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Bio-Based Economy Sketch: The Case of Romania

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Abstract: In a world shaken by unsustainability conundrums, a bio-based economy (bioeconomy) seems like the solution. This paper introduces two ways to define a sustainable bioeconomy, one advanced by Nicholas Georgescu-Roegen in the 1970s and another implemented by the European Union in recent years. Also, an overview of Romania'spotential to develop a bio-based economy is drawn. Its renewable energy profile is presented, followed by a discussion of the bio-based industrial sectors with potential for development.

Keywords: bio-based economy, bioeconomy, Romania
Classification JEL: Q42, Q56, Q57

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Introduction

Paul A. Samuelson, the *Father of Modern Economics* (Parker 2002, p. 25) called Romanian-born economist Nicholas Georgescu-Roegen "… a great mind… so far ahead of his time that he fails to get the recognition he deserves" (1999, p.xiii). Decades before the global concern about environmental destruction, Georgescu-Roegen proposed a new paradigm, 'the entropy economics', that acknowledges the economic process is an "irreversible process that admits no permanently renewable steady state for maintainable economic consumption" (Samuelson, 1999 p. xiv).

Georgescu-Roegen (1975) advanced Lotka's (1956) idea that the socio-economy should be looked at as an expanded form of the human metabolism and introduced the concepts of 'exosomatic' metabolism (outside the human body) versus 'endosomatic' metabolism (inside the human body). Similar to the healthy functioning of a body when all of its organs are healthy, from a socioeconomic metabolic point of view, local sustainability is a prerequisite for achieving global sustainability. Nevertheless, in our interconnected world, local sustainability might not be achieved without a global exchange of knowledge.

Romania is a country endowed with a large variety of natural resources (forests, natural gas, fertile agricultural lands—7.5% of utilized agricultural area in EU—brown coal and lignite, crude oil, salt, mineral, silver, gold and hydrological networks). Georgescu-Roegen confesses in his memories (1976, p. xi) that what made him "look at the economic process from an unorthodox viewpoint is the particular nature of the economy of my native country, Romania… a struggling, overpopulated, peasant-dominated culture and economy." As a result, in the 1970s he advanced the idea of bioeconomics "as a discipline based on parallel knowledge and application of social, economic and biophysical principles and emphasized the importance of an understanding of the reciprocal influence of this principles" (Giampietro and Pastore 1999, p. 287) and warned "The term is intended to make us bear in mind continuously the biological origin of the economic process and thus spotlight the problem of mankind's existence with a limited store of accessible resources, unevenly located and unequally appropriated" (Georgescu-Roegen1977, p. 361).

As a solution to modern world unsustainability conundrums, Georgescu proposed a minimal bioeconomic program required to build a sustainable world:

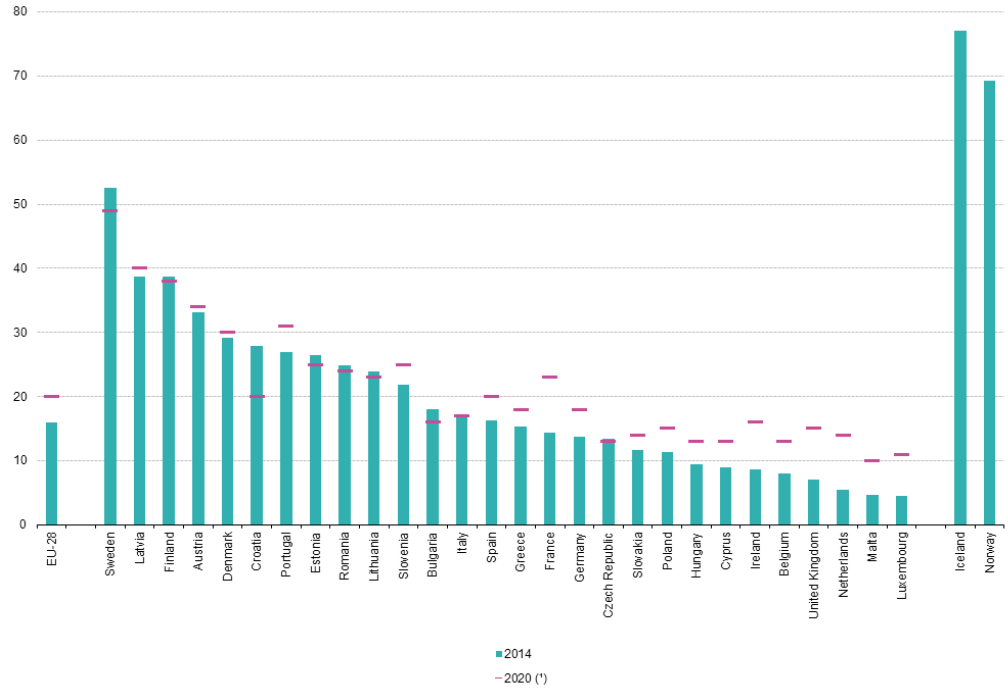
"the complete prohibition of weapons production, in order to release productive forces for more constructive purposes; immediate aid to underdeveloped nations; gradual decrease in population to a level that could be maintained only by organic agriculture; avoidance, and strict regulation if necessary, of wasteful energy use; abandon our attachment to 'extravagant gadgetry'; 'get rid of fashion'; make goods more durable and repairable; and cure ourselves of workaholic habits by rebalancing the time spent on work and leisure, a shift that will become incumbent as the effects of the other changes make themselves felt." (Gowdy and Mesner 1998, p. 151).

In the past ten years, the OECD and the European Union made concerted efforts to politically implement a bioeconomy concept that is quite different from Georgescu-Roegen's and those differences might prove to be, in the near future, dangerous challenges. In their OECD 2009 report, Arundel and Sawaya (p.19) show how "The application of biotechnology to primary production, health and industry could result in an emerging "bioeconomy" where biotechnology contributes to a significant share of economic output. The bioeconomy … is likely to involve three elements: advanced knowledge of genes and complex cell processes, renewable biomass, and the integration of biotechnology applications across sectors." In 2011, the European Commission (EC) defined bio-based products as "products that are wholly or partly derived from materials of biological origin, excluding materials embedded in geological formations and/or fossilized". In 2012, it adopted the strategy for building a sustainable bioeconomy in the EU, where the term bioeconomy means "an economy using biological resources from the land and sea, as well as waste, as inputs to food and feed, industrial and energy production. It also covers the use of bio-based processes for sustainable industries." (EC, 2012). Given that Romania is a State Member, the rest of the paper presents a very simplistic sketch of Romania's potential to develop a bio-based economy.

1. Romania's renewable energy profile

European strategy promotes diversification using renewable energy sources (RES) such as solar, wind, current, tide, geothermal, biomass and hydro energies (Zamfir, 2011).

Figure 1 Share of renewables in gross final energy consumption, 2014 and 2020 (%)



(*) Legally binding targets for 2020. Iceland and Norway: not applicable.
Source: Eurostat (online data code: t2020_31)

Source: Eurostat (2016b), Figure 1

The European Union officially adopted a 2020 target of 20% share of energy from renewable sources in final energy consumption (EC, 2009). EU member states set national targets lower or higher than 20%. In Romania, the target of 24% was already reached (Figure 1). In Romania, Law 199/2000 promoted RES and the National Regulatory Authority for Energy (ANRE) was established to supervise the liberalized electricity market.

Romania has a great potential of renewable energy (Table 1). It is worth mentioning that Romania has the largest surface of virgin forests in Europe. In 2013, one-third of the farms in the EU were located in Romania (though many are subsistence households).

Table 1 Primary production of renewable energy, 2004 and 2014

	Primary production (thousand toe)		Share of total, 2014 (%)				
	2004	2014	Solar energy	Biomass & waste	Geothermal energy	Hydropower	Wind energy
EU-28	113 134	195 814	6.1	63.1	3.2	16.5	11.1
Belgium	760	2 857	9.4	75.8	0.1	0.8	13.9
Bulgaria	1 009	1 842	6.9	63.6	1.8	21.5	6.2
Czech Republic	1 875	3 656	5.4	89.0	0.0	4.5	1.1
Denmark	2 447	3 144	2.6	61.5	0.1	0.0	35.8
Germany	14 568	36 018	10.3	70.8	0.5	4.7	13.7
Estonia	681	1 186	0.0	95.4	0.0	0.2	4.4
Ireland	282	854	1.4	39.6	0.0	7.1	51.8
Greece	1 571	2 329	22.2	47.1	0.5	16.5	13.6
Spain	8 816	18 003	17.3	39.1	0.1	18.7	24.8
France	15 769	21 002	2.9	63.1	1.0	25.7	7.1
Croatia	1 847	2 292	0.5	62.5	0.5	33.8	2.7
Italy	12 193	23 644	8.9	42.2	22.1	21.3	5.5
Cyprus	48	111	66.7	17.8	1.4	0.0	14.1
Latvia	1 837	2 371	0.0	92.3	0.0	7.2	0.5
Lithuania	849	1 358	0.5	92.8	0.1	2.5	4.0
Luxembourg	51	120	9.3	77.2	0.0	7.7	5.7
Hungary	950	2 051	0.5	89.2	6.3	1.3	2.8
Malta	0	13	80.3	20.5	0.0	0.0	0.0
Netherlands	1 881	4 555	2.1	86.0	0.8	0.2	10.9
Austria	6 618	9 370	2.7	55.8	0.3	37.6	3.5
Poland	4 321	8 054	0.2	89.0	0.3	2.3	8.2
Portugal	3 800	5 848	2.2	53.8	3.2	22.9	17.8
Romania	4 594	6 090	2.3	61.9	0.5	26.6	8.8
Slovenia	822	1 180	2.8	50.1	2.7	44.4	0.0
Slovakia	745	1 441	4.0	70.4	0.5	25.1	0.0
Finland	8 728	10 068	0.0	87.6	0.0	11.4	0.9
Sweden	13 147	16 660	0.1	61.2	0.0	32.9	5.8
United Kingdom	2 929	9 696	4.1	62.3	0.0	5.2	28.4
Iceland	2 333	5 223	0.0	0.0	78.7	21.2	0.0
Norway	10 542	12 965	0.0	8.4	0.0	90.1	1.5
Montenegro	–	329	0.0	54.2	0.0	45.8	0.0
FYR of Macedonia	304	278	0.4	56.9	3.1	37.4	2.2
Albania	704	621	2.0	32.5	0.0	65.5	0.0
Serbia	1 859	2 068	0.0	54.0	0.3	45.7	0.0
Turkey	10 783	12 010	6.7	28.8	29.3	29.1	6.1
Bosnia and Herzegovina	696	2 278	0.0	77.6	0.0	22.4	0.0
Kosovo (under UNSCR 1244/99)	176	263	0.1	94.9	0.0	5.0	0.0

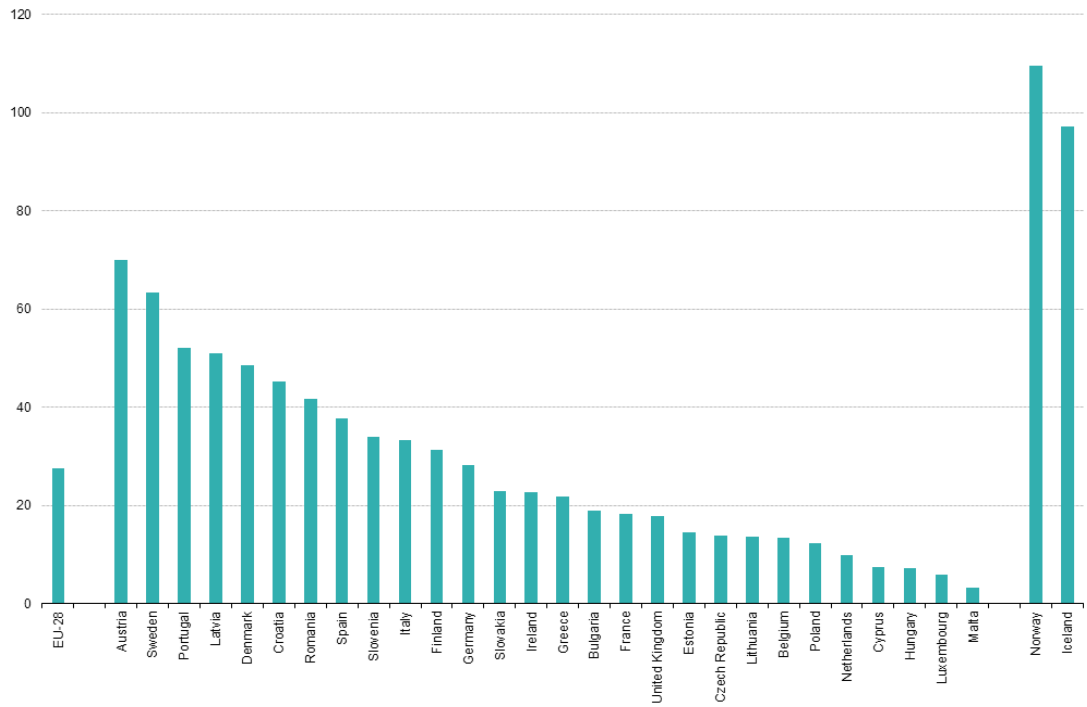
Source: Eurostat (online data codes: ten00081 and nrg_107a)

Source: Eurostat (2016b), Table 1

The intensive development of Romanian industries was based on the exploitation of natural resources, without mitigating the negative consequences on the environment. After joining the EU, the Romanian government approved the National Renewable Energy Action Plan and the Energy Strategy (NREAP, 2010). Those strategies take into account renewable energy sources.

Figure 2 shows the share of electricity from renewable sources in total gross electricity consumption at EU-28 level.

Figure 2 Share of electricity generated from renewable sources, 2014 (% of gross electricity consumption)



Source: Eurostat (2016b), Figure 2

Romania has considerable sources of crude oil, natural gas and oil, the energy dependency being lower compared to other EU countries. The primary energy sources in Romania are hydropower and fossil fuels. Almost 19% of the electricity in Romania is generated by two nuclear reactors from Cernavoda Nuclear Power Plant. More than half of the thermal generation uses power and heat cogeneration plants (Diaconu et al., 2008).

An important watershed for the Romanian hydrographic network is represented by the Carpathians. The main river collector is the Danube that flows into the Black Sea. Beside the Danube and other important rivers, Romania has more than 3500 ponds and lakes, though, irregularly distributed. Of the country's surface, 26.2% is covered by forests and other wooded lands. A surface of 180 000 ha in the Danube Delta has reed and other aquatic plants (United Nations, 2001). Portile de Fier is the largest hydropower plant in Europe and it is located on the

Danube River in Romania. There are other hydroelectric facilities in Romania of large and medium size, but since 2008, many small hydropower plants were constructed due to legislative incentives.

The winds blowing in Romania (mountain winds, wind-chill and Black Sea breeze) have an important impact on its energy potential. The policies stimulating the wind energy sector attracted many investments. Although Romania was among the first countries to implement programs for solar applications, solar energy has the lowest development from all its renewable resources. Many photovoltaic parks were built in Romania due to the green certificates scheme, but the number of solar projects is still low. A pilot research program promoted the use of photovoltaic systems in agricultural communities. Electromontaj S.A. built a 3MW pilot wind energy park in Banat Mountain, while PowerWind GmbH installed 56 wind turbines (Patlitzianas and Karagounis, 2011).

Geothermal resources are used for health and recreational bathing, heating, aquaculture and greenhouse heating, but they are still not exploited at their maximum potential. Some reasons are related to the lack of funding and the high costs of technologies. Most of the Romanian geothermal sites are used only for recreation.

In Romania, renewable energy is obtained using mostly traditional renewable resources (hydro) to the detriment of green renewable resources (Diaconu et al., 2008). Biomass energy is based on different resources: agricultural and household waste, forest wastes and energy crops. The production of biomass energy falls into two categories: biofuels (biomass is used to obtain liquid fuels that replace petroleum production needed in transport sector) and biopower (biomass is used to obtain electricity and heat). The local production of bioethanol and biodiesel began in 2007 but biofuels are produced at a low level, even if the country has a high potential of processing sunflower, corn, rape and soybean crops (Dumitru et al., 2004). Biomass represents 51.61% of the global RES potential in Romania, but a large amount of biomass is not used. There are only few incentives for using modern biomass technologies for electricity and thermal generation. The CEFA project was the first project in Romania for producing electricity from biomass (Vac et al., 2013). Other companies strive to use or implement similar technologies, but the development of this field is still low in Romania.

Eurostat provides country-specific energy balances (annual data) for various renewable sources of energy (EUROSTAT 2016b). We consider to be of interest to present some comparisons for countries in the Danube Region.

For all renewable sources of energy and also separately for solar photovoltaic, solar thermal, tide, wave and ocean, wind power, and biomass and renewable wastes, Germany had the highest production of primary energy in 2010 and 2015. For hydro power, Austria had the highest production in 2010 and 2015 (almost 11% in each year), being followed by Germany.

Germany was, in 2015, the largest consumer of energy based on all renewable sources similarly to 2010 (and that year it was also the leader in final consumption for biomass and solar thermal energy).

In 2010 and 2015, Romania was the only partner country to use geothermal energy in industry (39.39% of the energy consumption in industry in the entire EU-28), while Germany was the leader when the energy sources were either all renewable (12.25%) or biomass and renewable wastes (12.26%).

In terms of final energy consumption in various industries, in 2010 and 2015, Germany was the largest consumer for chemical and petrochemical, food and tobacco, paper, pulp and print, wood and wood product industries. For the textile and leather industry, in both years, the largest consumer of energy from all renewable sources and also from biomass and renewable wastes was Slovenia (3.54% in the total energy consumption in this industry in the entire EU-28 in 2010, respectively 10.73% in 2015).

The next section offers more details regarding some of the Romanian industries that are potential building blocks for a bio-based society.

2. Romania's potential for bio-based development

Researchers at the nova-Institute (2016) created a powerful graphic to explain what is their view on a bio-based economy. To them "Bio-based Economy introduces new chemicals, building-blocks and polymers with new functionalities. It enables the development of new process technologies such as industrial biotechnology and it delivers solutions for Green and Sustainable Chemistry.

It is supposed to help mitigate climate change through the substitution of petrochemicals by materials with lower GHG emissions."

For the case of Romania, Paşculea (2015) identifies fourteen sectors with a high potential for bio-based economic development. We will mention some of them. The food industry is the largest manufacturing sector, with a turnover of more than 1 billion euros.

Agriculture has a high potential to produce bioenergy (biofuel, biogas, biomethane), while solid garbage and vegetable residue might be used to produce green energy.

The bio-natural products sector based on the spontaneous flora has already decades of experience (for example, companies like Fares, Medica Group, Dacia Plant, Gerovital, Plafar).

Horticulture is another sector that could be easily stimulated given the valuable local horticultural genetic resources and know-how.

Pasculea (2015) also reports on the potential for developing bio-pharma since Antibiotics SA Iaşi already produces bio-active substances and those for semisynthetic conservation and bioequivalence studies for generic medicine are cheaper compared to the other European countries.

Environmental biotechnology, such as cleaning of contaminated soil using phytoremediation and microorganisms, is another sector of interest.

Conclusions

Given that our globalized world is confronted with major disequilibria directly connected to the 'modern' unsustainable way of living, this paper mentions two approaches that are called 'bioeconomy'. The first one was advanced by Nicholas Georgescu-Roegen in the 1970s and the other is implemented by the European Union. As a case study, Romania's potential to develop a bio-based economy was presented based on its renewable energy profile and the bio-based industrial sectors with potential for development.

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