



Q: What is overhead catenary?

A: “Overhead catenary system” (OCS) refers to a power system where trains connect to hanging overhead electric wires with a pantograph (check out our logo!). Catenary electric train are continuously connected to the power source and do not need refueling or recharging.

Q: What is the efficiency of overhead catenary?

A: **About 75% the energy from the electric power station reaches the wheels with overhead catenary rail**, compared to 56% for battery electric and only 20% for hydrogen fuel cells.

Q: What are the benefits of overhead catenary for passengers?

A: Electric motors have quicker acceleration than combustion engines, reducing travel time in and out of stations compared to diesel. They are also capable of higher speed travel than other modes. Together, this has the potential to decrease travel time and increase service frequency without increasing the number of locomotives or operators. For example, electrifying Caltrain alone shaved 25 minutes of travel time off of the slowest routes.

Q: What are the environmental benefits of overhead catenary?

A: Catenary trains are powered by overhead wires drawing power from the grid, meaning they emit zero greenhouse gases or ozone at point of source. California’s grid is currently around fifty percent carbon-free, and is mandated to grow to ninety percent by 2035. Electric trains also reduce particulate emissions from braking through the use of regenerative braking, and have steel wheels, unlike cars and trucks. Catenary trains are more energy efficient than other forms of zero-emission transport, including electric cars and trucks. Most importantly, catenary trains’ potential to improve rail service could induce mode shift and reduce the largest source of carbon dioxide emissions (cars and trucks).



...lead ultimately to a reduction in vehicle miles traveled (VMT), or distance traveled by cars and trucks. As of 2018, cars and trucks accounted for 40%, the largest single source, of carbon dioxide emissions in California, and this must cease to meet climate goals. Trains are more energy efficient than cars and trucks, and electric trains use less energy per passenger-mile while also reducing the need to mine environmentally-damaging minerals for batteries. Most climate models agree that substantially reducing VMT is necessary to stay under 1.5C of warming by 2050.

Q: What about hydrogen trains? Aren't they the future?

Hydrogen trains are currently in the nascent stage of development and have not been used in the United States prior to 2025, while overhead catenary is the global standard for rail. Hydrogen passenger trains have been tested in Germany and **found unsuitable due to cost and operations issues**. Hydrogen has low energy density by volume, reducing train capacity, and hydrogen trains do not currently exist for high speed (>100 mph) or freight applications. **99% of the hydrogen on today's market comes from fossil fuels**, and the alternative, electrolytic hydrogen, is produced from scarce water and could potentially increase fossil fuel consumption due to the low efficiency of the process. **High fuel costs remain a persistent issue for hydrogen**, discouraging frequent service. For a more detailed discussion of the downsides of hydrogen trains, see **our 2025 whitepaper**.

Q: What about battery trains?

Battery-alone trains have similar issues to hydrogen in terms of energy density, capacity, and charging time and are not recommended for anything other than low-speed, low-frequency uses such as switchers in rail yards. Battery-hybrid passenger trains with in-motion charging that can operate both on and off overhead wires are a good option for the transition to catenary while we build out the wire network.

Q: What's wrong with the diesel trains we have now?

Diesel trains are slower and more expensive to maintain than electric trains. While rail is more efficient and less polluting than cars or trucks, diesel trains still emit greenhouse gases like carbon dioxide, which must be eliminated to avoid catastrophic global warming. Diesel trains also emit ozone and particulate matter into the atmosphere, resulting in elevated risks of **cancer** and **asthma** in railyard-adjacent communities.

Q: Does electric rail work for freight trains?



freight.

Q: Doesn't overhead catenary require a lot of infrastructure?

A: Electrifying our rail lines will certainly require infrastructure investment to put up the wires to power the trains, which has the potential to create many green, union jobs. However, alternatives battery and hydrogen trains also require extensive infrastructure to support. Unlike overhead catenary, battery and hydrogen require charging/refueling infrastructure that require land to store non-operational trains while being charged or refueled. Battery electric train charging stations are often similar to or compatible with overhead catenary, also requiring overhead wires. Hydrogen storage, transportation, and refueling requires additional, highly specialized infrastructure to ensure safety due to its extreme flammability, propensity to leaks, and steel embrittlement.

Q: Is overhead catenary expensive?

A: While catenary will require upfront investment, it promises long term savings. Overhead catenary has a reputation for being expensive, due to the high cost of Caltrain's electrification project, which had a total cost \$47 million per mile. But for catenary alone, Caltrain's cost was \$12 million/mile, the rest of the costs being due to a bespoke signaling system and other unrelated upgrades. **However, other countries like Denmark, Israel, and New Zealand have recently electrified for only \$2-4.5 million, and procurement and permit reforms advocated by Californians for Electric Rail can bring upfront capital costs to similar levels. Additionally, catenary trains have half the lifetime maintenance costs compared to diesel and lower fuel costs, while hydrogen trains have higher long term costs compared to catenary trains.**

Q: Why aren't electric trains more common in the US?

A: 1) Freight railroads, which own much of the rail ROW in the United States, have tended to oppose overhead wires for passenger rail on their tracks. Freight carriers claim falsely that overhead wires interfere with double-stack diesel trains, and have been reluctant to invest in electrifying their own fleets.

2) Transit infrastructure in the United States costs **3x more to build than the global average**, with low-cost countries like Spain and South Korea significantly ahead of the US on rail electrification. This makes ambitious, infrastructure-heavy programs like rail electrification challenging. High costs are



Q: What is the In-Use Locomotive Rule?

A: It is a regulation passed by the California Air Resources Board in April 2023 that requires all newly purchased trains to operate in zero-emissions mode starting in 2030 for switcher and passenger rail and 2035 for freight line-haul locomotives. It also requires older locomotives to receive emissions-reducing upgrades and for the entire fleet to be zero-emissions by 2047. This ruling is technology neutral and does not discriminate between catenary, battery-electric, or hydrogen trains. Rail industry groups filed a lawsuit against the ruling in June 2023, and the regulation was officially withdrawn in 2025.

Q: What about the visual impacts of overhead electrification?

Local opposition to the aesthetics of overhead wires caused delays for Caltrain electrification, and has been a factor in keeping wires off of other projects. However, the AB 2503 CEQA exemption for electric rail allows agencies to avoid aesthetic lawsuits, while our proposed governance reforms would allow agencies to focus on service over hyper-local concerns. Additionally, many environmental groups, including the Sierra Club, Earthjustice, and their local environmental justice allies support overhead electrification. Diesel pollution kills 1,400 Californians annually, while visual impacts are subjective and arbitrary. The benefits of electrification far outweigh perceived aesthetic or political costs.

To learn more, check out [our op-ed in Streetsblog California](#) or visit the [Documents page](#).

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