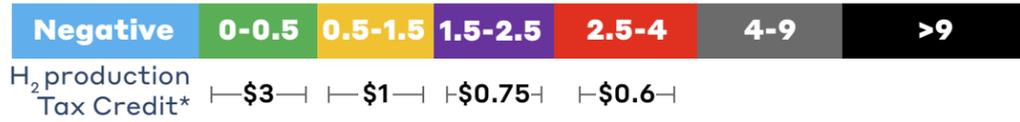


Making Hydrogen

FEBRUARY 2023

Hydrogen (H₂) is an important energy carrier for net-zero carbon economy; its emission profile and cost depends on the production method.

Equivalent emission in kilogram of CO₂ for every kilogram of H₂ produced:



From **Water**

Water (H₂O) can be split into H₂ and O₂ using electricity, heat, or sunlight.



Electrolysis

Uses electricity to split water.



Thermolysis

Uses heat to split water.



Photolysis

Uses visible light energy to split water.



From **Biomass**

Organic materials can produce H₂ using chemical and biological processes.



Thermo-chemical Process

Biomass can be broken down into H₂ and a mixture of gases (synthetic gas or syngas) using oxygen and steam.



Biological Process

Some algae and bacteria can produce H₂ from glucose or water.



From **Fossil Fuels**

Fossil fuels can be broken down into H₂ and other co-products. Carbon dioxide (CO₂) produced from these processes can be captured, compressed, and stored in geologic formations underground; a process referred to as carbon capture and storage.



Methane Reforming

Using O₂ and/or steam, methane (CH₄) can be split into H₂ and CO₂.



Methane Pyrolysis

Using a catalyst, low-carbon CH₄ can be split into H₂ and solid carbon.



Coal Gasification

Using steam, coal can be broken down into a mixture of gases including H₂.



Using Hydrogen

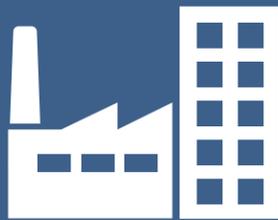
Hydrogen can serve as a low- or zero-carbon fuel in various end uses, enabling decarbonization across multiple sectors. Scalability and market maturity differs by application.

Electricity



Pure and blended hydrogen can be used in gas turbines to produce electric power. Energy conversion devices like stationary fuel cells can produce backup heat and power.

Industrial Heat



High-heat industrial processes make up the majority of industrial emissions. Hydrogen can provide high-density industrial heat without producing carbon emissions.

Raw Material



Hydrogen can be used as feedstock in various chemicals and products such as ammonia and synthetic fuel production. Hydrogen can also be used as a chemical agent to facilitate the production of steel.

Transportation



Light-duty and heavy-duty vehicles, rail, aviation, and marine vessels can be powered by hydrogen. Hydrogen is a light gas with high energy density, enabling fast refueling and long ranges.

Building Heat



Hydrogen can be blended with natural gas or substitute natural gas to decarbonize building spaces and water heating.

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