CALIFORNIA ENERGY COMMISSION

Hydrogen FACT SHEET

The climate crisis requires investing in a portfolio of low-carbon and zero-carbon solutions to achieve California's carbon neutrality goals. This portfolio includes hydrogen (H2), which has the potential to help the state reduce emissions from the transportation sector, meet the unique needs of industrial and commercial uses, and be used as a fuel for firm generation and energy storage.

About Hydrogen

- Hydrogen can be stored as a gas or liquid.
- Hydrogen is produced using different methods. The amount of greenhouse gases released per unit of hydrogen produced varies widely depending on the fuel source and production process.
- Currently, more than 95 percent of hydrogen is sourced from fossil fuels.
- Today hydrogen is used primarily in petroleum refining and ammonia production.
- Future hydrogen applications and applications which are developing include transportation, freight, industrial processes, electricity generation and stationary storage.

Types of Hydrogen

Hydrogen is classified based on how it is produced.

Gray Hydrogen

- Gray hydrogen is produced from fossil fuel feedstocks **without carbon capture** at the point of production.
- Gray hydrogen accounts for **more than 95%** of global hydrogen production today.

Blue Hydrogen

- Blue hydrogen is produced from fossil fuel feedstocks **with carbon capture** at the point of production.
- Blue hydrogen **could reduce emissions in end-use segments** in the mid- to long- term.

Green Hydrogen

Green hydrogen includes multiple carbon-neutral production pathways:

- **Electrolytic hydrogen or power-to-gas (P2G)**, is the conversion of electrical power into a gaseous energy carrier, such as hydrogen or methane, using an electrolyzer. When powered with renewable electricity, **P2G is a green hydrogen source**.
- Other green hydrogen generation pathways exist, including **biogas reforming and artificial photosynthesis**.

How Hydrogen is Used

Hydrogen can help reduce emissions from various sectors. It is already used in a wide range of applications, with overall demand continuing to be dominated by using hydrogen as an industrial feedstock. When assessing hydrogen for a certain application, it is critical to evaluate the cost and safety of this fuel relative to other zero-carbon solutions as they stand today and as they could evolve into the future. An examination of current and future potential, costs, and market and consumer uptake will be imperative to ensuring smart public investments are made in different zero-emission technologies. For example, fueling capacity and infrastructure are two factors, but not the only factors, that will influence consumer adoption of fuel-cell electric vehicles (FCEVs).

Power Sector:

- Backup Power
- Distributed Generation
- Hydrogen Turbines
- Reciprocating Engines
- Grid Services
- Microgrids

Transportation:

- Trucks
- Passenger Vehicles
- Buses
- Trains
- Forklifts
- Regional Ferries
- Ocean-going Ships
- Aviation and Aerospace

Industry:

- Ammonia and Methanol
- Refining
- Steel Production
- Synthetic Fuel and Production
- Furnaces and Ovens

Buildings:

- Combined Heat and Power
- Hydrogen Boilers
- Blending of Hydrogen in Natural Gas Boilers

Source: Guidehouse

California Energy Commission Hydrogen Investments

Since 2008, the CEC has invested $242 million to support hydrogen research, development, and deployment projects.

- Clean Transportation Program Investments | $224M
  - ◊ $169.4M: Publicly available hydrogen refueling infrastructure deployment[1]
    - * 50 stations, as of May 2021
    - * 179 (of which 24 will be privately funded) by 2026
  - ◊ $30.1M: Medium- and heavy-duty hydrogen refueling infrastructure deployment
    - * 5 stations in development, as of May 2021
    - * Infrastructure supports port, transit, and drayage applications
  - ◊ $17.2M: Fuel standards and equipment certification, light-duty fuel cell vehicle deployment, medium- and heavy-duty fuel cell vehicle demonstration, and regional alternative fuel readiness planning
  - ◊ $7.9M: Hydrogen production
- Active and Completed Hydrogen Research | $18M Invested
  - ◊ $1M: Hydrogen production
  - ◊ $5.1M: Storage and grid support
  - ◊ $10.5M: Transportation applications
  - ◊ $190K: Industrial applications
  - ◊ $250K: Use in buildings
  - ◊ $500K: Long-term research strategy
- Upcoming Research Investments | More Than $22M
  - ◊ $3.5M: Renewable hydrogen production
  - ◊ $5.6M: Hydrogen blending into existing California natural gas system
  - ◊ $4M: Hydrogen-based power generation systems
  - ◊ $8M: Truck and bus technology and heavy-duty infrastructure
  - ◊ $1.5M: Effects of hydrogen in end use appliances
  - ◊ $TBD: The role of green hydrogen in a decarbonized California, A roadmap and strategic plan

[1] As a point of reference and comparison, in the same time period, the Clean Transportation Program has invested $217.5 million in electric vehicle infrastructure. Electric vehicle and hydrogen fuel cell infrastructure investments are on par with one another.

Proposed Investments

The revised state budget proposal builds on the CEC's successes and momentum, investing in cutting-edge research and supporting both EV and hydrogen transportation infrastructure

- Proposed May Revise Investments
  - ◊ $500 million general use funds:
    - * $300 million to meet state goals for 2025 light-duty passenger vehicle infrastructure
      - Add approx. 60,000 additional EV stations to meet goal of 250,000 charging stations
      - Add approx. 21 additional hydrogen stations to meet goal of 200 hydrogen stations
    - * $200M: Medium- and heavy-duty electric and hydrogen infrastructure
  - ◊ $415M: Specialized (drayage, transit, school) heavy-duty electric and hydrogen refueling infrastructure
  - ◊ $250M: Zero emission vehicle manufacturing
  - ◊ $110M: Scaling green hydrogen production and use
  - ◊ $250M: Industrial decarbonization, includes hydrogen
  - ◊ $350M: Long duration storage, includes hydrogen

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