Biogas to Energy in Rural Romania. Scenarios of Sustainable Development

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Abstract: - This paper presents four exploratory scenarios of sustainable development using the biogas to energy in animal farms in Romania. This research was part of the doctoral thesis of the author, entitled "The Economic Impacts of Climate Change". The biomass sector is one of the most promising, but less developed fields of the Romanian energy sector. Based on a sectoral analysis of the biomass in Romania, with regards to the transition process towards the low-carbon economy, few scenarios were drafted, in order to provide the decision makers with eventual prospects and drivers in the field, in order to overcome with relevant policies. The study responds to the European Union's climate action, resource efficiency and raw materials priority and climate change mitigation effort, together with fostering renewable energy technologies.

Keywords: sustainable development, rural development, biogas to energy, waste to energy, low carbon economy

JEL Classification: Q16, Q42, Q56, R11.

1 General aspects

Previous studies and policy papers at national level have proven the strong dimension of the biomass sector in Romania. (ENERO, 2009) Although there is limited recent data provided, the biomass potential is ranking Romania on the 6th position among the EU Member States in this sector. The national policy documents refer to an energy potential of biomass of 7.6 mln. Tonnes oil equivalent (toe) (Ministry of Economy, 2010), which could cover 65% of targeted renewable energy sources by 2020. Regarding the use of biomass in the primary energy production, Romania is in the EU28 average, indicating 0.173 toe per capita. (European Commission, 2013). By all means, the actual production of energy from biomass is less than 5% of potential, with respect to its economic value, meaning that 85% of the primary energy consumption of biomass (3.8 mln. toe) is actually fired in traditional stoves, with purpose of heating in winter and cooking, in rural and peri-urban areas. (Ministry of Environment and Climate Change, 2012). The average yield of traditional stoves is less than 20% and most of the biomass, derived from wooden sources, is eventually wasted.

Which are the economic arguments in favour of biomass to energy?

- The Asset: the biomass stock is a local by-product, leveraging in rural areas, therefore giving an impulse to local development. The vegetal mass, the harvester wastes, the wooden wastes in sawmills, forests, parks and gardens' sanitations, the wood industry wastes, the animal manure and organic wastes of households are included in the biomass assets. Some other assets are the dedicated energy plants, like rapeseeds, sorghum, maize, which are already cultivated on large land surfaces in Romania;
- The Leverage: rural population in Romania ponders around 46% of total population (National Institute of Statistics, 2011), the employment rate is low, only 40% were legally employed in 2014. (National Institute of Statistics, 2014) Self-employment and agriculture workers are predominant in the structure of labour force and the available jobs are very low. The income gap and low economic development make inequalities deeper, between rural and urban population. Biomass to energy would foster the economic growth for rural and less developed towns, generating jobs, for less qualified and qualified workers;
- The Financing: national and European policies try to encourage the green economy, to provide economic stimulus for green growth. The dedicated programmes for rural development, agriculture,

energy policy, regional development, farmer start-ups, SME's, European funds, which could motivate investors and local entrepreneurs;

- The Innovation: the biomass sector gives an impulse to innovation. In order to make this activity efficient and profitable, new technologies are required. Romanian farmers already have significant knowledge dealing with biomass and biomass related technologies. The biogas sector has more than 30 years of experience in Romania, there is relevant expertize of engineers and farmers, which could become a competitive advantage. Eco innovation is one of the priorities of the national strategy for innovation (Ministry of Education and Research, 2014). This could intersect the interests of investors, local government and general government in order to provide additional tools for technology transfer and improvement of the knowledge base.

2 The method

A recent paper, which was adopted as a programming document by the Ministry of Economy (Ministry of Economy, NL Agency Olanda, Enero, 2010), identified a couple of relevant technologies for biomass which could be efficiently implemented in Romania: a) local fired-biomass plants in cogeneration or boilers in centralized system for residential heating and b) local biogas plants in cogeneration in centralized system for residential heating, based on organic municipal waste or animal manure in animal farms.

Following the results of this previous research, the present paper presents a scenario building exercise for implementing biogas plants in the animal farms in Romania. The scope of this exercise is to provide several possible paths of sustainable development by fostering the biogas to energy, at the horizon 2030, respectively three scenarios of sustainable development and an opposite scenario of sustained economic growth based on intensive exploitation of farms and biogas. The scenario building was based on identifying relevant drivers of change in the biogas sector, evaluating their impact and uncertainty, build up the impact/uncertainty matrix, wrap up scenarios narratives and providing a base scenario with policy recommendations.

The build-up scenario method is a frequently used instrument of strategic planning (Moriarty P., 2005) the method is based on systematic analysis of possible future trends, starting with present signals identified as trends or drivers. Exploratory scenarios or descriptive scenarios have a starting point in present and explore the future trends (EEA, 2011). In the environmental studies, scenarios are defined as"images of the future or possible futures, which are not either predictions or prognosis, but alternative images about how future might look like" (Alcamo, 2001). Scenarios are not necessarily the most probable or desirable future directions. Other theories entitle scenario building method with the role of formulating the adequate questions and stimulating the scientific debate and less the role to supply with the plausible answers about the future (Zurek, 2007). The normative scenarios, as compared with the exploratory ones, describe a desirable future and establish a set of objectives to reach a certain scope.

In order to identify the drivers of change, an exhaustive number of trends, statements and data were collected and analysed from relevant sources for the topic. The drivers were previously selected and grouped into categories of relevance: wide relevance group of factors, which included the drivers with more general importance, like the EU's energy sector, EU's legislation and policies related to biogas, the millennium objectives of sustainable development, global accords and environmental constraints. A second group of drivers included the drivers from the national and local level, national legislation, national energy system, public policies and incentives related to energy and biogas, market development, labour market, agriculture and technology transfer.

Using the STEEPV method, the drivers were afterwards regrouped, in order to have a more comprehensive image of their direct impact to the researched area. Based on this regrouping, the drivers were evaluated with marks from 1 up to 5, meaning 1 low impact/high probability and 5 high impact/high uncertainty. Drawing up the impact/uncertainty matrix has provided with the key drivers, which led to the four scenarios. The rest of the factors were used in compelling the narrative for each scenario. The four scenarios were defined based on the selected key drivers, indicating with a medium level of trust which one is the pessimistic scenario, the optimistic and the base scenario. The fourth one was considered as the negative scenario, with regards to the sustainable development vision, although it could be a possible future path, diverted of the reference objective.

3 Scenario building

In Table 1, the identified drivers were grouped after the level of relevance criterion and discussed separately about their actual relevance and future possible developments.

Table 1. Drivers of change, on impact level

Drivers	Status 2015	Trends 2030
EU energy sector		
– Energy Union	Baseline discussion	?
– Dependence on imports from Russia	Diversification sources	↘
– EU funds for farmers	Common agriculture policy	→
– Smart grids	Demonstration technologies	?
– EU climate policy	Europe 2020 Agenda, energy and climate change 2030,	↗
EU biogas sector		
– Biotech readiness	KET's	↗
– Small size biogas plants in cogeneration	Prototype and demonstration	↗
– Improvements in drying devices, desulfuration and chemical absorption of CO_2	Lower RDI expenditures than US	↗
– Fuel cells	KET's	↗
– Gas micro turbines	Prototype and demonstration	?
– High technology costs		↘
– Energy plants subsidies	Incentives for biofuels	↘
Romania's energy sector		
– national gas distribution network	Low interconnectivity, rubbished network, large gas deposits	↗
– energy mix	Balanced mix of energy sources, increase of renewable production, social pressure of the coal sector, old thermal plants, new energy strategy	?
– green energy subsidies	Green certificates scheme for generation of wind, solar, biomass, geothermal, up until 2017	↘
– social aids for heating	Social allowances for low income families, local authorities, for winter heating, including wood-fire in traditional stoves	→
Romania's biogas sector		
– Smart specialization in biotech	National RDI priority	↗
– Associations of farmers	Small sized farms, increased fragmentation	?
– Sustainable agriculture		?
– Highly qualified labour force shortage	Labour force migration, internal and external, professional conversion programmes, demographic decline	↗
– Illegal deforestation	Strengthening legislation, largely cut off deforestation	↘
– Ecological agriculture	Subsistence agriculture, organic products market in formation	↗
– Sustainability awareness	Traditional habits of consumption, low ecological values	↗
– Modernizing of village	Demographic decline, lack of utilities and infrastructure, asymmetrical reconfiguration	?
Global		
– global accord on climate change	New climate approaches, Paris COP 21 accord attained, increasing green economy, large emergent countries do not commit for emission targets	↗
– New Silk Road, export opportunities	Working concept, US – China – EU	?
- TTIP, TTP	Technology transfer opportunities, FDI, market integration	?

Source: author's concept

Further on, the drivers of change are presented and regrouped based on STEEPV method, as presented in Table 2.

Social factors:

- Entrepreneurial education of farmers: this factor is related to the education level in rural areas and the education system. The biogas to energy requires specialized education: engineering, energetics, economics, management, biochemistry and agronomy. These all are limited qualifications in rural areas, the farmers lack business management skills and qualified staff. It is possible though that with the education reform and university specialization, the sector to become attractive for undergraduates, but with a low level of confidence.
- Farmers associations: excessive fragmentation of parcels and lack of communitarian values represent the biggest barriers of the agriculture sector. Romania has now the smallest average farm surface in EU, fact which affects productivity and implies barriers of investments. The framers' association could determine more resources to get engaged, new technologies and biogas solutions, financing, increased productivity and scale up.

Technology factors:

- Biotechnology readiness: biotech is one of the most growing and innovating industries with incidence in animal breed and food industry, which could determine enhances of quality of products, cost cuts, new biological resources and it an impact on biogas production.
- Smart grids are a systemic innovation which could increase energy efficiency. It includes new technologies of measurement, command&control, system balance, smart metering, which determine reduced losses in transport&distribution of electricity. Smart grids require long and consistent effort to modernize and replace the network, to extend the infrastructure, interconnectivity of the national grids, with large social and economic implications. Therefore, uncertainty is increased. The impact on biogas sector could be high, due to supply opportunities, grid balance, which is vital in case of floating renewable energy production.
- Small residential boilers refer at specific models which could be feasible for biogas. Residential boilers have developed a lot and are successfully implemented in Romania, especially in the areas which are not supplied with any thermal energy, but as an alternative to more and more costly centralized system of heating. Residential boilers with biogas could impact the biogas sale and distribution to rural areas. These devices are still hard to be acquired by low income families, due to higher costs of installation and maintenance, but the costs are predicted to decrease.
- Automatization of agriculture: this is a process which didn't start yesterday, but technologies and innovation accelerate. Therefore, new solutions, machines, applications are experimented. The agriculture by drones, software management of agriculture processes lead to cost drop and higher yields, without the effort of agriculture workers. For biogas, automatization of agriculture could determine fluctuations of supply with raw materials and the quality of raw materials.
- The national gas network could influence the biogas development. If the network expands, due to efficiency of transport and distribution and new discoveries of sites, the biogas can be supplied to the final consumer. Uncertainty is high, due to high investment costs to expand network and unsafety of sources.
- Improvements of drying devices, desulfuration and chemical absorption of CO2 could lead to quality improvements of biogas, higher yields and reduced impact on the environment. This innovative process is feasible, the trend is signalled by specialized magazines of producers.
- Fuel cells are a new generation technology, to produce clean and cheap energy. This trend could influence the energy efficiency of renewable energy production.
- Microturbines using gas are a new technology, not yet developed, which assumes biogas utilization on a small scales

Economic drivers

- High technology costs: the biogas related technologies are in cost reducing trend, determined by technology readiness, economy of scale, China's growth in innovation in this sector, lower productions costs. China is the biggest producer of biogas facilities in the world, in competition with Germany and the Scandinavian countries. The initial investment is still at the high levels, as compared to other competitive technologies, including those in renewable sector, but depreciation period is longer. Therefore, without state aid and subsidies, the biogas sector could not develop

with imported technologies. On a long term, there are premises that the sector becomes self-reliant. Due to EU subsidies, the impact of the cost is lower in biogas development.

- Smart specialization of biotechnologies is knowledge based economic model of regional development, which is designed by the European Commission. The EU regions are induced to specialize on the internal market, based on their own strengths of high-tech, excellence and market driven industries, to put in value innovation partnerships between regions, universities and business. Following a consultation process and panel of experts, Romania has decided that one of the smart specialization priorities are biotechnologies. This specialization could give an impulse for technology development, which determines competitive advantages for the biogas sector.
- European funds for the farmers are a committed driver for agriculture in Romania. With more than 10 years' experience and an important leverage for business development in rural areas. Due to agriculture dimension and its growth potential, including the rate of absorption of EU funds, it is assumed that the trend will accelerate on a long term, which becomes a positive factor for biogas facilities and biogas to energy.
- The shortage of highly qualified labour force is still a deep social and economic impediment of rural area development. This driver can be assimilated with the social one, entrepreneurial education of farmers. This trend is not strictly social, but also a demographic fact, due to massive migration to EU countries and depopulation of villages. This can be counter-balanced only by increasing the wellbeing, incomes and creating jobs.
- The energy mix is specific to the Romanian energy system, which relies on varied and balanced sources of production. The energy mix is encouraged by energy security prerogatives, an important element of EU energy strategy. Therefore, the biogas could be a valuable alternative of diversification.

Ecological drivers

- Illegal deforestation is a large scale phenomenon in Romania. Illegal deforestation at local level, carried out by individuals and firms produces great damage to the environment, causing floods, landslides, but also the affects the forests and the exploitable and safe economic activity related to woods. Large amounts of wooden material are used for winter heating. Although the heating costs are lower with illegal cuts, the social costs are actually higher, due to environmental troubles they generate and the opportunity cost of the biogas boilers could efficiently solve the problem of heating.
- The global accord of climate change is a negotiating process under the aegis of UNFCCC. Although difficult, the negotiation will finally lead to ratification of this accord between the developed and emerging world, which could become a tipping point for low-carbon economy. This accord would give an impulse for clean technologies, including biogas related, establishing a price on carbon, which could balance the costs in favour of green economy.

Policy drivers

- EU policies of climate change: the EU targets of emission reduction, increase renewable energy production and energy efficiency will encourage technology transfer, including biogas related. The EU policies comprise a set of climate and energy actions, which lead the business and society towards committing to low carbon economy.
- Green energy incentives: this driver refers to European and national energy policies of feed in tariff and green certificates. Romania has had a generous programme to encourage solar, wind and biomass energy, guaranteeing as well priority to supply to the grid.
- Incentives for energy plants production. This type of incentive was common in EU policies. The trend is to cut them down, proving they were not really efficient and the economic crisis has pushed a drop in this type of allocation.
- Social aid for heating: very common policy of government and local authorities in Romania. Social aid for winter heating are granted for low income families, in a fiduciary form, supporting them purchase the fired-wood in rural areas and as a discount of the thermal agent bill, for most of the residents in urban areas. This driver is discouraging the biogas option, maintaining a lower cost for alternative solutions. On a long term, the uncertainty of granting social aids is high.
- The New Silk Road, as a geopolitical concept open several opportunities for Romania, which could improve trade and business on the East – West route. As an immediate impact, new trade zone would start up, which could foster new products and services, would lower the transport costs,

technology costs and raw materials. Therefore, this factor could determine an impact for the biogas sector, as well.

Value drivers

- The ecologic agriculture: a relatively recent trend it is influenced by the change of consumption patterns of average to high income population. The ecologic or organic agriculture does not have a large impact on biogas, except the fact that it concentrates production in specialized crops and the fertiliser should be organic. The fertiliser is a by-product of the anaerobic digestion, thus determines an increase of demand in agriculture.
- Sustainability: changing lifestyle, for a more quality driven consumption, could reduce waste, which is a significant objective of sustainable development. This trend is still slow motion and localized, much more in the developed world, where the preoccupation for environment and future generations is mainstream. Sustainability is anyway a societal value in rural communities, as well. The biogas sector could be encouraged by social choice, if communities enure new energy production solutions, sustainability values, care for nature and environment protection.
- Modernization of village: development gaps and lack of basic resources are the main constraints of inhabitants in the rural areas. The trend to shorten the gap will accelerate, under EU and national policies, as well as the labour force mobility and movement of capital. The investments in biogas could determine transformations of rural communities, economic leverage, new opportunities for development, new jobs and enterprises.

Based on the analysis above, each driver was marked from 1 to 5, thus the impact on the biogas sector marked 1 means reduced impact and marked 5, major impact. Consequently, uncertainty marked 1 means low uncertainty, marked 5 equals considerable uncertainty. The drivers were regrouped by STEEPV criteria, merged if redundant, thereafter marking each, based on qualitative and objective criteria.

Table 2. STEEPV drivers of change

Group	Drivers of change	impact	uncertainty
Social	Entrepreneurial education of farmers	5	4
	Farmers associations	4	5
Technologic	Biotechnology readiness	3	3
	Smart grids	5	5
	Small residential boilers	3	2
	Automatized agriculture	3	3
	National network of natural gas	3	4
	Improvements of drying devices, desulfuration and chemical absorption of CO2	4	4
	Fuel cells	2	4
	Microturbines on gas	3	4
Economic	High technology costs	2	5
	Smart specialization in biotech	4	4
	European funds for farmers	5	2
	Deficit of highly qualified labour force	4	2
	Energy mix	5	3
Ecologic	Illegal deforestation	1	4
	The global accord on climate change	4	5
Policy	EU climate change policies	5	2
	Green energy incentives	5	2
	Incentives for energy plants	5	2
	Social aids for winter heating	4	3
	The New Silk Road	4	5
Values	Organic agriculture	2	4
	Sustainability	4	4
	Modernization of village	4	3

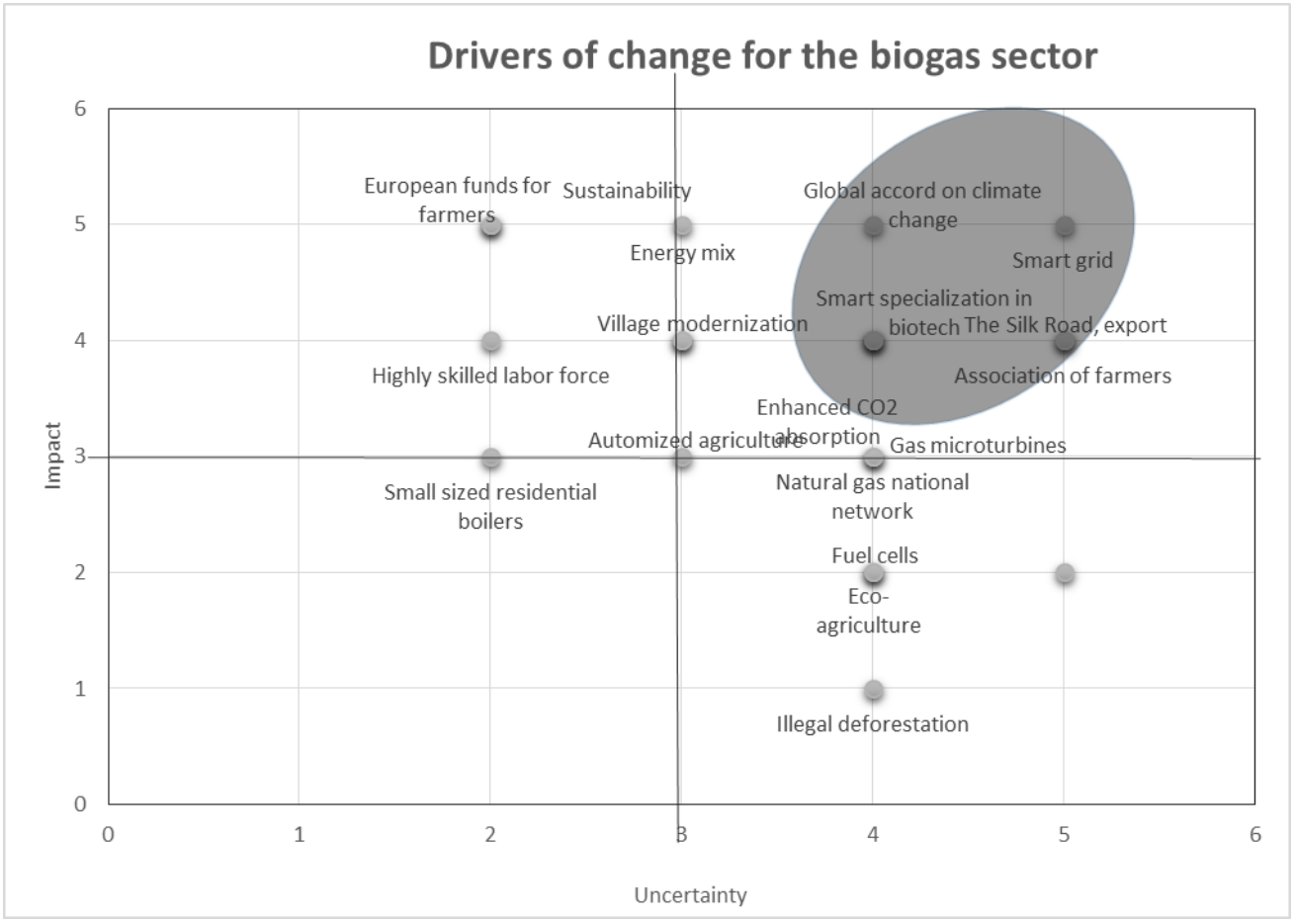
Source: author's concept

The driver of change chart of impact/uncertainty is presented in the Figure 1. In the second quadrant, there are the drivers with high impact and high uncertainty, which particularly define scenarios. Besides the drivers presented in quadrant 2, there were three other drivers which were excluded in order to compile the four scenarios. They were used together with the rest of drivers to write down the narratives of each of the four scenarios, which are defined as following:

– Waste to energy
– Farmers on the "Silk Road",
– United for biogas,
– Smart wastes.

Three of the resulted scenarios correspond to sustainable development target and the other scenario envisages an accelerated growth of agriculture. All four scenarios are provocative in the stance of the animal farming and indicative for biogas to energy in the national energy system. The four scenarios are obviously distinctive regarding the regional and global geopolitical trends and implicitly describe differently the policy priorities which might influence the biogas sector. A synthetic description of the four scenarios is presented in the Table 3.

Figure 1. Impact/uncertainty matrix



Source: author's concept

Scenario 1. *WASTE TO ENERGY* is conditioned by further European integration until 2030. The Energy Union fulfils and the European grid expands, based on wide and connected smart grid. In this case, the European policies are targeting the small producers of energy from renewable sources and off-grid solutions. The system balance and compensation of the peak consumption are solved by smart grid and interconnectivity. This scenario can be described as a reference scenario. As compared to the European Commission reference scenario on energy trends, this scenario is more optimistic and promotes new biogas facilities and integration. (European Commission, 2014), having an impact on transition to low-carbon economy. This scenario is also taking account of the global accord on climate change, which could determine a great impulse for EU targeting the 40% emission reduction in 2030, as compared to 2005.

Table 3. Scenarios of biogas to energy in rural areas in Romania

Scenario 1. ***Waste to energy*** - New smart grids develop widely, - Interconnectivity and grid balancing increases within the Energy Union, - European policies encourage grid expanding and newcomers, - There is a functional legally binding climate change accord, - Transition to low-carbon economy accelerates, - Romania faces an engineering shortage and labour force shortage in rural areas - Major investments take place in cogeneration based on biogas, in medium to large farms countrywide.	**Scenario 2.** ***Farmers on "The Silk Road"*** - Romania is a net exporter of livestock and agriculture products, - The renewable energy production of biomass increases and it is mostly used for internal demand, - There is no legally binding climate change accord, - National and European policies encourage renewable energy production, - Large scale introduction of very efficient small sized residential boilers, - Reduced illegal deforestation, - Wood-fired stoves are discouraged and social aids conditioned by installing residential boilers on biomass, - The growth of agriculture and transport has a negative impact on GHG emission.
Scenario 3. ***United for biogas*** - The national policies encourage farmers association and the small producers of energy, - The largest part of biogas output is transferred in the national natural gas network, - the European energy policies stagnate, but there is a functional accord on climate change, - The thermal energy plants are modernized by shifting the main resource in natural gas, - Most biogas technology is imported, - Romania has a shortage of engineers, - Significant progress towards low-carbon economy and renewable energy sources.	**Scenario 4.** ***Smart wastes*** - Romania becomes a producer of biogas technologies and biotechnologies, the costs drop, - Significant progress in biotech, anaerobic digestion of organic waste, which increase the quality of biogas and productivity, - Most farms, small to large, are self-sustainable, - Utilities development leads to modernization of rural area, - The national energy system is unbundling, off grid solutions are often preferred and small plants are encouraged.

Source: author's concept

On the opposite, Scenario 2. *Farmers on "The Silk Road"* is not focused on further European integration and climate action. In this case, the accent is on the geopolitics and geoeconomics of Romania on the world map. Therefore, increased cooperation on East – West direction is rather envisaged with political, commercial and economic view. The concept of "New Silk Road" could bring a different optic for the agriculture development of Romania and for the energy sector, as well. In this case, accelerated growth of agriculture would assume further capitalization of wastes in animal farms, biogas, for internal consumption of farms and villages, creating the opportunity of rural development. Intensive land use and animal breeding for export would lead to increased GHG emissions in agriculture and transport. This scenario could have a positive impact on growth and rural development, but negative impact in which regards sustainability and low-carbon economy.

Scenario 3. *United for biogas* is an average scenario, a little bit more protectionist in which regards the national energy policies. In this case, there won't be significant steps towards further integration of an Energy Union, but a global accord on climate change will bring stronger environmental standards for energy companies and industry, which will significantly change the energy mix and energy system. The old thermal energy plants will be modernized, meeting technology shift on more sustainable resources, like natural gas. The biogas would be a base resource for large scale plants in process of transformation and modernization. Small and medium farms should associate in order to develop new biogas facilities of larger capacity, which require a higher investment with higher returns. In this scenario, the national network of natural gas is also upgraded and used to

stock and transfer biogas. This scenario is making the steps towards low-carbon economy more slowly and with higher costs.

Scenario 4. *Smart wastes* is reportedly focused on smart specialization in biotech. This very optimistic scenario would have significant economic impact, with high value added and increased competitiveness. Romania would become a real player in the field of biogas technologies, with important expenditures in research-development and innovation and great competitive advantage, which would lead to lower technological costs. In this case, the low-carbon economy transition would be cheaper to realize. The lower cost of technology would permit farmers higher returns of biogas facilities. The impulse for growth would leverage new jobs and rural development, expanding the utility networks and increased incomes for villagers. In turn, it would have a large impact on the energy system, with further unbundling and off-grid facilities, which would lead to a wave of debranching from the centralized system of heating and additional arrears for the large state owned companies in the energy sector. If the trend of smart grid confirms, this scenario would lead Romania on a real convergence trend with European Union with a reasonable period of time.

4 Conclusions

Romania has assets to become a winner of the inevitable process of transformation of the economy towards a low-carbon economy. This research paper is presenting few exploratory scenarios to capitalize the biomass assets in Romania, a relevant sector with high growth potential for renewable energy production. On a long term, the biomass could substitute a significant weight of the fossil fuels.

Based on official estimates, the biomass could cover 65% of the required amount of renewable energy in 2020, although the present weight is only 5% of renewable energy production. Most of the biomass is used for heating in traditional stoves. More than this, only a small percentage of the organic waste is actually used, most of the registered biomass for heating is wood and wooden material.

Through fostering the biomass use for energy, the energy mix would restructure in a more sustainable way, to reduce GHG emissions and replace a large amount of fossil fuels in energy production. Some other studies have proven that in Romania case, the biogas technologies could be implemented with positive economic and environmental impact. (ENERO, 2009)

This scenario building exercise intends to present several possible directions for the future in the biogas sector in Romania. In that sense, there were identified trends and drivers that could decisively determine an impulse for the biogas sector. Four scenarios were drafted, as following: *Waste to energy*, *Farmers on the "Silk Road"*, *United for biogas* and *Smart wastes*. Three of these scenarios correspond to the sustainable development vision and one is opposed to sustainability.

The three scenarios of sustainable development are more or less influenced by the European Union and Romania's position, the evolution of the Energy Union, the climate change policies, farmers association in Romania and the agriculture policies. The reference scenario, entitled *Waste to energy*, promotes new biogas facilities in rural area in Romania and envisage further European integration with fulfilment of the Energy Union requirences and implementation of smart grids. Among the other scenarios, this has better chances to become a normative scenario. For further research new inputs would be required in order to enhance the exercise, based on a consultative process with stakeholder participation. A normative scenario build up on the current premises would provide the decision makers with relevant recommendations in order to comply with sustainable development objectives.

References:

[1]. Alcamo, J. (2001), *Scenarios as tools for international environmental assessments.* Luxembourg: Office for Official Publications of the European Communities.

[2]. EEA (2011), *Knowledge base for Forward-Looking Information and Services. Catalogue of scenario studies.* Copenhagen: EEA Technical report No 1/2011 . Retrieved from http://glossary.eea.europa.eu/

[3]. ENERO (2009), *Study on Scenarios Biomass Romania.* Bucharest.

[4]. European Commission (2013), Solid Biomass Barometer. *Eur'Observer*. December

[5]. European Commission (2014). *EU energy, transport and GHG emissions. Trends to 2050. Reference scenario 2013.* Brussels: European Commission.

[6]. Ministerul Economiei (2010), *Planul Naţional de Acţiune în domeniul Energiei Regenerabile.* Bucureşti.
[7]. Ministerul Economiei, NL Agency Olanda, Enero (2010), *Masterplan de biomasă, versiunea 2.* Bucureşti.
[8]. Ministerul Educatiei şi Cercetarii. (2014), *Strategia Naţională pentru CDI 2014 – 2020.* Bucureşti.
[9]. Ministerul Mediului şi Schimbărilor Climatice (2012), *Inventarul National al GES Romania 1989-2010.* Bucuresti: vizualizare electronica aprilie 2015.
[10]. Moriarty P., B. C. (2005), *Using Visions, Scenarios and Strategies within the EMPOWERS Planning Cycle* for *IWRM. EMPOWERS Working Paper No. 4.* Retrieved from http://www.empowers.info/page/1070
[11]. National Institute of Statistics (2011), *Population Census.* Bucharest: National Institute of Statistics. Retrieved 2014, from http://colectaredate.insse.ro/phc/aggregatedData.htm
[12]. National Institute of Statistics (2014), *Employed population and employees on age group and residential type.* Bucharest. Retrieved 2016, from http://statistici.insse.ro/shop/
[13]. Zurek, M. (2007), *Linking scenarios across geographical scales in international environmental assessments*. Technological Forecasting and Social Change 74(8), pp. 1282–1295.