



# Hydrogen's Economic Potential within the United States

Mark F. Ruth

MIT Energy Conference

March 12, 2021

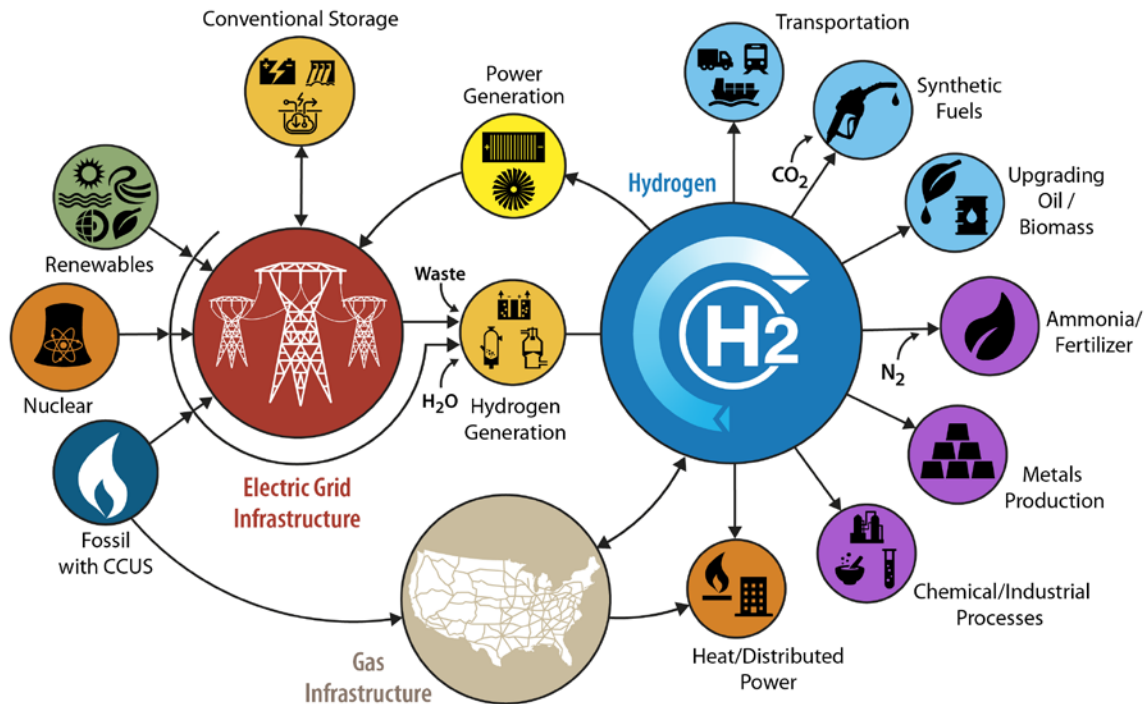
NREL/PR-6A20-79487

**Report available at:** <https://www.nrel.gov/docs/fy21osti/77610.pdf>

**Detailed demand report available at:** [https://greet.es.anl.gov/publication-us\\_future\\_h2](https://greet.es.anl.gov/publication-us_future_h2)

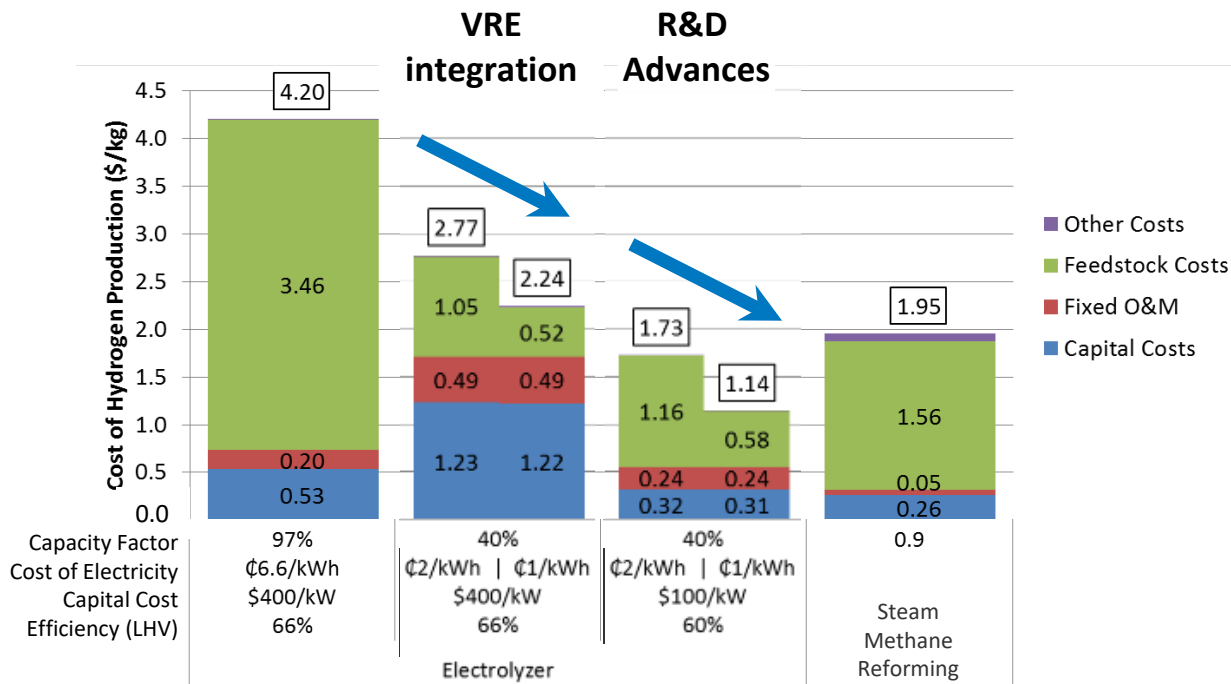
# H2@Scale

DOE initiative focusing on hydrogen as an energy intermediate.



<https://www.energy.gov/eere/fuelcells/h2scale>

# Low-Cost, Variable Electricity Could Be Source for Low-Cost Hydrogen



**Low-temperature electrolysis could produce hydrogen using low-cost, dispatch-constrained electricity.**

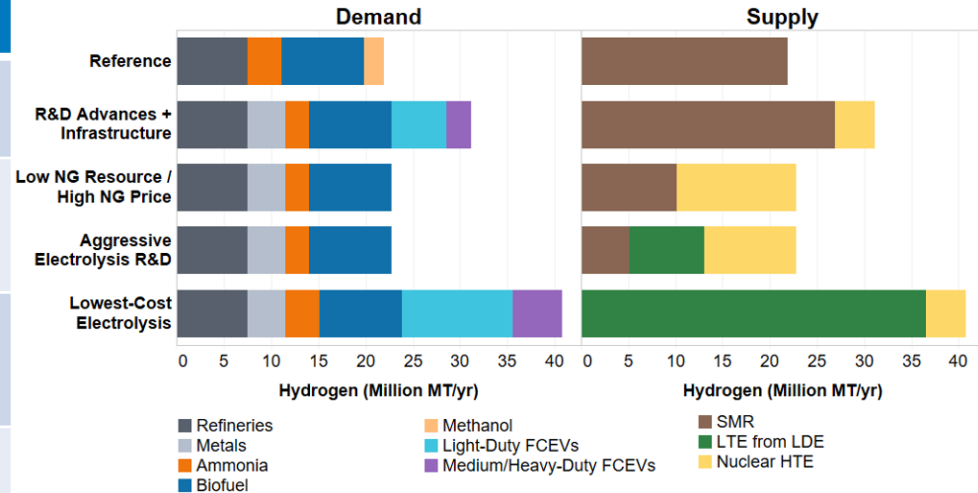
# Economic Potential: Limitations and Caveats

- **Market equilibrium methodology** and market size estimates in 2050
  - Transition issues such as stock turnover are not considered
- **New policy drivers, such as emission policies, are not included** either for hydrogen or the grid
- Technology and market performance involve many assumptions about adjacent technologies
  - In all but the non-reference scenario, the assumption is that R&D targets are met
- Demand analysis is limited to sectors that could be forecast for the foreseeable future
  - Hydrogen use to convert biomass based market size equal to 50% of aviation demand
  - Hydrogen for industrial heat is not included
  - Single hydrogen threshold price for fuel cell vehicle market estimates
- Estimates of delivery costs were standardized and without location specificity
- Potential long-term production technologies (e.g., photo-electrochemical) not included
- Economic feedback impacts are not considered
- Competing technologies (both for markets that use hydrogen and for resources to generate hydrogen) are addressed in a simplified manner only

# Five Economic Potential Scenarios

The economic potential of hydrogen demand in the U.S. is 2-4X current annual consumption based on our market-equilibrium analysis

Scenario	Insights
Reference	Growing markets for refining, ammonia, and biofuels met with low-cost NG
R&D Advances + Infrastructure	Higher penetrations of FCEV + drivers for metals, SMR dominates production due to low cost NG but have some nuclear HTE
Low NG Resource / High NG Price	High NG price increases cost of hydrogen for same quantity and limits FCEV penetration but more nuclear HTE
Aggressive Electrolysis R&D	Some LTE penetration at \$200/kW capital cost with grid value.
Lowest-Cost Electrolysis	Low-cost electrolyzers with high grid value reduce hydrogen cost and can enable additional H <sub>2</sub> applications



**Incentives are needed for hydrogen to compete for long-duration storage / dispatchable electricity generation and for use to generate heat (in place of or supplementing natural gas)**

FCEV: Fuel-cell electric vehicles  
 SMR: Steam methane reforming  
 NG: Natural gas

LTE: Low-temperature electrolysis  
 LDE: Low-cost, dispatch-constrained electricity  
 HTE: High-temperature electrolysis