

Power to Gas

Taking Wind and Solar Beyond the Power Grid

October 2018



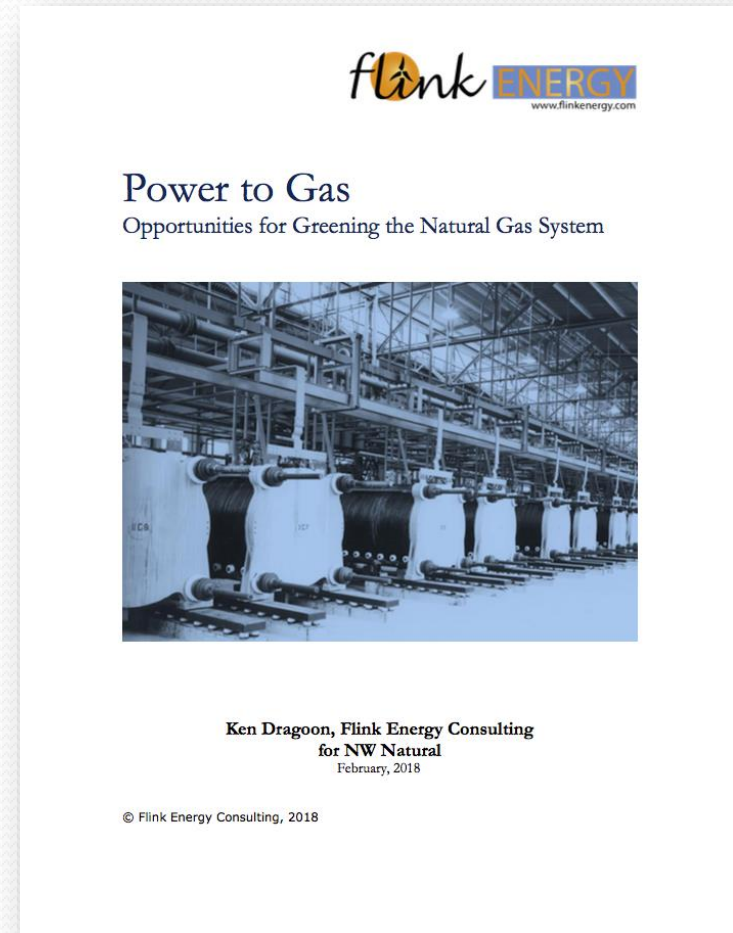
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Agenda

- Power to Gas Report
- Power to Gas Basics
- Need for Advocacy, Education & Policymaking
- Questions

Power-to-Gas Report

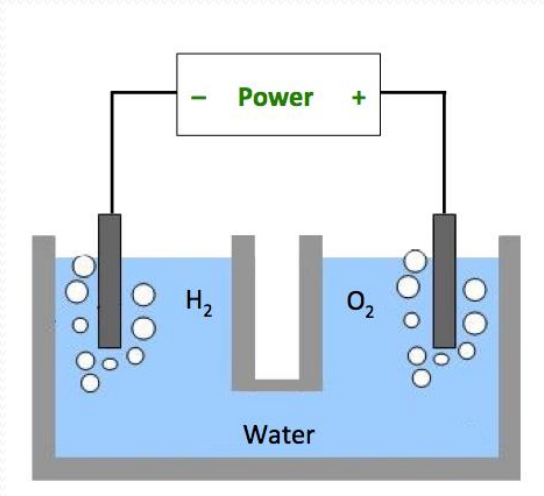
- Recognizes vital role of power-to-gas in decarbonization
- Uncovered recent price drops from economies of scale due to European deployments.
- Identifies need for advocacy



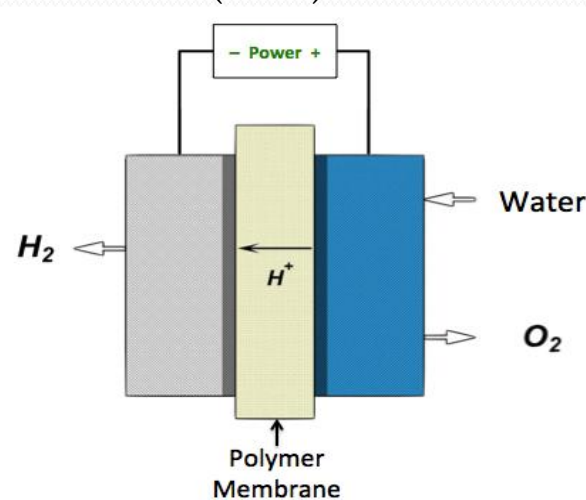
Power to Gas Basics

- Electricity + water = hydrogen, oxygen and heat
 - 200 year old technology
 - Gases created with this technology are called electrofuels
- Three technologies exist to create electrofuels

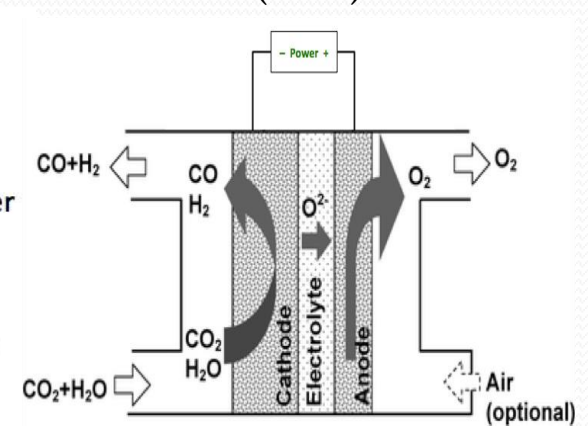
Alkaline



Proton Exchange Membrane (PEM)



Solid Oxide Electrolysis (SOE)



Hydrogen Uses

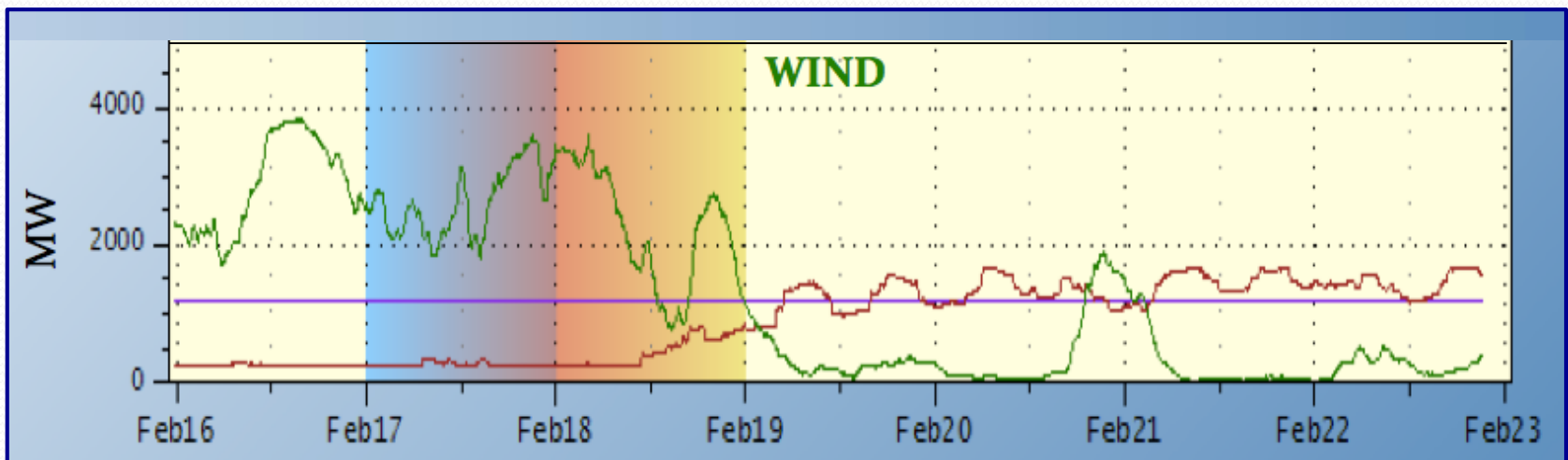
- Hydrogen can be used as a fuel directly
 - New hydrogen vehicles.
 - Can be substituted for natural gas in gas pipeline systems
- US produces 10 billion kg of industrial hydrogen annually from methane, leaving a large carbon footprint.
- Combines with carbon dioxide to form methane
 - Methane is completely interchangeable in the gas system



Audi Car Company 6 MW e-gas plant in Germany, begun in 2013.

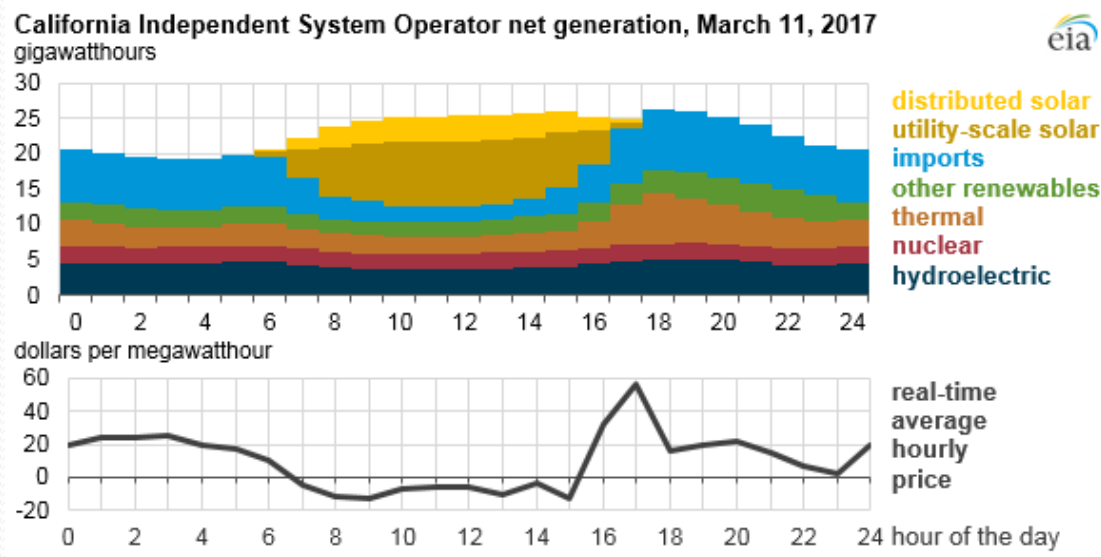
Renewable Power

- Renewable electricity is the key to reducing carbon emissions
- Future will increasingly rely on renewables
- Issues with relying entirely on renewable electricity
 - Variability
 - Sometimes way too much
 - Sometimes not enough



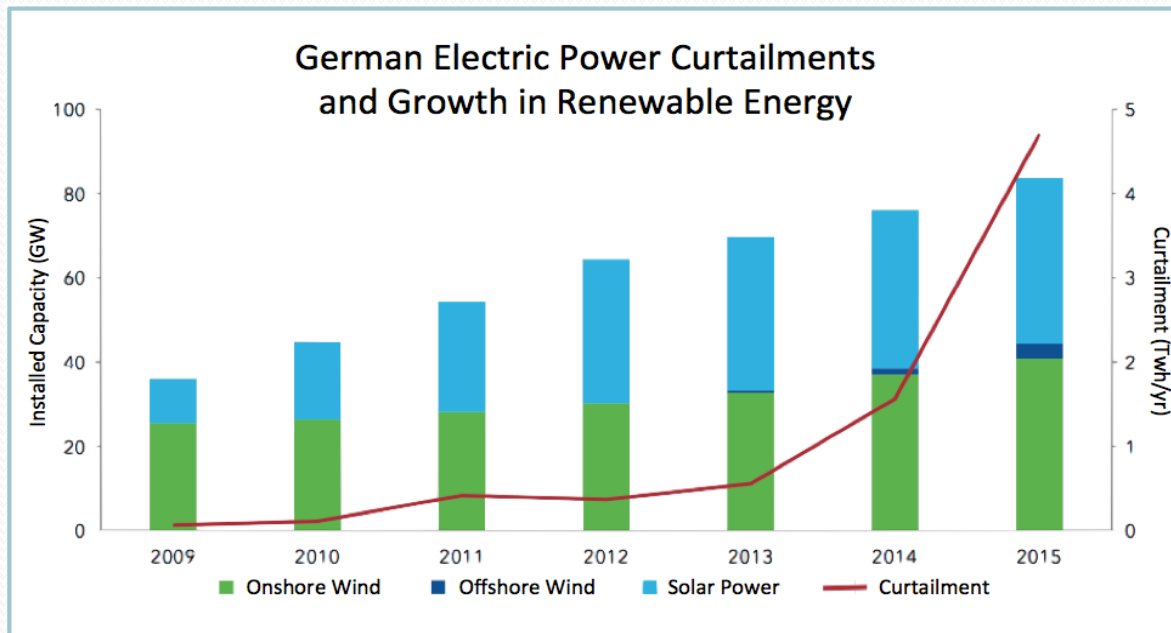
Renewable Power & Power-to-Gas

- Using increasing surpluses to create hydrogen:
 - Adds market for surplus power, bolstering the floor on electric prices.
 - Contributes fully flexible, fully dispatchable load.
 - Is the only economic source of seasonal renewable power storage
 - Nearly (or soon) cost competitive with fossil-derived hydrogen.



Renewable Surpluses

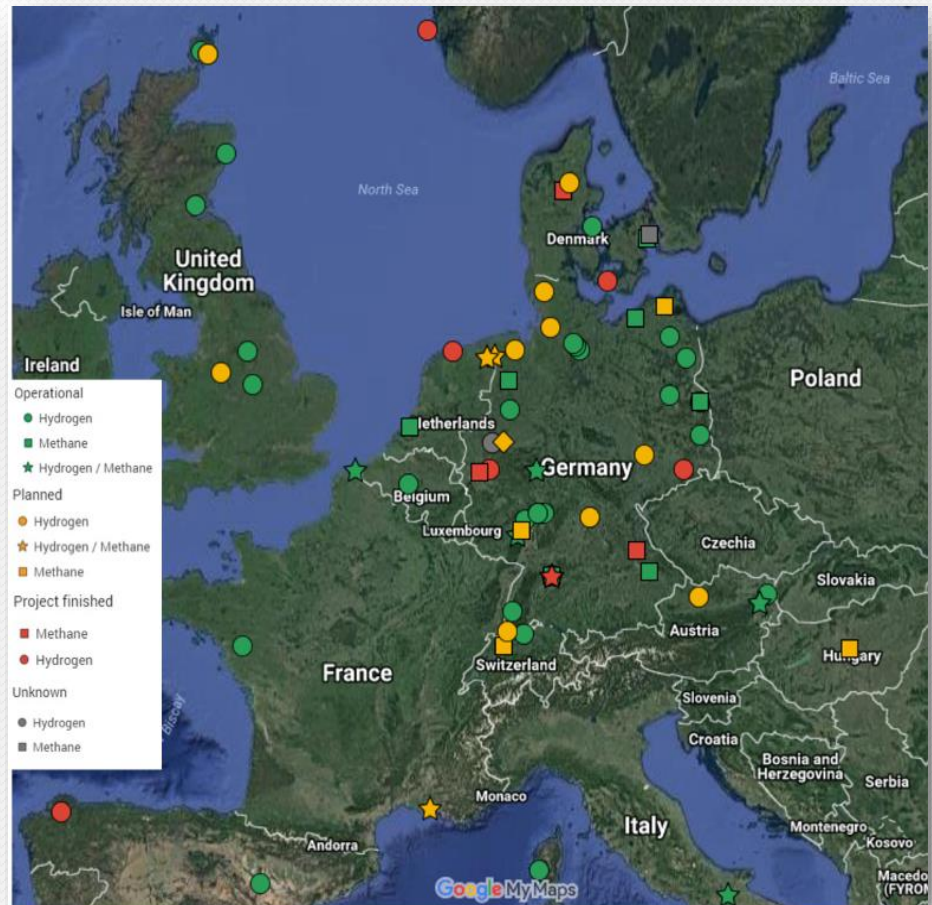
- Renewable Energy Curtailments in spring of 2017
 - **BPA:** 140,000 MWh (~\$4 million)
 - **California ISO:** 350,000 MWh (~\$10 million)
- German curtailments roughly doubled between 2013 and 2014, and doubled again in 2015 while adding just 20% more renewables.



Making more efficient use of available renewable electricity is a rapidly growing opportunity and imperative.

Technology Costs Plummeting

- Dozens of power-to-gas demonstration projects have cropped up in Europe to absorb renewable power.
- Important result is that electrolyzer technology is experiencing economies of scale—costs are less than half of just a few years ago.



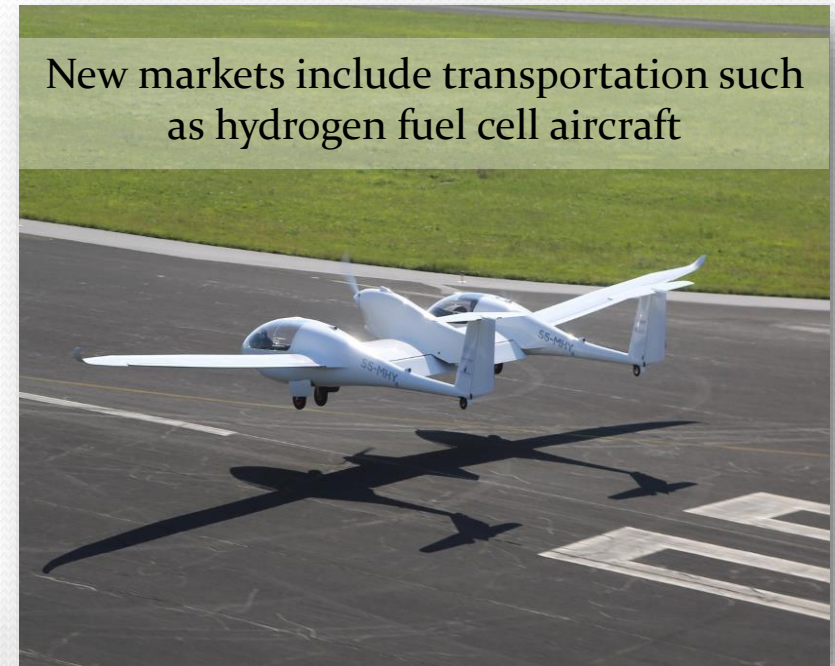
Renewable Hydrogen Needed for Decarbonization



Existing markets for hydrogen include ammonia, manufacturing, and refining



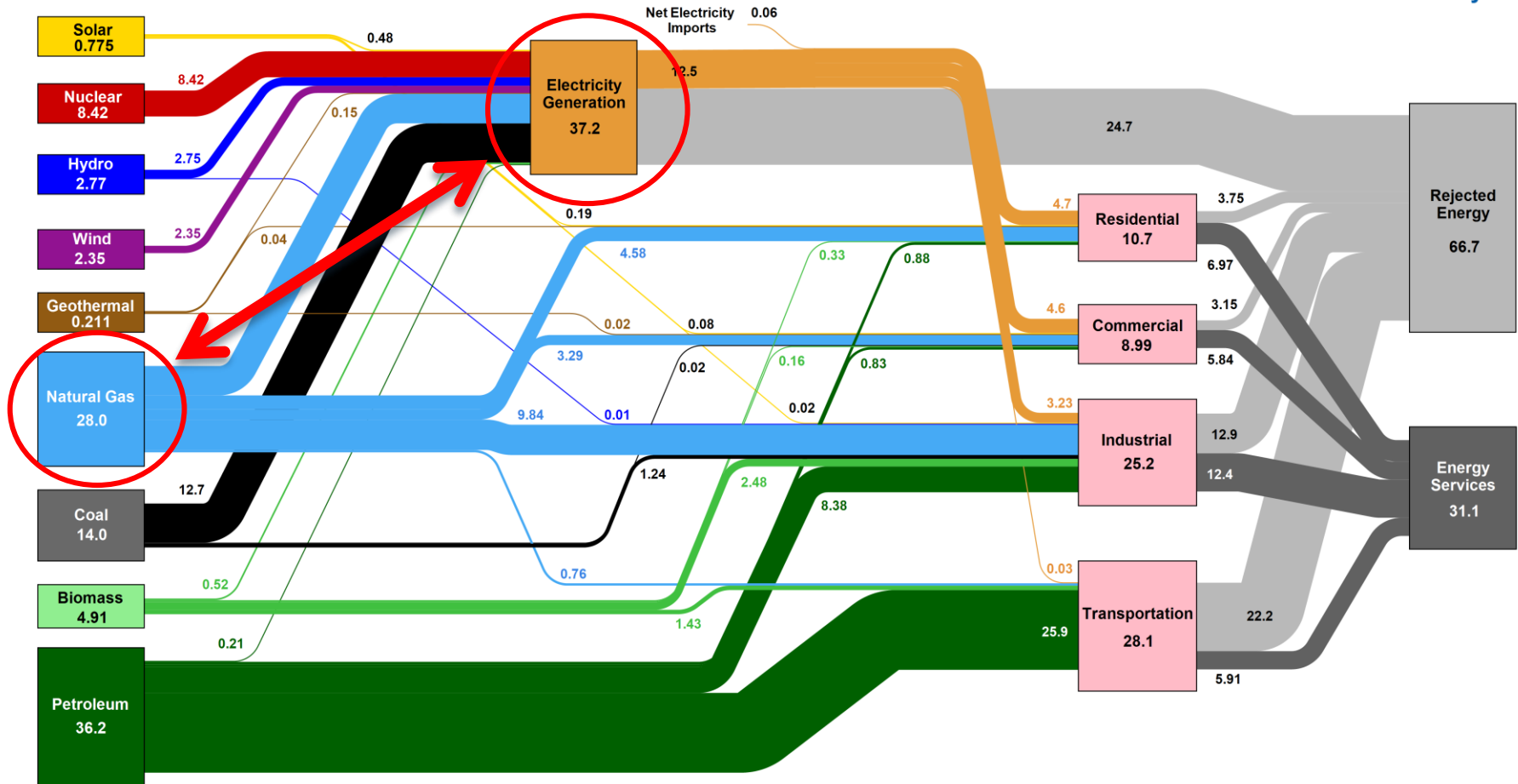
Nascent and growing markets include busses and trains



New markets include transportation such as hydrogen fuel cell aircraft

US hydrogen production in 2017 was the energy equivalent of ten billion gallons of gasoline– virtually all produced from fossil fuels.

Estimated U.S. Energy Consumption in 2017: 97.7 Quads



Source: LLNL April, 2018. Data is based on DOE/EIA MER (2017). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector, and 49% for the industrial sector which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Need for Advocacy

- Education
 - Explain role of electrofuels in building electric markets, shoring up wholesale prices, grid balancing, and decarbonization.
 - Provide information clearinghouse and forums for cross pollination across diverse stakeholders.
- Outreach
 - Utilities and renewable energy community.
 - Regulators, legislators, and others that green power to hydrogen is a critical step to reaching climate goals.
- Policy Development
 - Develop and promote effective policies to optimize the use of surplus power.

Renewable Hydrogen Alliance

www.RenewableH2.org

- New advocacy organization to educate, coordinate, and promote policies conducive to using surplus renewable electricity to produce hydrogen and derivative products.
- Actively soliciting memberships
- Members to date:
 - **Barlow Strategies**
 - **Bonneville Environmental Foundation**
 - **CEERT**
 - **Eugene Water & Electric Board**
 - **Flink Energy Consulting**
 - **HydroStar USA**
 - **ITM Power**
 - **Mark Thompson, Sanger Law**
 - **NW Natural**
 - **PERA**
 - **Phoenix Finance**
 - **Puget Sound Energy**
 - **Research Strategy Content**

Thank You - Questions



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