EXECUTIVE SUMMARY

FUEL CELL TECHNOLOGY ASSESSMENT

Potential Future Costs and Low-Carbon Fuel Considerations

Fuel cells were first developed over a century ago, but have not emerged as a dominant choice for stationary or transportation applications—such as power generation or fuel cell electric vehicles (FCEVs), respectively—due to tough competition from other technologies with more favorable value propositions, such as internal combustion engines. There is a dearth of independently developed cost and performance estimates for fuel cells due to a historical lack of transparency around products and projects; a relatively small number of real-world projects, often with highly site/project-specific requirements; and the ability of fuel cells to be used for numerous, sometimes niche applications (e.g., primary power generation, backup power generation, combined-heat-and-power, propulsion for on- and off-road vehicles). Therefore, even current fuel cell techno-economics often can only be discussed speculatively (e.g., how suitable a fuel cell would theoretically be for a given technology application, or how much a fuel cell stack or system might cost assuming a certain number are produced each year).

The prospect of utilizing hydrogen or other low-carbon fuels brings additional complexity and uncertainty to fuel cells' prospects. To date, most fuel cells—with the exception of proton exchange membrane fuel cells (PEMFC) used in FCEVs—typically utilize natural gas fuel (fed through a reformer) rather than directly using hydrogen (fed into the anode). At a minimum, energy companies and other electric sector stakeholders require coherent techno-economic information to make informed decisions about technology deployment.

The full report expands the knowledge base on fuel cells by using baseline techno-economic findings from LCRI's *2022 Fuel Cell Technology Assessment: Current State and Look Ahead* (3002025147), fuel cell manufactured capacity projections, endogenous technology learning/experience rates, and insights from selected industry experts. It also provides a better understanding of potential future stationary and on-road automotive fuel cell costs, as well as possible economic implications of direct hydrogen fueling for stationary fuel cells.

Key findings are summarized below:

- System- or aggregate-level learning (e.g., applying a given learning rate to a more aggregated cost metric) leads greater future cost decreases than subsystem- or component-level learning. This is consistent with the broader learning/experience curve literature and arguably more sound, as some field or "soft" costs cannot be expected to learn to the same extent as core technology components.
- Some cases result in considerable cost declines while others project more modest changes. These projections are highly speculative, but the ranges presented may provide a better sense of potential cost trajectories for conventional fuel cells. Major changes to fuel cell technology and business models will produce different trajectories.
- While it may present considerable challenges related to fuel production, delivery, and storage infrastructure, direct hydrogen fueling is a prospective transformation that could enable more favorable economics for stationary fuel cells at the plant level compared to systems running on natural reformate.

Electric company resource planning and research, development, and demonstration staff may use the insights from the full report to inform decision making around future technology options. Recognizing the inherent uncertainty in technologies and markets, these staff may also engage with other energy modelers and strategists within their companies to inform strategic discussions and decision-making at the system level.

The Low-Carbon Resources Initiative

This report was published under the Low-Carbon Resources Initiative (LCRI), a joint effort of the EPRI and GTI Energy addressing the need to accelerate development and deployment of low- and zero-carbon energy technologies. The LCRI is targeting advances in the production, distribution, and application of low-carbon energy carriers and the cross-cutting technologies that enable their integration at scale. These energy carriers, which include hydrogen, ammonia, synthetic fuels, and biofuels, are needed to enable affordable pathways to economy-wide decarbonization by mid-century. For more information, visit www.LowCarbonLCRI.com.

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3002026260 March 2023

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