Margareta RUSU
Faculty of Management, The Bucharest University of Economic Studies, Romania

ENEGY FORESTRY A SOURCE OF ENERGY FOR THE ROMANIAN ECONOMY

Case study

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Abstract

Using "grown fuels", as opposed to "fossil fuels" such as coal, natural gas and oil can be a possible solution to the global energy crisis by creating a decentralized power generation network. Wood is among the most efficient sources of bioenergy in terms of quantity of energy released by unit of carbon emitted compared with other energy crops. Research, development and innovation create new opportunities for the process of gathering and transforming the raw material into energy. Innovation should be targeted to deliver sustainability, biodiversity and economic growth. Romanian has a high potential and can develop energy forestry in order to reduce CO2 emissions and ensure an alternative energy solution and an energy reserve. This paper aims to analize the challenges and opportunities the biomass energy industry creates in the context of climate change mitigation which must be seen from an entrepreneurial perspective in Romania.

Introduction

Wood has been for a long time a primary source of energy and material for human society. Mankind had seen wood as a source of agriculture, raw material for construction, crafts, fuel, climate change mitigation material etc. Over the last century, we switched from many previously uses of wood to non-renewable materials such fossil fuels, metals, coal, concrete, oil, plastics etc that have a negative impact on the environment. (Inman, 2009; Oosthoek, K.J.W)

The destruction of the world's forests represents a major concern in our age because a whole range of environmental problems are associated with deforestation, among them flooding, accelerated loss of soil, encroaching deserts and declining soil productivity (Giurgiu 2010; Tasneem Abbasi& Abbasi, 2010; Tomescu, et. al. 2011).

Due to rapid and widespread changes in the world's human population, unprecedented levels of consumption present profound challenges not only to the human health and wellbeing but also to the natural environment. In order to cut down GHGs (green house gases) mankind needs to make growth greener and make our economic and environmental policies more compatible by mutually-reinforcing each other (Sathre and Gustavsson, 2009; Cozmei et al., 2012; Rusu 2013).

The imminent decline of the world's fossil fuels, coal and oil production, its high market prices and environmental impacts have made the production of biofuels to reach unprecedented levels over the last years. Consequently, there have been intense debates among the European Union policy makers, international organizations and political leaders in order to discuss the impacts of the biofuel use intensification.(Escobara et al. 2009; Volk et al., 2009)

Biomass in the context of climate change mitigation

According to Biomass Energy Center, biomass is biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to refer to plant based material, but biomass can equally apply to both animal and vegetable derived material.

The Food and Agriculture Organization (FAO, 2008) considers that compared to other energy crops, wood is among the most efficient sources of bioenergy in terms of quantity of energy released by unit of carbon emitted. Another advantage of generating energy from trees, as opposed to agricultural crops, is that trees do not have to be harvested each year, the harvest can be delayed when market prices are down, and the products can fulfil a variety of end-uses.

The availability of wood, and its potential as a biofuel to substitute fossil fuel in the future and its carbon sink properties, are unevenly distributed throughout the world. Romania, due to its natural resources (uneven distribution of forests/available wood), can promote an energy policy based on decentralised power generation. Global industrial round wood production was about 1.7 billion cubic meters in 2005, compared with fuel wood production of approximately 1.8 billion cubic meters (FAO, 2007). FAO reported that in 2012 at a global level 19 million metric tons of pellets were produced.(Retka Schill, 2013) There has been much discussion of the presumed benefits of bioenergy in terms of carbon dioxide emissions. It should be underlined that bioenergy is only a renewable and sustainable form of energy under certain conditions (Perley, 2008).

The carbon efficiency of wood-based combined heat and power systems is generally high in relation to non-renewable energy sources and most other biofuels. Spitzer and Jungmeier (2006) found that heat production from a combined cycle power plant operating on wood chips produced only 60 g CO2 equivalent for each kilowatt of energy produced. A similar plant using natural gas produced about 427 g. "Sufficient supply is not the right question, but how price levels and market trends will affect the mobilization potential of wood from the forest" pointed out one of the keynote speakers, Dr. Lauri Hetemäki from the European Forest Institute (European Forest Intitute, 2013).

The way in which wood is collected is influenced by the tradition and specificity of the activity in Romania. In Neamt, Bacau, Suceava the harvesting power of the firms which have high technology equipment and capital has risen, supporting a long term demand on the wood market. The main indicator that sustains this statement is the price of wood which at the Forest Department in Neamt (Directia Silvica Neamt) in 2012 registered a medium price increase for roundwood of 25%(127,5 lei/mc or 28,3euro/m3) and in the first semester of 2013 a price increase of 17%(149,9 lei/mc or 33,3 euro/m3).

The main increase in prices was obtained for spruce (genus Picea) used mainly in the wood processing and furniture industry due to its qualities. For the second semester of 2013 the demand for wood and in general certain species that are crucial for certain industries generated significant increase not only for the demand of spruce (roundwood prices increased to around 200 lei/mc) but also prices rose up to 600 lei/mc (133euro/m3) for oak (genus Querqus) used in the wood processing industry and a 33% increase in the price of firewood sold to the population for household consumption in October 2013. In the first semester of 2014 the price of spruce

roundwood continued to rise to aproximatly 250lei/mc and in the second semester the tendency is for it to rise to aproximatly 350 lei/mc due to the demand on the external markets.

For the biomass industry the important aspect is the energy produced from the wood and the cost of the raw material, therefore the price increase of the raw material has as a direct consequence the price increase of the biomass. In Romania and in Neamt county energy forestry is not exploited at its potential due to the high demand of wood and the constant increase in raw material prices, fuel prices and electricity.

There are nevertheless increasing debates whether biomass forestry can provide or not an added value to the biomass energy sector. If we look at Germany which has embraced the idea through its policies we can see its effects as debatable even if the company is owned by the state like Hessen-Forest (a forestry company owned by the western German state of Hesse). For some years now, wood has enjoyed a reputation for being an excellent source of energy -- one that is eco-friendly and presumably climate neutral. At the moment, more than half of the lumber felled in Germany makes its way into biomass power plants or wood-pellet heating systems. The decentralized power generation resulted in an increase of prices for wood and the related profit expectations. The prospect of making a quick buck, Martin Kaiser (a forest expert with Greenpeace), says "has led to a downright brutalization of the forestry business." (Spiegel Staff, 2013)

Europe continued to be a net importer of industrial round wood in 2011, with imports of 10 million m3 more than exports. In order of rank, Austria, Germany, Sweden, Finland and Belgium were the major importing countries. Prices for softwood saw logs fell in virtually all major markets worldwide in late 2011 and early 2012, as reported in the Wood Resource Quarterly, both in local currencies as well as in US dollars. This resulted in the third consecutive quarterly decline of the Global Sawlog Price Index (GSPI) to $85.90/m3 in the 1Q/12. The Index was down 3.0% from late 2011, and almost 9% lower than the all-time high in the first quarter of 2011. Before the recent decline, the Index had gone up continuously since early 2009. (FAO 2012)

The decrease in the price of wood in the last few years in Europe can be seen as a side effect of the international financial crisis. As the crisis for energy continues due to lack of solutions that can support the world demand and the constant increase of consumption of energy at a global level the price for bioenergy in this international context is going to constantly increase as seen in the previous example of the Romanian market.

The appropriateness of different bioenergy production systems in economic, environmental and social terms will depend to a large extent on regional strategies, national and local circumstances. In planning a bioenergy strategy, analysis of different options and their broad impacts should be carried out to ensure that policy objectives will be met without damaging ecosystems.

Advantages and disadvantages of using bioenergy

"Using biomass for energy can help in promoting new types of forest management and ensure livelihoods in rural areas by giving new economic alternatives. The new Forest Strategy is an appropriate framework to bring the wood energy discussion", pointed out Ms. Tarja Cronberg, Member of the European Parliament (European Forest Intitute, 2013).

Potential benefits and negative effects of bioenergy development and usage are summarised in the following paragraph (Berndes et al., 2003; Cozmei et al., 2012; Makeschin., 1994; Kishore et al., 2004, Payne, 1980 etc.):

Potential benefits:

- Diversification of forestry and agricultural products;
- Stimulation and long term development of rural economic development and poverty reduction;
- Higher income for biomass producers;
- Development of infrastructure and employment in rural areas;
- Lower greenhouse gas emissions/ carbon sink(CO_2 that is trapped in the biomass until it is used to generate energy) ;
- Increased investment in land rehabilitation;
- New revenues generated from the use of wood and agricultural residues, and from carbon credits;
- Reduction in energy dependence and diversification of domestic energy supply;
- Access to affordable and clean energy for small and medium-sized rural enterprises/ households;
- Alternative energy solutions ;

Potential negative impacts:

- Reduced local food availability if energy crop plantations replace farmland;
- Increased food, wood, and wood products prices for consumers;
- Demand for land for energy plantations may reduce biodiversity;
- Increased number of pollutants;
- Modifications to requirements for vehicles and fuel infrastructures;
- Higher fuel production costs;

- Increased wood removals leading to the degradation of forest ecosystems;
- Displacement of small farmers and concentration of land tenure and incomes;
- Reduced soil quality and fertility from intensive cultivation of bioenergy crops;
- Distortion of subsidies on other sectors and creation of inequities across countries due to different energy policies .

A considerable number of studies have arrived at widely different conclusions concerning the possible contribution of biomass in the future global energy supply (some from below 100 EJ yr−1 to above 400 EJ yr−1 in 2050). The major reason for the differences is that the two most crucial parameters—land availability and yield levels in energy crop production—are very uncertain, and subject to widely different opinions (e.g., the assessed 2050 plantation supply ranges from below 50 EJ yr−1 to almost 240 EJ yr−1). The expectations about future availability of forest wood and of residues from agriculture and forestry vary substantially among these studies underlined Göran Berndes, Monique Hoogwijk and Richard van den Broek (2003).

From the viewpoint of science (forestry, soil, ecology, etc.) general ecological criteria have to be considered in intensive forest land use systems. An entire and holistic view of the ecological consequences of energy forestry is necessary especially with respect to the long term, and to make forest biomass comparable and competitive with fossil fuels.

Research, development and innovation in biomass theology

Nowadays it has become apparent that the key to a successful innovation solution depends on many more factors than just technology and money. Factors such as creativity, entrepreneurship, knowledge development, knowledge sharing, public private research and effective lobbying against resistance to change also play an important role. Successful innovations require the development of strong 'innovation systems'; an innovation system comprises all stakeholders, infrastructure, standards, regulations, working processes that influence the speed and direction of innovation (Lanzi, 2013, Van den Hoveet al., 2012). The challenge of modern innovation management in the context of international turbulence is to effectively support the gradual growth of a strong innovation system in which the innovation will develop. Government support is not just a matter of subsidies. Governments need to provide other types of assistance, facilitation and guidance, removing institutional obstacles etc(Europe Horizon 2020, European Commission 2013) .

According to the European Commission (MEMO/13/274) in Romania high growth is observed for Community trademarks, Community designs and License and patent revenues from abroad. Growth for License and patent revenues was the highest for all Member States. A strong decline is observed for Non-R&D innovation expenditures and SMEs innovating in-house. Growth performance in Intellectual assets is well above average and in Firm investments and Innovators well below average.

While the use of wood for cooking and heating is as old as civilization, the efficiency of this energy source varies according to production systems. Open fires convert only about 5 percent of wood's potential energy. Traditional wood stoves increase this efficiency to about 36 percent, and charcoal-based systems are between 44 and 80 percent efficient, depending on the furnace design and charcoal production method. The modern wood pellet stove delivers about 80 percent efficiency for residential use (Karlsson and Gustavsson, 2003).

"Advanced wood combustion" a high-tech new way of wood burning holds great potential to save energy, cut costs, and even fight global warming. Mason Inman (2009) underlined that in advanced wood combustion power plants, intense heat and carefully controlled conditions ensure that nearly all the carbon in the wood is broken down into flammable gases. Then the gases are ignited, burning much more cleanly than a typical smoky home fireplace. Antti Asikainen, forestry expert at the Finnish Forest Research Institute, says that in the city of Joensuu where the technology has been used "air quality has improved greatly". Jack Byrne, director of the Middlebury College (in Vermont which opened a wood-fired power plant in 2009), Sustainability Integration Office, "[…] it will pay for itself" in about 13 years—"less than half the power plant's lifetime".

Biomass gasification is an area where we see a number of promising technological developments ("breakthrough technology"). Within a decade, as the reserve of natural gas decreases, green gas will become economically attractive; both as a sustainable fuel in industry as well as for domestic use, biofuel for vehicles. Gasification technology helps in realizing the international sustainable energy objectives, and pioneering research that contributes to this is taken up by industry. According to ERA-NET Bioenergy, the gasification of biomass works in a completely different way. Heating up dry biomass, wood for example, to extreme temperatures (up to 850 degrees) without the addition of oxygen, will cause the matter to 'gasify'. This gasification technology has been around for a long time, but from its early days the product gas contained all sorts of contaminants and its calorific value was too low. Modern technology has changed this due to the

development of gas cleaning processes(see table no1).

Innovation in the biomass energy sector has been receiving increasing attention as a means to achieve economic growth while also improving environment and energy use. In recent years, innovation has become an important component of international climate negotiations and strategies. It also provides support for implementing complementary policies that insure that energy consumption will not rise following innovation. The review of different economic studies considers the treatment of innovation in applied climate–economy models used for policy analysis. These models often lack empirical foundation and could be improved as the data analyzed do not come from the Romanian territory. In some cases, this would require an expansion of the empirical literature to consider more sectors or geographical areas. This is not always easy, as many studies, are often limited by data availability. (Berndes et al., 2003; D'Silva, & Appanah, 1993; Lanzi,2013; Inman, 2009; Kaltschmitta et al., 2003; Kishore, et al., 2004,etc.)

The biomass processing industry

Energy crops encompass plants/trees (willow, poplar, paulownia, miscanthus etc) that are purposefully planted to be used as fuel or converted into biofuel. The primary objective of energy crops is to obtain the highest possible amount of energy given the climatic conditions without damaging the environment. Energy crops are attracting increasing attention as they are seen as an indigenous alternative to fossil fuels that can reduce CO2 emissions and the need to import fossil fuels, oil and gas (Tasneem Abbasi& Abbasi 2010; European Forest Intitute, 2013, Perley, 2008).

Forestry is facing and is going to face changes because the demand for paper pulp is decreasing as recycling is increasing and more correspondence is conducted through the internet. The wood processing industry and biomass production in Romania are faced with a battle for the available raw material because the offer of wood on the Romanian market is limited due to the offer of wood and forestry laws. According to Giurgiu(2010), the National Forest Tree Planting Program aims to increase Romania's forest surface by 2 million hectares by 2035 but this is not enough to accommodate the future need of wood on the Romanian market.

The wood processing industry and furniture industry is fighting fiercely against

the renewable energy sector where wood is preferred as raw material. The added value in the wood processing industry is around 1044 euro/tone dry wood and only 118 euro /tone of wood used in the bioenergy sector. The amount of work hours in the wood processing industry if the technology is not old is around 54 hours/tone of dry wood as opposed to only 2 hours in the bioenergy sector. These figures and the subsidies offered in the European Union had a boomerang effect in increasing the use of wood for biofuel and decreasing the cheap available wood (European Commission MEMO/13/274).

Steam-turbine power boilers designed to work primarily with bark can be added to sawmills as an alternative to beehive burners or other equipment to dispose of waste. Heat from power boilers can generate steam, which can be used for electricity generation using turbines or to meet process requirements. Recovery boilers are used in a similar way in pulp and paper mills, to recycle black liquor and recover pulping chemicals, as well as to produce steam to drive the pulping process. The efficiency of a steam-turbine power boiler is generally about 40 percent (Karlsson and Gustavsson, 2003).

Romania has a great potential to produce and use bioenergy generated from wood(see table no 2). Firstly, small to medium sized plants can be established near the existing raw material. Secondly, energy fields can be seen as steady (yearly, at 2-3 years or up to 8-10 years depending on the tree species) income for farmers that can start to plant trees instead of crops. Thirdly, unlike crops which after being plated must be harvested at their due date wood plantations can remain several years without being harvested and grow until the selling price becomes profitable. Fourthly, partnerships can be set up between energy fields' owners and power plants for the future "production of wood" (Tomescuet. al. 2011, European Forest Intitute, 2013; Giurgiu 2010).

Steps in using energy fields have already been set in motion in Romania as more and more owners realise their economic potential despite the bureaucracy setbacks and the legislation that does not include energy fields neither in agriculture nor in the forestry activity. For example in Harghita there is an energy plantation of 12 hectare since 2007 and the willow harvested from it is transformed in coal.

Conclusions

When we talk about innovation, the most innovative countries in the European Union share a number of strengths in their national research and innovation systems with a key role played by the business activity and higher education sector. The business sectors of all innovation leaders perform very well, as measured by Business R&D expenditures and PCT patent applications. The innovation leaders also share a well-developed higher education sector as shown by very high scores in New doctorates graduates, International scientific co-publications and public-private co-publications with the latter also signaling strong

linkages between industry and science.(European Commission, MEMO/13/274)

Most of the times, green energy, comes at an enormous cost and the environment will also pay a price if mankind abuses its resources and expects more then what the land can offer. The effects of energy forestry on former arable soils are influenced positively due to the lack of frequent input of heavy agricultural machinery but also because some tree species can improve land that have been deteriorated by inappropriate agricultural methods applied over the years. Soil solution nitrate can significantly be reduced in soils planted with fast growing trees, as long as nitrogen fertilizers are applied in accord with the nutrient demands of the trees. The ground vegetation may also act as an important nitrogen sink during plantation establishment and after harvesting. (Makeschin 1994).

In the last few years the need for electricity in Romania has constantly increased. Due to the importance of green energy in the context of climate change mitigation it is desirable to use solar, wind or hydro energy. The problem is what source of energy can be used that is ecofriendly when there is no sun, no wind and no water?

The question how an expanding bioenergy industry based on the biomass from the wood sector would interact with other land uses, such as food production, biodiversity, soil and nature conservation, and carbon sequestration has been insufficiently analyzed. Innovation in this context is only desirable to the extent that it improves human well-being and contributes to economic, social and environmental stability. It is therefore difficult to establish to what extent bioenergy is an attractive option for climate change mitigation in the energy sector. A refined modeling of interactions between different uses and bioenergy, food and materials production—i.e., of competition for resources, and of synergies between different uses—would facilitate an improved understanding of the prospects for large-scale bioenergy and of future land-use and biomass management in general

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Table no 1:
Different types of fuels obtainable from biomass

Biomass	Fermentation	Ethanol	
	Esterification	Biodiesel	
	Digestion	Gas separation	Bio-methane
		Fischer-Tropsch process	Gasoline, diesel
	Gasification	Fischer-Tropsch process	Gasoline, diesel
	Extraction	Bio-oil	Gasoline, diesel
	Pyrolysis		
	Hydrothermal liquefaction		
	Catalytic depolymerization		

Source: Biomass energy and the environmental impacts associated with its production and utilization, Tasneem Abbasi, S.A. Abbasi (2010).

Table no 2:
Biomass fuel crops, Advantages and Disadvantages

Species	Advantages	Disadvantages
Willow	• Roots are a mat like mass immediately below the surface of the soil, helping to retain loose topsoil. • Has a leafy canopy so during heavy rainfall saturation of soil is prevented, reducing soil erosion and loss of nutrients. • Few pesticides are needed as levels of pest or pathogen damage can be higher for combustion than that of food production. • Can absorb heavy metals in the soil, from sewage used as fertiliser, and concentrate them in the wood.	• Rabbits are pests and rabbit proof fencing can be costly. • Romanian transportation and infrastructure is not able to match rate of willow chip production, so transport and storage of chips can be costly. • Currently antreprenours/farmers consider willow as a forest tree/marginal crop and subsidies are used to plant on set aside land, which can sometimes be of low quality, resulting in low yields. • A substantial amount of water is needed so a good watering system is required or planting in wetter regions. In Romania, with an advanced irigation system, dryer areas have produced successful crops.
Poplar	• Willow harvesting methods, already established could be relevant for poplar. • Yields of poplar have outperformed willow by up to 66% in some cases.	• Compared to Willow, planning is difficult because good apical buds are needed for effective planting and growth. • Planting machinery has not yet been developed, presently cabbage planters are being used and success is limited.
Miscanthus	• Grown using conventional agricultural methods and harvested yearly. • Harvested and stored using existing farming equipment and methods. • Already widely grown as an ornamental plant. • Less capital costs because of this. • Economical in its use of nutrients • Good internal recycling system.	• Deep root structure makes it difficult to rehabilitate and use the land for other crops. • Experience and information is limited as fewer sites have been planted for energy purposes.

Source: Biomass as a Fuel Source (http://www.esru.strath.ac.uk/EandE/Web_sites/06-07/Biomass/HTML/biomass_fuel.htm#energy), ARGE Miscanthus Romania (http://www.miscanthus.com.ro/),