

**Contract No. R-008-017**  
**"Energy Beet Research"**

Submitted by Green Vision Group, Inc.  
Principal Investigator: Maynard Helgaas

**PARTICIPANTS**

<b>Sponsor</b>	<b>Cost Share</b>
Ag Country	\$ 5,000
Amity Tech	\$ 5,000
Carrington Econ. Dev.	\$ 1,000
Garrison Diversion	\$ 2,000
Griggs/Steele Wind	\$ 40,000
ND Water Foundation	\$ 5,000
RRV Sugar Beet Growers Association	\$ 500
Ottertail Power	\$ 5,000
Stanley Consulting	\$ 8,500
Beta Seed	\$ 5,000
Green Vision	\$ 500
Syngenta	<u>\$ 5,000</u>
Subtotal Cash Cost Share	\$ 82,500
Green Vision Group, Inc.	\$ 99,062(in-kind)
Beta Seed	\$ 41,700 (in-kind)
Syngenta	<u>\$ 12,800 (in-kind)</u>
Subtotal In-kind Cost Share	\$153,562
North Dakota Industrial Commission	<u>\$165,000</u>
Total Project Cost	\$401,062

Project Schedule – 24 months  
Contract Date – July 19, 2010  
Start Date – April 1, 2010  
Completion Date – March 31, 2012

Project Deliverables:  
Report on Burn Test & Yield Trials: September 1, 2010 ✓  
Report on Juice Storage & Education Prog.: December 31, 2010✓  
Final Report Burn Test & Yield Trials: December 31, 2010 ✓  
Final Report Juice Storage & Education Prog.: March 31, 2012 ✓

**OBJECTIVE/STATEMENT OF WORK:**

This is Phase 2 of a three-phase project. This phase aims to advance the creation of an energy beet biofuel industry in five regional locations across North Dakota. The five targeted regions include: Oakes, Carrington, Hannaford, Turtle Lake and Williston. To accomplish this, the project will consist of four specific objectives:

- Conduct a commercial scale burn test of the combustion properties and lifecycle impacts of spray dried waste broth produced as co-products of energy beet biofuel production.
- Conduct dryland and irrigated energy beet yield trials at five regional locations across North Dakota.
- Develop processing methods to improve storage life of energy beet light juice.
- Conduct producer and community education programs in the five targeted regions.

This project is spearheaded by the private sector with plans to build five 20 million gallon per year ethanol plants across North Dakota in Phase 3.

## **STATUS**

Contract drafted and waiting for execution. Work has begun on the project.

Contract has been executed.

### **October, 2010**

The Interim Report on Burn Test and Yield Trials was received in September. The interim report includes the following information:

*Burn Test* – The first thing SCI did was to send a sample of the stored stillage to SDK Labs for analysis to see if there was any degrading of the material in the 18 months it has been in storage. There were no changes in the stored material.

SCI then sent 20 gallons of the stillage to Aveka for spray drying and Aveka submitted a report on the spray drying operation along with ten pounds of the energy powder. The energy powder was sent to Hazen Labs to perform a proxy and burn analysis.

Through an RFP process Hurst Boiler was selected to conduct the actual burn test. Work is being done to prepare for the burn test. This test will supply the verification of our process, the design and material of the boiler required and the stack emission information that is needed for environmental permitting.

*Yield and Demonstration Trials* – Yield and demonstration plots were managed by Blain Schatz, Director, Carrington Research Center and were located at five ND sites—Carrington (dryland & irrigated), Hannaford (dryland and irrigated), Oakes (irrigated), Turtle Lake (irrigated) and Williston (irrigated).

Three of the plots were planted mid-April (Carrington, Hannaford & Oakes) and two early May (Turtle Lake and Williston). Plot tours were held at the Williston location in early August and at Oakes on August 17, Hannaford & Carrington on August 18 and Turtle Lake on August 19. The tours were well attended by area farmers and community business leaders. A total of about 100 people attended the tours and their reaction was “wow”. They were very impressed by the quality and size of the beets in the plots. Extension Agents and seed company representatives from Syngenta Seeds estimated irrigated yields with good weather to be 40 ton/a. irrigated and 28 ton/a. dryland. We would describe the plots as a major demonstration program of our research grant activities and has created a great deal of interest in the communities.

### **January, 2011**

The December interim report was received in early January with extensive information about the work that had been done. The interim report provided information on each of the following five components of the work being conducted under this contract:

*Education & Extended Program* - In addition to numerous meetings held throughout 2010 (some were held prior to the funding provided by the Commission) two billboards have been funded to be located at Bismarck and Cooperstown. A website has also been developed [www.BeetsAllBiofuel.com](http://www.BeetsAllBiofuel.com) to use as a vehicle to deliver project updates, education, information and other programs associated with the project.

*Yield and Demonstration Trials/Program* - The series of energy beet variety trials were conducted as outlined in the earlier report. Both the dryland and irrigated beet trials at Carrington were harvested on October 21. The irrigated trial at Oakes was harvest October 20. The performance of energy beets in the Carrington and Oakes variety trials was excellent. The two irrigated sites averaged more than 37

tons per acre with sugar yields averaging more than 13,000 pounds per acre. The dryland site at Carrington averaged 25 tons per acre which represents a performance level competitive with sugar beets grown in the Red River Valley. Energy beet variety performance within the three trials conducted in collaboration with “Syngenta” identified varietal differences in root yield, sugar content, and overall sugar yield. The group of energy beet variety trials conducted in collaboration with “Betaseed” in Dazey, Turtle Lake and Williston were harvested in late September and October. Review of the energy beet performance from these trials would indicate very positive root yields and sugar content. The results from these trials clearly demonstrate that energy beet varieties respond differently across these three locations.

*Burn Test* - The purpose of the project was to make sure that the dried waste stillage from the distillation process of a beet or molasses based ethanol plant could be burned in a commercial boiler and if so to examine the carbon life cycle effects.

The work accomplished was to dry more of the waste stillage, analyze the powder again and to provide powder to the boiler producers to determine if the powder could work in a commercial scale. The boiler manufacturer selected for the actual burn test was Hurst Boiler. They conducted a commercial burn test and determined that the powder would work in their boiler and then provided costs estimates for the boiler system.

Stanley’s compared the financial and carbon life cycle information against using natural gas or an anaerobic digester instead of using the powder.

The project results show that although the powder system costs more capital in the beginning, it does work and that the additional energy recovered by the powder, the reduction in fossil fuel use and the lower carbon life cycle from the powder may justify the additional capital.

The potential application is in the use of the system in developing a stand-alone sugar based feedstock ethanol plant that is energy efficient and has a lower carbon foot print. Another application is to co-locate a beet ethanol plant next to either an existing power plant or ethanol plant to reduce their carbon foot print, by using the energy powder in their boilers to replace fossil fuel.

*Juice Storage* - A literature review was completed related to Improving Beet Juice Storage Life.

*Demonstration Plant Development* - Green Vision Group (GVG) and Heartland Renewable Energy (HRE) (collectively, the Partners) have embarked on a plan to develop an energy beet to ethanol “demonstration plant” prior to completing a full-scale commercial production plant. Key factors leading to the demonstration plant approach include the following:

- Project financing for a Greenfield commercial project during the global recession has been very difficult, if not impossible. The federal government’s funding support mechanisms for new renewable energy project developments tend to focus on cellulosic and algae feedstocks; not sugar from beets.
- HRE’s technology adopts various “sugar to ethanol processing” technologies or attributes from around the world. But these attributes have not been implemented in on facility before. One of these technologies include the conversion of what would normally be a waste stream material into about 70% of the plants thermal energy requirements. The process was patented, and has been proven in commercial scale burn tests at boiler manufacturers, but not in a commercial ethanol production plant.

- Successful demonstration plant results are important to prove both the technology and economic attributes of the project, and will allow for an “engineer, Procure, Construct” (EPC) or general contractor to provide performance guarantees to satisfy equity and debt funding sources.

The Partners have conducted multiple meetings with two prospective joint venture partners for the demonstration plant site, both with facilities located in North Dakota. The plan is to co-locate with an existing facility which can provide a portion of the equipment required for the demonstration project, thus reducing the capital cost required. The goal is to have the demonstration plant in operation by the end of 2012.

An initial meeting with an EPC has also been held and the company is currently doing its due diligence on information provided by the Partners. A successful conclusion may lead to match funds for the demonstration plant. Meanwhile, the Partners are also approaching others for the demonstration project match funding.

In addition to the information above, the Contractor provided a report on a European Energy Beet Tour taken in June, 2010. This was not a part of the original application but the report was provided as support for the ongoing work of the Contractor.

#### **June, 2011**

The Contractor has submitted a request for an amendment to the project. They are seeking authority to reallocate unused funding within the budget from one area to another area.

It is the intention of the Contractor to submit an application for additional funding during the special round that has an application submission deadline of July 1.

#### **July, 2011**

Industrial Commission, based on the recommendation of the Renewable Energy Council, on July 20, 2011 granted authority for the reallocation of funding between budget categories. The application for additional funding has been submitted for Council/Commission action.

#### **January, 2012**

The Industrial Commission, upon the recommendation of the Renewable Energy Council, approved funding in the amount of \$500,000 for Phase II of the Energy Beet Project. (See summary for Energy Beet Research, Phase II – Contract R-013-025.)

#### **April 1, 2012**

The Storage Life of Raw Thick Beet Juice for Ethanol Production report from North Dakota State University has been received. A copy of the full report is available upon request. The Executive Summary states the following:

“Studies were carried out to characterize stored raw thick juice from sugar beets as a first objective of this research project. The results obtained through experimentation suggest that it is possible to store raw thick juice in a stable manner through pH and refractometric dissolved solids (RDS) content adjustments.

“Raw thick juice was stored anaerobically at acidic and alkaline pH. The stable RDS, pH values, and fermentable sugars content in a raw thick juice stored for up to 12 weeks under acidic pH values indicate

a high probability of successful long-term storage. High acid conditions (pH 2 or 3) actually increased the content of fermentable sugars through hydrolysis of complex carbohydrates. Under alkaline conditions, abrupt drops in pH values are a concern in the sugar industry when storing thick juice. However, a pH decline did not actually indicate a significant loss of total fermentable sugars in this study. A second raw thick juice storage experiment is being conducted and it will have an estimated duration of six months (Objective 2). To fulfill this objective, 600 mL of raw thick juice is being stored in 950-mL amber jars. The pH of the stored samples is being monitored weekly and adjusted to its original value as necessary. This is done to prevent microbiological activity and avoid a loss of fermentable sugars. Allowing headspace in the storage containers and the routine monitoring and control of juice pH are common factory practices. Following the storage experiment, the viability of the stored samples will be evaluated through a fermentability test (Objective 3). Objectives 2 and 3 will be completed by the end of June, 2012.

“A small companion study was carried out to quantify total fermentable sugars in beets stored anaerobically at a temperature of 4°C for 10 weeks. Results showed a sugar loss of less than 10% under the storage conditions used. However, techniques such as modified and controlled atmosphere storage have been successful for the preservation of many perishable crops. A study combining modified atmosphere with temperature adjustment is underway. Results will assist in determining if such a technique is viable for the preservation of fermentable sugars in stored sugar beets.”

The Final Report for the Phase I Education program has also been received. A copy of the report is available upon request. The Summary states:

“Education, communications and promotion of the energy beet project are necessary as energy beets are a new industrial crop for growers and renewable energy beets as feedstock would be new to the biofuels industry in North Dakota and North America. The planning process we used was to identify what areas could they be economically grown and processed. In maintaining low carbon emissions we needed to keep transportation at a minimum in qualifying energy beets as an advanced biofuel. The production area was determined to be within a 20-mile radius of the processing plant.

“GVG identified those communities with qualifying infrastructure and energy beet production potential and began presenting the project through local information and education meetings. We presented the project to all twelve collaborating communities and also held specific grower information meetings in most of the twelve communities.

“The best promotional and education tools we initiated was the demonstration and yield plot tours, attended by fifty to seventy growers and community leaders. We have plans to expand the number of plots near collaborating communities from nine this past year to thirteen in 2012.

“The best promotional activity was the Media Event held December 13, 2010.

“Going forward, we plan to identify where the first plant will be built and begin to hold several meetings with those area growers as well as providing educational information to all other collaboration communities and growers.”

A one-page summary of this project has been posted on the website.