

GREEN HYDROGEN IN LOS ANGELES

Hydrogen is the simplest and most abundant element in the universe. With economy-wide decarbonization taking shape, there is growing interest in hydrogen as a promising energy carrier since it emits no carbon when used. Traditionally, hydrogen is produced from fossil fuels in processes that emit carbon, but LADWP is focused exclusively on planning for green hydrogen. Green hydrogen is produced from a process called electrolysis, using renewable power like wind and solar to split water into hydrogen and oxygen.

LA100 Key Finding:

New in-basin, firm generation—using renewably produced and storable fuels, that can come online within minutes, and can run for hours to days—will become a key element of maintaining reliability.

Green hydrogen is currently expensive and the necessary infrastructure to support the production, transportation, and storage is in its infancy. However, with an accelerated focus on clean energy, a commitment to safety, a developing landscape with supporting policies and funding, and rapid technology innovations, green hydrogen can play an important role in decarbonizing the power sector and the broader economy. Hydrogen may be critical in decarbonizing *hard-to-electrify* industries such as marine shipping, heavy-duty trucking, and aviation, as well as any industrial processes that require high-temperature heat such as steel and cement production.

L.A.'s 100% Clean Energy Future

Completed in March 2021, the groundbreaking Los Angeles 100% Renewable Energy Study (LA100) affirmed that LADWP could meet the city of Los Angeles' aggressive goal to be fully powered by 100% carbon-free energy as early as 2035 in the fastest scenario. The study results propelled Los Angeles City leaders to accelerate the city's decarbonization targets to 100% carbon-free power by 2035 with interim goals of 80% renewables and 97% greenhouse gas-free resources by 2030.

Role of Green Hydrogen in L.A.

One of LA100's key findings is that L.A. will need in-basin, reliable combustion generation—powered by a renewable energy like green hydrogen—to keep the lights on during the most extreme situations. Examples include a wildfire causing the loss of transmission and limiting its access to renewables or a heat storm during a period of low renewable generation. Green hydrogen also offers the potential to capture excess renewable energy and serve as a form of seasonal energy storage, which would reduce the amount of renewable energy that would otherwise be curtailed on a massive scale. The LA100 study also showed that combustion turbines powered by a renewable fuel, such as green hydrogen, will be needed to help achieve the last 10% toward a 100% carbon-free power supply that is reliable and resilient.

Key Challenges

Developing storage for green hydrogen, a pipeline system to transport it to LADWP's in-basin generating stations, and the cost of a green hydrogen economy are some of the key challenges that need to be addressed.

Storing Hydrogen

For hydrogen to play a meaningful role as an energy carrier, plentiful and reliable storage will be required to ensure demand can always meet supply. Storing green hydrogen will be key to using this clean resource to meet energy demand during critical periods. However, it will be one of the costliest elements—storing hydrogen will always be more expensive than fossil fuels because hydrogen requires more energy to compress and liquefy. LADWP will be assessing several major technologies to store hydrogen, such as salt caverns, ammonia, and liquid organic hydrogen carriers (LOHCs).

Transportation Network

Another key challenge is determining ways to transport hydrogen if it is to become a widely used energy carrier. The three main methods for conveying hydrogen include pipelines, truck-trailers, and ships. Trailers can carry compressed hydrogen gas, liquid hydrogen, ammonia, or LOHCs. Ships transport these forms of hydrogen as well, with the exception of compressed hydrogen gas. Pipelines can transport compressed hydrogen but will require longer construction lead times. The best method will depend on the demand volume and the distance required to transport hydrogen.

Cost of Green Hydrogen

Green hydrogen is expensive to produce, transport, and store, and it is currently more expensive to produce than fossil-based hydrogen. However, there is potential for the cost of green hydrogen production to fall as production scales up and the supporting infrastructure is developed. Additionally, future incentives and policies such as the U.S. Department of Energy's anticipated solicitation for H2Hubs will help to further drive down costs across the green hydrogen economy.

FREQUENTLY ASKED QUESTIONS

What are the benefits of using green hydrogen in combatting climate change?

- Using green hydrogen has the potential to eliminate 100% of CO₂ emissions at our generating stations.
- Green hydrogen has the potential to decarbonize LADWP's fleet of dispatchable generation, so that we can keep the power flowing even during critical periods while achieving our city's aggressive carbon-free targets.

What are LADWP's plans for green hydrogen?

- The LA100 results confirmed that L.A. will need roughly 2,600 MW of clean, dispatchable, local capacity by 2045¹ to keep power flowing reliably during extreme events, such as a wildfire or earthquake that threatens transmission bringing renewable energy into Los Angeles.
- LADWP also plans to use green hydrogen as a clean fuel to supplement a generation portfolio largely dominated by renewables. Green hydrogen would be used to fuel in-basin combustion turbines at times of low renewable generation combined with high electricity demand.
- Overall, our future in-basin power system would run green hydrogen turbines only a fraction of the time that we operate in-basin thermal units today.

¹ *The Los Angeles 100% Renewable Energy Study*, National Renewable Energy Laboratory, 2021.

Does LADWP have specific projects being planned within the city?

- LADWP is reviewing proposals submitted through a broad request for information (RFI), issued in 2021, for green hydrogen technologies and supporting infrastructure.
- LADWP's first step toward transforming local generation to be clean and reliable is to develop a green hydrogen-ready unit at Scattergood Generating Station by 2029, replacing the once-through cooling units.
- LADWP is also investigating the potential of retrofitting existing natural gas units so that they can run on green hydrogen.

How will LADWP ensure public and employee safety when using hydrogen power equipment?

- LADWP is committed to ensuring the safety of our communities and employees as we develop green hydrogen capabilities.
- LADWP has a long history of safely storing and using hydrogen at our power facilities as part of our generator cooling systems.
- As hydrogen is the lightest gas and flammable in the air, it is imperative that we use detection monitors on-site and at critical junctures like compressor stations and at end use stations.
- Hydrogen gas detection devices are designed to meet numerous industry and government standards and have been in use for many years through a mature and stable industry.²
- LADWP plans to implement the most advanced technologies available to detect and address potential leaks as early as possible, and will consider leak detection and other safety factors throughout the design process while applying all applicable safety standards.
- According to the U.S. Department of Energy, hydrogen is non-toxic and non-poisonous. It will not contaminate groundwater, nor will a release of hydrogen contribute to atmospheric pollution.³

Is LADWP aware of the climate impacts of hydrogen leaks?

- While hydrogen itself is not a greenhouse gas and does not produce carbon emissions when used for power generation, we are aware of concerns that hydrogen leaks to the atmosphere may have indirect greenhouse gas effects.
- We are monitoring ongoing research and will work with our national research partners to better understand any potential climate impacts of hydrogen leaks and continue to take all available measures to prevent and protect against hydrogen leaks

Does green hydrogen produce NOx emissions?

- Green hydrogen combustion produces NOx emissions because nitrogen and oxygen in the air combine at high temperatures.
- LADWP currently uses the latest technologies to ensure we meet California's stringent air standards, and we are committed to continue meeting current NOx permit levels and all other South Coast Air Quality Management District (SCAQMD) permitting standards as we transition to green hydrogen. These are some of the strictest standards in the country.

² *Hydrogen leak detection – low cost distributed gas sensors*, Department of Energy, 2012.

³ *Safety, Codes, and Standards Fact Sheet*, Department of Energy, 2017.

- We anticipate there will be a 90% overall reduction of NOx emissions by 2035 since we expect to use green hydrogen much less than natural gas today, as we transition to higher levels of renewable energy and combustion turbines are either retired or run less frequently.

How does NOx produced by green hydrogen compare with natural gas NOx emissions?

- Although hydrogen burns at a hotter temperature than natural gas, which theoretically leads to higher NOx emissions, manufacturers are developing technologies with improved combustors and catalysts to minimize and eliminate these NOx impacts.⁴ In addition, as stated above, we expect a significant overall reduction of NOx and will comply with current NOx permit levels while using green hydrogen.

Will green hydrogen turbines also produce PM emissions?

- Particulate matter (PM) from combustion turbines are primarily a result from carryover of noncombustible trace constituents in fuel.
- We expect PM emissions to remain the same when moving to green hydrogen power.⁵ This may improve as technology advances.
- However, as with NOx, overall PM emissions will be reduced compared to the level of emissions from our generating units today, since the hydrogen-fueled units will operate much less frequently.

How much water is needed for producing green hydrogen and where will it come from?

- Electrolysis requires ~10 liters of water for every kilogram of green hydrogen produced.⁶ This is equivalent to 1.2 gallons of water per pound of hydrogen.
- Based on LA100 modeling, the water required for electrolysis is far below the water used today at the generating stations.
- Overall, the total water required for future green hydrogen generating units will be significantly less than the power-related consumption of water today.
- LADWP's goal is to utilize reclaimed or recycled water when available. We will not use sea water in this process.

Has LADWP considered using non-combustion hydrogen technology (i.e. fuel cells)?

- LADWP is studying the potential for fuel cell technology as an alternative since it does not use combustion processes and produces no emissions. At this point, the technology is cost prohibitive and less mature.
- Fuel cells have significant potential in the transportation sector, particularly for heavy-duty trucks.

What will green hydrogen cost? What is LADWP doing to make it more affordable?

- Right now, green hydrogen is cost-prohibitive and doesn't compete with natural gas. But at this point, we consider it a critical investment to achieve our goals for 100% clean energy.
- We are focused on making smart investments now, working with partners, and seeking state and federal dollars to carve out a path to affordable green hydrogen.

⁴ Based on turbine manufacturer responses to LADWP's green hydrogen RFI and subsequent discussions.

⁵ Ibid.

⁶ Based on electrolyzer manufacturer responses to LADWP's green hydrogen RFI.