Joule, Future Energy

Advanced Biofuels of the Future: Atom−economical or energy−economical?

Electronic Supplementary Information

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High level analysis and optimistic conversions are considered in the main text for the sake of simplicity and presentation. However, Table S.1 and Figure S.1 are prepared to show that exactly same conclusions can be obtained if comparisons were based on detailed technoeconomic analysis reported in literature. Table S.1 provides product and carbon yields and Figure S.1 presents the carbon and energy flows for four different strategies: **(A)** biological conversion to ethanol (NREL 2011 report) [2], **(B)** catalytic conversion through GVL fractionation to hydrocarbons [3], **(C)** dilute acid and enzymatic deconstruction and catalytic conversion to hydrocarbons (NREL 2015 report) [4], and **(D)** biological conversion to ethanol [2], dehydration to ethylene [5], and catalytic conversion to hydrocarbons [6]. Figure S.1 is prepared considering that all four strategies provide their utility and power demand to run the biorefinery from burning solid residues and onsite electricity generation. The results show that strategies B, C, and D, which produce diesel are less atom−economical and require more energy during conversion at biorefinery (by producing less excess electricity) than strategy A which produces ethanol. However, overall, higher energy−economy is attainable in strategies B, C, and D compared to the strategy A because of impact of higher engine efficiency at consumption point.

Table S.1. Summary of product and byproduct yields, utility, and power consumption averaged for one Mg dry corn stover.

Strategy	Product yield	Carbon yield fuel/biomass	Electricity to Grid	Power used by process	Heat used by process	Cooling demand	Ref.
A	258 kg ethanol	30.2%	168 kWh	330 kWh	2.83 GJ	4.92 GJ	[7]
B	121 kg (30% C_8H_{18}, 26% $C_{12}H_{24}$, 25% $C_{16}H_{24}$, 19% $C_{20}H_{40}$)	23.1%	60 kWh	12 kWh	4.05 GJ	6.03 GJ	[3]
C	128 kg (20% Vol C_4–C_9, 80% Vol C_{10}–C_{30}+)	27.7%	19 kWh	335 kWh	a	a	[4]
D	155 kg (5% C_2–C_4, 26% C_5–C_8, 61% C_9–C_{16}, 8% C_{18+})	29.5%	91 kWh	368 kWh	3.22 GJ	a	[2], [5], [6]

a. Values are not reported but incorporated in the power generation and consumption of each strategy.

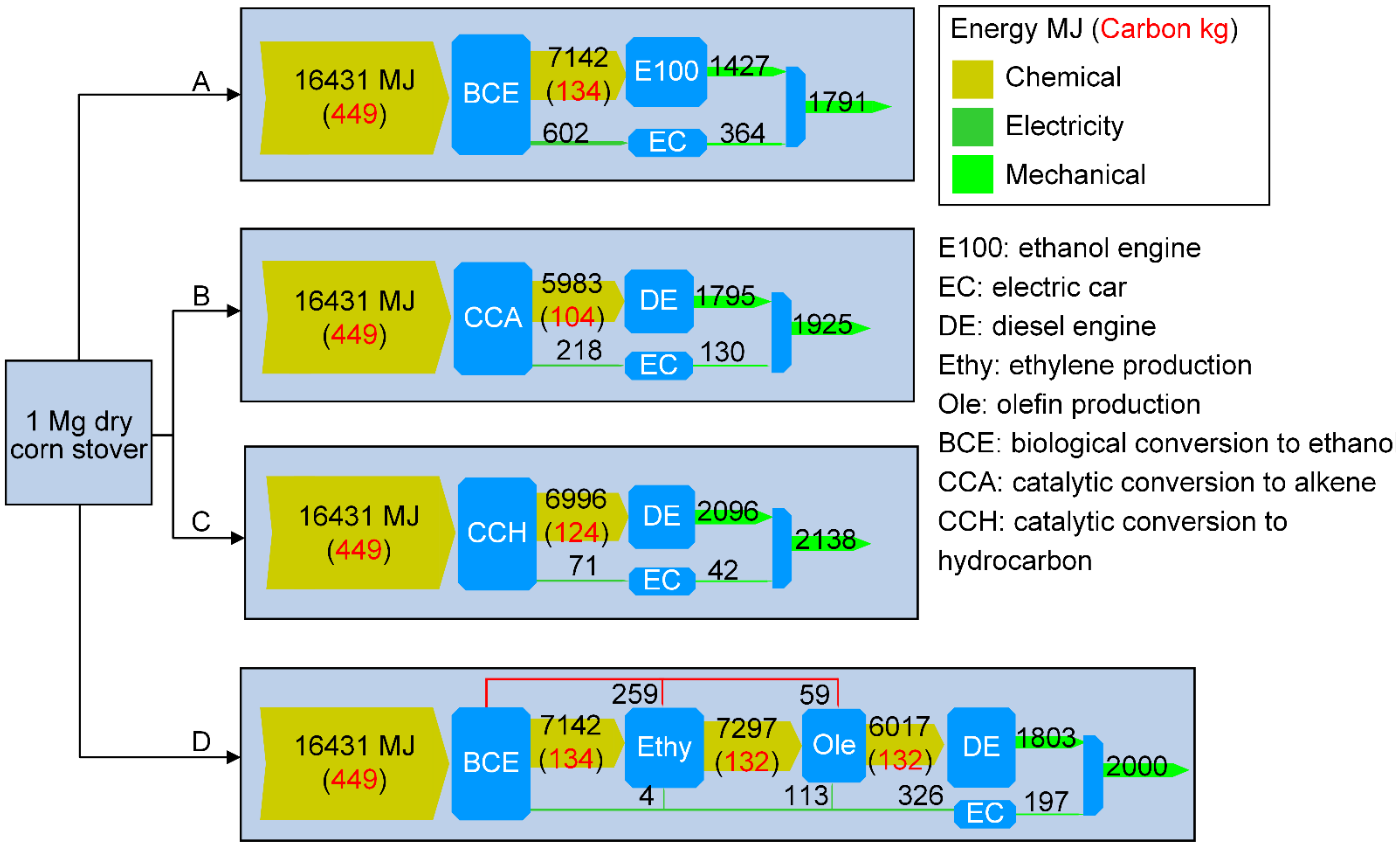

Figure S.1. Carbon and energy flows. **A.** Biological conversion to ethanol (NREL 2011 report) [2]. **B.** Catalytic conversion through GVL fractionation to hydrocarbons [3]. **C.** Dilute acid and enzymatic deconstruction and catalytic conversion to hydrocarbons (NREL 2015 report) [4]. **D.** Biological conversion to ethanol [2], dehydration to ethylene [5], and catalytic conversion to hydrocarbons [6] for conversion of one Mg dry corn stover based on detail analysis of current state of technology.

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