapting to different business realities
- Development of a model capable of simultaneously assessing both the level of maturity and circularity
- Development of a dynamic assessment system capable of monitoring circularity performance over time

Results:

- Model containing CE metrics tailored to the enterprise structure
 - Self-assessment questionnaire to assess the level of maturity with regards to CE performance
 - First test campaign and assessment
-

Duration

18 months

Partners

Fraunhofer Italia
Libera Università di Bolzano

Financing programme

Internal project

Monalisa

Monitoring key environmental parameters in the alpine environment involving science, technology and application



Description

The objective of the project is to develop new approaches for the monitoring of key environmental variables and of operational processes, using innovative monitoring technologies and non-destructive methods. The new techniques of crop and operational monitoring are applied to agricultural and forestry contexts typical of the alpine environment. The information collected through the monitoring activities is used to improve the decision-making processes at the management level, so that economic, operational and environmental performance are optimised.

Web: <http://www.monalisa-project.eu/en/home/Pages/default.aspx>

Duration

Around 12 months (scientific consulting Fraunhofer Italia) - 36 months (project)

Partners

Research institutions and private enterprises

Fraunhofer Italia Research (scientific subcontracting)

Financing programme

Research and Innovation – Autonomous Province of Bolzano

WEQUAL

Web service center for a quality multidimensional design and tele-operated monitoring of green infrastructures



Description

The WEQUAL project pursues the objective of creating a web platform to help design engineers and technicians from the public administration conduct monitoring activities of river areas and assess the environmental, economic and social impact of various design alternatives of hydraulic works. The use of innovative monitoring techniques and multi-dimensional assessment methods (multi-criteria and multi-attributes) allows to increase the amount of information collected and to evaluate with better precision the impact of a hydraulic work both during and after its realisation. For this purpose, various kinds of monitoring systems were used (vectors + sensors). The information extracted from the collected data was correlated with the information derived from manual monitoring systems. The final goal is to find out whether it is possible to replace existing manual monitoring systems with automated systems which are less costly and more rapid. Such a technological shift would allow to considerably increase the frequency of monitoring activities in the years following implementation, thereby reducing the total impact of maintenance interventions.

Web: <https://wequal.projects.unibz.it/>

Duration

10 months (scientific consulting Fraunhofer Italia) - 32 months (project)

Partners

Maccaferri Innovation Center (Head of the project);

Naturstudio

MAVTech s.r.l.

Libera Università di Bolzano

Fraunhofer Italia Research (scientific subcontracting)

Financing programme

ERDF 2014-2020, Autonomous Province of Bolzano.

BioChipFeeding

*Wood chip feeding technology of the future
for small-scale biomass boilers*



This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. FP7-SME-2013-1-606464



Description

In the context of this project, an autonomous wood chip feeding system allowing for a significant reduction in CO₂ and CO emissions was developed. Because many biomass plants do not differentiate between the various quality grades of the wood chips they burn, the project *BioChipFeeding* aimed at adapting the quality of the wood chips fed into the combustion chamber to the operating state of the latter. To make this feasible, Fraunhofer Italia developed an intelligent grab bucket specifically made for combustion chambers running on wood chips. In order to determine the energy content of the biomass fed into the combustion chamber, a series of sensors were placed on the bucket to measure the humidity and the dimensions of the wood chips. Prototypes of grab buckets of various sizes and kinds were developed in order to make sure that the technology could be used in plants of different characteristics. Finally, the grab buckets were designed in such a way that they were compatible with traditional cranes and could therefore be incorporated into already existing plants.

Duration

2013/10-2015/09

Partners

AT: HET Heiz- & Energietechnik Entwicklungs-GmbH (Lead Partner); Technische Universität Graz; BIOS BIOENERGIESYSTEME GmbH;

DE: Technische Universität München; HDG Bavaria GmbH;

IT: Fraunhofer Italia Research; Sinte S.R.L.;

Financing programme

EU-FP7

4 Publications on the topic (selected)

Sacco P., Brozzi R. and Giguere L., 2020. *Inventory of policy instruments and bioeconomy potential for the Autonomous Province of Bolzano*. ASP563 AlpLinkBioEco project. January 2020.

Mazzetto F., Gallo R. and Sacco P., 2020. Reflections and methodological proposals to treat the concept of "information precision" in Smart Agriculture practices. *Sensors*. doi: 10.3390/s20102847

Mayr S., Brozzi R., Cervellieri A., Desaler T., Gallo R., Gamper J., Geier B., Holzner L., Sacco P. and Mazzetto F., 2020. Brotweg-A Path of Bread in an Alpine Environment: New Mechanical Solutions for Grain Processing in Steep Mountain Slopes. In book: *Innovative Biosystems Engineering for Sustainable Agriculture, Forestry and Food Production*. DOI:[10.1007/978-3-030-39299-4_50](https://doi.org/10.1007/978-3-030-39299-4_50)

Vinante C., Sacco P., Orzes G. and Borgianni Y., 2020. Circular Economy Metrics: Literature Review and Company-Level Classification Framework. *Journal of Cleaner Production*. In review.

Brozzi R., Forti D., Rauch, E. and Matt D. T., 2020. The Advantages of Industry 4.0 Applications for Sustainability: Results From a Sample of Manufacturing Companies. *Sustainability* 2020, 12, 3647. DOI: 10.3390/su12093647

Gallo R., Sacco P. and Mazzetto F., 2019. New approaches for the automatic operational monitoring of aerial logging and motor-manual felling activities. 8th Symposium on Systems Analysis in Forest Resources to be held in Puerto Varas, Chile (3-7/3/2019).

Sacco P., Mazzetto F. and Gallo R., 2019. Farm Ontology (FO): a System Thinking approach for planning and monitoring farm activities. *Designing Sustainability for All*, Milan (3-5/4/2019).

Mazzetto F. and Sacco P., 2019. A methodological proposal to assess the information reliability in the Precision Agriculture decisional chains. *Metroagrifor*. <https://ieeexplore.ieee.org/document/8909230>

Mazzetto F., Gallo R., Riedl M. and Sacco P., 2019. Proposal of an ontological approach to design and analyze farm information systems to support Precision Agriculture techniques. *IOP Conference Series: Earth and Environmental Science*, Vol. 275, conference 1.

Sacco P., Gallo R., and Mazzetto F., 2019. Data analysis and inference model for automating operational monitoring activities in Precision Farming and Precision Forestry applications. 2019 *IOP Conf. Ser.: Earth Environ. Sci.* 275 01201 (<https://doi.org/10.1088/1755-1315/275/1/012013>).