BACK POCKET INSIGHT

P178 RESOURCE PLANNING FOR ELECTRIC POWER SYSTEMS

KEY INSIGHTS

- Combusting hydrogen in turbines for electricity production mirrors natural gas usage but emits no carbon dioxide.
- Hydrogen can be produced from fossil fuels (with or without carbon capture) or from water through electrolysis.
- Using electrolytic hydrogen for power generation may require additional upstream power generation in the future and is expensive due to high conversion losses.
- Technical challenges and safety concerns can be mitigated; standards for safe handling of hydrogen already exist.

Hydrogen in Energy System Resource Planning

by Romey James

Hydrogen holds potential as a carbon-free fuel source for dispatchable power generation, but it presents some technical and economic challenges.

The U.S. EPA has proposed emissions standards for power plants under section 111 of the Clean Air Act. The proposal includes the use of hydrogen blending to reduce emissions, requiring new baseload turbine plants without CCS to cofire 30% H_2 by 2032 and 96% H_2 by 2038.

Production Pathways

Hydrogen is predominantly sourced from fossil fuels for industries like petroleum refining and fertilizer production. While hydrogen can be produced by gasifying coal, biomass, or plastic waste, the most common pathway is steam methane reforming (SMR). SMR involves heating natural gas with steam in the presence of a catalyst to yield hydrogen and carbon dioxide. Carbon capture and sequestration can render these production methods low-carbon, though it is not widespread currently.

Hydrogen can also be produced from natural gas via methane pyrolysis, the biproduct of which is solid carbon rather than gaseous carbon dioxide.

Alternatively, electrolyzers can split water into hydrogen and oxygen using electricity, offering a zero-carbon option when powered by renewables or nuclear energy.

The optimal production pathway would depend on local factors such as availability of renewable energy, water, and favorable geology for carbon sequestration.

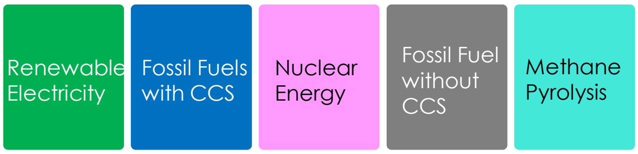

Figure 1. Colors of Hydrogen

Challenges and Opportunities

Hydrogen, a smaller molecular than methane, may leak through pipe connections and/or cause embrittlement of steel pipelines. Its higher flame speed and temperature may also result in combustion behavior different from that of natural gas.

In addition to these technical challenges, its economic viability as a fuel for electricity generation poses the significant barrier to widespread deployment. Even with the substantial tax credit of up to $3/kg offered under the Inflation Reduction Act's Section 45V, replacing natural gas with electrolytic hydrogen could increase fuel costs by a factor of four to twelve.

Achieving the U.S. Department of Energy's target goal, Hydrogen Shot, of $1/kg by 2031 will be crucial for unlocking hydrogen's potential in power generation.

Hydrogen from a Resource Planning Perspective

Electrolytic hydrogen requires additional upstream generation. For instance, a 100 MW hydrogen-fired turbine facility with a 10% capacity factor could necessitate 600 acres of dedicated solar for electrolysis, producing over four times as much upstream power as delivered by turbine facility. While round-trip efficiency could increase with a base-load combined cycle turbine facility rather than a peaking simple cycle, total energy losses and fuel expenses would be higher due to the higher capacity factor.

Besides hydrogen costs, planners must consider costs related to building hydrogen transportation and storage infrastructure or converting natural gas infrastructure. Coordination across sectors including transportation, building, and industry could alleviate the burden on electric utilities, allowing the costs and benefits of hydrogen infrastructure to be shared.

It will be important for electric company planners to balance costs and risks associated with hydrogen deployment over time, recognizing both technical viability and the uncertainty surrounding the future hydrogen economy.

This insight is derived from research conducted by EPRI's Low Carbon Resources Initiative (LCRI) and Program 178 Resource Planning for Electric Power Systems

RESEARCH CONTACT
Romey James
RJames@epri.com

FOR MORE INFORMATION
Explore EPRI's Energy Systems and Climate Analysis Research at **esca.epri.com**