

# Next-Generation Cellulosic Ethanol

FACTSHEET



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## Verenium Corporation: Leading the Way in the Development of Next-Generation Cellulosic Ethanol

### What is next-generation cellulosic ethanol?

Cellulosic ethanol is a renewable fuel source produced from natural, non-food feedstocks, such as sugarcane bagasse, dedicated energy crops and wood products. Cellulose, a long-chain polysaccharide found in nearly all plant life, is the most abundant organic compound on earth. The Environmental Protection Agency says cellulosic ethanol's high-oxygen content reduces carbon monoxide better than other oxygenates.

Verenium produces next-generation cellulosic ethanol using advanced enzyme science to reduce the cost of ethanol production and enable the use of a wide variety of biomass. Unlike traditional ethanol manufactured using natural gas or coal, cellulosic ethanol from biomass can be broken down into fermentable sugars using a mild acid or enzymatic hydrolysis. The biomass is hydrolyzed using steam and mildly acidic conditions. This portion of the process creates five carbon sugar (pentose) syrup from the hemicellulose found in the biomass, and prepares the remaining cellulose fiber for further enzymatic conversion into glucose. This is then turned into ethanol. Industrial enzymes also can be used to break the cellulose down into sugars that are then fermented into ethanol using microbes. Cellulosic ethanol can achieve the high yields vital to commercial success, has high octane and other desirable fuel properties, and is environmentally friendly.

### How does next-generation cellulosic ethanol differ from first-generation ethanol?

Unlike traditional ethanol made from food-based feedstocks like corn, next-generation cellulosic ethanol is made from biomass sources like dedicated energy crops and wood products, which offer much higher yields with much lower environmental impact. The principal feedstock now being used in Verenium's pilot facility is agricultural waste from sugar cane production, bagasse.

There are six principal advantages to using cellulosic biomass to produce biofuels:

1. use of dedicated energy crops
2. it is comparatively low-cost
3. it uses marginal lands for feedstock growth
4. it has a beneficial net energy balance
5. it uses less fertilizer and water relative to other crops
6. it reduces emissions of greenhouse gases.

While all molecules of ethanol are identical, they are not created equal in terms of environmental impacts – some are better than others. According to a report by Argonne National Laboratory, corn ethanol reduces GHG emissions by 18% to 29% per vehicle mile traveled as compared to gasoline, while cellulosic ethanol reduces them by approximately 85% per vehicle mile traveled. Cellulosic ethanol might have additional advantages in that it could realize possible revenues through the sale of carbon credits, given its substantially improved carbon emission profile.

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### How much cellulosic ethanol does America need?

Advanced biofuels are expected to play a major role in reducing America's reliance on gasoline, while sharply reducing net carbon emissions that contribute to global warming. The Energy Independence and Security Act of 2007 mandates the use of at least 16 billion gallons of cellulosic ethanol in our nation's automotive fuel supply by 2022 – about 10% of current consumption. Most cars currently on the road today in the U.S. can run on blends of up to 10% ethanol, and motor vehicle manufacturers already produce vehicles designed to run on much higher ethanol blends.

### How does Verenum differ from others in the ethanol industry?

Verenum is the first publicly traded, fully integrated, next-generation biofuel company, and its range of expertise and resources greatly enhances its potential for success. Verenum is mastering the entire cellulosic ethanol production process as the first and only company with the full complement of “field-to-pump” capabilities. This includes: growing energy crops, developing enzymes, processing biomass into fuel and, ultimately, selling it. Additionally, Verenum's partnerships, which range from industry giants like Syngenta to the U.S. Department of Energy, make the Company uniquely positioned for success.

Verenum pioneered the discovery and development of unique, high-performance enzymes for converting cellulose into fermentable sugars and ethanol and continues to develop enzymes in its San Diego, California labs. Verenum also uses proprietary microorganisms, called ethanologens, for the cellulosic ethanol fermentation process and proprietary equipment for ethanol production. The Company is now in the optimization phase at its Jennings demonstration-scale plant, which is the first of its kind in the U.S. The facility marks a milestone not just for the Company, but for the nation, in our efforts to diversify our energy supply.