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ENERGY RECOVERY OF BIOMASS IN THE CONTEXT OF EUROPEAN TARGETS

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Abstract: The challenges caused by climate change are becoming inevitable. The main cause is represented by human activities, which are associated with the overexploitation of ecosystem services and natural resources, to meet the ever–growing demand for human needs. This leads to extensive environmental degradation and the release of greenhouse gases into the atmosphere, leading to a dangerous increase in the global average temperature. The benefits of biofuels compared to traditional fuels aim at greater energy security, lower environmental impact, financial savings and socioeconomic aspects related to the rural sector. The concept of sustainable development embodies the idea of inter–connectivity and balance between economic, social and environmental concerns. Romania relies heavily on biomass for the contribution of energy from renewable sources in this sector, biomass being generally used more in rural areas.

Keywords: renewable energy, biomass, conventional energy use reduction

INTRODUCTION

The European Union is moving towards a sustainable energy system, which promotes a much higher consumption of energy produced from renewable sources and energy efficiency in all the sectors. Political instruments have a key role in achieving the assumed objectives (energy efficiency, increasing energy production from renewable sources, biomass utilization, etc.) and implementing this energy system (*ADR Centru, 2018*).

In order to be able to achieve the SDG 7 aim of ensuring an affordable, clean and secure energy system, the EU is seeking to increase the share of renewable energy in gross final energy consumption to at least 32 % by 2030 (*Eurostat, 2022*). The of renewable energy has grown continuously in the EU, with its share doubling since 2005 when renewables covered only 10.2 % of gross final energy consumption. By 2020, this figure had reached 22.1 %, surpassing the target of 20% set for 2020.

The policy framework 2020–2030 envisages improving biomass policies: maximizing resource efficiency techniques, using biomass in multiple sectors, sustainable land use, sustainable forest management (in line with the objectives of the forestry strategy) and ensuring efficient production of biofuel.

In all European countries, different lignocellulosic biomasses have started to be used for the production of renewable energy. Among these, we can mention: agricultural residues (straw, straw containing manure) or fractions of solid municipal waste available in large quantities, but little of this potential is used at the moment. Not all wastes have a suitable content for their treatment with the help of available techniques for transforming lignocellulosic biomass into renewable energy such as anaerobic digestion, ethanol production or thermal recovery (*European Commission – EUR 21350, 2005*).

Biomass has many forms and sources, being the most abundant source of renewable energy in the world that can easily be used by the majority of the population and can be divided in the following major categories:

- wood and wood waste;
- stems of some non–woody plants (annual or perennial); this includes cellulosic agricultural waste (CAW) such as: cereal straw and stalks from different crops as well as those from the processing of some technical plants (textile plants, tobacco stalks), stalks of spontaneously growing plants;
- fractions from municipal waste such as paper waste,
- lignocellulosic agricultural waste (LAW) represents a resource with high global availability and low price, resulting from the harvesting of cereals and some technical plants (the quantities that can be collected depending on the type of crop: wheat straw: 1.4–2.5 t /ha; corn stalks: 4–6.5 t/ha; sunflower stalks 1.9–5.0 t/ha; rape stalks 1.7–3.5 t/ha) (*Marcu, 2008*).

The estimates of biomass supply potential have been the focus of many studies. Different studies quantify the potential of biomass at global, regional and country level for the short– to long term. Studies take into account such factors as differing land use, water and resource availability estimates, as well as varying levels of population and economic growth to arrive at the biomass supply potential.

Romania has sufficient biomass resources to obtain solid of liquid biofuels at small scale or at an industrial level, the raw material being generally agricultural and forestry residues that are available in all regions and to any category of population.

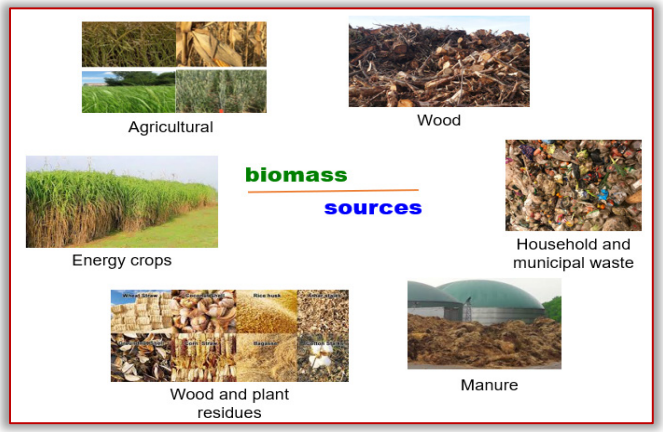

Figure 1 – Main biomass sources available for use to obtain energy

The paper presents the sources and manners of valorizing biomass for obtaining energy, in the context of national and European Union regulations and targets for decreasing the use of conventional energy sources in the following years.

MATERIALS AND METHODS

The most important categories of biomass usable for obtaining and their main uses for obtaining energy are presented below.

— Wood biomass is the most important renewable source of immediately accessible energy in Romania and is used as energy in several ways:

- for the production of heat (including residential buildings) and steam for industrial use;
- for generating electricity;
- as biofuel for transport.

Wood biomass is one of the most used types of biomasses and is divided into four major categories:

- woody residues;
- forest waste;
- urban wood waste;
- biomass resulting from clearing trees.

Forest waste includes waste that can no longer be used, dead trees, trees that do not meet commercial standards, and other trees that cannot be traded and must be cut to clear the forest. Some energy plant species are also part of the woody biomass category, for example fast–growing trees. The harvesting period of such plants varies between 3 and 10 years depending on the tree species, and the period between two plantings can be even more than 20 years (*INMA Bucharest, 2008*).

Forest biomass is the most important renewable energy source immediately accessible in Europe and is used as energy in several ways (Figure 2):

- for the production of heat (including residential buildings) and steam for industrial use;
- for generating electricity;
- as biofuel for transport.

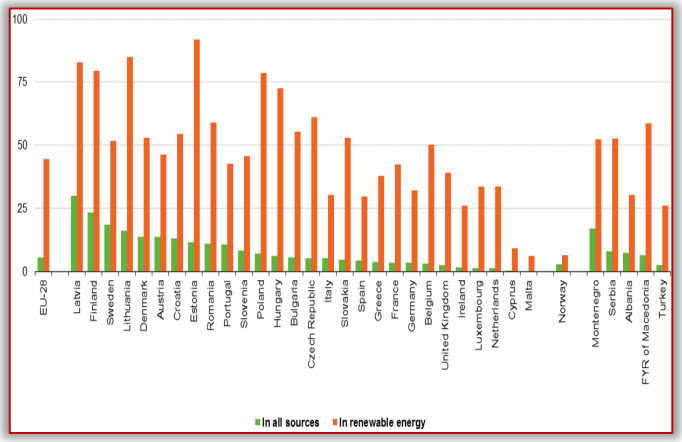

Figure 2 – Wood as a source of energy, 2014 (% share of wood and wood products in gross inland energy consumption, in toe) (*Eurostat, 2016*)

— Agricultural biomass is quantitatively appreciably more than woody biomass. Within it, the types currently most used for energy purposes are: straw; corn stalks and cobs; vine ropes; flax and hemp bushes; agricultural plants; sunflower and soy; biomass from fruits and seeds. Unlike woody biomass, agricultural biomass has an ash content of about 5% (*Vladut et al., 2012*).

Biomass from fruits and seeds. This category includes a number of residual products from agriculture. For example, rice husks are a residue from rice processing (approximately 20% of rice is the husk). This category can also include some solid waste from the food industry, such as the peels or remains of fruits and vegetables, kernels from the production of olive oil, peaches, apricots, etc. In the same way, the residues from the oil production industry, beet and rape constitute biomass that can be used energetically.

— Biomass specially grown for energy purposes includes biomass produced by cultivating plants, used as fuel for electricity generation; such plants are also called "energy plants". In this sense, several species of plants have been developed especially for the production of fuel. Some species of energy plants belong to the category of plant biomass (wheat straw, corn cobs, sunflower, sweet sorghum) and are selected to grow quickly, to be resistant to drought and pests and after harvest to be competitive to be used as fuels (*Vladut et al., 2012*). Energy plants can be grown on agricultural land that is not used for agriculture (usually land that is taken out of the loop for various reasons or land considered unsuitable for growing food plants). Compared to traditional agricultural plants, energy plants require less care and less mineral fertilizers or pesticides.

Energy plants can be divided into:

- annual herbaceous crops (barley, oat, rye, fodder crops, etc.);
- perennial herbaceous crops (reed, Elephant grass, Miscanthus, Cynara etc.);
- oleaginous seed crops (sun flower, soybean, rapeseed, camelina, etc.);
- oleaginous trees (palm tree, coconut tree, manacadamia tree, etc.);
- lignocellulosic annual crops (corn, sorgum, etc.);
- lignocellulosic trees (poplar, willow, eucalyptus, etc.).

— Biomass residues can be divided in primary residues, secondary residues and tertiary residues. Primary residues are produced from plants or forest products. This type of biomass is available "in the field" and must be collected for further use. Secondary residues are produced during the processing of biomass for the production of food products and for the production of finished wood products. They are available in the food industry, paper mills, etc. Tertiary residues result from the use of biomass. Here are included various wastes, (which differ from the point of view of the organic fraction contained) such as: household waste (the resulting amount under Romanian conditions is 0.8–1.5 kg/person/day, and the share of organic matter in urban waste is 40–50%), wood waste, sewage sludge, manure, etc.

RESULTS

Biomass is a renewable energy resource for which, at the national level, there is potential, but the applied technologies are not sufficiently efficient. Biomass is suitable for capitalization both in small–scale applications (individual heating systems) but also in medium/high power applications for the production of energy in cogeneration (electricity and thermal energy), in high energy efficiency systems (*ADR Centru, 2018*).

The energy content of biomass can be used by burning it directly or by chemically converting it into fuels, followed by burning them. Biomass has a very important role in fixing carbon dioxide from the atmosphere, the ambient air with an average concentration of 350 ppm (parts per million) carbon dioxide also representing an important reserve (*Romania's energy strategy 2019–2030, with the perspective of 2050*).

Figure 3 presents an assessment of bioenergy framework worldwide, showing that biomass energy comes from two different sources. The first is represented by primary bioenergy, using farmland or forests to produce biomass and the second is biomass residues that are generated as a by–product of food or wood products throughout their supply–consumption chain.

Even nowadays, approximately 90% of households in rural areas and 15% of those in urban areas are mainly heated with firewood, in inefficient stoves with incomplete combustion, without particle filters. Home heating is usually partial and thermal comfort low. In total, it is about 3.5 million homes, to which are added several tens of thousands of homes in mining areas, heated directly with coal.

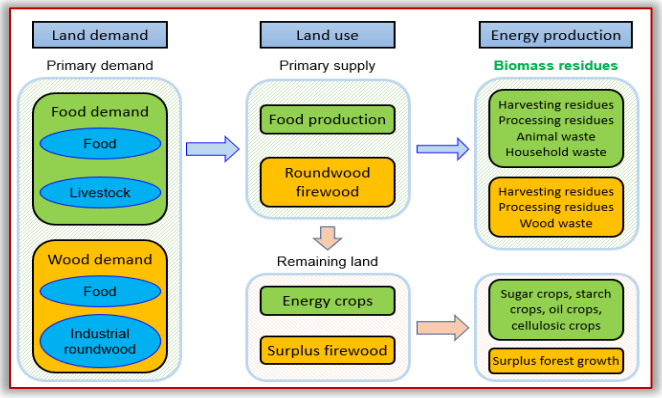

Figure 3 – Supply and demand framework of bioenergy (*INERA, 2014*)

The exploitation of energy sources from domestic resources is on a downward trend, and the dependence on imports is increasing, and despite a continuous reduction of the population, the final energy consumption is increasing. In Romania, approximately one third of energy consumption is related to the residential sector, followed by industry, transport, agriculture and other services (*European Commission, 2020*)

The demand for firewood will enter a downward slope also as an effect of the thermal insulation of rural homes. An increasing number of households, especially new homes, will adopt efficient biomass–based heating installations with complete combustion and no polluting emissions. This transition to more efficient and greener forms of heating with biomass will be increasingly felt in the coming years and will continue beyond 2030 (*European Commission, 2019*).

It is expected that in 2030 there will be in operation power plants that will be powered exclusively by biomass, bioliquids, or waste with a total capacity of 139 MW. The total production of electricity obtained through the utilization of biomass is estimated in 2030 at around 2 TWh (*Senocak and Goren, 2022*).

Final energy consumption from biomass and waste can register a notable increase, from 45 TWh in 2030 to 53 TWh in 2050. The total energy production based on biomass and waste shows, in all scenarios, a consistent increase in the analyzed period, 2030–2050. The tendency to accelerate biomass–based production after 2030, through the development of modern and efficient technologies on a large scale, especially in rural areas, is notable (*European Court of Auditors, 2017*).

By 2030, the consumption of biofuels will increase to the value of 4.1 TWh/year, a value sufficient to reach the national target for 2020, of a 10% SRE share in the transport sector. Biogas will register rapid growth, up to a

production of 3,500 GWh in 2030, against the background of the development of the agricultural sector and, to a lesser extent, the modernization of wastewater treatment plants.

For Romania, an increase in the use of renewable sources requires investments of at least EUR 22 billion by 2030 (*Ministry of Economy, Energy and Environment, 2020*) but, to have a just transition, a necessary budget of around EUR 0.7 billion is expected (*Energy policy group, 2020*). To reach a carbon neutral energy system by 2050, additional investments will be needed.

CONCLUSIONS

In the context of climate changes and the need to switch from conventional to renewable energy, biomass has a favourable future. By 2030, biomass could account for 60% of total final renewable energy use and biomass has potential in all sectors. Following the analysis of the potential of solid agricultural and forestry biomass, it was possible to draw the conclusion that Romania has enough biomass to obtain solid biofuels at an industrial level, the raw material being generally agricultural and forestry residues. The biomass potential in Romania is estimated at over 15 million tons of dry biomass, equivalent to 6 million tons of oil, of which agricultural waste is in first place (approx. 63%). Their exploitation and rational use in energy production provides the necessary prerequisites to cover a significant part of the energy needs for domestic and industrial needs, especially in rural areas.

Acknowledgement

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