MAKE IT CIRCULAR

THE RESULTS OF THE CIRCE2020 PROJECT

Interreg
CENTRAL EUROPE
European Union
European Regional Development Fund
CIRCE2020

WHAT IS CIRCE2020?

CIRCE2020 stands for Expansion of the CIRcular Economy concept in the Central Europe local productive districts MAKE IT CIRCULAR!

MAKE IT CIRCULAR.

The results of the CIRCE2020 project

Edited by **Andrea Torresan**

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RERA SD - Public Institution for Coordination and Development of Split Dalmatia Country was established with the objective of creating an operating entity serving as instrument of development for the region with emphasis on European integration and attraction of foreign investments. RERA is the communication leader of CIRCE2020 project

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The utility company CISTOCA CETINSKE KRAJINE is one of the most important waste utility companies for collecting and disposing of waste operating in Splitsko-Dalmatinska Županija. Founders of CISTOCA company are the cities of Sinj and Trilj and the municipalities of Otok, Hrvace and Dicmo

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AM Trans Progres Sp. z o.o. is a Polish private company which is interested in management of waste generated in industry, and consulting and design activities, shifting afterwards to sectors such as pharmaceutical, chemical and mechanical trade

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Website: https://www.interreg-central.eu/Content.Node/home.html - CIRCE2020 project Website: https://www.interreg-central.eu/Content.Node/CIRCE2020.html

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EXECUTIVE SUMMARY

ANDREA TORRESAN (ARPAV)

More than 100 different definitions of circular economy are used in scientific literature and professional journals. There are so many different definitions in use, because the concept is applied by a diverse group of researchers and professionals (Kirchherr, Reike & Hekkert 2017). Looking at the European Commission definition "In a Circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value." This can bring major economic benefits, contributing to innovation, growth and job creation.

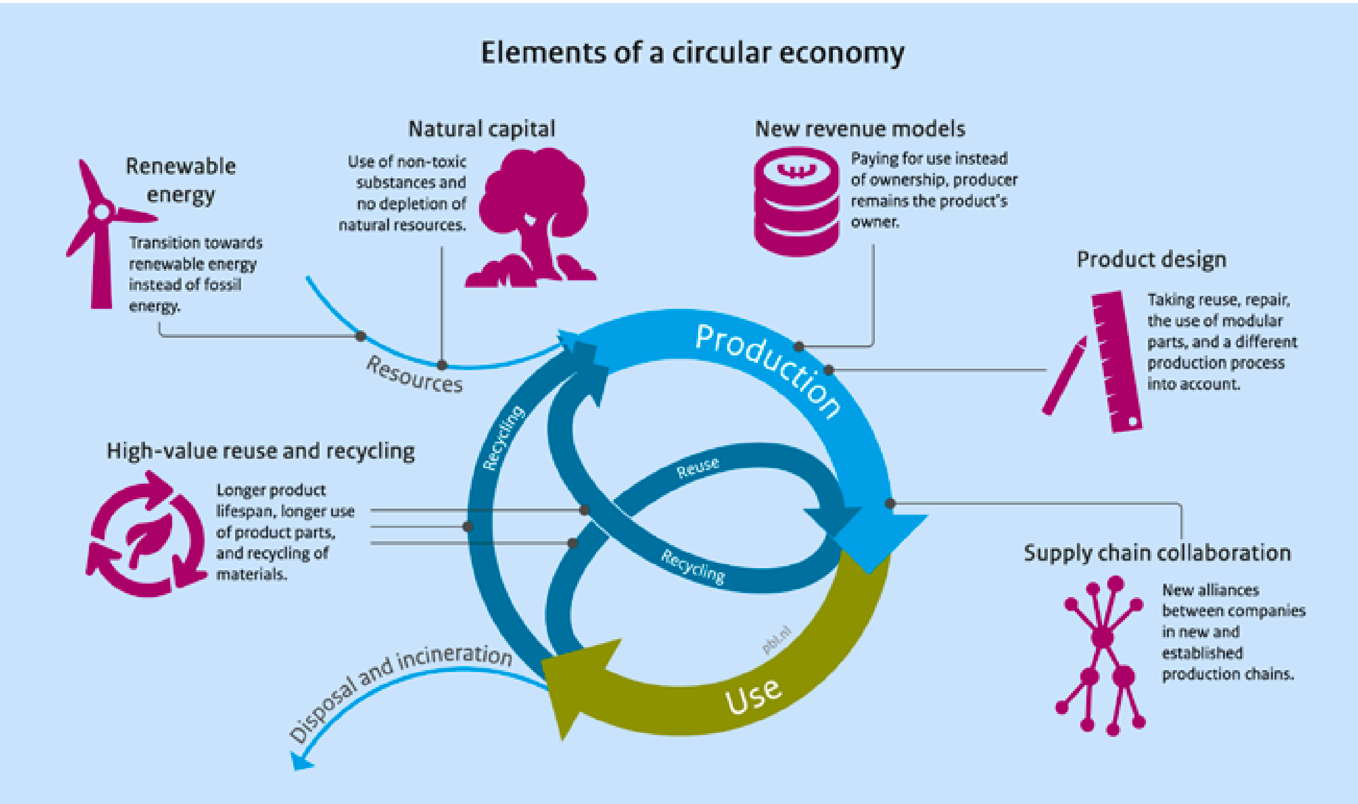

Figure 0: Some of the elements of a circular economy mentioned above and others in relation to each other (Source: PBL, 2019)

The Transition towards circular economy is the core priority of the EU 2020 strategy. Action at EU level can drive investment, create a level playing field, and remove obstacles stemming from European legislation or its inadequate enforcement.

It is particularly relevant for the Central European industrial areas due to the outstanding use of primary natural resources in various production stages: processing, packaging and transportation. Recycling rates are still far from directive targets and one main reason for this is that the reuse of by-products is often performed only by companies' independent initiatives.

In this context, the CIRCE2020 project aims to facilitate a larger uptake of integrated environmental management approach in five specific Central European industrial areas

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2008/98/EC on waste COM/2015/0595 final - 2015/0275 (COD) by shifting from linear economy to circular economy - using innovative instruments derived from the MFA (Material Flow Analysis), LCC (Life Cycle Costing) and LCA (Life Cycle Analysis).

CIRCE2020 stands for the CIRcular Economy concept in Central Europe's local productive districts.

The project is financed through the Interreg Central Europe Programme and involves 5 Countries and 8 Project partners

PROJECT DURATION

START DATE: 01/07/2017

END DATE: 30/09/2020

CIRCE2020 BUDGET

2.3MLN € TOTAL BUDGET

1.9MLN € ERDF FUNDING

The project activities are divided in 5 thematic work packages:

- WPT1: Mapping the physical primary & secondary raw material flows within a specific local production system
- WPT2: Profiling cross-value chain industrial symbiosis business model
- WPT3: Pilot actions to test sustainability of the circular economy business & encourage regional uptake
- WPT4: Transferability strategy for the expansion of the circular economy business model in CE space
- WPC: Dissemination of project results across wider catchment groups

One of the target of CIRCE2020 is the realization of a set of pilot actions based on the results of local surveys to identify the unevaluated waste streams using innovative instruments.
Each Pilot was chosen after the use of analytics to find the optimal technological, environmental and cost effective options. Summing up, the first step was the M-scale analysis of the physical flows at local industrial system level, basically what can be reused and where. Once that the most promising flows were identified, started the consultation of key-stakeholders and the establishment of permanent forum in each pilot site. Afterwards, were set some project operative key performance indicators and realistic targets to evaluate the pilot. But the core of CIRCE2020 Business Plan and one of the main output of the project was the creation of a MATRIX of Joint methodology which allows the users to assess the circularity of the solution identified and support the decision whether to adopt it or not considering the three most relevant drivers for a circular business: technology (TRM index), Environment (LCA) and economy (LCC).
As said before in each area the business plan was tested with the pilot actions that are:

- Landfill Leachate, Biogas Exploitation for the production of biomethane and PVC selection from plastic waste in Italy (Veneto region)
- Production of multi-material board from multipolymer waste and Production of multi-material and multifunctional panels from multipolymer waste in Wielkopolska Region, Poland
- Waste wood for the production of bio-char and Energy recovery from the low calorific fraction of a mechanical waste treatment plant in Tyrol, Austria
- Valorizing olive mill pomace from olive oil processing plant and Valorizing fish processing residues in a Biorafinery pilot concept in Split, Dalmatia County, Croatia
- Make granulate from waste tyre residues and Composite plastic waste intoa valuable product in Tatabanya Industrial Park, Hungary

Expansion of circular economy business model in Central Europe space, because the availability of successful case studies is crucial to raise up circular economy in political & business agendas.
To share mutual information among companies and to evaluate possible improvement scenarios in each area were organized two Business acceleration workshops; to open discuss on real cases and to foster the Industrial symbiosis were established several nudging actions to convince groups of promising companies to deepen their industrial symbiosis potential. Moreover a vouchering

activity to encourage the uptake of circular economy model was performed in each region training 5 waste utilities in the use of the CIRCE2020 analytics. Several other deliverables aimed to transpose the results and the principles at local, macroregional but also EU scale have been implemented. Some example are the Regional Action Plan to expand the secondary raw material market and a joint proposal to extend the industrial symbiosis concept at transboundary scale.

To improve the awareness related to the role of waste in a circular economy some deliverables took into account also the non technical public, with the publication of information and articles about the project in the digital news media the organization of a circular economy week and the activity in the schools to raise awareness and knowledge, the training organized for the journalist and it all comes together with the final conference and this final publication. MAKE IT CIRCULAR!

BACKGROUND: THE CIRCULAR ECONOMY IN CENTRAL EUROPE

CHAPTER 1

ANDREA TORRESAN (ARPAV) – This chapter was written on the base of Deliverable 1.2.5 - CIRCE 2020 PROJECT SUMMARY AND COMPARISON REPORT Based on EU Circular Economy Action Plan and the Local Reports of 5 Selected Pilot Areas prepared by: Biopolus Technologies Zrt. And Komlossy Mérnöki Kft.

BACKGROUND: THE CIRCULAR ECONOMY IN CENTRAL EUROPE

The traditional linear economy where natural resources are extracted, used, and disposed creates a never-ending supply of waste. This extractive industrial model must be replaced by a more circular concept. This shift means that the maximum value of a product or resource must be extracted whilst in use, then be recovered, altered, or regenerated at the end of its service life so that it can be recirculated back into the business cycle, greatly reducing waste, reducing the use of natural resources, and saving energy.

The Ellen MacArthur Foundation is one of the world's leading think tanks and networks for circular economy. The "foundation works with business, government, and academia to build a framework for an economy that is restorative and regenerative by design." **(Fig. 1.0)**

According to the foundation, in order to create a circular economy, system-wide innovation is needed, where products and services are redefined to design waste out, while minimizing negative impacts. By underpinning the transition with renewable energy sources, the circular model builds economic, natural, and social capital.

The following diagram is a Circular Economy System Diagram, created by the foundation, which illustrates the continuous flow of technical and biological materials through the 'value circle'.

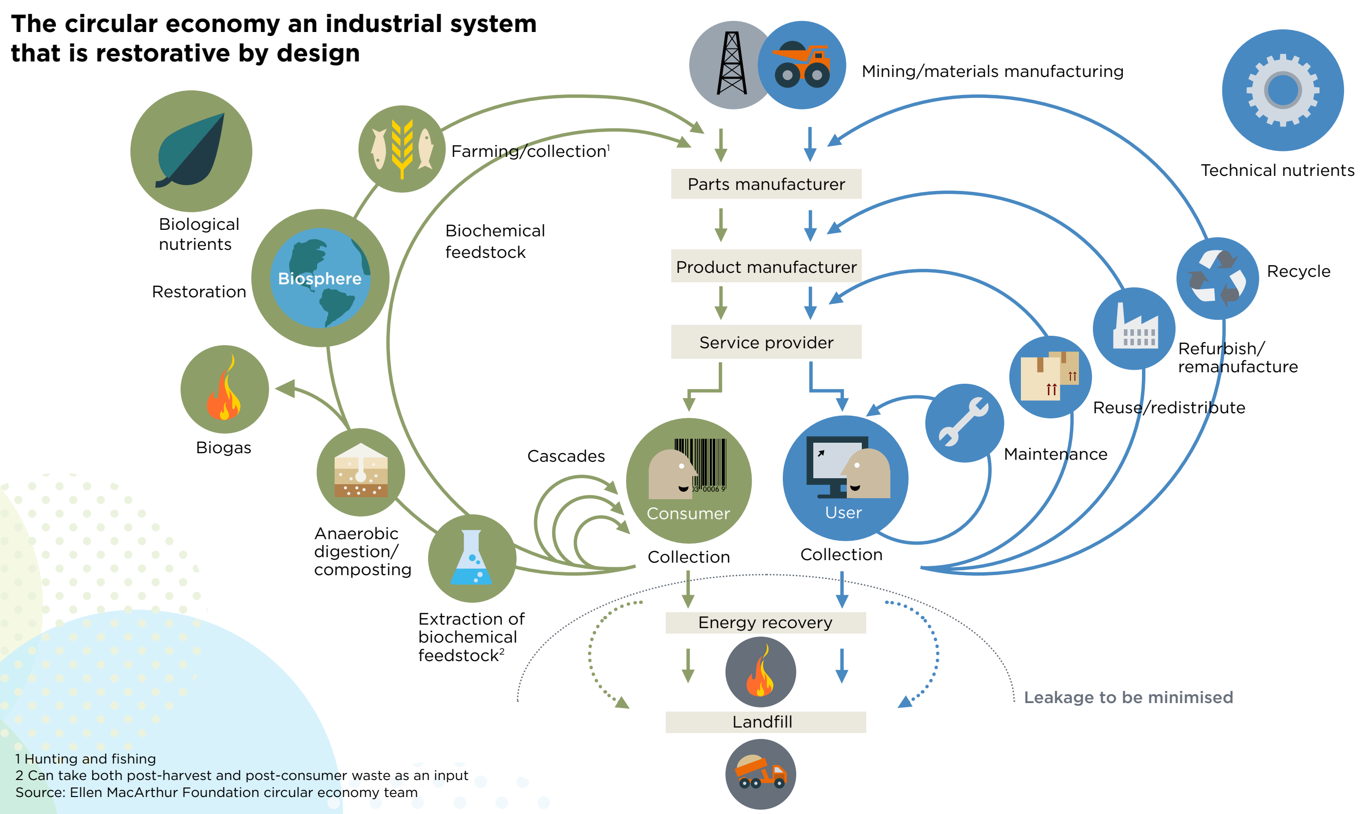

Figure 1.0: The Ellen MacArthur Foundation Diagram (https://www.ellenmacarthurfoundation.org/)

The diagram takes into account two macro areas, the renewable materials and the finite materials. Both are following different levels of “circularity” that are coming back to the final user, directly or through reprocessing processes. The aim is to minimise systematic leakage and to foster the system effectiveness.

At European level, in December 2015, the Commission adopted an “ambitious Circular Economy Package, which includes measures that will help stimulate Europe’s transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs.” [2]

The circular economy package includes an EU Action Plan for the circular economy, which establishes an action program with measures covering the entire cycle: from production to consumption, to waste management, the market for secondary raw materials, and a revised legislative proposal on waste. The package also includes an annex, which sets out a timeline for when the actions will be completed. The objective of the action is to “close the loop” of product lifecycles, through increased recycling and re-use, benefiting the environment and the economy. (Fig. 1.1)

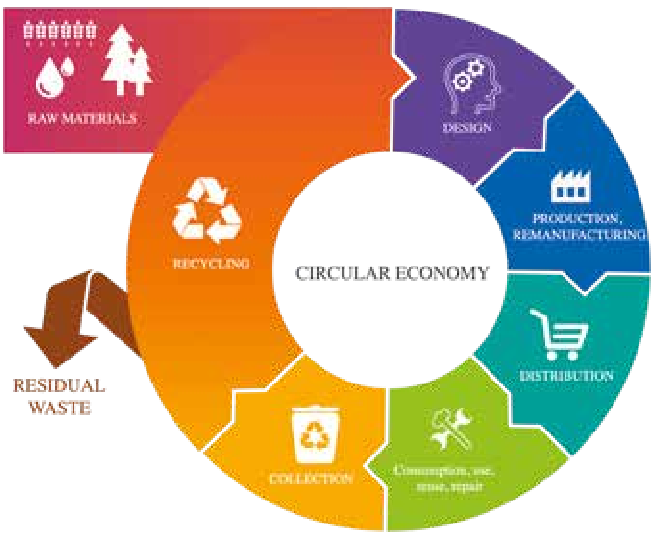

Figure 1.1: The circular economy concept

During the same year, were set also the Sustainable Development Goals (SDGs) by the international community as part of the UN 2030 Agenda for Sustainable Development through which countries of the world collectively are committed to eradicate poverty, find sustainable and inclusive development solutions, ensure everyone’s human rights by 2030. 17 SGGs have been defined with 169 associated targets. (Fig. 1.2)

The SDG number 12 “Responsible Consumption and Production” is the closest to CIRCE2020 principles and during the project implementation was taken into consideration in the several deliverable.

Figure 1.2: United Nation Sustainable Development Goals (SDGs)

In this context, the CIRCE2020 project’s aim is to change single, sporadic company recycling, to an integrated redesign of industrial interactions (through industrial symbiosis) based on the concept of circular economy. By comparing the Pilot Areas to the EU Action Plan, we §can gauge the current state of the industrial areas in terms of the circular economy, and see what needs to be done in order to help promote a larger uptake of integrated environmental management for industrial symbiosis. (Fig. 1.3)

This first baseline analysis was useful to understand the differences between the countries and to elaborate a table with the main data of each Pilot Area (Annex 1)

[2] (http://ec.europa.eu/environment/circular-economy/index_en.htm)

Figure 1.3: CIRCE2020 project area

1.1 ITALY

In the Italian Pilot Area, the official source of information on waste management is the collection of Environmental Declaration Forms (EDF) annually compiled by waste producers and treatment plants.

However, the evaluation and interpretation of waste streams are not possible or it is misleading because

- EDF's don't detail which waste treatment option (disposal/recovery) is applied in case of the waste reported.
- The huge production of waste deriving from the waste treatment plants leads to an overestimation of the quantity of actually generated waste, because secondary waste, by its intrinsic nature, constitutes at least a partial duplication of primary production.
- Actual waste production is determined by the fact that it is not possible to distinguish the original sources of secondary wastes.
- The identification of the treatment operation becomes even harder when the destination plant is located outside Veneto or abroad due to almost total lack of detailed information.
- The following series of producers are excluded by law from compiling EDF:
  - Supermarkets and stores as well as small traders, do not have to compile EDF because only entities and enterprises producing hazardous wastes, or entities producing non-hazardous waste and employing more than 10 employees are required to submit annual waste report. This leads to an

outstanding underestimation of packaging waste streams. [3]

- The agricultural enterprises.
- Generators of wastes coded by EWC 180103 * (needles, syringes and sharp objects) can transport their own waste, for a maximum quantity up to 30 kg per day, to a plant that carries out authorized disposal operations.
- Producers of wastes assimilated to municipal waste coming from non-domestic users (currently there are no standardize methods to quantify the amount of industrial wastes assimilated to municipal wastes).

1.2 CROATIA

Each municipality in the Republic of Croatia, or in this case, the Split – Dalmatia County, has to prepare a Waste Management Plan (WMP) for a period of five years. In WMPs, all data from certain municipalities are collected and analyzed. However, the data that is collected is not adequate, because some municipalities do not have an optimal system for data collection. Therefore, a common approach to data collection should be developed and applied for the municipalities in order to collect quality waste generation and material flow data.

Companies in the Pilot Area, Split–Dalmatia County have to report their technological waste generation into EPR (Environmental Pollution Register) system through default reporting forms. The EPR system is in the competence of Croatian Agency for the Environment and Nature (HAOP) and Ministry of Environment and Energy. Companies were selected and interviewed, from the Pilot Area, and waste information was collected from them. Unfortunately, the waste information from the companies sometimes differed from the data registered in the EPR system.

One of the recommendations for Croatia is to improve the EPR System to ensure the quality of data needed, and to create much more use-friendly reporting forms.

Information exchange between waste management companies or companies looking to purchase waste to use as raw material, is very popular in the Republic of Croatia, especially in the past few years.

The Croatian Environment and Nature Agency (HAOP) has prepared a Waste Prevention Portal in order to achieve its objectives of waste prevention, through information exchange and systematic monitoring of waste prevention projects/ activities. This Waste Prevention Portal provides information for possible methods, measures and activities of waste prevention and waste management. The portal can help companies to plan their own waste prevention activities, or to participate in common activities with other companies. The Waste Prevention Portal covers all areas of Croatia, including the Split- Dalmatia County.

The main goal of the portal is to encourage companies to exchange their work and positive practices regarding waste management. The hope is that by creating good communication, they are able to stimulate the use of waste as secondary raw material, a much needed step in the creation of a circular economy.

Examples of voluntary activities of companies for improving information exchange include educational activities encouraging green and sustainable public procurement. As part of these activities, there are education and information tools which include leaflets, manuals, web pages, and the improvement or establishment of a new portal.

Mostly, the classical instruments and tools for implementing waste prevention measures from European practices are recommended and adapted in the area of Split – Dalmatia County.

[3] this point should change due to the update of the D.lgs 152/2006 performed with the D.lgs 116/2020

1.3 HUNGARY

In Hungary, the Hungarian Environmental Information System (OKIR) – operated by the Ministry of Agriculture – is the publically available source of waste generation data. The generated waste amounts can be downloaded per companies, and per waste codes.

As part of this project, manufacturing companies located in the Hungarian Pilot Area, have been approached by a Circular Economy Survey. Out of the 20 companies were invited in the survey, only seven companies (35%) responded. Only two respondents stated that questions of confidentiality may be a barrier for sharing information.

The above companies were also approached to attend a workshop held by IFKA on 6th June 2018. The workshop was an informational event for companies, where the benefits of circular industrial symbiosis were presented, and where potential future partnerships were explored. Seven companies participated on the workshop, and they were all excited and ready to know more about circular economy and its implementation.

The experiences of the Hungarian Pilot Area show that obtaining useful material flow data is difficult. The majority of the respondent of the Circular Economy Company Survey provided raw material flow data, but the data they provided was very simplified and could not be used for material flow analysis. Generally speaking, obtaining data requires lots of time and personal interaction with company representative(s). Trust must be established, and clear motivation should be given, in order to make the information flow more freely. In the future, personal communication is to be developed with the involved companies to obtain the material specific data needed for a material flow analysis and Life Cycle Assessments.

One of the waste management companies of this Pilot Area was also interviewed. Based on their experiences, companies are not pro-actively looking for secondary raw materials or industrial symbiosis with other companies.

Occasionally, there is a demand for metal wastes, but Hungarian regulations forbid direct exchange of metal wastes in lack of specific waste management and purchasing/selling permits, so these deals are difficult to conclude.

Another conclusion of this Pilot Area is that circular practices are generally decided upon by the large 'parent' company, which has a regional policy that the local facility adheres to. Recycling and re-use occurs within the facility, or as part of a larger regional circular solution that includes waste transport to other external facilities (even if it is outside of the country of origin).

In order to address information exchange issues, the following recommendations were concluded in the Hungarian Pilot Area:

- User friendly, publically available waste management, and secondary raw material databases need to be established.
- Companies (including waste management) need to be informed of the existence of the above databases and the benefits of joining the database need to be highlighted.
- An education campaign where successful existing industrial symbiosis examples are highlighted may spark interest. In order to encourage waste management to take part in waste exchange networks, a business case highlighting ways in which they can profit as the third party should be also be included in the education campaign.

New developments in information exchange and industrial symbiosis are on-going. One such project is the FISSAC Software Platform (http://fissacproject.eu/en/fissac-software-platform/) - an EU H2020 research and innovation program - for which there is a Hungarian partner (Geonardo). This detect and assess potential industrial symbiosis on a multifunctional territory. The decision-support methodologies and tools. Using a life-cycle approach to material flow analyses and industrial clustering, and by quantification of economic benefits in a holistic manner. Dynamic by-product and waste flow analyses could be demonstrated on a map (geo-referencing of facilities) due to the development realized by the project partners.

1.4 POLAND

The information collected from companies in Wielkopolska Region showed that small enterprises/ manufactures are not interested in sharing any information with 3rd parties.

The main reasons of refusal to participate in the survey was:

- Lack of time,
- Low level of awareness /consciousness of EU strategy and the circular economy issue,
- Lack of trust to the system,
- Competition,
- Control,
- Confidentiality of the data.

One of the main reasons for low-level information exchange between waste producers and waste treatment companies is the lack of communication. Enterprises are afraid to share information because of:

- Lack of trust in potential business partners,
- Strong competition,
- Confidentiality of the data related to know-how, or technology patents,
- Confidentiality of the data related to their customers.

There is a demand to develop a method for information exchange, which is appropriate and addresses the concerns and barriers listed above. The channel for information exchange between waste generators and waste treatment companies is greatly needed. The information exchange has to be voluntary. The database and its tools must be prepared in a way, which allows the enterprises to use the various tools and functions on a level they accept. The introduction of these tools should be implemented in small steps and based upon trust and loyalty built among users.

In this Pilot Area, the establishment of an e-cloud application was recommended, where circular economy data is stored and can be accessed by authorized users. Companies however, need to be motivated in order to share their data and knowledge. The benefits, rights & obligations, and responsibilities should be clearly defined for the collection and management of this data in this e-cloud application.

E-platforms where you can buy/sell the products (ebay, allegro etc.) are more and more popular, and may serve as basis for the development of the information exchange channels.

1.5 AUSTRIA

A general conclusion for the Austrian Pilot Area is that obtaining data is only possible if confidentiality is ensured.

If companies find that the project (its goals, purposes, etc.) is useful, and specifically beneficial for them (e.g. provides some solution or idea for cost efficiency, and is in line with the company's philosophy and vision), then they are ready and willing to provide data with regards to their operation.

By consulting with them, the Austrian partner was able to offer them solutions to their companies' waste management problems, making them more willing to participate and share information.

There are several sources of publicly available information and data regarding waste generation and waste management. Although all data regarding waste origin and destination are annually collected and managed within EDM [4], very strict data protection laws make it impossible to extract and analyze any of this data. Available data is fragmented, and has various different origins, sources, scale, reference base, reference year, etc.

Based on the experiences of the Austrian Pilot Area, a platform to share and trade materials retrieved from waste streams is recommended. Companies providing secondary raw materials (as wastes) should be linked to companies using secondary raw materials. Such a platform could also attract start-up businesses, which specialize in making waste materials market-ready and usable for potential buyers.

[4] **Direct Automatic Data Interchange with the Austrian Ministry of Environment**

ANNEX 1

GIACOMO ARRIGO PIERETTI (ETRA SPA), HAIDA CHRISTIN (ATM) based on Summary report deliverable 1.3.2 – 1.3.3

The following table (Tab. 1.0) aims to collect crucial information in order to provide an overview of the pilot areas where CIRCE2020 project is implemented. Some rows require quantitative data; nevertheless, where those data are not available it is useful to explain the reasons generating those missing and it is sufficient to fill in the table with qualitative information.

CRITERIA	ETRA AREA (ITALY)	TATABÁNYA INDUSTRIAL PARK (HUNGARY)	SPLIT – DALMATIA COUNTY (CROATIA)	TYROL (AUSTRIA)	WIELKOPOLSKA REGION (POLAND)
GENERAL INFORMATION					
Extension of the pilot area (km²)	1.709 km²	4,5 km²	4.540 km² (land+island); 9.576 km² (sea)	12.640 km²	29.826 km²
Type of pilot area (e.g. political / administrative unit, county, retail park, industrial park, etc.)	Municipalities along the Brenta river in the Vicenza and Padua provinces	Industrial park	Administrative province of Croatia (Split is the administrative and economic center)	Administrative province of Austria	Administrative province of Poland
Number of enterprises (if available SMEs VS Large-sized entities 3)	Around 26.000; by number of employees: - < 9 94% - 10–49 5% - 50-249 1% - >250 1%	30 (50% are large enterprises)	379 registered units and 195 active units; prevalence of SMEs	Around 44.708; by number of employees: - < 9 91% - 10–49 8.4% - 50-249 1.3% - >250 0.2%	Around 409.865; by number of employees: - < 9 95,3% - 10–49 3,7% - 50-249 0,7% - >250 0,1%
Source(s) of data about waste production and destination	Environmental Declaration Form (EDF), Annual report about industrial waste by Regional and National Agencies	Central database operated by the Ministry of Agriculture: National Environmental Information System	Environmental Pollution Register (EPR database) of the Croatian Environment Agency (AZO)	Waste data: - Statistische Handbuch Bundesland Tirol 2014 (Statistic handbook province Tyrol) - Bundesabfallwirt-schaftplan 2017 (Federal Waste Management Plan 2017)	Marshall Office of the Wielkopolska Region, Regional Waste System, Waste Management Plan for Wielkopolska Region, Statistics Poland
Major economic activities for waste generation	1. Waste collection, treatment and disposal activities; materials recovery 2. Manufacture of fabricated metal products, except machinery and equipment 3. Manufacture of paper and paper products 4. Sewerage	1. Car glass production 2. Medical tools production 3. Clutch production 4. Tire production	1. Construction sector 2. Service sector 3. Manufacturing sector 4. Tratment and disposal NOTE: The characterisation of economic fabric by waste generation is not available for SDC; the proposed rank is related to the entire Republic of Croatia	1. Basic metals industry 2. Paper & cardboard industry 3. Wood production industry 4. Chemical & pharmaceutical industry	Not available
Reference year	2015	2016	2016	Predominantly 2015	2016
Data quality	EDF reports all the waste exchanges but it cannot provide a complete overview because of legal exemptions for some enterprises categories / sectors	Data are transmitted directly by the waste producers (companies)	Sometimes data provided by companies can be wrong, incomplete or not available. Moreover, the increasing quantity during the touristic season affects also data quality	On national level very good, on regional level incomprehensive (differing waste amounts depending on data source, e.g. Umweltbundesamt vs. Land Tirol)	EDF reports good quality data but it cannot provide a complete overview because of legal exemptions for some entities / waste codes
PRODUCTION of waste from economic activities					
Total waste production (t)	Industrial waste quantity from EDF: 814.258 t Additional industrial household like waste (estimation): 68.438 t	54.125 t	53.000 t	662.700 t (373.700 t municipal waste)	9.747.000 t
Total non-hazardous waste production (t)	746.606 t (EDF) + 68.438 t (assimilated)	51.527 t	49.050 t	601.700 t	9.634.441 t
Total hazardous waste production (t)	67.652 t	2.598 t	3.950 t	60.900 t	112.559 t

[3] ***Large-size entities are companies employing more than 250 employees, OR having an annual net revenue more than 50m euros, AND having an aggregate amount of the balance sheet more than 43m euros.**

CRITERIA	Etra area (ITALY)	Tatabánya industrial park (HUNGARY)
Most relevant non-H EWC codes from economic activities - first 10 non-H 6-digit EWC per quantity – (EWC, t) [4]	EWC DESCRIPTION T 120102 Ferrous metal dust and particles 71.876 120101 Ferrous metal filings and turnings 51.836 191212 Other wastes [...] from mechanical treatment of wastes [...] 45.720 190805 Sludge from urban WWTP 45.713 170904 Mixed construction and demolition w [...] 42.041 150101 Paper and cardboard packaging 32.000 170101 Concrete 25.309 120199 Wastes not otherwise specified 24.947 200101 Paper and cardboard 22.117 170405 Iron and steel 20.595	EWC DESCRIPTION T 160120 glass 29.022 070213 waste plastic 6.089 120199 Wastes not otherwise specified 5.168 070299 wastes not otherwise specified 1.789 150101 paper and cardboard packaging 1.734 150103 wooden packaging 1.419 120101 ferrous metal filings and turnings 1.138 160103 end-of-life tyres 1.096 NOTE: Groups 16, 07, 12, 15 represents 97% of the total production of non-H waste. The EWC of those groups over the threshold > 1.000 t are reported
DESTINATION of waste from economic activities [5]	*** Statistics within Veneto region according to the Regional Agency report (EDF data). For the assimilated quantity: 97% R; 3% D (Sustainability Report of ETRA)**	*** Statistics based on questionnaires filled-in by companies operating in the pilot area**
Disposal (D1 – D14) %	27% (non H) ; 71% (H) *	2%*
Material recovery (R2 – R12) %	70% (non H) ; 29% (H) *	28%*
Energy recovery (R1) %	3% (non H) ; 0% (H) *	70%*

[4] In case of data missing, provide estimation or qualitative description specifying the source / origin of data

[5] If percentages related to waste destination is not available for economic activities, use overall percentages (e.g. % about municipal waste) specifying the reference quantities and waste group.

Split – Dalmatia County (CROATIA)	Tyrol (AUSTRIA)	Wielkopolska Region (POLAND)
EWC DESCRIPTION T 191202 Ferrous metal 22.627 170405 Iron and steel 6.660 150101 Paper and cardboard packaging 4.857 190703 Landfill leachate [...] 1.392 170101 Concrete 1.376 150107 Glass packaging 1.182 190801 Screenings 868 120101 Ferrous metal filings and turnings 856 160103 End-of-life tyres 836 101304 Waste from calcination and hydration of lime 816	EWC DESCRIPTION T 200101 paper and cardboard 105.900 200301 mixed municipal waste 95.200 200140 metals 84.900	EWC DESCRIPTION T 10 wastes from thermal processes 3.026.884 17 construction and demolition wastes 2.425.784 19 wastes from waste management facilities [...] 2.326.953 02 wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing 742.777 03 wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard 432.610 NOTE: Detail at EWC 6 digit is not available
	*** Of municipal waste from households and similar establishments**	
50 %	0.1%*	Recovery in waste treatment plant 56% Neutralization / disposal 30% Transport outside region / temporary storage 16%
47 %	58.3%*	
1 %	41.7%*	

THE OPTIMAL BUSINESS PLAN

CHAPTER 2

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THE OPTIMAL BUSINESS PLAN

The first step in the CIRCE2020 Optimal Business Plan was the M-scale analysis of the physical flows at local industrial system level, basically what can be reused and where figuring out materials and energy demands of the industrial sectors of the five studied EU regions. Afterwards, those flows could be matched with waste quantities going to disposal to find out recycling opportunities and close the loop at local level. The M-scale analysis is built upon the Material Flow Analysis (MFA) approach that is a systematic assessment of the flows and stocks of materials within a system defined in space and time. The big challenge for all the involved partners has been the data collection. In fact, available quantitative information were uncomplete, not publicly disclosed or not suitable at local scale. Therefore, the M-scale analysis of the project focused on waste flows. Once that the most promising ones were identified, started the consultation of key-stakeholders and the establishment of permanent forums in each pilot site. Afterwards, were set some project operative key performance indicators and realistic targets to evaluate the pilots. But the core of CIRCE2020 Business Plan and one of the main output of the project was the creation of a MATRIX of Joint methodology which allows the users to assess the circularity of the identified solution . The innovative Decision Support System (DSS) considers the three most relevant drivers for a circular business: technology (TRM index), Environment (LCA) and economy (LCC). The following chapter deepens those concepts from a more technical perspective. **(Fig. 2.0)**

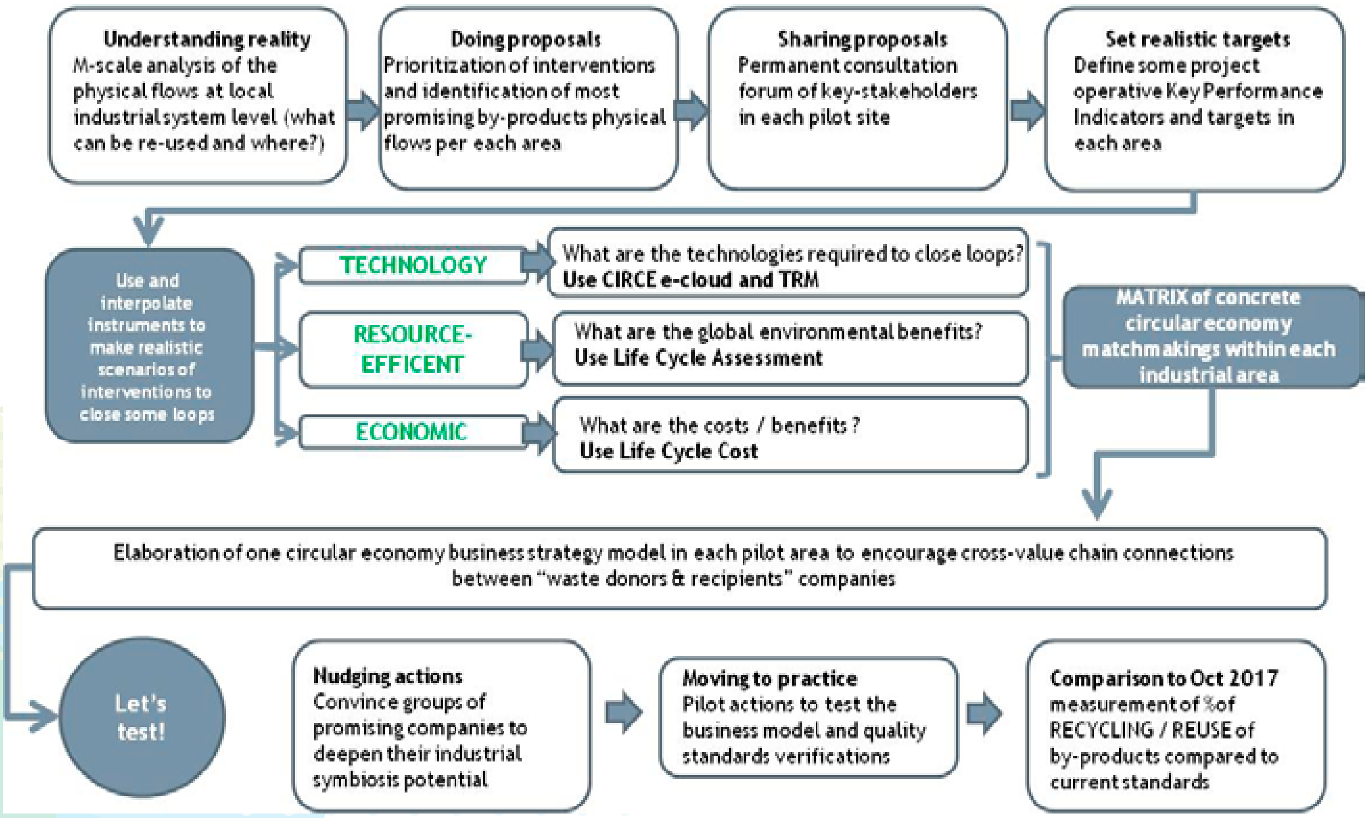


Figure 2.0: Circe2020 workflow

2.1 TECH CLOUD AND TRM

The Technology Rating Methodology (TRM) was developed to provide researchers, engineers, investors and owners the possibility to execute a self-test of their projects idea.

With helping of TRM index, CIRCE2020 can suggest to select the "best" technology or business model from a technical point of view.

The colleagues of BZN investigated different methodologies addressing similar purposes, but any was available for technology rating, especially for circular economy. Therefore, as part of CIRCE2020 project, was developed a new methodology for ranking different technologies. The added-values of this metric (as well as of any other tools developed within the project) is the coordination among partnership, grouping partners from different sectors and different countries. Each experience counts and all the contributions have been integrated in the final results.

The TRM index output it's a single number, but to determine this number, different aspects are considered, as summarized in the Table 2.1 and explained below.

Tab. 2.1: TRM index aspects

Best technology to recovery (TRM INDEX)
Technology readiness level (TRM 1)
Market references (TRM 2)
Reliability (TRM 3)
Circularity level (TRM 4)
Operational experience (TRM 5)
Technical limits (TRM 6)
Other aspects (TRM 7)

2.1.1. TECHNOLOGY READINESS LEVEL (TRM 1)

The first aspect is the readiness level of technology, exploiting the well-known method of the technology readiness levels (TRLs). TRLs has been in widespread use at NASA since the 1980s where it was originally invented and it's a method technology maturity estimation during an acquisition process and is based on a scale from 1 to 9 with 9 being the most mature technology. The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology. The European Commission advised EU-funded research and innovation projects to adopt the scale in 2010 which they did from 2014 in its Horizon 2020 program.
According to Horizon 2020 program, the following maturity degree is applied to determine the TRL:

- TRL 1 – basic principles observed,
- TRL 2 - technology concept formulated,
- TRL 3 – experimental proof of concept,
- TRL 4 – technology validated in lab,
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies),
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies),
- TRL 7 – system prototype demonstration in operational environment,
- TRL 8 – system complete and qualified,
- TRL 9 – actual system proven in operational environment.

According to the above levels the project defined the TRM 1 as follow:

1 point:	TRL 1 -	basic principles observed,
	TRL 2 -	technology concept formulated,
2 points	TRL 3 -	experimental proof of concept,
	TRL 4 -	technology validated in lab,
3 points	TRL 5 -	technology validated in relevant environment,
	TRL 6 -	technology demonstrated in relevant environment,
4 points	TRL 7 -	system prototype demonstration in operational environment,
	TRL 8 -	system complete and qualified,
5 points	TRL 9 -	actual system proven in operational environment.

2.1.2. MARKET REFERENCES (TRM 2)

For TRM 2 the suggestion is to classify the selected technologies according to market references.

Nowadays, an innovative technical solution should easily become an operating technology that investors can investigate and make sure of the real operation. If we have more reference points in the market, it would more promising for investors.

Of course, due to the project time frame and budget limitation could be very difficult to visit all reference sites, so the suggestion could be to investigate this aspect by the available information from the internet or any other resource.

1 point: no reference,
2 points: one reference site, but not in Europe (it is difficult to check it),
3 points: one reference site in Europe (it is easy to check it),
4 points: two or more reference sites, but not in Europe,
5 points: two or more reference sites in Europe.

2.1.3. RELIABILITY OF THE TECHNOLOGY PROVIDER (TRM 3)

In order to choose the best available technology from the market it is advisable to consider the financial background of the provider. Nowadays the confidence is one of the most valuable things in the business life. Therefore it needs to investigate the reliability of the technology or service provider. Why we need to consider it? Since the market changes dynamically nowadays, one start-up company can arise quickly and one can go to ruin easily. We need a reliable company who can ensure spare parts and the service for reparation within a short period. It goes without saying that the most reliable companies are the well-known firms with good financial and technical background.

So, for TRM 3 the suggestion is to classify the selected technologies according to reliability of technology provider:

1 point: no information about the company,
2 points: Start-up Company (unknown background),
3 points: Start-up Company (well-known background),
4 points: well-known, reliable SME company,
5 points: well-known, reliable company (not SME).

2.1.4. CIRCULARITY LEVEL (TRM 4)

Although, the TRM basically is focused the technological point of view, we considered the circularity level too, since this methodology was developed primarily for circular economy's solutions. Based on the worked out method of MFA, we suggest to use the same definition for the different stage of circularity.

So, for TRM 4 the suggestion is to classify the selected technologies from the following points according to circularity level of the selected technology.

1 point: no circularity (the waste goes to disposal),
2 points: weak circularity (waste to energy recovery),
3 points: good circularity (waste to material recycling)),
4 points: very good circularity, (preparing to reuse, repair, remanufacturing),
5 points: strong circularity (waste prevention and product prolongation).

2.1.5. OPERATIONAL EXPERIENCES (TRM 5)

While the TRM 2 focuses mainly on quantitative references, the qualitative descriptions of the existing experiences are investigated in TRM 5. In fact, the decision maker can collect information about reliability and operative features of the equipment by onsite visit, papers, brochires, blogs and others.

So, for TRM 5 the suggestion is to classify the selected technologies from the following points according to operational experiences of the investigated technology.

1 point: no information about the operation
2 points: weak operation (instable and not reliable operation)
3 points: average operation (semi-reliable, need more maintenance)
4 points: good operation (stable and reliable operation – may be not cheap)
5 points: very good operation (stable, cheap and reliable operation).

2.1.6. TECHNICAL LIMITS (TRM 6)

The flexibility of the studied technologies is important parameter. The higher rating is reserved to robust technologies that not require pre-treatment of the incoming flow, any previous test to check the quality and the presence of unwanted substances. In the elaborated metric the lowest value is assigned to fragile and "picky" technologies.

1 point: very strict limitation (it can be used only in homogeneous, pure waste fraction),

2 points: strict limitation (it can be used only homogeneous waste fraction),

3 points: average limitation (it can be used for average, mixed waste),

4 points: few limitation (one or two substance is restricted),

5 points: no limitation/restriction in the technology.

2.1.7. OTHER ASPECTS (TRM 7)

In order to ensure a larger implementation of the methodology in different contexts, the TRM 7 could be set in other to integrate specific aspects, important for the comparison.

2.1.8. CALCULATION OF TRM INDEX

When the TRM elements are determined, it's easily calculable the overall TRM index for each selected technology. Before the calculation, must be set a weighting factor for each TRM aspects. The weighting factors are determined by the investors (or the project partners), depending of the importance of each aspect. So, the set of the weighting factors is subjective by the users.

In the following definition can be seen the calculation of the TRM, where TRMi is the specific TRM aspect and Wi is the specific weighting factor.

$$TRM = \sum_{i=0}^{n} TRMi * Wi$$

In case of more technologies it's possible to calculate the TRM index for each of them and after that it is easily to compare two or more technologies by the technical point of you.

2.2 LIFE CYCLE THINKING IN CIRCE2020

In order to assess the environmental and economic performance of the investigated circular solutions, the Circe2020 project embeds the Life Cycle Thinking tools, in particular Life Cycle Assessment and Life Cycle Costing methodologies. It is important to highlight that the LCA guideline is based on very detailed reference documents with stringent rules while such reference documents do not exist for LCC. While the main challenge of the LCA/PEF [5] guideline for the CIRCE2020 project is the simplification and applicability of the existing rigid rules, the LCC guideline has been built up based on a more flexible and generic reference. On the one hand the lack of existing strict rules for LCC can be seen as a weak-point, on the other hand it offers the possibility to easily adapt the generic indications to specific needs of project partners.

Coordination among external experts of partners in charge of the elaboration of LCA and LCC support materials has been the added value since the beginning of the related activities. Training sessions, conceptualization, guidelines and tutorials conceived in Technical Work Package 2.2 and 2.3 ground on the same methodological approach, in particular for the definition of the system boundaries and the functional unit (F.U.) of the studies.

The main goals of the LCT-based studies can be summarized as follows:

- quantify the potential benefits of the identified CE solution compared to the current waste management practice in terms of environmental and economic aspects;
- Identify the hotspots of the CE solution to be used as indication for a further improvement of the technology solution and its implementation at pilot scale.

2.2.1. SYSTEM BOUNDARIES

As general rule the system boundaries shall be from cradle to grave, but considering that the main application of CircE2020 pilots has been the waste management sector, a narrower delimitation of the product system has been conceived. The definition of the system boundaries

[5] see chapter 2.2.3

is of extreme importance for enabling a fair comparison of the two scenarios that will be analysed in the studies (CE solution vs current waste management practice). They have to be clearly outlined in order to take also into account other expected additional functions of the CE solution. A generic and simplified description of the system boundaries applicable in the CIRCE2020 project is described in figure 2.1.

In order to appreciate the circularity, two perspectives have been developed within Circe2020 project: "waste donor" and "waste recipient", gathering the point of view of the two key performers in a circular matchmaking. Depending on the perspective, defined in goal definition, parts of these systems can be excluded while specific "system expansions" may be needed in order to assess a fair comparison between Business as Usual (BaU) and Circular Economy (CE) scenarios. However, LCC and LCA may exclude parts of the systems based on differing cut-off limits in financial or environmental significance. For example, research and development involves cost demanding thought and calculation processes, laboratory and testing work but no large, environmentally significant production volumes. Other examples are marketing activities or infrastructure and machinery which is often excluded in LCA but may be included in LCC if their cost are relevant in a life cycle perspective.

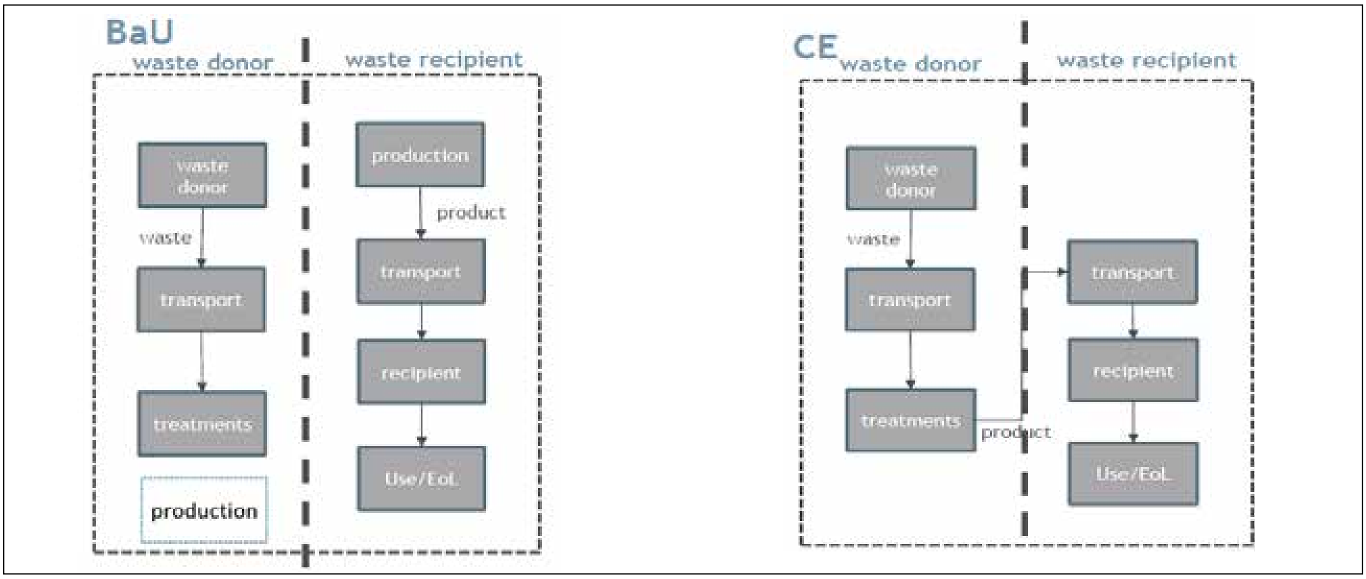


Figure 2.1: Simplified description of system boundaries in the CIRCE2020 project. Business as Usual (BaU) on the left, Circular Economy (CE) on the right. (SOURCE: proceedings of partnership meeting in Padua October 2018 - speaker: Balázs Sára)

2.2.2. FUNCTIONAL UNIT

The functional unit (FU) is the quantified performance of a product system, to be used as a reference unit (e.g., the FU of paint could be described as providing protection of 1mq of substrate for 50 years with a minimum 98% opacity). Meaningful comparisons shall only be made when products fulfil the same function. Therefore, the FU shall describe qualitatively and quantitatively the function(s) and duration of the product, according to the four aspects reported in Table 2.2:

Table 2.2 Four aspects of the FU to be taken into account (SOURCE: DT2.2.1 - Guidelines for adaptation of LCA methodology to estimate environmental impact)

The function(s)/service(s) provided: "**what**"
The extent of the function or service: "**how much**"
The expected level of quality: "**how well**"
The duration/life time of the product: "**how long**"

For intermediate products, the FU is more difficult to define because they can often fulfil multiple functions and the whole life cycle of the product is not known. Therefore, a declared unit should be applied, for example, mass (kilogram) or volume (cubic meter).

Performing the LCA and LCC studies, partners have selected the same functional unit, according to the selected perspective (donor VS recipient).

2.2.3. LIFE CYCLE ASSESSMENT

In recent years, the environmental considerations are increasingly part of the operations and marketing strategies for a large number of companies and for their investors. Such companies are increasingly using Life Cycle Assessment (LCA) as a tool to assess their own or their suppliers' green credentials and to measure (and improve) the environmental performance of their products and services.

In the project framework, in order to test the environmental sustainability of the pre-selected Circular Economy (CE) cases in the pilot areas, a life cycle assessment was performed based on the latest Product Environmental Footprint (PEF) methodological requirements. In particular, specific guidelines for developing the PEF-based studies have been developed by Ecoinnovazione, ETRA external expert, with a two-fold purpose:

- Adapting the PEF methodology to the project specific application (waste management or, in more general terms, the optimisation of use of virgin resources) and simplifying some specific methodological requirements;
- Defining a set of specific rules to calculate the relevant environmental impacts of the CE cases and their potential improvements with respect to current management of the analysed waste streams with the aim of enabling comparisons of the CE cases analysed within the pilot areas.

The Product Environmental Footprint (PEF) is a Life Cycle Assessment (LCA) based method to quantify the relevant environmental impacts of products (goods or services). It builds on existing approaches and international standards. The aim of the PEF is to set the basis for better reproducibility and comparability of the results within EU market [1].

The conceptualization document (DT2.2.5) and the guidelines (DT2.2.1) have been the main references for the partnership to perform LCA studies. The main challenge has been to provide common and operative rules, applicable in different sectors and contexts (2 pilots * 5 industrial areas) following general prescriptions of the Product Environmental Footprint Category Rules (PEFCR) guidance.

2.2.3.1 DATA COLLECTION AND DATA QUALITY

A focus must be done on the data collection phase, two types of data have to be gathered:

1. Specific data (primary data), which are data directly measured or collected representative of activities at a specific facility or set of facilities. The data should include all known inputs and outputs for the processes. Inputs are (for example) use of energy, water, materials, etc. Outputs are the products, co-products, and emissions to environment.

2. Generic data (secondary data) refers to data that are not based on direct measurements or calculation of the respective processes in the system. Generic data can be either sector-specific, i.e. specific to the sector being considered for the PEF-based study, or multi-sector.

The choice between using primary and secondary data is dealt with the PEF methodology in a different way than with the "traditional" LCA approach. One of the main features of the PEF methodology is the attempt to operationalise the "materiality" approach, i.e. focusing where it really matters. In the PEF context the materiality

[1] European Commission - COM(2013) 196 final "Building the Single Market for Green Products. Facilitating better information on the environmental performance of products and organisations

approach is developed around two main areas:

1. Impact categories, life cycle stages, processes. These should be the contributions where companies or other relevant stakeholders should focus more;
2. Data requirements: as the most relevant contributions are those driving the environmental profile of a product, these shall be assessed by using data with higher quality compared to the less relevant contributions, independently from where these processes happen in the supply chain.

In this perspective what becomes relevant are two elements:

1. Which are the processes that are driving the environmental profile of the product (most relevant processes)?
2. What is the level of influence that the company performing the study has on them?
   a) Is the process run by the company performing the study?
   b) If not, does the company have the possibility to have access to more specific data?

Based on the relevance of the processes for each impact category and the level of influence a company performing the study will have to use for each process data according to one of the options described in the table 2.3. Whenever applicable, option 1 represents the preferred one.

It should be noted that since the analysis performed in the project framework considers likely scenarios, it may be not always feasible applying the materiality approach. However, it is recommended to apply it whenever possible.

Table 2.3: Data collection

		MOST RELEVANT PROCESS	OTHER PROCESS
SITUATION 1: process run by the company applying the PEFCR	**Option 1**	Provide company-specific data	
	Option 2	Provide company-specific data	Use default secondary dataset in aggregated form
SITUATION 2: process not run by the company applying the PEFCR but with access to company-specific information	**Option 1**	Provide company-specific data	
	Option 2	Use company-specific activity data for transport (distance), and use the specific supply-chain electricity mix and means of transport (available at http://lcdn.thinkstep.com/Node/)	
SITUATION 3: process not run by the company applying the PEFCR and without access to company-specific information		Use default secondary data set in aggregated form	

The data quality was addressed by applying the requirements set in the ISO 14044 standard, and not according to the PEFCR Guidance, due to the lack of its full applicability in the context of the project. More in detail, the LCA applicant is requested to document in the study the following criteria:

- time-related coverage: age of data and the minimum length of time over which data should be collected;
- geographical coverage: geographical area from which data for unit processes should be collected to satisfy the goal of the study;
- technology coverage: specific technology or technology mix;
- precision: measure of the variability of the data values for each data expressed (e.g. variance);
- completeness: percentage of flow that is measured or estimated;
- representativeness: qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);
- consistency: qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;

- reproducibility: qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study;
- sources of the data;
- uncertainty of the information (e.g. data, models and assumptions).

2.2.3.2 CHARACTERISATION AND NORMALIZATION

The list of the 16 impact categories [2] to be used to calculate the PEF profile and the related global normalisation factors have been provided in the guidelines. The document recommended to use the last version of the PEF-ILCD method included in the LCA software if, for any technical reason, the updated characterisation and normalisation factors won't be available in the LCA software for completing the PEF-based studies according to the project timeframe.

Moreover common weighted factors have been suggested.

2.2.3.3 INTERPRETATION OF THE RESULTS

Specific rules for the interpretarion fo the results have been provided in the guidelines (Table 2.4).

Table 2.4 Summary of requirements to define most relevant contributions. (SOURCE: DT2.2.1 - Guidelines for adaptation of LCA methodology to estimate environmental impact)

ITEM	AT WHAT LEVEL DOES RELEVANCE NEED TO BE IDENTIFIED?	THRESHOLD	ADDITIONAL NOTES
MOST RELEVANT IMPACT CATEGORIES	Normalised and weighted results	Impact categories cumulatively contributing at least 80% of the total environmental impact (excluding toxicity related impact categories)	
MOST RELEVANT LIFE CYCLE STAGES	For each most relevant impact category	All life cycle stages contributing cumulatively more than 80% to that impact category	
MOST RELEVANT PROCESSES	For each most relevant impact category	All processes contributing cumulatively more than 80% to that impact category	The identification of the most relevant processes shall be done at whole life cycle level

2.2.4 LCC

Considering the Life Cycle Costing (LCC), even if has a long history (with first applications in the 60's) there is no existing generic standard about this methodology. Distinct and different conceptual foundations and methodological approaches can be traced to its developmental roots in systems engineering. A significant variability of the existing applications depends on how exactly "life cycle" is defined. In economics it is more closely related to marketing, referring to life cycle on the markets: product development, introduction, growth, maturity, and decline. On the other hand, "life cycle" has its physical interpretation deriving from methodologies such as life cycle assessment (LCA). In this case, a life cycle is composed of production, usage and end of life of products.

Current main application of LCC techniques are related to procurement, building sector and products where use phase is typically long and costly.
The selection of the best LCC approach for the CIRCE2020 project started with the analysis of the project goals and with the research of available LCC literature. The project meeting in Budapest (21- 22/03/2018) offered a good occasion to clarify what exactly the project partners expect from the applied LCC and which kind of approach fits best to the project.

[2] climate change; ozone depletion; human toxicity, cancer; human toxicity, non-cancer; freshwater ecotoxicity; particulate matter; ionising radiation; photochemical ozone formation; acidification; eutrophication, terrestrial; eutrophication, marine; eutrophication, freshwater; land use; water use; resource use, fossils and resource use, minerals and metals

A major challenge within the project was related to the harmonisation of the LCC with the environmental assessment using a LCA-based method, the product environmental footprint (PEF) . This was one of the main reason why the physical life cycle concept has been selected for the LCC method which guarantees consistency with LCA. Within the wide LCC literature a main reference method has been identified, called Environmental LCC: a method specifically designed to be used in parallel with LCA efficiently and consistently.

This LCC approach helps to avoid double work, overlaps and gaps when LCA and LCC are used in combination. The structure of the LCC is defined following the logic of the main LCA standard, ISO 14040.

According to the selected approach LCC is an assessment of all costs associated with the life cycle of a product that are directly covered by any one or more of the actors in the product life cycle (supplier, producer, user/consumer, end of life actor). Costs are the monetary value of goods and services that producers and consumers purchase, so they are real money flows, classified as:

- Internal costs: an entity (a producer, transporter, consumer or other stakeholder involved) is paying for the production, use or end-of-life expense. These costs can be treated as business expense and can be divided into costs inside and outside an organization, depending on the perspective.
- External costs cover financial costs, expressed in monetary units that are not directly borne by an actor of the product chain. Noteworthy, these costs are already priced due to their feature of being relevant for future decision-making processes. Carbon taxes or other forms of taxes on pollutants are the typical examples of external costs.

It is clear that the selected LCC approach is more complex compared to more "conventional" LCC approaches devoted to the assessment of only real, internal costs, sometimes even without end of life or use costs. On the other hand, there are existing LCC approaches (called Social LCC) considering not only real money flows associated with the life cycle and externalities in the decision-relevant-future but also externalities that could be monetized or even those that are difficult to monetize and may therefore only be considered qualitatively. The damage costs of emissions are possible external costs belonging to the first group, while public health and social well-being could represent externalities to be qualitatively measured.

The LCC approach of the CIRCE2020 project considers only optional the extension of the assessment towards social externalities because of the considerable uncertainties involved.

After the development and sharing of the first versions of the LCC guideline for the CIRCE2020 project (June-July 2018), a training was organized for the project partners (Padova, 09/10/2018). The experience of this training event helped to test and additionally improve the LCC guideline.

In the CIRCE2020 project the following generic goals can be defined:

- to compare costs of existing "business as usual" (BAU) and new "circular economy" (CE) solutions,
- to identify costs and benefits of waste donors and/or recipients when applying CE solutions,
- to upscale the potential economic benefits of the CE solution to regional or national levels.

Last but not least it is important to clarify that LCC is not a method for financial accounting. It is a cost assessment and management method with the goal of estimating the costs associated with the existence of a life cycle system for comparing alternatives.

The following cost categories are recommended to be included, according to the LCC guideline:

- materials, water, energy (electricity, thermal)
- transports
- administration, commercialisation
- depreciation
- labour
- other cost types, identified as significant in the specific case.

Also external costs, expressed in monetary units that are not directly borne by an actor of the life cycle chain, can be included in the LCC study. It is recommended mainly if a decision maker anticipates that some external costs may come into play during the time of the decision relevant future such as taxes, fees and new regulations. Some examples, selected from LCC literature are the following:

- Costs related to CO2 emissions to be internalized by the producer in the decision relevant future at the current prevailing price of CO2 in the European Union market.[2]
- Costs related to road transport emissions are acknowledged by the European Commission within the Clean Vehicles Directive (2009/33/EC)[3]

2.2.5. LCA AND LCC JOINT CONCLUSIONS

During the partnership meeting in Poznan, an international event orgnized by Polish partner AMTP was the right moment to share results and conclusions of the studies performed in each pilot area (Fig. 2.2).

Moreover, a closed session in the same day allowed a more detailed analysis of challenges and solutions that partners encountered during the implementation of the common methodologies

Figure 2.2: CIRCE2020 partners and external expert after the International event in Poznan (PL)

[2] Bettini, F., Amerighi, O., Burchi, B., Buttol, P.: A methodological approach to Life Cycle Costing of an innovative technology: from pilot plant to industrial scale in What is sustainable technology? The role of life cycle-based methods in addressing the challenges of sustainability assessment of technologies, Rome 27 September 2012

[3] Life Cycle Costing (LCC) in public procurement, Studio Fieschi – Scuola Superiore Sant'Anna, Webinar, 9 June 2015.

A short list of emerged points is reported:

– Availability of data (both primary and secondary) strongly affected the data collection phase for LCA and LCC analysis

– The external company involvement may be crucial for the proper conceptualization of the scenario and complete data availability, but it represented a great challenge for partnership

– The quality of secondary raw material assessed in the CE scenario could not completely fits with the quality of the substituted primary one; therefore, warnings should be taken in the interpretation of results for a fair comparison

- In some pilots, LCC studies do not add any useful information respect to the standard economic and financial analysis that companies already perform in a procurement procedure. This is due to lack of robustness and consistency in the monetary quantification of environmental and social externalities

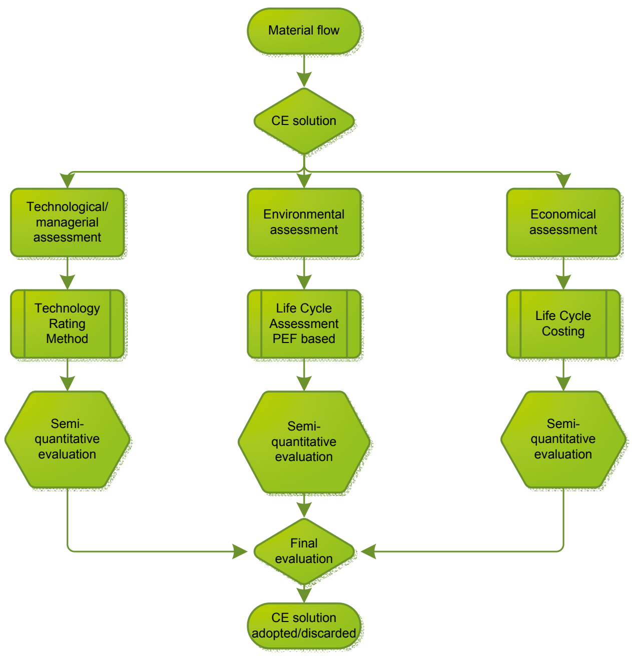
- Difficulties have been encountered in the definition of the scenario and in many crucial steps of the LCC analysis; improvement in harmonisation and validation of results (for example with a third-party involvement) has emerged as foreseeable

– The implementation of the studies as scheduled in the project timetable (requiring specific data) counters with the development of the pilots (in the early running test available data are partial and not representative of a long-term productivity)

2.3 BUSINESS PLAN MATRIX JOINT METHODOLOGY

The present tool realized within CIRCE2020 project represents an instrument which allows the user to assess the circularity of the solution identified for a specific material flow, considering the three most relevant drivers for a circular business: technology, environment, economy. This matrix aims to support the user on the decision whether to adopt or not a specific solution comparing it with the current situation.

The spreadsheet is structured in different tabs following the flowchart reported below:



The first section of the matrix consider the identified technology and after the calculation of the TRM index was used an evaluation grid to determine a semi-quantitative assessment for CE solution:

Table 2.5: TRM index evaluation grid

	EVALUATION GRID			
TRM index	**from 88 to 126 points**	**from 127 to 164 points**	**from 165 to 202 points**	**from 203 to 240 points**
Qualitative evaluation	not recommen-ded	partially not recommeded	limited recom-mended	recommended
Score	1	2	3	4

The second part quantify the current and the expected potential environmental improvements connected to the implementation of the chosen solution at territorial level.
In the definition of the environmental indicator were selected only the following 5 categories, resulting from the PEF-based studies:

1. Climate change
2. Particulate matter
3. Acidification
4. Eutrophication, terrestrial
5. Resource use, minerals and metals

According to external experts, the 5 selected categories represent the main environmental aspects (soil, air, water) and ensure enough robustness, inventory cover completeness and inventory robustness. The results of LCA were normalized in terms of impact/person and was considered a weighting factor to these impact categories = 1 and then summed for the CE scenario and for the BAU scenario. The environmental index was calculated using the formula:

$$\text{ENV Index} = \frac{\text{Env impact (BAU scenario) - Env impact (CE scenario)}}{\text{Env Impact (BAU scenario)}}$$

To transpose the ENV index into a qualitative evaluation and to provide a score the following evaluation grid was used:

Table 2.6 Environmental index evaluation grid

	EVALUATION GRID QUALITATIVE EVALUATION			
ENV index	**ENV index < -20%**	**-20%< ENV index <0**	**0< ENV index <20%**	**ENV index > 20%**
Qualitative evaluation	not recommended	partially not recommeded	recommended	highly recommended
Score	1	2	3	4

The last section of the matrix aim to quantify the current and the expected potential economic improvements connected to the implementation of the chosen technological or managerial solution at territorial level and it's based on the calculation of the LCC index which measures the variation of LCC shifting from BaU scenario to CE scenario.

$$\text{LCC Index} = \frac{\text{LCC (BAU scenario) - LCC (CE scenario)}}{\text{LCC (BAU scenario)}}$$

In order to provide a robust rational for the LCC evaluation, it could be useful to disaggregate the cost among the main contributions (personnel, transportation, investments, etc.)
Also for the LCC an evaluation grid was set to transpose the results and provide it with a score

Table 2.7: Econominal evaluation grid

	EVALUATION GRID			
LCC index value	**LCC index < - 0,2**	**- 0,2 < LCC index < 0**	**0 < LCC index < 0,2**	**LCC index > 0,2**
Qualitative evaluation	not recommended	partially not recommeded	recommended	highly recommended
Score	1	2	3	4

Once that each driver corresponds to a semi-qualitative value it's possible to fill in the "Matrix of concrete CE matchmakings". The final assessment would synthesize all the information, leading to the choice of adopting or discarding the identified solution for the selected flow.

Table 2.8: Matrix of joint methodology

MATERIAL FLOW: (insert the definition)			
CE SOLUTION: (insert the definition)			
	Technological driver	**Environmental driver**	**Economic driver**
qualitative evaluation score	....	....	....
driver weight (qualitative)	...	...	....
Final assessment	...decided to adopt the CE solution		

In the qualitative evaluation score, the final score for each main driver is reported (range from 1 to 4).
The qualitative driver weight can deal with different options:
option 1: the 3 drivers have equal weights;
option 2: personalised weights according to the specific case and chosen by the PP.
In a decisional process there are a lot of factors which may influence the final choice. The joint proposal has been to adopt qualitative weights defined as follows:

- Low relevance
- Medium relevance
- High relevance

At the end of this process a focus is needed to describe the evidence of the Matrix and its final assessment, pointing out:

- The rational behind the choice of the weight for each driver
- Other relevant factor influencing the decision

The video tutorial and the guidelines are published in the CIRCE2020 Wiki-Web platform in the "Tools and Tech" section. (https://www.circe2020-wiki.eu/)

CIRCE2020 PILOT ACTIONS

CHAPTER 3

CIRCE2020 Pilot Action Infographic realized by Mia Monterisi
This chapter was written on the base of deliverable 3.2.3 prepared by:

- *Italy: Giacomo Arrigo Pieretti and Omar Gatto, ETRA spa*
- *Croatia: ČISTOĆA CETINSKE KRAJINE d.o.o. and Public Institution RERA S.D for coordination and development of Split - Dalmatia county*
- *Austria: ATM team with friendly support of Management Centre Innsbruck (Environmental, Process & Energy Engineering) and University of Innsbruck (Unit of Environmental Engineering, Group "Waste Treatment and Resource Management").*
- *Poland: Aldona Konopczyńska and Marcin Konopczyński, AM Trans Progres sp. z o.o.*
- *Hungary: IFKA - Public Benefit Non-Profit Ltd.*

LANDFILL LEACHATE CAMPODARSEGO (PD), ITALY

THE CASE

The target waste in this business model is the EWC 190703 (landfill leachate), generated by a closed municipal waste landfill sited in Campodarsego, within the Italian pilot area. In the post-operation authorisation is reported that the landfill leachate has to be treated before the discharge in the sewage system. Therefore the current managerial solution (direct discharge) is not more suitable. This obligation is consistent with technical aspects related to the management of the downstream waste water treatment plant. The reduction of the pollution load is appropriate because ammonia concentration in landfill leachate further exceeds "standard" capacity of the plant; moreover, with future addition of new sewage user the situation could worsening. For other parameters, leachate quality is similar to municipal wastewater, with low metals concentrations. The envisaged CE solution consists in a treatment plant within the landfill gate. The leachate is stored in fixed tanks before the chemical treatment. The addition of caustic and acid substances in consequential steps allows reducing the amount of dissolved nitrogen in the wastewater stream. The core of the treatment consists in a stripping process exploiting the equilibrium of ammonia in aqueous and air matrix . The stripped ammonia is concentrated in a solution of ammonium sulphate, potentially valuable as either liquid or solid salt fertilizer in agriculture.

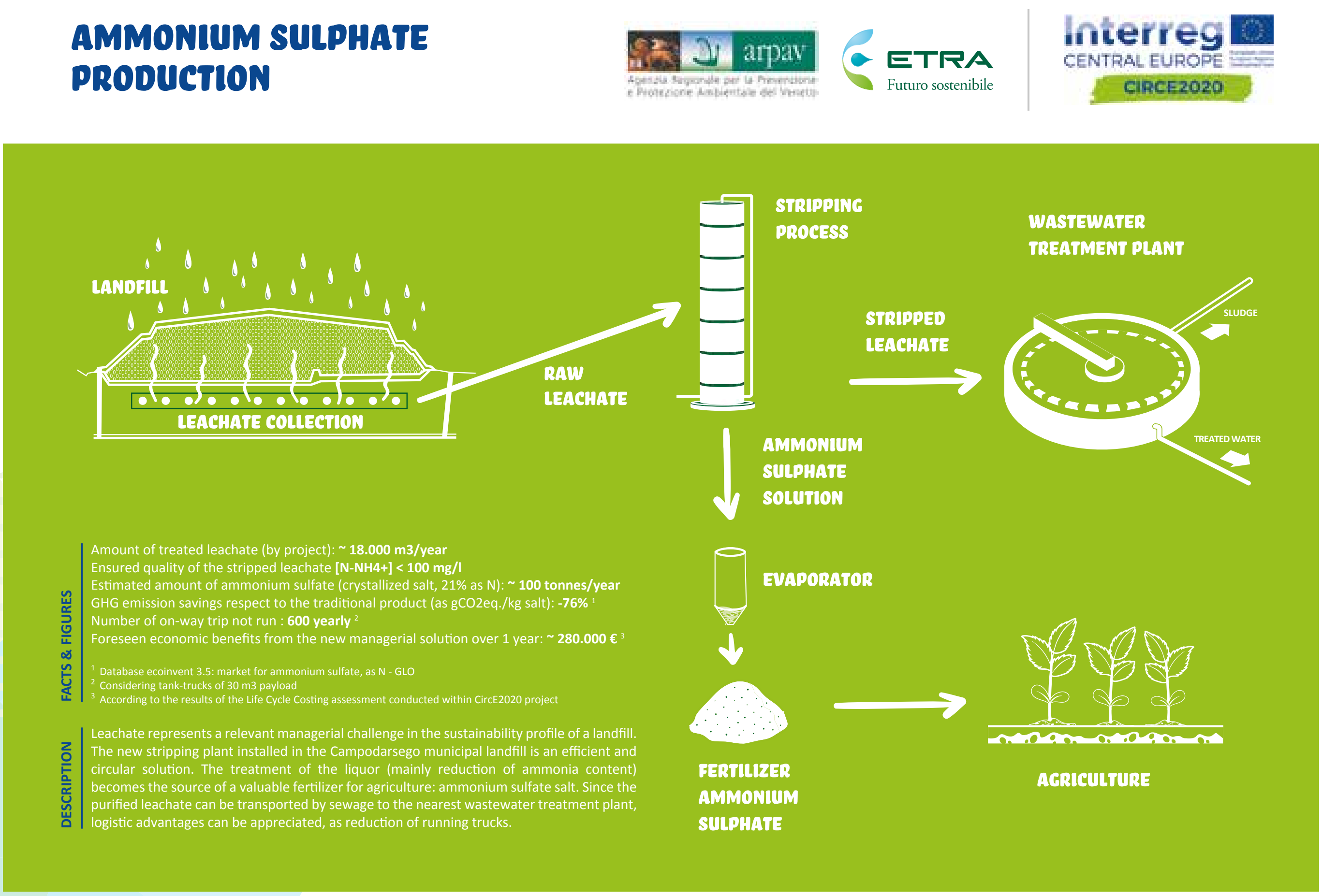


Figure 3.0: Ammonium suplhate production. Pilot case infographic

RESULTS ACHIEVED

Since September 2019, once passing the final tests, the treatment plant is in operation, treating the total quantity of leachate collected from the landfill. The plant mainly runs during daily hours, exploiting the heat recovered from the motors; it stops from 5 pm to 8 am. While the plant is designed for around 50 m3/day of leachate, the current production rate is around 15 m3/ day (about 360 m3/month). This low value is the result of the final capping installed on the top of the landfill, but also weather conditions counts. Thus, the liquid ammonium sulphate is collected and stored in a specific tank. The last update reports around 16 m3 of liquid ammonium sulphate stored (mid-August 2020). A parallel discussion is started with experts in order to understand how to frame the new product in compliance with current legislation and potential valorisation alternatives of the substance.
The treated leachate is flowing to the wastewater treatment plant where it is purified before the final discharge in the water body.
On 30th December 2019, ETRA received the direct ownership of the plant. In order to optimize plant performance, the supplier will run the process till the end of October 2020, when also the management burdens will be internalized. As set in the authorization, the monitoring plan is respected.

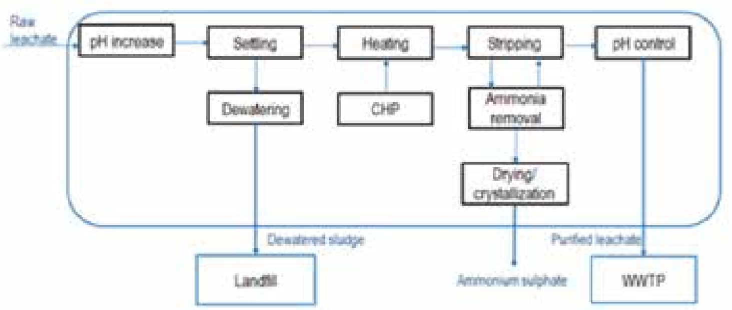


Figure 3.2: Ammonium sulphate production flow

FINAL CONSIDERATION

The selected technological solution is the best considering the context: a simple and specific treatment decreases the inflow load to the wastewater treatment, safeguarding its capacity. Moreover, the envisaged treatment plant for the landfill leachate disclosures the opportunity to create a valuable product (ammonium sulphate) from an effluent, according to the circular economy principles. According to the LCA study performed within Circe2020 project, the perspective to partially substitute traditional product with a locally available one with identical properties seems to result also in environmental benefits

BIOGAS EXPLOITATION BASSANO DEL GRAPPA (VI), ITALY

THE CASE

The plant under focus is located in Bassano del Grappa (BdG). It treats mainly kitchen waste (biodegradable) collected in the nearby municipalities (~ 35.100 t in 2017) and a minor part of green waste (~ 3.700 t in 2017) as structuring material. The treatment consists in an anaerobic degradation followed by a composting phase.

Biogas production from anaerobic digester in 2017 was 4.367.378 m3. Note that the qualitative and quantitative variability of inflow waste, amplified by environmental factors (e.g. weather, temperature) and managerial choices strongly affects the quantity and quality of biogas. For instance, additional maintenance works have further decreased the biogas production in 2017 (4.919.000 m3 in 2016;5.044.000 m3 in 2018).

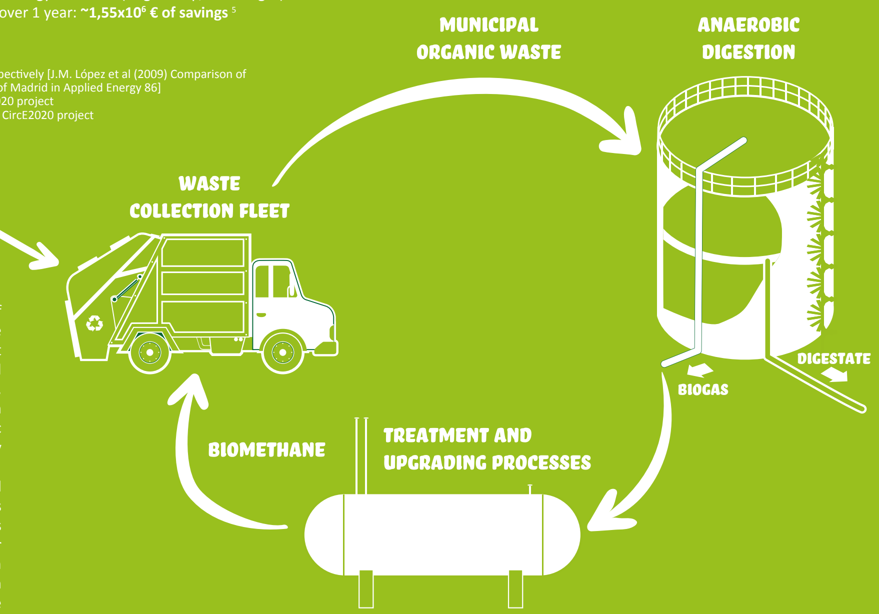
The biogas is actually exploited as energy source fuelling cogenerations motors. The new solution conceives the installation of a further treatment process able to recover methane from the inflow and rejecting the carbon dioxide as off-gas. The bio-methane is injected into the national grid, after a compression step. The new scenario is completed by a cogeneration unit that burning natural gas from the grid provides energy and heat to the whole system.

BIOMETHANE PRODUCTION

FACTS & FIGURES

Yearly amount of generated biogas: **~ 5x10^6 Nm3** [1]
Yearly potential biomethane production: **~ 2,9x10^6 Nm3/year** [2]
Fossil raw material (diesel) savings: **~ 2,3x10^6 kg/year** [3]
GHG emission savings of “Biomethane scenario” respect to the “energy scenario” (as gCO2eq./Nm3biogas): **-30%** [4]
Foreseen economic benefits from the new managerial solution over 1 year: **~1,55x10^6 € of savings** [5]

[1] ETRA SpA, Sustainability report 2018
[2] Considering a mean CH4 content of ~60% in the biogas
[3] Assuming a consumption of 647,7 and 637,5 g/km for methane and diesel, respectively [J.M. López et al (2009) Comparison of GHG emissions from diesel, biodiesel and natural gas refuse trucks of the City of Madrid in Applied Energy 86]
[4] According to the results of the Life Cycle Assessment conducted within CircE2020 project
[5] According to the results of the Life Cycle Costing assessment conducted within CircE2020 project



DESCRIPTION

The target of sustainable biofuel set at national level is 10% of total fuel consumption within 2020. The quota is far to be achieved even if it represents a key aspect to reduce transport sector environmental impacts. The production of “advanced biofuel”, namely Biomethane from municipal organic waste, represents an opportunity to greening the waste collection fleet. Since 2002, in Bassano del Grappa the dry anaerobic digester generates biogas that is exploited for electricity production.

The upgrading process will substitute Combined Heat and Power motors, removing carbon dioxide from the inflow biogas and achieving standard-compliant Biomethane. The product is exploitable as Compressed Natural Gas at service station or injected into the national grid. In particular, the first solution corresponds to the closure of the virtuous loop that starts with the collection of organic waste and ends with the Biomethane injected to the truck for the collection of the same waste.

Figure 3.3: Biomethane production. Pilot case infographic

RESULTS ACHIEVED

The closure of the tender is fixed on 29th September 2020. The environmental and economical assessment developed within the project activities supported the elaboration of technical documents needed for the administrative and authorization procedures. In particular, the screening Environmental Impact Assessment have been filed, with in Annex the LCA results demonstrating the environmental benefits deriving from the new scenario.

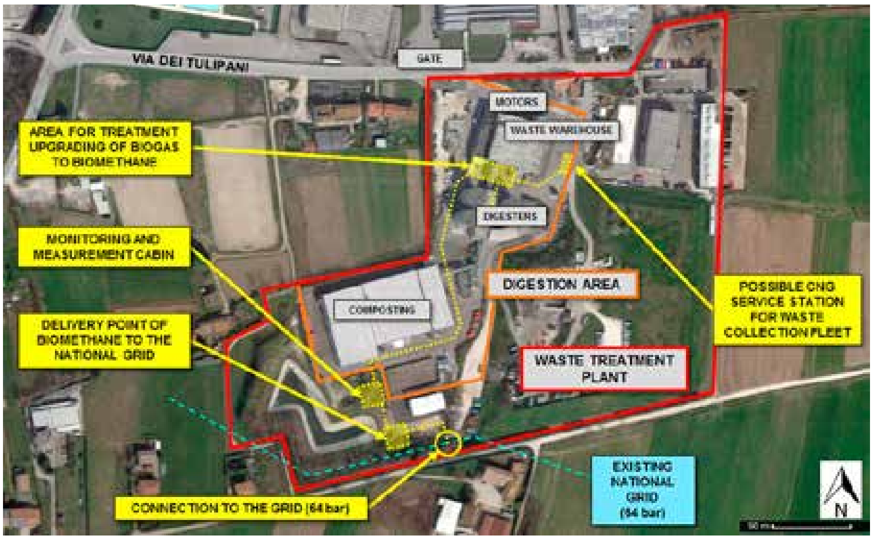
A defined timetable exists to ensure the respect of the date corresponding to the public incentive deadline. The following milestones are set:

- Deadline of the tender: 29th September
- Start of civil work: Febraury 2021
- Start of the plant: October 2021

The substitution of the company fleet takes into account the new industrial strategy with a shifting from diesel to methane fuelled vehicles.

The Regional resolution n. 1233 / DGR of 20/08/2019 recognised the Biomethane from waste within the End of Waste framework, opening the opportunity for operators to proceed for authorization of new plant (or refurbishment of new one).

Figures 3.4: ETRA's plant in Bassano del Grappa (right) and biomethane production (left)



FINAL CONSIDERATION

Environmental analytics, in particular Life Cycle Assessment, argue a narrow burden between biogas exploitation as energy and biofuel. Since major impacts of the new scenario are strictly correlated with the energetic system expansion (production of electricity), expecting a greening of the national energy supply system, the gap will increase in favour of the material recovery (bio-methane). Moreover, the tender has been set in order to reward more efficient and performing technological proposals from an energetic point of view.

Assuming an invariance in terms of environmental burdens, the main driver in the business model is the financial one. Thanks to the public funds, the new scenario represents relevant profit margin. On one hand ETRA increases its independency in terms of fuel supply, as a matter of fact the entire waste collection fleet will be powered by the biofuel generated in Bassano del Grappa. On the other hand, the energetic demand (heat and power) for the entire site - satisfied by biogas combustion in cogeneration motors today -, will be dependant to the fossil methane from the national grid. Great efforts are required to optimize performance of cogeneration unit to minimize the consumption of the resource.

PVC SELECTION FROM PLASTIC WASTE BASSANO DEL GRAPPA (VI), ITALY

THE CASE

ETRA signed a confidentiality agreement with the sector agency PVC FORUM in order to test as pilot action the selection of PVC waste deriving from different flows brought to its selection plants:

1. Bulky waste
2. Hard plastic waste
3. Industrial, C&D waste

The activity involves different actors:

NAME OF THE PERFORMER	ROLE IN THE INDUSTRIAL SYMBIOSIS
Manager of the Intermunicipal Centre for Temporary Storage & Recycling Centres - ETRA	Collection and pre selection of different waste flows
Manager of waste selection facility - ETRA	Mechanical and manual sorting of the PVC waste, press and storage of bales
Owner of waste treatment plant	Production of secondary raw material from the selected PVC waste
PVC businesses agency	Matchmaking donor/recipient, trainings for facilities operators

Expected results (qualitative and quantitative)

- Reduction of disposal in landfill / incineration of PVC waste and increase of material recovery of plastics
- Improvement of the secondary plastic waste (EWC 191204) management
- Positive environmental impacts from the recycling activity and additional service provided to users

PVC

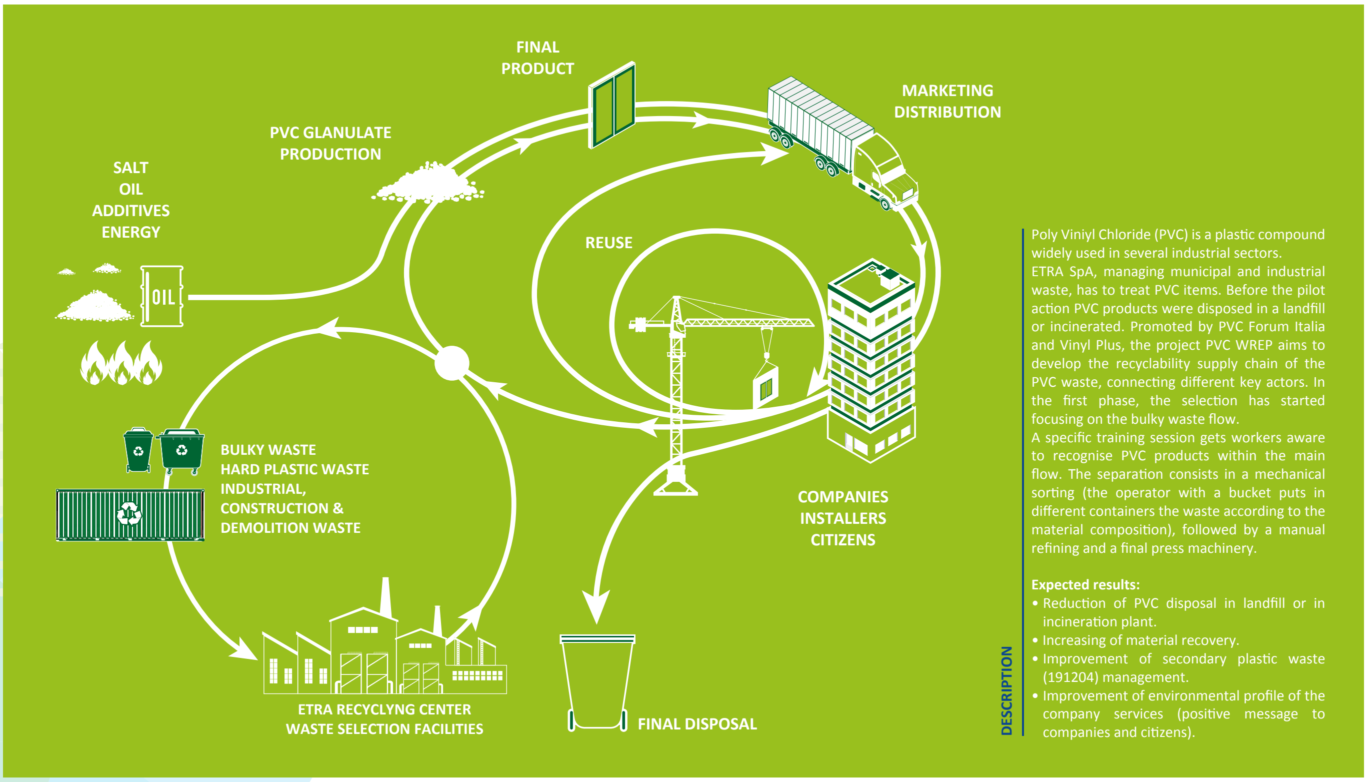


Figure 3.5: PVC flow. Pilot action infographic

RESULTS ACHIEVED

Main phases:

- Agreement with PVC forum (business association) → July 2019
- Agreement with the “waste recipient” (PVC recycling plant) → August 2019
- Training sessions for the operators of the selection plant (Figure 1) → September 2019
- Monitoring pilot action → October 2019 (start)
- The pilot action has started focusing on the bulky waste flow. The separation consists in a mechanical sorting (the operator with the bucket puts in different containers the waste according to the material composition) and a further manual refining before the press machinery. This system has sorted out around 84 t of PVC waste from the beginning till July 2020.
- In parallel around 15 local plastic companies have been contacted, offering a collection service of the waste, in order to find out opportunities of matchmaking.
- To reduce the risk of PVC contamination, the hard plastic waste flow has not been involved in the pilot action and it follow the previous procedure of recycling.

Figures 3.7: Selected PVC (above) and PVC selection workshop (below)

FINAL CONSIDERATION

The quantity collected July 2020 from a unique waste flow (bulky waste) is promising. The action represents an important change-of-mind because the PVC waste was not recovered before, while now it could be potentially valorised with minimal modification of the existing structure.

The implementation of the recycling system could solve a challenge in waste management because PVC was actually discarded and burns into incinerators, with all the correlated relevant problems. Find out a proficient destiny represents an important step further.

VALORIZING OLIVE MILL POMACE FROM OLIVE OIL PROCESSING PLANT SPLIT, DALMATIA COUNTY (HR)

THE CASE

In the area of Split-Dalmatia County many small to medium olive oil production companies are in operation. These companies periodically, seasonally, once a year, process olive fruit and produce olive oil. After harvesting of olive fruit, the olive growers transport the olives for processing to the olive mill facility, where after production of the oil, waste remains (olive mill pomace). The proposal for the CE solution and pilot action is to valorize the olive mill pomace with the aim of producing high-value compost, which would close the loop between olive cultivation, and processing waste and thus return biological material back to the agricultural land. Due to the use of compost and reduced use of mineral fertilizers in olive groves, olive growers would also achieve significant financial benefits due to the reduced need for mineral fertilizers. In addition to organic farming due to the use of the produced compost in olive groves, olive growers would also achieve significant financial benefits due to the reduced need for industrial fertilizers. All together is effective driving force to create proposed closed loop system.

Considering that composting is a long process, for this pilot action, during the composting, the addition of Bio-algeen products will be used. Bio-algae is an ecological brown algae preparation that speeds up the degradation process and shortens it to about 6-12 months

Figure 3.8: Olive processing waste. Pilot Action infographic

RESULTS ACHIEVED

It is proposed to develop composting guidelines to help smaller olive growers achieve organic farming goals with maximum valorisation of the biological residue of olive oil production. Guidelines for proper composting can help smaller olive growers, especially olive growers on the islands of Split-Dalmatia County, manage their olive groves in a sustainable way with ecological farming and reduce the costs associated with the treatment of agricultural land.

Figures 3.9: Olive treatment plant (left) and olive mill pomace (right)

FINAL CONSIDERATION

The proposed CE solution is directed to valorisation of the olive pomace with the aim of producing high-value compost (fertilizer), which would close the loop between olive cultivation and olive processing waste and thus return biological material back to the agricultural land. In addition to organic farming due to the use of the produced compost in olive groves, olive growers would also achieve significant financial benefits due to the reduced need for industrial fertilizers. All together is effective driving force to create proposed closed loop system.

VALORIZING FISH PROCESSING RESIDUES IN A BIORAFINERY PILOT CONCEPT TRILJ, SPLIT, DALMATIA COUNTY (HR)

THE CASE

In Split-Dalmatia County many small to medium fish processing companies are in operation. During this pilot action, valorisation of high-value fish by-product, which is only partially valorised by the current method of disposal, is taken into account. Suggested CE solution primarily valorises high-value omega 3 acids that can be extracted from high-value by-product (oil extraction, transesterification..) and placed on the pharmaceutical market. Considering, it is possible to use high-quality blue fish in an optimal way, with the possibility of extracting additional competitive advantages of the fish processing company. The results can easily be transposed to similar plants, many of which are in the territory of SD County, but also in other coastal counties of the Republic of Croatia. For the Pilot action, company located in City of Trilj in Split – Dalmatia County, donated representative sample of fish by-products from the sardine canning plant. After taking the representative sample, the extraction of fish oil, protein and water from a fish by-product sample was carried out. The Faculty of Chemical Engineering and Technology in Zagreb conducted the laboratory analysis

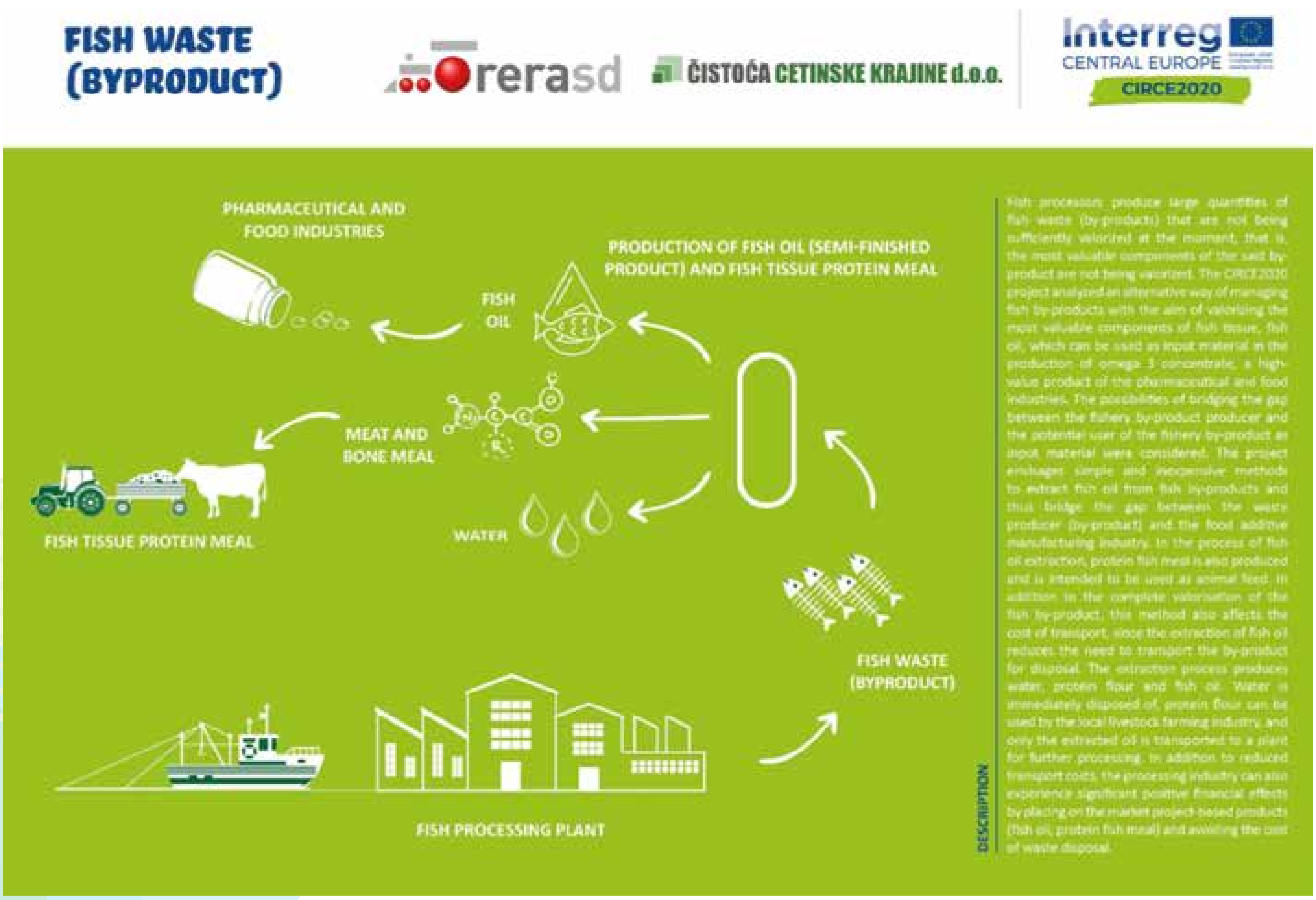


Figure 3.10: Fish waste by products. Pilot action infographic

RESULTS ACHIEVED

The main aim of this pilot action is bridging the gap between waste (by-product) donor (producer) company and a fish waste (by-product) recipient company. Water would be properly disposed of, fish protein could immediately be sold to the animal feed market and the unrefined fish oil would be sold as input material for pharmaceutical and food supplement industry and thus bridge the gap between waste donor and waste recipient. It is also proposed to consider the financial effects during business plan drafting that may be favourable for a waste donor company that may, besides complete valorization of fish by-products, also achieve significant positive financial effects.

Figures 3.11: Fish byproducts and lab. test

FINAL CONSIDERATION

Partial processing of the fish tissue by-product at the very location of the fish processing facility would facilitate immediate fish by-products processing. Proposed CE scenario enables great financial opportunity to exploit fish by-products. This technological solution set the possibility of introducing additional standards in the processing of animal by-products from which higher-value raw materials for other industries can be produced and extraction from the raw by-product by a wet reduction process has a rather small contribution to environmental footprint. All together is effective driving force to create closed loop remanufacturing system.

MAKE GRANULATE FROM WASTE TYRE RESIDUES

TATABÁNYA INDUSTRIAL PARK (HU)

THE CASE

Waste stream (annual 1500 tonnes) consists of production rejects (55%) – qualitatively inappropriate vulcanized final products - and industrial waste residues (45%) – unvulcanized residues from the manufacturing process in case of Michelin Hungary Ltd..

The following alternative treatment processes had been identified and analysed:

- Incineration and energy recovery;
- Material recycling:
  - production of crumb rubber based products (e.g. shock absorbing surface, soundproofing material),
  - crumb rubber in road construction (e.g. rubber bitumen);
- Pyrolysis;
- Other R&D directions:
  - devulcanization,
  - production of injection moulding rubber products.

The main difference is the condition of the waste types that causes huge treatment problems: the unvulcanized waste stream is in various forms, inelastic, deformed by heat and able to form a large block with the materials in contact with it. Therefore, the transportation and also the waste processing and incineration are hard, it requires special treatment procedure that is not exists at this moment.

When IFKA identified this problematic waste flow the cooperating company gave some information about the treatment process which was in connection with the incineration and energy recovery. Tire producer company currently transport the waste flows together to Polgár incineration where it turned out that they are not able to incinerate the huge blocks because they do not have shredder what can do this process. So the waste amount has not been incinerated, just temporary stored

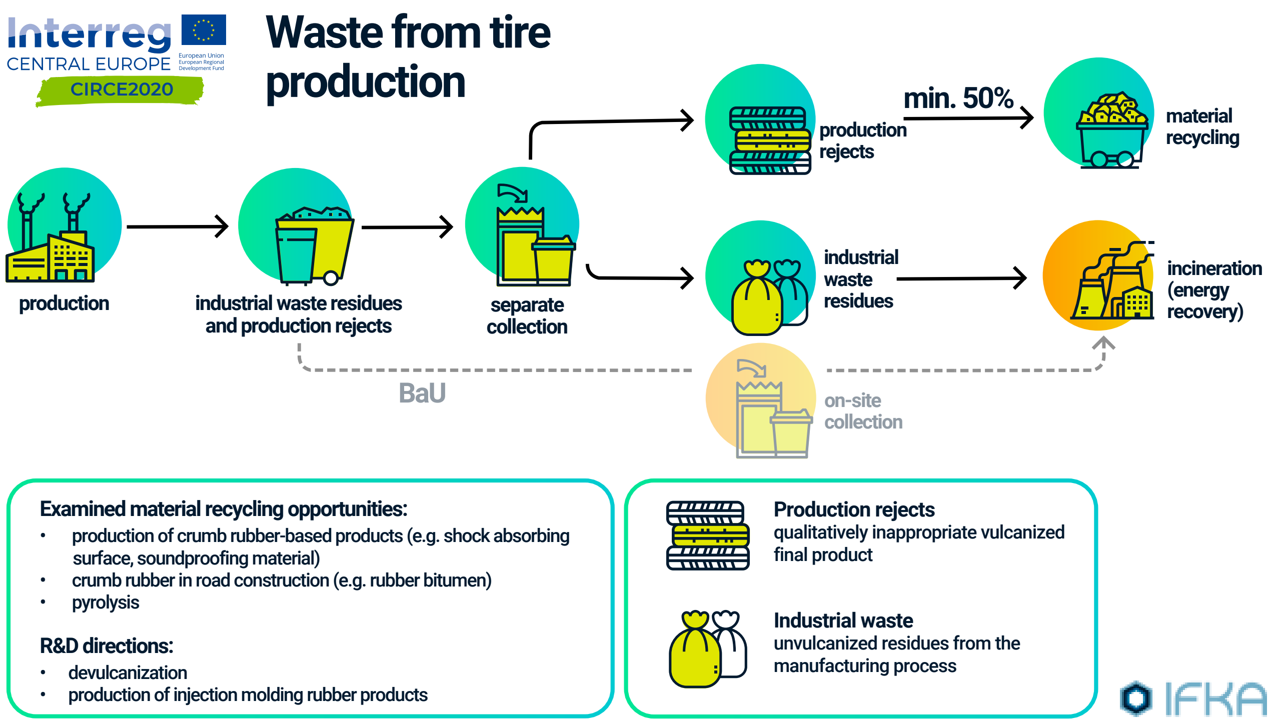


Figure 3.12: Waste from tire production. Pilot action infographic

RESULTS ACHIEVED

The main results what IFKA would like to achieve is a separate collection of the vulcanized and un-vulcanized waste types at the donor company. In this case the shredded rubber, then granulate can be produced from the vulcanized residues and the amount of the landfilled waste could reduce.

To sum up:

- Separate collection of the vulcanized and unvulcanized waste flows;
- Reduce the waste amount that goes into storage at the moment;
- Material recycling (make granulate) of the vulcanized waste rubber residues instead of incineration & energy recovery;
- Less environmental impact.

LCA and LCC analyses have been prepared to estimate the economic and environmental effect of the current business as usual and circular economy solutions in case of tire waste.

IFKA has also prepared a document where the available processing technologies, contacts and suggestions were summarized. This document's aim was to give valuable information for the producer company about their waste, its environmental and processing problems and alternative (better) technologies to handle their waste.

Figure 3.13: Waste tire selection in Hungary

FINAL CONSIDERATION

IFKA made some suggestions to foster material recycling opportunities through separate collection of the waste types. Donor company is cooperative but representatives of the company have little influence on decision making.

However during the project they highlighted those processes what should be improved within the factory, separate collection of the rubber waste residues and scrap materials is needed in order to utilize the valuable materials and to keep them in the material loop as long as possible.

The waste company will no longer accept unvulcanized materials from 2020, so the producer company is kind of forced to look for new more circular solution. This might led to more space for innovations in this respect. The negotiations are still ongoing.

COMPOSITE PLASTIC WASTE INTO A VALUABLE PRODUCT

TATABÁNYA INDUSTRIAL PARK (HU)

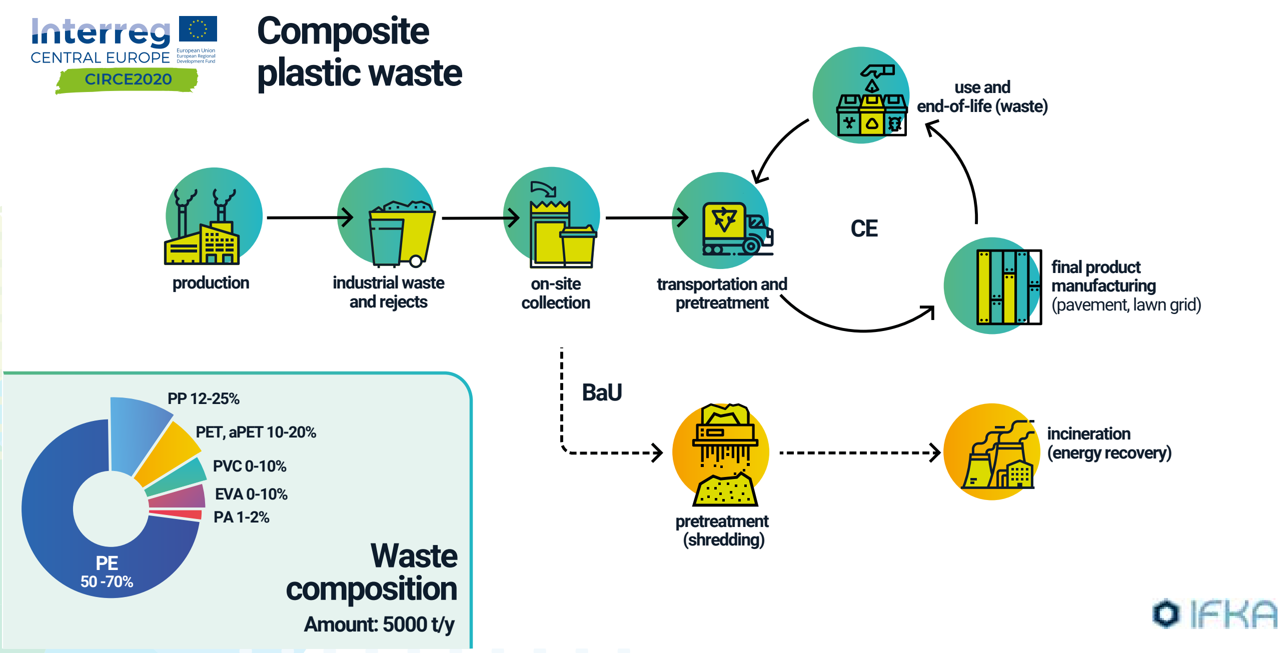
THE CASE

The donor company (Coloplast Hungary Ltd.) develops product and services that make life easier for people with very personal and private medical conditions. It offers a wide selection of products to meet the different needs of their customers. Their portfolio offers a range of innovative ostomy bags that make the consumers feel secure and confident. Quality is the most essential point in their operation because it is a medical product. They need to work with primary raw materials, no secondary resources could be integrated into their production system. Due to the production lines and the quality control mechanisms of the given company this is the biggest amount of homogenous waste – 5000 tonnes – generated by the company. The previously applied waste management technology of the critical amount of plastic waste is incineration with energy and steam recovery. The aim is to change the present waste management system and develop the present treatment choice to a higher and more efficient level or - being a critical material- to produce valuable products from these waste plastics.

Possible recipient – a recycler – company (Csatári Plast Ltd.), whom we initiated negotiations and tests, is committed to environmental protection. Its products are produced through efficient recycling of municipal and industrial plastic waste. The production is environmental friendly, since the raw materials used for their production previously have been transferred to landfill sites without utilization. The shredded multilayer plastic is delivered to this plastic waste utilization site where the next plastic products can be manufactured from the waste:

- grass grids,
- pavements,
- reusable storage bins - that can be used by the donor company in their transportation processes.In this case they could be the biggest buyers of these products utilizing their own waste and by- products this way

The high quality of the products is constant; the products have a very long lifetime



Composite plastic waste. Pilot action infographic

RESULTS ACHIEVED

The whole amount of waste composite plastic (annual 5000 tonnes) is usable as a raw material and valuable products can be produce from it. The donor company is part of a Danish parent company, and waste from all companies in the group is currently incinerated. The company is highly dependent on the incinerators and their operation which is very risky. So material recycling is a great opportunity to eliminate this dependency besides this solution is more environmental friendly than incineration.

The LCA and LCC analysis of the waste stream have been done in two scenarios (Business as usual and circular economy). Results were shown that material recycling is beneficial in case of technology, economic and environmental aspects.

IFKA also found a possible recipient company which can utilize the whole amount of waste and produce various products from waste. Results of tests are very promising, so currently discussion is in progress regarding prices and other important corporate factors.

Cooperation with the Budapest University of Technology is also in progress because to produce and sell these products product info sheets are necessary which the university can produce based on their measurements.

Figure 3.15: Composite plastic selection

FINAL CONSIDERATION

To process the waste composite plastic material recipient company needs to develop their machinery. This investment could be financed from the Green National Champions - Economic Development and Innovation Operational Programme (EDIOP) which targeting energy and water use efficiency, fostering electro mobility and secondary raw material usage (industrial symbiosis).

The program's main goal is to support the developments of local micro-, small- and medium-sized manufacturing companies with high growth potential related to the green economy and industry facilitating technology change. A complex pre-qualification procedure has been developed by IFKA and enterprises have to comply with the different "green" criteria – like material efficient measures - waste management, industrial symbiosis synergies, climate related risk assessment; renewable energy use during production – to get the "Green National Champion" certificate.

Acquiring this certificate is a precondition to apply for the EDIOP 1.2.11-20 call getting the chance to receive financial support for their development concept that is in line with the above mentioned objectives. The amount of non-refundable support is 20-400 million HUF (57 000 - 1 142 800 euro) with a 50% maximum aid intensity. The budget of the call is 7.3 billion HUF (20 857 000 euro).

ENERGY RECOVORY FROM LOW CALORIFIC FRACTION (LCF) OF A MECHANICAL WASTE TREATMENT PLANT INNSBRUCK (AT)

THE CASE

This case study focuses on the low calorific fraction (LCF) as the output flow after shredding and sieving of residual waste at a mechanical waste treatment plant (MWTP). Currently, the LCF is transported for 300km to the nearest waste incineration plant (WIP). Incinerating the LCF is very energy intensive, as the waste flow is humid (<60% DM) and rich in organic matter (>45% of FM). Therefore, this case study aims at improving the environmental impact of transportation and the energy efficiency of processing this waste stream. For this reason, the LCF is intended to be further separated into fractions which can be either used as secondary raw materials or processed more sustainably. To do so, an hydrocyclone was specifically designed and installed in a nearby waste water treatment plant. After adding water to the LCF (< 12 mm) the hydrocyclone processes an overflow and underflow consisting of two new outputs (see Figure 1 and Figure 2):

1. liquid fraction, rich in organic matter (overflow)
2. solid inert fraction containing glass, stones and sand (underflow).

The liquid fraction, rich in organic matter, was co-digested to produce heat and energy. The dewatered sewage sludge was separated into its components. The glass component can be potentially recycled, and the remains (sand and stone) has to be transported to a landfill. Due to the complexity of the input, the different outputs and their pathways of continued use, there are several stakeholders involved.

Figure 3.16: Residual Waste. Pilot action infographic

RESULTS ACHIEVED

Depending on the intended continued use of the new output flows, the pilot action is dived into two parts: energy generation and recyclables recovery.

Energy generation

First test runs have been conducted to generate energy. Activities included:

- Producing an appropriate input substratum, which is suitable for co-digestion

This required to sift the original LCF input material (12-40mm) into smaller fractions. During the first test runs it turned out that the hydrocyclone worked most sufficiently with an input material of < 12 mm grain size.

- Running of co-digestion processes in test reactors

The amount of produced biogas and its methane content suggest a stable methane production. This indicates a stable digestion process and attests the biogas potential

Recyclables recovery

It is the aim to test the feasibility of using the glass output recovered from the LCF as secondary raw material, and hence to close the regional material loop. The main emphasis was on finding new regional business partners who use the recovered glass as input into their production process.

- Initiating business cooperation

A meeting with one of the biggest companies in the region working with glass took place to discuss (i) possible utilization pathways for the glass fraction, (ii) potential donors and recipients, and (iii) technical solutions for the sorting process. The inert output consists of glass, sand, stones, etc. (see Figure 3.17). Glass recycling companies, however, are only interested in pure glass. Separating the fractions, currently is only possible manually, which is labour and time intensive. A technical solution for the sorting process is required.

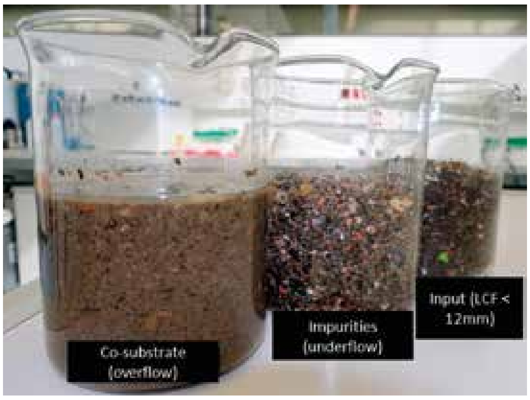


Figure 3.17: Inert output

FINAL CONSIDERATION

The overall aim of the pilot action was to test the feasibility and to advance the implementation of energy recovery from the LCF of a mechanical waste treatment plant. To co-digest the LCF, an appropriate input substratum could be successfully produced. The co-digestion process ran stably and the methane production achieved good to very good results, demonstrating the technical feasibility. Furthermore, calculating the profitability, showed a clear economic advantage to the current situation. In particular, if the CE solution is fully implemented and runs on a large scale, it is expected to mobilize renewable energy reserves, which are yet unexplored. Comparing the current situation with a scenario when the CE solution is fully implemented, several economic and environmental indicators demonstrate an improvement.

Therefore, the solution developed within the Circe project will be continued.

WASTE WOOD FOR THE PRODUCTION OF BIO-CHAR

SCHWAZ (AT)

THE CASE

This case study focuses on waste wood, which is gasifyed, to produce energy and charcoal using a wood-fired power plant. Currently, this process only runs with untreated wood, qulity A1, and the existing technology needs to be adapted, in order to also use waste wood as input. Due to the different origins, waste wood can be contaminated to varying degrees with foreign substances (contaminants). For this reason, in the German Waste Wood Ordinance waste wood divides waste wood into four quality categories:

- A1 – natural, untreated wood, which has only been processed mechanically
- A2 - glued, painted, coated, or otherwise treated waste wood without halogenated organic compounds in the coating and without wood preservatives
- A3 - waste wood with organohalogen compounds in the coating without wood preservative
- A4 - Waste wood treated with wood preservatives, such as railway sleepers, electricity line postes, hop poles, vine piles, and other waste wood, which cannot be assigned to waste wood categories A I to A III because of its pollution, with the exception of waste PCB wood

Activating the charcoal makes it suitable for treating contaminated wastewater, such as landfill leachate. However, up to now, this charcoal is classed as a waste product and an adequate legislative seeting needs to be established in order to utilize this valuable by-product.

The ingoing waste wood needs to be pre-processed (cut into smaller pieces) with a so-called wood shredder/clipper. Also, contaminants (e.g. metals and non-ferrous metals) need to be partially removed.

Figure 3.18: Waste wood. Pilot action infographic.

RESULTS ACHIEVED

As the pilot action is still ongoing and the final results will be reported upon its conclusion, this report only describes preliminary results.

Input material

First test runs to produce appropriate input material have been conducted. Activities included:

- Shredding of waste wood with a stationary shredder
  To date, this included only wood of EWC 15 01 03 'wooden packaging from waste packaging' in quality A1 and A2, according to the German Waste Wood Ordinance (see DT2.1.1 for more detail).
- Quality control of input material

To control the quality of the shredded waste wood, several physical and chemical parameters of the produced wood chips were tested.

Technology

To be able to use waste wood as input for the wood fired power plant, the existing technology needs to be adapted. Activities included:

- Adapting the reactors

Calculations and detailed drawings were set up and are about to be finalised in consultation with the constructor.

Figures 3.19: Waste wood tratment flow (left) and chipwoods used as imput materials (right)

FINAL CONSIDERATION

The overall aim of the pilot action was to test the feasibility of utilizing waste wood to produce energy and charcoal by means of a wood-fired gasification plant.

The waste wood could be successfully shredded to the necessary particle size. The shredded material was of good quality and could be used as input material.

To adapt the technology to be able to process waste wood, the reactors had to be changed. Detailed drawings and calculations have been finalised.

Test runs with the new reactors will start shortly and seem to be very promising to have a positive outcome. Therefore, the solution developed within the CIRCE2020 project will be continued.

PRODUCTION OF MULTI-MATERIAL BOARD FROM MULTIPOLYMER WASTE WIELKOPOLSKA REGION (PL)

THE CASE

The case developed a waste stream of mixed plastic PC and PI produced in the recycling of PVC waste. The PVC recycling process will be carried out without the use of water, therefore, the multipolymer waste will be processed without washing and the final product may have many inclusions of other substances, such as sand, stones and ceramics. The waste in the landfill will be reduced, especially if it's made of plastic, and the production process requires less energy consumption in comparison with materials previously offered on the market. The manufactered product will have better properties than those available on the market.

Figure 3.20: EMABO - Multipolymer board production. Pilot case infographic

RESULTS ACHIEVED

The pilot action is over. The result of the actions taken is a value market product. At this stage, the potential uses of the product in the future have been identified, product has entered the market and the first contract are signed. The production plant is equipped with a technological line. The form of the product is variable (shape, thickness, colors) and can be determined refer to the customer expectation.

As a result of the implementation and completion of the pilot action, the following results were achieved:

- The amount of mixed plastic waste sent for landfill will decrease significantly.
- Qualitative tests confirmed the expected physical and chemical properties of the product
- LCA research allowed for the implementation of the best CE scenario, thus reducing the impact on the environment.
- Along with the increase in production and the demand for incoming input, the recycler is getting ready to start accepting additional streams from other producers who do not currently have the possibility to manage mixed plastic waste
- As a result, the action pilot was created a valuable market ready product

Figures 3.21: Multipolymer board production plant (right) and imput materials (left)

FINAL CONSIDERATION

All the activities related to the pilot action confirmed that the development direction adopted in CE is effective, appropriate and feasible. The action affects the recovery and the increase in the amount of reused resources, giving potential income. LCA, LCC confirmed the environmental and economic benefits. Establishing quality standards made it possible to duplicate the solution by other entrepreneurs. CE solution has a positive impact on the development of the technology used in production.

POLAND – MULTI-MATERIAL AND MULTIFUNCTIONAL PANELS FROM MULTIPOLYMER WASTE IN FACILITY WIELKOPOLSKA REGION (PL)

THE CASE

The case study developed a waste stream of mixed plastic PC and PI produced in the recycling of LDPE waste. The LDPE recycling process is carried out with the use of water, therefore, the multipolymer waste will be processed with washing therefore the final product is clean and homogeneous. The waste in the landfill will be reduced, especially if it's made of plastic, and the production process requires less energy consumption in comparison with materials previously offered on the market. The manufactured product will have better properties than those available on the market.

Figure 3.22: DTJ Multipolymer panel production. Pilot action infographic

RESULTS ACHIEVED

The pilot action is over. The result of the actions taken is a product prototype. At this stage, the potential uses of the product in the future have been identified. The production plant is equipped with a technological line. The final form of the product (shape, thickness, colors) will be determined after selecting the target markets.

As a result of the implementation and completion of the pilot action, the following results were achieved:

- The amount of mixed plastic waste sent for landfill will decrease significantly.
- Qualitative tests confirmed the expected physical and chemical properties of the product
- LCA research allowed for the implementation of the best CE scenario, thus reducing the impact on the environment.
- Along with the increase in production and the demand for incoming input, the recycler is getting ready to start accepting additional streams from other producers who do not currently have the possibility to manage mixed plastic waste
- As a result, the action pilot was created a prototype material

Figures 3.23: Panel production process (left) and imput material (right)

FINAL CONSIDERATION

All the activities related to the pilot action confirmed that the development direction adopted in CE is effective, appropriate and feasible. The action affects the recovery and the increase in the amount of reused resources, giving potential income. LCA, LCC confirmed the environmental and economic benefits. Establishing quality standards made it possible to duplicate the solution by other entrepreneurs. CE solution has a positive impact on the development of the technology used in production.

CIRCE2020 BRIDGING TO THE EU GREEN NEW DEAL

CHAPTER 4

Andrea Torresan (ARPAV) – This chapter was written on the base of deliverable 3.3.2 Regional Action plan prepared by:

- ***Italy: Andrea Torresan, ARPAV***
- ***Croatia: Public Institution RERA S.D for coordination and development of Split - Dalmatia county***
- ***Austria: ATM team with friendly support of Management Centre Innsbruck (Environmental, Process & Energy Engineering) and University of Innsbruck (Unit of Environmental Engineering, Group "Waste Treatment and Resource Management").***
- ***Poland: Aldona Konopczyńska and Marcin Konopczyński, AM Trans Progres sp. z o.o.***
- ***Hungary: IFKA - Public Benefit Non-Profit Ltd.***

CIRCE2020 BRIDGING TO THE EU GREEN NEW DEAL

The European Commission adopted a new Circular Economy Action Plan – one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth. With measures along the entire life cycle of products and building on the work done since 2015, the new Plan focuses on the design and production for a circular economy, with the aim to ensure that the resources used are kept in the EU economy for as long as possible.

Published under the umbrella of the EU Industrial Strategy, the Circular Economy Action Plan proposes measures to design waste out of the economy by transforming it into high-quality secondary resources that are fed back into the production process. To that end, the Commission will explore setting an EU-wide, harmonised model for the separate collection of waste and product labelling.

In the coming months and years, a series of policies is expected to stem from the plan. Most notably, a legislative framework on sustainable products, the right to repair, and on the sectors that use the most resources and where the potential for circularity is high (e.g. electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, and food) are slated for adoption in the near future.

Within CIRCE2020 project each partner developed a "Regional Action Plan to expand secondary raw material market" to draw attention to the need and necessary steps towards a transition to a circular economy. It intends to give an objective overview of the current situations, success stories and also highlighting some of the critical issues in this respect. It also intends to provide some ideas and actions to support the SRM markets resulting in resource efficient economic operations.

4.1 PERSPECTIVES IN THE 5 PILOT REGIONS

4.1.1. ITALY – VENETO REGION

Italy has approved a series of policy actions towards the adoption of CE in the country such as the law 221 (28 December 2015) and other legislative decrees that define guidelines and criteria for e.g. the calculation of the rate of differentiated collection for municipal solid waste or the criteria for the eco-design of WEEE.1 Moreover, in a recent document named "Towards a model of Circular economy for Italy", the Ministry of Environment and the Ministry of Economic Development outlines Italy's strategic positioning on the CE and recalls the general basic principles and features of the CE (Ministry of Environment and Protection of Territory and See, 2017).

The country is scarce of natural resources and largely depends on imports (in particular fossil energy and metals). The transition to CE would render more sustainable, competitive and secure the national economy reducing its exposure to the negative effects of its high resource dependency (EUROSTAT, 2016). Natural resources are important for the internal economy and in particular for the manufacturing of goods that Italy widely exports all over the world (ISPRA, 2013).

With this premise, it's pretty clear that the adoption of the principle of the Circular Economy in Italy and more locally, in Veneto, could be a benefit not only for the environment but also for the economy.

Within CIRCE2020 project the regional action plan aims to provide a guideline for the regional policy maker in order to boost the CE "revolution" on a regional scale.

Some of the objective of the plan are:

- Reduction of resources consumption,
- Reduction of waste production,
- Reduction of CO_2 production,
- Reduction of harmful substances use,
- Reduction of soil consumption.

To reach those objectives were analyzed the critical elements for a real implementation of the circular economy, like the legal bindings and the national implementation of the EU directives, the marketing issues regarding the "circular products" and the SRM market.
The plan proposes also several actions and best practices to boost the transition. First of all the new EU investment (ERDF and cohesion fund) for the period 2021-2027 and the proposal for the future actions. Then a focus on the Green Public Procurement due to the fact that Europe's public authorities are major consumers. By using their purchasing power to choose environmentally friendly goods, services and works, they can make an important contribution to sustainable consumption and production.

The other actions take into consideration:

- By-products and how to push the market. A proposal for a financial instrument
- Reuse and Recycle, that are on top of the European waste hierarchy
- Sustainable tourism. Veneto Region it's the first region in Italy for tourism and it's strictly related to the environment
- Food Waste, trying to intercept the products at the large-scale retail and the consumption of the local products "from the producer to the costumer"
- Construction and Demolition sector, that in Veneto it's responsible of the 40% of the special waste (ARPAV, 2017)
- Waste Management, trying to valorise the concept of the waste as resources analyzing the production process under a more circular point of view with the support of technical instrument as LCA, LCC and MFA developed during the project
- Textile sector, with a focus on the raw material but also the use of the by-products. The use of plastic fibers are responsible for the dispersion of the micro plastic in the environment and the ocean
- Plastic Materials, with a focus on the bio-plastic, packaging and the management of the waste to avoid the dispersion in the environment
- Digital Technologies as a tool for the monitoring of the pollution, but also the issue related to the eBusiness and the packaging.
- Citizen information, because they are the main users and the one that will make a choice between products. Provide them with the right information to "know how to choose" will boost the market of the circular products
- Stakeholder involvement with a permanent circular economy round table to boost the industrial symbiosis and bring to to the regional policy makers new proposals.
- To keep track of the Circular Economy status and improvement a set of indicator was proposed. Each indicator will monitor one objective of the plan:
- Percentage of separate waste collection
- Air quality considering PM2.5, PM10, 03, NO2, SO2
- Circular material use rate measures the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use.
- Soil consumption
- Quantity of renewable energy used

4.1.2. AUSTRIA

In 2019, Austria became the first EU member state to publish a circularity gap report at national level (Circle Economy and ARA, 2019). It states that the Austrian economy is only 9.7% circular. Thus Austria is slightly above the average of the world economy (9.1%), but there is a massive gap to close the cycle. In addition to the typical recycling rates, this value relates to the proportion of secondary raw materials in the total consumption of materials. 55% of the use of these materials and resources (also known as the material footprint) occurs outside the country's borders and is typical for a developed industrial nation. Mobility and consumer goods in particular, with almost half of the material footprint, have an impact here. Particularly noteworthy here are the material flows from the construction sector.

The Circularity Gap Report (Circle Economy and ARA, 2019) examines four scenarios of how Austria's circularity can be increased:

1. The switch from fossil fuels to renewable resources (increase in circularity to 9.9%);
2. The recycling of recyclable waste (18.8%);
3. Maintaining the current inventory of materials in buildings and infrastructure so that the need for building materials can be met from existing demolition material; and
4. An increase in the proportion of secondary raw materials in imported goods (20.1%).

In combination, these scenarios can increase the circularity from 9.7% to 37.4%.

Building on this, the Circularity Gap Report (Circle Economy and ARA, 2019) suggests four steps to close material cycles in Austria

1. Form a national coalition that is diverse and inclusive. In this way, leading companies, governments, NGOs and science are brought together and expertise and performance are increased so that social needs can be met better and more sustainably.
2. Translating national strategies into regional and commercial measures. In this way, regions, cities, industry and business can develop practical approaches that are tailored to the local context, incentives, markets and mandates.
3. Development of decision-making bases and framework conditions for monitoring. In this way, Austria can promote the setting of goals, assessments and control measures, which in turn serve to measure progress and compare it with long-term global ambitions such as the Paris climate goals and the UN goals for sustainable development (SDGs).
4. Promote mutual learning and knowledge transfer. This can accelerate the international diffusion of effective circular economy policies and practices and create a collaborative environment that helps increase understanding of the circular economy and accelerate change.

The Regional Action Plan, which was elaborated by the Waste Management Association Mid-Tyrol for the region of Mid-Tyrol presents some strategies which encompass Circular Economy, secondary raw materials and includes traditional waste prevention. These strategies are based on the 7R Framework (Kirchherr et al. 2017, Abfallhandbuch Graz, 2012) and defined in Table 4.0. This approach was chosen based on meetings with regional key-stakeholders (D.T3.3.5) and due to the nature of ATM as an environmental service organisation for municipalities. It allows to integrate the aim of a Circular Economy on different regional levels (local authorities, municipalities, companies and civil actors and society).

Table 4.0: 7 R Framework. Based on Kirchherr et al. 2018, Abfallhandbuch Graz, 2012.

STRATEGY	DEFINITION
Refuse	Make a product redundant by abandoning its function or by offering the same function with a radically different product
Rethink	Make product use more intensive (e.g. by sharing)
Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Reuse	Reuse by another consumer of discarded product which is still in good condition and fulfils its original function
Repair	Repair and maintenance of defective product so it can be used with its original function
Redesign	Use discarded product or its parts in a new product with a different function
Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality

4.1.3. CROATIA

The Government of Croatia has legislated numerous laws, plans and strategies towards the adoption of Circular economy policy. The Strategy of Sustainable Development of the Republic of Croatia and the Law on Sustainable Waste Management form the very basis of the policy's implementation. Furthermore, the National Development Strategy 2030 is in progress of being developed and it will integrate all the existing and planned legislated decrees and actions considering sustainable development.

Croatia has great potential for producing clean energy from its water resources as well as from wind and solar energy utilisation. Croatia's eastern region Slavonia presents an agricultural treasure with numerous small farms which can directly affect the implementation of 'Farm to work' concept carried out in EU Green Deal. The Adriatic region, however, bases its economic growth mostly on tourism, nautical activity and other activities such as shipbuilding and manufacturing. On the other hand, high dependency on imported goods like metals, fossil fuels and food make the national economy liable towards negative external effects. Furthermore, the waste generation is much higher, while the recovery and recycling rates are much lower than the EU average.

It is clear from the aforementioned that Croatia has great potential and would gain a lot of benefit from the implementation of CE not just for boosting its economy's resilience but from an environmental perspective as well.

The Regional Action plan provides guidelines for the regional policy makers in order to boost circular economy in Split-Dalmatia County. The drafted Plan includes several objectives that are crucial for the establishment of CE in the region:

- Increasing awareness on the importance of circular economy
- Strengthening the secondary raw materials market
- Development of a functional waste management system

The analysis pointed out the critical issues in reaching these objectives as well as legal constraints and deficiencies. The lack of industrial production in the region and underdeveloped SRM market pose issues regarding the usage of 'circular materials '.

Within the objectives listed above, the Plan proposes different priorities that should be taken into consideration while implementing CE in Split-Dalmatia County. They include the following:

- Continuous process of information to citizens and legal subjects on the importance of CE and sustainable waste management
- Sustainable tourism – Split-Dalmatia County is one of Croatia's leading regions in tourism and most of its income comes from that activity. Due to increased nautical activity especially during the tourist season, more municipal waste and pollution is generated. Therefore, with the rising popularity of the region as a tourist destination, the environmental concerns also rise as well as the need for a sustainable transition.
- Municipal waste management and actions towards increasing waste separation
- Development of innovative solutions regarding CE
- By-products that can be used to push the development of SRM market in Split-Dalmatia County. Currently, the sludge from the water treatment plants is considered a resourceful by-product that can be used in e.g. agriculture and construction. Also, organic waste that can be used for energy purposes or composting.

Each objective includes different measures for the implementation of the aforementioned and a set of indicators that will be used for monitoring the entire progress.

4.1.4. HUNGARY

In November 2018, the first Hungarian Circular Economy Platform was established by the Hungarian Business Council for Sustainable Development, the Embassy of the Kingdom of Netherlands and the Ministry of Innovation and Technology. 80 companies and organizations - including IFKA and BZN- have joined the Platform so far, which aims to accelerate the transition to a circular economy model by sharing knowledge, creating joint projects and fostering collaborations.

Why is the establishment of the Circular Economy Platform important? Because:

- most organizations are not yet fully aware that this model can increase the resilience of the world economy and make it easier to reach the Paris Climate Change Agreement and the United Nations Sustainable Development Goals (UN SDGs).
- it plays a key role in creating a change of mindset and common thinking, in shaping community-minded and action-driven change leaders, and in sharing business solutions that bring real change
- in order to change old business operation models, collaboration and knowledge sharing is needed involving

the corporate, governmental and scientific sphere.

- Based on a survey done by the Platform members some factors were identified which can support the spread of circular economy and use of secondary raw materials. These are the followings:
- Government (primarily financial) incentives (e.g. applications, direct grants);
- Showcasing good practices of industrial symbiosis (e.g. more effective cooperation examples between companies regarding use of waste as a secondary raw material);
- Legislative provisions (e.g. extended producer responsibility, priority waste streams);
- Creation of a Hungarian circular economy development strategy or plan;
- Presenting good practices for resource-efficient operation, production.

So there are things to be done in all levels: from the government and legislation, through the producer companies to the consumers.

Hungary introduced a product fee in 2000. In 2011 the state took over the roles and responsibilities carried out by Extended Producer Responsibility Organizations (EPR) based on the "polluter pays" principle creating a unique "Hungarian EPR system".

The manufacturers of selected products (e.g.: packaging, tires, batteries etc.) have extended responsibility for their goods at post-consumer stage. Producers have to pay a fee to the Hungarian Tax Authority. The national budget uses this tax to co-finance the collection and treatment of end-of life products through public procurements. The concept is theoretically properly worked out, however there are some factors that hinders the efficiency:

- Payment of the fee puts a great financial burden on producers, their responsibility seems to end with this payment. There is no motivation for eco-design, producing "green" materials and products (no incentives, no well functioning green public procurement processes)
- Only approximately 20% of the fee is used directly to finance collection, recovery, awareness raising related communication and the development of the waste collection network and recycling technology system
- Financing the waste collection and recovery operations could happen only through the lengthy public procurement processes, since no state co-financing can be provided without it in the EU. As a result, the co-financing suffers from long delays (even over a year), so both collectors and recyclers have to face cash flow issues which might hinder their R&D activities and related developments.

It would be practical to separate the producer responsibility systems and the product fee systems in a way that the aforementioned hindering factors could be eliminated.

There is no incentive for manufacturer to use secondary raw materials in this system. There is no positive distinction for consciously designed products (recyclable, reusable elements, out of recycled materials) resulting in a low level of eco-design development. An incentivising scheme should be worked out to urge manufacturers toward Ecodesign and to foster the use of secondary raw materials. Deposit-refund systems are only voluntary, although there are ongoing discussions on the introduction of a compulsory system in the last 20 years no direct actions have been taken yet.

New R&D calls in this topic, legislation related to green public procurement, compulsory regulations for recycled materials all could give a boost to circular economy.

There is also a need for more clearly defined end-of-waste criteria. A clearer distinction between the concept of waste and by-product would facilitate the use of secondary raw materials and it would be useful to provide clear criteria for judging by-product and waste status (such as waste/ by-product as fuel or soil substitute) for some major material flows.

Without providing enough input materials to recyclers, it is impossible to make operators financially stable and to produce all the needed secondary raw material quantities. So collection should be also intensified and developed. In 2013 the rearrangement of the MSW collection system took place, as well coming with the central state coordination. Besides some positive aspects - like the even service content, cost cuts for the citizens, central monitoring of the public services and the fulfilment of the waste related targets, optimisation of the capacities and integration initiatives - there are some aspects that should be developed in the near future:

Late financing due to public procurement procedures generates organizational and financial challenges to the sector, and since the state owns the separately collected waste materials there are no real incentives for the collector companies to develop the collection systems.

There is also a need for legislation stability. The reforms introduced in the recent years were so deeply rooted that the system should be fine-tuned several times. That is why the new Law on Waste was modified approximately 25 times in the last 6–7 years. Until the deadline for implementing the recent amendments - July 5th, 2020 -, the system should be stabilized to offer a stable base for long term planning and development.

There is a lack of central financing of research, development and innovation, but this should be targeted both to the producers and to the recyclers. Some of these calls could be financed from the paid in product fees and landfill tax.

Last but not least, there is an advanced need for dissemination. The concept of Circular economy and the related strategies might sound good, but the business sector won't be aware what kind of actions should be implemented. Good practices - like industrial symbiosis - and methodologies - just like life cycle assessment, life cycle costing - should be presented to them with which they could decide which scenario should be followed and what results could be achieved with them. A great example for the related methodology is worked out within the framework of CIRCE2020 project.

4.1.5. POLAND

On 10/09/2019, the Council of Ministers approved the Circular Economy Road Map prepared by the Ministry of Entrepreneurship and Technology. It is a signpost for the development of this economic system in Poland, indicating specific actions to be taken. The basis of the circular economy concept is the assumption that all elements of the production chain, products, materials and raw materials remain in circulation as long as possible. However, the generation of waste should be kept to a minimum. The Circular Economy Road Map outlines the basic steps in the transition to a circular economy model. This requires taking appropriate actions at all stages of the product life cycle, starting from obtaining the raw material, through design, production, consumption, waste collection and its management. The implementation of the circular economy concept is not possible without organizational, process and product innovations.

Poland's priorities within circular economy include:

- Innovation, strengthening cooperation between industry and the science sector, and, as a result, the implementation of innovative solutions in the economy.
- Create a European market for secondary raw materials where their circulation is easier.
- Provision of high-quality secondary raw materials that result from sustainable production and consumption.
- Development of the service sector.

The Circular Economy Road Map is a document containing a set of tools, not only legislative, aimed at creating conditions for the implementation of a new economic model in Poland. The proposed activities relate primarily to analytical and conceptual, information and promotional and coordination works in the areas within the competence of individual ministries.

- Chapter I "Sustainable Industrial Production" is to draw attention to the important role of industry in the Polish economy and to new opportunities for its development.
- Chapter II "Sustainable Consumption" shows how much potential exists at this - until now often overlooked - phase of the life cycle.
- Chapter III "Bioeconomy" concerns the management of renewable resources (biological cycle of circular

economy), which in the Polish reality have great potential.
- Chapter IV "New business models" indicates the possibilities of reorganizing the ways of functioning of various market participants based on the concept of circular economy.
- Chapter V concerns the implementation and monitoring of circular economy.

The Circular Economy Road Map is one of the projects of the Strategy for Responsible Development.

At the same time, the development strategy of the Wielkopolska Region is being developed. It is in line with the assumptions of the CE Road Map for Poland.
The Wielkopolska 2030 Strategy supports the key potentials of creating economic and social growth without giving up on the answers to the region's problems.

Challenges for the region were defined, as well as strategic goals to be achieved.

The basic challenges are:
- Increase of competitiveness, productivity and innovation of the economy
- Developing and efficient capital use human
- Improving living conditions respecting the environment natural
- Counteracting and adaptation to climate change

The main strategic goals of the Region are:
- Economic growth Wielkopolska based on the knowledge of its inhabitants
- Social development of Wielkopolska resource-based tangible and intangible region
- Development of infrastructure respecting the environment natural environment of Wielkopolska

The implementation of the development of Smart Specializations is also very important for the development of CE in Poland and the Wielkopolska Region.

The National Smart Specialization Circular Economy (S3 CE) - water, fossil resources, waste indicates preferential areas of support for research, development and innovation (R & D & I), serving the transformation of the Polish economy towards a circular economy model. This change is related not only to technological and product innovations, but also to new solutions, including systemic, legislative, organizational, financial and educational solutions, taking into account the value chain and all stakeholders.

Among the issues discussed there were, among others:
- ECODESIGN
- Create resource-efficient and energy-efficient new, improved, reworked or refurbished products
- Creating products using raw materials recovered from waste and sewage
- Increasing the durability and extending the life of the devices and products used
- Providing substitutes for hazardous, complicated and burdensome substances in the recycling process
- Development of substitutes for non-renewable resources and water
- Ensuring a new application and / or re-use of products, their parts, materials
- WASTE PROCESSING
- Waste treatment technologies that reduce emissions of CO_2 and other greenhouse gases into the atmosphere
- Technologies for the recovery of scarce and critical raw materials from waste
- Technologies for processing multi-material, multi-layer and composite waste
- Technologies for the management of materials obtained from waste processing
- Multi-material and composite products based on waste for use in various branches of the economy

Circular Economy is a very important direction of economic development at the national and regional level. The achievements of the CIRCE2020 project are in line with the assumptions made in the previous months and are an important element supporting future projects planned for the period 2021-2027.

4.2 TRANSERABILITY

During the entire project, but mainly in the last stage, the communication strategy and the transferability of the CE concept and CIRCE2020 findings have been essential for the impact of the project. According to the European Commission, to raise up circular economy concept in political and business agendas the availability of successful case studies and a solid transferability mechanism are crucial.

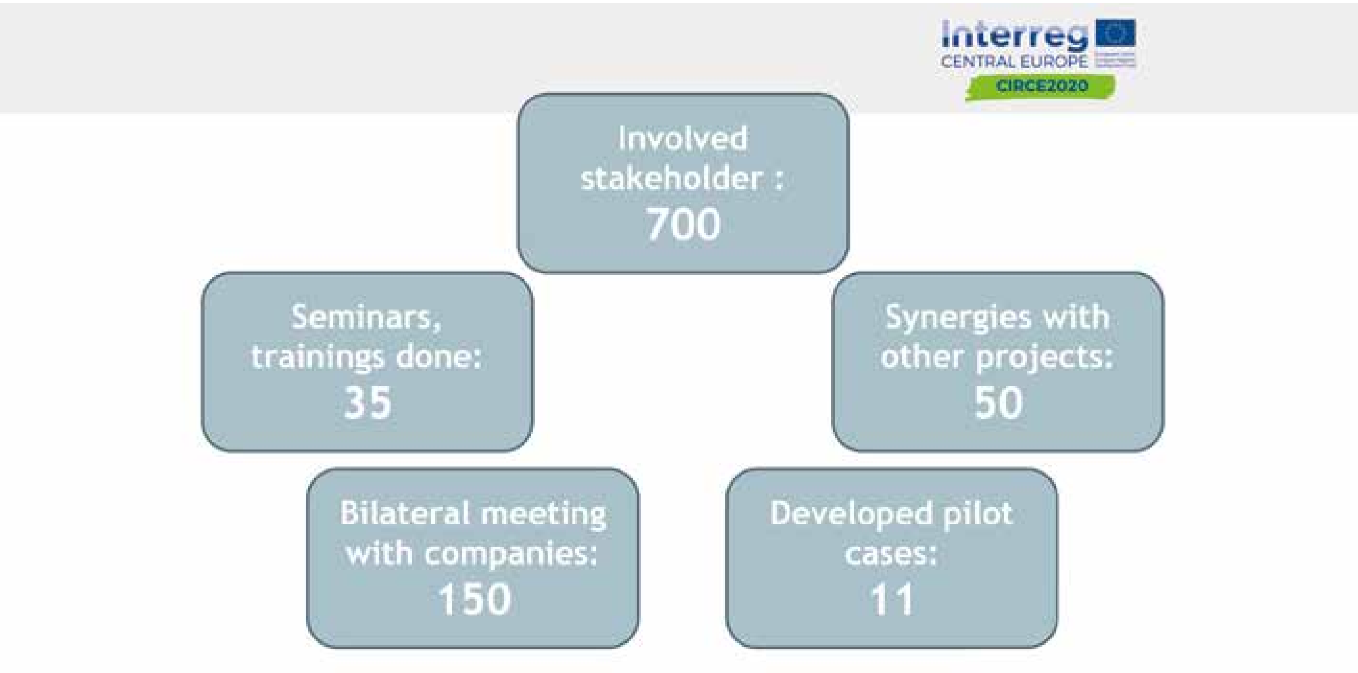


Fig 4.0 CIRCE2020 transferability strategy in numbers based on a Ratio using the Italian number as benchmark (ETRA S.p.A)

Indeed, the Central Europe area is characterized by territorial disparities and diversity in the way of implementing EU Regulations, Directive and Thematic Strategies and the Financed projects brings novelty that might help public and private institutions to formulate new approaches and paradigma to contribute at EU goals.

The main goal of CIRCE2020 is to enhance the transferability strategy between research institutions, businesses (in particular SMEs), the educational sector as well as the public sector that can enable better access to project results for "local ecosystem" and consequently stimulate further investment in the application of innovation, enhancing the competitiveness of regions.

To reach this goal the strategy tackled the "public" from different point of view with a

- Political Push that aims to create a favourable background for the public administration, waste utilities and companies
- Information Push to widen the CIRCE2020 communities of practices
- Technical Push with the training of 5 specific waste utilities to use CIRCE2020 tools

4.2.1. POLITICAL PUSH

As part of the political push, the position paper for standardization of secondary raw materials physiognomies aims to establish more harmonized rules to determine when a secondary raw material should no longer be legally considered as 'waste' looking at EU & Central Europe specificity, by clarifying existing rules on 'end-of-waste'. The full document, available on the CIRCE2020 website, with the e-library on the wiki-web platform that provid es an overview of key documents related to the top ic of Circular Economy in Europe. Another deliverable developed during the project implementations aims to "...extend the industrial symbiosis concept at transboundary s cale". The ultimate

purpose of the present document is to stimulate a nd inspire future cross-border projects supported by the INTERREG / European territorial cooperation in th e frame of the CBC financial instruments of the EU M ultiannual Financial Framework 2021-2027. Indeed, all partners of CIRCE2020 are eligible for INTERREG CROSSBORD ER projects and they could generate new bilateral proje cts, aggregate new partners and concretely pave the way towards collaboration between waste-utilities, agencies and companies located across a single border to facilitate the cross-border circulation of secondar y raw materials as well as the set-up of stable secondar y raw materials supply. The main objective of the INTERREG bilateral project is to boost contacts and cooperation between local and regional institutions, waste utilities and comp

anies to facilitate – by a certain number of pilot actio ns - the cross-border circulation of secondary raw m aterials (by-products) as well as the set up of stabl e secondary raw materials supply chains. The project will p rovide a valuable contribution to the EU Circular Econom-y Action Plan 2020 towards the creation of a well- funct ioning EU market for secondary raw materials.1 Hence, the fo cus of the project is not only to promote Circular Econom y and enable stakeholders to get benefited from it, but it will also promote pilot ᵗo

ols that will enable Circular Economy / industrial symb iosis experiences in the area, inform, train, m entor and network relevant stakeholders, introduce local entrepreneurs and enterprises to the concept of Circular

Economy, raise awareness and create a sustainable and repli cable outcome enhancing in the long-term entrepreneur ship. 4.2.2. Information Push During this phase eac h PP's engaged at least 10 stakeholders to take part in the network . The main targets were waste public util

TIES, BUSINESS SUPPORT O

rganization, and environmental agencies. To the targeted stakeholders was offered the access to the informat ion and the technologies developed during the project: MFA– LCA – LCC tutorials, CIRCE2020 Business Plan, Technology e-cloud, Business Acceleration Workshop, Knowledg e Video Elicitation, Possible transnational

- interaction with other pla
- yers. A focus must be don
- e on the Business Ac
- celeration Workshops2 that, in m
- ost of the cases due to the C
- OVID-19 emergencies were held on-line, losing some of t

heir technical aim but widening the public also if the topiᶜs covered were strictly technical. Business acc eleration workshop differ from a tradition-based wor kshop as we are adopting the open innovation approach (co llaborative method that encourages

companies to acquire outside sources of innovation in order to improve their own business). A set of "Know ledge video elicitation" was also realized and it's accessible from the CIRCE2020 YouTube channel3. T he purpose of those videos was to get s

omeendorsementsfromoutsidethepartnertoincreasethevisi bility. 4.2.3. Technical Push Knowledge voucherinᵍ consi sts in training for third party (other waste utilitie s) that are supposed to implement the CIRCE2020 analyt

[1] D.T. 4.4.1 "Operative proposal to extend tje industrial symbiosis concept at transboundary scale" developed by ETRA spa with the support of Marco Meggiolaro on behalf of EURIS srl

[2] 2 for each area

[3] https://www.youtube.com/channel/UC6bCyzi9-rD3uJXnPMjJxEg

ICS AND/OR BUSINESS MO

del to assess a possible investments and to share the use of technology supporting reuse of secondary raw materials. To keep a common line between the partners before the vouchering activities was held in Bassano del Grappa the "Transnational Bootcamp" with the aim to def

ine a common educational programme to be implemented d uring the 5 waste utilities coaching. (Fig. 4.1) To e ach waste utility was presented the CIRCE2020 approach and the tools developed during the project and how to replicate them. Then, together with the se

lected business was selected a case study to analy ze, applied the chosen tool and/or elaborated a simplifi ed intervention/investm

ent scenarios. At the end of the vouchering activity was asked a feedback to receive useful information, i mprove the and close the loop. Strategy Definition R efuse Make a

product redundant by abandoning its function or by offerin g the same function with a radically different product Re think

Fig 4.1 Circe2020 PP's during the Transnational Bootcamp in Bassano

CIRCE2020 PROJECT CONCLUSIONS

CHAPTER 5

The path of circular economy is challenging but there are no sustainable alternatives

CONCLUSIONS

Nowadays everyone is talking about circular economy but are they really implementing it? On the other side, some companies don't know what does it means "Circular Economy" but are already applying its principles.

CIRCE2020 project aimed to facilitate a larger uptake of integrated environmental management approach in five specific Central European industrial areas by shifting from linear economy to circular economy and did it with an integrated and practical approach, developing instruments and pilot cases.

After 3 years the project highlighted many problems and solved some of them. The system is dynamic and it's constantly changing due to technical progress, new materials, new waste, new regulations, ecc....

Therefore, is this the end?

The end of the project doesn't mean the end of the "approach": Circularity is a never-ending story.

Most of the pilots will continue beyond the project while others provided a solid baseline for new approaches.

Moreover, tools and knowledge are transferable and were transferred during the whole project and the networking, open to new projects, new ideas of collaboration and Circular initiatives, have been integrated in counseling programmes of some key service agencies for the industrial sector.

Summarising the lesson learnt are:

1) Circular Economy is already a relevant issue of the market and this relevance will probably increase in the coming years (Green new deal, marketing, raw materials strategy, etc)

2) Companies need to stay in the market and the most relevant factor of the market is the economic one, so we need a policy of coherent INCENTIVES & DISINCENTIVES

3) There are currently many environmental costs that are externalities: we must push their internalization through the wider and strict application of the Extended Producer Responsibility, which can also support eco-design, essential for the harmony of the CE supply chain

4) The CE system is mature but needs politic steps to decrease instability, mainly due to:
   - price dynamics;
   - missing markets for secondary raw materials;
   - some uncertainty and lack of flexibility in the regulatory framework;
   - missing coordination and planning at regional level (waste management is a 0 km issue);
   - still weak application of Green Public Procurement.

5) A strong and honest cooperation among politics (planners), businesses and researchers is needed, not only to find solutions but also to find the problems and understand their priorities

6) Raising awareness is always welcome

7) The system must be guided also by market interventions and the definition of objectives that reward circular products

The path of circular economy is challenging but there are no sustainable alternatives