Energy Quarterly

News and analysis on materials solutions to energy challenges

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MRS Bulletin

Analysis of life-cycle costs and benefits of hydrogen fuel cells

Life-cycle analysis (LCA) of energy devices should focus on that technology's total impact. In LCAs of fuel cells, efficiency is typically a focus. At times, this becomes a hyperfocus, even to the point of ending the conversation. Hydrogen proton-exchange membrane (PEM) fuel cells, and the related electrolyzers that produce hydrogen, are cited as too inefficient, among other criticisms of manufacturability and cost. In these analyses, however, we must include the broader impact of fuel cells and see how the overall gains surpass these apparent shortcomings.

Efficiency matters in the grandest context: to remove carbon from our emissions. If overall electrical generation efficiency were the only metric of merit, then coal plants would not be displaced by solar and wind power. Renewable power generation continues to grow because of its ability to help us move beyond carbon. California provides an interesting example of losing sight of this goal. While leading in deployment of solar power, California has also built natural-gas peaking plants to provide capacity late in the day as solar output declines (the "duck" curve). To move beyond carbon, this is not a viable long-term path. Fuel cells, on the other hand, which kept the lights on and cell towers running after Hurricane Sandy, are known by grid operators as readily sited, scalable, and couple perfectly with renewables. PEM electrolyzers can absorb every electron produced by intermittent renewable power generation. At this system level, it's clear how renewable hydrogen generation is simultaneously beneficial for the users of hydrogen and renewable power producers (not to mention all of us).

A closer look at manufacturing and cost details does not raise any red flags. Membrane electrode assemblies (MEAs) for PEM fuel cells are being mass-manufactured on former Kodak film manufacturing systems by American Fuel Cell, recently acquired by Plug Power. On the cost side, automakers have demonstrated that fuel cell vehicles will soon require only as much precious metal as our current catalytic converters, less than 10 g per vehicle. Platinum recycling is feasible and cost-effective at scale. A relative benefit of the noble metals is that they are easy to reclaim. The present is bright and the future brighter, as many groups are taking up the materials challenges that Tim Palucka describes well in this issue.

Fuel cells enable us to move to an all-solar and wind-powered grid that also produces hydrogen for cars that can (already today) drive nearly 400 miles and refuel in about three minutes. That is the future my wife and I want for our kids. That's the kind of analysis we should keep in mind in these conversations.

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