Minnesota Sustainable Aviation Fuels Guiding Principles

Fresh Energy, Friends of the Mississippi River, and The Nature Conservancy
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This document represents the perspectives of Fresh Energy, Friends of the Mississippi River, and The Nature Conservancy. As three of Minnesota's leading conservation and clean energy organizations, we are committed to advancing solutions that address climate change, improve water quality, and ensure healthy ecosystems throughout Minnesota. Sustainable Aviation Fuel (SAF) policies have enormous potential to drive positive environmental and social outcomes in Minnesota. To grow the market sustainably and achieve the best outcomes, we must engage in thoughtful debate guided by the best available science.

The guiding principles outlined in this document ensure that low-carbon fuel pathways reduce aviation industry emissions while advancing progress toward complementary environmental and social goals. Although the principles and perspectives here are focused on Minnesota, we recognize that sustainable aviation fuel markets are global, and therefore, commodity markets, community impacts, and environmental consequences cannot be limited to one geography.

Because we are committed to co-creating a Minnesota SAF market that works for all, we view this as a living document that will be responsive to future discovery, innovation, science, policy opportunities, and further collaboration with partners on this important work.

The Potential of SAF

Reduce emissions: The aviation industry cannot be wholly decarbonized through electrification and will require low- and zero-carbon fuels. Development of SAF fuel pathways that use regenerative cropping systems and carbon-free energy has the potential to significantly reduce emissions in both the transportation and agriculture sectors, helping to meet Minnesota's economy-wide carbon reduction goals.

Accelerate cropping innovation: Minnesota-developed winter annual oilseed (e.g. camelina and pennycress) and perennial oilseed (e.g. silflower) crops can produce innovative biofuels that are significantly lower-carbon than biofuels produced from dominant cropping systems, and enhance farm prosperity and ecosystem function.

Advance sustainable market growth: Minnesota can demonstrate a best-in-class approach to sustainable SAF market development by prioritizing the lowest carbon fuel pathways derived from Minnesota-grown regenerative cropping systems and Minnesota-generated carbon-free energy. Acknowledging the scaling potential of fuel pathways given the demands for carbon-free renewable electricity and green hydrogen economy-wide is also essential.

Demonstrate state leadership: Minnesota companies, producers, and innovations can lead the transformation to the market of the future, providing a national model that decarbonizes the aviation industry.

The Peril of SAF

Increase emissions: If there is increased corn and soybean feedstock production and indirect land use change in response to demand for SAF, agricultural emissions will rise. Likewise, if carbon-intensive energy sources are used for SAF feedstocks (e.g. blue hydrogen), the emissions reduction potential for the aviation industry will be eroded. Increases in emissions would undermine Minnesota's economy-wide reduction goals and the credibility of the Minnesota SAF market.

Increase land conversion: Increasing demand for dominant cropping systems and practices (e.g. corn, soybeans) will result in the conversion of more—and increasingly marginal—land to production. Increased cropland acreage will likely result in the loss of grassland, wetland, forest, conservation acres, and the biodiversity on those lands.

Reduce ecosystem function: Policies that further intensify dominant cropping systems and practices will dramatically exacerbate our water quality challenges and are incompatible with achieving our state's habitat and pollinator goals.

Unsustainable market growth: Developing fuel pathways now that are reliant on dominant cropping systems and/or carbon-intensive energy—instead of investing in regenerative cropping systems and fuels utilizing carbon-free energy—risks locking in carbon-intensive feedstocks. Developing the SAF market without a lens on state decarbonization goals and in a way that does not account for immense economy-wide demand for carbon-free energy (e.g. renewable electricity, green hydrogen) will also result in unsustainable market growth.

This document has been co-created by Fresh Energy, Friends of the Mississippi River, and The Nature Conservancy. This is a living document, which will be periodically updated to respond to future discovery, innovation, science, policy opportunities, and further collaboration with partners in this important work. 7.17.24

Guiding Principles

Include science-based greenhouse gas reduction goals: Minnesota updated the Next Generation Energy Act in 2023 to more closely align with climate science, setting a state goal of a 50% reduction in emissions (from a 2005 baseline) by 2030 and being net-zero by 2050. A SAF strategy should include specific greenhouse gas reduction timelines and milestones that align with the state's science-based goals.

Align SAF market development with Minnesota's economy-wide clean energy transition: All SAF fuel pathways will rely on clean energy, and the demand in other sectors of the economy for the same clean energy sources will be high given the state's decarbonization goals. The MN SAF market must be developed with a realistic lens on the availability of clean energy sources, like carbon-free renewable electricity and green hydrogen, to ensure reliable and sustainable growth.

Invest in environmental justice and equity: SAF represents a unique opportunity to advance feedstock supply chains that help address persistent environmental, economic, and racial injustice and inequity in our agriculture and energy systems. We must embed equity, inclusion, and environmental justice values and clear metrics for success in a Minnesota SAF strategy.

Rely on realistic cropland emissions assumptions: On-farm emissions from biofuel feedstock production must be accurately accounted for in the life-cycle assessment process, including realistic and verifiable on-farm emissions reductions and science-based carbon sequestration assumptions (e.g. no-till and cover-crop strategies do not reliably result in additional, permanent in-field carbon sequestration).

Prevent land conversion: A SAF strategy should not result in the conversion of marginal lands, conservation lands, grasslands, wetlands, or forests to biofuel production, or the reduction of food production. Bio-based SAF should be limited to feedstocks produced on croplands with a demonstrated cropping history starting from a defined baseline year.

Define "sustainable" to include air, water, biodiversity, and clean energy: A SAF strategy must consider impacts on clean water, healthy ecosystems, clean air, and the economy-wide transition to clean energy. A carbon intensity score is not sufficient to fully evaluate these impacts. A SAF strategy must include an approach to more holistically assess its environmental impacts (such as an environmental integrity score).

Maximize winter oilseeds as a preferred feedstock: Winter annual oilseeds (e.g. winter camelina and pennycress) produce very low-carbon aviation fuels while also providing significant benefits for water quality, wildlife, and pollinators. A SAF strategy should include benchmarks for utilizing winter annual oilseeds feedstocks over time.

Prioritize scaling the most sustainable fuel pathways: In order to avoid land conversion while scaling up SAF production, corn- and soybean-based SAF fuel pathways must be considered near-term bridge solutions to decarbonization as the Minnesota SAF market develops. A SAF strategy should include a commitment to invest in scaling fuel pathways that rely on regenerative cropping systems and carbon-free energy from day one.

Invest in carbon capture from sources beyond biofuel refineries: Carbon dioxide will be an important feedstock in power-to-liquid SAF fuel pathways. A SAF strategy should prioritize capturing carbon dioxide from hard-to-decarbonize end uses, like cement manufacturing, to increase the potential for economy-wide decarbonization. A SAF strategy should not default to capturing carbon dioxide from refineries that process dominant cropping systems, whose cultivation contributes to significant water and air pollution and biodiversity loss.

Promote permanent storage and/or utilization of carbon dioxide: Carbon dioxide will play a role as both a feedstock and byproduct of specific SAF fuel pathways. For SAF fuel pathways where carbon dioxide is produced as a byproduct (e.g. alcohol-to-jet), permanent storage and/or utilization of that carbon dioxide should be promoted. Further, carbon dioxide feedstock providers for SAF fuel pathways (e.g. power-to-liquid) that prioritize permanent storage and/or utilization should be engaged preferentially. Utilization must preclude enhanced oil recovery.

The Current State of Play

Greenhouse Gas Emissions[1]

Transportation: The largest source of emissions in the state, accounting for approximately a quarter of the state's total emissions. Emissions are generated by on-road vehicles, airplanes and other aviation equipment, trains, vehicle air conditioning units, and natural gas transmission pipelines. Emissions have decreased 18% since 2005, but that trend is primarily an artifact of a reduction in aviation and vehicle usage during the pandemic. Decarbonized solutions will include electrification and low- and zero-carbon fuels.

Agriculture: The second largest source of emissions in the state. Emissions are underpinned by fertilizer use, livestock, and land management practices, with emissions from fertilizer and manure increasing since 2005. Decarbonization solutions will include electrification, low- and zero-carbon fuels, adoption of regenerative agriculture practices, and a transition away from dominant cropping systems and practices (e.g. corn, soybeans) and towards regenerative cropping systems (e.g. continuous living cover, winter oilseeds).

Power: The third largest source of emissions in the state. Emissions are underpinned by natural gas and coal but have dropped 54% since 2005. Decarbonization will require

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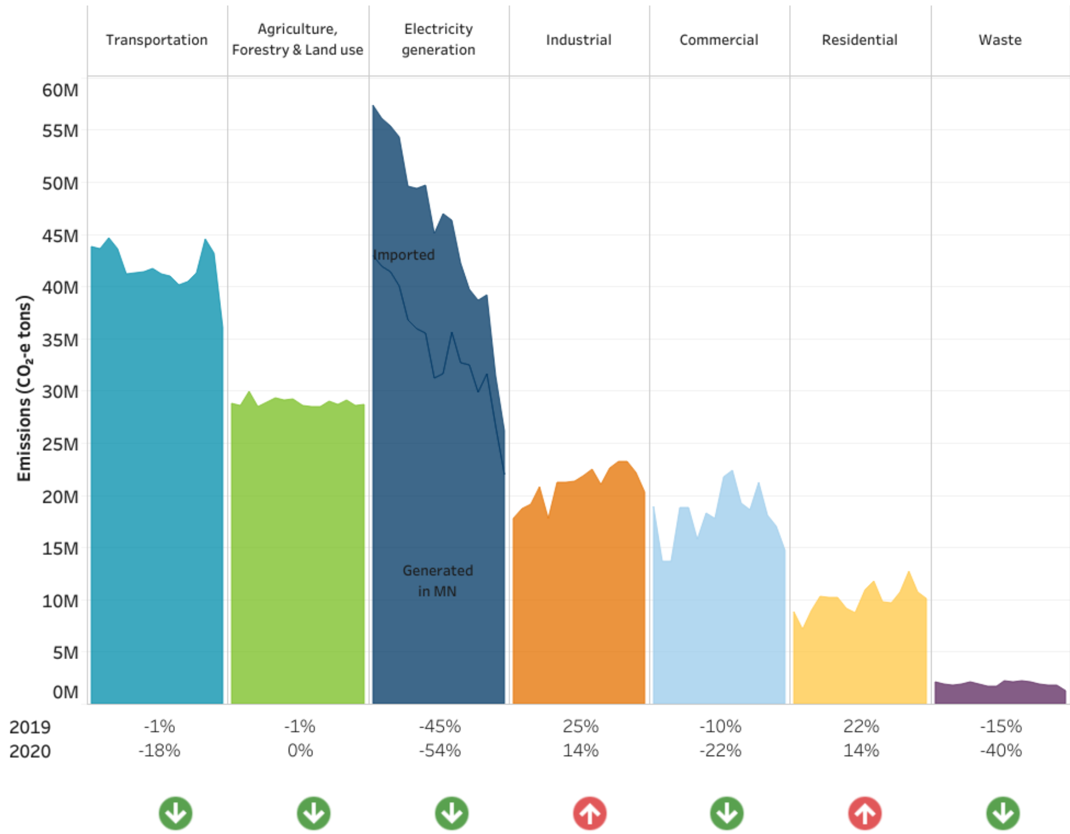
1. Minnesota Pollution Control Agency. 2023. Greenhouse gas emissions in Minnesota 2005-2020. https://www.pca.state.mn.us/sites/default/files/lraq-2sy23.pdf



completing the transition away from natural gas and coal to carbon-free renewables like solar and wind for electricity generation.

Industry: The fourth largest source of emissions in the state, and growing, with emissions rising 14% since 2005. Emissions are underpinned by fossil fuel combustion (natural gas, coal, oil), taconite processing, and petroleum refining. Decarbonized solutions will include electrification and low- and zero-carbon fuels.

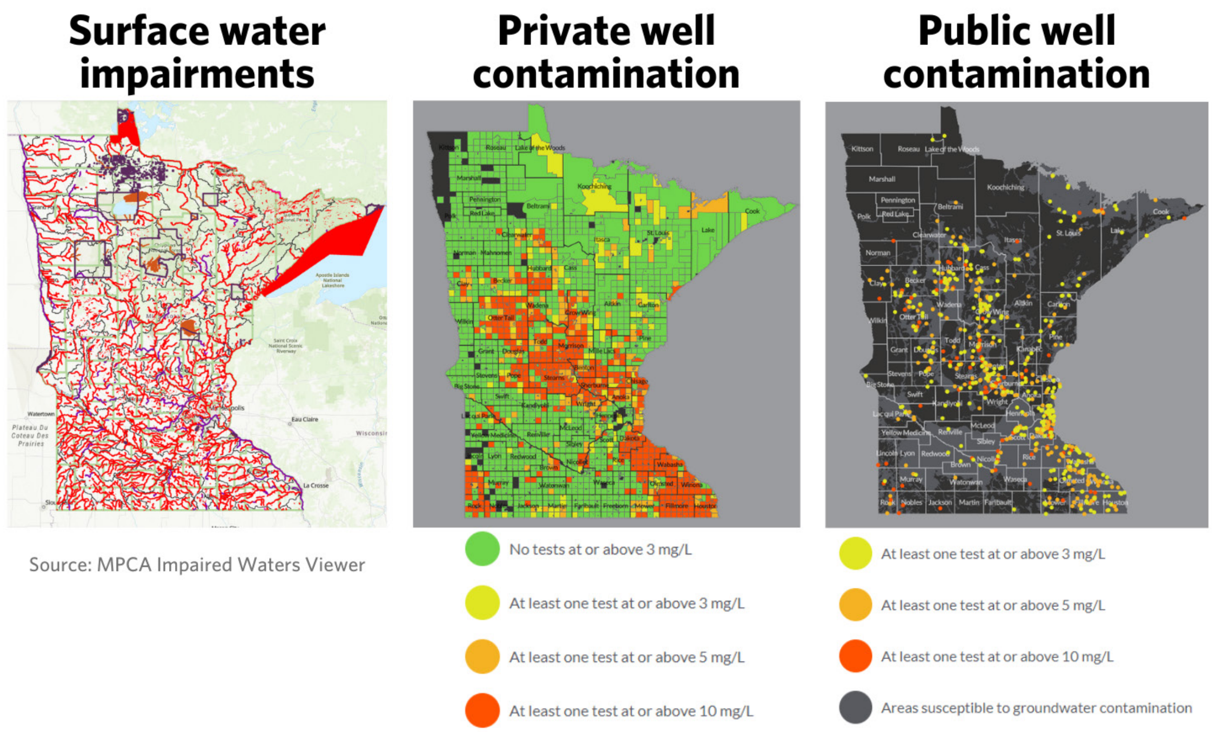
Buildings: Commercial and residential buildings are the fifth and sixth largest source of emissions in the state, respectively. Emissions are primarily underpinned in both sectors by oil and natural gas use. While commercial emissions have decreased 22% since 2005, residential emissions have risen 14%. Electrification and energy efficiency measures are the primary decarbonization solutions for buildings.

Ecosystem Function

Water quality: Minnesota faces pervasive challenges to achieving our surface water and groundwater goals. Our water quality challenges, including the public health crisis of elevated nitrates in drinking water in many Minnesota communities, are primarily associated with dominant cropping systems and practices, the primary sources of pollution to our surface waters and groundwater.[2,3]

Land use change: Conversion of grasslands, wetlands, and forests to dominant cropping systems and practices has been driven by biofuel production.[4] Land use change that results in the loss of grassland, wetland, or forested habitat is inextricably linked to loss of ecosystem functions such as water quality, biodiversity, and soil health. For example, 74% of grassland bird species show population declines,[5] with loss of habitat cited as a leading contributor to the decline, and both commercial and wild bee populations have shown declines in recent years.[6]

Soil health and resilience: Dominant cropping systems and practices reduce the capacity of soils to provide critical services, including ongoing agricultural production, air and water purification, and habitat for soil organisms. When this happens, it can lead to reliance on increasing chemical inputs and tillage, which exacerbates environmental concerns



2. Minnesota Pollution Control Agency. 2013 Nitrogen in Minnesota Surface Waters. https://www.pca.state.mn.us/sites/default/files/wq-s6-26a.pdf
3. Minnesota Department of Agriculture. 2024. Nitrogen Fertilizer Management Plan. https://www.mda.state.mn.us/pesticide-fertilizer/minnesota-nitrogen-fertilizer-management-plan
4. Wright et al. 2017. Recent grassland losses are concentrated around U.S. ethanol refineries. Environmental Research Letters 12:044001.
5. Rosenberg et al. 2019. Decline of the North American avifauna. Science 366:120-124.
6. Durant et al. 2019. Feeling the sting? Addressing land-use changes can mitigate bee declines. Land Use Policy 87:104005.

and diminishes farmers' bottom line.[7] While there is substantial interest in employing practices like cover crops to sequester carbon, there is no scientific consensus around the permanence of in-field soil carbon sequestration.[8]

Policy Landscape

Modeling technology: The GREET (Greenhouse gasses, Regulated Emissions, and Energy use in Technologies) model, created and maintained by Argonne National Laboratory, is the leading method for assessing carbon intensity of fuel pathways. While regularly updated using peer-reviewed science and public comment, the accuracy of GREET is highly dependent on the quality of the assumptions and inputs it uses. The Renewable Fuel Standard (RFS; federal), Low Carbon Fuel Standard (LCFS; California, Oregon, Washington), and SAF production tax credit (federal) all utilize GREET.

Market-based fuel policies: The RFS and state-based LCFS policies are the primary market-based fuel policies today. The reliance of the RFS on corn ethanol has led to impaired ecosystem function, and there is intense debate in the scientific community over whether the RFS has actually reduced emissions.[9,10] California, Oregon, and Washington have adopted LCFS policies, and Minnesota has explored, but not passed, its version (the Clean Transportation Standard Act) during the 2023 and 2024 legislative sessions.

Minnesota SAF fuel credit: The Minnesota Legislature passed $11.6M in funding for a state-based SAF Fuel Credit in 2023,[11] signaling strong interest in developing a Minnesota SAF market. Both producers and blenders are eligible. The credit is available for SAF sold after June 30, 2024, and before July 1, 2030, for tax years beginning after December 31, 2023.

Minnesota SAF Hub: Minnesota is home to the recently launched Minnesota SAF Hub, led by GREATER MSP, Bank of America, Delta Air Lines, Ecolab, Xcel Energy, and numerous industry, state agency and nonprofit partners. The Hub's multi-year strategy is focused on aggressively decarbonizing the airline industry through affordable, abundant, and environmentally sustainable aviation fuels.

100% Carbon-free: The Minnesota Legislature passed a 100% clean electricity law in 2023, committing all utilities to provide their customers with 100% carbon-free electricity by 2040.

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7. Baer, S. G., and H. E. Birge. 2018. Soil ecosystem services: an overview. Pages 17-38 in D. Reicosky, editor. Managing soil health for sustainable agriculture. Burleigh Dodds Science Publishing Limited, Cambridge, UK.
8. Derrie et al. 2023. Current controversies on mechanisms controlling soil carbon storage: implications for interactions with practitioners and policy-makers. A review. Agronomy for Sustainable Development 43:21. https://link.springer.com/article/10.1007/s13593-023-00876-x
9. Wright et al. 2017. Recent grassland losses are concentrated around U.S. ethanol refineries. Environmental Research Letters 12:044001.
10. U.S. EPA. Biofuels and the Environment: Third Triennial Report to Congress (External Review Draft). EPA/600/R-22/273, 2022.
11. MN Department of Revenue. 2023. Sustainable Aviation Fuel Credit website. https://www.revenue.state.mn.us/sustainable-aviation-fuel-credit

Inflation Reduction Act: Several federal production tax credits will significantly impact fuel production pathways in Minnesota, and come with sustainability concerns.

- 40B incentivizes the sale or use of SAF, but there are concerns that GREET model assumptions around indirect land use change (iLUC) and soil carbon storage make SAF look less carbon-intensive than it is.[14]
- 45Z incentivizes the production of zero- or low-emissions transportation fuels, including SAF. The tax credit is technology neutral as long as emissions targets are met.
- 45Q incentivizes investment in carbon dioxide infrastructure for both permanent storage and enhanced oil recovery, when permanent storage is clearly the best option in terms of reducing emissions.
- 45V will likely incentivize multiple hydrogen production pathways, from carbon-free renewables ("green" hydrogen) to natural gas ("blue" hydrogen), when green hydrogen is clearly the best option in terms of reducing emissions. Final guidance on how these tax credits will be administered from the U.S. Treasury has not yet been released.

Farm bill: The upcoming Farm Bill has the potential to accelerate the development and adoption of viable alternative feedstocks, including winter annual oilseeds, by amending crop insurance, funding research, and leveraging cost-share opportunities.