

Research engineers at RTI International are developing a process that could enable the United States to replace fossil fuels with domestically produced cellulosic biofuels. This technology has the potential to reduce the demand for imported petroleum and reduce greenhouse gas emissions. This two-year project is being funded by the Department of Energy's recently formed Advanced Research Projects Agency-Energy (ARPA-E).

What is second-generation biofuels?

Second-generation biofuels are produced from nonfood agricultural residues such as

- Corn leaves, husks, and stalks (collectively known as corn stover)
- Wood residues from the forest products industry
- Switchgrass, fast-growth trees, and other dedicated energy crops

Converting Biomass into Fuels

RTI is developing a process through which second-generation biomass feedstocks are transformed into bio-crude oil.

Like light, sweet petroleum crude, this bio-crude could be upgraded into liquid transportation fuels—gasoline, jet fuel, or green diesel—using existing processes at U.S. refineries. The refined fuel could be stored, pumped, and used exactly as petroleum-based fuels are today.

Harnessing the Benefits of Second-Generation Biofuels

Rather than using valuable food crops to produce the bio-crude, RTI's process uses second-generation biofuels such as agricultural waste or forest residues. Second-generation biofuels processes do not impact food supplies and are more environmentally sustainable than first-generation biofuels.

Congress has set aggressive targets for producing cellulosic (or second-generation) biofuels—21 billion gallons per year by 2022. If successful, the work of RTI and our partners under this project will help meet this goal.

Impact on U.S. Economic and Energy Security

Once fully commercialized, this advanced biofuels technology has the potential to replace fossil fuels with domestically produced biofuels that could

- Reduce the demand for imported petroleum by approximately 30 million barrels per year
- Lower greenhouse gas emissions, eliminating more than 15 million tons of CO₂ per year
- Create new jobs, particularly in rural agricultural areas of the United States.

The commercial concept envisioned is a distributed network of processing facilities that would produce bio-crude for use in existing refineries, establishing the United States as a leader in biofuels production.

Technology that Transforms the State of the Art

Current technology uses what is known as flash pyrolysis—where biomass is heated for less than 2 seconds—to produce liquid bio-oil that retains 60% of the carbon in the biomass (also known as carbon efficiency). Although this bio-oil can be upgraded to fuel, its high oxygen content makes it corrosive and unstable. It also contains metals and nitrogen that foul refinery catalysts, and the upgrading process requires large amounts of expensive hydrogen.





What is pyrolysis?

Used to render wood into charcoal, dry roast coffee beans, and caramelize sugar, pyrolysis is the decomposition of substances by heating. Pyrolysis differs from simple burning in that it does not involve a reaction with oxygen.

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A new approach to pyrolysis, the catalytic process under development would produce a dramatically improved bio-oil. By using multifunctional catalysts to remove the oxygen and other contaminants, we expect to produce a bio-oil that is highly carbon efficient, requires less hydrogen to upgrade, and can be integrated into existing refineries.

Analysis of the cost of the process is a key component of the project. The cost of the catalytic pyrolysis process must be balanced with cost reductions in the refining process.

Partnering with Industry to Deploy Commercial-Scale Biofuels Technology

RTI's project extends beyond process chemistry to develop solutions to challenges that have prevented other alternative fuels from replacing fossil fuels. This research project extends from the farm to the refinery. By partnering with Albemarle Catalysts Company, Archer Daniels Midland Company (ADM) and ConocoPhillips, we are incorporating industry knowledge and experience to arrive at a solution for full commercial deployment.

- **Albemarle Catalysts** will support catalyst development using their unique experimental capabilities to rapidly screen potential catalysts to assess their ability to control pyrolysis chemistry. This will accelerate the development of active and robust catalysts for commercial-scale production of biofuels.
- **ADM**, a leader in first-generation biofuels production, will integrate solutions for large-scale collection, storage, and transportation of corn stover to minimize feedstock costs for a distributed network of catalytic pyrolysis facilities. They will assess farming practices, equipment, harvest and storage methods, and pretreatment processes to ensure the economic viability and sustainability of this biofuels process.
- **ConocoPhillips** will apply its extensive experience in downstream chemical processing for fuels production in petroleum refineries to test the process for upgrading the bio-oil to transportation fuels. They will also assist with analysis and characterization of the resulting fuels to ensure they meet fuel quality standards.

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RTI International is a trade name of Research Triangle Institute.