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CIRCULAR ECONOMY IN ROMANIA: AN INDUSTRIAL SYNERGY IN THE AGRI-FOOD SECTOR

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Abstract

As a feature of the green economy, circular economy proposes the re-use of resources used in products whose shelf life has come to an end or which have lost their usefulness to construct new objects, the same quality or even better. The circular economy model may be the ideal solution for relaunching sustainably the European economy which has suffered in recent years (2008-2012). In the circular economy, the value of products, materials and resources is maintained in the economy for as long as possible and the generation of waste minimised. In this paper we shall stress on issues of eco-innovation promoting the circular economy in Romania. One of the most important concepts for the new paradigm of circular economy and resource efficiency improvements is the industrial symbiosis, implemented in eco-innovation parks (EInvP) developed to optimize economic and environmental efficiency of the involved companies and communities. In practice using industrial synergy as an approach to commercial operations – using, recovering and redirecting resources for reuse – means resources remain in productive use in the economy for longer. We analyse here a successful good practice of industrial synergy in the agri-food sector implemented within the ECOREG EInvP of Suceava County. The conclusions point to the important economic, social and environmental benefits to raise awareness for regional eco-innovation and circular economy prospects in Romania.

Key words**:** *green economy, circular economy, regional metabolism, eco-innovation, industrial synergy*

INTRODUCTION

The green economy is called to implement a more systemic and holistic socio-economic mechanism taking into consideration the sustainable management of the environmental and economic assets, so as to preserve the ecosystem services and to ensure the increased welfare of the planet (Frone D.F., Frone S., 2015) [5].

A green economy aims at sustainable management of environmental resources, based on the belief that our biosphere is a closed system with finite resources and a limited capacity for self-regulation and self-renewal.

As a feature form of the green economy, circular economy proposes the re-use of resources used in products whose shelf life has come to an end or which have lost their usefulness, to construct new objects, the same quality or even better.

The circular economy model may be the ideal solution for relaunching sustainably the European economy which has suffered in recent years (2008-2012).

The European Commission will assist the Member States, regions and local authorities in strengthening their circular economy approach through targeted outreach (EC COM/2015/0614 final) [4].

In this respect, the main objective of the paper is a grounding and analysis of some concepts, trends and issues for the implementation of the circular economy in the EU and Romania, as well as for the sustainable regional economic development.

This is possible with the implementation of the industrial synergy within eco-innovation parks, a concept that has been analysed in previous research and will be exemplified in the paper. In this paper, with the theoretical and empirical approaches employed there is argued again on the need of using industrial synergy as an approach to commercial operations, since using, recovering and

redirecting resources for reuse means resources remain in productive use in the economy for longer. In this context, the paper presents an analysis of the implementation of a successful good practice of industrial synergy in the agri-food sector, applied within the ECOREG eco-innovation park (EInvP) of Suceava County [13].

MATERIALS AND METHODS

First, there are introduced and explained some of the most important concepts and principles that are characteristic for the green and circular economy, with a recall of previously analysed issues and trends.

The strategic objectives and principles of the circular economy and among them, of the industrial symbiosis are conceptually highlighted and also analysed, within the case study based on the official reporting from the ECOREG pilot project.

Within the empirical approach of the case-study there is presented the complex industrial synergy developed around the SC PRODINCOM Company – Suceava, by:

-Identifying the economic and environmental drivers in this industrial synergy;

-Describing and analysis of the indicators and features of industrial synergy within the eco-innovation park ECOREG, for the case study;

-Analysis and synthesis of the environmental, economic and social benefits of the IS;

-Several computations in tables for a dynamic analysis of the main environmental and economic indicators.

RESULTS AND DISCUSSIONS

Conceptual and methodological issues

In (Frone D.F., Frone S., 2015) [5] it was introduced and analysed the global resource nexus model, as very suggestive for the model of circular economy and also for the topic of industrial symbiosis.

The green economy is designed for a more systemic and holistic socio-economic mechanism taking into consideration the sustainable management of the environmental and economic assets, so as to preserve the ecosystem services and to ensure increased welfare of the planet.

The circular economy is a form and a paradigm of the green economy, involving the reuse or recycling of material resources used in products whose life has come to an end or which have lost their usefulness, to construct new objects, of the same quality or even better.

Industrial symbiosis (IS), as part of the industrial ecology field of research, focuses on the flow of materials and energy from local and regional economies.

The industrial symbiosis traditionally engages separate industries in a collective approach to a competitive advantage involving physical exchange of materials, energy, water, and/or by-products as well as services and infrastructures shared at the industrial park scale to reduce environmental impact and overall production cost (Massard, 2011) [12].

The factors for industrial symbiosis are collaboration among actors (in sharing and recycling of resources) and the synergistic possibilities offered by geographic proximity (Chertow, 2000) [2].

In this respect, the process of recycling can take two ways: down-cycling and upcycling. As will be exemplified further on in the case-study, there are interesting industrial synergy facilities of down-cycling or upcycling the waste materials or the by-products.

A particularly useful and innovative concept for the ecological and circular economy is the regional metabolism. Also, it opens the possibility of describing in detail the links between ecosystem services auditing and economic sectors they support (Frone S., Constantinescu A., 2015) [6].

The dynamic nature of all elements of an integrated ecosystem approach brings attention to the complex issue of regulating the system of regional metabolism. Considering, on the one hand, the alarming situation of environmental degradation and on the other hand, the need to maintain economic growth, its functioning is ensured primarily by eco-innovation.

The eco-innovation has the ability to maintain a balance between ecosystem services and the intrinsic economic circuits, adjusting also, by geared technical means, both the renewing of

resources according to the assimilative capacity of the environment and the transactions that include ecosystem services into the economic cycle.

In previous papers we have focused on the theoretical and methodological features of the eco-innovation as a driver of sustainable economic development (Frone S., Constantinescu A., 2014) [7], and further on the role of eco-innovation parks (EInvP) as vectors of transition to a green economy (Frone Simona, 2015) [8].

In the present paper we aim to analyse more the role of the eco-industrial and eco-innovation parks as regional metabolisms and industrial ecosystems, by grouping several SME-s in a certain area in order to let them share some technological eco-innovation facilities, as well as to put them in a relation of industrial synergy, leading to waste recovery and recycling as a resource, eventually improving the resource efficiency and productivity at the microeconomic as well as the sectoral and regional scale.

Industrial synergy in eco-innovation parks promoting a circular economy

According to the definition of the Competitiveness and Innovation Framework Programme of the European Union, eco-innovation is "any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy" (EC COM, 2006) [3].

In the study that analyses conceptually and empirically the role of eco-innovation parks as vectors of a green economy (Frone Simona, 2015) [6], the term eco-innovation park (EInvP) is introduced and used to define both eco-industrial parks and eco-innovative areas combining residential and industrial activities. EInvP are optimized from an environmental point of view (e.g., piloting installations and processes that incorporate environmental technologies and services) and are open for continuous improvement (e.g., collaboration with institutions of research and development).

In this section, the case-study analysis of an industrial synergy from the ECOREG (a pilot EInvP in the Romanian Suceava County) aims to provide evidence for the actual dimension and realization in these categories of green and complex environmental, economic and social benefits provided by the EInvP. Our research recommends the study of the EInvP as regional metabolisms, since as stated in (Frone S., Constantinescu A., 2015) [6] the ultimate purpose of the regional metabolism is eco-efficiency, which may indicate the quality of the entire process and on the other hand, represent a guarantee for the willingness of business and community to restore the health of our habitats.

Such regional metabolisms are inspired by the advent of the new theory of Industrial Ecology (IE) designed to enable transformation of traditional model of industrial activity in a more comprehensive model by which regional economies can be assembled in an industrial ecosystem composition, so the residues of some companies can be used as inputs for others. In addition, industrial ecosystems can be organized around product or material supply chains and/or in defined geographical areas (Frone Simona, 2016) [8].

Important from the view point of the current research is the key feature of the eco-innovation park in which material flow exchanges (or industrial symbioses) generally also encompass other eco-criteria, in particular energy efficiency, waste and water management, so leading to an almost exponential growth in the local resource-efficiency, for all the clustered companies. This inner circular mechanism of the EInvP closing-the-loop of resource use in a region deserves further attention due to the outstanding green economic growth impact. The role of creating and developing eco-industrial parks, namely EInvP is not limited on their potential of increasing the resource efficiency but also to implementing and making work the new modern synergic and circular business models, with industrial symbiosis.

To foster eco-innovation in eco-industrial parks, several tools have been developed to analyse data on material and energy flows.

Most focus on supporting the identification of potential networking and industrial symbiosis (Grant G.B. et al., 2010) [11].

As case study, according to the official reporting (nisp-ecoreg.ro) ECOREG [13] was a pilot project aimed at testing the applicability of Industrial Symbiosis in Romania. This entails reuse of resources and by-products used in one production cycle into another, thus creating mutually beneficial partnerships between companies in various sectors.

The most important feature of the ECOREG is ***the industrial symbiosis as eco-innovation implemented at the regional scal***e. It is supported by the numerous industrial synergies (200) identified in the area (Frone Simona, 2017) [10].

We analyse such an agri-food industrial synergy in the following, namely the one identified and implemented between:

(a)The SC PRODINCOM Company – Suceava, a slaughterhouse and meat processing SME in the Suceava County. (b)A cluster of agri-food companies that generate animal waste and had problems with the management of this waste. Among others companies: SC RUX (an animal farm having 500+ cows, situated in Veresti, 15km S of Suceava City); SC COZURAX (wheat mill, bakery, dairy products, milk processing – a company situated in Ilisesti, the Suceava County); SC TEORUX (an animal farm in Ilisesti – Suceava County); PRODINCOM itself; other small meat producers (there are more than 130 SMEs having this object of activity registered in the Suceava County, having from 10 to 2000 animals).

There should be first acknowledged the environmental issue leading to this industrial synergy. According to (A Pattern of Cooperation for Better Animal Waste Management, 2011) [1] the common problem of the partners is the animal waste (carcasses, expired animal or dairy products, waste generated by the slaughterhouse, etc.).

Animal waste constitutes a hazardous waste that, if not disposed properly, can constitute a source of discomfort (smell) and health hazard for the inhabitants living nearby the meat and dairy processing companies (insects breeding on the organic waste are vectors that could spread infections, illnesses).

Table 1. Main technical details of the PRODINCOM incinerator

Feature	Value	Remarks and comments
Incinerator capacity	1,000-1,500 kg/day, depending on the properties of animal waste	The capacity of incinerator exceeds the actual capacity of PRODINCOM. It processes solid organic waste from PRODINCOM as well as from several animal processing companies in the Suceava County. Small meat producers occasionally send their animal waste to PRODINCOM. In this way, the extra available capacity transforms the incinerating unit in a profit centre.
Operational temperature	800-1,200ºC	This ensures a correct processing of all kind of organic waste
Hot water generation	Yes	The incinerator comes with a shell and tube heat exchanger that generates all the hot water needed by PRODINCOM Company. In this way, animal waste producers get rid of their waste in a proper manner and PRODINCOM turns it in an environmentally friendly, sustainable energy source for its own technologies
Hot water parameters	60ºC 0.5 m3 /hour	Hot water is also used for all technological processes and to heat the PRODINCOM premises (offices, workshops) *No additional fossil fuels are needed!*
Ash	Landfilled	Ash resulting from the incinerator is not a hazardous waste. Analysis shows that *it may be used as a fertilizer*
Extra jobs created	3 extra jobs	Additional employees will feed the incinerator, discharge the ash, and monitor the operational parameters.

Source: Table 1, pg.2 in (A Pattern of Cooperation for Better Animal Waste Management, 2011) [1]

The animal waste is a constant problem for all farms and meat processing in the Suceava County as there are no incinerating facilities available at a reasonable distance. Besides, PRODINCOM had a history of conflicts with the Suceava County Environmental Guard (fees paid for poor waste management).

The eco-innovation solution identified by the ECOREG team was the installation of an *organic waste incinerator* at PRODINCOM that could help the company and other similar businesses to get rid of their animal waste.

With financial support in the Norwegian –

Romanian Cooperation Agreement, the ECOREG team has helped PRODINCOM to buy a state of the art incinerator, featuring some important properties (Table 1) including the possibility of recovering the heat generated by the animal waste incineration.

The environmental, economic and social benefits of the ECOREG [13] industrial synergy for animal waste hosted by PRODCOM are very significant (Table 2):

(i)Environmental Benefits include: at least 430 tons of hazardous waste diverted from landfill and used to generate valuable energy (figure refer to the period Jan – Nov 2011, of the ECOREG Project. Representative values are in the range 28-50 tons waste processed per month); the Carbon Dioxide generated by the incinerator does not come from fossil fuel so it does not add to the existing CO2 amount in the Earth atmosphere – approx.15 tons of CO2 from fossil fuels is no more emitted; PRODINCOM and partners using the incinerator comply to strict environmental regulation in EU / Romania and align the companies involved in the synergy to EU similar ones; the ash produced is a valuable fertilizer; virgin resources saved include about 5,000 litres of Diesel fuel (replaced with animal waste from various sources)

(ii)Economic Benefits include: savings since no more fossil fuel needed by PRODINCOM for hot water production. The area occupied by the Diesel storage vessel becomes available for other uses, and the pumping and piping network system become redundant and may be used in other part of the company; 15,000-20,000 RON saved by PRODINCOM (the cost are taken form the accounting book and represents cost of Diesel for preparing hot water as recorded in 2008, 2009); for the about 430 tons of waste processed in the incinerator during the ECOREG project period (Jan-Nov 2011), the companies would have to pay, if processed at a different incineration facility a total cost of approx. 121,000Euros) while the cost of incinerating the waste at PRODINCOM is estimated at 20 % of this figure (practically no transport fees and reduced incineration fees). So the savings amount at 80% of the figure above i.e., 96800Euros (this figure refers only to the period of the ECOREG Project); no more fees paid to the Environmental Guard, no taxes paid for the waste generated (transport, landfill, processing)

(iii)Social Benefits include the following: the Incinerator creates 3 new jobs at PRODINCOM; having a proper animal waste management system is a must for SME that wish to sell their products in the EU countries. The incinerator sustains, in this way, the agri-food business of SMEs in the Suceava County; a pattern of cooperation among various companies emerged in the Suceava County.

Table 2 Main environmental, economic and social benefits of the PRODINCOM cluster animal waste industrial synergy

	Type	**Value and characteristics**
1.	Economic Benefits	150-200 lei /ton for waste transport to a different incinerator, saved; 1,000 lei/ton for incinerating the waste at other location, saved Cost of LPG* saved =15,000 Lei/an
2.	Environmental Benefits	No waste to landfill 15 tons CO2 less emitted from LPG replaced
3.	Social Benefits	3 new jobs

Source: Table 1, pg.3 in (A Pattern of Cooperation for Better Animal Waste Management, 2011) [1]
LPG = Liquefied Petroleum Gas

Companies using the incinerating facility at PRODINCOM are no longer adversaries but members of a win-win partnership.

The synergy sustainability is really high since the animal farming and dairy production are traditional businesses and will last forever in the Suceava County.

The industrial synergy presented is fully sustainable and needs only the input from the users of the incinerator.

The replication potential is also good. Clusters of SMEs in the animal product business exist and may still appear all across Romania, as animal farming is a part of Romanian history and culture.

The experience and results of the cluster that uses the incinerator at PRODINCOM would help all interested in replicating the eco-innovative solution of industrial symbiosis implemented by the ECOREG.

Problems or issues encountered refer only to the fact that a part of R&D was necessary to be implemented. Therefore, the research institute ECOIND (an institute of national and international interest in the field of environmental research and services, with over 30 years of experience) was involved in the eco-innovation park ECOREG and has provided analytical work for characterizing the water and ash at PRODINCOM.

CONCLUSIONS

For the green and circular economy, eco-innovation is based on centralizing knowledge on material and energy flows as an efficient tool to foster a transition from a linear industrial system to a closed-loop system mimicking biological ecosystems.

In this paper there are analysed and highlighted some of the objectives, features and principles of the circular economy as they are implemented through industrial synergies in these very eco-innovation parks.

The example of agri-food industrial synergy implemented by the ECOREG is only one within the total of 114 synergies implemented in the area of the project (Suceava County, Romania).

Since in Romania over 95% of the waste is landfilled, there are still high opportunities for developing the circular economy in Romania. As exemplified in our paper, some bottom-up civil society and private sector initiatives have indeed identified the existence of opportunities in this sector.

In a green market economy, the interest of economic operators to establish a synergy is still firstly financial, each industrial manager aiming to increase resource efficiency of its business and find a market for its wastes and/or by-products. The ECOREG Project was therefore promoted by highlighting the potential economic benefits of joining the programme in order to boost the interest of industry. This approach was also required in Suceava as result of the limited availability of economic operators participating in environmental projects, which most of them perceived as time demanding and costly.

Nevertheless, it is also stated in the testimonial from the Environmental Protection Agency Suceava that:

„The ECOREG project's economic success is due to the means for the economic operators to increase efficiency while the environmental importance is even greater because this project uses models from the wild where in natural ecosystems there is no waste. Once a product becomes waste it is not thrown away polluting the environment but becomes a new product that can be used by consumers, saving exhaustible natural resources and also avoiding environmental pollution. So the life cycle of products was changed, from "cradle to the grave" to the "cradle to cradle".

Despite numerous constraints and over a period of economic crisis (2009-2011), the implementation of the ECOREG project proved successful in setting up an Industrial Symbiosis network, in other words in implementing an eco-industrial park at the county level involving circular economy.

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