

Zero Emission Transportation and Power

The Opportunity of Hydrogen Energy

Widespread use of hydrogen and fuel cells for transportation, goods movement, and stationary power in California will reduce greenhouse gas (GHG) emissions and criteria pollutants, improve air quality, decrease our dependence on fossil fuels, support the expansion of renewable electricity, and create good, high-paying clean energy jobs. Despite these benefits, hydrogen as an energy carrier is being largely ignored in the discussion on how to address California's energy challenges.

Most energy in the U.S. is heavily reliant on carbon-based fuels, emitting GHGs in the process of extracting and using energy. While renewable energy sources represent an increasing share of energy production in CA and the U.S., much of that electricity cannot be used as efficiently and flexibly as current fossil-based fuels. Hydrogen can and is already beginning to fill that gap. When produced from renewable resources, hydrogen is:

- a renewable, domestically produced, and emission free alternative for generation of stationary power similar to solar and wind,
- a renewable energy alternative for transportation similar to biofuels and internal combustion engines, offering fast-refueling, long-range, and light to heavy duty transportation options, e.g. rail, shipping, air and space travel,
- a scalable option to transport and store large amounts of energy efficiently for extended periods of time,
- a solution that provides intelligent demand response and ancillary services for balancing the grid in times of medium and high penetration of renewable energy.

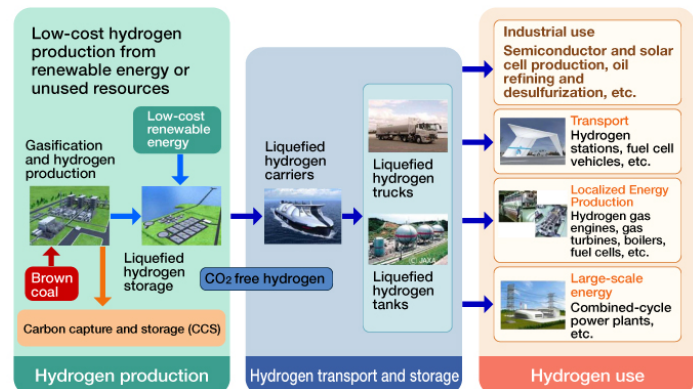
Hydrogen and fuel cells hold the promise of decarbonizing all energy use, providing the vision for a zero-emission, renewable energy future.

Highly Versatile Technology to Fully Decarbonize Energy Sectors, Yet Largely Overlooked in Public Policy

Hydrogen and fuel cells have been around since the 19th century and are now used in small to large-scale devices, from drones to spacecraft, from remote telecom towers to power plants. Hydrogen as an energy carrier can seamlessly replace any existing energy technology, without requiring a change in customer behavior.

Key barriers are developing economies of scale and infrastructure, both of which require public support. To date nearly all government grants and incentives for alternative energy in the electricity and transportation sectors support non-hydrogen technology. Ignoring hydrogen and fuel cells in public policy severely limits their potential.

CO₂ Free Hydrogen Infrastructure Concept



Source: Kawasaki Heavy Industries; editorial revisions by Nippon.com.

Benefits Our Economy, Environment, and National Security

Hydrogen can be produced using traditional or renewable energy sources, and in every case provide GHG and air quality benefits over combustion technology. Encouraging the production and use of hydrogen for energy purposes will help achieve key goals of California's energy, air and environmental policy. These include:

- Supporting 50% of retail electricity from renewable power by 2030¹
- GHG reductions to 1990 levels²
- Policies to increase distributed generation
- An executive order for 1.5 million zero emission vehicles by 2025³

¹ SB350, Clean Energy & Pollution Reduction Act 2015

² AB 32, California Global Warming Solutions Act

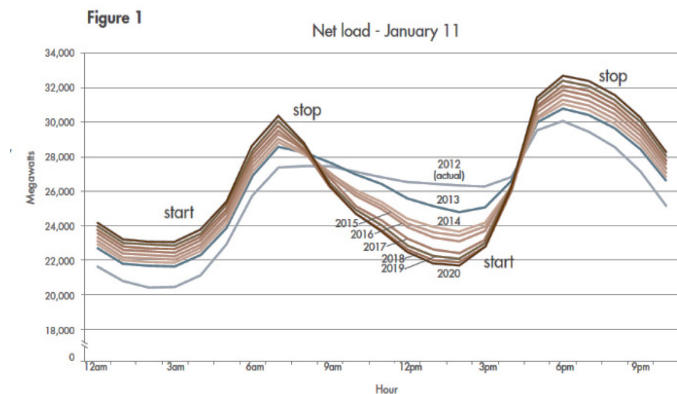
³ California Air Resources Board's ZEV Mandate, California Executive Order B-16-2012

Status Quo of the Technology - Where are we today?

There are limited but growing number of applications:

In the transportation sector, several car companies (Honda, Toyota, Hyundai, and in 2018, Mercedes-Benz) are selling or leasing FCEVs in California, with numerous other auto manufacturers having announced plans to offer vehicles within the next few years. In 2017, over 3,000 FCEVs were registered, despite the lack of federal tax credits for FCEVs that are offered for other electric vehicles. However, infrastructure deployment remains an important task and additional funding, similar to the support provided for charging infrastructure, is needed to achieve large market penetration. Over 20 fuel cell electric buses are in operation at Sunline Transit, AC Transit and Orange County Transit.⁴ Medium and heavy duty fuel cell trucks are being tested in the LA area and, with additional incentives, can be rolled out at a larger scale, as is happening today in China. In the rail sector, hydrogen trains are replacing diesel trains in Canada, Germany and China, at lower cost than building catenary lines over long distances. Ships are being converted and in operation using hydrogen in the Bay area and in several European countries.

In 2016, about 25% of the electricity generated in the State came from renewable resources, primarily solar and wind. Hydrogen offers a huge opportunity to increase this share by allowing surplus renewable electricity to be converted to high value hydrogen fuel for transportation, stationary power, or other uses, reducing curtailment.⁵ In addition, hydrogen can be used for energy storage and grid balancing to address the “duck curve”, allowing dispatch of power during the neck and tail times of the curve. Power can be provided either by using hydrogen in fuel cells or in regular gas turbines, when hydrogen is injected into the natural gas grid, reducing the carbon intensity of the gas mix.



Source: California Independent System Operator (CAISO)

Currently, most hydrogen is used in the chemical sector (fertilizer and plastics) and oil refining. Since there are no renewable requirements for these sectors, 95% of the hydrogen produced in the U.S. is non-renewable. Meanwhile, 42% of hydrogen used in the transportation sector for FCEVs is renewable, and with stronger incentives and requirements for the other sectors, the overall share of renewable hydrogen can increase considerably, helping decarbonize the chemical and oil refining sectors as well. With the projected massive increase of FCEVs on the road in the next decade, and consequently higher demand for hydrogen, supporting the deployment of renewable hydrogen production facilities today will address an array of climate and decarbonization goals in CA.⁶

Helping Build a Market for Hydrogen Energy with Government Incentives

Incentives are necessary to make hydrogen and fuel cells more competitive in the marketplace with traditional forms of energy. Policy tools such as hydrogen production and infrastructure investments, preferred electricity rates, mandates and adoption programs can grow the market and overcome initial scale-up costs. In time, with increasing market penetration, these incentives can be scaled down and eliminated.

State support must be directed towards projects with the greatest commercial viability and technical merit, no matter their industry. Tax and incentive programs that level the playing field by recognizing the most flexible and versatile technologies will guide California towards meeting GHG and air quality goals more quickly, cleanly, and affordably. Instead of being a forgotten form of energy, hydrogen must be a key element in California's energy future.

(January 2018)

⁴ 2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development – California Air Resources Board

⁵ <https://electrek.co/2017/03/27/california-solar-wind-renewable-electricity-record-high-peak>

⁶ <http://www.planete-energies.com/en/medias/close/hydrogen-production>; 2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development – California Air Resources Board