



# **Western ElectroFuels Association**

## **Carbon-Free Fuels From Renewable Energy Sources**

**April 2018**



Front Cover: Columbia River Gorge ; Electromagnetic spectrum of hydrogen  
Back Cover: 135 MW electrolyzer plant, Glomfjord, Norway, 1953-1991, Credit Nel Hydrogen

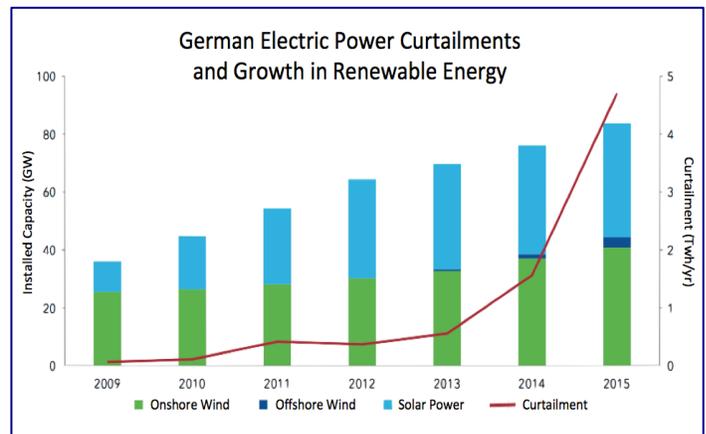
## What Are Electrofuels?

Electrofuels are created when electricity is used to split water to make hydrogen that can be used as a fuel, or as a building block to make other energy-intensive products such as ammonia and methane. Using renewable electricity to make climate-neutral fuels reduces the carbon footprint of sectors currently dependent on fossil fuels and extends the reach of wind and solar power beyond the confines of the electric grid. Electrolyzers are the set of technologies for converting electricity and water into fuel. They can become completely flexible electrical loads, helping to accommodate the variability of renewable resources, and reduce the amount of renewable energy wasted due to lack of demand.

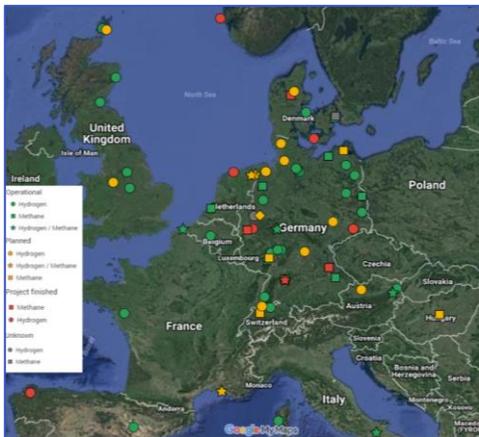
## Background

Wind and solar power have become the preeminent means of reducing carbon emissions from electricity production. Power from these sources varies between zero (e.g., at night for solar energy) and the nominal maximum production values (e.g., at noon on a sunny summer day for solar). The average output of these sources is typically 25-40 percent of nominal maximum. Depending on solar and wind for significant fractions of total electrical consumption implies both periods of under-production when the resources are insufficient to meet demand and over-production when the available power exceeds demand.

Over-production conditions are already occurring in both North America and Europe. In the spring of 2017, both the Bonneville Power Administration (BPA) and the California Independent System Operator (CAISO) prevented the generation of hundreds of gigawatt hours of otherwise available renewable energy for lack of demand. Between 2013 and 2015, wind and solar resources in Germany increased just 20 percent, but the amount of "curtailed" energy from those resources quadrupled. Another effect of the surpluses of renewable electricity is depressing wholesale electric prices. For example, California experienced daily occurrences of negative market prices (i.e. producers paying wholesale "purchasers" to take power) around noon in the spring of 2017.



The response to the burgeoning opportunity of low cost renewable electricity on the wholesale market has been greater in Europe where the penetration of wind and solar is higher. Dozens of projects have cropped up designed to absorb renewable electricity and produce climate-neutral combustible fuels—often to supplant natural gas.



European PtG projects. Adapted from [European Power to Gas Platform](#).

Electrolyzers convert water into hydrogen (and oxygen) with electricity, a process ("electrolysis") that has been known for more than two centuries. It is getting far more attention now, with the advent in recent years of surplus renewable energy. Commercial activity has vastly increased, reducing the cost of the technology by about a factor of two in just a few years, with further reductions expected as production increases. The combination of decreasing cost of utility-scale, commercially available electrolyzers and increasing availability of low wholesale price

The many potential benefits of using surplus renewable electricity to produce hydrogen and other products:

1. Making better use of available renewable electricity.
2. Relieving downward pressure on wholesale electric prices.
3. Expanding the reach of wind and solar resources to decarbonize energy uses beyond the electric grid; including transportation, steel and fertilizer manufacturing, and refineries.
4. Providing renewable resources an additional market avenue, potentially one that is not dependent on "firm" transmission capacity.
5. Making climate-neutral fuels more available to existing and new markets for both hydrogen and natural gas.
6. Creating an economic avenue for the long-term storage of renewable electricity as hydrogen in energy dense media for which considerable infrastructure already exists.

These multiple value propositions are potentially attractive to multiple entities:

1. Electric utilities:
  - a. Higher market prices for surplus energy sales.
  - b. Fewer curtailments of owned renewable resources.
  - c. Lower cost in meeting renewable portfolio or climate goals.
  - d. Flexible load that can contribute to balancing grids.
2. Renewable Developers:
  - a. Greater value for the power generated.
  - b. Potential to double the market for renewable electricity.
  - c. Potential to develop projects where power transmission is congested.

"Results indicate that [in an 80% renewable system] power-to-gas can reduce required wind and solar capacity by as much as 23% and curtailment by as much as 87%."

*System-level power-to-gas energy storage for high penetrations of variable renewables, Lyseng, et al, International Journal of Hydrogen Energy, December 2017*

3. Gas utilities:
  - a. New source of fuel to reduce carbon footprint of their product.
  - b. Potential to apply expertise to promoting carbon neutral fuels (e.g., hydrogen).
4. Environmental stakeholders, climate activists, ratepayers.
  - a. Expands reach of low-cost solar and wind energy to reduce carbon beyond electric grid (e.g., transportation, fertilizer production, refineries, steel manufacturing).
  - b. Reduces the cost of meeting carbon emission goals.
5. Electrolyzer manufacturers, and other manufacturers of hydrogen-related equipment (fuel cells, ammonia production, transportation).
  - a. Expands the availability of climate-neutral hydrogen.
  - b. Reduces cost of climate neutral-hydrogen.

“Using this gas with existing gas infrastructure, smartly combined with renewable electricity in sectors where it adds most value, can lead to €138 billion societal cost savings annually compared to decarbonisation without a role for renewable gas [in Europe].”

Gas for Climate: How gas can help to achieve the Paris Agreement target in an affordable way, Ecofys, 2018

Despite multiple benefits to multiple important industries and stakeholders, the value and importance of creating climate-neutral fuels from renewable electricity is not widely recognized by most of the affected parties. In addition to limited recognition of the value of this resource, a way needs to be cleared to pursue projects. For example, electric tariffs were largely predicated on utility obligation to serve load and not utility option to serve load. The lack of appropriate tariffs, and relative obscurity of commercial contract terms for this type of electrical load, need to be addressed. Similarly, practices and terms for injecting hydrogen and climate-neutral methane into transmission and distribution pipelines may need to be developed.

## Why This, Why Now

As the West moves to increase its reliance on renewable energy, surpluses of renewable energy will also rise. Incidence of curtailed renewable generation and negative wholesale market prices will also increase. At the same time, deployments of European electrofuel projects are causing the cost of electrolyzer technologies to drop. In short, the need for this technology is rising at the same time that the costs are dropping. A trade association can help pave the way for these technologies that hasten cost-effective deployments that will reduce the cost of reducing reliance on fossil fuels.

## Mission, Vision, Values

The Western ElectroFuels Association mission is to

“Air Liquide is committing to increasing by 2020 the percentage of hydrogen produced for these applications from carbon-free processes, i.e. sources that emit no CO<sub>2</sub>. The Group’s objective is to produce at least 50% of the hydrogen required by hydrogen energy applications from carbon-free energy sources...”

[Air Liquide Blue Hydrogen Initiative](#), web posting, 2018.

**Promote and foster the use of renewable electricity to produce climate neutral hydrogen and other products that replace fossil fuel generation.**

WEFA’s vision is

**A decarbonized electricity system in which electrofuel production complements renewable generation to optimize the value of renewable energy sources.**

WEFA’s values are

- ♦ **Equity and respect for the community and the environment.**
- ♦ **Working innovatively and collaboratively among many stakeholders to realize mutual benefits for its members and society at large.**
- ♦ **Independence and veracity.**

## Objectives and Functions

WEFA’s objectives are to foster the development of flexible electrical loads to create climate-neutral fuels from renewable energy. Its five-year objectives are:

1. Creation of a viable trade association that serves its membership.
2. Organize and fund an annual electrofuels conference.
3. Identify needed policies, regulations, and legislation to overcome barriers to electrofuel plants.
4. Educate all stakeholders on the multiple values and roles of electrofuels in establishing decarbonization.
5. Foster at least 500 megawatts of electrofuel loads in the Western US.
6. Create a scholarship fund to assist at least one student per year in pursuing an educational program in science, technology, or engineering at the undergraduate or graduate level with a focus on electrofuels.

“Hydrogen production in the United states is currently [2004] about 9 billion kg, or the energy equivalent of 8 billion gallons of gasoline [about 10% of US gasoline consumption].”

The Hype About Hydrogen, Joseph Romm, Island Press, 2004.

The proposed functions of the organization are:

1. Educate stakeholders, public, legislators and regulators on the vital role of electrofuels to maximize the value of renewable electricity, and reduce the cost and expedite the rate of decarbonization.
2. Facilitate member meetings in which challenges are identified and solutions developed.
3. Conduct annual conferences to facilitate the exchange of ideas, news, policy proposals and best practices.
4. Provide members a clearinghouse for information relating to the costs, benefits, and opportunities relating to electrofuels.

“As the pressure to reduce carbon emissions increases, and the cost of the technology improves with scale, there will be increasing opportunities for cost-effective PtG applications.”

Power to Gas:  
Opportunities for Greening  
the Natural Gas System,  
Flink Energy Consulting,  
2018.

Although the stakeholders can independently undertake these functions individually, or in loose coordination with one another, creating a reputable independent organization will result in greater effectiveness, and credibility.

## For More Information

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## WEFA Founding Committee

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Kris Nelson, Principal, Phoenix Finance

## Resources

[Power to Gas: Opportunities for Greening the Natural Gas System](#), Flink Energy Consulting for NW Natural, February 2018.

[Gas for Climate: How gas can help to achieve the Paris Agreement target in an affordable way](#), Ecofys, February 22, 2018.

[The Coming of Electrofuels](#), David White, March 27, 2018.

[Renewable Hydrogen, Fuels, & Chemicals](#), Gerry Snow, October 13, 2017.

[Power System Flexibility Strategic Roadmap](#), Ecofys for European Copper Institute, 2015.



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