



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-199

Proposal Title: Accessible Biogas Fuels for Minnesota's Small Family Farms

Project Manager Information

Name: Seamus Kane

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: Development of a portable, low-cost biogas processing, compression, and storage system for on-farm use; overcoming the key barrier for greater adoption of renewable biogas digesters in Minnesota agriculture.

ENRTF Funds Requested: \$680,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Energy (E)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Anaerobic Digesters, which allow organic wastes to decompose and produce both Biogas and a rich fertilizer product, capture untapped energy and reduce greenhouse-gas emissions in Minnesota. Biogas is renewable fuel which can be further purified to make renewable natural gas (RNG). Farm wastes alone could replace roughly 12% of Minnesota's fossil natural gas demand, yet fewer than 20 agricultural digesters currently operate statewide. In turn, these wastes are aerobically processed (composted) and the energy is lost. Adoption is constrained by high capital costs, but also distance from pipelines for RNG injection and sale. The central opportunity is to use RNG directly on the farm as a substitute for expensive diesel and propane, creating an integral market that avoids pipeline interconnection entirely but captures the monetary value via fuel cost differential. RNG-compatible tractors, grain dryers, and other farm equipment already exist, but biogas conditioning, compression, and storage costs remain prohibitive for most producer-sites. Lowering the cost of fuel treatment with a portable, low-cost system would allow farms to convert wastes into high value biofuel, reduce energy costs and environmental impacts, strengthen farm profitability, and improve resilience—preserving family farms amid increasing financial and structural pressures, while building reliance on renewable fuels.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Traditional biogas-to-RNG upgrading systems require pipeline access (proximity) and extensive capital, excluding many, especially smaller, farms. We are proposing a "midpoint" solution: a small-scale biogas-upgrading system for on-farm consumption or for rural cooperatives. This also creates a community-based economic niche for owner-operator fueling services, similar to shared harvesting equipment like combines.

The developed system will utilize multi-stage compression and a water-wash/chilling process to remove hydrogen sulfide, carbon dioxide, and moisture from biogas to make RNG. The unit will be powered by a biogas-fueled engine (e.g., Honda GX690) or a tractor's power-takeoff (PTO) shaft.

Our proposed development follows three stages:

1. Power Unit: Adapting a standard V-twin engine to run on conditioned biogas.
2. Processing Trailer: A mobile system that strips impurities from biogas to make RNG and compresses it for storage or fueling.
3. Demonstration: A real-world pilot with a Minnesota producer and an RNG-powered tractor to prove economic, practical, and environmental viability.

By offering a modular alternative to expensive pipeline injection infrastructure, we enable smaller operations to replace costly diesel and propane with high-value, locally produced fuel, significantly improving their return on investment.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Minnesota's agricultural resilience depends on both financial and ecological sustainability. Biogas and RNG offer a lower-carbon, cost-effective alternative to traditional fuels for direct on-farm use. Expanding access to RNG for small and mid sized farms improves profitability and helps preserve a critical resource: the family farm. Environmentally, biogas systems reduce methane emissions while converting agricultural residues into nutrient rich digestate that can replace synthetic fertilizers and improve nutrient efficiency, reducing runoff and pollution. By lowering cost barriers to biogas adoption, Minnesota can increase the value of agricultural wastes, strengthen rural communities, and deliver meaningful environmental benefits locally and globally.

Activities and Milestones

Activity 1: Modify existing commercial V-Twin combustion engine to create biogas-fueled power unit

Activity Budget: \$242,212

Activity Description:

A small utility V-Twin engine will be modified to accept low-pressure conditioned biogas as a fuel source for use as a power-unit in Activity 2 and 3. The engine will be fitted with a high-flow low-pressure gas admission system to create a balanced supply of fuel and air. These systems are commercially available for propane but can be modified by our team to work with biogas. Later, the engine will be tested at varied speeds and loads using a small-scale dynamometer and emissions data will be collected. The fueling and ignition strategy will be modified to achieve maximum power or “Maximum Brake Torque” while minimizing emissions. This will maximize the use of biogas energy. As biogas’ components vary by source and time of year, biogas composition will be varied based on known compositions from our project partners. Composition will be simulated using bottle gases in the Murphy Engine Research Lab. The final engine power unit design will be resilient and will accommodate a variety of agricultural biogas compositions.

Activity Milestones:

Description	Approximate Completion Date
Commercial V-Twin engine repowered to operate on biogas fuel	September 30, 2027
Engine dynamometer testing on biogas for power and emissions analysis	April 30, 2028
Fuel system iteration and implementation with dynamometer testing to confirm optimal power and emissions.	June 30, 2028

Activity 2: Construct and validate multi-power renewable natural gas compression unit for small-scale refueling on-farm

Activity Budget: \$236,075

Activity Description:

The V-twin engine power unit from Activity 1 will be integrated into a simple mechanical drivetrain, which can also optionally accept PTO power from a tractor. Power from either source will drive a 3-stage commercial compressor system sized for medium-scale farm usage (tractors, storage, grain-drying). The compressor system will be combined with a conditioning system to remove water, hydrogen sulfide, and CO2 from the biogas to make it RNG and more suitable for high-pressure storage and use. A small storage vessel will be included with the unit. Finally, the entirety of this unit will be trailer-mounted to make it highway mobile and connectable to a tractor’s PTO system. Compression will be tested using inert gases first, and conditioning step(s) to purify the biogas will be tested with known gas concentrations created from compressed gas cylinders. Finally, the entire unit will be tested on a simulated biogas feed while compressing and purifying that same gas to confirm operation. The power unit emissions and power curve developed in Activity 1 will be verified against the integrated power unit to confirm the actual input/output specifications match.

Activity Milestones:

Description	Approximate Completion Date
Powertrain, Compression, Conditioning and Storage components selected and integrated for operation with power-unit.	December 31, 2028
Compression and conditioning stages tested using bottled gases of known compositions.	March 31, 2029
Biogas conditioning and compression achieved using power-unit demonstrating 100% operational capacity	June 30, 2029

Activity 3: Field demonstration of RNG compression unit and RNG tractor

Activity Budget: \$201,713

Activity Description:

A Minnesota biogas / RNG production farm will work with the University of Minnesota to demonstrate the RNG gas compression and fueling unit. The farm will provide access to their biogas (pre-compression to RNG) to allow the power unit to drive the compression process and to upgrade the biogas to RNG. University of Minnesota owns one Case New-Holland Biomethane tractor, which will also be available for demonstration. As such, the compression unit will be demonstrated using this tractor’s PTO power while simultaneously filling the RNG tanks on the tractor for fieldwork. Later, the tractor will be demonstrated operating on-farm using the compressed RNG from our compression system. Concurrently with physical demonstration of the RNG compression unit and its technologies, public outreach will be conducted to reach potential users and stakeholders in the greater Minnesota area. A techno-economic analysis will be conducted, the results of which will be communicated to farmers and dairy operators as well as various stakeholders in the agricultural sector. Most important are the financial benefits and the upfront cost of our demonstrated system. Small and medium-scale farmers can better decide on how biogas can help increase their margins and decrease their ecological footprint simultaneously.

Activity Milestones:

Description	Approximate Completion Date
Farm site selected and RNG tractor obtained for demonstration of biogas compression on-site	September 30, 2029
Public on-farm demonstration of tractor and biogas compression with key stakeholders and local community members	April 30, 2030
Techno-economic and commercial impact analyses for small scale on-farm biogas compression systems completed	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Brad Matuska	Agricultural Utilization Research Institute	Subrecipient and project partner: management of data, dissemination, impact analysis and leading expert on Minnesota Biogas ecosystem.	Yes
Michael Crinion	Ash Grove Dairy, LLP	Dairy Farm Demonstration Partner for Activity 3 of Proposal	No
Emma Ingabretsen	Centerpoint Energy	Green Energy Financial Credit and Renewable Natural Gas analysis partner	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

As part of the prototype RNG compressor development and demonstration, a techno-economic analysis (TEA) and green-energy credit economic analysis will be performed and made freely available to the public through our partner AURI. Any academic research by the University of Minnesota into development of the biogas engine or compression system, or of joint work on the TEA or energy credit analysis will also be published in a peer-reviewed academic journal and made open-access so that the public can freely access it.

Results of this work will also be presented and shared through the final activity demonstration in year 3, where the above development, research and analysis will be shared with the general public, and through local MN agricultural events such as MN Farmfest 2029 and 2030. (dates to be announced).

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

After project completion, the portable small-scale RNG compression and fueling system will continue to be demonstrated and shown at agricultural events nationwide. Project metrics, outcomes and results will be published and made freely available online to interested parties through AURI and/or academic journals. Depending on demand from potential customers, this prototype compression system and its design may either be commercially developed by a university spin-out company or workshopped to existing integrators in the US to help foster development of small-scale RNG compressors for rural customers.

Project Manager and Organization Qualifications

Project Manager Name: Seamus Kane

Job Title: Research Manager (IC Engine, Combustion and Fuels)

Provide description of the project manager's qualifications to manage the proposed project.

Dr. Seamus Kane is a Research Manager at the T.E. Murphy Engine Research Lab at the University of Minnesota's Twin Cities Campus. Dr. Kane has most recently managed, alongside PI Dr. William Northrop, 10 graduate and undergraduate students along with 1 post-doctoral researcher on alternative fuel combustion through Minnesota's Renewable Development Account. Prior to that, he worked alongside students and as a student himself on two LCCMR projects at the same engine lab dating back to LCCMR's M.L. 2016.

Dr. Kane is also the CEO of MN-local engineering startup Aza Power, which focuses on combustion of Anhydrous

Ammonia and was spun out of the University of Minnesota in 2021. Dr. Kane has overseen two funded grant projects through Aza Power totaling \$496K since 2024 and has managed the company's 5 employees during that time. In the proposed project, Dr. Kane will work alongside 1-2 well-qualified research assistants at the University of Minnesota's Mechanical Engineering Department, leading the technical and integration efforts for the biogas compression system and demo. He will also work with partner AURI to develop the techno-economic analysis proposed as part of Activity 3 and be the primary demonstrator of the technology at project completion.

Organization: U of MN - College of Science and Engineering

Organization Description:

The University of Minnesota (U of M) is a leading public research institution committed to advancing knowledge, fostering innovation, and promoting community engagement. With over 50,000 students across its Twin Cities and regional campuses, U of M offers a diverse range of academic programs and interdisciplinary research opportunities. Its world-class faculty and researchers are dedicated to addressing global challenges in health, technology, agriculture, and the environment. The university boasts state-of-the-art facilities and strong collaborations with industry, government, and non-profit organizations, positioning it as a hub for cutting-edge research and transformative solutions. U of M is committed to driving societal impact through discovery and education.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Principal Investigator		Direct experimental project and conduct research/development			27.8%	1.5		\$216,064
Co-Principal Investigator		Direct reseach and development and advise graduate student(s) on project			27.8%	0.24		\$74,529
Research Assistant		Primary labor and data gathering during development of the project objective			42.07%	1.5		\$119,371
							Sub Total	\$409,964
Contracts and Services								
Agricultural Utilization Research Institute (AURI)	Service Contract	AURI will provide to the UMN Team Coordination for our Year-3 Biogas Demo, a Techno-economic Analysis of small scale RNG production, analyze clean-energy leverage with Centerpoint Energy and facilitate public outreach. They will also manage year-end reporting to LCCMR in tandem with the UMN team				3		\$104,000
							Sub Total	\$104,000
Equipment, Tools, and Supplies								
	Tools and Supplies	1) Bottled fuel gases, 2) Gas analyzer upkeep gases for emissions, 3) computing resources, 4) Fuel metering system for bottled fuel gases	These non-capital items are fundamental to activity 1 in order to repower an engine for biogas fueling. Here we are making biogas from bottled pure gases, metering them, and measuring the emission output of the engine to ensure fitness-for-purpose.					\$10,116
	Tools and Supplies	Tools (wrenches, tube benders, dynamometer fixtures, laser-cut plates and frames,) Equipment and Hardware (swagelok components, nuts, bolts, brackets, steel stock, filters, PPE, gas detection, basic sensors, teflon tape, sealants, lubricants, compressed gases for leak detection, etc)	These funds, requested over 3 years, are to accomodate smaller tooling, components, plumbing and sensors that will not ultimately be used to construct the capital asset (renewable natural gas processing and compression system) or are numerous					\$30,000

			and of small value individually. Additionally, anything consumable or constituting PPE is included in this budgetary entry.					
							Sub Total	\$40,116
Capital Equipment								
		Components for Compression System, Power Unit, Safety and General Gas Handling (Engine, gas plumbing and handling, driveline, trailer, gearbox) (Year 1)	Each of these components will be used to create the small-scale biogas compression unit for demonstration at the end of this project. The total system is split into two years development with year 1 focused on the engine itself, gas handling, valves, safety, the driveline and transmission system, and finally the trailer it will be mounted to in year 2.	X				\$57,960
		Components for compression system (Year 2) Water pumps, 3-stage compressor for RNG, water wash pressurized gas filtration system, activated iron sponge scrubber, fuel tank fill interface, fuel tank, block and bleed valves, flow measurement devices, high pressure plumbing, spare bearings/electronics for trailer, heat exchangers and safety sensors/equipment. Power-TakeOff shaft and all mechanical framing to join the Power Unit to this system.	Each of these components will be used to create the small-scale biogas compression unit for demonstration at the end of this project. The total system is split into two years development with year 1 creating the power unit, and this entry being the incorporation of the power unit into the actual compression, filtering, storage and dispensing of Renewable Natural Gas for heat, work and power in the final on-farm demonstration.	X				\$57,960
							Sub Total	\$115,920
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel to farm site (to be decided) within Minnesota including transportation of demonstration compression system and RNG tractor, rental vehicle,	In-state travel is required to demonstrate the vehicle at a farm site					\$10,000

		mileage, meals and expenses, and lodging. Approx 3 people for 2 weeks + transport	to achieve the final milestone of the proposed project.					
							Sub Total	\$10,000
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	\$680,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Equipment		Components for Compression System, Power Unit, Safety and General Gas Handling (Engine, gas plumbing and handling, driveline, trailer, gearbox) (Year 1)	<p>The listed capital equipment is necessary to complete the project milestones. Without the equipment, the project will not have the envisioned impact on energy systems in Minnesota and prove that the small farm can use biogas to improve profitability and resiliency.</p> <p>Additional Explanation : The capital equipment is the foundation for the work to be completed in the project. The equipment will used throughout the project and after project completion as a demonstration and prototype for commercial development.</p>
Capital Equipment		Components for compression system (Year 2) Water pumps, 3-stage compressor for RNG, water wash pressurized gas filtration system, activated iron sponge scrubber, fuel tank fill interface, fuel tank, block and bleed valves, flow measurement devices, high pressure plumbing, spare bearings/electronics for trailer, heat exchangers and safety sensors/equipment. Power-TakeOff shaft and all mechanical framing to join the Power Unit to this system.	<p>The listed capital equipment is necessary to complete the project milestones. Without the equipment, the project will not have the envisioned impact on energy systems in Minnesota and prove that the small farm can use biogas to improve profitability and resiliency.</p> <p>Additional Explanation : This capital equipment entry constitutes the year 2 expenditure as part of activity 2 where the biogas power unit is incorporated into a self-contained biogas-to-RNG compression and filtration system. These items are needed to achieve activity 2 and 3 milestones of this proposed work and are completely necessary.</p>

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
In-Kind	Unrecovered F&A calculated at 54% MTDC	Support of ME facilities where research will be conducted.	Secured	\$288,277
			Non State Sub Total	\$288,277
			Funds Total	\$288,277

Total Project Cost: \$968,277

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [11a7808d-d7c.pdf](#)

Alternate Text for Visual Component

Four Visual components top to bottom: (1.) MN Biogas Potential graphic from American Biogas Council, (2.) Activity 1 graphic biogas powered engine, (3.) Activity 2 Graphic RNG Compressor powered by PTO or Biogas Engine, (4.) Activity 3 Graphic Biomethane Tractor and RNG compressor demo on-farm Ash Grove Dairy...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
UMN Sponsored Projects Administration: Institutional Support Letter	ebc75a7c-c5d.pdf
Letter of Support: Ash Grove Dairy Farm	d0b838d1-0bb.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care,

treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

William Northrop (University of Minnesota), Alexandra Sullivan (University of Minnesota), Brad Matuska (AURI), Matthew Leiphon (AURI)

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

Yes, I understand