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EDITOR'S NOTE: SOLUTIONS

Steven A. Meyerowitz

**BIDEN ADMINISTRATION AND CONGRESS
FOCUS ON METHANE EMISSIONS**

Kevin T. Crews, Robert S. Fleishman,
Jonathan E. Kidwell and Jennifer C. Cornejo

**HYDROGEN: A CLEAN SOLUTION TO HEAVY-
DUTY DIESEL TRANSPORTATION**

Nicolas Borda and Karim Al-Hassan

**PROPOSED BUILD BACK BETTER ACT
PROVIDES SIGNIFICANT FUNDING FOR CLEAN
ENERGY AND CLIMATE INITIATIVES**

Timothy C. Brightbill, Laura El-Sabaawi,
Christopher B. Weld and Theodore P. Brackemyre

**ENVIRONMENTAL LAWS AND REGULATIONS
AFFECTING U.S. OFFSHORE WIND**

Seth Kerschner and Brittany Curcuru

**WINTER WEATHER READINESS REQUIREMENTS
FOR GENERATION ENTITIES IN TEXAS**

James F. Bowe, Jr., Craig Stanfield and
Tyler R Brown

**NAVIGATING THE LANDSCAPE OF
ESG-RELATED SHAREHOLDER LITIGATION**

Bruce A. Ericson, Ari M. Berman,
David Oliwenstein, Kimberly D. Jaimez and
Roland C. Reimers

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1

Biden Administration and Congress Focus on Methane Emissions

Kevin T. Crews, Robert S. Fleishman, Jonathan E. Kidwell and

Jennifer C. Cornejo

3

Hydrogen: A Clean Solution to Heavy-Duty Diesel Transportation

Nicolas Borda and Karim Al-Hassan

11

Proposed Build Back Better Act Provides Significant Funding for Clean Energy and Climate Initiatives

Timothy C. Brightbill, Laura El-Sabaawi, Christopher B. Weld and

Theodore P. Brackemyre

17

Environmental Laws and Regulations Affecting U.S. Offshore Wind

Seth Kerschner and Brittany Curcuru

20

Winter Weather Readiness Requirements for Generation Entities in Texas

James F. Bowe, Jr., Craig Stanfield and Tyler R Brown

30

Navigating the Landscape of ESG-Related Shareholder Litigation

Bruce A. Ericson, Ari M. Berman, David Oliwenstein, Kimberly D. Jaimez and

Roland C. Reimers

35

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Hydrogen: A Clean Solution to Heavy-Duty Diesel Transportation

*By Nicolas Borda and Karim Al-Hassan**

In this article, the authors explain that political, market and regulatory trends all have converged to create an unprecedented opportunity for hydrogen, with the versatile fuel poised to finally have its big moment.

Hydrogen is the most abundant element in the universe. Described by many in the energy industry as the “Swiss Army Knife” of climate solutions due to its potential to replace fossil fuels in transportation, power plants, and many other industries, hydrogen is a clean fuel that, when consumed in a fuel cell, produces only water. Due to its versatility and potential to decarbonize hard-to-abate sectors such as shipping and steel production, hydrogen is currently enjoying exceptional political, business, and investor support, with global policies, targets, and projects expanding rapidly.

Furthermore, the World Energy Council, in conjunction with PwC and the U.S. Electric Power Research Institute, estimates that hydrogen could account for six percent to 25 percent of global energy consumption by 2050, illustrating the integral role this multipurpose fuel will have in reducing global emissions, which is essential to arresting the worst effects of climate change.

The future of mobility (aviation, marine transportation, trains, and cars) is based on clean energy technologies. In addition to lithium-powered electric vehicles (“EVs”), hydrogen will be a game-changer in the near future. In terms of range, speed, acceleration, and time to recharge, hydrogen-powered cars are better than EVs. However, the average price of a new entry-level hydrogen-powered car is still above the average price of an entry-level lithium-powered EV.

FROM CHINA TO TEXAS

China is a massive player in the world of clean energy. The Chinese government is aiming to have one million hydrogen-powered vehicles on the country’s roads by 2030, starting with trucks and buses. The central government will provide incentives to those cities that achieve hydrogen adoption targets. This approach may also be used in the United States to increase the use of clean transportation.

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Texas is the largest hydrogen producer in the United States and a leader in solar and wind energy, which is essential to the production of low-cost green hydrogen. Therefore, when analyzing the feasibility of hydrogen in the transportation sector, it is important to consider the role of China as a producer of hydrogen-powered cars and hydrogen engines and the role of Texas as a producer of hydrogen fuels, especially green hydrogen using solar and wind energy.

Hydrogen has myriad use cases, such as powering vehicles, buildings, and manufacturing processes. Although hydrogen is capable of disrupting every aspect of a zero-emission economy, this article focuses on its role in the Californian commercial transportation sector as the state races to meet its commitments under the recently enacted Advanced Clean Truck regulation.

Moreover, with private capital flowing toward the development, deployment, and scaling of hydrogen capabilities, market participants should continue to stay abreast of exciting developments in this emerging space.

And, as will be discussed below, the medium- to heavy-duty commercial transportation sector is ripe for hydrogen-enabled disruption, affecting incumbents, investors, and end users.

IN CALIFORNIA

California has emerged at the forefront of the establishment of the “hydrogen economy,” instituting regulatory, infrastructure, and business policies to facilitate the continued growth of the industry, further improving both the near- and long-term prospects for hydrogen utilization within the commercial transportation sector.

The Advanced Clean Truck regulation, approved by the California Air Resources Board (“CARB”) on June 25, 2020, and one of the first of its kind in the world, requires manufacturers to sell increasing percentages of zero-emission trucks in an effort to reduce the life cycle emission of greenhouse gases (“GHGs”) and eliminate tailpipe emissions of air pollutants in California. In 2024, zero-emission trucks will begin to replace dirty diesels, with the aim of nearly one in three new tractor-trailers producing no pollution by 2030.

The rule extends to 2035, providing a clear market signal to industry that they can plan and make investments with increased certainty. Furthermore, through the Clean Transportation Program, California is investing in projects throughout the state that accelerate both the advancement and adoption of emission-free medium- and heavy-duty vehicle technologies and fueling stations to support increased deployment.

Additionally, in California, fossil fuel-powered transportation accounts for 50 percent of GHG emissions, with heavy-duty trucks, which only represent

two percent of road vehicles, contributing nine percent of such emissions. Accordingly, California's regulatory and market landscape, coupled with existing familiarity, investment, and infrastructure related to hydrogen, creates a strong opportunity for hydrogen-powered vehicles to play a primary role in supplanting conventional medium- and heavy-duty vehicles in the state.

WHY HYDROGEN FOR HEAVY-DUTY VEHICLES?

Hydrogen-powered trucks are seen by many industry watchers as the future of long-haul heavy-duty trucking. Currently, heavy-duty trucking in the United States makes up 40 percent of truck routes, consumes 75 percent of all diesel fuel used by the trucking sector, and accounts for roughly 17 percent of transportation GHG emissions.

Thus, decarbonization of the heavy-duty trucking sector is paramount, with hydrogen poised to play a significant role. There are manifold factors justifying this view.

First, trucks powered by hydrogen have a much longer range than those powered by electric batteries, with the former expected to reach twice the number of miles per full charge/tank.

Second, since fuel cell trucks are much lighter, they are better suited to carry heavy cargo. For instance, when comparing cargo capacity losses relative to diesel-powered trucks, it has been estimated that hydrogen-powered trucks lose 1,000 pounds while battery-powered trucks have the potential to lose up to 5,000 pounds.

HYDROGEN DEMAND AND FUEL CELL INFRASTRUCTURE CONTINUE TO DEVELOP, FURTHER BOLSTERING ADOPTION, APPEAL AND SCALABILITY

California buys significant amounts of blue hydrogen produced and trucked from Texas and Louisiana. However, prices for green hydrogen are expected to decrease significantly every year over the next 20 to 30 years, leading to increased demand for and consumption of green hydrogen in lieu of blue hydrogen. Moreover, if aviation and maritime transportation accelerate the adoption of hydrogen as the fuel of choice for planes and vessels, the synergies will grow exponentially. As green hydrogen reaches cost parity with both gray and blue, hydrogen's proportion of the California energy mix will continue to grow, further facilitating the demand for fuel cell vehicles.

California has 47 hydrogen refueling stations in operation and another 147 in development, meaning it has one of the largest hydrogen fueling station networks in the world. Furthermore, as the world emerges from the COVID-19 pandemic, which has significantly hamstrung further infrastructure develop-

ment in the state, ambitious plans to expand the hydrogen refueling system continue to pop up. To illustrate, the California Fuel Cell Partnership (“CaFCP”), a hydrogen fuel cell trade group, recently outlined a large-scale plan to put 70,000 heavy-duty fuel cell trucks on California’s roads by 2035, with the development of 200 hydrogen fueling stations to support them. Furthermore, in November, California announced approval of a \$1.4 billion three-year infrastructure push to meet the state’s ambitious goals for EVs and hydrogen fuel-cell vehicles. Included in the plan is an allocation of \$690 million for medium and heavy-duty zero-emission vehicle infrastructure, with portions of those funds earmarked for fuel cell commercial truck infrastructure. On top of that is an additional \$77 million provision for hydrogen fueling infrastructure.

Additionally, California continues to attract innovative industry players with the technical know-how and ability to produce green hydrogen in increasingly cost-effective and sustainable ways. For example, this summer, Republic Services and Raven SR teamed up to process more than 99.9 tons of organic waste per day at a California landfill, allowing Raven to produce more than 2,000 metric tons of green hydrogen per year. Based on these estimates, this one facility would produce enough hydrogen to power 200 heavy-duty vehicles per day. As similar projects and partnerships continue to pop up in California, the cost, availability, and demand dynamics of hydrogen will steadily improve, affording the public and private sectors the strong market signals needed to facilitate enhanced and sustainable investment into the sector.

As to actions by auto manufactures themselves, Hyundai, utilizing grants from CARB and the California Energy Commission (“CEC”), plans to deploy 30 hydrogen trucks beginning in the second quarter of 2023, which according to the automaker would be the largest deployment of hydrogen Class 8 trucks in the United States. Furthermore, General Motors, the largest automobile manufacturer in the United States, has teamed up with Navistar International Corp. to develop a hydrogen-powered commercial truck and supporting fueling infrastructure by 2024.

Lastly, Daimler Truck, the recently spun-off affiliate of the Mercedes-Benz brand, is currently testing a hydrogen-powered truck that could be ready for use in 2027, as long as fueling infrastructure is scaled up. Although a small sample size, these examples provide a clear market signal of both the near- and long-term potential of hydrogen-powered trucks, with established automakers making big bets that the technology has a solidified and sustainable role in the green economy.

GOVERNMENT INCENTIVES WILL CONTINUE TO DRAW BOTH INVESTMENT AND CONSUMER CAPITAL INTO HYDROGEN PROJECTS

Similar to the way solar and wind energy have benefitted over the last decade, hydrogen will benefit from existing and future government incentives, facilitating cost efficiencies, scale, and wider adoption, with California leading the pack. To capitalize on the opportunity to be at the forefront of a fuel slated to meet 14 percent of total U.S. energy demand by 2050, California will have spent about \$230 million on hydrogen projects by the end of 2023. Notable incentives include:

- Zero-emission vehicle (“Zev”) rebates;
- Alternative fuel vehicle (“AFV”) and fueling infrastructure grants;
- Fleet vehicle and procurement requirements; and, as mentioned above
- The Advanced Clean Truck regulation.

Furthermore, tax incentives, grants, and support will emerge at the federal level as policymakers continue to sharpen their focus on hydrogen. For example, the house version of President Biden’s signature “Build Back Better Plan” included a 10-year tax credit worth up to \$3 per kilogram of clean hydrogen produced. Moreover, while discussing the crucial need to rapidly decarbonize the United States’ energy sector, the Biden administration has consistently voiced hydrogen’s ability to decarbonize critical aspects of the economy, portending similar incentives. Additionally, in a move creating significant tailwinds for the hydrogen vehicle industry, President Biden recently signed an executive order directing the federal government to decarbonize itself by 2050, a task that includes zeroing out GHG emissions from the federal vehicle fleet. Notably, the executive order would direct the federal government to make only zero-emission vehicle purchases by 2035, forming a colossal source of demand for hydrogen-powered vehicles.

As these incentives continue to drive adoption and spur demand, investment into all aspects of the hydrogen value chain will increase, touching not only the development of vehicles and fueling infrastructure, but also production, transportation, and storage infrastructure. As capital inflows rise, overall costs will continue to drop, reducing the appeal of dirty fuel sources such as diesel and jet fuel, leading to further demand gains.

CONCLUSIONS

There are many variables that will help bolster the hydrogen truck transportation, including:

- The ability to finance and purchase truck fleets;

- Broad industry technology support;
- An adequate legal and regulatory framework; and
- Reliable, affordable and convenient fueling infrastructure.

The decarbonization of the U.S. transportation sector will be a multi-decade and capital-intensive endeavor, with both public and private efforts needed to free the economy of intensive fossil fuels emissions. To meet this onerous challenge, the energy mix must be sufficiently diverse to clean up all corners of transportation, leaving ample room for the proliferation of hydrogen-powered vehicles.

Moreover, as recent experience during the COVID-19 pandemic has shown, overreliance on global supply chains has the potential to create debilitating effects, an important factor to be noted as China continues to dominate the global supply of lithium. The COP26 United Nation Climate Change Conference, which took place from October 30 to November 12, 2021, brought additional awareness of hydrogen as a key factor in fighting climate change.

Accordingly, political, market and regulatory trends have all converged to create an unprecedented opportunity for hydrogen, with the versatile fuel poised to finally have its big moment.