

## **Why Biofuels and Why Tennessee?**

### ***Why should the State invest in a University of Tennessee-sponsored research and development program for biofuels?***

*As a state land grant institution, UT is the ideal vehicle for state investment. UT is charged with teaching, research and economic development for the future success of the state's citizens. The UT Biofuels Initiative addresses each of these charges while meeting a national demand for enhanced energy security.*

#### **Details:**

- Tennessee is well-situated to produce enough acres of switchgrass and other biomass to fuel industrial needs without displacing current production of food and feed crops. Energy prices could be lowered without negative effects on food or feed.
- The UT Biofuels Initiative is using cutting-edge research to help develop a new industry for the state to provide thousands of new jobs that will drive local economies with hundreds of millions of dollars annually in new farm and business revenues. Students of agriculture, chemistry, engineering and other disciplines will have opportunities to participate in the research and ultimately the staffing involved in developing and maintaining that industry.
- Despite being only two-and-a-half-years into a five-year investment plan, the state's initial \$70 M investment has returned more than \$161 M in new federal research dollars and industrial capital: \$135 M for the Federal Bioenergy Science Center in Oak Ridge; more than \$20 M from DDCE to partner in the biorefinery; \$4.9 M from DOE for Genera Energy Biomass Project; and \$1.1 M from DOE for C3Bio Project at UT. More research and industrial investment is expected.

#### **Timeline of Biofuels Initiative activities to date:**

- 2007— General Assembly approves Governor's budget including UT Biofuels Initiative (June); UT partners with Mascoma Corp. (Sept.); economy turns downward (Fall).
- 2008—UT begins contract farming for switchgrass with East TN producers (March); Mascoma proposes to DOE a 2 M GPY facility for the purpose of winning additional capital funding— facility to be operated on wood chips and switchgrass (awarded April); UT and Mascoma fail to reach mutually agreeable business terms (June); UT partners with DDCE, who brings more than \$20 M in capital for a 250,000 M GPY facility—facility initially to be operated on corn cobs (July); State Building Commission, others, approve new scale of facility (Sept.) ; construction begins (Oct.).
- 2009—Construction on schedule and nearing completion (Dec.); UT enters second year of contract farming for switchgrass with East TN producers (Spring); Fiscal Review Committee questions scale (Nov.).

### **Regarding the Change in the Scale of the Biorefinery:**

#### ***Why and when did the ethanol production capacity change from an estimated 5 million gallons per year (GPY) to a smaller scale?***

*The short answer as to why the scale was changed is that a balance needed to be reached between the required, meaningful research for developing the new industry as measured against adequate production of the product and reasonable cost.*

#### **Details:**

- The primary purpose of this pilot biorefinery is to conduct large-scale R&D and generate data on the process, engineering, feedstock handling, and economics that will lead directly to commercial-scale plants and markets for cellulosic ethanol. UT researchers—and researchers around the country and world—have worked continually to improve the processes and efficiencies. The facility and its capacity are considered the optimal size – small enough for research, while large enough for the lessons learned to be applied to large-scale commercialization, currently expected to be in excess of 15 million GPY.
- Expectations on the economics of production have improved since 2007, now suggesting that a cellulosic biorefinery could be commercially profitable at 15-25 MGY instead of 100-125 MGY (which is the case for corn ethanol biorefineries, and was thought to be the case for cellulosic biorefineries in 2006 and 2007). With this new information, the UT project team, in line with state-of-the-art research and expectations in the industry, decided that the optimal scale for a demonstration-scale biorefinery was considerably less than 5 MGY.
- As the UT project team worked with the original partner, Mascoma, in 2007 and early 2008 the economy was entering its current downturn. Initial engineering plans for the demonstration biorefinery indicated that the proposed 5 M GPY capacity was too large to achieve a balance between proposed scale, research flexibility, and available funds. In 2008, public notices, press releases, and project fact sheets made available during an application for additional funding by DOE noted that the facility was to be a 2 M GPY facility designed to be operated on wood chips and switchgrass.

#### ***When did the scale reach 250,000 GPY? And who was informed?***

*UT brought the intention to change from collaboration with Mascoma to collaboration with DDCE for the construction of a biorefinery before the Governor and State constitutional officers in July 2008, prior to entering a term sheet with DDCE. The scale and scope of the new biorefinery was proposed to be 250,000 GPY and a Process Development Unit (PDU) was included; the biorefinery would operate on both corn cobs and switchgrass, using up to \$36.7 million of state appropriated capital funds.*

#### **Details:**

- This announcement, made at the State Capitol during a press conference with the Governor, was extensively covered in the local, state and national media.

- UT then brought the proposed changes in the project partner, scale, and feedstock, and the addition of a PDU and further details about the switchgrass utilization demonstration before the General Board of Directors, UTRF Board of Directors, UT Board of Trustees Executive & Compensation Committee, and State Building Commission in September 2008. All approved unanimously.
- A public groundbreaking ceremony at the Vonore, Tennessee, site for the biorefinery occurred on October 14, 2008. It was attended by the Governor, members of the legislature, local officials and federal representatives. It, too, was covered in the local, state, and national media.

### ***Who made the decision regarding the biorefinery's scale?***

The final decision about the optimal scale for the pilot biorefinery was determined by the UT project team. The final decision to construct the present biorefinery was made at the time that UT entered into a term sheet (July 2008) and subsequent collaboration agreement (September 2008) with DuPont Danisco Cellulosic Ethanol (DDCE) for the design, construction, and operation of the pilot biorefinery. Both the term sheet and collaboration agreement were approved by the Governor and state constitutional officers, and the construction was approved by the State Building Commission.

### ***What happened to Mascoma?***

Following a prolonged good-faith effort to negotiate a partnership agreement with Mascoma for the joint construction, operation, and financing of our cellulosic ethanol R&D facilities, we were not able to achieve a partnership agreement that was aligned with the objectives and requirements of the state and university. Ultimately, we were not able to reach a mutually beneficial business agreement with Mascoma and terminated negotiations.

### ***What would be the consequences of building a pilot biorefinery with a 5 MGY capacity?***

*It would require much more capital than any commercial partner was willing to commit, could not be operated profitably as a research facility, would not be flexible enough to have as much research value, and would cost up to \$10 million annually to operate.*

#### **Details:**

- It would have cost in excess of \$100 million to build a research-oriented 5 MGY biorefinery. Originally, a corporate technology partner, Mascoma Corporation, was willing to cover the capital costs beyond the state's commitment of \$40.7 million, as committed in a Letter of Intent and as presented to the State Building Commission in October 2007.
- As financial markets tightened, Mascoma was unable or unwilling to commit more than \$60 million for a 5 MGY biorefinery. Even with a potential federal DOE grant of \$26 million for the project, Mascoma was unable or unwilling to commit more than \$34 million for a 5 MGY biorefinery.

- If a 5 MGY biorefinery were operated to maximize production (which a research facility is not designed to do), it would potentially generate enough revenue from the sale of the ethanol to cover the operating costs (but none of the fixed or capital costs).
- If a 5 MGY biorefinery were operated to maximize research value (which is a stated objective of the Biofuels Initiative), it would potentially require an additional \$5 million to \$10 million annually to operate the facility, net of ethanol product sales. Over 10 years, a 5 MGY research-oriented pilot biorefinery would require net operating funds of \$50-\$100 million.

### **Regarding the Feedstock for the Biorefinery:**

#### ***When was it determined that the facility would operate on multiple feedstocks, corn cobs and switchgrass?***

*The Biofuels Initiative has always claimed that it would consider a range of regionally appropriate biomass feedstocks and a range of biochemical conversion technologies and products, but the primary focus would be switchgrass to ethanol. This continues to be true.*

#### **Details:**

- Initially, the intention was to design and construct a facility that would operate on wood chips and transition to switchgrass. This was described to the legislature in 2007, widely discussed in public meetings including UT Board of Trustees meetings, described fully to the State Building Commission in October 2007, and a federal DOE funding application in August 2007 and January 2008.

#### ***Why will the facility operate on cob first? When will the facility operate on switchgrass?***

*Starting the pilot plant on cob is the most accelerated path to demonstration of switchgrass to ethanol. DDCE's parent companies have applied many years, dollars, and bright minds researching the conversion of cellulose from cobs to ethanol and their technology is now ready for pilot scale demonstration.*

#### **Details:**

- While the pilot plant starts operations in December 2009 on cob, the smaller PDU that is co-located with the pilot plant will start operations by early 2010 on switchgrass. Once the switchgrass operations in the PDU reach the required technical milestones, expected to be by the end of 2010, switchgrass operations will move to the larger pilot plant.
- Industry-wide, the cellulosic biomass feedstocks that have been the subject of the bulk of R&D and are nearest to piloting and commercial demonstration are wood chips, bagasse (the byproduct of processing sugar cane), corn cobs, and wheat straw. These have been the focus of the majority of the conversion research for the last decade.
- UT, ORNL, and other research partners continue to research other biomass feedstocks, which will ultimately contribute to a biobased economy, including short rotation woody crops, sorghum, miscanthus, energy cane, ag and forest residues, among others. Additionally, researchers at ORNL and elsewhere continue to research technologies for combined bioprocessing, where multiple feedstocks can be processed simultaneously in a biorefinery.

***What are you doing with the switchgrass that has been produced so far? How much switchgrass will be used in the biorefinery and when? What will you do with the rest of the switchgrass?***

- The University of Tennessee has contracted with farmers within a 50-mile radius of Vonore to produce switchgrass for the biofuels program. Switchgrass harvesting for 2009 has just begun on about 2,700 acres currently in production. Plans are to scale the program up to add about 3,000 additional acres under contract in 2010, the third and final round of the contracting program.
- ALL of the switchgrass produced under contracts with local farmers is being utilized. To date, some has been used for research programs (e.g., storage studies, testing characterization equipment and technologies, testing grinding and hammermilling equipment, etc.). The rest of the 2008 harvest has been stored at a central storage site and is being used for large-scale testing for ethanol production and also for other uses. (Some has been pelleted, torrefied, pyrolyzed, and gasified, as well as used in a hydrogen conversion process). The 2009 harvest has just begun and all of the switchgrass not required for research will be stored on farms or at the centralized storage sites until it is used in processing.
- New partnerships and opportunities are under negotiation that will require the rest of the switchgrass not used in the biorefinery and lead to significant future expansion of feedstock markets and opportunities.

***How easy is it to convert land back after it has been planted with switchgrass? Is it expensive?***

- The extensive, deep, filament-like roots of switchgrass have multiple benefits. During active growth of the plant, they are able to extract moisture from deep below the soil surface making switchgrass drought tolerant. They also provide stability and fixation during periods of extreme wet or flooding conditions.
- A perennial, switchgrass can continue to be productive as a dedicated energy crop for an indefinite period of time with appropriate management as an energy crop. Some of the UT switchgrass research plots are more than 20 years old and still highly productive.
- UT researchers have investigated procedures and methods for removal of switchgrass. UT Extension has developed guidelines for such removal practices. Research has shown that switchgrass fields can easily be converted to other uses. The root system of the switchgrass crop improves soil tilth and organic matter and increases soil carbon, resulting in higher soil productivity post-switchgrass than pre-switchgrass.
- Actual removal methods vary by situation, but can include an increased frequency of mowing and/or harvesting, application of specific herbicides at proper timing intervals, or over-grazing. The cost of the removal of switchgrass is in line with costs associated with other grass plantings/species.

## **Regarding the State's ROI:**

### ***What "return" should the State expect for this investment in the Biofuels Initiative and the pilot scale biorefinery?***

- **Intellectual Property (IP).** The UT Research Foundation (UTRF) will own and manage all IP arising out of UT faculty and employees' work on energy crop development, including genetically modified varieties of switchgrass, harvesting and storage systems, and feedstock handling and preprocessing, among other feedstock-related issues and processes. Significant research efforts in bio-materials and lignin and chemical co-products are also areas with significant potential to generate IP and proprietary information that can return significant value streams to support future developments and research. Switchgrass and energy crop densification and green power uses are also potential sources for returning IP value. Further, any IP or improvements on IP developed jointly by UT researchers and DDCE in the pilot biorefinery would be shared.
- **Success Fee.** As part of the Master Collaboration agreement, Genera and DDCE agreed to a milestone-based success fee to be paid by DDCE to Genera (returning value to UT as UTRF's purpose is to further UT research and commercialization efforts) as commercialization and revenues from processes developed and demonstrated by DDCE in the pilot plant and PDU return value. Success fees are paid when a minimum level of commercial cellulosic ethanol production is achieved using the DDCE process technology, with incremental payments based on increasing threshold levels of production and revenue.
- **Economic Development.** When this research and development effort is successful, including private investments to build a commercial scale biorefineries in Tennessee, we will have proven to farmers, investors and bankers, regulators, and additional private concerns that Tennessee switchgrass can be used to produce ethanol in a commercially viable and sustainable manner. We think such an exhibition of the economics and engineering of the biorefinery's industrial process, along with the UT Biofuels Initiative showing of full-scale agricultural production and logistics for switchgrass feedstock, are keys to kicking-off the non-food-based bio-based economy we are seeking to initiate in Tennessee. The economic development opportunities, in particular in rural areas where biomass feedstock will be produced, extend beyond job creation and new sources of economic activity to building a better base for commercial business presence and attracting new businesses and providing a platform for creating new companies based in the State. The State also has other legitimate interests in the accomplishment of the Project related to feedstock supply such as new sources of agricultural income and high-value and sustainable use of marginal agricultural lands.
- **Competitive R&D Benefits.** The R&D investments and opportunities in this Project also benefit the University and its partners such as ORNL by giving them a competitive advantage in hiring new scientists and faculty. World class research facilities and access to top researchers and data in the field are highly valuable in creating attractive offers for potential hires. The research facilities and opportunities offered by the Project also increase researchers' competitiveness for other grants, programs, and partners that can complement research and programs in the UTBI.

### **Regarding the Fiscal Review Committee Report:**

#### ***What is the purpose of the contract amendment that UT had planned to present to the Fiscal Review Committee on 11/4/09?***

- In October 2008, the University submitted a contract between UT and the UT Research Foundation to the Fiscal Review Committee. The contract did not involve any new funds; it provided administrative and programmatic support services to implement the university's biofuels initiative including the construction and operation of a pilot scale cellulosic biorefinery and switchgrass utilization demonstrations and farm production of switchgrass. The contract was approved unanimously by the Fiscal Review Committee.
- In November 2008, the University submitted an amendment to the previously-approved contract between UT and UTRF. The amendment expands the scope of the contract to allow UTRF, through its wholly owned subsidiary Genera Energy, to provide the administrative and support services for the switchgrass farmer contract program, previously provided through the UT Institute of Agriculture, and to execute the operations of the biorefinery and the switchgrass supply chain and utilization demonstration, following the natural transition of responsibilities for this initiative to achieve a self-sustaining competitive industry at the end of state funding support. The amended scope and budget and terms reflect further refinement of plans for implementing the project's objectives, accomplished within the state's stated investment in the Biofuels Initiative.

#### ***What would happen if the Fiscal Review Committee fails to approve the amendment?***

*Failure to approve the amendment effectively limits the ability of UT and Genera to transition to a self-sustaining industry model and would delay commercialization efforts.*

#### **Details:**

- In particular, the reallocation internally of already-allocated Biofuels Initiative funds is designed to speed the transition from state subsidies to commercial operations. Moving the final year of switchgrass farmer contracts from UT to Genera provides a natural transition to a market-based industry contract through Genera's role in organizing the Tennessee Biomass Supply Cooperative.
- The initial commitment to the Biofuels Initiative included two components: (1) \$40.7 million in capital, which was appropriated in FY 2008 and is expected to be fully encumbered by the end of the year for the biorefinery, PDU, and switchgrass utilization demo, and (2) \$29.75 million in operating, which is spread over 5 years and is primarily used for the switchgrass farm production program, R&D, initial operation of the facilities, education, and administration. Operating funds have been received in FY 2008, FY 2009, and FY 2010. The initial commitment includes additional appropriations of \$5.3 million in FY 2011 and \$5.3 million in FY2012. Since farmer switchgrass contracts are for 3 years, all three years of those payments are encumbered at the time the contract is signed. Thus, the bulk of all operating funds received to date are required for the farmer contract program.

- Without the final two installments of the operating funds, the program would likely:
  - be required to scale back the acreage it could enroll in the switchgrass program,
  - cut back on the work it is doing to expand the program statewide,
  - cut back on efforts to work with commercial partners to develop new commercial investments in the biomass industry, and
  - scale back important R&D efforts around biomass production, co-products, and biomass supply chain improvements (all of which have significant potential to generate new IP for the university).

***Are we using state dollars to subsidize large, financially stable corporations, DuPont and Danisco and their joint Venture DDCE?***

- Working in partnership with DDCE, we will speed the time from state subsidies to independent commercialization. DuPont and Danisco have jointly invested \$140 million to develop the first pilot and demonstration facilities, in addition to their respective legacy investments in technologies. The powerful public-private partnership formed by the State of Tennessee, UT/Genera Energy and DDCE is critical to helping Tennessee become a clean-fuel state. Our collaboration is creating jobs, strengthening our state's agricultural leadership, and accelerating the national development and deployment of cellulosic ethanol