

**Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 135-H

Ready-to-use Fuels Production and Waste Remediation Demonstration Project

Topic Area: H. Renewable Energy

Total Project Budget: \$ 1,555,000

Proposed Project Time Period for the Funding Requested: 3 yrs. July 2013 - June 2016

Other Non-State Funds: \$ 0

Summary:

To demonstrate the application of pyrolysis and algae technologies developed through LCCMR funded projects for the production of fuels using used tires and wastewater derived algae and sludge as feedstocks.

Name: Roger Ruan

Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>	Employment	<input type="checkbox"/>	TOTAL <input type="checkbox"/> %



Environment and Natural Resources Trust Fund (ENRTF)

2012-2013 Main Proposal

PROJECT TITLE: Ready-to-use Fuels Production and Waste Remediation Demonstration Project

I. PROJECT STATEMENT

Many new bioenergy technologies are facing economic barriers and their environmental impacts are unknown. The proposed project will take an innovative approach to develop and demonstrate an integrated bioenergy production and waste remediation facility based on the technologies developed through previous LCCMR funded projects, the "Pilot Pyrolysis Project" (2007-2010), and the "Pilot Algae Fuel Project" (2010-2013). We will demonstrate the application of these two technologies for the production of ready-to-use (or "drop-in" as described by DOE) fuels using three feedstocks, i.e., recycled tires (currently used mainly for landscape decoration), and algal biomass and sludge derived from wastewaters.

Our studies have clearly indicated that the bio-fuels produced from used tires (and plastics, both of which were tested during the Pilot Pyrolysis Project) and algal biomass using our pyrolysis process are superior to those from cellulosic feedstocks because used tires and algae contain much higher hydrocarbons and no lignin. By using wastes as feedstock for energy production and at the same time remediating the wastes, the approach is expected to significantly improve the economic outlook of these technologies and move a major step towards the commercialization of these technologies while providing **multiple measurable ecological benefits** including improving water quality, minimizing freshwater and land use, reducing carbon emission, and producing cleaner energy. Freightmasters Logistics (Eagan, MN), who has long been interested in our pyrolysis technology for renewable fuels production and has access to unlimited supply of used tires, will partner with us to develop the demonstration facility in Freightmasters Logistics location where algae will be grown using the wastewater from nearby MCES' Seneca Plant (See attached maps).

Building on the knowledge previously gained and leveraging the technical and business expertise of Freightmasters Logistics, we see an opportunity to combine the two technologies to produce renewable energy and add value to and treat wastes sustainably. Our experience in operating the pilot facilities developed previously will help ensure the successful development and operation of the proposed facility. The proposed work will include:

- Improvement and modification of pyrolysis and wastewater-to-algae processes
- Scale-up design and fabrication of pyrolysis and wastewater-to-algae production system
- Systems testing, demonstration, and life cycle analysis (LCA)

The key deliverables will be:

- An integrated system for ready-to-use renewable fuels production and wastewater treatment
- Demonstration of the pyrolysis and wastewater-to-algae production system to stakeholders
- Life cycle analysis with measurable outcome of environmental and ecological benefits

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Develop and build an integrated system for drop-in fuels production and waste remediation

Budget: \$ 1.3 million

These demonstration systems, to be built on Freightmasters Logistics site, will consist of:

- An improved wastewater-to-algae production facility
- An improved processing facility to convert tire, sludge, and algae to ready-to-use fuels

Prior to the development of these improved systems, process optimization, scale-up, and design will be carried out using existing pilot pyrolysis system and pilot algae production facility currently installed in Rosemount.

Outcome	Completion Date
1. Pyrolysis and wastewater-to-algae processes optimization, scale-up, and design	6/30/2014
2. Pyrolysis and wastewater-to-algae systems design, fabrication, and installation	6/30/2015
3. Pyrolysis and wastewater-to-algae systems testing	6/30/2015

Activity 2: Conduct renewable fuels testing and life cycle analysis (LCA)

Budget: \$210,000

We will collect technical and environmental data to evaluate renewable fuels quality, environmental and ecological impacts and benefits.

Outcome	Completion Date
1. <i>Collect technical data from the pyrolysis and wastewater-to-algae systems</i>	12/31/2015
2. <i>Collect environmental and ecological data</i>	12/31/2015
3. <i>Conduct life cycle analysis (LCA)</i>	6/30/2016

Activity 3: *Demonstrate the systems to stakeholders and disseminate and report results* **Budget:** \$45,000

After the improved pyrolysis and wastewater-to-algae systems are tested and remaining issues are resolved, we will demonstrate the pyrolysis and algae systems to the stakeholders which are the citizens of the state of Minnesota. While the system will be made available to anyone to see, we will make extra efforts to invite law makers, LCCMR staff, people working with municipal, animal, and industrial wastewaters, high school and college teachers and students, entrepreneurs with interests in renewable energy production. Results from the project will be published through various publication mechanisms including peer-reviewed journals, technical conferences, workshops, and brochures. Summary data and results will be made accessible on the Internet through our and/or LCCMR's website. Progress reports will be submitted to LCCMR as required.

Outcome	Completion Date
1. <i>Public announcement and invitation for on-site demonstrations (5 on-site days)</i>	6/30/2016
2. <i>System is made available for demonstration to all stakeholders (3 field days)</i>	6/30/2016
3. <i>Publish results and submit report</i>	9/30/2016

III. PROJECT STRATEGY

A. Project Team/Partners

The project will be carried out by a team of researchers and engineers from University of Minnesota and personnel from Freightmasters Logistics.

Dr. Roger Ruan, Professor and Director, Center for Biorefining and Department of Bioproducts and Biosystems Engineering (BBE), UMN, will be the PI and project director. He will be responsible for overall project planning and budget control, development, design and evaluation of the demonstration system. He will also lead improvements, demonstrations and present project results. He is proposed to receive fund from LCCMR.

Dr. Paul Chen, Associate Research Professor and Program Director, Center for Biorefining and Dept. of BBE, UMN, will be a co-PI and coordinator of the project. He will also be responsible for experiment design, monitoring and documentation of project progress and results, and publicizing the project. He will also be involved in process optimization, scale-up and design, and LCA. He is proposed to receive fund from LCCMR.

John Snyder, Freightmasters Logistics, will be an industrial collaborator of the project, and the liaison between Freightmaster Logistics, Center for Biorefining and Seneca Wastewater Treatment Plant. Freightmasters Logistics will provide suitable outdoor sites for the construction of greenhouses and indoor sites for housing the downstream processing and conversion equipment, supply used tires, interface with Seneca Wastewater Treatment to provide the media for algae growth, provide physical support in all aspects of construction throughout the term of the project. He will not receive fund from LCCMR.

B. Timeline Requirements

This is a three-year project. The first two years are required to improve, develop and construct the pyrolysis and wastewater-to-algae systems. In the third year, the systems will be evaluated and demonstrated. Technical and environmental data will be collected for life cycle analysis work. Additional data will be collected during testing and demonstration, which will be of importance to further R & D and eventual technology transfer. The educational outreach and communication will be conducted throughout the project.

C. Long-Term Strategy and Future Funding Needs

The proposed project, built on our existing knowledge and expertise, does not need additional investment other than the requested financial support to complete. However, further R & D leading to eventual technology transfer and commercialization will be our long-term goal and may require additional funding. All patents and licensing and commercialization incomes will be shared with LCCMR as agreed between UMN and LCCMR.

2012-2013 Detailed Project Budget

IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel: All at University of Minnesota	
Roger Ruan, PI and PD, 16%, 3yrs, including 36% benefits, project management, overlooking R&D, leading demonstration, supervising postdocs and RA	\$ 102,956
Paul Chen, co-PI, 50%, 3yrs, including 36% benefits, project coordination, conducting R&D, project evaluation, progress report	\$ 150,402
2 Postdocs, 100%, 3yrs, including 23.2% benefits, conducting R&D, operations, demonstration, data analysis	\$ 341,483
3 50%-time Graduate Research Assistants, 3yrs, including 18.5% benefits and tuitions, conducting R&D, operationg, demonstration	\$ 367,514
Contracts:	
Outside consultant, to be determined for microwave conversion system improvements.	\$ 90,000
Equipment/Tools/Supplies:	
improved pyrolysis equipment and major components for wastewater to algae demonstration systems and auxiliary production and conversion equipment	\$ 180,000
General used tire, algae, and sludge pyrolysis and wastewater to algae production systems improvement operating and service including components fabrications, outside testing and analysis, etc.	\$ 123,636
Lab and operation supplies including materials for the covered outdoor simple greenhouse based algae production photobioreactor development and chemicals for production and analysis, etc.	\$ 139,091
Minor equipment/tools for fabrications and testings	\$ 15,455
Repairs and Maintenance including various equipment and analytic instrumentation repairs and maintenances	\$ 30,554
Travel: mainly for researchers travel between campus and demonstration site over the 3yrs project period	\$ 13,909
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 1,555,000

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ Being Applied to Project During Project Period:	none	
Other State \$ Being Applied to Project During Project Period:	none	
In-kind Services During Project Period: <i>Freightmasters Logistics has committed to provide outdoor sites for the construction of greenhouses and indoor sites for housing the downstream processing and drop-in fuel conversion equipment, interface with Seneca Wastewater Plant to provide the media for algae growth, and the physical support in all aspects of construction and demonstration throughout the term of the project</i>	\$ 307,800	Secured
Remaining \$ from Current ENRTF Appropriation (if applicable): current LCCMR funded algae for fuels pilot project, will be completed by 6/30/13.	\$ 250,000	<i>will be used up by 6/30/13</i>
Funding History: <i>M.L. 2010, Chp. 362, Sec. 2, Subd. 7a "Algae for Fuels Pilot Project", \$900,000; and M.L. 2007, Chp. 30, Sec. 2, Subd. 5o titled "Pyrolysis Pilot Project", \$500,000</i>	\$ 1,400,000	

PROJECT TITLE: Drop-in Fuels Production and Waste Remediation Demonstration Project

PI/PD: Roger Ruan, University of Minnesota

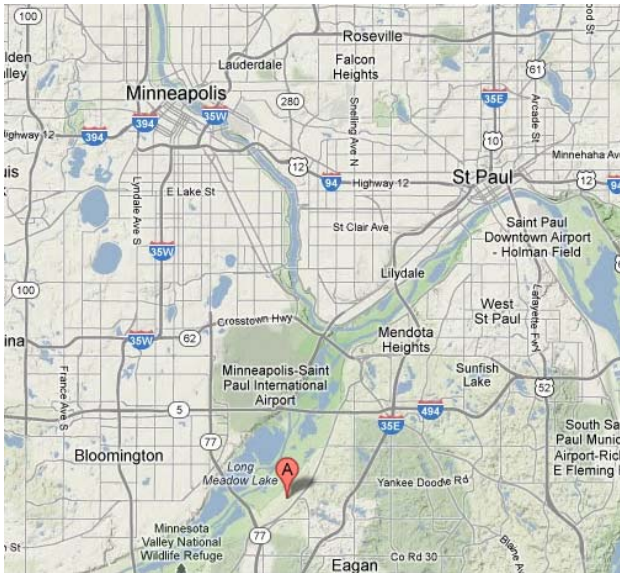


Figure 1. Map showing demonstration site in Twin Cities

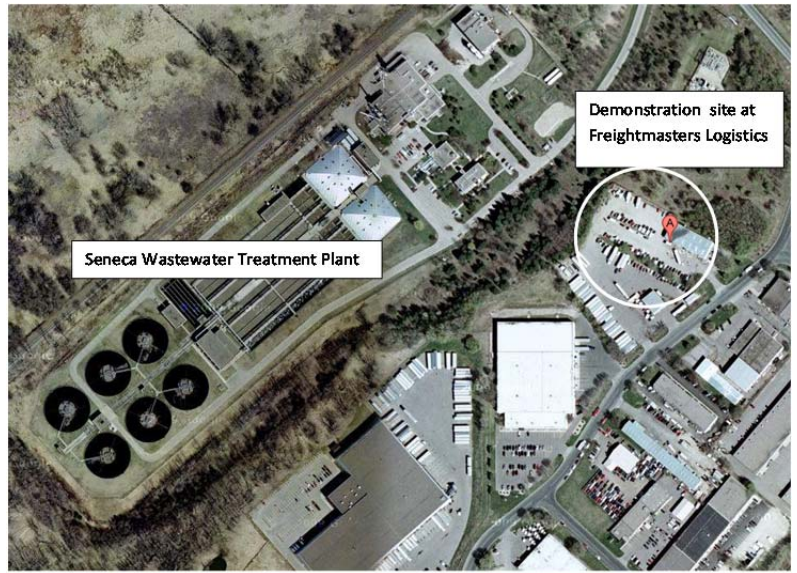


Figure 2. Map showing locations of Freightmasters Logistics and MCES' Seneca Wastewater Treatment Plant

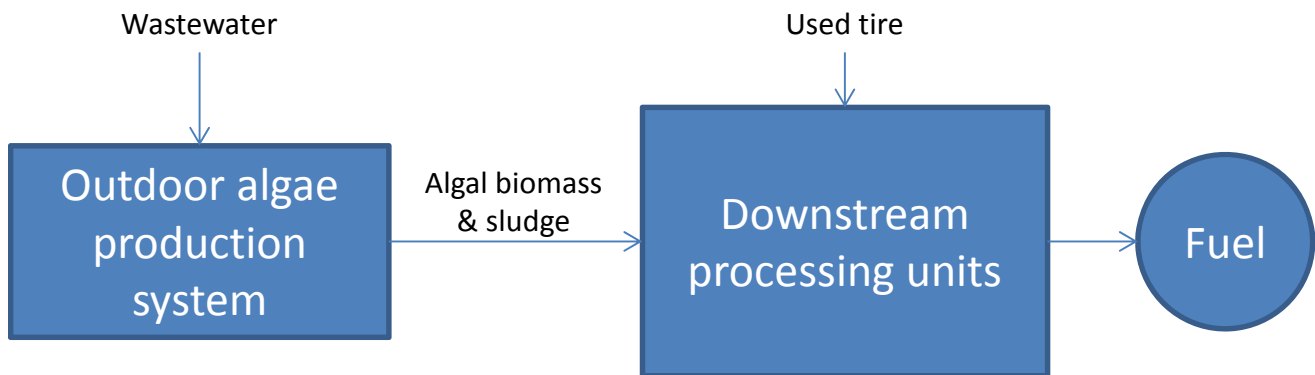


Figure 3. The covered outdoor algae production system will be built in an existing parking lot space. The downstream processing units will be housed in a tall ceiling building next to the parking lot. A fuel tank is about 30 yard away from this building, which can be used to store the fuels produced.

Project Manager Qualifications and Organization Description

Dr. **Roger Ruan**, Professor and Director, Center for Biorefining and Department of Bioproducts and Biosystems Engineering, co-leader of Bioenergy and Bioproducts Cluster of the Initiative of Renewable Energy and Environment (IREE), University of Minnesota, is the project director of the proposed project. Dr. Ruan is a leader in the bioenergy field. Dr. Ruan's research focuses on renewable energy and the environment as well as food safety and quality. Dr. Ruan has published over 200 papers in refereed journals, books, and book chapters, and over 300 additional meeting papers and other reports, and holds 13 US patents. He has supervised more than 40 graduate students, 60 post-doctors, research fellows, and other engineers and scientists, and 7 of his students hold university faculty positions. He has received over 120 projects totaling over \$20 millions in various funding for research. Ruan has given over 160 invited symposium presentations, company seminars, and short courses, and has been a consultant for many local, national, and international companies and agencies in renewable energy and products as well as food and value-added processing areas. Dr. Ruan has also given frequent interviews on related topics to various news media.

The research group led by Dr. Ruan has very active ongoing research programs on renewable energy. Thermochemical conversion (microwave assisted pyrolysis or MAP and hydrothermal treatment) and algae production and processing are the major focus of his current research. **Two of his bioenergy projects, the "Pilot Pyrolysis Project" (2007-2010, \$500K), and the "Pilot Algae Fuel Project" (2010-2013, \$900K), were funded by LCCMR, and received excellent reviews by peers.** Dr. Ruan and his co-workers have published extensively in bioenergy areas over the years, and accumulated extensive experiences and set up a wide range of cultivation, downstream processing, and analytical capacities from bench to pilot scale. Specifically, they have two pilot scale MAP systems and three pilot scale algae cultivation systems, all of which are operational. They have more 10 papers in each of the pyrolysis and algae cultivation areas published in the last few years. Their experiences and existing facilities will help ensure the successful completion of the proposed project.

The **Center for Biorefining** is affiliated with the University of Minnesota Initiative for Renewable Energy and the Environment to coordinate the University efforts and resources to conduct exploratory fundamental and applied research; provide education on bioenergy, biochemicals and biomaterials; stimulate collaboration among the University researchers, other public sector investigators, and private investigators involved in biobased production technology development; promote technology transfer to industries; and foster economic development in rural areas. The Center's research programs are funded by DOE, USDA, DOT, DOD, LCCMR, IREE, Xcel Energy, and other federal and state agencies, NGOs, and private companies. The Center is equipped with state of the arts analytical instruments, and processing facilities.

Freightmasters Logistics, Inc. was formed in 2007 and is based in Eagan, Minnesota. The company is a bonded freight broker serving customers in all 50 states and Canada. Warehouse services are provided in addition to a wide range of transportation services. The company has their own fleet of trucks. They are very interested in developing new renewable fuels business and using renewable fuels for their trucks for better economic return and environment.