Electrochaea Corporation (April Arbour)

Electrochaea provides industrial-scale technology for the production of renewable synthetic natural gas. This fuel is produced through methanation, a process that synthesizes synthetic natural gas (an e-fuel) using electrolytic hydrogen and carbon dioxide as the substrates.

When the CO2 is captured from biogas or other biomass-based sources, the resulting synthetic natural gas is considered a subset of biomethane. To ensure the Washington State Clean Fuels Program (CFP) remains aligned with other low-carbon fuel regulations, Electrochaea advocates for the following regulatory amendments:

- Formally recognize synthetic natural gas produced from biomass-based CO2 and renewable hydrogen as an eligible credit-generating fuel.
- Explicitly allow electrolytic hydrogen to be used as a feedstock for synthetic natural gas production.
- Permit the use of book-and-claim accounting for the renewable electricity used to generate electrolytic hydrogen.

Synthetic natural gas production process. Synthetic natural gas is produced from CO2 and hydrogen using a biological or chemical catalyst . In the first step, renewable electricity, such as from solar, wind or hydropower, is used to produce renewable hydrogen by electrolysis (electrolytic hydrogen). In the second step, methane is synthesized from hydrogen and CO2. CO2 can be from different biological sources, such as from biogas upgrading, ethanol production, or direct air capture. The resulting synthetic natural gas (also called e-methane) has a carbon intensity (CI) significantly lower than natural gas. When the CO2 is derived from biological sources, it is estimated in the literature, depending upon the source of the renewable energy, that the CI is 1.5-6.1 gCO2eq/MJ . The majority of the energy required for methanation comes from the production of the electrolytic hydrogen4, requiring that the electricity used for hydrogen production is renewable. The global warming potential (GWP) of synthetic natural gas is similar when a chemical or biological catalyst are used in the synthetic process . deRoeck et al., (2022) estimated that the GWP is 26.95 kgCO2eq/MWh (7.5g CO2eq/MJ) for electrolysis combined with methanation and 1.61 kg CO2eq/MWh (0.5 g CO2eq/MJ) for methanation alone.

Benefits of synthetic natural gas use in transportation. Since biogas is approximately 40% CO2, methanation of the CO2 nearly doubles the amount of transportation fuel that can be obtained from a biogas source . Additional benefits include increasing decarbonization of the gas grid, support of the hydrogen market, and use and storage of electricity that might have to be curtailed.

Electrochaea´s innovative biomethanation process. A biological catalyst is used in Electrochaea´s method for production of synthetic natural gas . The reactor contains a methanogenic archaeon within a stirred nutrient solution which maintains the activity of the organism. The archaea take up hydrogen and CO2 and synthesize methane and water. The low CI synthetic natural gas leaves the reactor and goes through a post processing step to make it ready for gas grid injection or on-site use. As is generally the case for the production of e-fuels, the largest use of energy is in the production of electrolytic hydrogen. Electrochaea's CI can vary between 2-12 gCO2eq/MJ depending on region of production due to the way electricity is accounted for in different region's methodologies and excluding a potential liquefaction For Electrochaea's process in Canada and the European Union, 50-75% of the energy is required for hydrogen synthesis, with the remaining energy required for feedstock gas compression, stirring of the reactor contents and preparation of the gas to meet gas grid specifications. The production process used for the generation of synthetic natural gas is parallel to those used in the production of other alternative fuels such as sustainable aviation fuel, which has a high energy demand due to the electrolysis process and can use renewable electricity to lower the CI from its process energy.

Compared to chemical catalysis, biological catalysis occurs at a lower temperature and is not damaged by feedstock gas contaminants. In Electrochaea's process, raw biogas can be used as the CO2 source and the low CI methane leaving the reactor is a mixture of synthetic natural gas and the methane originally present in the biogas.

Electrochaea's comments on the proposed regulations

1. Definition of biomethane.

Synthetic natural gas is included within the definition of biomethane. However, synthetic natural gas should be further defined to be certain that synthesis by a catalyst from biomass-based CO2 and renewable hydrogen is included in the definition of biomethane. Further defining synthetic natural gas clears up the misinterpretation that synthetic natural gas can only come from processes such as gasification and pyrolysis, acknowledging the distinct differences in how the synthetic natural gas is generated provides clarity on the renewable and low-CI nature of the fuel.

Clarifying that synthetic natural gas synthesized using biomass-based CO2 and renewable hydrogen is included under the definition of biomethane will aid in aligning the CFP with other low carbon fuel programs in the US. For example:

• Oregon's SB 98 utility RNG procurement program includes in the definition of Renewable Natural Gas (RNG), "methane derived from biogas, carbon oxides, or hydrogen from renewables and waste CO2."
• New Mexico's Clean Transportation Fuels Program also distinctly recognizes synthetic fuel and its importance to the program, citing that broadening the definition to include synthetic fuel allows for more inclusion of innovative future fuels.
•
Synthetic natural gas is also recognized and prioritized internationally.

• In Quebec, the main gas utility, Energir, has shown specific interest in their version of synthetic methane (3G RNG). Studies within Quebec show that 2.6% of the grid by 2030 will be from 3G RNG, increasing to between 13.1-25.6% by 2050.
• The European Union, under its categorization RFNBO, prioritizes e-methane and other hydrogen derivatives with a specific regulatory framework and various quotas in industries such as the maritime sector and Germany's transportation sector.

Electrochaea previously requested (comment letter of August 1, 2025) that the definition of biomethane be clarified to ensure that synthetic natural gas produced by methanation of biogenic CO2 with electrolytic renewable hydrogen be included in the program. We received the following response:
"Ecology did not make any changes in response to this request. The current definition mentions "synthetic natural gas derived from renewable resources," which may already include fuels

produced by Electrochaea. Ecology may consider refining the definition in a future rulemaking once it has more time to learn about any relevant technology and production methods."
In this comment, we are making the same request and providing more information about the production of synthetic natural gas by methanation. We would be pleased to provide more information in person or in writing.

2. Use of electrolytic hydrogen as a feedstock for synthetic natural gas production

It is clear that electrolytic hydrogen produced from renewable resources can be used in the program if the hydrogen will be used directly as a transportation fuel. However, synthetic natural gas is excluded as a pathway that can correctly account for this electrolytic hydrogen.

The proposed rule section "WAC 173-424-610 Obtaining a carbon intensity (9)(n) Utility-specific carbon intensities for alternative jet fuel and alternative marine fuel" indicates that electrolytic hydrogen can be used as process energy for production of alternative jet fuels and alternative marine fuels. It does not state that electrolytic hydrogen can also be used as feedstock for production of synthetic natural gas that would be used as a general transportation fuel. A pathway for using renewable electrolytic hydrogen as a feedstock for synthetic natural gas synthesis as a general transportation fuel should also be included.

The inclusion of this pathway will allow synthetic natural gas using renewable electrolytic hydrogen to be generated in compliance with the CFP and, in turn, allow the CFP to target even more of Washington's hard-to-decarbonize sectors. In Washington's 2023-2025 Budget and Policy Highlights, transportation is cited as the state's largest source of emissions, targeting specifically medium- and heavy-duty vehicles. Synthetic natural gas' capability as a low-CI drop-in replacement for fossil transportation fuels should be considered to help in decarbonizing these sectors. The CFP rejecting the use of electrolytic hydrogen as a feedstock for synthetic natural gas production prevents Washington from using a robust strategy to decarbonize these emission intensive sectors.

3. Use of book-and-claim to purchase renewable electricity for hydrogen

Synthesis of Electrochaea's synthetic natural gas requires the production of electrolytic hydrogen using renewable electricity. While the CFP is clear that renewable electricity can be used for the purpose of hydrogen production , and that book-and-claim accounting can be used to purchase electricity in the CFP, it is not clear that this applies for the production of hydrogen that would be used as a feedstock for biomethane production. In an effort to standardize with other clean fuel programs, the CFP should allow the use of book-and-claim renewable electricity for process energy. The newest U.S. low carbon fuels program, the New Mexico Clean Transportation Fuels Program, distinctly allows the use of book-and-claim accounting with the use of offsite renewable electricity.2 This methodology allows flexibility in how a fuel producer can lower their carbon intensity score, and therefore encourages the reduction of GHG emissions. Book-and-claim is also permitted at the federal level with the implementation of the IRC Section 45V Clean Hydrogen Production Tax Credit. This credit requires the use of Renewable Energy Certificates (RECs) to purchase energy for use in generating tax credit compliant hydrogen, going off of an endorsement from the EPA of book-and-claim electricity as a good approach for utilizing low CI electricity for the credit. Clarity in this regard would allow additional alternative fuels to be made available for use in the Washington transportation market.

Electrochaea appreciates the opportunity to participate in this rulemaking.

Sincerely,

April Arbour
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March 3, 2026

Submitted via Public Comment Form

Department of Ecology
Climate Pollution Reduction Program
300 Desmond Drive SE
Lacey, WA 98503

Re: Chapter 173-424 WAC and WAC 173-455-150 – Clean Fuels Program Rule and Clean Fuels Program Fees

Electrochaea provides industrial-scale technology for the production of renewable synthetic natural gas. This fuel is produced through methanation, a process that synthesizes synthetic natural gas (an e-fuel) using electrolytic hydrogen and carbon dioxide as the substrates.

When the CO_2 is captured from biogas or other biomass-based sources, the resulting synthetic natural gas is considered a subset of biomethane. To ensure the Washington State Clean Fuels Program (CFP) remains aligned with other low-carbon fuel regulations, Electrochaea advocates for the following regulatory amendments:

- Formally recognize synthetic natural gas produced from biomass-based CO_2 and renewable hydrogen as an eligible credit-generating fuel.
- Explicitly allow electrolytic hydrogen to be used as a feedstock for synthetic natural gas production.
- Permit the use of book-and-claim accounting for the renewable electricity used to generate electrolytic hydrogen.

Synthetic natural gas production process. Synthetic natural gas is produced from CO_2 and hydrogen using a biological or chemical catalyst[1]. In the first step, renewable electricity, such as from solar, wind or hydropower, is used to produce renewable hydrogen by electrolysis (electrolytic hydrogen). In the second step, methane is synthesized from hydrogen and CO_2. CO_2 can be from different biological sources, such as from biogas upgrading, ethanol production, or

[1] F. Goffart De Roeck, A. Buchmayr, J. Gripekoven, J. Mertens, J. Dewulf (2022) Comparative life cycle assessment of power-to-methane pathways: Process simulation of biological and catalytic biogas methanation, Journal of Cleaner Production, 380: 135033 (https://doi.org/10.1016/j.jclepro.2022.135033)https://doi.org/10.1016/j.jclepro.2022.135033) AND AY Raya-Tapia, FJ López-Flores, A Sánchez, M Martín, C Ramírez-Márquez, and JM Ponce-Ortega. (2025) Power-to-X and the Green Chemical Revolution: A Review on Sustainable Energy Carriers and Synthetic Fuels. Industrial & Engineering Chemistry Research 64 (43), 20379-20403 (https://doi.org/10.1021/acs.iecr.5c02274)

direct air capture. The resulting synthetic natural gas (also called e-methane) has a carbon intensity (CI) significantly lower than natural gas. When the CO_2 is derived from biological sources, it is estimated in the literature, depending upon the source of the renewable energy, that the CI is 1.5-6.1 gCO_2eq/MJ[2]. The majority of the energy required for methanation comes from the production of the electrolytic hydrogen[4], requiring that the electricity used for hydrogen production is renewable. The global warming potential (GWP) of synthetic natural gas is similar when a chemical or biological catalyst are used in the synthetic process[3]. deRoeck et al., (2022) estimated that the GWP is 26.95 $kgCO_2eq/MWh$ (7.5g CO_2eq/MJ) for electrolysis combined with methanation and 1.61 kg CO_2eq/MWh (0.5 g CO_2eq/MJ) for methanation alone.

Benefits of synthetic natural gas use in transportation. Since biogas is approximately 40% CO_2, methanation of the CO_2 nearly doubles the amount of transportation fuel that can be obtained from a biogas source[4]. Additional benefits include increasing decarbonization of the gas grid, support of the hydrogen market, and use and storage of electricity that might have to be curtailed.

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[2] A Litheko, B Oboirien, B Patel. (2023) Life cycle assessment of Power-to-Gas (PtG) technology – Evaluation of system configurations of renewable hydrogen and methane production. Sustainable Energy Technologies and Assessments. Volume 60,103527 (https://doi.org/10.1016/j.seta.2023.103527)

[3] F. Goffart De Roeck, A. Buchmayr, J. Gripekoven, J. Mertens, J. Dewulf (2022) Comparative life cycle assessment of power-to-methane pathways: Process simulation of biological and catalytic biogas methanation, Journal of Cleaner Production, 380: 135033 (https://doi.org/10.1016/j.jclepro.2022.135033)https://doi.org/10.1016/j.jclepro.2022.135033)

[4] N Elhaus, S Kolb, J Müller, M Goldbrunner, J Karl, K Herkendell (2023) Environmental assessment of anaerobic digestion and biological methanation in power-to-methane systems. Journal of Cleaner Production 429: (https://doi.org/10.1016/j.jclepro.2023.139509).

[5] MR Martin, J Fornero, R Stark, L Mets, and LT Angenent (2013) A Single-Culture Bioprocess of *Methanothermobacter thermautotrophicus* to Upgrade Digester Biogas by CO_2-to-CH_4 Conversion with H_2. Archaea Vol. 2013. (http://dx.doi.org/10.1155/2013/157529)

[6] Carbon intensity calculations completed using EU RFNBO methodology (https://www.iscc-system.org/wp-content/uploads/2025/10/ISCC_EU-205-1_RFNBOs_RCF_GHG-Emissions_v1.4.pdf), Canada Fuel LCA Model Methodology (https://www.canada.ca/en/environment-climate-change/services/managing-pollution/fuel-life-cycle-assessment-model.html), and US EPA methodology (https://www.epa.gov/renewable-fuel-standard/lifecycle-analysis-greenhouse-gas-emissions-under-renewable-fuel-standard).

Compared to chemical catalysis, biological catalysis occurs at a lower temperature and is not damaged by feedstock gas contaminants. In Electrochaea's process, raw biogas can be used as the CO_2 source and the low CI methane leaving the reactor is a mixture of synthetic natural gas and the methane originally present in the biogas.

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Synthetic natural gas is included within the definition of biomethane.[7] However, synthetic natural gas should be further defined to be certain that synthesis by a catalyst from biomass-based CO_2 and renewable hydrogen is included in the definition of biomethane. Further defining synthetic natural gas clears up the misinterpretation that synthetic natural gas can only come from processes such as gasification and pyrolysis, acknowledging the distinct differences in how the synthetic natural gas is generated provides clarity on the renewable and low-CI nature of the fuel.

Clarifying that synthetic natural gas synthesized using biomass-based CO_2 and renewable hydrogen is included under the definition of biomethane will aid in aligning the CFP with other low carbon fuel programs in the US. For example:

- **Oregon's SB 98** utility RNG procurement program includes in the definition of Renewable Natural Gas (RNG), "methane derived from biogas, carbon oxides, or hydrogen from renewables and waste CO_2."[8]
- **New Mexico's Clean Transportation Fuels Program** also distinctly recognizes synthetic fuel and its importance to the program, citing that broadening the definition to include synthetic fuel allows for more inclusion of innovative future fuels.[9]
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Synthetic natural gas is also recognized and prioritized internationally.

- In **Quebec**, the main gas utility, Energir, has shown specific interest in their version of synthetic methane (3G RNG). Studies within Quebec show that 2.6% of the grid by 2030 will be from 3G RNG, increasing to between 13.1-25.6% by 2050.[10]
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[7] See definition of biomethane, pg. 3.
[8] Oregon SB98, 2019. https://olis.oregonlegislature.gov/liz/2019R1/Downloads/MeasureDocument/SB98/Enrolled
[9] NM CTFP, 2025. https://www.env.nm.gov/opf/wp-content/uploads/sites/13/2025/12/Exhibit-A_NMED-Final-Rule-with-In-Line-Reasoning.pdf
[10] Energir GNR Technical Study, 2023. https://energir.com/files/energir_common/import/Fichiers/Corporatifs/Publications/Fiche-technique-GNR_FINALE.pdf

CO_2 with electrolytic renewable hydrogen be included in the program. We received the following response:

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The inclusion of this pathway will allow synthetic natural gas using renewable electrolytic hydrogen to be generated in compliance with the CFP and, in turn, allow the CFP to target even more of Washington's hard-to-decarbonize sectors. In Washington's 2023-2025 Budget and Policy Highlights, transportation is cited as the state's largest source of emissions, targeting specifically medium- and heavy-duty vehicles.[12] Synthetic natural gas' capability as a low-CI drop-in replacement for fossil transportation fuels should be considered to help in decarbonizing these sectors. The CFP rejecting the use of electrolytic hydrogen as a feedstock for synthetic natural gas production prevents Washington from using a robust strategy to decarbonize these emission intensive sectors.

3. *Use of book-and-claim to purchase renewable electricity for hydrogen*

Synthesis of Electrochaea's synthetic natural gas requires the production of electrolytic hydrogen using renewable electricity. While the CFP is clear that renewable electricity can be used for the purpose of hydrogen production[13], and that book-and-claim accounting[14] can be used to purchase electricity in the CFP, it is not clear that this applies for the production of hydrogen that would

[11] Concise Explanatory Statement Chapter 173-424 WAC Clean Fuels Program Rule: Summary of Rulemaking and Response to Comments, October 2025. https://apps.ecology.wa.gov/publications/documents/2514090.pdf

[12] Washington 2023-2025 Budget and Policy Highlights, 2022. https://ofm.wa.gov/wp-content/uploads/sites/default/files/public/budget/statebudget/highlights/budget23/202325PolicyBudgetHighlights.pdf

[13] See definition of renewable hydrogen

[14] See definition of book-and-claim accounting

be used as a feedstock for biomethane production. In an effort to standardize with other clean fuel programs, the CFP should allow the use of book-and-claim renewable electricity for process energy. The newest U.S. low carbon fuels program, the New Mexico Clean Transportation Fuels Program, distinctly allows the use of book-and-claim accounting with the use of offsite renewable electricity.[9] This methodology allows flexibility in how a fuel producer can lower their carbon intensity score, and therefore encourages the reduction of GHG emissions. Book-and-claim is also permitted at the federal level with the implementation of the IRC Section 45V Clean Hydrogen Production Tax Credit. This credit requires the use of Renewable Energy Certificates (RECs) to purchase energy for use in generating tax credit compliant hydrogen, going off of an endorsement from the EPA of book-and-claim electricity as a good approach for utilizing low CI electricity for the credit.[15] Clarity in this regard would allow additional alternative fuels to be made available for use in the Washington transportation market.

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[15] 90 Fed. Reg. 2254 (January 10, 2025) ("The EPA also noted that EACs are an established means for documentation and verification of the generation and purchase of zero-GHG-emitting electricity. Moreover, the EPA advised that, in the context of electrolytic hydrogen, EACs that possess specific attributes that meet certain criteria are an appropriate way in the context of section 45V of verifying the generation and delivery of zero GHG-emitting electricity and can serve as a reasonable methodological proxy for quantifying induced grid emissions associated with new load from electrolytic hydrogen production being added to an existing grid."). In a 2013 determination letter, EPA did not allow book-and-claim for utilizing low CI electricity due to tracking and enforcement issues. EPA, May 22, 2013, https://www.epa.gov/sites/default/files/2015-08/documents/absolute-energy-rec-determination-5-22-13.pdf. However, as reflected by EPA recent full endorsement of book-and-claim for utilizing low CI electricity, tracking has become much more advanced over the last decade.