DOCKETED	
Docket Number:	23-IEPR-06
Project Title:	Hydrogen
TN #:	252362
Document Title:	Electrochaea Corporation Comments - End-ues of Renewable Hydrogen
Description:	N/A
Filer:	System
Organization:	Electrochaea Corporation
Submitter Role:	Public
Submission Date:	9/22/2023 12:42:20 PM
Docketed Date:	9/22/2023

Comment Received From: Electrochaea Corporation
Submitted On: 9/22/2023
Docket Number: 23-IEPR-06

End-ues of Renewable Hydrogen

Additional submitted attachment is included below.

Electrochaea Corporation • 9921 Carmel Mountain Rd. #325 • San Diego, CA • 92129-2813

September 22, 2023

Commissioner Patty Monahan
California Energy Commission
715 P Street
Sacramento, CA 95814

Re: IEPR Commissioner Workshop on the Potential Growth of Hydrogen

Dear Ms. Monahan:

Electrochaea Corporation appreciates the opportunity to provide comments on the California Energy Commission's September 8 IERP Commissioner Workshop on the Potential Growth of Hydrogen. Our comments focus on an important end-use of renewable hydrogen, the production of renewable synthetic fuels.

Electrochaea Corporation is a subsidiary of Electrochaea GmbH, a growth-stage company that has developed a power-to-gas solution for the production of clean, synthetic methane. Synthetic methane is a low carbon intensity (CI) replacement for fossil-based natural gas. Power-to-gas is a means to provide renewable gas for any current use of natural gas including industrial use and firm power generation, and a means to store renewable hydrogen.

Electrochaea agrees that many benefits in the fight against climate change can come from increased production and use of clean hydrogen. Hydrogen can play a role in California's ability to reach net zero by 2045 if significant uses of clean hydrogen are rapidly developed. Electrochaea recommends that further emphasis be placed on the benefits that occur when renewable methane is produced from renewable hydrogen and carbon dioxide. Developing new uses of hydrogen that can leverage existing gas-grid infrastructure will promote the hydrogen market, allowing prices to decline. In addition, the production of synthetic methane from hydrogen is a means to store hydrogen and renewable energy as well as providing a solution to hydrogen transportation.

A. Production of clean synthetic methane using hydrogen and CO_2

Power-to-gas, specifically power-to-methane, is a technology in which energy from renewable electricity is stored in renewable methane via the production of renewable hydrogen. Power-to-methane produces clean synthetic methane from CO_2 and hydrogen. The resulting methane can be used as a renewable resource that can replace any current use of fossil natural gas, be transported in the existing gas infrastructure, and be used in current gas appliances, industrial equipment, and electrical generators.

In Electrochaea's grid-scale power-to-gas solution, first clean hydrogen is produced by electrolysis using renewable energy. Second, hydrogen and CO_2 are combined by a microorganism called Archaea which synthesizes methane. Clean, synthetic methane has a carbon intensity that is significantly lower than fossil natural gas. Thus, the use of low-carbon-intensity synthetic methane significantly reduces lifecycle GHG emissions. Electrochaea's two-step power-to-gas biomethanation process is illustrated in Figure 1.

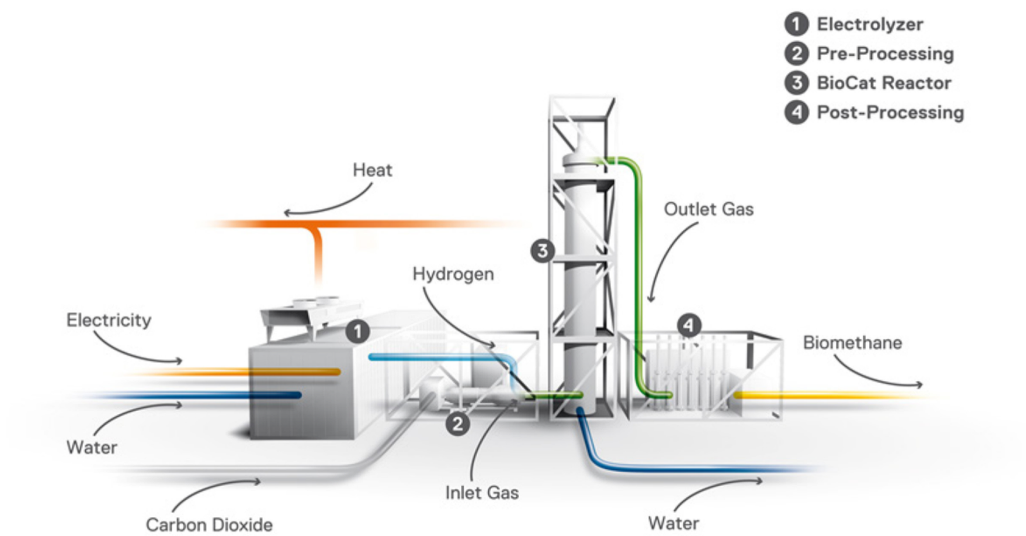


Figure 1. (1) Renewable energy is used to produce hydrogen by electrolysis, (2) hydrogen and carbon dioxide are delivered to the reactor (3) in which clean, synthetic methane is synthesized by the archaea. (4) Clean, synthetic methane (biomethane) is prepared for grid injection or use.

B. Production of synthetic methane using hydrogen as a feedstock is a means of storing renewable hydrogen and renewable energy

Storage of clean hydrogen in synthetic methane. The production of methane from hydrogen by power-to-methane is an efficient means to store hydrogen and the energy contained in the hydrogen molecule. When hydrogen is produced by electrolysis using renewable energy, the energy is stored in the clean hydrogen molecule. When that hydrogen is used to produce methane, 86% of the combustion energy is retained in the methane molecule[1].
In certain applications, hydrogen is more difficult and expensive to store and transport than natural gas. Instead of storing hydrogen directly, hydrogen can be used to produce synthetic

[1] When 4 moles of hydrogen are combusted with 2 moles of oxygen, 949 kJ of energy is released. When 1 mole of methane is combusted with 2 moles of oxygen, 818 kJ of energy is released. Thus, the methane molecule retains most of the combustion energy of hydrogen. *Thauer et al. 2010. Hydrogenases from Methanogenic Archaea, Nickel, a Novel Cofactor and H_2 Storage. Annual Review of Biochemistry 77:509-536*

methane, a natural gas replacement, which can be easily stored and transported in the existing gas infrastructure reducing capital investment, technology risk, and land use concerns. The US has the design capacity to store ~4,690 billion cubic feet of natural gas[2], which is equivalent to 1.37 billion MWh. In comparison, ~12,000 MW of battery storage capacity was planned for 2023[3]. Thus, there is as much as 100,000 times the amount of storage in the natural gas infrastructure as in the 2023 battery storage circumstance.

Long-term energy storage that cannot be achieved with traditional batteries. Power-to-gas adds a critical and additional advantage to renewable energy generation by providing seasonal storage of renewable energy. Analogous in many ways to pumped hydro or other forms of gravity-based storage, power-to-methane converts power generation into synthetic methane for much later future use, addressing the seasonal mismatch in supply and demand that makes it difficult to achieve 100% renewable electricity. This cannot be achieved with traditional batteries since they are designed to store energy for much shorter periods.

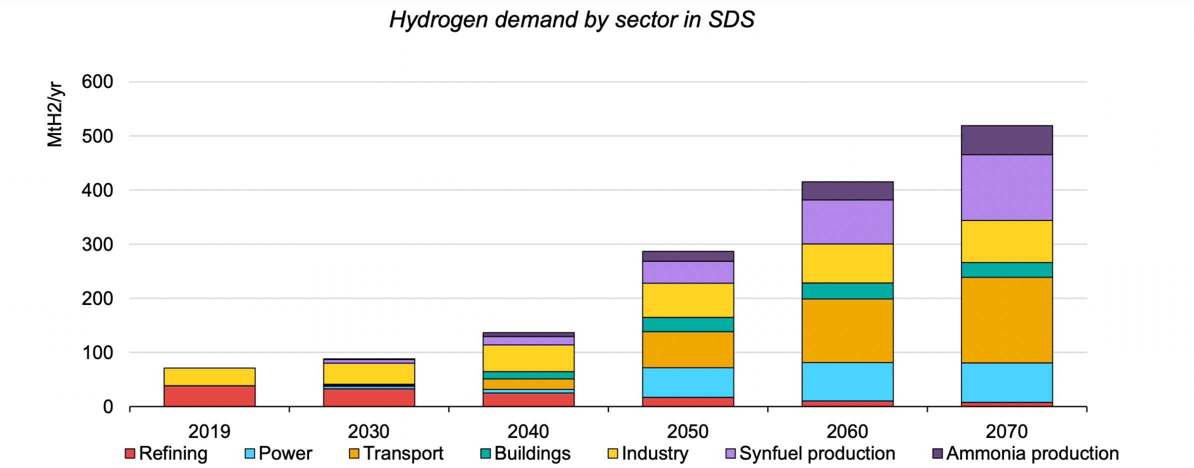
Storage of power that would be otherwise curtailed. When renewable power is available but cannot be used immediately, the power must be curtailed. If this otherwise curtailed power is available for the production of synthetic methane, the energy will not be lost and can be stored in the existing gas infrastructure. This enables full use of renewable energy production, even in the absence of available consumers, thus enabling continued growth of the market for renewable electric power, while providing an expanding source of renewable gas.

C. Use of hydrogen in synthetic methane production supports the hydrogen market

As markets for clean hydrogen develop, diversifying end uses can be an important risk mitigation strategy. New sectors that use clean hydrogen will drive the clean hydrogen markets, especially as many hydrogen-related technologies are nascent. Mechanisms and incentives to support multiple types of end-users for clean hydrogen produced in the H2Hubs or elsewhere are essential means to sustain and grow the hydrogen markets and indirectly the renewable power market. In the 2023 tracking report from the International Energy Agency on hydrogen[4], the agency concluded that “hydrogen demand is growing, but it is concentrated in traditional sectors”. The IEA reports that only 5% of new hydrogen projects have made firm investment decisions because of “uncertainties around the future evolution of demined, the lack of clarity about certification and regulation, and the lack of infrastructure available to deliver hydrogen to end users.” Thus, it is essential that a diverse array of end uses for clean hydrogen are supported to ensure financial feasibility. Figure 2 provides a prediction for hydrogen demand through 2070 under a sustainable development scenario (SDS)[5]. Synthetic fuels such as synthetic methane address several of the current problems and, accordingly, make up a significant demand in the IEA’s analysis.

---

[2] https://www.eia.gov/todayinenergy/detail.php?id=30632
[3] https://www.eia.gov/todayinenergy/detail.php?id=49236
[4] *https://www.iea.org/reports/hydrogen*
[5] *https://iea.blob.core.windows.net/assets/a76b2cc9-f7e3-459e-945e-91b8ff54d0fc/210318_IEA_Kristiansen.pdf*).



In the SDS, hydrogen demand grows 7-fold by 2070. Hydrogen and derived fuels account for 13% of global final energy demand, mostly used in transport and industry.

Figure 2. The International Energy Agency provides a prediction for clean hydrogen demand. This chart highlights the need for multiple end-users and shows that the production of chemicals, including fuels, is an important use of hydrogen.

D. Power-to-methane participates in environmental decarbonization by using CO_2 that would be directly emitted into the environment

Many industries can benefit from the implementation of power-to-methane because it provides them a use for their CO_2 that is simply vented and released to the atmosphere. One example is renewable natural gas production, which typically takes biogas from landfills or anaerobic digestors focused on organic waste diversion as the main feedstock. By taking advantage of the extra biogenic CO_2 in the biogas in power-to-methane production, plant operators have the opportunity to double the amount of clean methane produced from those sites. The renewable gas produced by power-to-gas and other technologies will initially cost more than our current natural gas. However, like wind solar, and other nascent technologies, the cost of assets and production will likely decrease with scaling and market growth.

Across industries, carbon capture technologies combined with power-to-methane can reduce emissions of CO_2, while increasing the availability of clean, synthetic methane. Such possibilities are enabled when CI is used as the metric for the reduction in GHG emissions. When CO_2 is captured from industries with unavoidable CO_2 emissions, such as ethanol or cement production, additional fossil natural gas is prevented from ever entering the grid.

E. Production of synthetic methane from hydrogen can play a role in integrated resource planning

Renewable synthetic methane combined with biomethane stored in the existing natural gas reservoirs can provide reliability benefits to the power grid and can be used to generate low CI electricity. A renewable gas reserve would enable continued use of current electricity generation assets to produce firm renewable electricity, maintaining jobs and existing infrastructure with known reliability and performance metrics. The loss of renewable production for even short periods, due to weather conditions alone, could jeopardize the power grid in the absence of reliable and proven gas generation assets.

A synergy likely exists in the coupling of the renewable power sector with renewable gas production. As intermittent renewable electricity generation increases in the US, there will necessarily be greater curtailment of electricity generation throughout the country. The power that is being curtailed could first be stored in the hydrogen molecule and then in the methane molecule using power-to-methane. By providing a buyer for economically curtailed power, the production of low-cost renewable gases would be enabled, and lost revenues for the renewable power producers would be recovered. The power-to-gas process can stabilize economic returns for the developers of renewable power while reducing the risk of the development of additional renewable generation assets.

Conclusion

Electrochaea appreciates the opportunity to participate in this discussion on the development of the SB 1075 Report. We are encouraged by the steps California is taking to ensure that renewable hydrogen plays an important role in the energy transition. However, we urge California to also highlight the potential role of power-to-gas as an end-use for renewable hydrogen and a method for decarbonizing the natural gas grid and stabilizing the electric grid.

Sincerely,

Chris Wilson
Manager Global Sustainability
Electrochaea Corporation
Chris.Wilson@Electrochaea.com
(862) 438-7116