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Re: *Request for Comments: Executive Order on Tackling the Climate Crisis at Home and Abroad. Docket (USDA-2021-0003)*

Electrochaea Corporation (Electrochaea) appreciates the opportunity to submit the following comments to the U.S. Department of Agriculture (USDA). Our comments address questions in Section 2 on the role of the USDA in tackling the climate crisis with respect to the production and use of biofuels, wood and other bioproducts and renewable energy. Electrochaea is a supplier of an industrial scale biomethanation technology that uses a biocatalyst to produce synthetic methane, a renewable fuel that is referred to as biomethane or renewable natural gas (RNG).

I. Summary

Electrochaea encourages the USDA to:

- Propose to the National Climate Task Force the creation of a system of incentives and financing mechanisms to build out our nation's infrastructure for more optimal carbon utilization and synthetic fuel production
- Utilize existing RD&D grants and financial incentives to specifically encourage the growth of the renewable fuel production industry
- Evaluate the use of consequential definitions and terminology across programs to ensure new technologies aligned with climate goals are eligible to qualify for available incentives and programs.
- Coordinate across agencies/departments to address opportunities for synthetic renewable fuels to meet the needs of other sectors
- Support the development of demand for biofuels outside the traditional transportation sector by recognizing their potential as drop-in replacements for fossil gas

II. Introduction

The agricultural sector contributes significantly to greenhouse gas emissions, notably from emission of methane from dairy and swine production, release of CO_2 from industrial processes such as ethanol production, and decomposition of forest residues. Concurrently, on several fronts, the agricultural sector supports achievement of climate goals through the deployment of anaerobic digestors to capture methane as well as hosting wind farms (99 percent of America's wind turbine infrastructure is based in rural communities)[1].

[1] https://fowmedia.com/wind-farms-fueling-growth-in-rural-communities

We believe that the USDA can promote agricultural practices and climate-driven policy implementation, both through its own programing, and in collaboration with the U.S. Environmental Protection Agency, the U.S. Department of Energy and other agencies. New policies can deliver additional benefits to meet the challenge of climate change while supporting emerging technologies that were not considered when current policies were implemented.

Increasingly, the solutions needed to address climate change will require multi-sector coordination and creative opportunities that operate across agency boundaries. The USDA should embrace opportunities to work with other departments and agencies to ensure that there are not only financial incentives for supporting the development of biofuels, but also that there are appropriate and sufficient offtakers of renewable fuels to drive demand. Increasing the demand for RNG can in turn drive additional economic benefits for rural and agricultural communities.

Biomethanation may be among the most high-potential technologies to leverage the assets, capabilities, and economic motivations of our agricultural sector:

- Biomethanation converts wasted and likely emitted CO_2 into a valuable renewal fuel, biomethane, which is a direct replacement for fossil-derived natural gas.
- When the biomethanation process is implemented with agricultural biogas, CO_2 is captured and the renewable fuel production is doubled.
- Biomethane can be stored on the existing gas grid, our largest and most reliable energy distribution and storage system.
- Biomethane produced from renewable resources and stored on the gas grid decreases the carbon intensity of the gas grid, analogous to the way the power grid is being "greened" with electricity derived from intermittent resources like solar and wind.
- As investment in solar and wind renewable capacity is increased, there will be surplus potential energy at certain times of the day. This results in curtailment, that is, shutdown of otherwise productive assets. Biomethanation, a solution to this problem, can use that surplus energy to generate biomethane and store the energy for later use. The higher utilization of this energy source has an additional advantage in facilitating the construction of more renewable energy sources.

The production of synthetic fuels, which do not increase greenhouse gas emissions, is a critical component of a multifaceted approach to tackle climate change. Sustainable synthetic fuels with measurable and verifiable carbon emission reductions can immediately replace fossil fuel use. Advanced renewable fuel technologies, which are currently ready for commercialization, such as biomethanation, need the support of the USDA.

While solar and wind electricity generation will make up the largest proportion of zero-carbon power solutions, renewable electricity alone is not sufficient to fuel our economy. As the electricity grid benefits from a greater and greater proportion of renewable power, the inherent intermittent characteristics of renewable electricity become more apparent. It becomes more critical to store energy from renewable power generation capacity that would be otherwise wasted.

One solution for this energy storage is to produce methane by combining hydrogen and carbon dioxide using biomethanation (Fig. 1). This process is also referred to as "power-to-gas", recognizing its utilization of electric current to split water into hydrogen and oxygen, with that hydrogen used as a feedstock. When renewable power is used to fuel the production of hydrogen, and the carbon dioxide is derived from biomass or carbon capture, the resulting methane is renewable with an ultra-low carbon intensity. This fuel can be used to replace any existing use of fossil-derived natural gas. By coupling any biogas source with power-to-gas using renewable power, essentially every carbon molecule from biomass can be used to generate a renewable fuel and the net carbon dioxide emission from digestion of agricultural biomass can be reduced to near zero.

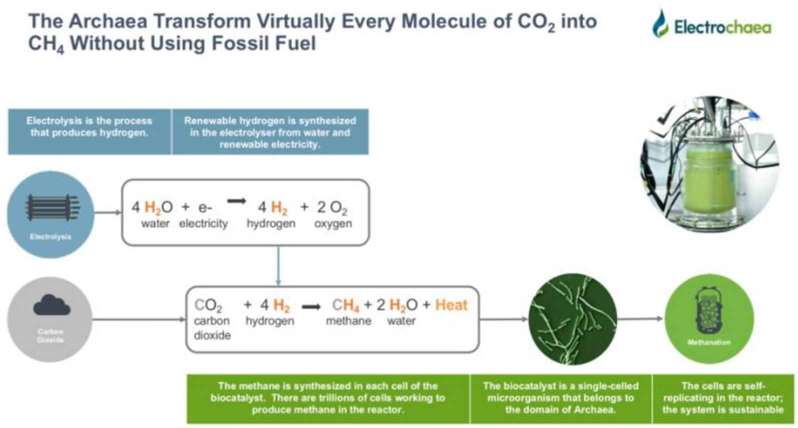

Figure 1. Hydrogen is produced by electrolysis. Carbon dioxide is recovered from a waste resource. The biocatalyst combines the CO2 and H2 into methane, a replacement for fossil natural gas.

Biomethanation was not envisioned as a source of renewable fuels when many of the current regulations and incentive programs, including the Renewable Identification Number (RIN) program for the Renewable Portfolio Standards[2], were first drafted. The USDA's responsibilities are at the intersection of numerous challenges and opportunities associated with climate change. In the spirit of the "whole-of-government" approach being taken by the Biden Administration[3], Electrochaea requests that the USDA proposes to the National Climate Task Force[4] the creation of a system of incentives and financing mechanisms to build out our nation's infrastructure for more optimal carbon utilization and synthetic fuel production.

III. Background on Electrochaea

Electrochaea has developed a patented methanation technology for the production of renewable methane, a fuel which replaces fossil natural gas. The technology converts hydrogen, made with renewable energy, and carbon dioxide into grid-quality methane using a biomethanation process. The proprietary process, when using renewable power to produce hydrogen is also known as power-to-gas, makes it possible to store surplus renewable energy and recycle CO_2 in a cost-effective way. The core of Electrochaea's power-to-gas technology is a selectively evolved microorganism – a methanogenic archaea – that converts CO_2 and hydrogen

[2] https://www.epa.gov/renewable-fuel-standard-program/renewable-identification-number-rin-data-renewable-fuel-standard
[3] https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/
[4] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

into methane. The unprecedented catalytic ability and industrial robustness of this biocatalyst enables our biomethanation technology to operate at lower capital and operating costs and with greater flexibility than conventional thermochemical methanation processes. Any source of CO_2 can be used in the process, including CO_2 present in biogas that results during anaerobic digestion of animal waste, community wastewater, and in landfills. CO_2 from carbon capture can also be used as a source of CO_2.

Electrochaea is a dynamic growth-stage company based in Sacramento, California, owned by Munich-based Electrochaea GmbH. The technology has been de-risked and studied at industrial-scale demonstration facilities in Denmark and Switzerland, and a research reactor in Golden, CO at the National Renewable Energy Laboratory (NREL). The Electrochaea story started in the year 2006 with basic research and four years of proof-of-concept work in Prof. Laurens Mets' laboratory at the University of Chicago. De-risking of the process for commercialization began in 2011, using raw biogas to produce methane at a brewery digester in St. Louis, MO, and continued with field trials in Foulum, Denmark. In 2016, an industrial scale plant was commissioned in Avedøre, Denmark at a wastewater treatment plant. The plant produced grid-quality methane (>97% methane) from raw biogas and from pure CO_2 purified by a biogas upgrading process. A second-generation plant, with automated remote operation, was commissioned in 2019 in Switzerland, and was injecting high quality methane onto the gas grid within 96 hours of startup. Both plants have demonstrated flexible operation with immediate recovery after different periods of shutdown. This flexibility is important to accept intermittent renewable power, when it is available.

IV. Comments

A. Production of renewable natural gas using biomethanation has many advantages in the achievement of climate goals.

1) Biomethanation reduces greenhouse gas emissions.

CO_2 is being needlessly released into the atmosphere during many agricultural and industrial practices. By partnering with existing sources of CO_2 and methane emissions, biomethanation can serve to recycle these emissions into a new renewable fuel for storage in the gas grid or for immediate use. Just as the carbon index of the power grid is increasingly reduced, we can deliberately lower the carbon intensity of the gas grid by displacing fossil gas with biomethane and continue to use our largest and most reliable energy distribution and storage system, the gas grid, to meet our climate goals. Using existing infrastructure further reduces capital investment and land use concerns.

Biomethanation can use any biogas source as a feedstock to produce biomethane, including biogas that results during anaerobic digestion of animal waste, community wastewater, and in landfills. Since biogas is typically 60% methane and 40% CO_2, the ability to convert the CO_2 into methane nearly doubles the amount of renewable methane that can be produced from waste, doubling the amount of fossil fuel that is displaced.

With the growing market for renewable fuels that can immediately replace fossil fuel, the agricultural community can participate in the solution to climate change, while improving their bottom line. In addition, expanding the use of biogas in biomethanation plants will capture methane that would be flared, or even worse, vented, and similarly reuse CO_2 that otherwise would be vented.

2) **Biomethane can replace any current use of natural gas.**

Since biomethane is a drop-in fuel for natural gas, it can be used in any application that currently uses fossil natural gas. Every cubic ft. of biomethane produced prevents the extraction of a cubic ft. of fossil-derived natural gas. Biomethane can be used directly at the site of production to generate electricity, heat boilers, or fuel farm machinery and vehicles[5]. In addition, biomethane is needed for many industrial practices that cannot be completed with electricity, including industrial processes requiring high heat[6].

Biomethane can also be used to produce renewable electricity when other renewable sources of power are not available. The increased availability of biomethane can meet current power needs to support grid balancing.

3) **Implementation of advanced technologies provides jobs in rural communities.**

The Global Commission on the Future of Work predicts that there will be 24 million new jobs worldwide by 2030 in the green economy[7]. This will include jobs in rural America in the construction and operation of plants that produce synthetic fuels.

B. Coordination across multiple sectors and under the authority of multiple agencies/departments is necessary to reach full potential of RNG.

Electrochaea is pleased to see the USDA considering the department's role in promoting biofuels and generally contributing to solutions that address climate change. While we support the idea that additional funding for research, demonstration, and development and new mechanisms for financial incentive structures are critical under the department's own purview, we also emphasize in our comments the need for solutions outside of one agency or department.

1) **The definition of biomethane must be more inclusive and programs must strive for broader eligibility to draw in new technologies.**

Importantly, the biomethanation process can also synthesize biomethane from industrial sources of CO_2, such as CO_2 emitted during fermentation of biomass to produce ethanol for transportation fuel, CO_2 captured from flue gases, or from cement or steel plants. While some of these industrial sources of CO_2 do not result in a biomass-derived fuel, they do produce an identical methane gas with a low carbon intensity. These industrial sources of CO_2 as a feedstock for the production of a synthetic fuel should not be overlooked. Industrial processes emitted 23% of the greenhouse gases in the USA in 2019[8]. However, current regulations and incentive programs, frequently disqualify this type of fuel because its feedstock is not from biomass. A synthetic fuel that recycles CO_2 preventing greenhouse gas emissions should be recognized in the same way as a synthetic fuel that is produced from biomass. The artificial distinction between the two fuels results in a disincentive to capture CO_2 in a useful fuel.

[5] https://www.waste360.com/gas-energy/rng-produced-california-crr-flows-socalgas-pipelines-first-time
[6] https://www.brookings.edu/essay/why-are-fossil-fuels-so-hard-to-quit/
[7] https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_662410.pdf
[8] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Similarly, and though biomethanation and power-to-gas have been studied for more than 15 years, a renewable methane made by this process was not envisioned when the first regulations were drawn up to support renewable fuels for transportation. At that time, ethanol was the preeminent biofuel. The Renewable Fuel Standard program created under the Energy Policy Act 2005 and administered by the EPA, defines a biofuel as a transportation fuel that is derived completely from biomass, including the energy used to produce hydrogen. Thus, a fuel produced with renewable energy from the sun or the wind, is not covered by the program, even though it meets the goals of the program in providing a renewable fuel that can replace a fossil fuel. In order to take advantage of as many technologies as possible to tackle climate change, these programs and policies should be modernized.

Electrochaea supports definitions that track across multiple sectors and encourages the USDA to evaluate whether its own incentive programs, whether existing or new, may be too restrictive to allow for new technologies to be eligible.

2) Power-to-gas biomethanation provides storage of surplus power and aids in electric generation reliability

Ensuring that there is a viable production supply chain and growing market for biomethane requires looking outside the traditional scope of various agency jurisdiction and coordinating to maximize benefits and lower costs across multiple sectors. While RNG has often been utilized most commonly in transportation sectors, a new source of demand can be in replacing fossil fuels for electric generation. The USDA should support efforts to drive this demand to benefit biofuel production under their own jurisdiction.

When biomethanation is implemented as a power-to-gas technology, it provides a solution for a growing problem in the production of electricity from the sun and wind: intermittent availability. In order to meet the US goal of a net-zero emissions economy by 2050, with a 100% carbon-pollution-free power sector by 2035[9], the capacity of solar and wind electrical generation, must be increased by as much as 10-fold[10]. This will result in periods when there is a surplus of power. This is already happening in California; in 2020, 1.6 TWh of renewable power was curtailed[11]. The solar and wind electricity generations resources were available to provide power but were not used. When power-to-gas is implemented, renewable solar and wind assets can be fully used, preventing valuable resources from being curtailed. If this unrealized power generation had been used to produce biomethane via power-to-gas technology, this energy could have been stored, and later used, for renewable power generation. Using would-be curtailed power promotes the optimization of existing renewable assets, as well as the construction of more renewable assets, which is needed to reach the 2050 climate goal.

Critically, power-to-gas adds an additional advantage of providing seasonal storage of renewable energy. Energy captured in renewable natural gas is an energy storage mechanism; this clean renewable gas can be stored on the gas grid. Unlike a conventional battery, energy stored on the gas grid is not subject to loss-of-charge, nor loss of capacity, over time. The gas

[9] Pledged on April 22, 2021 by President Biden.
[10] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/March/IRENA_World_Energy_Transitions_Outlook_2021.pdf.
[11]http://www.caiso.com/informed/Pages/ManagingOversupply.aspx#:~:text=%E2%80%8BOversupply%20and%20curtailments&text=Sometimes%2C%20during%20the%20middle%20of,%2C%20or%20%E2%80%9Ccurtail%22%20generation.

grid can serve as a seasonal "battery" by time-shifting the availability of renewable power. As an existing infrastructure, this asset is in place and ready to support the required battery functionality. This reliable reservoir of low-carbon fuel would provide the power sector with a renewable resource adequacy asset it desperately needs and enable continued use of our fleet of generation assets to produce low-carbon electricity.

C. Challenges and barriers to the widespread implementation of biomethanation.

The challenges to the widespread implementation of biomethanation are not limited to any one department, agency, or sector, and ultimately this need for coordination is one of biomethane's biggest barriers. Biomethane is technologically suited to provide solutions to emissions in the agricultural and transportation sectors, reliability in the electric sector, and applications in the industrial sector that require higher heat than can be provided by electricity, in a cost-effective way. Because of this, a bigger picture approach is necessary. The USDA must recognize its important role in this bigger picture and work with other sectors to enable biomethane production.

Mobilizing financing to support investment in the production of biomethane is also needed. To reach the ambitious benchmarks of zero greenhouse gas emissions by 2050, the U.S. government must take a multifaceted approach. Incentives are needed for technologies that can support the 2050 goal, and especially those that can store surplus power. In the future, evolving economic incentives may be appropriate to stimulate storage of biomethane to be used for grid balancing and to contribute to a reliable and affordable energy system. RNG can be used to support the grid during times of intermittency when it is used as a clean fossil fuel alternative, but also times of renewable under-utilization to support the production of RNG.

One of the remaining challenges for implementation of biomethanation in the United States is for the appropriate regulatory and policy bodies to evaluate and model the use of the gas grid as a battery, to be able to effectively track and predict the renewable gas production and storage "charging" cycles, and to combine this with the known "discharge" cycle from the combustion assets that will serve the power grid with renewable gas. Standards of conformity for response times, charging and discharging ramp rates, power capacities and the like would be critical to allow markets to value gas grid battery services, and enable participants to design and provide cost estimates for capital to deploy power-to-gas assets. In the absence of clear regulatory guidance recognizing the potential contribution of RNG to climate policy goals, would-be project operators and developers will under-invest in the potential of power-to-gas projects, a systemic loss of available value.

V. Conclusion

To summarize, Electrochaea encourages the USDA to take a multifaceted approach to the solution of climate change. Such action would include encouraging the adoption of a broad range of technologies, going beyond those envisioned in 2005 to reduce greenhouse gas emissions with advanced technologies that can reduce emissions while reutilizing carbon. Capturing the emission from agricultural sources of CO_2, such as biogas, should be high priority. Working together with other agencies, the USDA can encourage regulatory policies, incentives and financing mechanisms that will accelerate the transition to the zero-emission economy.

Thank you for the opportunity to provide our input about the role of renewable fuels in the zero-emission economy.

Sincerely,

/s/ Mich Hein

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