บรรณาธิการปริทัศน์/Editorial Corner

เศรษฐกิจชีวภาพ เศรษฐกิจหมุนเวียน และเศรษฐกิจสีเขียว และกระบวนการกลั่นชีวมวลลิกโนเซลลูโลส: การพัฒนาที่ยั่งยืนและการลดภาวะภูมิอากาศแปรปรวน

Bio-Circular-Green Economic Model BCG and Lignocellulose Biorefinery: Advancing Sustainable Development and Climate Change Mitigation

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ศูนย์วิจัยอุตสาหกรรมเคมีชีวภาพและวิศวกรรมกระบวนการแบบอัตโนมัติ ภาควิชาวิศวกรรมเคมีและกระบวนการ บัณฑิตวิทยาลัยวิศวกรรมศาสตร์นานาชาติสิรินธรไทย-เยอรมัน มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ

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Global warming is a crucial environmental challenge that has wide-ranging impacts on human health, economics and environment. Global warming is mainly caused by the release of greenhouse gases (GHGs), such as methane (CH_4), nitrous oxide (N_2O), ozone (O_3), fluorinated gas, and carbon dioxide (CO_2) in the atmosphere. It comes from burning fossil fuels, deforestation, and industrial processes. These greenhouse gases will trap heat in the atmosphere, as a result, the world's temperature is increased. This increase in temperature affects the weather and alters the ecosystem, such as drought, uplifting of sea level and ozone hole [1].

To mitigate global warming occurrence, the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP), e.g. Paris Agreement, requested actions from governmental and industrial sectors worldwide to move forward to renewable energy, which facilitates zero carbon discharge [2]. Lignocellulosic biomass, derived from agricultural waste, food waste and energy crops, etc., represents a potential and abundant resource for renewable energy. It contains cellulose, hemicellulose and lignin, which can be processed into a wide range of valuable products. Due to present practice, agricultural residues are discarded by combustion on fields that causes uncontrolled releases of GHG and particulate matter (e.g. PM2.5). PM2.5 can overspread long distances, affecting both local and regional air quality.

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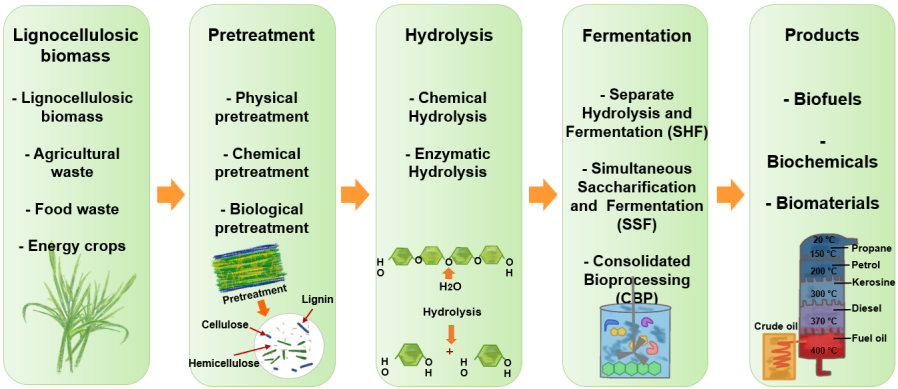

Figure 1 Schematic of lignocellulose biorefinery.

The utilization of lignocellulosic biomass within the framework of the Bio-Circular-Green Economic Model (BCG) holds great promise for achieving Sustainable Development Goals (SDG). Lignocellulosic biomass serves as a valuable source for the production of sustainable products and materials, such as bio-based chemicals, bioplastics, and biomaterials [3]. These bio-based products have the potential to reduce carbon footprints and decrease reliance on non-renewable resources. During the growth phase, plants absorb CO_2 from the atmosphere, storing carbon within their biomass. When utilized in biorefinery processes, carbon is retained in bio-based products, effectively sequestering CO_2 and reducing emissions. This carbon cycle supports the BCG economy's goal of reducing greenhouse gas emissions.

Biorefinery processes transform lignocellulosic biomass into various products. The conversion process typically involves multiple steps, including pretreatment, hydrolysis, catalytic conversion/ fermentation and product recovery (Figure 1) [4]. Pretreatment helps to alter the structure of biomass to increase access to enzymes and microorganisms used in the bioprocessing process.Hydrolysis is an enzymatic degradation process that converts cellulose, hemicellulose, and lignin to monomeric sugars and lignin monomers. The fermentation process is a metabolic pathway in which microorganisms, such as bacteria, yeast, or fungi, convert sugar from lignocellulose hydrolysate into various end products. Downstream processing plays a crucial role in separating, purifying, and recovering the desired products, such as bioethanol, biobutanol, biogas, bio-based chemicals, and other value-added products from the fermentation broth [5].

Biorefinery processes are important in helping to achieve several SDGs [6]. For example, SDG 7 (Affordable and Clean Energy) aims to ensure access to affordable, reliable, sustainable, and modern energy for everyone. Biorefinery processes make a notable contribution towards SDG 7 by providing a renewable and clean energy source (such as ethanol, biodiesel, and biogas), especially in amidst of rising trend of fossil fuel prices caused by the war between Russia and Ukraine.

SDG 9 (Industry, Innovation, and Infrastructure) emphasizes the promotion of inclusive and

sustainable industrialization, fostering innovation, and upgrading infrastructure. The biorefinery contributes to technological advancement and innovation in the production of high value products from lignocellulosic biomass and reduction of waste. SDG 12 (Responsible Consumption and Production) targets on ensuring sustainable consumption and production patterns. Biorefinery promotes resource potency and circular economy principles by converting biomass wastes and by-products to value-added products. SDG 15 (Life on Land) focuses on the protection, restoration, and sustainable use of terrestrial ecosystems. By utilizing sustainable biomass feedstocks such as marine microalgal feedstock, biorefineries promote responsible land management practices. Furthermore, the integration of bioenergy production with sustainable agriculture and forestry practices can contribute to ecosystem conservation and biodiversity preservation [7].

Altogether, lignocellulose biorefinery is one of a solution, on one hand, to resolve the global warming situation and, on the other hand, to promote economic growth. However, this process is still in the early stage of development and only several numbers of industrial-scale processes are in action. Several aspects are needed for development and support, including the mutifeedstock process to avoid insecurity in supplies, logistic cost and route for bulky biomass, government law and regulation to support the rural biorefinery facilities nearby agricultural fields.

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