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Harmonization of Reported Life-Cycle and Techno-Economic Algal Biofuel Process Results

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METHODS

Life-Cycle Harmonization

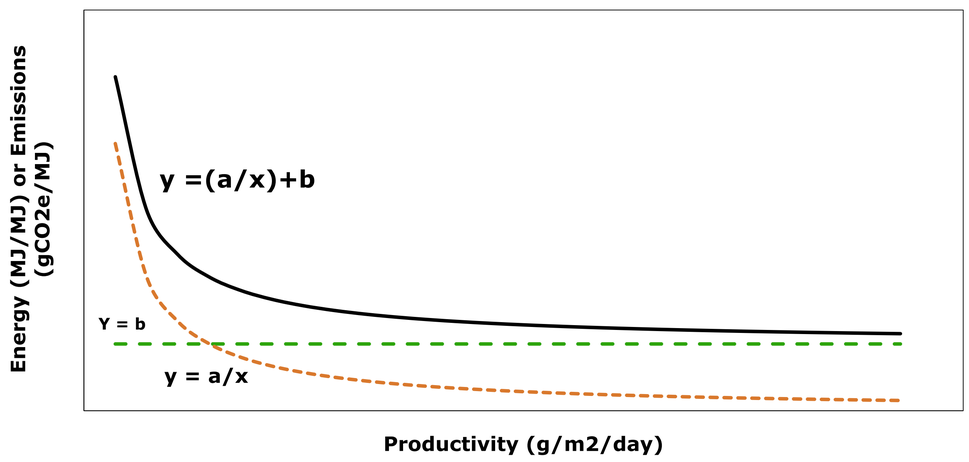

Figure 1: The growth scaling equation used to harmonize growth rates across studies to 25 g/m^2/day. The curve was fit to reported data across more than 20 papers and was verified against several papers that reported multiple growth rates for the same process. The (a/x) term corresponds to the energy required for biomass growth (such as mixing energy), which decreases on a per mass basis as productivity increases. The constant (b) term is independent of the growth rate, and includes processes such as harvesting, downstream conversion, and CO_2 delivery.

Techno-Economic Harmonization

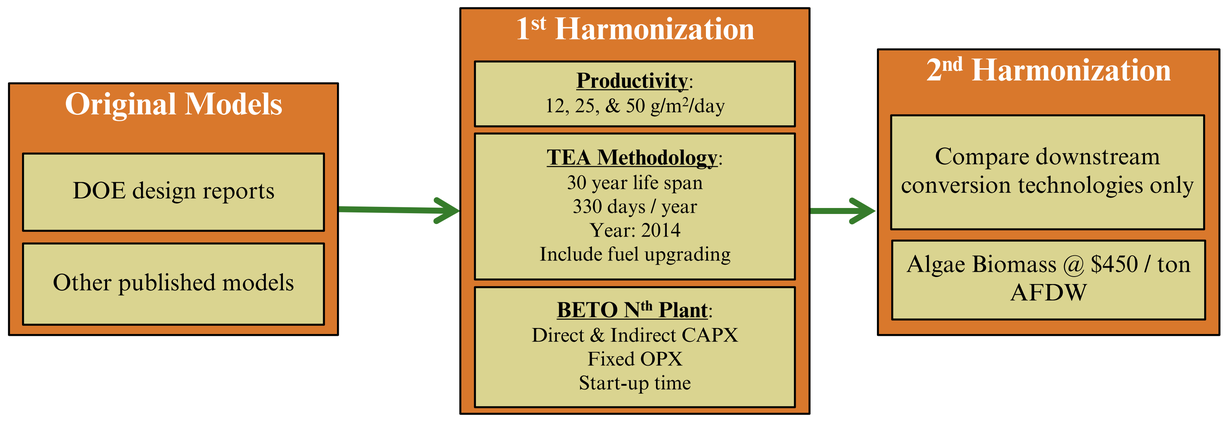

Figure 2: The two-step harmonization process for techno-economic models. Models were developed from both DOE design reports and other literature publications. They were then harmonized by: (1) productivity and TEA methodology, using the standard Bioenergy Technologies Office (BETO) nth plant assumptions; followed by (2) a growth-platform-neutral biomass cost of $450 / ton ash-free dry weight, to compare downstream conversion technologies only. 22 models from 9 different sources were developed and harmonized. Here, CAPX and OPX are capital and annual operating costs, respectively.

LCA RESULTS

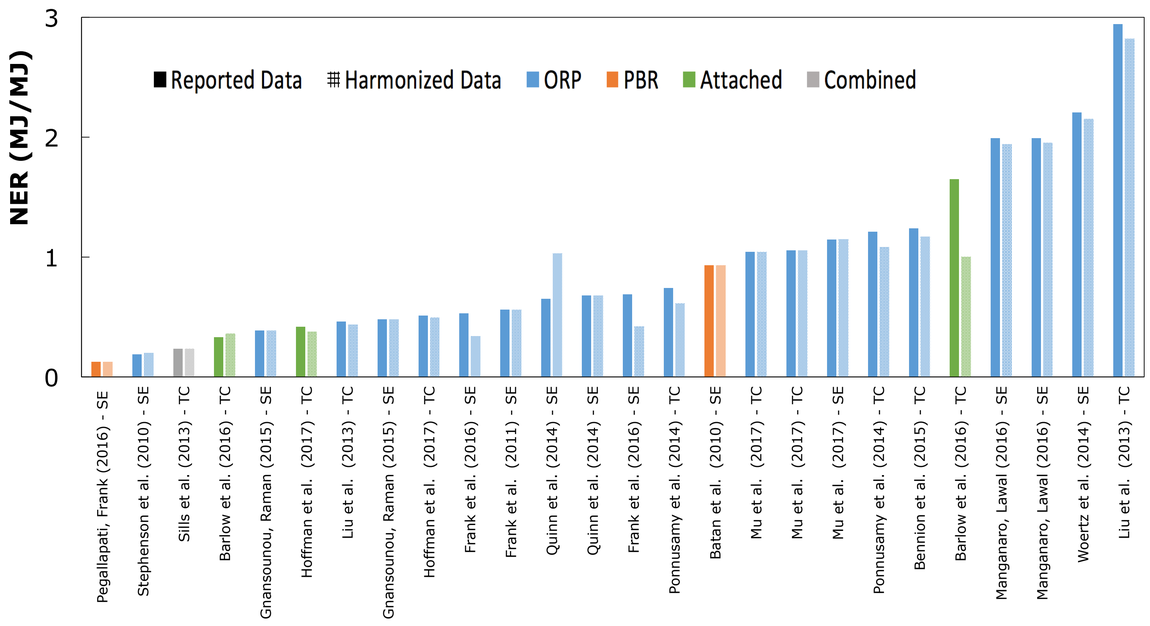

Figure 3: Results of applying the growth scaling equation (y=a/x+b) to the following papers. Color indicates growth platform and pattern indicates reported vs. harmonized data.

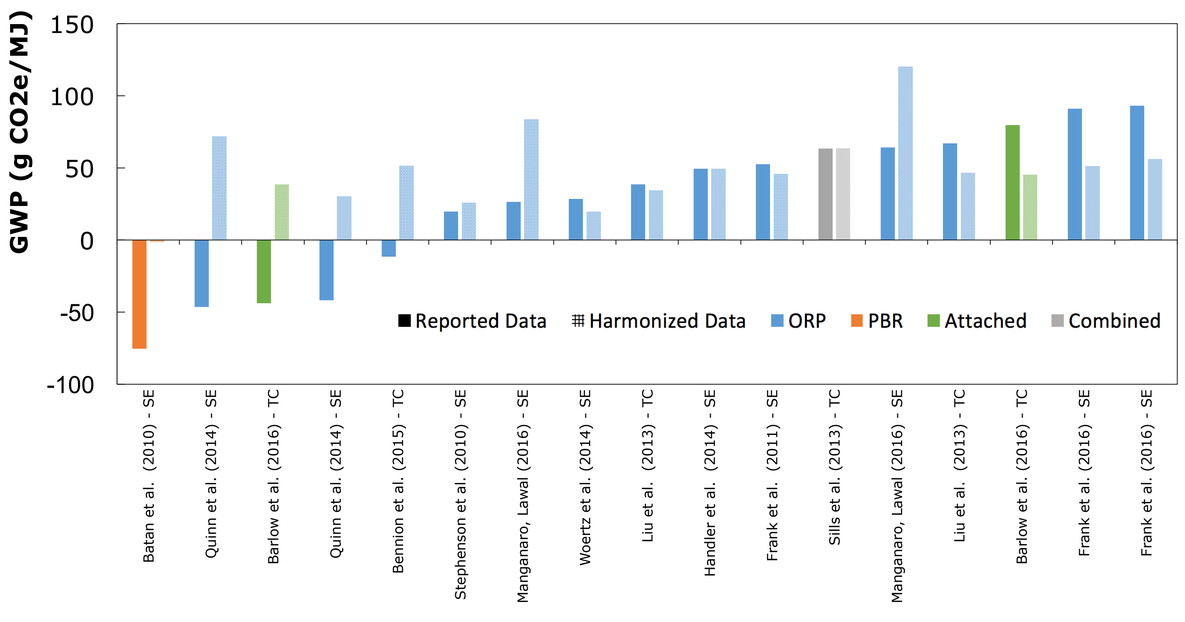

Figure 4: Results of Global Warming Potential before and after the harmonization. Color indicates growth platform and pattern indicated reported vs. harmonized data. Assumptions made for harmonization include, productivity of 25 g/m^2/day and a Well-to-Wheel system boundary.

TEA RESULTS

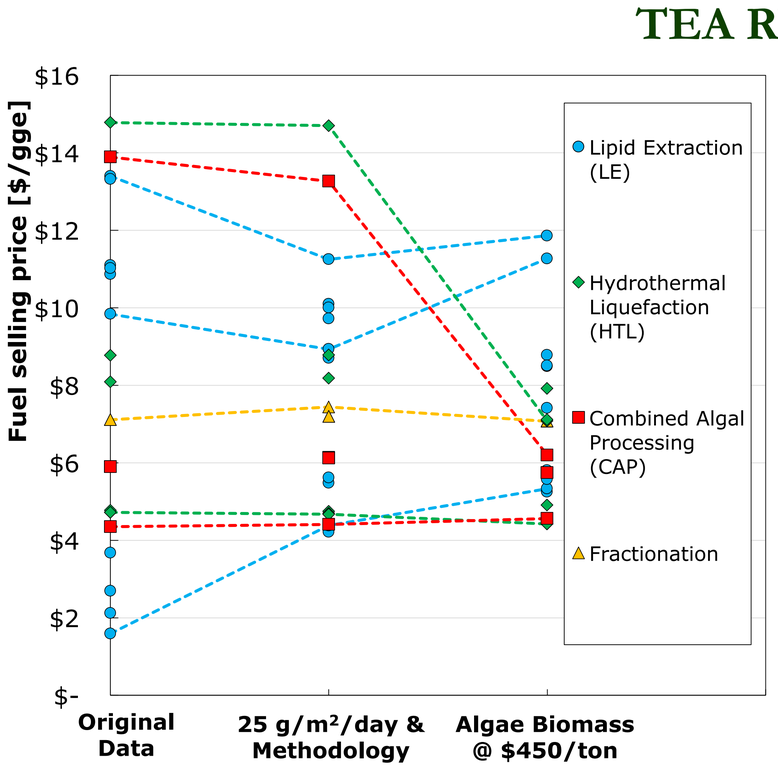

Figure 5: The change in calculated TEA result (minimum fuel selling price $/gallon-gasoline-equivalent, GGE) with each harmonization step. The lines connect results from single models, with each color representing a different technology.

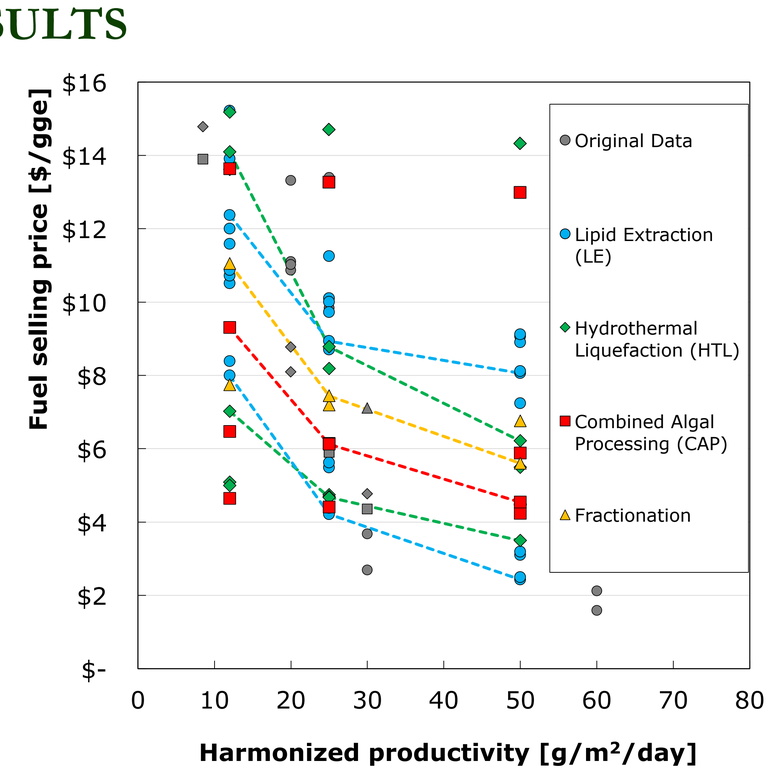

Figure 6: The change in TEA result for different productivities (12, 25, and 50 g/m^2/day) after the first harmonization. Lines connect the results from representative studies with the best growth-through-downstream process and TEA models.

Conclusions

- Adjusting system boundaries to Well-to-Wheels allow for better comparison to standard fuels.
- The Growth Scaling equation gives a reliable option for comparing studies.
- Standardization of TEA assumptions help decrease the range of results
- A growth rate of 25 g/m^2/day is a good target baseline for modeling work.
- Harmonization helps us select the processes with more future potential.

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