A Clean Fuels Policy for the Midwest

A WHITE PAPER FROM THE MIDWESTERN CLEAN FUELS POLICY INITIATIVE

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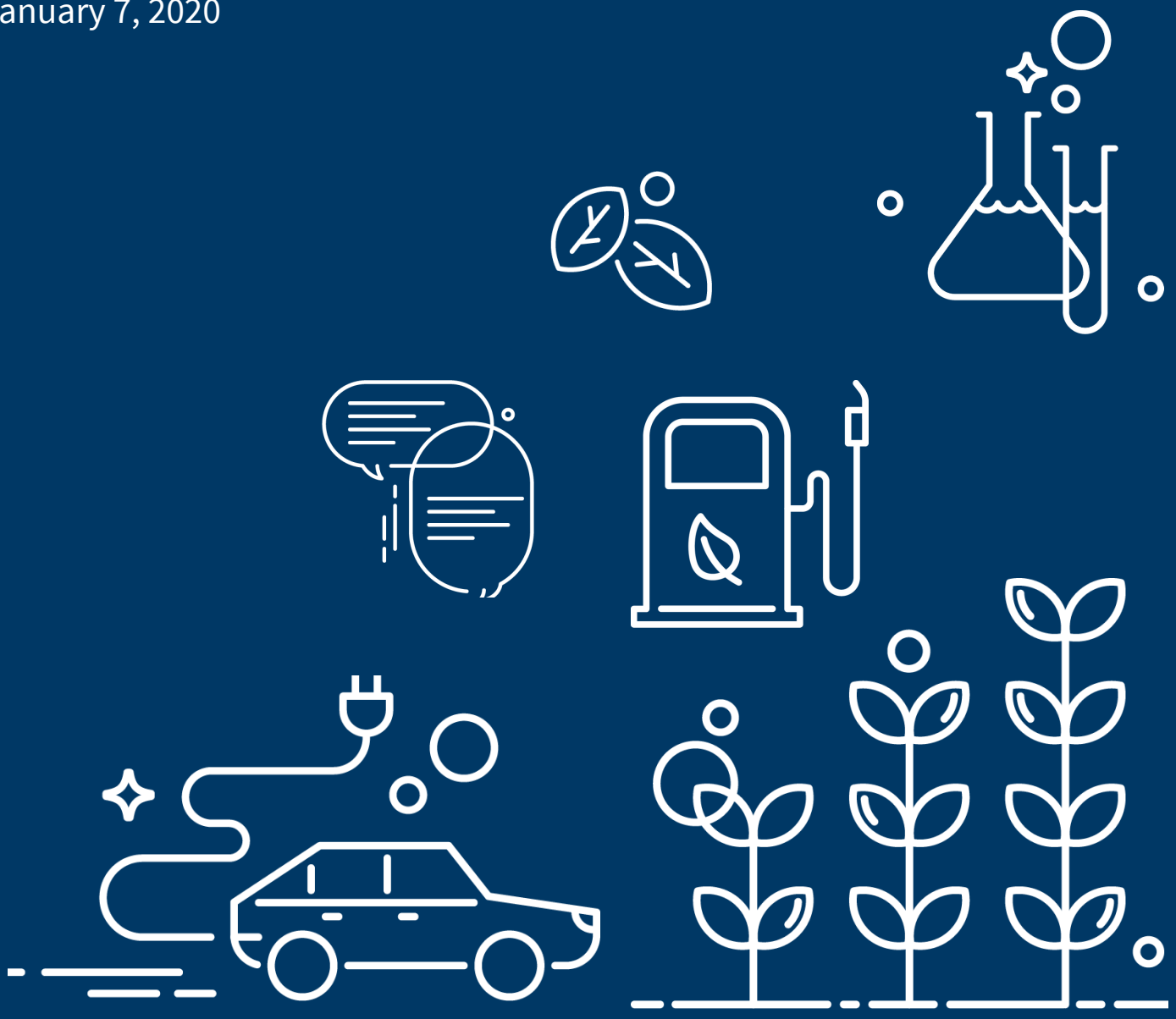

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We are grateful to all the participants in the Midwestern Clean Fuels Policy Initiative for devoting their time and expertise to finding a portfolio approach for promoting clean fuels in the Midwest, the Steering Committee for overseeing the process, and the McKnight Foundation for hosting many of the stakeholder meetings. ICF provided modeling and analysis that informed the discussions of the Midwestern Clean Fuels Policy Initiative.

Contents

Midwestern Clean Fuels Policy Initiative

The Midwestern Clean Fuels Initiative, facilitated by the Great Plains Institute, is a broad coalition of fuels producers and marketers, nonprofit and research organizations, scientists and engineers, and agriculture and industry stakeholders. The coalition works to create economic benefits for the region through policy, research, and education on the production and use of cleaner fuels. In addition to economic benefits, the use of cleaner fuels will reduce greenhouse gas emissions, increase energy security, improve water, air, and soil quality, and lead to improvements in public health.

LIST OF ORGANIZATIONS

This Initiative is exploring a clean fuels policy, at the state or regional level, as a market-driven approach to achieving our economic, energy security, climate, environmental, and public health goals. This white paper presents policy design considerations that are intended to inform further discussion of new and existing clean fuels policies and how they could be tailored to benefit the Midwest. These considerations should not be viewed as an endorsement of any specific piece of legislation. The Midwestern Clean Fuels Initiative stakeholders are committed to continuing to work together to address unanswered questions and to engage additional groups that are not yet at the table.

The following organizations participated in the Midwestern Clean Fuel Policy Initiative stakeholder discussion that informed this white paper:

- Alternative Fuels Council
- American Coalition for Ethanol
- Center for Energy and Environment
- Christianson PLLP
- Coalition for Renewable Natural Gas
- Conservation Districts of Iowa
- Conservation Minnesota
- Environmental Law and Policy Center
- EcoEngineers
- Fresh Energy
- Governors' Biofuel Coalition
- Highwater Ethanol, LLC
- Iowa Soybean Association
- Iowa State University Bioeconomy Institute
- Kansas Corn
- Low Carbon Fuel Coalition
- Minnesota Bio-Fuels Association
- National Biodiesel Board
- Partnership on Waste & Energy (Hennepin, Ramsey & Washington Counties)

- Renewable Fuels Association
- Renewable Products Marketing Group
- South Dakota Corn
- Sustainable Farming Corporation
- Union of Concerned Scientists
- Xcel Energy
- ZEF Energy

The following state government entities were observers in the process:

- Minnesota Department of Agriculture
- Minnesota Department of Commerce
- Minnesota Department of Transportation
- Nebraska Ethanol Board

The following individuals served as technical advisors to the process:

- Doug Karlen, retired, USDA Agricultural Research Service
- Emily Heaton, Iowa State University
- Lisa Schulte-Moore, Iowa State University
- Shaina Westhoff, South Dakota State University
- David Clay, South Dakota State University
- Jane M F Johnson, North Central Soil Conservation Research Laboratory
- Nicholas Jordan, University of Minnesota
- Michael Wang, Argonne National Laboratory
- Hoyoung Kwon, Argonne National Laboratory

The following individuals served on the steering committee:

- Paul Austin, Conservation Minnesota
- Mike Bull, Center for Energy and Environment
- Geoff Cooper, Renewable Fuels Association
- Scott Hedderich, Renewable Energy Group
- Brian Jennings, American Coalition for Ethanol
- Jonathon Lehman, American Capitol Group
- Nicholas Martin, Xcel Energy
- Kevin Schwain, Xcel Energy
- Joe Smentak, Minnesota Soybean

Background

CLEAN FUELS POLICY OVERVIEW

A clean fuels policy, also known in some jurisdictions as a low carbon fuel standard or clean fuel standard, is a performance-based incentive program that supports the commercial deployment of fuels with lower lifecycle carbon intensity. A clean fuels policy evaluates all fuels used in the relevant jurisdiction based on lifecycle carbon accounting and assigns each fuel production method a unique carbon intensity (CI) score that is the complete well-to-wheels carbon equivalent emissions normalized for the energy content of the fuel. For example, a CI score for gasoline or diesel includes emissions from crude oil extraction, transportation, refining, and combustion in a vehicle. A CI score for a biofuel includes emissions from farming, biofuel production, and combustion in a vehicle. A CI score for electricity includes emissions from production of electricity (including all relevant upstream emissions), sources of electricity, and the efficiency of electric vehicles (EVs).

A well-designed clean fuels policy has numerous positive attributes for the economy and environment:

- Designed to be technology-neutral.
- Compensates any clean fuel or low carbon fuel[1] provider that can achieve a lower CI than the policy requires.
- Supports a portfolio of clean fuels and compensates fuel producers based on their actual carbon performance without discriminating against or disproportionately favoring any fuel.
- Encourages a competitive marketplace in clean fuels and offers incentives to support access to the market.
- Supports development of a variety of clean fuel types, including but not limited to biofuels, electricity, and hydrogen.

A clean fuels policy differs from other policies impacting fuels such as the federal Renewable Fuel Standard, which is based on volumes of fuel rather than carbon reductions, and vehicle-based policies like an EV tax credit that does not place requirements on the electricity used in the vehicle.

[1] Clean fuel and low carbon fuel have the same meaning, as defined in the glossary.

A well-designed clean fuels policy has many benefits:

- Increased investment in a portfolio of cleaner fuels and subsequent economic benefits.
- Reductions in air pollution and subsequent health benefits.
- Increased energy independence by relying less on imported resources and more on domestic resources.
- Supports market access for clean fuels that are often lower cost than conventional fuels and currently face barriers to entry in the marketplace, which benefits consumers.
- Reduced greenhouse gas (GHG) emissions in the two largest emitting sectors of transportation and electricity as well as in the agricultural sector.

Every state and region is unique in terms of its history, resources, and policy framework and will necessarily take a different approach in supporting clean fuels development.

There are several examples of existing or emerging clean fuels policies in the US and other nations:

- The California LCFS regulation was proposed in 2007, approved in 2009, and went into effect in 2011.
- British Columbia passed an LCFS in 2008.
- The Oregon Clean Fuels Program rulemaking was authorized in 2009 and was fully implemented in 2016.
- Brazil, the European Union, and the United Kingdom have similar policies.
- Clean fuels policies are in development or under consideration in Canada, Colorado, New York, and Washington.

This white paper considers the impacts of a potential clean fuels policy in the Midwest. Although informed by efforts in other states and nations, this is a truly Midwestern approach.

A REGIONAL APPROACH

The Midwest already has a strong foundation for clean fuels development and will have a head start on other regions in reducing the CI of transportation fuels. The region is home to the largest concentration of biofuel producers in the country and has been more successful than other regions in promoting higher biofuel blends. Additionally, Midwestern states have already taken policy and administrative actions to support various clean fuels. The Midwestern Clean Fuels Policy Initiative will build on the existing state policy framework. The appendix lists existing policies and regulations in Midwestern states that provide a foundation for a Midwestern clean fuels policy and help achieve the vision of this initiative.

A Vision for a Clean Fuels Policy for the Midwest

A clean fuels policy, whether adopted at the state level in the Midwest, in other states, or at the regional level, should seek to achieve the following outcomes for the region:

- Contribute to meeting and exceeding existing goals and policies at the state level, including policies to replace petroleum, increase biofuel use, support EV goals, and more fully actualize transportation greenhouse gas reduction goals and policies.
- Support a portfolio of clean fuels, including biofuels, low and zero-carbon electricity for transportation, and other clean fuel options.
- Make the economic prize bigger by expanding the clean fuels market and avoid pitting different clean fuels against each other.
- Create a backstop if federal policy supporting clean fuels is undermined.
- Create broad rural and urban economic development, benefits for communities, consumers, and agriculture, and increased energy security from increased reliance on clean fuels produced in the Midwest.
- Achieve additional GHG reductions through increased renewable content in transportation fuels over time.
- Support existing farmer-led efforts to adopt agricultural practices that benefit soil health and water quality while contributing to GHG reductions.
- Contribute to electricity sector decarbonization, increased use of renewable electricity, and benefits for electricity customers as managed EV charging enables efficient renewable electricity integration and puts downward pressure on electric rates.
- Improve air quality and public health.

Principles for a Midwestern Clean Fuels Policy

The Midwestern Clean Fuels Policy Initiative aims to create a market specifically for regional clean fuel producers that simultaneously delivers environmental and economic benefits. Over an approximately 20-month long process, the Initiative led stakeholder discussion to consider potential costs and benefits of a Midwestern clean fuels policy being adopted at the state level and coordinated regionally. When developing new policies, the following principles should be considered:

- Design a market-based approach while remaining fuel and technology neutral, relying on a portfolio of clean fuels including biodiesel, ethanol, renewable natural gas, electricity as a transportation fuel, hydrogen, and other renewable and low-carbon fuels. Design the policy based on the lifecycle assessment (LCA) of fuels. Lifecycle assessments should be consistent for all fuel types, science- and engineering-based, up to date, incorporate upstream emissions, and reflect differences in vehicle fuel efficiency with different drive trains. The latest Argonne GREET model should be used as a basis for conducting lifecycle assessments. The Argonne GREET model uses a rigorous process based on the best available science. It is maintained by Argonne National Laboratory, a United States

Department of Energy laboratory that has the capacity to keep the model updated.

- Consider regional factors in the Midwest, including the impact of renewable electricity development on the electric grid, current production practices at biofuel facilities, adoption of farming practices that impact soil organic carbon and nitrous oxide emissions, and current and aspirational biofuel blending levels.
- Build on existing state policies rather than replacing those policies. Great progress has been made in the region to develop a mature ethanol and biodiesel industry and a small but growing EV and renewable natural gas sector. Any new policies should build on rather than replace existing state and federal fuel and GHG policies, such as state biofuel blending requirements and incentives, state EV goals, state GHG goals, and the federal Renewable Fuel Standard.
- Reinforce and complement existing efforts by the agricultural sector to increase the adoption of practices that improve soil health and water quality and have the potential to lower the carbon intensity of biofuel production by storing more soil organic carbon and reducing nitrous oxide emissions related to farming. Support methane reduction efforts by supporting increased use of renewable natural gas.
- Recognize emissions reductions at the farm level that contribute to the reduced carbon intensity of fuels.
- While recognizing state autonomy in policy making, states should collaborate and seek to create a uniform regional approach where possible. If possible, states should seek to achieve interoperability and explore credit fungibility with other clean fuels programs, both within and outside the region.

Midwestern Clean Fuels Policy Considerations

The Midwestern Clean Fuels Policy Initiative offers the opportunity for economic development in the Midwest by using regionally-produced raw materials to increase the production and consumption of clean fuels in the region. Features of a Midwestern approach to clean fuels policy that offers competitive advantages are discussed below.

- **Achievable reductions.** This white paper was informed by modeling for achieving average CI reductions for all transportation fuels of either 10 percent, 15 percent, or 20 percent by 2030 and finds that all those scenarios are achievable mostly with clean fuel production resources available in the region.
- **Fair lifecycle assessment.** Lifecycle assessment should be fair for all fuel types, incorporating upstream emissions in a consistent manner and including agricultural conservation practices and reduced emissions from transportation of clean fuels transportation via biofuel and electrification. Argonne National Laboratory's GREET lifecycle model should be used for conducting lifecycle assessments to assign CI values to fuels. The Argonne GREET model is regularly updated to incorporate new science and data through a rigorous process. The Argonne team strives to be impartial in their assessments and keep the model up to date, already sourcing some data and information from

Midwestern land grant universities. Lifecycle models must be continuously updated, and the Argonne GREET team already has the infrastructure to do this.

- **Program administration.** We do not recommend a specific program administrator; this will be determined by each individual state that chooses to move forward with a clean fuels policy. However, any state that chooses to move forward with a program will need to choose a program administrator.
- **Point of regulation.** A point of regulation should be selected that avoids placing a burden on small fuel retailers and simplifies compliance as much as possible.
- **Regional coordination.** States that move forward with a clean fuels policy should work together to achieve a coordinated approach in the Midwest and beyond. A Midwestern clean fuels policy will be more efficient, drive higher demand, create a larger market, and will make more efficient use of administrative resources if it is implemented in multiple states simultaneously and states follow a consistent approach.
- **Benefits for clean fuel producers.** The focus of a clean fuels policy is on supporting development and use of clean fuels, and clean fuels producers (i.e., the producers of low carbon biofuels, electricity, and other fuels) should be the credit-generating entities under the program in most cases.
- **Renewability.** States should consider a minimum renewability requirement (e.g., 30 percent renewable) for clean fuels participating in the program.
- **Administrative efficiency.** Because of the importance of operating an administratively lean program and ensuring collaboration with programs in other regions of the country, Midwestern states should consider a surgical approach to approving fuel pathways that starts with pathways approved in other states and then makes changes to specific emissions factors where it is justified. Calculating CI scores using Midwestern data and using the latest GREET model will produce lower CI scores in Midwestern states. States should seek to adapt existing pathways, look-up tables, simplified calculators, and other tools that are used in other programs in the United States and Canada and update specific emission factors, rather than completely recreating the pathway approval process. States should consider collaborating to create a common approach to establishing fuel pathways to reduce the administrative burden for fuel providers and states and create a larger regional market.
- **Consistent approach.** Midwestern policies should take a consistent approach across all clean fuel types (e.g., by allowing indirect accounting [described below] for low-carbon electricity for all fuel types instead of allowing it only for electric and hydrogen vehicles). States should consider allowing indirect accounting for low-carbon energy use in fuel production facilities and upstream facilities (e.g., soybean crush plants).
- **Indirect accounting.** Indirect accounting (or book and claim) has unique potential for incentivizing decarbonization of electricity and natural gas in the Midwest due to abundant but distributed wind, solar, and biogas generation potential. Indirect accounting refers to a lifecycle a methodology for fuel production that allows off-site generation of lower-carbon and/or renewable

energy and electricity to be counted as an input to fuel production despite not being physically connected to the production facility.
    - Indirect accounting for low-carbon electricity, biogas, and other low-carbon intensity energy inputs should be allowed for all clean fuel producers, building on existing protocols such as utility green tariffs. Double counting of environmental benefits should be avoided, as well as double-counting of environmental liabilities, unless otherwise acceptable under a program under federal jurisdiction.
    - Indirect accounting should demonstrate that the renewable or clean energy input is only being used by the project claiming it and is not being double-counted. The renewable or low-carbon attribute of the off-site electricity, biogas, or other low-carbon intensity energy input should be tracked, and retirement of the environmental credit should be documented to ensure that the environmental attribute is not being claimed for compliance with another policy or a voluntary procurement program, unless otherwise allowed under a federal program.
    - Indirect accounting for electricity could be based upon participation in a utility-sponsored green power program or tariff and should include retirement of a renewable energy credit on behalf of the producer.
    - Indirect accounting for renewable natural gas should involve tracking and retirement of a renewable natural gas credit.
    - Full lifecycle emissions for indirect accounting should be calculated using GREET and incorporate upstream emissions.
- **Midwest-specific emissions factors.** Midwestern policies should include updated and regionally-specific emissions factors in the following areas:
    - Calculation of induced land use change should use the most current science and reflect actual historic land use changes.
    - Electricity emissions factors should be calculated using GREET to incorporate all emissions related to power production, transmission, and use. The mechanism should motivate increased use of renewable resources and give credit to use of renewable and low-carbon electricity that is better than the state or regional average. The options are as follows:
        - States should publish an average electric grid carbon intensity based on the most accurate state or regional value. The state or regional grid mix emissions factor should be available as a default value if a utility-specific value is not available. State or regional electricity emissions factors should be calculated within GREET to reflect the fuel resource mix and upstream lifecycle emissions. Default values should be updated to reflect the use of utility-specific values by certain utilities.
        - Utilities should publish a utility-specific grid mix carbon intensity and other necessary data to enable calculation of full lifecycle emissions factors for electricity using GREET. The published grid mix should subtract renewable electricity or clean energy credits that are used for voluntary green purchasing programs and

retired, in order to avoid double-counting of environmental benefits. The utility-specific grid mix for the appropriate utility should be an option for any fuel producer that uses electricity as an energy input.
        - Clean fuel producers that use electricity as a process input should be able to reduce their electricity emissions factor through generation of on-site generation or using indirect accounting for low-carbon electricity and double counting of electricity environmental benefits should be avoided.
    - Direct accounting for low-carbon electricity, biomass, solar thermal, biogas, and other low carbon intensity energy inputs for on-site use should be allowed for all fuel producers. Double counting of environmental benefits should be avoided, unless otherwise acceptable under a federal program.
    - Transportation distances for feedstocks should be updated for all fuels to reflect the transportation distance to the Midwestern state where the fuel is being used.
    - State or sub-state regional average emissions factors for farming practices and soil carbon storage should be determined for use in biofuel carbon accounting.
    - Lifecycle accounting for all fuels should differentiate between co-products that are the main product, byproduct, residue, or waste. Double counting should be avoided.
    - Lifecycle accounting for biofuels should reflect state biofuel blending requirements that are already in effect, thus lowering the carbon intensity of fuel used for transportation and farm equipment.
    - States should include E85 plug-in hybrid electric vehicles (PHEVs) as a balanced strategy for lowering fuel carbon intensity that benefits from efficiencies and carbon intensity reductions from electricity and ethanol. States should consider the efficiency benefits of higher blends in flexible fuel vehicles and new engine technologies optimized for high octane fuel.
    - States should account for the benefits of higher octane in mid- and high-level ethanol blends in determining the energy efficiency ratio of vehicles that use these blends.
    - Biogenic carbon dioxide emissions for fugitive hydrocarbons should be zero.
- **Clean fuels policies and agricultural practices.** Farming practices are a significant part of the overall carbon intensity of biofuels, and there is great potential to lower biofuel carbon intensity through the adoption of agricultural practices that store soil carbon, reduce nitrous oxide emissions, or accomplish both. In most cases, these practices further benefit soil health and water quality. The region should leverage state clean fuels policies to support and complement existing efforts by agriculture and other stakeholders to support the adoption of

farming practices that store soil carbon, reduce emissions, and improve water quality. We explore three major ways to accomplish this:

- States should ensure that farming emissions factors for Midwestern states are fair and accurate and incorporate soil organic carbon storage, recent increases in the adoption of various conservation practices like no-till and cover crops that impact soil carbon and nitrous oxide emissions, the impact of state policies like state nutrient reduction strategies and rules, and other factors. Midwestern states should develop updated average farming emissions factors at the state and sub-state levels as appropriate.

- States should benefit from and build on an ongoing collaborative effort by Argonne National Laboratory, universities, United States Department of Agriculture Agricultural Research Service and Natural Resources Conservation Service and other agriculture researchers, and stakeholders to develop approaches that would allow fuel producers to demonstrate that their feedstock suppliers are achieving an emissions factor lower than the state or sub-state averages. A protocol to allow this is not available today, but efforts should be made to develop it. The protocol should allow for site-specific farm practice scoring, traceability, and verification. States could also look to the experience under the European Union Renewable Energy Directive, including the International Sustainability Carbon Certification program, in auditing farm practices and learn from that system as a Midwestern approach is developed. Midwestern groups should seek acceptance of the farm practices verification by other entities, including other states with clean fuels policies and voluntary programs seeking GHG reductions from agricultural supply chains. Farm practices verification should be something the Midwest leads on and is proud of and enables the region to produce the lowest CI agricultural products in the nation and world.

Models for Agricultural Producers to Benefit from a Clean Fuels Policy

While not a definitive list, there are various ways that credits might be generated to benefit agricultural producers to compensate for adoption of practices that offer GHG reductions. These are options for policy makers to consider in designing a clean fuels policy that benefits farmers.

- Agricultural producer generates credits, selling them to a biofuel producer.
- Agricultural producer generates credits, selling them to any market participant.
- Cooperative/grain aggregator owns credits and pays a higher price for commodities from agricultural producers.
- Biofuel producer owns credits, negotiating with agricultural producers to pass on the value.
- United States Department of Agriculture Natural Resource Conservation Service or state conservation service owns credits, passing on credit value as cash-match for adoption of practices.

    - States should consider setting aside a percentage[2] of overall credit revenue to directly invest in adoption and scaleup of agricultural practices that benefit soil health and water quality, consistent with existing state and federal efforts. These practices may also increase soil carbon storage, reduce nitrous oxide emissions, or both. These activities should complement current investments. States should avoid diverting credit revenue for purposes unrelated to the clean fuel policy, but this issue is important enough to be the exception to the rule.
- **Carbon capture and storage.** States should recognize the potential for CI reductions from carbon capture, utilization, and storage from ethanol, renewable natural gas, and other low-carbon fuel producers.
- **Fueling infrastructure is essential for transitioning to a cleaner fuel system.** Broad consumer access to cleaner fuels should increase and accelerate the benefits of a clean fuel policy. States should consider allowing credit generation for underutilized infrastructure for fuels with under-served passenger car populations, including E85 and mid-level blend, EV charging stations, and hydrogen fueling.

Areas for Future Work

The Initiative recommends a few areas where additional work is needed:

- **Farm-level carbon accounting**. The stakeholder group has a strong interest in developing the ability to compensate farmers for conservation practices that increase soil organic carbon storage and/or reduce nitrous oxide emissions. While this idea is appealing in principle, much more work is needed to determine how this could work in practice.
- **Biofuel credit value distribution**. There is a concern that in the California LCFS market, refiners have been able to prevent credit value from reaching biofuel producers, farmers, and consumers because of California's ethanol blending limit of E10 and the abundance of low carbon ethanol on the market. Additional policy design consideration is needed to assure that credit revenue from low carbon biofuels reaches its intended beneficiaries, resulting in economic benefit for farmers and biofuel producers and cost savings for fuel consumers.
- **Electricity credit distribution**. More work is needed to determine who can generate credits for EVs and how this credit value can best be used to achieve

[2] The group has not taken a position on a specific percentage and numbers as high as 30 percent were discussed.

the goals of the program. Electric vehicle credits should be used in a timely manner to accelerate market adoption.

Conclusion

The Midwestern Clean Fuels Policy Initiative deliberated for a long period of time before publicly releasing this white paper. A clean fuels policy is complicated and requires careful consideration of many details. This white paper offers high-level considerations on how to structure a policy to benefit the Midwest. More work will be required.

The Midwestern Clean Fuels Policy Initiative is unique in its ability to draw in a broad range of organizations that do not always work together. The Initiative includes agriculture, biofuels, the nonprofit sector, the EV community, auto manufacturing, and the electric utility sector. This group sees power in a collaborative approach and will continue working together to refine a Midwestern clean fuels policy to achieve its vision with broad economic and environmental benefits.

Technical Glossary

Argonne GREET model: Updated annually, the Greenhouse gases, Regulated Emissions, and Energy use in Transportation—or GREET—model was created and is maintained by Argonne National Laboratory. The tool simulates energy use and emissions outputs for various vehicle and fuel combinations to generate a full life cycle estimate. The model is available at Argonne's GREET website, https://greet.es.anl.gov/.

Biofuel: Per the US EPA, biofuels are gaseous or liquid fuels developed through the conversion of biomass into liquid fuels. Sources for biomass can include: grassy and woody plants, agriculture or forestry residue, algae, crops (such as corn or soybeans), vegetable oils, organic waste, or animal fats. The two most common biofuels are ethanol and biodiesel.

Biogas: A mixture of gases produced by the breakdown of organic matter in the absence of oxygen, primarily consisting of methane and carbon dioxide.

Biogenic CO_2: Per the US EPA, CO_2 emissions related to the natural carbon cycle, as well as emissions from the production, harvest, combustion, digestion, fermentation, decomposition, and processing of biologically based materials.

Biologically-based feedstocks: As defined by the US EPA, non-fossilized and biodegradable organic materials originating from modern or contemporarily grown plants, animals, or microorganisms (including products, by-products, residues, and wastes from agriculture, forestry, and related industries, as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material). These do not include materials like peat, coal, petroleum, natural gas, and other products that are derived from biologic materials but are non-renewable relative to a policy-making timeframe. More can be read in the EPA's Framework for Assessing Biogenic CO_2 Emissions report, at https://www3.epa.gov/climatechange/Downloads/Framework-for-Assessing-Biogenic-CO2-Emissions.pdf.

Blending requirements: A policy or mandate that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. For example, the United States adopted a Renewable Fuel Standard, and many individual states have biofuel blending requirements.

Carbon capture: Refers to a group of technologies that prevent industrial and electric power facility carbon emissions from reaching the atmosphere or remove carbon dioxide (CO_2) from the atmosphere.

Carbon-dioxide equivalent (or CO_2e): a standardized unit for measuring carbon footprints; CO_2e calculates the equivalent impact of criteria pollutant greenhouse gas (GHG) emissions such as nitrous oxide and methane. CO_2e allows for consistent comparison across practices, processes, and emission metrics.

Carbon intensity (CI): Regarding fuels, CI refers to the lifecycle GHG emissions for a fuel per unit of transportation energy delivered. The CI of a fuel is calculated by assessing the GHG emissions in the lifecycle or "pathway" of the fuel and is determined by assessing the GHG emissions throughout each stage of the fuel's feedstock production, conversion, and use. CI is measured in grams of CO_2-equivalent per mega joule (gCO_2e/MJ or g/MJ).

Carbon intensity reduction targets: For a clean fuels policy, carbon intensity reduction targets are set for the gasoline and diesel standard(s). Targets are typically a proportional reduction achieved by a specific date (i.e., 15 percent carbon intensity reduction by 2030). Targets are used to establish total emission reductions achieved by a policy.

Carbon storage: Typically coupled with carbon capture, carbon storage refers to the long-term sequestration of carbon dioxide in geologic formations or fossil reservoirs.

Clean fuel: fuel that results in lower lifecycle GHG emissions on an energy equivalent basis compared to a reduction baseline.. See also, low carbon fuel.

Clean fuels policy: Refers to a policy or program that requires fuels to achieve carbon intensity reductions over time.

Co-products: Refers to secondary goods that are generated during the manufacturing process and can be sold or reused profitably. Co-products may also be manufactured together or sequentially because of product or process similarities. Co-products include main product, byproduct, residue, or waste.

Credit bank: Refers to the net stock of credits generated or owed from a market-driven policy, like a clean fuels standard. When an alternative fuel pathway generates credits relative to the carbon intensity of the standard, the total credits in the bank increase.

Decarbonization: Refers to the process of reducing the average amount of carbon emissions or carbon intensity in a system (for example, transportation sector) over a period of time.

Energy economy ratio (EER): A dimensionless value that accounts for the difference in energy density and engine efficiency when calculating carbon intensity or credit generation. Generally, EER represents the efficiency of a fuel as used in a practice (in a powertrain) compared to a reference fuel.

Electric grid mix: The proportional contribution of various electricity generation fuels (i.e., natural gas, petroleum, renewables, etc.) to the total electricity generation of the energy grid. The grid mix is important to help calculate the carbon intensity or emissions factor of a specific utility or electricity region.

Electric vehicle (EV): A vehicle powered by electricity, generally provided by electric batteries or fuel cells.

Electric vehicle charging station: The fueling infrastructure for electric vehicles that connects an EV to an electricity source. Charging stations are characterized by their voltage—Level 1 chargers operate on 120V alternating-current (AC), Level 2 use 240V alternating-current (AC), and DC fast chargers (DCFC) use 480V direct-current (DC). Charger level also informs speed of battery recharge where Level 1 is the slowest and DCFC is the fastest.

Emissions factor: An emissions factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the mass of pollutant divided by a unit mass, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). For a clean fuels policy, emissions factor helps understand, for example, the CO_2e emissions associated with one mega joule of fuel used. See also, a carbon intensity.

Energy security: Refers to the relative confidence that energy (through the electric grid, fuel producers, or from a biological feedstock) will be reliable and cost effective. For example, in the context of the liquid fuel supply, increased energy security corresponds to increased confidence that liquid fuels will be distributed safely and consistently to consumers.

European Union (EU) renewable energy directive (RED): A policy adopted by the EU that sets a binding target of 20 percent gross energy consumption from renewable sources by 2020 (20 percent RES). To achieve this, the Directive allocates individual targets to Member States ranging from 10 percent in Malta to 49 percent in Sweden. It was followed by RED II, which increased 2030 targets to 32 percent. More info on the EU Science Hub, https://ec.europa.eu/jrc/en/jec/renewable-energy-recast-2030-red-ii.

Fuel pathway: The fuel pathway is the sequence of production processes used to produce a fuel and acquire or grow the feedstock it is made from. In lifecycle analysis, the fuel pathway is considered on a “well-to-wheels” or “cradle-to-grave” basis, which includes feedstock production or extraction, transportation of feedstock and fuel to the production facility, fuel refining, fuel transportation and distribution, and finally fuel use or combustion. The fuel pathway is used to calculate the carbon intensity of a fuel, which is determined by assessing the GHG emissions throughout each stage of the fuel’s production and use.

Fugitive emissions: Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases, mostly from industrial activities. The US EPA further clarifies fugitive emissions as unintended emissions from facilities or activities (e.g., construction) that "could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening."

Fugitive hydrocarbons: A form of fugitive emissions, specifically of volatile hydrocarbons that can contribute to the formation of smog and ozone.

Greenhouse gas emissions (GHGs): Gases that trap heat in the atmosphere are called greenhouse gases. The most prevalent are carbon dioxide, methane, nitrous oxide, and fluorinated gases (which consist primarily of hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride) which are synthetic GHGs emitted from a variety of industrial sources. The impact of each gas with regards to climate change is determined by three main factors: the concentration or abundance in the atmosphere, how long it can last in the atmosphere, and its potency.

Induced land use change (ILUC): Emissions resulting from land conversion in response to increased biofuel demand and impacts on global commodity prices and commodity demand.

Lifecycle accounting: The practice of tracking and scoring the carbon intensity of fuels by including the full lifecycle GHG emissions impact of feedstock extraction, fuel refining, distribution, and use or combustion. Lifecycle accounting uses the carbon intensity score produced through a lifecycle assessment (LCA) analysis.

Lifecycle assessment (LCA): A technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.

Low-Carbon Fuel Standard (LCFS): A rule enacted to reduce carbon intensity in transportation fuels as compared to conventional petroleum fuels, such as gasoline and diesel. LCFS uses market-based mechanisms that allow providers to choose how they will reduce emissions while responding to consumer demand. California adopted a Low Carbon Fuel Standard in 2007 that requires a reduction in the carbon intensity of transportation fuels that are sold, supplied, or offered for sale in the state by a minimum of 10 percent by 2020.

Low-carbon fuel: fuel that results in lower lifecycle GHG emissions on an energy equivalent basis compared to a reduction baseline. See also, clean fuel. **Nitrous oxide emissions**: Nitrous oxide is a greenhouse gas emitted during agricultural and industrial activities, combustion of fossil fuels and solid waste, as well as during treatment of waste water. Nitrous oxide was 6 percent of US GHG emissions in 2017 according to US EPA, and has a global warming potential of 298 times carbon dioxide. The application of nitrogen fertilizers accounts for the majority of nitrous oxide emissions, and these emissions can be reduced through various agricultural conservation practices.

Portfolio approach: Refers to the use of multiple clean fuels or strategies to achieve a policy, social, or environmental goal.

Renewable energy credit (REC): A certificate corresponding to the environmental attributes of energy produced from renewable sources such as wind or solar, or other carbon reducing activities.

Renewable Natural Gas: Biogas that has been upgraded to a quality similar to fossil natural gas.

Soil carbon management: Soil carbon management refers to any activity used to store or sequester higher amounts of carbon in soil organic matter. In agricultural contexts, this may include tillage practices, fertilizer application management, cover cropping, and system rotation, among many others. Soil carbon management can reduce carbon dioxide in the atmosphere and improve soil health.

Soil organic carbon (SOC): The solid terrestrial matter stored in global soils. It is considered an indicator of soil health and soil fertility.

Utility green tariff: As defined by the US EPA, utility green tariffs are optional programs in regulated electricity markets offered by utilities and approved by state public utility commissions (PUCs) that allow larger commercial and industrial customers to buy bundled renewable electricity from a specific project through a special utility tariff rate. Utility green tariffs provide larger energy customers an option to meet their varying sustainability and renewable energy goals, reduce long-term energy risks, and demonstrate commitment to the development of new renewable energy projects.

Appendix: Existing State Policies and Regulations that Provide a Foundation for Clean Fuels Policy Development in the Midwest

State	GHG policy	Renewable or clean electricity standards	Biofuel blending requirement or production incentives	Incentives for biofuel blending infrastructure	Water quality goals and policies	Electric vehicles
Minnesota	Reducing emissions: • 15% below 2005 levels by 2015, • 30% below 2005 levels by 2025, • 80% below 2005 levels by 2050.	Renewable Energy Standard: • Requires that 25% of retail electricity sales be generated or procured using eligible renewable sources by 2025, with a higher standard for Minnesota's nuclear utility, Xcel Energy.	• Biodiesel Blend Mandate • Petroleum Replacement Goals: Replacement of Petroleum with biofuels 2020 goal of 25% and 2025 goal of 30%	• Department of Agriculture investments in E15 infrastructure	• Minnesota Nutrient Reduction Strategy • Minnesota Agricultural Water Quality Certification Program, a voluntary program for farmers and ag landowners to implement conservation practices that protect water. Certified producers receive regulatory certainty, recognition, and technical assistance.	• State commitment for 20% EVs in state fleets, EV buses in Metro Transit fleet. • Plan to initiate low emission vehicle/zero emission vehicle rulemaking.
Illinois	• Illinois enacted targets in 2007 for reducing emissions: 1990 levels by 2020; 60% below 1990 levels by 2050. • 80% below 2005 by 2050.	Renewable Portfolio Standard: • 25% of eligible retail electricity sales from renewable energy by 2025. • Electric coops and municipal utilities are exempt from RPS.	• Biodiesel Production Tax • Biofuels Tax Exemption		• Illinois Nutrient Loss Reduction Strategy • Michigan's Lake Erie Domestic Action Plan	EV purchase incentive
Missouri	• Renewable Energy Standard: 15% by 2021. • City of Columbia—30% by 2028.				Nutrient Criteria Implementation Plan	

State	GHG policy	Renewable or clean electricity standards	Biofuel blending requirement or production incentives	Incentives for biofuel blending infrastructure	Water quality goals and policies	Electric vehicles
Nebraska		Ethanol and Biodiesel Tax Exemption		Pesticides and Water Quality Protection Goal		
North Dakota	Renewable and Recycled Energy Objective: 10% by 2015.	• Advanced Biofuel Incentives • Agriculturally-Derived Fuel Production Facility Loan Guarantees	• Biodiesel and Renewable Diesel Blender Tax Credit • Biodiesel and Renewable Diesel Sales Equipment Tax Credit • Biodiesel and Renewable Production and Blending Equipment Tax Credit • Biofuel Loan Program			
Ohio		Alternative Energy Portfolio Standard: 12.5% by 2026		Alternative Fueling Infrastructure Incentive	Ohio's Nutrient Reduction Strategy	
Indiana		Clean Energy Portfolio Standard voluntary goal of 10% clean energy by 2025, based on 2010 numbers				

State	GHG policy	Renewable or clean electricity standards	Biofuel blending requirement or production incentives	Incentives for biofuel blending infrastructure	Water quality goals and policies	Electric vehicles
Iowa		• Alternative Energy Law: 105 MW of renewable generating capacity • Petroleum replacement goal: biofuels replacing 25% of petroleum by 2020	• Alternative Fuel Production Tax Credits • Biodiesel Blend Retailer Tax Credit • Iowa Energy Plan: Calls for increased biofuel production & usage and expanded use of alternative fuel vehicles	Biofuel Infrastructure Grants	Iowa Nutrient Reduction Strategy	EV infrastructure plan
Kansas		Renewable Energy Goal: • 2011-2015: 10% • 2016-2019: 15% • 2020: 20% for each calendar year	Renewable Fuel Retailer Tax Incentive	• Biofuel Blending Equipment Tax Exemption • Alternative Fueling Infrastructure Tax Credit • Renewable Energy Property Tax Exemption	Surface Water Nutrient Reduction Plan	
Michigan	Michigan enacted targets in 2009 for reducing emissions: • 20% below 2005 levels by 2020 • 80% below 2005 by 2050.	Renewable Energy Standard: • All utilities: 15% by 2021		Alternative Fuel Development Property Tax Exemption	• Michigan Water Strategy • Michigan's Lake Erie Domestic Action Plan	

State	GHG policy	Renewable or clean electricity standards	Biofuel blending requirement or production incentives	Incentives for biofuel blending infrastructure	Water quality goals and policies	Electric vehicles
South Dakota		Renewable, Recycled and Conserved Energy Objective 10% by 2015	• Biodiesel Blend Tax Credit • Tax Refund for Methanol Used in Biodiesel Production • Biodiesel Tax			
Wisconsin		Renewable Portfolio Standard: • Statewide target of 10% by 2015; requirements vary by utility	Renewable Fuel Producer Excise Tax and Inspection Exemption		Wisconsin Areawide Water Quality Management Planning	