

The Role of Hydrogen in Decarbonizing U.S. Industry

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Abstract

There is a growing interest in hydrogen for decarbonizing hard-to-abate industries. However, determining which industries to target, the scale of the opportunity, and how to meet the hydrogen demand out to 2050 is complex and highly uncertain. The most significant decarbonization opportunity identified in this review is in the refining and chemicals industries, where annual emissions could reduce by up to 24% by 2050 from 2021 levels if emissions-intensive grey hydrogen is replaced with clean hydrogen. New (clean) hydrogen applications include replacements for carbon-based reductants in steelmaking (18% steelmaking emissions reduction by 2050) and fuel for high-temperature heat in cement, aluminum, and glassmaking, with annual sectoral emissions reductions by 2050 of up to 23%, 3%, and 32% respectively. Hydrogen technologies have high readiness levels and face modest technical barriers in burner and furnace design. The primary challenge lies in reducing clean hydrogen production and delivery costs to \$0.4–0.7/kgH₂ to compete with natural gas and scale its production from <1% of all U.S. hydrogen production today.

The literature presents diverse U.S. industry clean hydrogen demand predictions (4–22 Mt/year by 2050) due to conflicting projections of industrial output, some incompatible with decarbonization goals; e.g., growth in gasoline production. After reconciling literature on hydrogen technology readiness, alternative decarbonization strategies, and U.S. climate targets, we estimate 2050 industrial clean hydrogen demand at 3.8–14.9 Mt/year, saving 28–133 MtCO_{2eq} (1.5–7.0% of current U.S. industry emissions). Green hydrogen production will require up to 682 TWh of low-carbon electricity, equivalent to 90% of current renewable generation.