POWERING THE FUTURE WITH HYDROGEN FUEL CELLS

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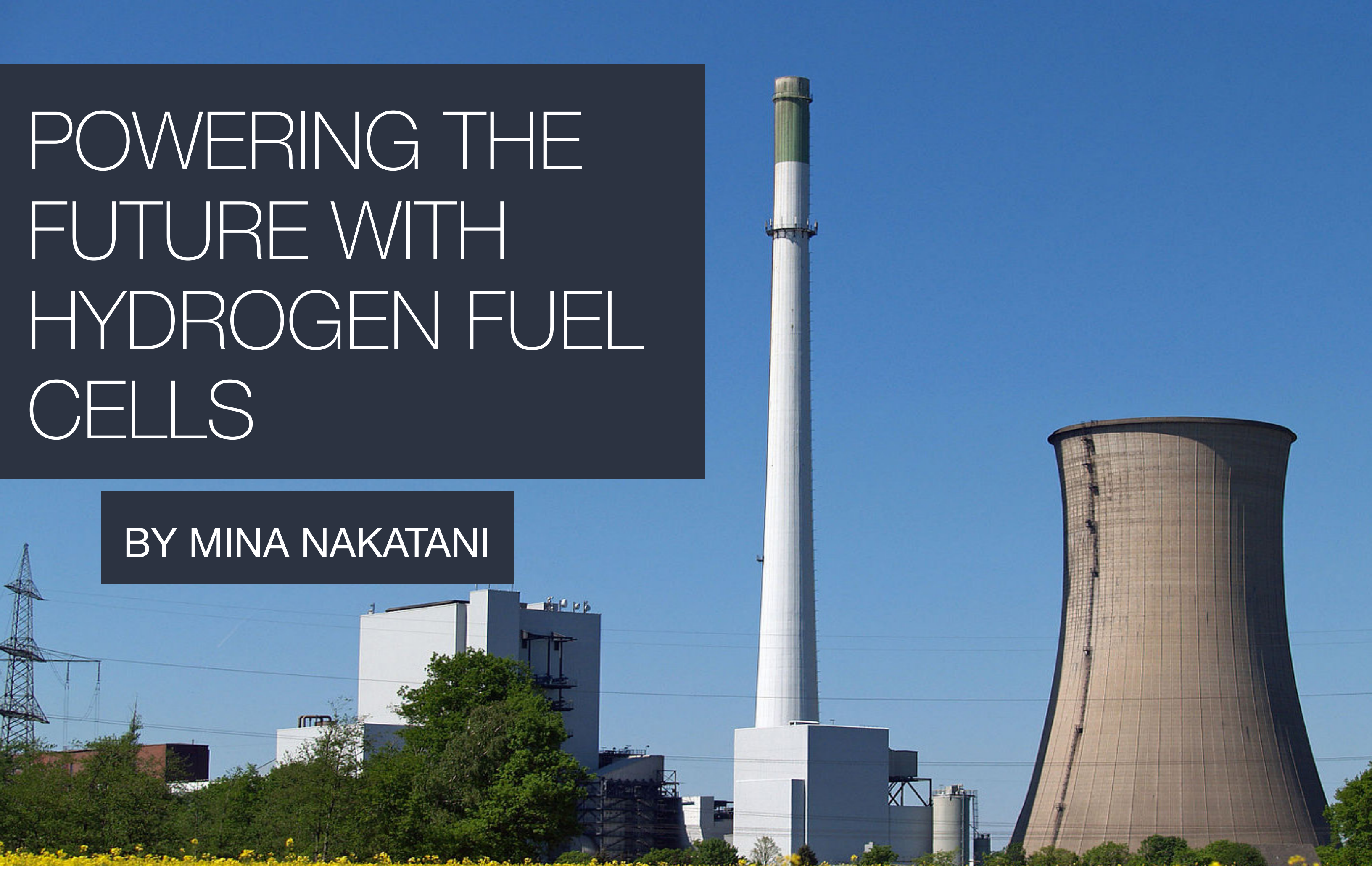

"Similar to lighting a match, the ensuing chemical reaction releases usable energy; the difference is that instead of creating carbon dioxide as a byproduct, only water is produced, a much greener process."

Back in 2010, the infamous BP oil spill in the Gulf of Mexico sent news stations scrambling for photos of the catastrophe. Images of the ocean, stained with a swirling mix of slick blacks and sickly browns like some sinister Impressionist painting, flooded the news. Before long, discussions circled around to questions of clean energy and the future of energy production. In recent years, one promising source of clean energy—the hydrogen fuel cell—has begun to show the potential to make significant changes to the face of industry, emerging as a major possible fuel source in the near future. Energy production at present comes largely from the burning of fossil fuels, such as gasoline. In much the same way as striking a match or lighting a fire, burning fossil fuels ultimately gives off energy in the form of light and heat. Unfortunately, the byproduct is carbon dioxide, a greenhouse gas whose emissions have increased significantly since the turn of the century.[8] Hydrogen fuel cells offer a promising alternative, storing hydrogen gas and providing a surface on which it can react with oxygen. The ensuing chemical reaction releases usable energy as well; however, because only water is produced as a byproduct rather than carbon dioxide, it is a much greener process.[4] Nonetheless, as with any new technology, hydrogen fuel cells still encounter problems that do not have an immediate solution. One such problem is the physical storage of hydrogen itself. Compressing a gas in any scenario is dangerous, and attempts to do so in an unsafe manner can lead to rather explosive results. This problem is only compounded by the fact that hydrogen tends to erode its containers, even without external factors—such as emptying and refilling tanks, or simply the chaos of everyday life.[6] There are several methods being considered in order to combat this issue. One possibility involves the use of materials known as metal hydrides—positively charged metallic atoms bonded to negatively charged hydrogen atoms—to store hydrogen. Ideally, in this form, the hydrogen being stored is not hydrogen gas, but effectively dormant hydrogen ions, which do not undergo the rapid expansion, better known as an explosion, that hydrogen gas can.[3] Although metal hydrides can undergo potentially dangerous reactions and retrieving hydrogen from this form is not easy, storing hydrogen in this manner nevertheless reduces risks by avoiding an explosive gaseous phase.[3] More detrimental to the use of hydrogen fuel cells, however, is that the chemical

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processes which must occur are kinetically unfavorable—on their own, they are either slow or unlikely to occur at all. For the reaction between hydrogen and oxygen to occur at any reasonable rate, a precious metal catalyst, such as platinum, is required.[1] The problem with this is fairly obvious: because platinum is scarce and extremely expensive, any large scale application is too costly to be reasonable. Moreover, lacking knowledge of how exactly the reaction takes place, there is no definitive way to eliminate platinum from the fuel cell entirely.[1] Nonetheless, there are some alternatives, including alloys and the employment of different geometries. Research is being done on using metal alloys—mixtures of metals—made up of platinum, with more common metals such as nickel or copper acting as a filler of sorts.[5] The use of various geometries is also being researched: forming the platinum into thin sheets or nanowires, using inexpensive, non-precious metals for the core.[6] In both cases, the same logic is used: exposing the greatest amount of platinum surface to catalyze the reaction, all while using the minimum amount of platinum overall. Though the ideal solution to this problem would come from understanding the reaction itself, these methods are a start. Beyond that, there is also the possibility of replacing platinum entirely, using replacement materials like molybdenum and tungsten, in conjunction with other metals, in order to replicate very similar catalytic properties.[5] Combining that with research into the effectiveness of different geometries—thin sheets, nanowires, and possibly other two- or three-dimensional shapes—could render the problems surrounding platinum obsolete in the years to come.[5] In addition, hydrogen fuel cells also have logistical problems to overcome. Much like the need for new charging stations to service electric cars, new infrastructure and equipment would be needed to refuel cars with hydrogen, all of which may prove costly to implement. For that matter, only 74 stations are predicted to exist in all of California by 2020.[4] In order for hydrogen to be considered a major energy source, it would require much more infrastructure than that. Moreover, currently, due to the scientific and technological issues that remain to be solved, the price of a fuel cell vehicle is still higher than that of a comparable internal combustion—or even electric—vehicle.[9] Even then, any future of hydrogen fuel cells hinges largely on public opinion; people often tend to place more trust in the known, feeling less safe with newer technologies, regardless of scientific potential.[9] Yet the future of hydrogen fuel is promising, even if its coming may be slow. It already has begun to impact the automotive industry, with Toyota taking to selling hydrogen-powered cars with plans to sell 30,000 per year by 2020.[7] This move could ulti-

Figure 1. Some fueling stations for hydrogen-powered vehicles do exist, but the infrastructure is still lacking for wider use.[4]

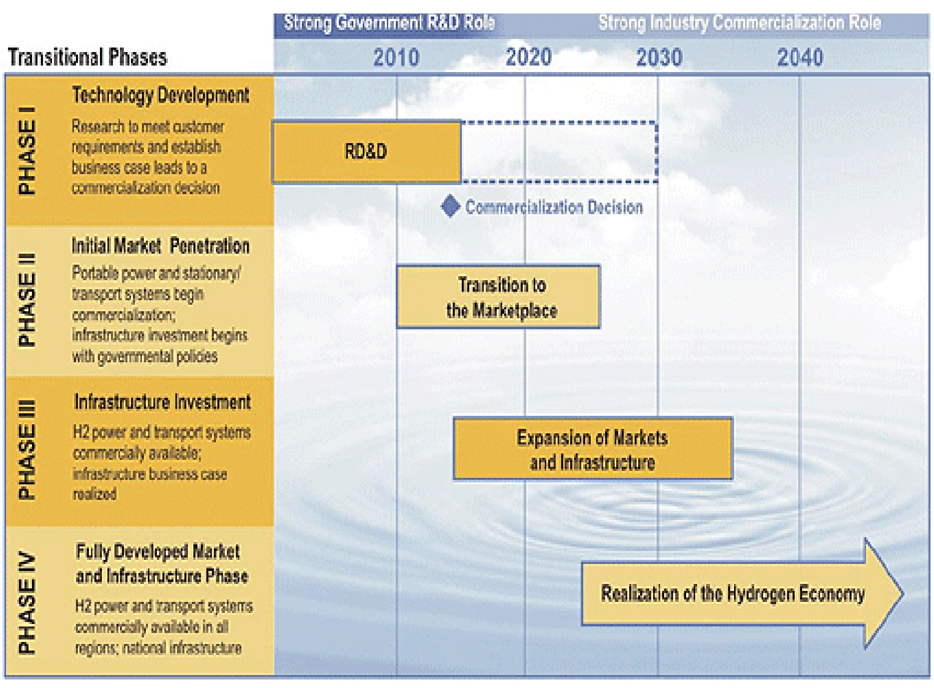

Figure 2. The planned development of hydrogen as a fuel source.

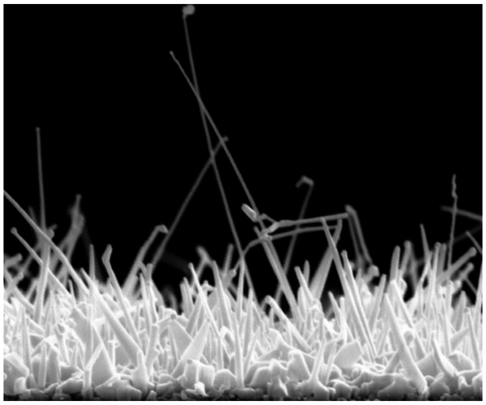

Figure 3. Microscopic view of metallic nanowires, a proposed geometry for platinum catalysts in hydrogen fuel cells.[6]

mately lessen the price of these vehicles and force the creation of more infrastructure, especially as the price of gasoline is likely to rise.[9] In addition, the U.S. Department of Energy has plans in place to gradually implement hydrogen as a major fuel source, moving away from carbon-based fuels with the intention of improving technology such that 90% of energy will come from hydrogen by the year 2080.[8] More intensive research would also allow hydrogen fuel cells to ultimately move outside solely the automotive industry. On a larger scale, it could be used for purposes like heating buildings;[9] on a smaller scale, it can theoretically be used to power handheld diagnostic devices, such as pregnancy tests.[2] Overall, despite the problems still facing hydrogen fuel cells, their potential, even in diverse applications, is quite promising for the future of energy.

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IMAGE REFERENCES

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