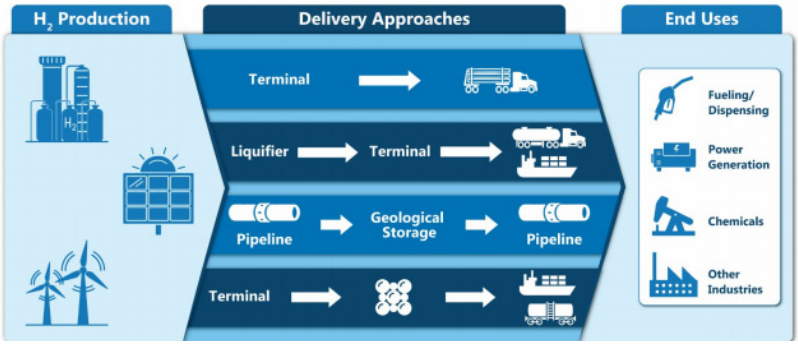
Clean Hydrogen Future Coalition

CLEAN HYDROGEN TRANSPORT AND DELIVERY

Hydrogen can be used as a carrier to move and deliver clean energy to where it is needed. Today, hydrogen is transported from the point of production to the point of use via pipeline, over the road in cryogenic liquid tanker trucks or gaseous tube trailers, by rail or barge, and using chemical hydrogen carriers. Hydrogen used in portable or stationary applications can be delivered by truck to a storage facility or in cylinders, similar to the propane used for gas grills, or in cartridges that would resemble a battery. The technologies required to imporove these delivery pathways are at various stages of development, but they must ultimately be both affordable and meet or exceed the level of safety, convenience, reliability, and energy efficiency expected from existing infrastructure used for other fuels for clean hydrogen to become a replacement fuel.



The four main methods of hydrogen delivery: gaseous tube trailers, liquid tankers, pipelines, and chemical hydrogen carriers

Hydrogen Pipelines. The United States has over 1,600 miles of hydrogen pipelines and three caverns that have the capacity to store thousands of metric tons of hydrogen. By contrast, there is about 2 million miles of natural gas distribution mains and pipelines in the U.S. currently. Hydrogen pipelines are often used in regions where there is significant demand and that demand is expected to remain stable for a long period of time. This is because hydrogen pipelines are capital intensive, but when the quantity of hydrogen demand is high, they have a lower levelized cost over time. While pipelines are the most energy-efficient approach to transporting hydrogen, their deployment is challenged by their high capital costs.

Chemical Hydrogen Carriers. Another emerging method to transport large amounts of hydrogen is the use of chemical hydrogen carriers, which are liquid- or solid-phase materials that can chemically bond with hydrogen to "carry" it at low-pressure and can then release the hydrogen on demand. They offer the potential for significantly higher energy density compared with gaseous or even liquid hydrogen transport, reducing hydrogen delivery costs. The most common form of a chemical hydrogen carrier is ammonia.

Hydrogen Dispensing and Fueling. Once hydrogen is transported to the site of use, it may need to be conditioned by pressurizing, cooling, or purification, and it is commonly stored on-site in bulk. These processes can involve a number of different systems—for example, hydrogen fueling stations for hydrogen used in fuel cell electric vehicles.

Transport/Delivery Challenges

Delivery technology for hydrogen infrastructure is currently available commercially, and several U.S. companies deliver bulk hydrogen today. Some of the infrastructure is already in place because hydrogen has long been used in industrial applications, but existing infrastructure is not sufficient to support widespread use of hydrogen as an energy carrier. Because hydrogen has a relatively low volumetric energy density, its transportation, storage, and final delivery to the point of use increases the cost for it as an energy resource and results in inefficiencies associated with its use as an energy carrier.

The key challenges to hydrogen delivery include reducing delivery costs, increasing energy efficiency, maintaining hydrogen purity, and minimizing hydrogen leakage. Further research is needed to analyze the trade-offs between the hydrogen production options and the hydrogen delivery options when considered together as a system.

It will also take time to develop a national hydrogen delivery infrastructure and will likely include combinations of various technologies. Delivery infrastructure needs and resources will vary by region and type of market: urban, interstate, or rural. Infrastructure options will also evolve as the demand for hydrogen grows and as delivery technologies develop and improve.

Transport/Delivery Needs:

- Lower-cost and more-reliable systems for distributing and dispensing hydrogen
- Continued research on utilizing existing natural gas pipelines to transport hydrogen
- Advanced technologies and concepts for hydrogen distribution including liquefaction and material based chemical carriers
- Rights-of-way, permitting, and reduced investment risk of deploying delivery infrastructure
- Materials compatibility with hydrogen at high pressures and/or low temperatures
- Innovations in hydrogen liquefaction
- Innovative components for low-cost distribution and dispensing

Information and graphics courtesy of the U.S. Department of Energy's 2020 Hydrogen Program Plan unless otherwise noted.