Hydrogen Fuel Cell Locomotives

Hydrogen fuel cells are a type of zero emission technology that can be used for rail.

Pros

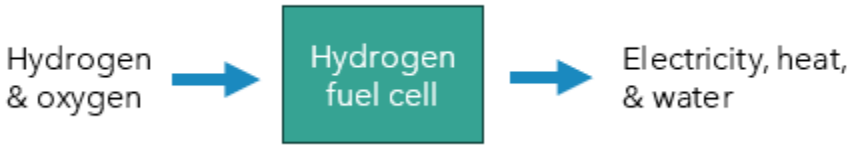
- Zero tailpipe emissions
- Short refueling time
- Can have long operational range
- Can be combined with other propulsion technology
- Rail track does not need to be upgraded

Cons

- Requires new infrastructure
- May need hydrogen tender cars to carry fuel
- Currently not powerful enough to be the only power source for line haul locomotives
- Hydrogen currently costs more than diesel

Hydrogen Fuel Cells

Figure 1. Hydrogen fuel cell diagram



Hydrogen fuel cells create electricity that can power a locomotive. Heat and water are the only byproducts of the process. To use hydrogen fuel cell locomotives, hydrogen fuel and refueling equipment is needed along a train's route.

In 2025, hydrogen fuel cell locomotives have a power output of up to 1.2 megawatts (MW). Diesel line haul locomotives are usually rated for 3.3 MW.[1] More powerful fuel cells will need to be developed for line haul locomotives to be powered by only hydrogen fuel cells. Switchers can be powered by current hydrogen fuel cell technology more easily. This is because switchers usually only need short bursts of power. Diesel switchers are rated at up

[1] California Air Resources Board, Initial Statement of Reasons, Appendix F, p. 37, September 2022. (Weblink: *https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/locomotive22/appf.pdf*).

to 1.7 MW.[2] Switchers may require less than 1.7 MW, depending on their specific operations.

Good Uses

- Places near hydrogen supply centers
- Long routes
- Switchers

Safety

Hydrogen fuel cell locomotives go through the same strict safety testing as any other locomotive. They can only operate on the national rail network after getting approved by the Federal Railroad Administration (FRA). FRA requires crashworthiness testing, daily inspections, yearly tests, and many more safety precautions.[3]

Resources

- *California Air Resources Board (CARB) Fuel Cell Activities*
- *CARB In-Use Locomotive Regulation Initial Statement of Reasons, Appendix F, September 2022*
- *CARB Zero Emission Rail Project Dashboard*
- *Caltrans, California State Rail Plan*
- *U.S. Department of Energy (DOE), An Action Plan for Rail Energy and Emissions Innovation, December 2024**
- *DOE, Hydrogen and Fuel Cell Technology Basics*
- *U.S. Department of Transportation, Framework for a Technology Innovation for Energy-Efficient Railyards (TIEER) Pilot Study, December 2024*

* Including this source does not mean the DOE or U.S. government endorses this document.

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[2] Code of Federal Regulations, Title 40, Chapter I, Subchapter U, section 1033.901. (Weblink: *https://www.ecfr.gov/current/title-40/chapter-I/subchapter-U/part-1033/subpart-J/section-1033.901*).

[3] Code of Federal Regulations, Title 49, Subtitle B, Chapter II, Part 229. (Weblink: *https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-229*).