Net Negative Carbon Goal&Sustainability: Role of Green H_2 in Decarbonization, Biomass Valorization & Waste Plastic Recycling

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Achieving the net-zero goal by 2050 is a cherished ambition of all world economies and the projected global energy demand of 49,000 TWh will see 73% of its contribution from renewable sources, with hydrogen accounting for 25% of this share. Hydrogen is uniquely suited to converting biomass and CO_2 emitted from various sources into fuels and chemicals. It also paves the way toward a carbon-negative scenario when used as an energy source in conjunction with other renewable non-carbon sources such as solar, wind, tidal, geothermal, and nuclear. The hydrogenation of biomass yields a variety of valuable products. Consequently, the refineries of tomorrow will essentially become “carbon dioxide refineries,” converting CO_2 into hydrocarbons, methanol, dimethyl ether (DME), formic acid, alcohols, syngas, electricity, fuel cells, ammonia, fertilizers, and other chemicals using hydrogen produced via water splitting. DME is an ideal replacement for diesel and LPG, allowing for the use of existing infrastructure. This approach can drive a carbon-negative economy, potentially reducing global temperatures below 1.5°C.Today’s crude oil-based economy for the production of fuels, chemicals, and materials is unsustainable in the long term. With the dual challenges of sustaining socioeconomic development and reducing the environmental footprint of chemicals and fuel manufacturing, emphasis must shift toward converting biomass into low-value, high-volume biofuels or refining it into a diverse range of products. Using carbon for fuel is a flawed strategy and unlikely to meet any nation’s socioeconomic or environmental objectives. In controlling CO_2 emissions, hydrogen will play a crucial role. It is the most effective means for converting waste biomass and CO_2 from both fossil and biomass sources into fuels and chemicals. Hydrogen, as an energy source, contributes to a carbon-negative scenario alongside other renewable non-carbon sources.This new paradigm for fuel and chemical production not only maximizes the monetization potential of biomass and shale gas but also allows for reduced output and improved atom and energy efficiencies in oil refineries. Additionally, there is an urgent need to reconsider the ban on single-use plastics (SUPs) and to develop a policy that incentivizes the public to pay a deposit on every single-use item, irrespective of size, with a refund upon return, enabling source segregation. Several hydrogenation reactions can be applied to depolymerize waste plastics or convert them into fuels, while undesirable elements such as Cl, S, and N in plastics can be converted into HCl, H_2S, and NH_3 for safe absorption. Waste plastic represents a significant source of fuel and chemicals.