Living Mobility is Sustainable

Spotlight on hydrogen

In conversation with Arjun Garg, partner

Living Mobility is Sustainable. Hydrogen has the potential to be a sustainable fuel source that could be used in many transportation modes. The by-products of a hydrogen fuel cell are simply water and heat, so the sustainability of hydrogen as a fuel source depends ultimately on how the hydrogen is sourced. Arjun Garg discusses the promise of hydrogen as an enabler of sustainable mobility and the challenges for adoption of hydrogen as a clean fuel.

What role can hydrogen play in improving the sustainability of mobility and transportation?

Garg: Hydrogen power is attractive because it offers potential to address sustainability through technology. Hydrogen can be a green alternative to fossil fuels. The chemical reaction of hydrogen with oxygen generates energy to power a vehicle, and the by-products are water and heat—no emission of CO_2 or other greenhouse gases. Depending on how cleanly the hydrogen is produced and distributed to users, it could be a near zero-emission fuel source. Moreover, hydrogen is non-toxic and unburdened by the typical risks of environmental contamination associated with other energy sources.

What kinds of transportation applications does hydrogen have?

Garg: Innovators are exploring any number of hydrogen applications for ground, air, and marine transportation. Hydrogen will not necessarily be an optimal solution for every use case, but active efforts exist to use hydrogen to power cars, buses, trucks, trains, airplanes, drones, ferries, shipping vessels, and more. Today, there already are hydrogen-powered cars, buses, and trucks on the road, along with hydrogen refueling stations, in various countries around the world—although still in relatively small numbers. Hydrogen-powered trains have already been running trials in Europe and are moving into regular commercial operation. Similar progress from demonstration to commercial deployment is occurring for marine vessels. Aviation manufacturers are working to retrofit existing aircraft with hydrogen powertrains as well as develop clean-sheet designs for new hydrogen propulsion aircraft.

What are the main challenges in moving toward adoption of hydrogen in transportation systems?

Garg: The merits of hydrogen are appealing in theory, but have to be proven commercially viable in practice. The challenges break down into four categories: production, distribution, cost, and performance. How can hydrogen be cleanly produced at mass scale? How can hydrogen be distributed effectively to end users? Will hydrogen be cost-effective for operators? And will hydrogen-powered vehicles meet performance expectations, including safety requirements?

All these challenges involve a mix of technical, economic, and policy considerations. And they all tie back to the physical characteristics of hydrogen that create advantages and limitations.

If hydrogen can be consumed cleanly, what concern is there with the sustainability of hydrogen as a fuel source?

Garg: The concern for sustainability turns principally on how hydrogen is produced. Even though hydrogen is abundant, it does not typically exist in isolated, pure form. Rather, it is commonly a component element of water (H_2O) or hydrocarbons such as methane (CH_4). Some processing has to be done to extract hydrogen from water or hydrocarbons. For hydrogen as for other fuel sources, the extraction process factors significantly in the cleanliness of the supply. The extraction process itself requires significant energy input, and it leaves a by-product (oxygen from water, or a carbon compound from hydrocarbons). Ideally for environmental purposes, the precursor would be water, the energy input to process it would be renewable or carbon-neutral, and the by-product would be oxygen. Development is ongoing to realize the goal of producing green hydrogen that is affordable at mass scale. One idea being explored is to produce hydrogen during periods when renewable power generation creates electricity supply that otherwise outstrips demand, taking excess energy for which the grid has no use and converting it, through electrolysis of water, into hydrogen as an energy store. That hydrogen could then be used as fuel for transportation or for shoring up the grid when electricity demand surges.

Apart from its environmental impact, what are advantages and disadvantages of hydrogen as a transportation fuel?

Garg: Hydrogen not only can be clean, but also offers important practical advantages. Most focus on five major advantages of hydrogen. First, hydrogen is an abundant element with effectively unlimited availability. Second, a hydrogen fuel cell is perhaps two to three times more energy efficient than a fossil-fueled internal combustion engine, meaning that, pound-for-pound, hydrogen moves a vehicle farther than gasoline does. Third, re-fueling with hydrogen can be completed in minutes, faster than recharging a battery and potentially faster than refilling with fossil fuel. Fourth, a hydrogen fuel cell has no internal moving parts, so it can be more reliable and quieter than a conventional engine. Fifth, hydrogen delivers consistent performance as it gets depleted. These advantages must be weighed against disadvantages. Perhaps the most significant challenges relate to storage and movement through the supply chain. Hydrogen has to be stored under high pressure as a gas or at very low temperature as a liquid to reduce its volume to a manageable level, complicating its movement through the supply chain and its incorporation into vehicle designs. Successful commercialization of hydrogen-powered transportation will require finding applications and supply chains that affordably capitalize on hydrogen's benefits while overcoming its limitations.

Featured Speaker

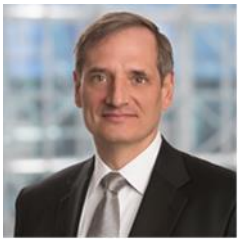
Arjun Garg

Partner, Washington D.C.
+1 202 637 6423
arjun.garg@hoganlovells.com

Contact Us

Patrick Ayad

Partner, Global Leader Mobility and Transportation, Munich and Berlin
+49 89 290 12 236
patrick.ayad@hoganlovells.com



Lance Bultena

Senior Counsel, Global Director of Thought Leadership Mobility and Transportation, Washington D.C
+1 202 637 5587
lance.bultena@hoganlovells.com

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