

**BayoTech®**



# Fueling the Future of Mobility

Reliable & Economical  
Hydrogen Supply Solutions

Making Hydrogen Easy®

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# Reliable & Economical Hydrogen Supply Solutions

**The Fueling Infrastructure Challenge**

As commercial fuel cell vehicle fleets and rail networks continue to expand, fleet operators are confronted with critical decisions concerning their fueling infrastructure. One critical consideration is securing a reliable supply of hydrogen fuel. Hydrogen's role as a significant contributor to the total cost of ownership for fuel cell vehicles makes it an essential aspect in making fuel cell transport feasible and sustainable. Ensuring a reliable and efficient hydrogen supply is crucial for making fuel cell transport a realistic option for fleet operators. Additionally, scalability, environmental impact, and safety are other important factors that must be taken into account when choosing a hydrogen supply method.

In this paper, we will delve into the primary options available to fleet operators for securing a hydrogen supply: hydrogen delivery from offsite or onsite hydrogen production. We will explore the factors that influence the choice between these options and their implications for fleet operations. By considering these factors and making informed decisions, fleet operators can support their long-term success, optimize operational efficiency, and achieve their sustainability objectives.



Hydrogen Delivery



Onsite Production of Hydrogen

# Planning your Hydrogen Supply

When starting to plan hydrogen supply, fuel cell fleet operators must give careful consideration to several critical factors. Starting by thoroughly evaluating these points allows them to make informed decisions on how to secure a reliable and dependable hydrogen fuel supply. By taking into account the specific needs of their fleet and operational requirements, fleet operators can optimize their hydrogen supply strategies and ensure smooth and efficient operations for their fuel cell vehicles.



## Total Cost of Ownership

Hydrogen fuel is a significant contributor to the total cost of ownership for fuel cell vehicles. Therefore, fleet operators need to ensure they have a reliable and cost-effective source of hydrogen throughout the entire lifespan of their vehicles. The cost of hydrogen, including production, delivery, and storage, should be evaluated.



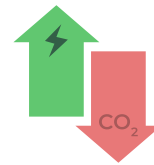
## Operational Efficiency and Reliability

A reliable supply of hydrogen is vital for the efficient and uninterrupted operation of fuel cell vehicles. Fleet operators need to avoid disruptions in fuel availability to meet customer demands and avoid any potential revenue losses or operational setbacks.



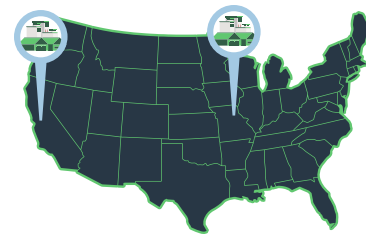
## Scalability and Fleet Growth

As fuel cell fleet operators expand their operations and increase the size of their vehicle fleet, they need to ensure that their hydrogen supply can scale accordingly. Evaluating the scalability of the hydrogen supply option is essential to meet growing demand without compromising operational efficiency.



## Carbon Intensity and Environmental Impact

Many fuel cell fleet operators prioritize sustainability and aim to reduce their carbon footprint. Therefore, securing a supply of hydrogen in the most low carbon method is important. Fleet operators should assess the environmental impact of their chosen hydrogen supply option and align it with their goals.



## Geographic Location and Infrastructure

The accessibility of hydrogen fueling infrastructure is a critical consideration. Fleet operators should assess the availability of hydrogen stations or production facilities in their operational regions. If the infrastructure is limited or insufficient, fleet operators may need to invest in additional infrastructure or explore alternative supply options.



## Supplier Reliability and Relationships

Establishing reliable partnerships with hydrogen suppliers is crucial. Fleet operators need to evaluate the track record and credibility of potential suppliers, ensuring they can consistently provide a high-quality and reliable hydrogen supply. Building strong relationships with suppliers can contribute to long-term reliability and ensure a stable fueling solution.



## Safety

Fleet operators must consider compliance with applicable regulations related to hydrogen fueling, storage, and transportation. Safety measures should be taken into account when choosing a hydrogen supply option, ensuring adherence to relevant safety standards and protocols.



# Hydrogen Delivery

With this option, hydrogen is transported from the production site to the fleet operator’s refueling stations using specialized hydrogen transport vehicles. These transport vehicles may be in the form of gaseous hydrogen trailers or cryogenic liquid tankers. Hydrogen is dispensed from the trailers directly to the vehicles or into hydrogen storage tanks onsite.

Hydrogen delivery can be an ideal option for fleet operators with:



**Limited available real estate at the depot**  
Compact, high-pressure hydrogen transport trailers and storage modules require minimal space and can be repositioned as necessary.



**Fuel cell fleet size of less than 10 vehicles**  
The fueling infrastructure for a pilot fleet must be temporary or scalable, and not entail substantial changes to the operating environment at bus fueling facility.



**Limited capital budget to fund infrastructure investments**  
The fleet operator will contract for hydrogen delivery on a dollar per kilogram basis. The industrial gas provider typically installs, maintains, and operates the fuel storage and dispensing equipment, providing this service for a monthly fee.

# Comparing Hydrogen Delivery Methods: Liquid vs. Gaseous

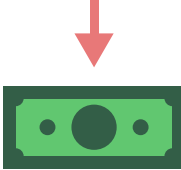

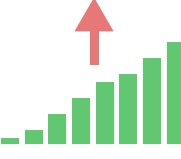
When evaluating the option of hydrogen delivery, fleet operators must weigh two options - liquid versus gas. Delivery of hydrogen in liquid form presents challenges. The low volumetric energy density of hydrogen makes long-distance transportation inefficient and costly. It requires extremely cold temperatures to remain in a liquid state. Liquid hydrogen must be stored and transported at cryogenic temperatures, which calls for specialized infrastructure and equipment. This adds complexity and cost to the storage and distribution systems. Insulation issues can arise, leading to evaporation and decreased efficiency. The energy-intensive liquefaction and infrastructure equipment needed adds to the overall cost of the hydrogen supply chain. Liquid hydrogen also requires additional permitting, which can add complexity to the process and creates additional costs and time to the process.

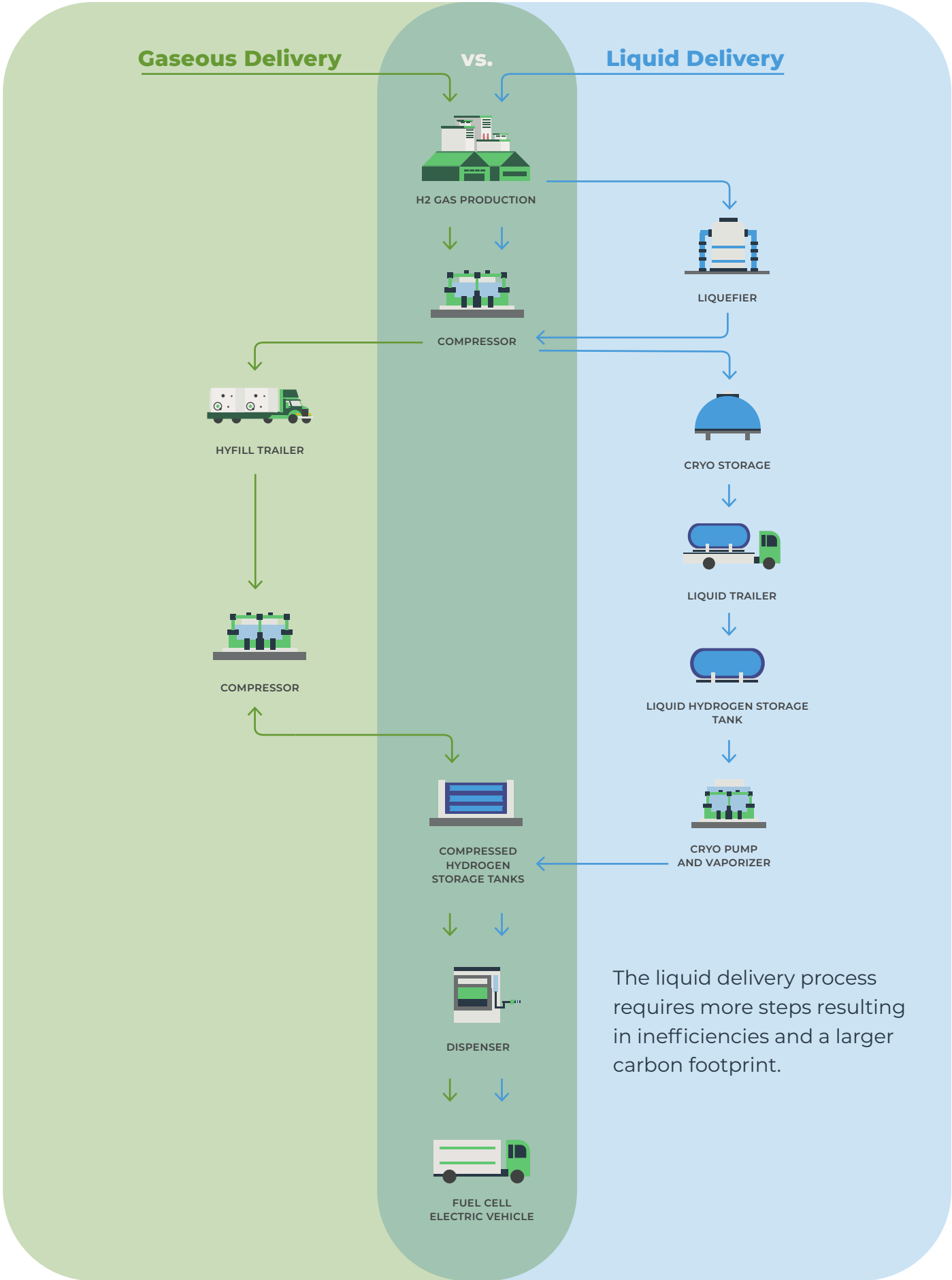
Additionally, the process of liquefying and distributing hydrogen over far distances significantly increases its carbon footprint, impacting its environmental sustainability. Moreover, this method may lead to reliability and supply inefficiencies, with customers relying on long-haul transport being the first to experience potential supply disruptions.

On the other hand, the alternative to liquid hydrogen is gaseous hydrogen, which is typically delivered using trucks known as tube trailers. Gaseous hydrogen does not require cryogenic storage or specialized insulation, simplifying the storage and transportation process. It can be compressed and stored in high-pressure tanks, which are easier to handle compared to cryogenic systems. Gaseous hydrogen tube trailers utilize high-pressure composite cylinders or steel cylinders to contain and transport hydrogen. Compressed hydrogen gas occupies less space than liquid hydrogen, allowing for efficient storage and transportation. This approach avoids the energy-intensive liquefaction process, resulting in higher energy efficiency and cost savings.



Localized hydrogen production and delivery in gaseous form present an even more advantageous alternative. Bayotech’s decentralized hydrogen hubs are strategically situated along transportation corridors to enhance supply availability and efficiency. They provide a reliable and efficient solution for meeting the growing demand for hydrogen fuel. These hubs offer fuel cell fleet operators the opportunity to optimize their hydrogen supply chain, ensuring seamless operations and contributing to a cleaner, more sustainable future for transportation.

	Large-scale centralized production Delivery in liquid form	Localized production Delivery in gaseous form
 <b>Total Cost of Ownership</b>	<b>High Cost from Transportation</b> Hydrogen low volumetric energy density makes inefficient to transport long distances.	<b>Decreased Transportation Costs</b> Able to deliver more hydrogen than traditional steel tube trailers. More sites can be refueled per trip lowering transportation costs and maximizing driver productivity.
 <b>Carbon Intensity and Environmental Impact</b>	<b>High Carbon Intensity</b> Liquifying and distributing hydrogen to far destinations increases its carbon footprint sixfold.	<b>Lower Carbon Intensity</b> Short transportation distances and avoiding liquefaction reduces the lifecycle emission of the hydrogen.
 <b>Operational Efficiency and Reliability</b>	<b>Unreliable Supply</b> Customers who receive excess hydrogen from the central plant and rely on its long-haul transport will be the first to lose their supply.	<b>Reliable Supply</b> Multiple decentralized production locations provides redundancy. Hydrogen can be delivered from a nearby second source if supply is interrupted at one location.





# Onsite Hydrogen Production

## Produce your own supply of hydrogen

Alternatively, a fleet operator can own and operate equipment to produce hydrogen onsite to meet fleet needs. To mitigate the challenges of unreliable supply and high delivery costs, some fleet operators are taking the step to become fuel producers. They are purchasing electrolyzers or small steam methane reformers to produce hydrogen for their own consumption.

### Pros and Cons to managing your own onsite hydrogen production:

#### PROS

##### More Control and Independence

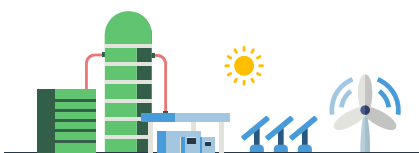
Producing hydrogen onsite grants fleet operators greater control over their fuel supply. They are no longer reliant on external suppliers, ensuring a consistent and reliable source of hydrogen. Fleet operators can scale their infrastructure as needed and are not tied to long-term supply contracts.

##### Cost Savings Potential

By reducing transportation costs, and producing hydrogen at a lower cost compared to external suppliers, fleet operators can reduce the total cost of ownership for their fuel cell vehicles.

##### Lower Carbon Intensity and Environmental Impact

Onsite hydrogen production can be integrated with renewable energy sources like solar or wind power, reducing the carbon footprint associated with fueling the fleet. This aligns with fleet operators' sustainability goals and promotes lower carbon-intensity operations.



#### CONS

##### High Infrastructure Investment

Establishing hydrogen production facilities requires a significant upfront investment. Fleet operators need to consider the costs associated with equipment, permits, and operational infrastructure. There is also the risk of potentially being burdened with rapidly outdated equipment if technology advances quickly.

##### Operational Complexity

Managing onsite hydrogen production entails specialized knowledge and expertise. Fleet operators must ensure they have the necessary resources and capabilities to effectively handle the production, storage, and distribution processes. Adequate training and maintenance protocols are crucial to ensure operational efficiency and safety.

##### Scalability Challenges

Scaling up onsite hydrogen production may pose challenges, especially if the fleet size expands rapidly. Additional investments in production capacity and infrastructure may be necessary to accommodate the increased demand. Space availability must also be considered, as larger-scale production facilities require sufficient room for operation.

## The Solution: BayoTech's Hydrogen Hubs

Not ready to take on these challenges of onsite hydrogen production? There is a solution: BayoTech will install, own and operate a hydrogen production facility near your depot and deliver over short distances.



##### Control and Independence

Ensure a consistent and reliable source of hydrogen. Take as much hydrogen as you need. We'll sell the rest to other customers. Need more? Take our supply. We can also scale up production for you. Units can be added based on customer demand.



##### Cost Savings

By reducing transportation costs, and producing hydrogen at a lower cost compared to external suppliers, fleet operators can reduce the total cost of ownership for their fuel cell vehicles. By reducing off-take size, project development cycles can be shortened, and capital costs lowered.



##### Carbon Intensity and Environmental Impact

We use an RNG blend that brings carbon intensity to zero. This aligns with fleet operators' sustainability goals and promotes lower carbon intensity operations.



##### Low Infrastructure Investment

Requires limited infrastructure at the fleet owners site – gaseous delivery, high pressure storage, dispensing. No risk of owning outdated equipment.



##### Operational Ease Low risk

BayoTech designs, installs, maintains, owns and operates the hydrogen generation equipment. Bayotech has the specialized knowledge and expertise to effectively handle the production, storage, and distribution processes.



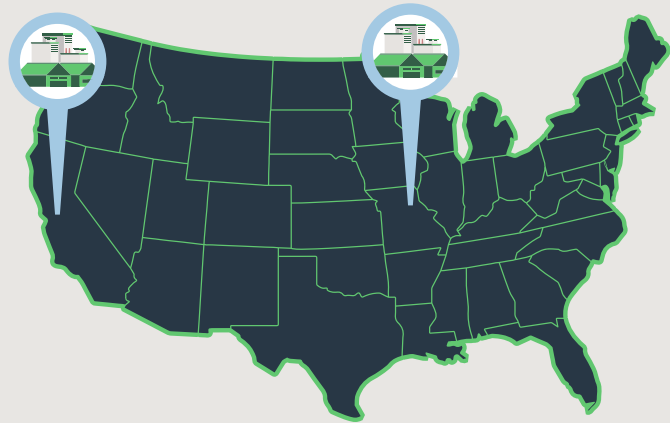
##### Scalability

Our hubs are quick to deploy. Using uniform SMR technology across units enables easy scalability and eliminates risks associated with scaling up. Hubs are factory-built on the skids, allowing faster deployment than stick-built methods.



Our Production Hubs

Our hydrogen production hubs are strategically located starting in Wentzville, MO and Stockton, CA.



Our Vision for Decentralized Production



Decentralized hydrogen hubs will be strategically located along major trucking corridors to increase the available supply for applications.

- ✓ Optimize Logistics
- ✓ Cover Demand
- ✓ Support Environmental Justice

All your hydrogen needs are covered by one supplier.

- ✓ Production
- ✓ Delivery
- ✓ Storage

Delivery to regional customers involves short-haul transport via high-capacity trailers.

- ✓ Low Carbon
- ✓ Low Cost

Hydrogen supply will scale alongside your business needs.

- ✓ Flexibility
- ✓ Reliability
- ✓ Efficiency

Navigating the Hydrogen Supply Choice: Key Decisions for Fuel Cell Fleet Operators

The path to obtaining hydrogen involves considering various factors, such as the fleet’s specific needs, available infrastructure, on-site space, and cost-effectiveness.

Both delivery and onsite production options offer distinct advantages and drawbacks, making it vital to tailor the choice to the fleet’s unique requirements. Deciding requires balancing risks and rewards, carefully assessing the pros and cons to ensure the best fit for the fleet’s goals and objectives.

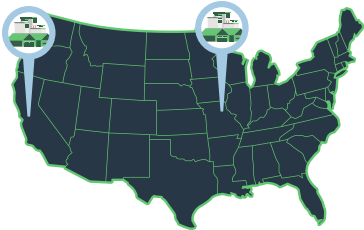
Factors Influencing the Choice

Several factors come into play when deciding between choice of hydrogen supply:



Fleet Size and Growth Plans

The fleet’s current and future size play a crucial role. Larger fleets may benefit from onsite production, gaining better control and potential cost reductions. Smaller fleets may find hydrogen delivery more practical and manageable.



Geographic Considerations

The availability of hydrogen suppliers and infrastructure in the fleet’s operational region is pivotal. Access to reliable suppliers nearby may make hydrogen delivery a viable option, while lacking such infrastructure might favor onsite production.



Financial Analysis

Conducting a thorough cost analysis is crucial, taking into account hydrogen pricing, transportation costs, infrastructure investments, and potential cost savings from onsite production.



Expertise and Resources

Evaluating the fleet operator’s capabilities and resources is key. Onsite hydrogen production requires specialized knowledge and operational expertise, which may influence the decision. Partnering with experienced suppliers might be more suitable in certain cases.



Securing a reliable hydrogen fuel supply is critical for fuel cell fleet operators. While hydrogen delivery offers simplicity and scalability, onsite production provides control, potential cost savings, and environmental benefits. Careful evaluation of fleet size, growth plans, geographic location, financial considerations, and available expertise will guide operators towards the best-suited option. Ultimately, the chosen hydrogen supply method should align with the fleet operator's long-term vision and priorities in achieving sustainable and efficient fuel cell transport.

## Want to analyze your options?

Contact Bayotech for a custom evaluation at [info@bayotech.us](mailto:info@bayotech.us)

JOIN THE HYDROGEN REVOLUTION TODAY!

