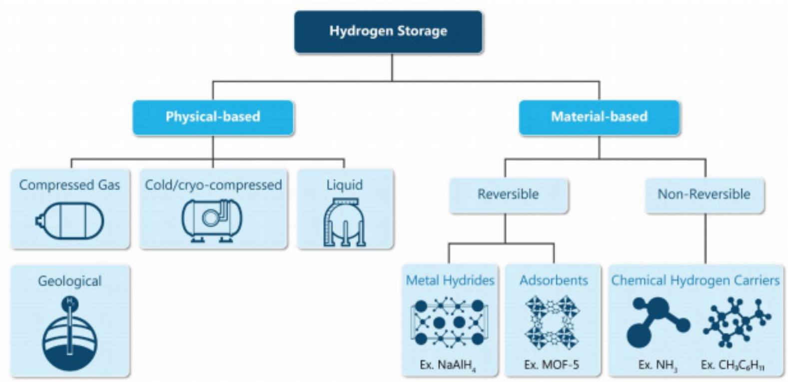
LOW CARBON HYDROGEN STORAGE

Hydrogen has nearly three times the energy content of gasoline per unit of mass, but the volumetric energy ensity of gaseous hydrogen is low, making it difficult to store in compact containers. To overcome this challenge, hydrogen is usually stored using physical processes, as a gas or cryogenic liquid; it can also be stored using material-based processes that incorporate hydrogen in chemical compounds.

Physical-based Storage. Gaseous hydrogen is typically stored in metal, pressurized tanks for transportation and other stationary and power generation applications. Large-scale geologic storage within salt caverns, saline aquifers, depleted natural gas or oil reservoirs, and engineered hard rock reservoirs offers opportunities for long-duration energy storage applications. One example is the industrial-scale hydrogenstorage salt cavern located in Beaumont, Texas, which currently serves as a buffer in the Gulf Coast hydrogen pipeline system. More research is needed to reduce the cost and ensure the safety of gaseous hydrogen storage.



Current portfolio of hydrogen storage options. Includes physical-based gaseous and liquid storage in tanks, and reversible and non-reversible materials-based storage. Approaches for large-scale bulk storage (such as geological storage) are also under investigation.

Material-based Storage. Clean hydrogen can also be densely stored at low pressures in certain material compounds. Different categories include metal hydrides, adsorbents, and chemical hydrogen storage. Metal hydrides store hydrogen atoms by chemically bonding them to atoms in the compound structure, such as magnesium borohydride. Adsorbents utilize weak bonding between molecular hydrogen and adsorbent surfaces, and typically require lower storage temperatures. Hydrogen storage via metal hydrides and adsorbents is considered reversible, since hydrogen uptake and release can be controlled by changing the temperature and/or the pressure. Many chemical hydrogen carriers (as discussed in our transport fact sheet, such as ammonia) have the potential to store large quantities of hydrogen by mass and volume. With these chemcial carriers, thermal or catalytic chemical reactions are needed both to bind and release the hydrogen, and these processes can result in significant round-trip energy losses. Currently no material-based storage approaches are commercially mature, and foundational material and system-level RD&D are needed for the discovery and optimization of viable hydrogen storage materials capable of achieving the cost, energy density, and hydrogen uptake and release required for commercialization.

Storage Needs and Challenges:

- Lower-cost hydrogen storage systems
- Higher storage capacity, with reduced weight and volume
- Large-scale storage, including onsite bulk emergency supply and in geologic formations
- Optimized storage strategies for co-locating stored hydrogen with end-use applications to meet throughput and dynamic response requirements and reduce investment cost
- Materials compatible with hydrogen for durability and safety
- Cryogenic RD&D for liquid hydrogen and cold/cryo-compressed storage
- Discovery and optimization of hydrogen storage materials to meet weight, volume, kinetics, and other performance requirements
- Optimization for round-trip efficiency using chemical hydrogen carriers
- Storage of hydrogen in the form of a chemical energy carrier that can be used in hydrogen turbines
- Identification, assessment, and demonstration of geologic storage of hydrogen

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