Why the Hydrogen Feud Needs to End: Analysis

Hydrogen fuel cell research is in the midst of a tumultuous debate. Proponents of the fuel continue to sink money into research and marketing—citing promising statistics and lab-grown developments. Opponents refute optimistic claims with their own numbers, asking that researchers shift time and money to more promising technologies, like batteries. So what exactly is the state of hydrogen fuel cell research? Unfortunately, that depends on whom you ask.

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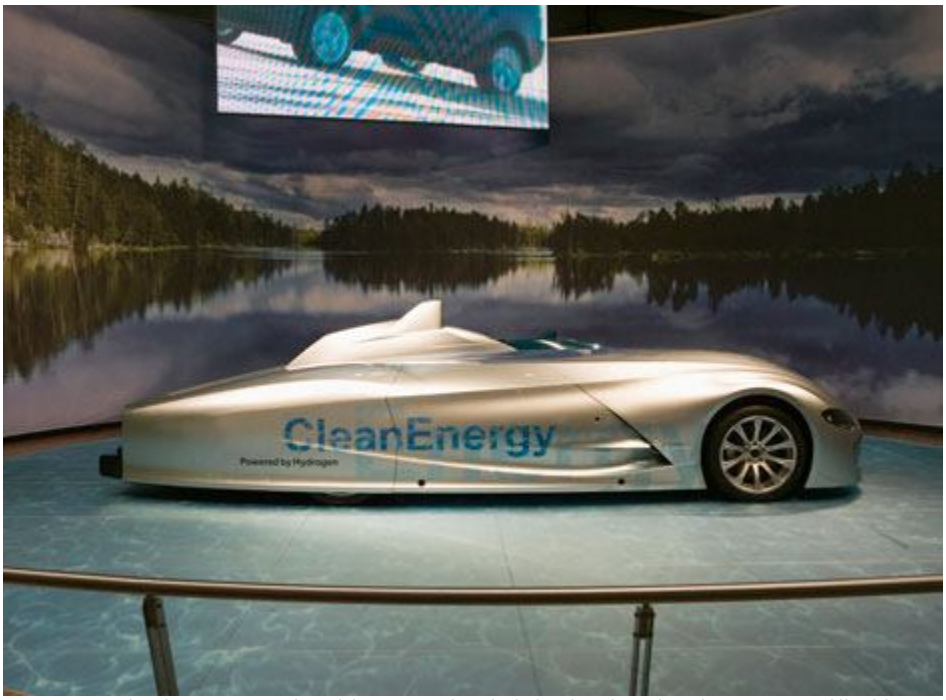

BMW's H2R (Hydrogen Record Car) is powered entirely by the clean-burning process of liquid hydrogen combustion. This futuristic race car has already set nine speed records of 300 km per hour and above.

This past summer, the war over hydrogen escalated. After secretary of energy and Nobel laureate Steven Chu publicly railed against the near-term potential of hydrogen energy research—Chu claimed, among other things, that it would take "four miracles" for hydrogen to work—the Department of Energy presented Congress with a 2010 budget excised of transportation-related hydrogen funding. And lo, like a great hand on an even greater keyboard, Congress tapped out a grand "undo," restoring more than $200 million in slashed funds to some 190 projects around the country.

Perhaps it's a sign of progress that the federal government is skirmishing not over whether to pursue alternative fuels, but over how many such technologies are worth investing in. Still, the hydrogen debate is not a healthy one. There are accusations hurled by bitterly opposed camps, each painting the other as ignorant, liars, or both. There are numbers crunched on both sides, with utterly different results. And there are past grievances that need avenging. What could have been a civil discourse between researchers has become, instead, a deathmatch between battery-powered electric vehicles and hydrogen-powered fuel cell vehicles—if you will, two zero-emission cars enter, one zero-emission car leaves.

Hydrogen Is Dead: The EV Boosters and H2 Naysayers

For many supporters of electric vehicles (EVs), hydrogen represents something far worse than a potentially stalled transportation technology. When President George W. Bush announced federal support for fuel cell vehicles in 2001, every dollar spent—some $1.5 billion so far—was seen as a dollar lost to EVs. Then, in 2003, the California Air Resources Board (CARB), which had been pushing for thousands of zero-emission vehicles, threw its weight behind fuel cell vehicles. "We lost the better part of a decade and hundreds of millions that went down that rathole," says Paul Scott, a solar power consultant and founding member of the EV advocacy group, Plug In America. "The hydrogen people promised they'd bring all these fuel cell cars to market. Six years later, there are maybe 300 fuel cell cars worldwide. By the end of this year, we'll have 1200 new EVs on the road. Next year, it'll be tens of thousands."

CARB, and its decision to back hydrogen, is often seen as one of the main culprits in the demise of the previous generation of electric vehicles—the movie, *Who Killed the Electric Car?* makes that case, and the sentiment has been echoed for years on pro-EV blogs. The argument can begin to sound like classic conspiracy theory: Who would stand to benefit from smothering EVs in the crib, and a new, trillion-dollar buildout of hydrogen pipelines and other fueling infrastructure? Big Oil,

with help from the Bush administration, becomes the grand architect of the EV's sudden death, willfully ignorant of the seemingly insurmountable obstacles facing a true hydrogen economy.

Now, Secretary Chu, a Nobel-winning physicist, has dragged this feud into the mainstream glare. Between his now-infamous "four miracles" comment to *Technology Review* and the less cryptic briefing this summer in which he explained the funding draw-down, saying, "We asked ourselves, is it likely in the next 10 or 15, 20 years that we will convert to a hydrogen car economy? The answer, we felt, was no," Chu has become the latest target for the hydrogen camp, and EV boosters' most high-profile champion.

Chu is one of the few scientists to wade into this debate on the side of EVs—or, maybe more accurately, against hydrogen. But fellow physicist and Nobel-winner Burt Richter, former director of the Stanford Linear Accelerator at Stanford University, is joining the fight, claiming that, "hydrogen is not deployable except for movie stars and Wall Street tycoons." Hydrogen's biggest problem, according to Richter, is platinum, the catalyst material in today's fuel cells. "It isn't just the fact that it's expensive, it's that it's not there," Richter says. "Right now it takes 60 grams of platinum per fuel cell. The entire world supply of platinum wouldn't be enough for the cars produced in the U.S. alone." There are other issues—the lack of a hydrogen infrastructure, the apparent low efficiencies and short lifetimes of fuel cells—but the platinum is a potential non-starter for mass production. Richter compares the state of hydrogen fuel cell research to that of liquid metal batteries, one of the long-shot projects being funded in the Department of Energy's new ARPA-E program. But hydrogen, he says, isn't even ready for ARPA-E. "We need to quit fiddling around and get back in the lab to work on the fundamental electrochemistry," Richter says. "We need to come up with a better catalyst."

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Long Live Hydrogen: Automakers and Researchers Push Ahead

Even without criticism from the likes of Chu and Richter, hydrogen appears to be in trouble. Energy firm BP—part of the Big Oil crowd that EV conspiracists claim are behind the hydrogen push—has dropped its research into hydrogen for transportation. And while the restoration of DOE funds was seen as a victory by hydrogen supporters, $204 million is a pittance compared to the more than $8 billion in federal loans to automakers for EV production and research. Plus, there's

the more ineffable sense of momentum. EVs have it, with new plug-ins announced monthly and the hype surrounding Tesla and Fisker's flashy vehicles, not to mention the auto industry's biggest gamble, GM's Volt. On the hydrogen side there is GM's tiny, blink-and-you'll-miss-them fleet of fuel cell Equinoxes and Honda's FCX Clarity, an unassuming sedan that requires approval from Honda to lease, based on your proximity to a hydrogen fueling station. Consider that GM's ill-fated EV1 was also lease-only, back in 1996, and it's easy to see the fuel cell vehicle as either seriously delayed, or headed for the same compactors that devoured hundreds of EV1's.

There are hydrogen holdouts, though, who point out that the inevitability of the EV may have been oversold. "There are a ton of 'ifs' conspiring against batteries," says Craig Scott, manager of Toyota's Advanced Technologies Group. "People on the other side underestimate the challenge of electric-vehicle infrastructure. There are a very large percentage of people who don't have garages to plug into. And it will take billions to upgrade to a smart grid, so that, come 5 pm, you don't plug in and take down the neighborhood." Scott, it should be noted, also oversees Toyota's electrified vehicles. But the current anti-hydrogen sentiment has him playing defense. Technically speaking, Toyota takes the same stance as its competitors—hydrogen looks slow, but when you track the rate of progress, it's a research success story. "Take where we were in 1996 and where we are in 2009, and you'll see the fuel cell has had leaps and bounds greater development than the EV," Scott says. "The fuel cell vehicle used to have to tow around its power train in a gigantic trailer. Now we have refueling in 3 to 4 minutes and a range over 400 miles." By comparison, Scott claims that today's EV's are still plagued with short ranges and have "almost identical charge times" to that of Toyota's electric RAV4 in 1997. Like many automakers, Toyota plans to release plug-ins in the next couple of years, and hydrogen vehicles a few years later, possibly as soon as 2015.

That happens to be the same time frame cited by researchers like Joan Ogden, an associate professor of environmental science and policy at UC Davis. "At present, the cost of mass-produced fuel cells is estimated to be about 70 dollars per kilowatt," Ogden says. "The costs are coming down and the performance is good, over twice that of comparable internal combustion gas engine vehicles." A common thread among many hydrogen supporters is a big-tent approach—the belief that there's no single successor to the gasoline engine, but an array of vehicles and fuels that seem confusing in the abstract, but that future, cost-conscious drivers will be more than happy to figure out. Cynics might claim that automakers are simply hedging their bets with such multi-fuel talk, but researchers who study both hydrogen and battery vehicles are harder to shout down. "There's been a lot of very vocal and unfortunate sparring between the battery and fuel cell camps." Ogden says. "I see them as coexisting. It's not hydrogen as something that's 20 years beyond EVs. I really don't see that much of a difference in the timelines. Maybe batteries get out a couple years earlier."

The biggest problem facing fuel cell vehicles, though, might have nothing to do with technology. "People lose interest in things that don't produce results in 15 minutes," Scott says. "The reason everyone was talking about hydrogen in 2001, 2002, was because Bush made it his push. Before that, Clinton was pushing compressed natural gas. Now Obama's got batteries." The phenomenal rise and fall of ethanol is the most obvious lesson of the dangers of judging the merits of a given alternative fuel by its political momentum, and subsequent commercial interest.

There's no reason to assume that EVs will suffer an ethanol-like crash and burn, but one thing is clear: The bitterness of the EV–hydrogen feud, and the implication that any discussion of the benefits of one approach is a condemnation of the other, makes it almost impossible to assess the real potential of hydrogen fuel cell research. And the serious questions of who would build a hydrogen infrastructure, and what material could replace platinum as a catalyst, won't be answered with vitriol. Whether hydrogen is promising in the short-term, and whether it deserves more or less funding, are matters for scientists to debate. For now, the discussion is dominated by lobbyists and activists nursing wounds from another decade and politicians with no clear guidance or consensus from the scientific community. As in most wars, diplomacy has failed. That doesn't mean it's too late for a truce.

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