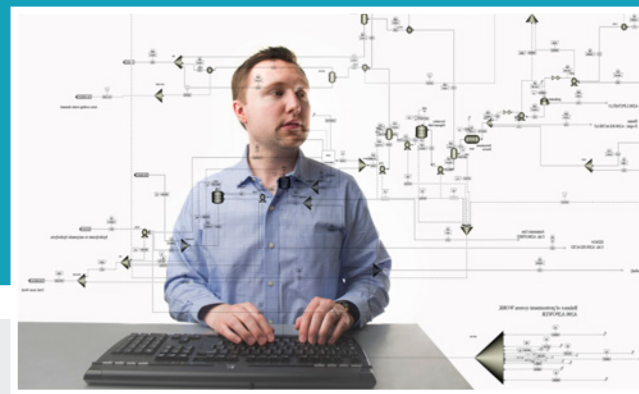
Biorefinery Analysis

NREL's expert engineers provide analyses to connect research with future commercial process integration, a critical step in the scale-up of biomass conversion technologies.



NREL's biorefinery analysis team focuses on process modeling and TEA to help advance from research to commercialization. *Photo by Dennis Schroeder, NREL 30266*

Techno-Economic Analysis (TEA)

Assess technical and economic feasibility of a process

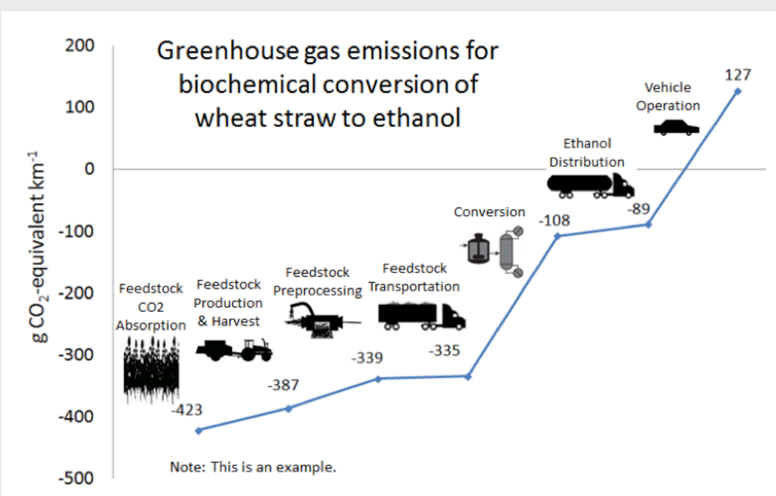
These analyses can be useful in determining the potential for near-, mid-, and long-term viability of emerging technologies. The results of a techno-economic analysis are also useful in directing research toward areas in which improvements will result in the greatest cost reductions.

- Detailed process analysis with mass and energy balances (see publications for recent work)
- Impact of major cost drivers (sensitivity studies)
- Research/cost targets set and used as a measure of research progress against current benchmarks
- Versatile models for evaluation of both fuels and chemicals production technology pathways
- Studies include broader market perspectives as necessary.

Life-Cycle Assessment (LCA)

Overall environmental impacts of conversion technologies

Conducting a full life-cycle assessment is important for determining the environmental benefits and burdens of lignocellulosic biofuels. Federal and state energy policies, such as the Energy Independence and Security Act Renewable Fuel Standard and California's Low Carbon Fuel Standard, use LCA to determine which fuels meet policy goals for greenhouse gas reductions or other sustainability metrics.



NREL analysts perform life-cycle assessments to determine environmental impacts, such as greenhouse gas emissions. *Figure by David Hsu and Abhijit Dutta, NREL*

Variables included in NREL's life-cycle assessments include:

- Greenhouse gas emissions
- Water use
- Fossil fuel requirements
- Other environmental impacts.

How NREL Can Help

Allow NREL's team of analysts to provide in-depth modeling and results based on your customized processes with the highest confidentiality maintained.

Expertise

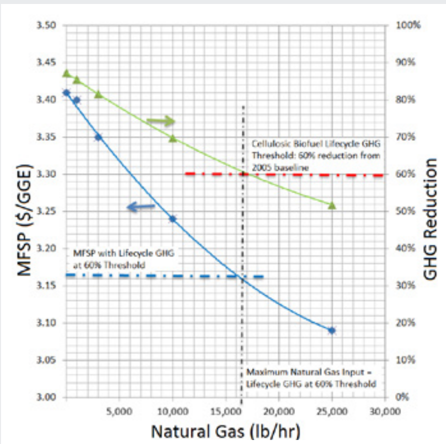
- Existing models of varied conversion processes
- World-renowned experts
- Reputation for successful commercial partnerships.

Model proficiency

- Aspen Plus and HYSYS—models continuous processes to obtain material and energy balances. NREL has in-house capabilities for refinery integration, detailed heat integration, and custom models.
- Aspen Capital Cost Estimator—performs detailed process equipment cost estimates.
- Aspen PIMS—helps evaluate the impacts of blending biomass-derived fuels.
- Crystal Ball—operates within Microsoft Excel and incorporates uncertainties in forecasting analytical results.
- Stella—carries out system dynamics modeling of policy and market scenarios.
- SimaPro and GREET (ANL) LCA Tools—quantifies sustainability metrics based on life-cycle inventories.

Project Successes

Researchers at NREL use process and sustainability analyses to understand the economic, technical, and environmental impacts of biomass conversion technologies. These analyses reveal the economic feasibility and environmental benefits of biomass technologies and are useful for government, regulators, and the private sector. Over the years, NREL's biorefinery analysis team has collaborated with many companies including Chevron, Petrobras, Ecopetrol, ConocoPhillips, and Honda among many others. In addition, NREL's Energy Analysis Office (www.nrel.gov/analysis) integrates and supports energy analysis functions spanning other technology areas.



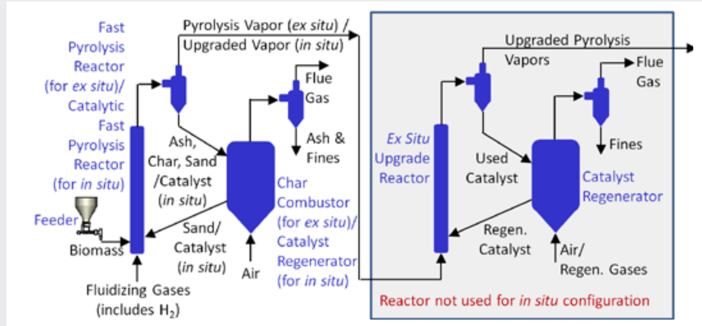
Analysis showing the tradeoff between production cost (MFSP) and greenhouse gas reduction with the use of supplemental natural gas in a biomass conversion process as shown in NREL/TP-5100-62402.

Some examples of work include:

- NREL performed techno-economic analysis as part of an international collaborative effort with Petrobras, Ensyn, and Fibria that successfully demonstrated co-processing of pyrolysis oil in conventional refinery operations to produce biomass-derived fuels, including gasoline and diesel fuel blendstocks that were registered and approved by the U.S. Environmental Protection Agency.
- Chevron and NREL collaborated to develop techniques to improve the production of liquid transportation fuels using microalgae. Researchers identified and developed promising microalgal strains. The collaboration relied heavily on NREL's TEA modeling to benchmark process economics and inform R&D progress within the effort.
- NREL partnered with ConocoPhillips and Iowa State University for the techno-economic comparison of biochemical, gasification, and pyrolytic conversion of corn stover to ethanol. Detailed reports are publicly available.

Recent Reports

- *Process Design and Economics for the Production of Algal Biomass: Algal Biomass Production in Open Pond Systems and Processing Through Dewatering for Downstream Conversion.* 128 pp. NREL/TP-5100-64772, 2016. www.nrel.gov/docs/fy16osti/64772.pdf



Conceptual design of *in situ* and *ex situ* catalytic fast pyrolysis processes as detailed in NREL/TP-5100-62455.

- *Process Design and Economics for the Conversion of Lignocellulosic Biomass to Hydrocarbons: Dilute-Acid and Enzymatic Deconstruction of Biomass to Sugars and Catalytic Conversion of Sugars to Hydrocarbons.* 133 pp. NREL/TP-5100-62498, 2015. www.nrel.gov/docs/fy15osti/62498.pdf
- *Process Design and Economics for the Conversion of Lignocellulosic Biomass to Hydrocarbon Fuels: Thermochemical Research Pathways with* In Situ *and* Ex Situ *Upgrading of Fast Pyrolysis Vapors.* 275 pp. NREL/TP-5100-62455; PNNL-23823, 2015. www.nrel.gov/docs/fy15osti/62455.pdf
- *Process Design and Economics for the Conversion of Lignocellulosic Biomass to Hydrocarbons via Indirect Liquefaction: Thermochemical Research Pathway to High-Octane Gasoline Blendstock through Methanol/Dimethyl Ether Intermediates.* 189 pp. NREL/TP-5100-62402; PNNL-23822, 2015. www.nrel.gov/docs/fy15osti/62402.pdf
- *Process Design and Economics for the Conversion of Algal Biomass to Biofuels: Algal Biomass Fractionation to Lipid- and Carbohydrate-Derived Fuel Products.* 110 pp. NREL/TP-5100-62368, 2014. www.nrel.gov/docs/fy14osti/62368.pdf
- *Process Design and Economics for the Conversion of Lignocellulosic Biomass to Hydrocarbons: Dilute-Acid and Enzymatic Deconstruction of Biomass to Sugars and Biological Conversion of Sugars to Hydrocarbons.* 147 pp. NREL Report No. TP-5100-60223, 2013. www.nrel.gov/docs/fy14osti/60223.pdf
- *Process Design and Economics for Conversion of Lignocellulosic Biomass to Ethanol: Thermochemical Pathway by Indirect Gasification and Mixed Alcohol Synthesis.* 187 pp. NREL Report No. TP-5100-51400, 2011. www. nrel.gov/docs/fy11osti/51400.pdf
- *Process Design and Economics for Biochemical Conversion of Lignocellulosic Biomass to Ethanol: Dilute-Acid Pretreatment and Enzymatic Hydrolysis of Corn Stover.* 147 pp. NREL Report No. TP-5100-47764, 2011. www. nrel.gov/docs/fy11osti/47764.pdf

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www.nrel.gov/bioenergy/economic-sustainability-market-analysis.html

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