



Advancing Clean Hydrogen Production and Alternative Transportation Fuels in Connecticut's Transportation Sector

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The search for alternative, carbon-free fuels to eliminate the world's dependence on fossil fuels has been a long journey for industry and academia. The recent global economic disruption, due to supply chain challenges related to the war in Ukraine, is only the newest reminder that our dependence on fossil fuels cannot continue for much longer. And of course, the urgency for carbon-free fuels is pressing as climate disruption from CO₂ emissions looms large.

Hydrogen is often looked at as the solution to fueling our transportation fleet, but it comes with challenges in its transportation and storage. It is a chemical difficult to store and capture and its synthesis is harmful to the environment, because it is produced from fossil fuels. **Policies need to be put forward that incentivize green and blue hydrogen production, but also address the challenges of storage and transportation, as they relate to the State's transportation sector.**

Clean Hydrogen Production

Clean hydrogen production involves generating hydrogen gas using methods that minimize or eliminate greenhouse gas emissions and other pollutants. One common method is electrolysis, where water is split into hydrogen and oxygen using electricity, often sourced from renewable energy like solar or wind power. Another approach is steam methane reforming with carbon capture and storage (CCS), which captures and stores the carbon dioxide emitted during the process. These clean production methods aim to produce hydrogen without contributing to the climate crisis or other environmental harms, offering a promising solution for decarbonizing various sectors including the transportation industry.

Clean hydrogen production faces challenges due to its higher cost compared to conventional methods, limited infrastructure, and the need for further technological advancements to scale up production efficiently. Additionally, energy-intensive processes and a lack of supportive policies and regulations hinder widespread adoption.

Hydrogen Alternatives

In addition to thinking about clean hydrogen production, hydrogen alternatives must also be considered. Hydrogen carriers, chemicals that are rich in hydrogen and release (only) water when reacted with air, are being considered more and more as alternatives to hydrogen. One example of a hydrogen carrier is ammonia. Ammonia is a versatile chemical and can be used within fertilizers, refrigerants, cleaning agents, and pharmaceuticals. It is estimated that the global value of the ammonia industry is over \$70B. Ammonia can also be used as a fuel in internal combustion and jet engines.

Benefits of using ammonia as fuel include:

1. Combustion free of carbon emissions
2. Stability surpassing that of refined fossil fuels such as gasoline or diesel

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3. Low flammability
4. Established transportation and supply chain infrastructure
5. High energy density

However, using ammonia as fuel also entails many challenges. While ammonia has a well-established supply chain, the “green ammonia” market is new and unknown. The discussion regarding alternative chemicals requires deeper exploration, particularly considering that opting for a hydrogen carrier instead of hydrogen itself could significantly decrease the carbon footprint of the transportation industry.

Policy Recommendations

The search for alternative, carbon-free fuels has been a journey marked by challenges and reminders of the urgent need for new infrastructure and systems. The recent global economic disruptions underscore the necessity to reduce our dependence on fossil fuels. While hydrogen is often hailed as a solution for transportation, its challenges in transportation, storage, and production from non-fossil fuel sources necessitate a comprehensive approach.

The State of Connecticut is uniquely suited to address these challenges because it has deep experience with fuel cell and electrolyzer manufacturing, increased funding through the Infrastructure Investment and Jobs Act & the Inflation Reduction Act, and state and regional climate and energy goals. Lastly, Connecticut is a world leader in aerospace and submarine manufacturing.

In order to address the challenges related to hydrogen production and lack of infrastructure relating to the use of alternative chemicals, Connecticut must:

1. Investigate the possibility of focused policy and market development support to encourage the production and use of clean hydrogen in the most crucial sectors. These sectors include:
 - a. Aviation (long- and medium-haul)
 - b. Cargo ships
 - c. Long-haul trucks
 - d. High heat industrial processes
 - e. Hydrogen fuel cells for peak power generation
 - f. Material handling equipment with extended operating times and restricted recharging capabilities.
2. Support the development of local technologies, through support of innovation, entrepreneurship, start-ups, and spin-offs, that can produce hydrogen carriers where they are needed, rather than relying on centralized production, with a focus on meeting the needs of specific transportation sectors in Connecticut.

Leveraging the strengths and advantages discussed above, Connecticut can lead the way in addressing hydrogen production challenges and advancing alternative and sustainable transportation fuel solutions.