Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-426

Proposal Title: Minnesota Sustainable Aviation Fuels Supply Chain Transition Optimization

Project Manager Information

Name: Qi Zhang

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: We will develop a computational supply chain transition optimization model to determine how sustainable aviation fuels can be manufactured in Minnesota to decarbonize the state's aviation fuel supply.

ENRTF Funds Requested: $448,000

Proposed Project Completion: June 30, 2029

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 and In the Future

Narrative

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

Air travel is responsible for approximately 3% of global CO2 emissions. In 2024, over 99 billion gallons of aviation fuel were consumed globally, with over 400 million gallons consumed at Minneapolis St. Paul airport (MSP). Sustainable aviation fuel (SAF) is produced from non-fossil carbon sources, has lower carbon intensity upon combustion, and can be used in plane engines without retrofit. As such, it is the most viable approach to achieve net-zero air travel by 2050. Technical pathways exist to manufacture SAF from bioethanol already produced throughout Minnesota, dry or wet organic waste, and non-fossil CO2 captured from industrial sources. Low-carbon hydrogen is also required for these pathways and can be produced via electrolysis using Minnesota's rich wind resources. However, SAF production does not currently occur at scale, with the largest U.S. facility only producing 10 million gallons per year. As a result, the production cost and life cycle impact of the different production pathways are not systematically understood. Furthermore, the transition to SAF will likely involve production via multiple feedstocks and will occur over multiple decades. The economic viability of this transition will be critical toward widespread adoption of SAF and making aviation more sustainable in Minnesota.

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.

We propose to develop state-of-the-art computational optimization models that help inform the development of SAF production facilities and ultimately a SAF supply chain in Minnesota. Modeling of SAF production facilities will optimize technology selection and sizing as well as operational considerations (i.e., accounting for seasonality and/or renewable energy variability) toward the lowest SAF production cost for each production pathway over a relevant range of locations within Minnesota, production scales, and installation years between now and 2050. The carbon intensity of each production pathway will also be determined through life cycle assessment. The results of facility-level modeling will then be incorporated into a supply chain optimization model to determine the lowest cost transition to net-zero aviation at MSP by 2050. This modeling will determine the type, location, scale, and installation year of new SAF production accounting for the spatial and temporal variation of feedstock availability. It will also configure the transportation network required to bring SAF to MSP. The best approach to this supply chain transition is not necessarily intuitive due to the complex interplay of many factors. The proposed quantitative decision-making aids in determining the most economical transition by holistically optimizing trade-offs across these factors.

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?

A SAF supply chain will rely on many of Minnesota's natural resources including corn for ethanol production, dry and/or wet waste, water, and land for agriculture and new wind generation. Quantifying the cost and life cycle impacts of different SAF production pathways through a consistent framework and ultimately optimizing a transition to SAF will allow for the most impactful use of these resources toward more sustainable aviation in Minnesota. A supply chain transition in which SAF is both produced and used within Minnesota has transformative potential and allows Minnesotans to benefit fully from the use of these resources.

Activities and Milestones

Activity 1: Techno-economic optimization and life cycle assessment of SAF production pathways

Activity Budget: $258,248

Activity Description:
Modeling for SAF production facilities will combine chemical engineering principles such as mass and energy balances with available pilot-scale and commercial technology cost and performance data (e.g., feedstock conversion, energy efficiency) as well as relevant federal and state policy incentives. This facility-wide modeling will optimize the selection, sizing, and operation of all technologies required to make SAF via a given pathway, including renewable energy generation, hydrogen production, CO2 capture from industrial sources, and conversion of non-fossil carbon feedstocks and potential intermediates. This modeling optimizes operation simultaneously with technology selection and sizing to account for time-varying factors such as seasonal feedstock availability and renewable energy generation variability. The assessment of life cycle impacts will use data from the U.S. Department of Energy GREET model. The range of different production scales and locations selected for modeling will be based on feedstock availability such as existing ethanol production, potential for dry or wet organic waste, and industrial non-fossil CO2 emitters. Location will also affect renewable generation potential. Cost modeling up to 2050 will incorporate projected cost decreases and performance improvements for different technologies as these are more widely adopted as part of a broader sustainability transition.

Activity Milestones:

Description	Approximate Completion Date
Definition of SAF production pathways from ethanol, organic waste, and CO2 feedstocks	August 31, 2026
Data collection for feedstock availability, renewables potential, technology cost and performance projected until 2050	November 30, 2026
Modeling and optimization of SAF production pathways	September 30, 2027
Life cycle assessment of optimal SAF production pathways	December 31, 2027

Activity 2: Development of data-driven SAF cost models and public database

Activity Budget: $99,441

Activity Description:
The detailed optimization models developed in Activity 1 are too complex to be directly included in a supply chain planning model. However, they can be used to generate simulation data that can then be used to create computationally efficient surrogate models. These surrogate models need to predict how various inputs (scale, location, installation year) affect the cost and environmental impact of the SAF production process. We propose to apply state-of-the-art machine learning methods, such as random forests and artificial neural networks, that can capture these complex relationships while resulting in computationally tractable model formulations. We will collect the simulation data and corresponding surrogate models in a database that can be used by technical laypeople. This database will allow a user to select a production pathway, location, scale, and installation year and receive a production cost range and life cycle impact characteristics such as carbon and energy intensity as well as water and land use. This database will be made public as part of the dissemination activities under this LCCMR grant. This will allow for interested stakeholders to become more informed about the economic outlook and environmental impact of various SAF production pathways in a specific Minnesota context.

Activity Milestones:

Description	Approximate Completion Date
Surrogate modeling for cost and environmental impact of SAF production	April 30, 2028

Completion of SAF production cost and life cycle impact database and associated documentation	September 30, 2028
Database user experience testing with selected range of technical laypeople	November 30, 2028
Final dissemination of SAF production cost and life cycle impact database	December 31, 2028

Activity 3: Modeling optimal transition to in-state sustainable aviation fuel supply

Activity Budget: $90,311

Activity Description:

We will develop a supply chain optimization model that will determine the lowest cost transition to in-state SAF production and transportation to enable net-zero aviation at MSP by 2050, a goal set by Minnesota SAF Hub members in September 2024. To this end, the model will determine which feedstocks and production pathways to use and when, where, and how large these new facilities should be. It will also optimize the transportation of SAF to MSP and explicitly allow for the possibility of partial conversion of a feedstock to a cheaper-to-transport intermediate at one facility and final upgrading to SAF at another facility. The planning horizon will be from 2030 to 2050. The model will account for the spatial variation of feedstock availability and renewable generation potential as well as spatial constraints on land for renewable generation and water stress. The supply chain model will be applied across multiple scenarios such as (i) minimum SAF checkpoints before 2050 (e.g. 10% SAF by 2030), (ii) maximum supply chain-wide carbon intensity, or (iii) different public policy environments. Considering different scenarios will help identify SAF production pathways critical to success as well as potentially transformative policies to catalyze this industry in Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Development of multiperiod supply chain transition optimization model	December 31, 2028
Optimization of supply chain transition for net zero aviation at MSP by 2050	March 31, 2029
Exploration of different supply chain transition scenarios	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Prodromos Daoutidis	Dept. of Chemical Engineering and Materials Science, University of Minnesota - Twin Cities	Co-PI. Daoutidis has deep and world-renowned expertise in sustainable systems engineering, especially in power-to-fuels and power-to-chemicals technologies. He and Prof. Zhang have an established track record of successfully co-advising graduate students in their research. This research idea is a result of this long-standing collaboration.	Yes

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?

The optimized SAF supply chain transition plan could serve as the basis for a SAF manufacturing roadmap in Minnesota, which should be of interest to policymakers as well as the energy and aviation sectors. We will make our developed models publicly available such that they can be readily used by other researchers and practitioners. After this project, we will seek further funding from the state and industry to refine our models to address more specific questions. We will also pursue federal funding opportunities to extend this work to a SAF supply chain at the national level.

Project Manager and Organization Qualifications

Project Manager Name: Qi Zhang

Job Title: Associate Professor

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

Prof. Qi Zhang is an Associate Professor in the Department of Chemical Engineering and Materials Science at the University of Minnesota (UMN). Prior to joining UMN, Prof. Zhang worked at BASF, the world's largest chemical company, in Germany and in Houston. His expertise is in the area of sustainable systems engineering, where he uses computational modeling and optimization tools to analyze complex low-carbon manufacturing and energy systems including large-scale industrial supply chains. His work has been recognized with several national and international awards, including the NSF CAREER Award, the Junior Sargent Medal, the Hutchison Medal, and the AIChE CAST Outstanding Young Researcher Award. He has also been awarded the UMN's McKnight Land-Grant Professorship and Guillermo E. Borja Career Development Award.

One of Prof. Zhang's major research efforts is related to the green production, utilization, and distribution of ammonia, where he has been leading interdisciplinary teams across multiple departments and with collaborators at the West Central Research and Outreach Center in Morris, MN. He currently manages a research group of 11 graduate students and one postdoc. He will oversee this project and be responsible for the day-to-day operations.

Organization: U of MN - College of Science and Engineering

Organization Description:

The College of Science and Engineering (CSE) is one of the colleges of the University of Minnesota. CSE contains 12 departments and 24 research centers that focus on engineering, the physical sciences, and mathematics. The mission of the college is to train the next generation of scientists and engineers and conduct high-quality research that advances science and addresses major societal challenges. The project will take place in the Department of Chemical Engineering and Materials Science (CEMS), which is part of CSE. CEMS is one of the top chemical engineering departments in the

country (currently ranked #6 according to U.S. News). CEMS is widely known for our cutting-edge research programs, a highly collaborative atmosphere, and a dedication to world-class undergraduate and graduate education. Energy and sustainability are major research themes in the department. At CEMS, there is a strong emphasis on mathematics, modeling, and data science, which is reflected in our recently established first-of-its-kind M.S. program Data Science in Chemical Engineering and Materials Science as well as the $3M NSF-funded training program focused on training the next generation to use AI for improving energy security, sustainability, and human health.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Qi Zhang		PI, project manager			36.6%	0.24		$44,718
Prodromos Daoutidis		Co-PI, will co-advise the graduate student and postdoc			36.6%	0.12		$43,561
Graduate Student		PhD student from the Dept. of Chemical Engineering and Materials Science assigned to the proposed project, will work on all proposed activities			71.3%	3		$192,466
Postdoctoral Associate		Postdoc for the first two years of the project, will primarily work on Activities 1 and 2, in parallel to the graduate student; a postdoc comes with more research experience and will be able to make quick progress in the project while at the same time help mentor the graduate student			25.9%	2		$157,168
							Sub Total	**$437,913**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
							Sub Total	**-**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								

	Miles/ Meals/ Lodging	2 trips per year, ~300 miles per trip (at a rate of $0.6/mile), 2 nights of lodging per trip, meals	In-state travel to meet with stakeholders and present findings at events related to project					$10,087
							Sub Total	**$10,087**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$448,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $448,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: fd131ca4-d76.pdf

Alternate Text for Visual Component

The proposed supply chain transition optimization model takes forecasts of SAF demand and resource availability as input and outputs the optimal SAF production and distribution infrastructure investments and the corresponding operational decisions over the given planning horizon. The figure illustrates the evolution of a Minnesota SAF supply chain over time....

Supplemental Attachments

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

Title	File
UMN SPA Letter	d6891b5a-3d3.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?

Yes

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

Yes

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

No

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

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:

Becky Wyatt (CEMS, UMN), Benjamin Vargas, Victoria Troxler (both SPA, UMN)

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

N/A