SDTC Announcement 2007

Vidir Biomass Inc. (bstNRG) Round 11-2007A

Environmental benefits: Climate Change / Clean Air / Clean Soil

Total Project Value: **$12,658,000**
SDTC Funding: **$ 4,570,000**
Leveraged Funding: **$ 8,088,000**

Demonstration of Community Combined Heat and Power (CHP) District Heating System Using Standardized Agricultural Solid Bio-fuels

Cost-effective distributed energy systems have been a challenge for most small communities. This project will demonstrate a Biomass Combined Heat and Power system in a rural community which uses a variety of distributed agricultural biomass as an alternative to burning coal and other fossil fuels. Vidir Biomass, the lead proponent, is developing a two-stage 2 MWth combustor which vitrifies the high silica content associated with straw. Vidir's partners in the project will further develop a low cost feedstock densification technology (biomass cubing) and also a proprietary thermodynamic power cycle to produce hot water and electrical power to demonstrate a district heating system for rural communities.

Original Consortium Members

Vidir Biomass Inc.
Entropic Energy Inc.
Prairie Bio Energy Inc.
Community of Saint Laurent
Manitoba Hydro
University of Manitoba

Work Plan and Statement of Project Objectives

1. Project Description

bstNRG Inc and Prairie Bio Energy Inc. will endeavor to develop and demonstrate three technologies which, when integrated, form a reliable bio-energy system that uses low value agricultural feedstock to supply power and heat to V-bins manufacturing plant in Morris, Manitoba. This project will showcase high efficiency, reliability and cost competitiveness in a semi-rural setting. The Consortium recognizes a common market of clients who seek to displace natural gas, propane, coal and grid electricity with renewable energy generated on-site. Prairie Bio Energy is developing proprietary technologies to capitalize on the solid bio-fuels market based on a low cost densification process, flexibility in biomass feedstock and use of municipal industrial wastes. bstNRG is developing two-stage combustor technology that can use low cost 500-kg (1,000 lb) round straw bales as feedstock and which is also capable of handling the high concentration of silica and potassium found in this feedstock. bstNRG expects to select a suitable partner/contractor which can provide a technology that can cost effectively generate 100 kWe of electricity and produce hot clean air at 170°C for space heating. A potential intended partner/contractor for such a technology is Manitoba Hydro who is demonstrating a series of technologies to convert raw biomass into useful energy through the Corporation's Bioenergy Optimization Program Demonstration Project. This project has been recommended for funding from the Government of Canada's Clean Energy Fund being administered by Natural Resources Canada.

Two technologies that Manitoba Hydro is deploying as part of the project are (1) an Organic Rankine Cycle (ORC) power generation system and (2) a Stirling engine power generation system. Both systems are powered by waste heat sources.

The ORC system is based on using R245FA refrigerant as the working fluid. The refrigerant is evaporated by means of a low to medium temperature waste heat source and then passed through a microturbine generator. The refrigerant is condensed and then pumped back to the evaporator where the cycle repeats. The ORC system being used is a model WHGI25 manufactured by Calnetix Power Solutions in Stuart FL. The WHG125 is capable of delivering

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100 kW of electricity, a size which is equivalent to the output of the proposed Wet Brayton Cycle power generation system. The specifications for the ORC system are attached. This product has not yet been installed and operated in Canada.

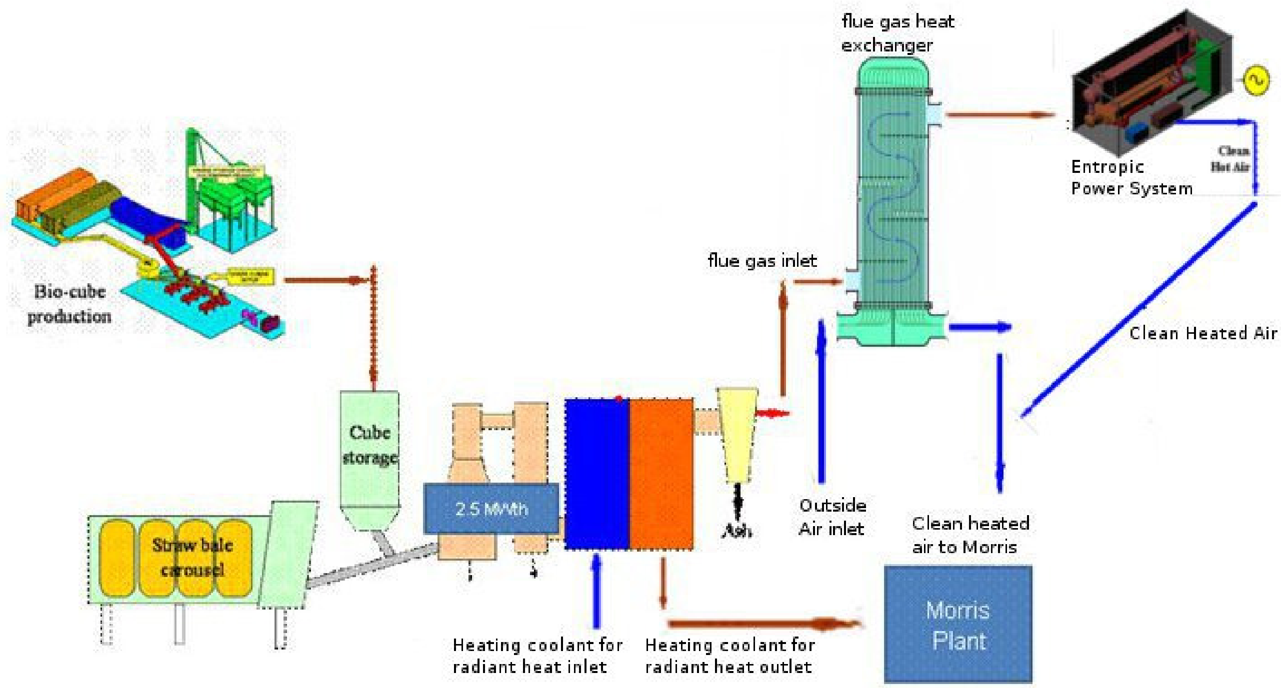
The Stirling engine system is based on using hydrogen as the working gas. The hydrogen transfers high temperature heat to the engine. The hydrogen is transferred back and forth between hot and cold portions by the motion of the engine cylinders. Expansion of the hot gas provides the driving force to turn the generator. The Stirling engine being accessed is a modified FleXgen unit manufactured by Stirling Biopower in Ann Arbor MI. The modified FleXgen will be capable of delivering 50kW of electricity. The modifications required entail equipping the unit with a combustor capable of handling 900 C temperature exhaust gas streams with moderate size particulate loading. This product has not yet been installed and operated in Canada.

Another potential contractor is Entropic Energy Inc who could provide its wet Hybrid Brayton Cycle (HBC) technology for the purpose of the project. One of these partner/contractors will be able to provide the electricity generating technology needed to demonstrate the overall efficient combined heat and power (CHP) generation technology (see diagrams on next page). The selection of this partner/contractor will be undertaken during the Milestone 1 period and BstNRG may elect to submit a request to SDTC for additional funding to help offset any additional costs associated with the installation and demonstration of the CHP unit. The Consortium also includes Manitoba Hydro who will contribute grid connectivity to V-bins plant and the University of Manitoba to document results obtained from the demonstration.

The three interrelated bioenergy technologies involved in the Consortium consist of densification of biomass residues (in particular straw), thermal conversion of solid bio-fuels (straw bales and bio-cubes), and CHP production (generating electricity and clean hot air). Together these technologies can form an integrated supply chain for solid bio-fuel delivery and energy production that is cost competitive with fossil fuels and grid power. This Project supports three technology developments with their defined metrics and offers a coordinated demonstration of their synergy and ability to be integrated.

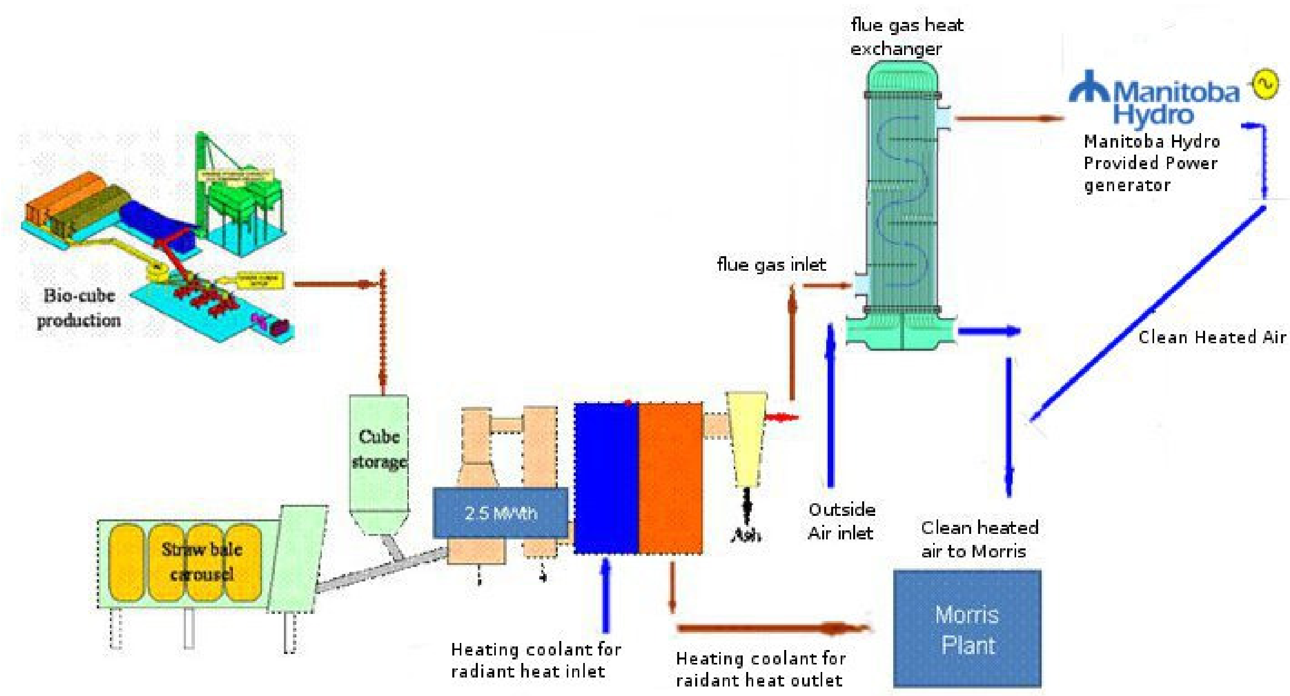
The Consortium seeks to demonstrate efficient energy conversion and affordability on small-scale application to release new sources of renewable energy. Traditional approaches of large bioenergy plants have limited practicality due to huge investments, costly biomass transportation and little opportunity for co-generation economics. Small-scale CHP places the energy market into the hands of small industry, communities and individuals. Greater market impact will result when small-scale biopower is commercially viable due to the proven technologies that this Project represents.

Option 1: Prairie Bioenergy, Entropic and BstNRG



1. Fuel for this system is fed from either the straw bale carousel or the bio-cube storage bin.
2. Biomass fuel is then gasified in the BstNRG combustor and burned in the secondary combustion chamber.
3. Heat produced by the secondary combustion chamber is used in a liquid to air heat exchanger for radiant heating.
4. The heat from the flue gas will be passed through the Entropic power generation system to produce 100 kWe of electricity and clean hot air.
5. The remaining heat from the flue gas heat exchanger and entropic system will provide heated air to the powder coating oven.

Option 2: Prarie Bioenergy, BstNRG, 3rd party power generation



1. Fuel for this system is feed from either the straw bale carousel or the bio-cube storage bin.
2. Biomass fuel is then gasified in the BstNRG combustor and burned in the secondary combustion chamber.
3. Heat produced by the secondary combustion chamber is used in a liquid to air heat exchanger for radiant heating.
4. The heat from the flue gas will be passed through the Manitoba Hydro provided power generation system to produce 100 kWe of electricity and clean hot air.
5. The remaining heat from the flue gas heat exchanger and entropic system will provide heated air to the powder coating oven.

2. Sustainable Development Focus

2.1 Greenhouse Gas Emissions are mitigated directly by the displacement of fossil fuels through the generation of heat and power from GHG-neutral biomass. This project will bring commercial viability to the implementation of unused straw now being openly burned in farmers' fields. It will showcase a new CHP technology that can utilize biomass for energy capture. It will counter the emerging trend to use coal in small-scale combustion systems with unregulated emissions. Two forms of straw utilization will be demonstrated; loose bales and densified bio-cubes. In numerical terms, agricultural residues translate into a reduction of 1.05 tonnes CO_2 / tonne bio-cube; power displacement by Canadian average of 0.22 tonnes CO_2 / MW_Ehr; diesel displacement of 0.66 tonnes CO_2 / MW_Ehr and heating oil displacement of 0.26 tonnes CO_2 / MW_{TH}hr.

2.2 Clean Air is enhanced when displacing coal combustion systems. High temperature biomass combustors using cyclones reduce particulate emissions. A cyclone meets emission requirements in rural settings and a baghouse meets emission regulation in high population areas. Local use of straw bales reduces trucking costs; reducing associated exhaust emissions, odour and fossil fuel use. Avoiding the springtime burning of wheat stubbles in fields reduces a significant contributor to poor seasonal air quality.

2.3 Sustainability requires society's transformation from fossil fuels to renewable energy. This cannot happen unless there are commercially viable technologies that can be applied to available biomass resources capable of converting low-value renewable fuel into high quality forms of energy; electricity and transportable heat. This Project will bring three enabling technologies to commercial availability with the following benefits.

- Productive utilization of waste straw that is currently burned in fields every spring before new crops are planted
- Densification of straw resource into bio-cubes that can be combusted in a variety of commercial combustors
- Displacement of coal that is now burned in small-scale heat combustors
- Displacement of fossil fuels in small-scale gen-sets
- Creation of a new income stream from an agricultural waste product
- Availability of a viable small-scale CHP system for distributed power generation
- Increased investment into renewable energy production by making it affordable for individuals and communities
- Advanced quality of life in remote, forest communities by reducing noise, odour, spill and emission pollution
- Enhanced economy of remote, forest communities by reducing dependency on imported fossil fuels, creating employment and keeping energy dollars local

BstNRG Activities

BstNRG will operate the close-coupled combustor and CHP system at Morris, Manitoba for demonstration purposes. Power produced will be connected to the plant electrical system while the clean hot air will be used as is supportive of plant operations but in any case will be measured to determine the energy content. Shipments of bio-cubes from Prairie will be used in demonstration and data recorded. Straw bales will also be used for demonstration with data recorded.

Manitoba Hydro Activities

Manitoba Hydro will perform in-kind contribution to interconnect the power output of the integrated combustor – CHP system to the plant electrical system. Manitoba Hydro will monitor and record operational data for its own internal uses.

University of Manitoba Activities

The University of Manitoba will perform emissions testing of the BstNRG close-coupled combustor. This testing will be done on the combustor in a variety of operating conditions and fuel applications.

The University of Manitoba will perform tests and generate reports on the operation of the integrated combustor – CHP system. These reports will cover the operation of the system on various fuels and under a number of typical operating conditions.

Intellectual Property

This project is an application of existing technology with the intent of proving the equipment and systems as commercially viable products. It is intended to bridge the Innovation Chain, taking these technologies to commercialization by proving them in a real world test situation. The Consortium Members do not anticipate producing new intellectual property however this project will allow the respective companies to demonstrate background intellectual property in market ready systems. For the integrated application, non-exclusive revocable rights to the individual technologies will be granted to the other Consortium Members as may be needed for the fulfillment of this project and only for the duration of the project and through a Consortium Agreement these rights will be applied to any applicable third parties agreements until project end.

BstNRG has developed and tested its close-coupled combustor design for the specific and preferred application of straw burning. BstNRG has proven the fundamental design principle, has obtained a US patent on its straw bale shredder and has patent-pending status for its Biomass Gasification System. This project will apply their intellectual property and scale it to the larger size. The intent of this project is to prove the BstNRG technologies through demonstration and application. There is no transfer of intellectual property from BstNRG to other Consortium Members within the SDTC project.

Emissions Reduction Forecast

This emissions reduction forecast is a summation of the estimates for the individual technology implementations. It is recognized that each technology represents an independent opportunity for displacement of fossil fuels in a variety of applications. Although this project acknowledges a synergy which creates a solid fuel supply chain, this forecast looks beyond this particular effort to identify the greater contribution of the many additional applications for these technologies.

This forecast assumes that heat from the bstNRG close-coupled combustor will displace current heat sources that consume fossil fuels. The analysis uses a value of 73.16 kg CO2 equivalent per GJ for displacement as this represents the emission levels of diesel, light oil or heating oil. This is considered a conservative figure since some installations may actually be used to displace local coal consumption which has a higher carbon footprint. Biomass combusted is estimated to contain a HHV of 2.87 kJ per tonne dry but is considered available at 30% moisture content. It is further assumed that the bstNRG close-coupled combustor will supply heat at 75% thermal capture efficiency with respect to energy within the biomass fuel it consumes.

This forecast assumes that bio-cubes produced by Prairie Bio Energy will be used primarily to displace coal in local farm consumption. This is reasonable since Prairie is particularly aware of the installed base currently using coal and intends to focus on this market. This analysis uses a value of 88.84 kg CO2 per GJ for displacement which represents coal with a heating value of 14,000 Btu/lb and 78% carbon content. The thermal capture efficiency will be unchanged since the same technologies will be used for both fuels.

This forecast assumes that power and heat generated by the Entropic HBC system will displace diesel generated power in its first installations and half of its future installations and will use 50% of its available heat productively. Diesel power represents 1.32 tonnes CO_2 equivalent per MW-hr of electricity at 20% conversion efficiency. The analysis uses a value of 73.16 kg CO_2 equivalent per GJ for displacement of heat as this represents the emission levels of heating oil. For grid connected power the Canadian average value of 0.221 tonnes CO_2 equivalent per MW-hr is used.

Finally it is assumed that no installations will be made during the three year project schedule and new installations will commence immediately following. The reporting time of three years following project completion is used for the forecast. This forecast contains forward-looking statements that are qualified by uncertainties and risks that could cause actual results to differ materially from what is contemplated here and may include, without limitation, general economic conditions, market conditions in which the technology companies are engaged as well as behaviour of customers, suppliers and competitors.