Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)

LCCMR ID: 168-F3+4

Project Title: Strategically using Minnesota's Biomass for Heat and Electricity

Category: F3+4. Renewable Energy

Total Project Budget: $ $291,000

Proposed Project Time Period for the Funding Requested: 2 yrs, July 2011 - June 2013

Other Non-State Funds: $ 0

Summary:

This project connects sources of biomass with statewide needs for heat and electricity. Learning where to utilize both will promote economic markets for biomass while supporting environmental conservation throughout Minnesota.

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Sponsoring Organization: U of MN

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Web Address

Location

Region: Statewide

Ecological Section: Statewide

County Name: Statewide

City / Township:

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ Employment	_____ TOTAL _____%

PROJECT TITLE: Strategically using Minnesota's Biomass for Heat and Electricity

I. PROJECT STATEMENT

Protecting Minnesota's natural resources—our waters, wildlife, soils, and biodiversity—while meeting our energy needs requires integrated planning at the highest levels of state government and industry. We propose an innovative way to support that planning by linking energy, environment, and agriculture. These are often seen to be in conflict, but in the future we envision, they need not be.

Importance: Contemporary electrical plants capture only about one-third of their fuel's energy. The remaining two-thirds is unused, lost as waste heat*. Such poor efficiency results from three constraints, (1) inherent limits in the laws of physics that govern energy conversion, (2) far too much heat generated to be used in any single geographic location, and (3) the impracticality of transporting heat very far. Electricity can be transported long distances but heat cannot.

Therefore, greater than two-to-one improvements supporting renewable energy result from (1) targeting smaller electrical plants in the future that generate only the amount of heat needed, (2) locating those plants where heat can be used, (3) transporting the electricity over a distributed electrical grid, and (4) designing for available feedstocks, including grassland and woodland biomass as well as agricultural residue. The state's consumption of raw energy for electricity can be reduced by more than two times, from a present efficiency of less than 40% today to more than 80% in the future, by not wasting the heat.

Auxiliary benefits. Major side-benefits are: (1) Biomass fueling the plants will be carbon-neutral or negative. (2) Restored lands for bioenergy will increase wildlife habitat and restore soil fertility. (3) Judiciously placing biomass sites to buffer agricultural runoff will purify Minnesota's waters. (4) The economy will improve from a new local fuel source. (5) Jobs will be distributed across the rural landscape. (6) Transportation costs of biomass will be reduced.

Examples. Processes that can utilize heat include dehydrating food, such as potatoes or pasta; baking on paint; heating and cooling homes and businesses; climate-controlling year-round greenhouses. Rahr Malting of Shakopee is a local example of an electrical facility designed to utilize the heat from renewable energy. The general idea of combining heat and power is not new but the timing is right to accomplish the goals in upcoming years with proper planning now.

Goals. The goals of the project are to:

- ¤ Quantify current and potential future biomass sources state-wide.
- ¤ Locate current and potential future heat and electrical energy consumers.
- ¤ Determine the realistic sustainable conversion rate of biomass to heat and electricity.
- ¤ Develop an economic model for optimally connecting biomass energy with community and industrial needs for heat and electricity on a statewide level.

Work plan: We will identify existing facilities that can utilize biomass for heat or power production with limited renovations. Moving forward, we will identify where new facilities could be located and determine what conversion technologies would be most suitable. We will quantify economic parameters based on local feedstock sources and industry needs, applying previously tested quantitative models to determine where bioenergy will be most efficiently produced and consumed for greatest economic and environmental benefit throughout Minnesota.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Identify existing and locate potential heat/energy users **Budget:** $62,000

For combined heat and power (CHP) to be economically viable requires above 80% utilization of heat generated. Not only are large users required but the electrical grid must be capable of transmission to and from the selected sites.

Outcome	Completion Date
1. Develop a database of known and potential heat users by location.	*January 2012*
2. Assess electrical grid capacity and overlay with data base.	*April 2012*

* *A large giga-watt electrical plant generates approximately two gigawatts of heat, usually in the form of low pressure steam in cooling towers or plumes.*

Activity 2: Create biomass availability maps **Budget:** $67,000

Expand the data-based model generated by previous state-funded UMN Biofuels Feasibility Studies for White Earth and Chisago, Isanti and Pine counties (2009) to predict productive capacity for establishing and sustainably harvesting native grasses, woody biomass, and agricultural residue statewide.

Outcome	Completion Date
1. Schedules for establishing seed-base and achieving mature plantings capable of supporting an economically viable region.	*June 2012*
2. Inputs required to achieve economically acceptable biomass yields.	*October 2012*

Activity 3: Quantify economic modeling parameters **Budget:** $71,000

Develop interactive economic model based on discounted cash flow that includes capital cost, operating costs, biomass feed stock costs and other relevant inputs for the optimization model in activity 4.

Outcome	Completion Date
1. Quantified material and energy balances, operating labor, maintenance, utilities cost for CHP plants as a function of scale.	*November 2011*
2. Capital cost estimates including site development, permitting, engineering, etc. for various size CHP plants.	*January 2012*
3. A robust spread sheet model based on discounted cash flow that will compute internal rate of return and net present value for a variety of scenarios.	*April 2012*

Activity 4: Develop biomass economic model **Budget:** $91,000

Develop an optimization algorithm using linear programming that can effectively integrate the data presented in activities 1, 2 and 3 into a data-based model, based on past successful efforts, to produce a comprehensive plan for optimizing Minnesota's renewable energy industry in upcoming decades.

Outcome *A robust working optimization model showing optimum location of biomass conversion plants.* **Completion Date** *June 2013*

III. PROJECT STRATEGY

Project Team/Partners. Faculty members involved with this project include Dr. Ken Valentas as project manager, to provide engineering expertise and write reports, Dr. Massoud Amin for expertise on power grids, Dr. Clarence Lehman for experience on bioenergy and associated ecosystem services, plus computer processing, Dr. Steven Taff for his experience on economic modeling of agricultural and natural systems. We will work in cooperation with engineering and design firms. Valentas and Lehman will receive funds from the grant; Taff and Amin will provide in-kind time.

Timeline Requirements. We are requesting two years of funding to complete the activities listed.

Long-Term Strategy and Future Funding Needs. Development of a sustainable biomass industry is a "chicken and egg" dilemma. Facilities that generate power from biomass won't be built unless there is a feedstock supply, and that supply will not be cultivated until there are facilities to buy it. This project is one essential component of a suite of projects designed to understand the social, ecological, and economic responses to incorporating bioenergy into Minnesota's power grid. The diverse team participating in this integrated suite of projects allows us to leverage funds from other disciplines that are related to the efforts of this project.

2011-2012 Detailed Project Budget

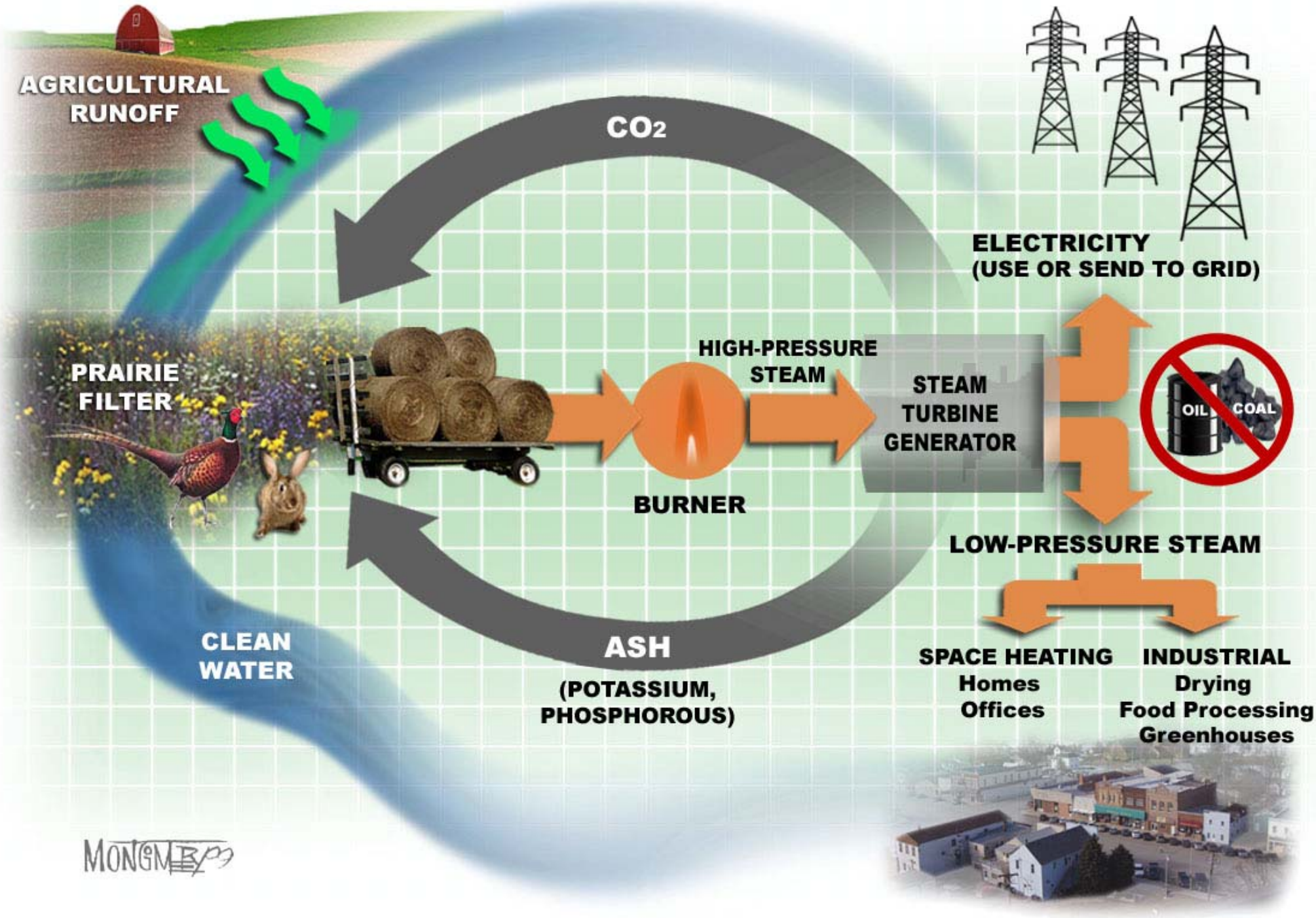
Strategically using Minnesota's biomass for heat and electricity

IV. TOTAL TRUST FUND REQUEST BUDGET *2* years

BUDGET ITEM *(See list of Eligible & Non-Eligible Costs, p. 13)*	**AMOUNT**
Personnel: Academic -- Ken Valentas (2 years 20% FTE w/benefits) $60,000; Clarence Lehman (2 years 25% FTE w/benefits) $50,000;	$ 110,000
Personnel: Students -- Pre or Post-doctoral researchers -- (4 years Full-time w/ benefits) $40,000/year	$ 160,000
Contracts: Engineering and design services	$ 15,000
Travel: For trips to various regions of Minnesota to collect data	$ 6,000
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST	$ 291,000

V. OTHER FUNDS

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period: *Indicate any additional non-state cash $ to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	$ -	*Indicate: Secured or Pending*
Other State $ Being Applied to Project During Project Period: *Indicate any additional state cash $ (e.g. bonding, other grants) to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	$ -	*Indicate: Secured or Pending*
In-kind Services During Project Period: *Indicate any in-kind services to be provided during the funding period. List type of service(s) and estimated value. In-kind services listed must be specific to the project.*	$ -	
Remaining $ from Current ENRTF Appropriation (if applicable): *Specify $ and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspect or not yet legally obligated at the time of proposal submission. Be as specific as possible. Describe the status of $ in the right-most column.*	$ -	*Indicate: Unspent? Not Legally Obligated? Other?*
Funding History: *Indicate funding secured prior to July 1, 2011 for activities directly relevant to this specific funding request. State specific source(s) of funds.*	$ -	


AGRICULTURAL RUNOFF
CO_2
ELECTRICITY
(USE OR SEND TO GRID)
PRAIRIE FILTER
HIGH-PRESSURE STEAM
STEAM TURBINE GENERATOR
OIL
COAL
BURNER
LOW-PRESSURE STEAM
CLEAN WATER
ASH
(POTASSIUM, PHOSPHOROUS)
SPACE HEATING
Homes
Offices
INDUSTRIAL
Drying
Food Processing
Greenhouses

Project Manager Qualifications

Kenneth Valentas is Adjunct Professor in the Biotechnology Institute (BTI) at the University of Minnesota. Previously he was Director of the BTI for 16 years and Associate Director for two years. Prior to joining BTI, Valentas was Vice President of Engineering at Pillsbury, and in total dedicated 24 years in industry at Sinclair Oil, General Mills and Pillsbury/Grand Met. He holds seven patents related to process engineering.

His PhD in Chemical Engineering is from the University of Minnesota under Regents Professor and former head Neal Amundson. Valentas is a recognized expert in process engineering and the author of two books on the subject. His research while at the BTI has focused on renewable energy with particular emphasis on thermochemical processing and hydrothermal carbonization of biomass.

As Director of the BTI, Valentas has gained particular expertise in managing teams of inter-disciplinary researchers. The most pertinent experience relevant to this proposed project was his role as principal investigator and project manager for two state funded Biofuel Feasibility Studies[1,2]. The highly successful inter-disciplinary project team was composed of some of the same individuals participating in this proposed project. The present project team is inter-disciplinary and comes from the departments of Ecology, Evolution and Behavior; Applied Economics; Electrical Engineering; and the Biotechnology Institute.

(1) Valentas et al (2009) "White Earth Biofuels Feasibility Study", 94pp., Funded by MNDA under Minnesota statute 48A.10.
(2) Valentas et al (2009), "Chisago, Isanti and Pine Counties Biofuels Feasibility Study",90pp., Funded by MNDA under Minnesota Session Laws 2007 Chapter 45.

Copies are posted at www.bti.umn.edu

Organization Description

The University of Minnesota is the state's main research and graduate teaching institution. Our university has been repeatedly ranked number-one in the nation for Ecology/Environment and Chemical Engineering, based on the citational influence of its scientific publications.