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Opinion:

Editor's Note: This is another in a series of occasional columns intended as a forum for readers. Contributions are welcome. The editor reserves the right to reject suggestions and edit material to fit our format without, of course, changing the author's basic views.

Charting a New Path for Fuel Cell Development

By Noriko Behling

Fuel cells have long been heralded for their potential as a cost-efficient and environmentally friendly means to convert readily available chemical energy into electric energy. Since the early 1960s, major governments, including Europe, Japan, and the United States, have spent an estimated $20 billion to develop fuel cell technology, infrastructure, and manufacturing capabilities (Behling, 2012). Private corporations have invested at least as much. In the last two decades, the Department of Energy (DOE) alone has spent $2.5 billion for fuel cell applications research, product development, and market subsidies. But these efforts have not yet yielded products that can compete head-to-head with conventional counterparts without subsidies or tax incentives.

Recently, automakers have announced plans to introduce polymer electrolyte membrane fuel cell (PEMFC) vehicles to the market in 2015. These vehicles are expected to be more efficient and have a greater driving range than previous models. However, two critical challenges must be overcome before there is market acceptance: costs must be reduced and a track record of longevity and reliability established. At this time, the automakers likely are looking to governments to provide subsidies to increase market acceptance as well as build the fueling infrastructure.

Other fuel cell products have established niche markets, such as stationary power units, forklifts, unmanned vehicles, and backup power systems. These applications use phosphoric acid, alkaline, molten carbonate, solid oxide, and direct methanol fuel cells, in addition to PEMFCs. Each application has unique technical challenges, but they all share the same problems of high cost, low reliability, and limited longevity. Many of manufacturers still depend on government subsidies, tax incentives, or both.

What makes fuel cell technology so difficult to commercialize? It is easy to make a single working fuel cell in the lab, but building fuel cell stacks that generate useful power reliably and cheaply is another matter entirely. History is full of stories in which fuel cell companies developed moderately functional fuel cells, scaled them up for commercial applications (often with government assistance), and rushed the product to market, only to find that their fuel cells did not achieve wide market penetration. When issues of cost or efficiency or reliability arose, companies always believed these could be fixed with a little more time and a little more money. But no matter how many fixes were made, fuel cells

remained uncompetitive with other power sources. The fuel cell industry was looking for tactical fixes when strategic solutions were needed.

The challenge of making reliable, efficient fuel cells is rooted in the complexities of how they operate, which involves multiple chemical and physical interactions at the atomic level. Few advanced technologies on the market today require the scale, magnitude, and range of scientific, physical, and engineering knowledge that fuel cell technology demands.

But progress is being made. Recently, some scientists have successfully applied advanced research tools to understand the details of fuel cell operations and are developing theories to explain these processes. For example, researchers at Tohoku University have demonstrated how computational chemistry can accurately duplicate real-life degradation of catalysts in fuel cells (Suzuki, Williams, 2012). SOFC researchers have also achieved dramatic advances in reducing operating temperatures and increasing power densities (Steele, 2001; Oishi, 2005; Suzuki, 2009; Wachsman, 2011), even demonstrating power densities of 1.3W/cm2 at 450! (Prinz, 2013), as well as increasing some SOFC lifetimes to tens of thousands of hours (Blum, 2012). Indeed, this type of research, if integrated into a single collaborative effort, could achieve groundbreaking discoveries that would ultimately lead to viable commercial products. Perhaps new fuel cell materials that are an order-of-magnitude cheaper and more efficient and durable than today's technology will be discovered or developed. But in order to reach these goals, a concerted effort must be made to invest in fuel cell research and development.

As a first step toward this goal, the National Academies should be commissioned to recommend a strategic plan for future fuel cell R&D. This study would assess what is being done now, identify specific areas to be explored, and provide a detailed blueprint for future fuel cell research. The study would evaluate what is needed to promote the discovery and detailed characterization of fuel cell electrochemical processes and operations; the development of a theoretical understanding and empirical validation of underlying causes that drive performance shortfalls, (such as cell degradation that leads to insufficient longevity, reliability, and robustness); and the exploration of disruptive technologies to enable creation of revolutionary fuel cell types, catalysts, and supporting components that would use less expensive materials. The National Academies has agreed this study is worth doing, and some sponsors already have been found.

The need is urgent. Other countries already are expanding their commitment to fuel cells. Both Japan and South Korea have substantially increased investment in fuel cell technology and are now leading the world in terms of fuel cell patents and market share (Behling, 2014). The European Union established a new Framework Program (Horizon 2020) that will increase investment in fuel cell technology as part of its goal to create a low carbon society. Meanwhile, US government investment in fuel cells has been declining and the US position as a leader in fuel cell technology is eroding.

The United States government and industry need to step forward and support the Academies study. Without a clear path for fuel cell development, the US fuel cell industry will remain stuck in a cul-de-sac, marketing high cost products that no one wants to buy without government support and relying on technology that often is less reliable and efficient than that of foreign manufacturers. Embarking on the study now offers a real chance for the US to recapture its lead in fuel cells.

Noriko Behling is an analyst of fuel cell and other science and technology policies. She is the author of "Fuel Cells: Current Technology Challenges and Future Research Needs." Elsevier, 2012, 704 pages.