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BIOREFINERY ROLE IN THE BIOENERGY PRODUCTION

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Problem of the investigation. In recent years we have seen the first steps into the transition towards a Bio-based Economy. Multiple drivers, some policy and geographically dependent, are steering an economy where material wastes are minimized, new bioproducts are replacing their fossil counterparts, Green House Gas (GHG) emissions are reduced; while economic perspectives are developed supported by innovative policies. The recent extreme volatilities in prices (fossil oil, biomass raw materials) and strongly fluctuating demand ask for robust systems to be competitive in the long run. An economy based on innovative and cost-efficient use of biomass for the production of food, feed, bioenergy and bio-based products should be driven by well-developed integrated bio refining systems.

Analysis of the latest publications. There are a lot of publications devoted to the investigation of the bio-economy and its sectors. It is important to concentrate attention to the works of Kean Birch, David Tyfield [1], Robert Carlson [2], Jonna Goven and Vincenzo Pavone [3]. These researchers investigate different issues of the modern bio-economy. As to Ukrainian publications, there are a lot of works devoted to the bioenergy (Geletukha G., Zheleznaya T., Kucheruk P., Olejnik E. [4], Andrejchuk I., Metoshop I., Aleksin O. [5]). As to biorefinery investigating, there is a lack of Ukrainian works devoted to such problem.

Emphasizing the unsettled problem. The lack of the investigations devoted to the biorefinery concept and its role in the bioenergy production causes the necessity of such work.

Research goal. The main aim of the investigation is to analyze the biorefinery concept and to define its role in the bioenergy production.

Main results. The International Energy Agency (IEA) was established in November 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement an international energy program. It carries out a comprehensive program of energy cooperation among OECD member countries. Its aims include promoting: systems for coping with oil supply disruptions, rational energy policies, an oil market information system, improved energy supply and demand structures, and integrated environmental and energy policies.

IEA Bioenergy was set up in 1978 by the International Energy Agency (IEA) with the aim of improving cooperation and information exchange between countries implementing programs for bioenergy research, development and deployment. Presently there are 13 Tasks operating under the IEA Bioenergy umbrella covering all major aspects of the bioenergy field. The relevance of biorefinery in a successful bioenergy research policy has been acknowledged by the establishment of a specific IEA Bioenergy Task 42 on biorefineries, co-producing transportation fuels, power, heat, added-value chemicals and materials from biomass.

The major objective of this Task is to assess the worldwide position and potential of the biorefinery concept, and to gather new insights that will indicate the possibilities for new competitive, sustainable, safe and eco-efficient processing routes for the simultaneous manufacture of transportation fuels, added value chemicals, new materials and heat and power from biomass. This Task covers an exciting field which can have a large impact both in environmental and technological innovation policies and practices. To open up the biorefinery related potential, system and technology development is required. RD&D programs can link industry, research institutes, universities, governmental bodies and NGOs, while market introduction strategies need to be developed.

The aim of IEA Bioenergy Task 42 is to initiate and actively promote information exchange on all features of biorefinery. Information exchange and cross fertilization will cover all aspects of biomass feedstock, conversion and fractionation technologies, integration of processes and use of side-streams, products, energy efficiency; economic, socioeconomic and environmental performance as well as other potential sustainability impacts (such as consequences on food production, water use and quality, changes in land-use, access to resources, biodiversity, and the net balance of greenhouse gases). This exchange of information should reduce fragmentation in this multidisciplinary and multistakeholder field. It will also result in cross-thematic synergies, among the IEA Bioenergy tasks, defining research priority needs and infrastructure.

The members of IEA Bioenergy Task 42 have agreed on the following definition for biorefinery: "Biorefinery is the sustainable processing of biomass into a spectrum of marketable products (food, feed, materials, and chemicals) and energy (fuels, power, heat)». This means that biorefinery can be a concept, a facility, a process, a plant, or even a cluster of facilities. This brochure gives an overview of the different types of biorefineries. The brochure will illustrate at which scale (commercial, demonstration or pilot) these biorefineries are currently operational. The port of Rotterdam, in the Netherlands, is included as an example of a cluster of facilities which together can be considered as a biorefinery.

A biorefinery should sustainably produce a spectrum of marketable products and energy. The products can be intermediates or final products, such as food, feed, materials, and chemicals; whereas energy includes fuels, power and heat.

The main focus of biorefinery systems which will come into operation within the next years is on the production of transportation biofuels (i.e. biofuel driven biorefineries). Selection of new biofuels is based on the possibility that they can be mixed with gasoline, diesel or natural gas, and using the already existing infrastructure in the transportation sector. IEA Bioenergy Task 42 has defined that both multiple energetic and non-energetic output need to be generated for a facility to be considered as a biorefinery. The volume and prices of present and forecasted products should be market competitive (Fig. 1).

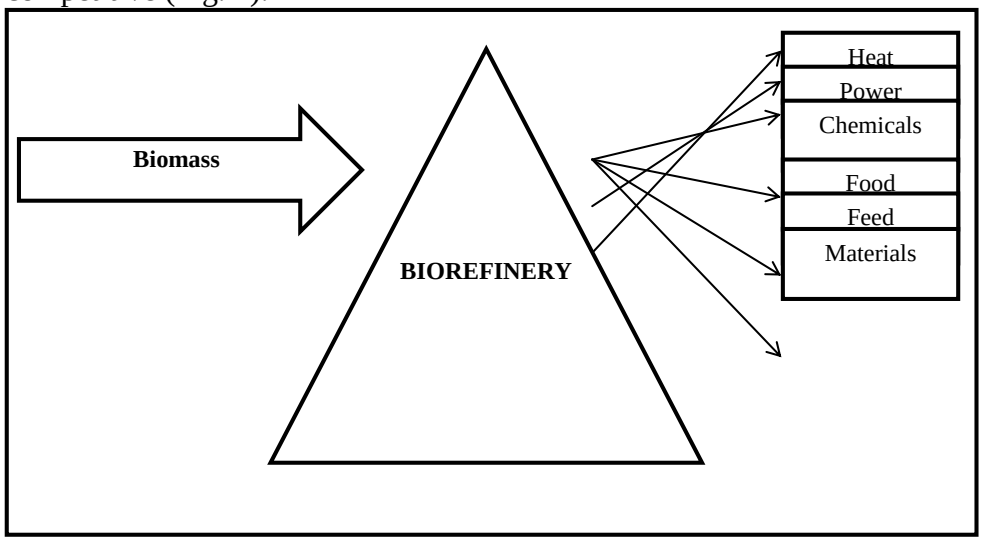

Fig. 1. – The role of Biorefinery in the transformation of biomass [6, p. 3]

In most countries the use of biomass for the production of biofuels, and to a lesser extend energy, is still more costly than the use of traditional petrochemical resources. By integrating conversion processes and equipment to co-produce multiple products (i.e. fuels, chemicals, (CH) Power, and materials) from biomass, by a so-called "biorefinery approach», advantage can be made of differences in biomass components and intermediates, maximizing the total value derived from the biomass feedstock. A general overview of the Biorefinery concept is shown in Fig. 2.

Currently four complex biorefinery systems are forced in research and development.

"Lignocellulosic Feedstock Biorefinery», using "nature-dry» raw material such as cellulose-containing biomass and wastes.

"Whole Crop Biorefinery», using raw materials, such as cereals or maize.

"Green Biorefineries», using "nature-wet» biomasses, such as: green grass, alfalfa, clover, or immature cereals.

"Two Platform Concept Biorefinery», including the sugar and the syngas platforms [8].

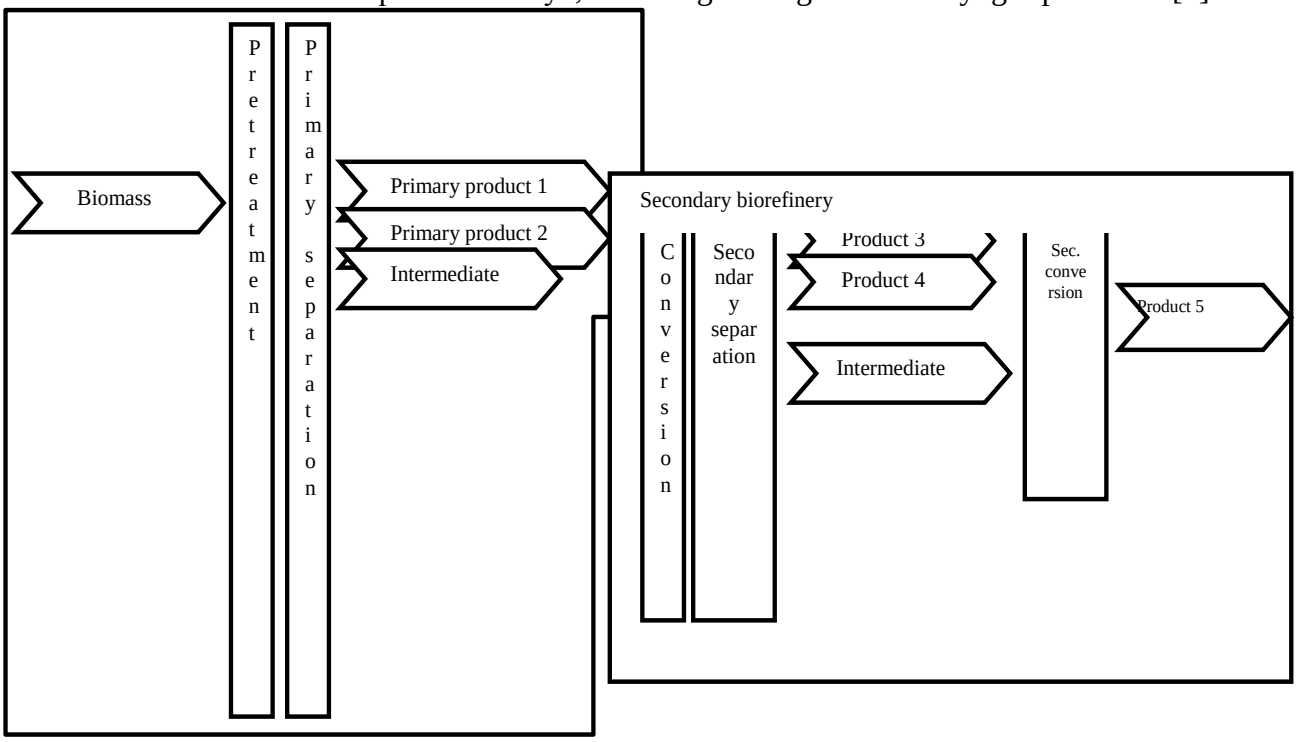

Fig. 2. – Schematic overview of a general Biorefinery concept [7, p. 3]

From the perspective of the industry striving for sustainability with sound economic foundations, this draws the attention to three key areas.

Production: The actual production process has a major environmental impact both on efficient use of energy and resources and on emission and waste production; this is especially so in bulk industries.

Integration: Implementing a strategy for sustainability requires coordination between different levels of a supply chain, product portfolio and fine-tuning between distributed technological capabilities. Key technologies in conversion, extraction, and separation will lay the foundation for further improvement in bulk production and the development of products with well-defined functionalities.

Use and re-use: In terms of specific functionality, life-cycle and recycling or safety, the actual performance of end-products importantly defines the contours of a market oriented strategy for sustainable resource use [9].

Conclusions. A biorefinery is characterized by an explicitly integrative, multifunctional overall concept that uses biomass as a diverse source of raw materials for the sustainable generation

of a spectrum of different intermediates and products (chemicals, materials, bioenergy/biofuels), allowing the fullest possible use of all raw material components. The co-products can also be food and/or feed. These objectives necessitate the integration of a range of different methods and technologies.

The importance of biorefinery in a successful bioenergy research policy has been acknowledged by the establishment of a specific Bioenergy Task 42 on biorefineries, co-producing transportation fuels, power, heat, added-value chemicals and materials from biomass.

Bioenergy Task 42 has defined that both multiple energetic and non-energetic output need to be generated for a facility to be considered as a biorefinery. The volume and prices of present and forecasted products should be market competitive.

It is defined these biorefinery systems:

"Lignocelluloses' Feedstock Biorefinery», using "nature-dry» raw material such as cellulose-containing biomass and wastes;

"Whole Crop Biorefinery», using raw materials, such as cereals or maize;

"Green Biorefineries», using "nature-wet» biomasses, such as: green grass, alfalfa, clover, or immature cereals;

"Two Platform Concept Biorefinery», including the sugar and the syngas platforms.

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