The University of Tennessee-DuPont Danisco Cellulosic Ethanol (DDCE) Collaboration FREQUENTLY ASKED QUESTIONS

What is the University of Tennessee Biofuels Initiative (UTBI)?

The UTBI is the active implementation of Tennessee's vision that answers the global challenge of securing sustainable, renewable, affordable energy while advancing the local economy and protecting the environment. The overall objectives of the UTBI are to: (1) demonstrate the establishment of a dedicated biomass energy crop supply chain with farmers to supply a cellulosic biorefinery; (2) demonstrate the pre-commercial production of ethanol from switchgrass and other biomass feedstocks; (3) establish premier long-term research and development capability in bioenergy and bioproducts; and (4) develop a viable, sustainable, long-term path to commercialization of cellulosic biofuels and energy crops in Tennessee.

Who are the collaborators in the new biorefinery?

The UTBI is a comprehensive model, developed and implemented by the University of Tennessee, acting as stewards for the State's investment in developing a cellulosic biofuels industry in Tennessee. An important aspect of the UTBI is the construction and operation of a pilot scale cellulosic ethanol biorefinery that can provide dynamic opportunities for research and demonstration of cellulosic ethanol processes and economics and integration of a farm-based energy crop supply chain. There are a number of important entities collaborating in various ways in the feedstock supply chain and the biorefinery aspects of the UTBI, including The University of Tennessee, the University of Tennessee Research Foundation, the UT Institute of Agriculture, Genera Energy LLC, and DuPont Danisco Cellulosic Ethanol LLC.

The University of Tennessee has ultimate responsibility and accountability to the **State of Tennessee** for implementation of the UT Biofuels Initiative, including the biorefinery demonstration. Within the UT System, the **UT Institute of Agriculture** (UTIA) has the lead for the UTBI project, including the Switchgrass Farmer Incentive Program and R&D related to developing and improving this new farm-based energy crop opportunity. Within UTIA, the administration and management of the UTBI lies in the **Office of Bioenergy Programs** (OBP), created in 2007 to serve as an umbrella for a variety of related programs in this field, including the Southeastern Regional Center of Excellence for the national Sun Grant Initiative, the UTBI, educational curriculum development, and other related R&D.

While much of the feedstock development work and farmer programs and R&D remain in the University of Tennessee, the University and State recognized early on that achieving the ultimate vision and benefits of the UTBI would require partnerships with private partners and considerable flexibility in designing, constructing, operating, and accessing the biorefinery. The University and State approved a project structure to allow UT to grant the UTBI capital funds to the **University of Tennessee Research Foundation** (UTRF), and UTRF to invest those funds in a wholly-owned Tennessee limited liability company created specifically to collaborate with private partners for the construction and operation of the pilot scale R&D biorefinery.

In January 2008, the UTRF created **Genera Energy, LLC** as the entity that would be positioned to work with private companies to form strategic partnerships to implement the biorefinery. Genera has now entered into a letter of intent for a collaboration agreement with **DuPont Danisco Cellulosic Ethanol LLC** (DDCE) to serve as the exclusive process technology partner in the pilot scale cellulosic ethanol biorefinery project. DDCE is a 50/50 global joint venture formed by DuPont and Genencor, a division of Danisco, to develop and commercialize the leading, low-cost technology solution for the production of cellulosic ethanol -- a next generation biofuel produced from non-food sources – to address a $75 billion global market opportunity.

DuPont is a science-based products and services company. Founded in 1802, DuPont puts science to work by creating sustainable solutions essential to a better, safer, healthier life for people everywhere. Operating in more than 70 countries, DuPont offers a wide range of innovative products and services for markets including agriculture and food; building and construction; communications; and transportation.

Danisco U.S. Inc. is the U.S. subsidiary of a Denmark-based company with 9,700 employees in more than 40 countries. It is one of the world's leading suppliers of food ingredients, sugar and industrial bioproducts. Based on its technology platform, it uses nature's own raw materials and resources to develop and produce ingredients for food and other products used in everyday life. Danisco was founded in 1989 and is listed on the Copenhagen Stock Exchange.

Compared to previous announcements and expectations for the biorefinery pilot plant, what is different about the new agreement between Genera and Dupont Danisco?

The scale of production for the pilot biorefinery will be smaller, with a capacity of 250,000 gallons of cellulosic ethanol per year. This size is considered optimal to enhance the ability of researchers to make adjustments to the production methods for the purpose of continually improving the process and economics and obtaining required data to move to commercial scale operations. Additionally, a process development unit (PDU), allowing introduction of new R&D from laboratory scale research, will be built onsite, and two feedstocks – corn cobs and switchgrass -- will be used to produce cellulosic ethanol.

Does DDCE anticipate a different ethanol production process?

The DDCE technology will combine:

- A differentiated pretreatment process developed by DuPont through its collaboration with the U.S. Department of Energy National Renewable Energy Laboratory (NREL) that allows for reduced capital costs;
- Enzyme technologies and production platforms enabling high biomass-to-sugars conversion rates developed by Genencor, a leader with world-class capabilities in the discovery, optimization and production of enzymes for cellulose conversion;
- A proprietary ethanologen, also developed through the DuPont-NREL collaboration, based on Zymomonas mobilis. This ethanologen has the ability to convert sugars contained in the feedstock into high yields of ethanol with fewer byproducts, and;
- The companies' joint engineering capabilities in process integration and facility design and industrial operations.

Up to five million gallons a year was touted as the potential size of the pilot biorefinery. Will the reduction in biorefinery capacity affect the need for switchgrass or other feedstocks?

While it is true that the new scale for the pilot biorefinery will need fewer tons of switchgrass for the production of cellulosic ethanol, significant amounts of switchgrass are still expected to be needed to satisfy R&D needs in feedstock development. First, commercialscale biorefineries will need significant quantities of feedstock, including switchgrass, corn cobs and other biomass. Second, the UTBI is interested in developing a portfolio of uses for bioenergy crops, further reducing risk for farmers and stabilizing supplies. For example, research results show promise that switchgrass can be economically processed into pellets and then burned to produce steam and other forms of energy and power. This sort of application would also contribute to the mission of UTBI to enhance the nation's energy independence through farm-based commodities. Additionally, research is being performed on the possible use of switchgrass as forage for cattle and potential wildlife and conservation management benefits.

Why the significantly smaller scale of production?

A smaller-size facility will allow flexibility to focus on research. The facility and its capacity are considered the optimal size – small enough for research, while large enough to go straight to large-scale commercialization, currently expected to be in excess of 20 million gallons per year.

What is a PDU?

PDU stands for process development unit. PDUs are highly desirable and valuable research tools that are small-scale versions of larger scale processes. While the pilot plant integrates all of the processing steps, the PDU allows somewhat independent operation of the various processing steps, making it more modular in design and operations. In this case the PDU will model the pilot biorefinery while allowing for customized additions or changes to the processing procedures.

Why is a PDU advantageous?

A PDU will allow researchers to test proposed variations in the process in advance of running larger-scale tests through the biorefinery itself. PDUs are an economical way of "tweaking" a process or testing new technologies in independent steps.

When is commercial scale-up anticipated?

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DuPont Danisco Cellulosic Ethanol's experience and previous research with corn cobs as the primary feedstock suggest that cellulosic ethanol can be produced in a commercial scale biorefinery as early as 2012. The current expectation is that an additional year of research and development will be needed to demonstrate sufficient process and economic data to support commercial scale 3 investment in switchgrass-based ethanol. While current R&D progress suggests commercial scale switchgrass ethanol production by 2013, favorable results in the PDU and piloting phases of R&D may shorten the time to commercialization.

Once the economic viability of cellulosic ethanol is determined, the UTBI calls for private investment in a network of commercial-scale biorefineries across the state. As many as 4,000 new jobs could be created in biorefineries and related industries, expected to concentrate in rural areas of the state where switchgrass and biomass feedstocks are produced.

Why is commercialization of switchgrass ethanol technology still estimated to be several years out?

To date, commercial switchgrass to ethanol technology has not been demonstrated. This technology is evolving at a rapid pace and on track to demonstrate pilot scale cellulosic ethanol from switchgrass by 2010. Upon successful pilot demonstration, it will still take several years to move to successful commercial developments, expected to occur by 2013.

Has the partnership change delayed the project timeline?

No, in fact, it has accelerated the process. DDCE brings the knowledge, experience and resources in this area to ensure immediate demonstration of technology. The expectation is that construction on the biorefinery will being this fall with ethanol production from the facility by the end of 2009.

How does research on corn cobs process translate to switchgrass process?

In one sense, biomass is biomass. But in the early stages we are in today, some biomass feedstocks are nearer commercial development than others. Laboratory research indicates that pretreated cobs and pretreated switchgrass have very similar chemical and physical profiles and that they respond similarly to the proprietary process to be employed in the pilot plant.

Will the pilot plant also process hardwood chips or other forest material?

No, not initially. However, both the University of Tennessee and our research partner Oak Ridge National Laboratory have active research programs in developing forest-based biomass feedstocks for the cellulosic ethanol industry. In addition to the long history of wood products research at the University of Tennessee, UT is also the national lead for the US Department of Energy in the development of short rotation woody crops that can support the developing cellulosic ethanol industry. Short rotation woody crops, in particular, hybrid poplar, is a major research emphasis for ORNL's BioEnergy Science Center in addition to their research emphasis in switchgrass. As the conversion process matures and becomes more robust, it is expected that a broader range of potential biomass feedstocks, including forest-based material, can be tested in the PDU and then the pilot plant. A long term objective of the research will be to expand the range of biomass crops and materials that can be used as feedstock for the conversion process, allowing different regions of the country to use their natural resources most efficiently and effectively and further enhancing the environmental and economic sustainability of the cellulosic ethanol industry.