CONSIDERATIONS REGARDING THE NATIONAL AND EUROPEAN CONTEXT FOR THE USE OF BIOMASS AS A RENEWABLE ENERGY SOURCE

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Abstract: *At European level, Directive 2018/2001 / EU on energy from renewable sources is the legal framework for its development in all sectors of the EU economy. Among the other sources, biomass for energy (bioenergy) continues to occupy a leading place in the EU, with a share of almost 60%. Biomass energy can be used for heating, electricity and transport fuels, contributing to economic growth, job creation and reducing greenhouse gas emissions. Biomass production takes place from the growth of raw materials to the final conversion of energy, but ultimately renewable energy in biomass must meet the sustainability criteria. At present, sustainability criteria are regulated for agricultural biomass that does not have to come from forests with high forest biodiversity. The process of producing pellets consists of subjecting the very fine dry biomass to high pressures and temperatures, and the compression is done through a hole of a few millimeters where small cylinders are produced which are cut to the desired length and then cooled. The pellets have a cylindrical shape, with a diameter between 6-10 mm and 10-30 mm in length, are easy to handle, represent a dense fuel in energy (650 kg / m3 bulk density), and the use of local resources in the production of pellets makes a concrete contribution to environmental change.*

Keywords: *biomass, pellets, energy, sustainability*

Introduction in the current national and European context of renewable energy. The particular case of biomass production

The use of pellets as a biofuel has increased significantly in Europe, America and also Asia, such as Korea, China and Japan. The increased demand for pellets as a global fuel has been due to environmental problems to reduce pollution resulting from the burning of fossil fuels, but, due to the increased demand for pellets for heating, the traditional raw material, sawdust, is also beginning to decline.

Therefore, attention began to turn to the use of a variety of agricultural products and waste as a raw material for the production of pellets. Such raw materials include cultivated energy crops (e.g. short rotation forest, reed grass, hemp), agricultural waste and by-products (straw, grain projections, rapeseed meal, rapeseed cake, distillery waste) (AMIRTA R. ET AL., 2010). Energy grasses and straw are a raw material with a higher energy density than wood chips or bales and reduce the costs of handling, transport and storage throughout the supply chain (WHITTAKER C., SHIELD I., 2017), also, for the process of obtaining pellets, residues from the forestry and agricultural industries can be used successfully, being an alternative in obtaining products with added value to energy generation (BRAND M. A. ET. AL., 2018). Biomass can be transformed into pellets or briquettes which are compact shapes that reduce the volume, facilitating storage and transport. Compared to other raw materials, biomass has a calorific value of up to 19.5 MJ kg − 1 and low moisture content (LISOWSKI A. ET. AL., 2020). Biomass raw materials are a significant source of renewable energy, especially in countries that obtain biomass from various sources. As the global pellet market has developed rapidly, the use of wood residues has become insufficient to meet market requirements (MOSTAFA M. E. ET. AL., 2019).

Analysis of the technical characteristics of biomass transformed into pellets Biomass has a diverse nature and this explains the uncertainty about how biomass particles combine to form densified pellets, and one way to explain biomass diversity is to describe biomass in general. Biomass contains cellulose, hemicellulose and lignin, with various structural characteristics that are related to functional groups, these primary components, due to their polymeric nature, have carbon molecular structures and functional groups attached to carbon chains that are affected by pellet processing conditions , such as temperature and compressive strength; for example, elevated temperature produces chemical changes that are significant for the properties of the pellets (ANUKAM A. I. ET. AL., 2020). The increase in pellet consumption has led to greater diversity when it comes to the use of raw materials for the manufacture of pellets. As a result, the industry has begun to look for products such as forestry, agricultural waste or a combination of these, and a wide range of these products is now available.

Thus, in 2011, the implementation of the EN 14961 standard regulated the market for densified products, making possible the development of manufacturing technology and encouraging the international trade of these products. Recently, the EN ISO 17225 standard replaced the previous specifications and introduced new classifications, such as wood pellets for industrial applications, whose requirements were lower than those corresponding to residential and tertiary use (MIRANDA T. ET. AL., 2015).

Growing industrial demand for wood pellets for bioenergy and the issue of sustainability has encouraged many to start producing non-wood biomass fuel pellets, and the production and use of pellets for use as fuel from various raw materials, have opened therefore, opportunities and challenges for existing technologies (PRADHAN P. ET. AL., 2018). The production of pellets obtained from biomass has always been caused by several factors, including the lack of understanding of the mechanism involved in how the particles combine to form pellets under standard conditions of the pellet press (ANUKAM A. ET. AL., 2021). This type of fuel, unlike raw biomass, has stable and fixed parameters, which makes the pellets easy to use and also very convenient for the end user. Given the rapid development of the European market for pellets, there is, however, a lack of used wood raw material (STOLARSKI M. ET. AL., 2011).

Pellets have become a popular form of biomass for electricity generation and residential heating due to easier transport and handling, as well as for feeders in treatment units, but also a possibility of improved conversion and storage (ERLICH C. ET. AL. , 2006). Biomass pelletization for bioenergy purposes is an important step towards reducing greenhouse gas emissions (HOLM JK ET. AL., 2007), being a key opportunity in promising scenarios of energy transition as a renewable energy source, but the long distance between place of production and end-user locations, pellets may face fluctuating storage conditions, leading to their physical and chemical degradation (GILVARI H. ET. AL., 2020). Raw (or white) biomass pellets are a source of bioenergy in power plants for heat production, but roasted (or black) pellets have a promising future (GARCÍA R. ET. AL., 2019).

The good physical quality of the pellet in terms of surface hardness and smoothness, but also the low percentage of ash and chlorine, led to an increase in fuel density from 198 kg / m3 to 716 kg / m3, facilitating transport and storage (GONZÁLEZ -BARRAGÁN I. ET AL., 2007). Pelletizing technology is gaining in importance because it is an alternative for optimizing energy recovery from solid biomass. The widespread implementation of wood pellets as a biofuel represents a potential in the production of thermal and electrical energy (GARCÍA-MAROTO I. ET. AL., 2014), and the production and trade of wood pellets has increased in the last few years, being a good substitute for coal and other fossil fuels (PIRRAGLIA A. ET. AL., 2013). Coupling roasting with pelletizing can help improve biomass processing and performance, proving that pelletized roasted biomass is less prone to moisture absorption, combining roasting with pelletizing can solve the shortcomings of transport, handling and storage (GAITÁN-ALVAREZ J. ET. AL., 2017). The roasting process is carried out by a heat treatment in an inert atmosphere and at a temperature of 200–300 ° C. The roasted product has 90% of its initial energy content and loses 30% of its initial mass, partially reducing volatile matter and biomass moisture (KIZUKA R. ET. AL., 2019). Torefaction is a strategy that can improve the grinding capacity and uniformity of wood-based pellets. The particles in the ground roasted pellets are more uniform in size and shape, making them easier to handle and store (WANG L. ET. AL., 2020). Wood pellets are widely used as a heat source by individual customers because they have a high calorific value and release a small amount of ash, but in order to protect the environment, it is necessary to reduce deforestation (GREINERT A. ET. AL., 2020).

Pellet production is a process that takes place in several stages, in which the processing phases of the supply and energy input depend on the characteristics of the biomass (PANTALEO A. ET. AL., 2020). Increased use of biomass for new products, new applications and energy purposes is needed for a successful transition to a sustainable bioeconomy. The traditional pelletizing process is performed in several pre-treatment stagess: drying, grinding and conditioning, but also post-treatment stages: cooling and storage (FRODESON S. ET. AL., 2019). The production of pellets is carried out by subjecting very fine dry biomass to high pressures and temperatures, then compressing it through a hole of a few millimeters and obtaining small cylinders that are cut to the desired length and cooled. The global production of pellets, obtained annualy, was estimated at about 6-8 million tons, with a net potential of up to about 13 million tons, and since 2020 the demand for pellets has increased to about 50 million tons annually, industrial pellet consumption will increase steadily at a rate of 21% per year and household consumption will increase by 8.5% per year (CIVITARESE V. ET. AL ., 2019).

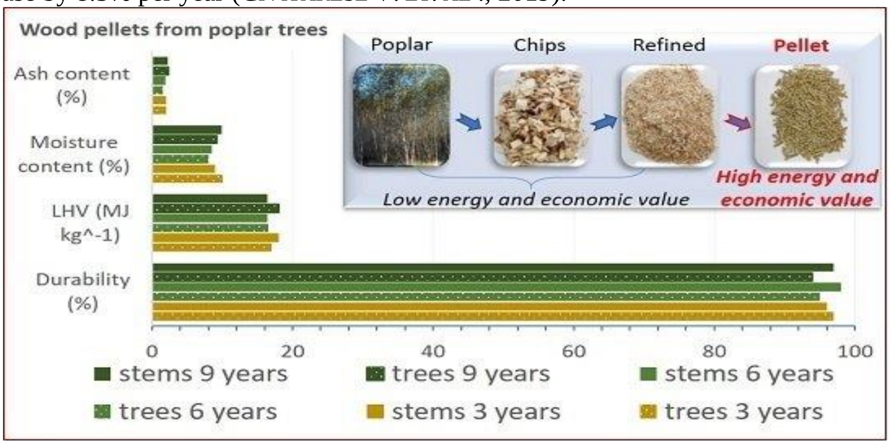

Fig. 1. Wood pellets obtained from energetic poplar trees
(CIVITARESE V. ET. ALL., 2019).

Pelletizing is a method of increasing the bulk density of biomass by mechanical pressure (compression) and heat. The pellets have a cylindrical shape, with a diameter between 6-10 mm and 10-30 mm in length, are easy to handle, represent a dense fuel in energy (650 kg / m3 bulk density), and the use of local resources in the production of pellets makes a concrete contribution to environmental change (NOLAN A. ET. AL., 2010). Pelleting and briquetting are compaction processes that are carried out at high pressure by forming solid bridges due to the mechanical interlocking of particles and the modification of the chemical components of protein, starch and lignin in biomass (TUMULURU J. S., 2014). Biomass pretreatment improves the breakdown and accessibility of crosslinking lignin, which acts as a binding agent (IROBA K. L. ET. AL. 2014).

The quality of the pellet can be affected by the properties of the raw material used: particle size distribution, moisture content, chemical composition, by the operating conditions: mold temperature, pressure applied and holding time (PICCHIO R. ET. AL., 2020). The size of the mold influences the compression and extrusion pressure, and the rotational speed of the mold controls how long the material stays in the mold, and the moisture content plays an important role in the interaction with the biomass composition components due to the high temperature and pressure encountered in the mold (TUMULURU J. S. ET. AL., 2016).

In order to obtain high quality pellets, the moisture content must be controlled, being a primary attribute of quality of pelletized biomass materials (MCKEOWN MS ET. AL., 2017), thus, due to its quality standards and energy density pellets are classified according to their chemical and physical composition (FERREIRA MEC ET. AL., 2012). In the pelletizing process many improvements have been made for the efficient production of high quality pellets from individual biomass assortments, for example: development of production technology, optimization of process settings, development of pre-processing methods and handling of raw materials, etc. (LARSSON SH ET AL., 2021). The binding mechanism of the primary components in the densified biomass pellets is a complex event to understand, and the knowledge is insufficient about the relationship between the binding mechanisms and the biomass characteristics.

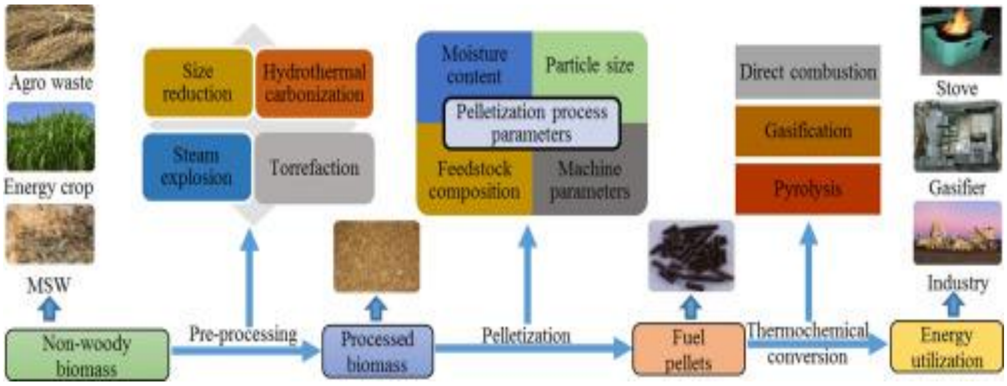

Fig. 2. Scheme for obtaining biomass pellets produced by grass species (adapted from PRADHAN P. ET. AL., 2018)

CONCLUSIONS

The use of biomass as a renewable fuel has grown rapidly over the last decade, but due to the challenges related to biomass supply, its heterogeneity and the inherent physicochemical properties of biomass, such as low bulk density, and high moisture content, it has not led to an increase in biomass implementation as anticipated (Cutz L. et. al., 2021). Following studies, it has been shown that due to the high moisture content, the mechanical durability of pellets can be reduced, and after exceeding a certain limit value of the moisture content, the mechanical durability decreases sharply.

However, the mechanical durability and the optimum moisture content of the raw material depend on the type of biomass, and on the other hand, if the pellets are too dry, the mechanical durability decreases, therefore, natural additives are used to improve the mechanical durability (DYJAKON AND NOSZCZYK, 2019).

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