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Mihaela Denisa COMAN*, Constantin Aurelian IONESCU,
Mihaela LIXANDRU (LEASA)

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Romanian Economy between Linearity and Circularity. A Bioeconomic Perspective

Mihaela Denisa COMAN^{1*}, Constantin Aurelian IONESCU²,
Mihaela LIXANDRU (LEASA)³

Abstract

Romania's present economy is characterized by its linearity, an important consumption of non-renewable resources, an incipient form of recycling and a production based on a high consumption of resources at high costs. At European Union level, the desire to evolve and transform the current economies into bio-economies is astringent. A bioeconomy, characterized by the achievement of sustainable production with a minimum consumption of fossil resources and a maximum result, the development of durable products, limiting the effects of pollution, increasing the quality of life and health of the population, reducing dependence on non-renewable resources, increasing food security, recycling rate and waste reduction, outlines a new model of economy that requires society to evolve into a future based on sustainable development.

The aim of the paper is to analyze aspects of the bioeconomy and to point out how Romania can transform its current economy into a bioeconomy, while at the same time achieving sustainable economic development.

Keywords: *Bioeconomy; linear economy; circular economy; non-renewable resources; recycling; biofuels.*

¹ PhD. Research Assistant, Institute of Multidisciplinary Research for Science and Technology Valahia University of Targoviste, Romania, cmndenisa@gmail.com

² Lecturer, Hyperion University of Bucharest, Romania, ionescuaurelian89@gmail.com

³ PhD Stud, Valahia University of Targoviste, Romania,, mihaelalixandru89@yahoo.com

* Corresponding author.

1. Introduction

The extensive development of global industrialization, combined with the massive use of fossil fuels and uncontrolled deforestation, has led to an increase in carbon emissions in the atmosphere (40% in comparison to the previous century; this increase began in 1970 and has continued ever since, leading to a period when global energy consumption has grown significantly) disturbing the balance of the carbon cycle in nature, as natural processes that can restore balance are slower compared to the rapid pace of development of polluting human activities [16].

The predominant economic model currently originates in the non-uniform distribution of natural resources by geographic regions and is named by specialists in the field of linear economy. Thus, the concentration of large industrial producers, especially in the Western countries, has led to severe exploitation of natural resources globally and to their export to highly industrialized countries. At the same time, industrial consumers have benefited from an abundance of non-renewable resources and energy at low prices, which has led to the emergence of business models that rely on exhaustive consumption of natural resources and low labor productivity [21]. The result of irrational resource consumption, reduced labor productivity, and poor labor remuneration has led to neglecting recycling and re-use of products, as well as minimal follow-up throughout their lifecycle [5: 14]. The essence of the linear economy is "the use of resources - the production of goods - the realization of profit", which has led to the emergence of enormous quantities of products that are temporarily used and discarded without being recycled when other more productive products emerge. In this global context, in order to slow down the pace of natural resources use and reduce the impact on the environment, it is necessary to increase social responsibility [8], as well as bring about a change in the ideology of economic activities, by transitioning them from a predominantly linear economy to a circular economy and bioeconomy.

The urgent need for evolution towards the era of bioeconomy leads to new opportunities but also to risks in the existing business environment due to the tendency to minimize the consumption of non-renewable natural resources, the exhaustive implementation and use of research and innovation within companies, increased responsibility for environmental protection, the use of renewable resources and the identification of economically viable and productive uses, the life cycle assessment of products and their full recycling, the implementation of biotechnologies at the level of production units, etc. [4]. The aim of the paper is to analyze aspects of bioeconomy and to point out how Romania can transform its

current economy into a bioeconomy, while achieving sustainable economic development.

2. Theoretical Background - The relation between the circular economy and bioeconomy

The concept of circular economy has an increasing interest in academic research, by discussing it in numerous articles in specialized scientific publications [11]. At the same time, companies are becoming more and more aware of the benefits and opportunities offered by the circular economy [8]. Increased emissions from combustion of fossil resources as well as rampant deforestation have led to the accumulation of greenhouse gases in the atmosphere, such as: carbon dioxide, nitrogen dioxide and methane with solar retention effect in the Earth's atmosphere. At the same time, the increase in the atmospheric temperature has led to the greenhouse effect and generated climate change. Climate change is characterized by: i) increasing global average temperature; ii) melting glaciers; iii) reduction of rainfall and the occurrence of desertification phenomena; iv) increased ocean temperature and acidity [25]. Climate change affects not only the environment but also the socio-economic sectors through a significant negative impact on [16]: i) water reserves - changing the regime and the amount of rainfall can lead to a severe water shortage or massive flooding that can be corroborated with the melting of the glaciers that lead to the rise of oceans and lead to the flooding of coastal areas and soil erosion; ii) agriculture and food security - high temperatures and uneven distribution of rainfall have a negative effect on agricultural crops; iii) people's health - temperature and rainfall variations, as well as the alternation of seasons can contribute to the rapid rise and spread of various epidemics. Also, excessive heat leads to exhaustion, cardiovascular disease, psychological stress on long-term etc. [14]; iv) ecosystems and biodiversity - the increase of the atmospheric regime has an effect on their growth and extinction rate.

At European level, economy depends on an active flow of natural resources, such as: metals, ferrous and non-ferrous minerals, minerals, wood and crops, which are mostly insured by imports, thus generating a dependency on them and becoming in time a source of vulnerability to the economy. As the need for these resources grows globally, it leads to the emergence of a strong competitive environment that results in significant increase in price as well as resource volatility [6]. The fluctuation of resource prices as well as the instability of their supply can affect or destabilize the

sectors of economy that depend entirely on these resources, leading to postponement or reduction of production, to reorganization of the labor force, to stopping the supply of goods or services and to reducing investment.

In this context, it is important to emphasize the need to create a circular economy at European level that can contribute to addressing current challenges by making the use of natural resources more efficient, thus generating significant economic benefits reflected in reducing the costs and inherent risks generated by natural resource dependency, as well as increasing productivity and competitiveness. The circular economy leads to the stimulation of research and innovation to identify natural resource substitutes, to improve products and services, to create new jobs and new professions, in order to provide economy with an effective competitive advantage worldwide [1, 9].

In recent years the circular economy has led to economic, political and business dialogues attempting to define this new economy typology as an economy based on multiple mechanisms of creating value independent of the consumption of natural resources, having three significant principles: preserving and strengthening natural capital - balancing and rationalizing the use of non-renewable resources, expanding use and increasing the yield of renewable resources; product optimization - by extending life, but also by recycling, restoring or reusing products both as a final product and as raw material used in the manufacture of other products; reducing the negative effects of using non-renewable natural resources on water, soil, climate change, human health, etc. [13].

The new optics of the circular economy redefines the relationships between the market, customers and the use of non-renewable natural resources. This implies the evolution from the linear model of the relation, namely "the use of resources - the production of goods - the realization of profit" towards a renewable model by design, namely "minimizing the consumption of non-renewable natural resources - maximizing the use and efficiency of the renewable natural resources - reuse, recovery or full recycling of products - sustainable development". The purpose of this relationship is to maximize the value resulting from resource processing by increasing product lifetime, re-using, refurbishing and optimally recycling them. Thus, the circular economy proposes an economically assessed model from a life cycle perspective and not from the point of view of the chain of values as the linear economy. At the same time, it is necessary to change the mentality both individually and collectively, as well as rethinking business

practices as the circular economy revolutionizes production and consumption as well as demand and supply of goods, generating awareness of the important role of research and innovation in economic entities that will activate within them.

Business models are reoriented towards increasing quality and life of products, towards responsible resource use and gaining significant economic benefits due to the production of high - quality goods [2].

At the same time, the circular economy becomes a restorative economy that maintains the usefulness and value of products, components and materials, minimizing the need for new materials and energy resources for production, thus reducing negative environmental impacts, such as harmful substance emissions, resource extraction, waste, etc. The new concept of economy based on product lifecycle, on rational and efficient resource management, on waste management and on the effects of economic activities on the environment provides opportunities for wealth, growth of employment rate, increased labor productivity and a harmonious development of the business environment in accordance with readjusting the environmental balance and securing the future for the next generations [9]. Thus, the economic circular model is characterized by: reduction in the use of non-renewable natural resources (minimization, rationalization, optimization of consumption of non-renewable natural raw materials, dependence reduction of imports of natural resources, reduction of energy and water consumption and efficient use of natural resources); increase in the use and efficiency of renewable and recyclable resources (non-renewable resources replaced predominantly by renewable resources by ensuring efficient logistics and distribution, increasing the use of recyclable materials instead of natural materials); reduction of carbon emissions and other types of greenhouse gases (greening production processes, reducing fossil fuels); reduction in waste loss, in the quantity of material waste and scrap (reducing waste, minimizing waste of resources); improvement in the qualitative value of products, components and materials (product lifetime extension, component reuse and recycling). The aims of the circular economy can be achieved through the following lines of action [6]: eco - design (products designed for long - term use that allow modernization, renovation, reuse or restoration, also being designed to allow recycling of materials at the end of their lifecycle); fixing-up, modernisation or restoration (processes designed to extend the life of the product or its components); recycling (refining the recycling system allows waste reduction, the use of recycled materials as secondary raw materials); business models (based on product service

delivery, collaborative consumption, extended producer responsibility, industrial symbiosis, and value chain transparency); eco - innovation (use of technological, social and organizational innovation departments in economic entities).

The scientific research undertaken reveals that the essential characteristics of the circular economy are equivalent to the premises of sustainable development which reflects the maintenance of the resources and factors necessary to support life and, implicitly, the evolution of the human society. Thus, the long-term conservation of essential environmental resources such as biodiversity, water, air, soil, wood, fish and the climate optimally leads to a new economic orientation, which is bioeconomy that develops technological capacities to create alternatives for non-regenerative natural resources or for the management of climate change.

At the same time, sustainable development is dependent on economic growth which can be achieved, without degrading the environment, by reducing the amount of resources used and the amount of harmful substances emitted to produce a unit of product. By undertaking a lifecycle analysis, one can identify the most environmentally-friendly production technologies as well as ways of remediating the negative effects on the environment in the long term.

A mobilizing tool for sustainable development is biotechnology, which involves enhancing the ecological efficiency of primary production, of industrial processing, bio-remediation of negative effects on water, air, soil, pesticide and fertilizer reduction, genetic fingerprinting, biotechnological applications that reduce harmful emissions, etc. [9]. The scope of bioeconomy includes: the production of renewable biological resources, biological products, biofood, biofuel, bioenergy. In addition to this, through characteristic tools and technologies, bioeconomy can be active in sectors such as agriculture, forestry, fish farming, aquaculture, food industry, paper industry, as well as in energy, chemical and pharmaceutical industry, etc. [22].

In the context of the contemporary challenges of climate change caused by greenhouse gas emissions, biodiversity conservation, food safety, increased material availability and energy, global research recommends bioeconomy that will revolutionize the current economy and industry through three main directions of development: i) the transition from the use of fossil natural resources to biological resources that can be used in industrial productions by using biological substitutes such as bioplastics, biocomposites, biofuels, bioenergy, etc. [18]; ii) bioeconomy is the essential element of the circular economy that induces multiple use of a resource in

different forms over a period of time [17]; iii) bioeconomy involves modernizing traditional economic sectors by implementing new technologies such as nanotechnology, robotics, biotechnology, etc.

Bioeconomy imposes directions of action and generates opportunities in accordance with current and future challenges of the society [4]:

- *Sustainable management of natural resources: minimizing soil erosion and expanding agricultural areas; new varieties of plants adapted to climate change, with high productivity and minimum need for irrigation; reducing water consumption during the production chain;*
- *Sustainable production: implementation of biotechnology and advanced techniques for improving the productivity and efficiency of the economic sectors; the cascade use of renewable material for the production of goods with increased added value; the development of bio-based industries such as biofuels, biofood, biofeed, etc.; the development of multitrophic aquaculture; maintaining and expanding the base and genetic diversity of plants and animals to ensure flexible systems that increase security of the supply chain; the use of waste for the production of biogas or biomaterials;*
- *improving human and animal health: developing new foods with high nutritional value to help ensure people's health and prolong life expectancy; optimized farm management by improving animal resistance to disease, developing prophylactic vaccination programs to avoid outbreaks of disease; the development of plants that can be used in pharmaceutical production;*
- *climate change management: the use of bio-catalyzes to replace chemical processing and reduce carbon emissions; the reduction of the amount of energy and water used during the production chain; implementation and use of bio-energy systems; the reduction of dependence on non-renewable natural resources;*

Having presented the characteristics, the directions of action, as well as the objectives of the two new types of economies, namely the circular economy and the bioeconomy, one can conclude that they develop a complementarity relationship. Both models have common objectives such as: sustainable development of economy and implicitly the harmonious evolution of humanity, efficiency and reduction of dependence and consumption of non-renewable natural resources, reduction of greenhouse gas emissions, reduction of fossil fuel consumption and, implicitly, minimization of climate change and the reduction of the harmful effects on the environment. At the same time, the two concepts also develop common action directions, such as: improving resources and eco-efficiency of their use, reducing carbon emissions and harmful substances, reducing the

demand for fossil natural resources, improving waste and recycling management, as well as secondary flows within industrial sector [15].

As a result of analysing the two future models of economy, we can conclude by asserting that their evolution will be concomitant and integrated into a single economic model, namely the circular bioeconomy that will corroborate the totality of objectives and directions of action of the two models and will work together to achieve a sustainable long-term development, ensuring a harmonious evolution of future generations by providing them with an optimal and balanced environment in terms of climate conditions, food security, human health and development of research and innovation. At the same time, this concept will revolutionize and change the radical organization and industrial development that will focus on research and innovation, on enhancing environmental responsibility, rationalizing the use of non-renewable resources and increasing the use of renewable resources.

3. Romanian economy - linearity versus circularity and bioeconomy

The attempts to use, implement and regulate the circular economy, the opposite of the linear economy that has been widely used in the twentieth century, have intensified in recent years, particularly in the European Union, where more and more companies have become aware of the vulnerability of the linear model .

To transform a linear economy into a circular economy, business models and design strategies need to work together. A multitude of design models and strategies, approaches, methods and tools to support the shift to a circular economy [11] will also be needed, while at the same time achieving sustainable economic development.

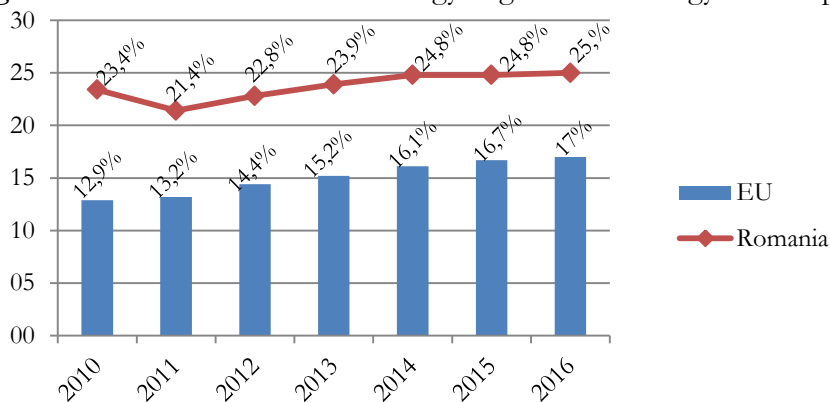
As far as Romania is concerned, the concepts of circularity and bioeconomy are on an upward trend, which proves that they are of increasing interest among researchers [3, 10, 12]. Thus, Pasculea (2015) has even identified and proposed a number of sectors that have high potential for the development of Romania's bioeconomy, including the food industry, agriculture (biofuel, biogas, biomethane), while solid residues and vegetable residues could be used to produce green energy), bio-natural products (spontaneous flora), horticulture, biotechnology, etc. [20]. Thus, in order to meet new and emerging challenges such as economic decline, depletion of natural resources, food security, energy security, poverty eradication,

migration of young people and so on, hopes of change can focus on bioeconomy in the context of sustainable development, integration of economic dimensions , social and environmental, where the bioeconomy sectors have the inexhaustible resources in Romania in key areas such as agriculture, forestry, energy, food, water [3].

The research approach focuses on identifying and highlighting some indicators reflecting Romania's evolution towards bioeconomy and circular economy or, more precisely, circular bioeconomy. The indicators considered relevant for the research undertaken are: (i) share of renewable energy in gross final energy consumption; (ii) share of renewable energy in fuel consumption of transport; iii) generation of municipal waste per capita EU vs Romania (kg per capita), v) recycling rate of municipal waste EU vs Romania (%); (v) Romanian trade in recyclable raw materials (tonnes).

The indicator share of renewable energy consumption in gross final energy consumption (Figure no.1) measures the share of renewable energy in gross final energy consumption; as far as Romania is concerned, it is in the reference period on an upward slope increasing in 2016 compared to 2010 by 1,6% exceeding the European Union average by 8% in 2016. This growth is also due to government efforts that have supported the use of renewable energy production facilities, but also to citizens' information campaigns on the benefits of renewable energy.

Figure no.1. Share of renewable energy in gross final energy consumption

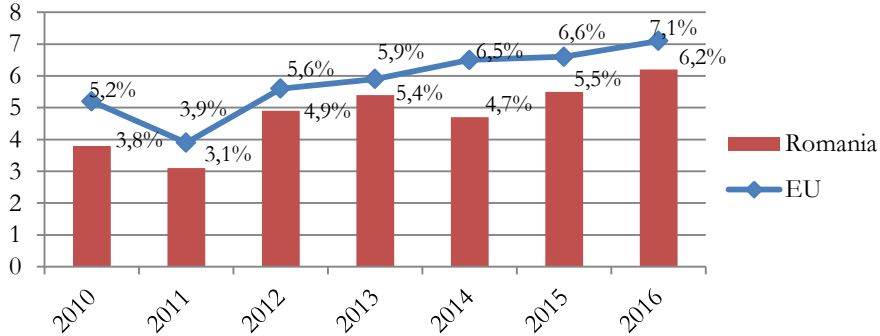


(Source: Eurostat statistics)

The indicator Share of renewable energy in fuel consumption of transport (Figure no.2) quantifies the amount of biofuel used in fuel

consumption of transport and reflects an increase in use by 1.9% in 2016 compared to 2010.

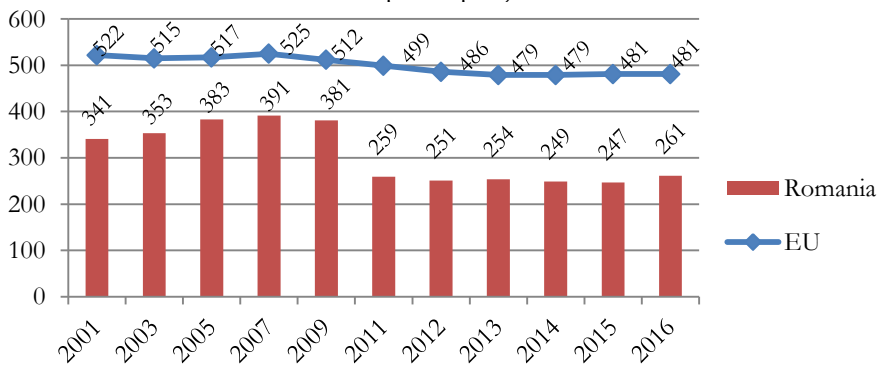
Figure no.2. Share of renewable energy in fuel consumption of transport



(Source: www.insse.ro)

The indicator reflects the amount of municipal waste collected and stored through waste management systems. We note that in Romania, the amount of collected waste per inhabitant decreased in 2016 as compared to 2010 by 80 kg / inhabitant, following the downward trend at the European Union level.

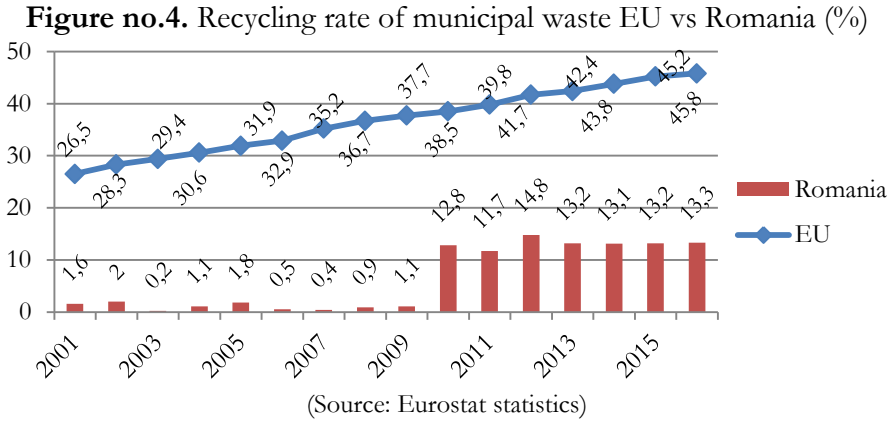
Figure no.3. Generation of municipal waste per capita EU vs Romania (kg per capita)



(Source: Eurostat statistics)

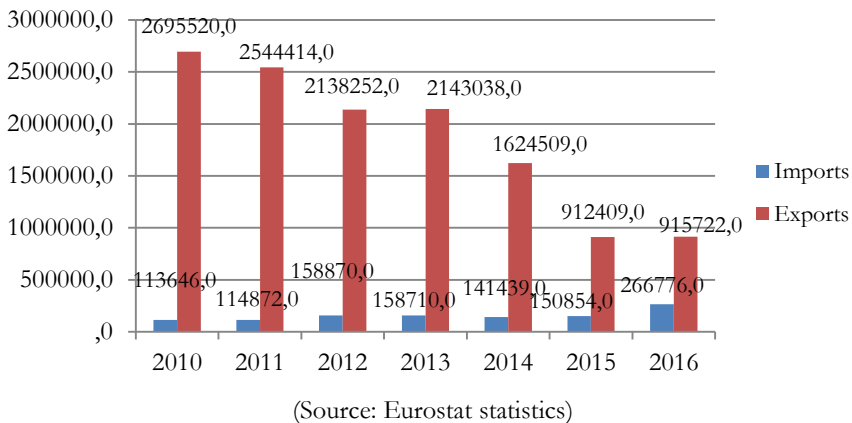
The recycling rate of municipal waste in Romania (Figure 4) shows a positive increase in the level of 2016 compared to 2001 by 11.7% due to the interest and increase of the investments in the development of efficient recycling infrastructures, but also the investment effort because the average

recycling rate at the European Union level in 2016 was 45.8% net higher than Romania's recycling rate.



The indicator RomanianTrade in recyclable raw materials (tone) measures the quantities (expressed in mass unit) of selected wastes and by products that are shipped across intra and extra EU borders. The indicator includes the following variables: imports to EU countries of recyclable raw materials; imports from non-EU countries and exports to non-EU countries of recyclable raw materials.

Figure No.5. RomanianTrade in recyclable raw materials (tone)



Exports to EU countries of recyclable raw materials. For this indicator, for the period considered, there is a sharp decrease in the exports that Romania has made, together with a slight increase in imports for such

materials. As a result of the analyzes carried out there was a positive evolution regarding the share of renewable energy consumption in gross final energy consumption, the consumption of biofuel in transports, the increase of the recycling rate and a significant decrease of the amount of municipal waste collected and stored through the systems waste management. Thus, we can say that Romania is making significant efforts to create the necessary framework for the evolution of the economy towards biocirculation.

4. Conclusions

The evolution of Romania's economy towards bioeconomy and circularity is a long-term process that will require the following directions of action and consolidation of the transition: i) a correlation between development objectives and investment programs in support of natural capital; ii) implementing green technologies and developing eco-efficiency criteria in production and service activities; iii) increasing people's awareness in what concerns the ecological education which can lead to an increase in the recycling rate of materials; (iv) waste management; v) governmental support for research into the development of biotechnologies; vi) creation of research-innovation departments within the economic entities; vi) support and promotion of alternative energy resources through governmental programs; vii) ensuring food safety and security; viii) increasing agricultural productivity, promoting organic farming; (ix) increased use of biofuels, etc.

This transition of the economy involves and implies an adaptation of all participants in order to achieve a sustainable economy. At the level of economic entities, the unitary concept of "resource use - production of goods - making profits" has to change towards a sustainable approach, namely "minimizing the consumption of non-renewable natural resources - maximizing the use and efficiency of renewable natural resources - production of goods - restoration or full recycling of products - sustainable development. "

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